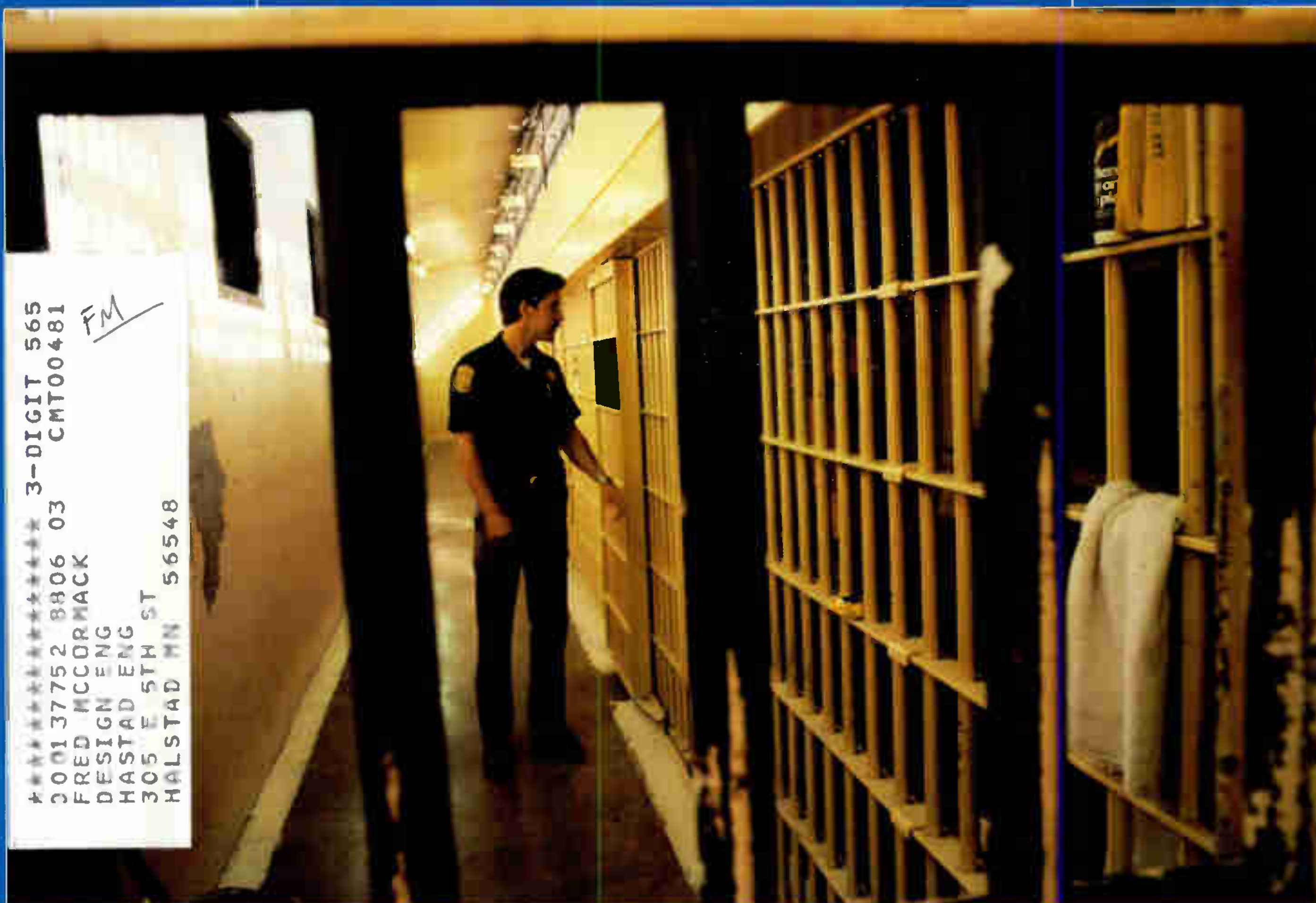
COMMUNICATIONS TECHNOLOGY

Official trade journal of the Society of Cable Television Engineers



Maximum security from signal theft

Fifth Anniversary Issue

Five years in the making

March 1989

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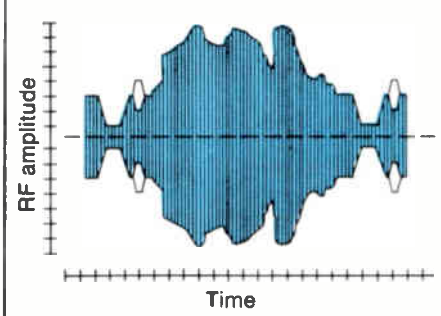

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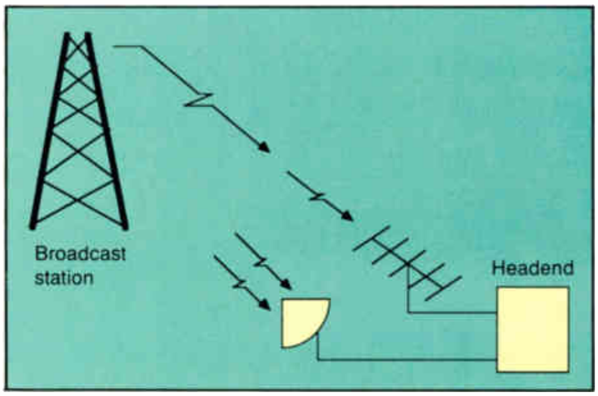

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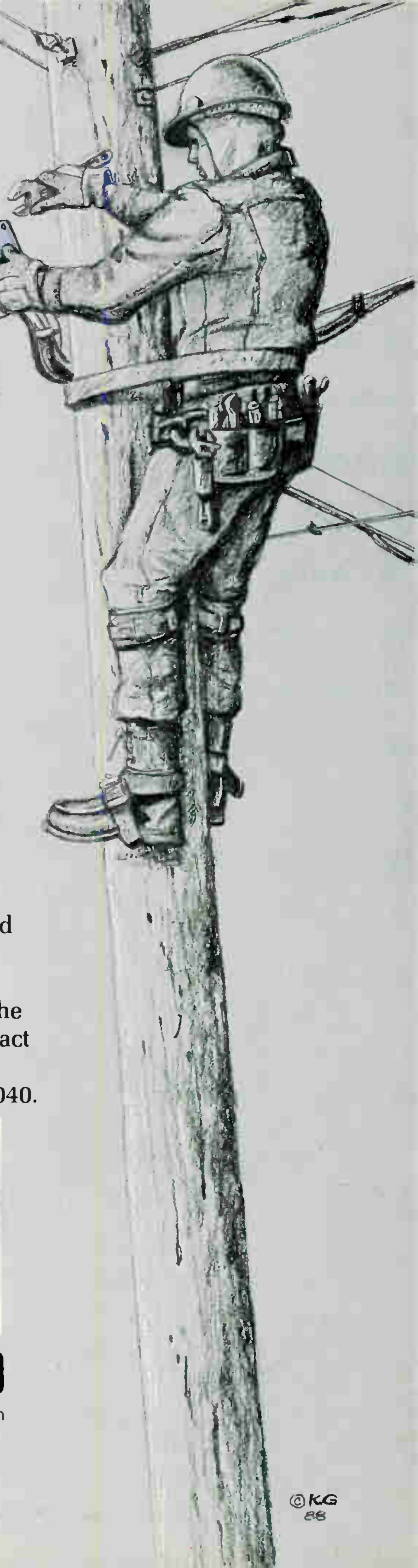

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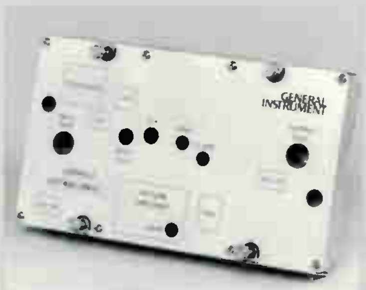

GENERAL INSTRUMENT

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Reader Service Number 4.

SCTE board members relaxing during the 1984 Cable-Tec Expo in Nashville are: John Warner, Bob Vogel, Dick Kreeger, John Kurpinski, Sally Kinsman, Tom Polis, Jim Emerson and Richard Covell.

Reminiscences

Welcome to *CT*'s fifth anniversary. Those of you who remember our first issue might also recall the excitement in the industry when we launched this new project. As I wrote in my March 1984 letter, "We felt it was time the engineering community had a high quality, high tech publication that presents relevant information on a consistent basis." And for the past five years, it has been our goal—and our pleasure.

However, when we started Communications Technology (the company, not the magazine) in January 1984, we were operating under a few assumptions. First, there was the need for a highly professional, hands-on publication for the industry; we filled that void. Toni Barnett, who was present at the "creation," recalls: "Five years ago, *Communications Technology* was launched (with the assistance of well-known advisors) to provide the industry with practical information. It originated as an educational tool for engineers. Five years later, that is still our intent—to assist technical personnel in their daily operations.

"When new technologies were developed, we made the industry aware of these issues. Once these technologies became practical, we were there to show how they worked. Our friends in the engineering community have kept the faith and propelled us into new horizons and higher goals. Plus the assistance and close working relationship with the Society of Cable Television Engineers have made this experience rewarding for us as well as for the entire technical community."

The second thing we knew back then was that we had to fight for a position in the industry. We sought and gained an alliance with the SCTE, led by the strong personalities of Tom Polis, Sally Kinsman, Richard Covell, Andy Devereaux, Jim Emerson, Dick Kreeger, Bob Vogel, Mike Cowley, Gerald Marnell, Glyndell Moore, John Warner and Roger Barth. These board members and the other 2,000+ in the Society immediately contributed a strength to *CT* that has grown and prospered to this day.

Third and finally, we hoped to survive as a magazine; it was indeed a gamble. (My first desk was my grandfather's poker table.) Starting the company with me were Toni as vice president of editorial, Wayne Lasley as managing editor and Sharon Lasley as art director (and, by the way, they're still here). To no surprise, we did survive and have succeeded beyond our expectations.

CT Publications continues to evolve and grow with new publications and projects. The first offshoot of *CT* was *Cable Strategies*, designed to give practical information for marketing and operations personnel. Last year we launched *Installer/Technician* (the result of our purchase of *CATJ* and *CableTech* magazines), which features hands-on training tips for technical people in the field. Also, the *CT Daily* is the only engineering and technical daily at major shows. Our information card packs provide the latest in technology and services from industry manufacturers and distributors.

The direction of each of these projects is the same—to assist in the continuing education of CATV personnel on all levels. And perhaps we've actually had an impact in helping the industry operate in a more profitable way.

Like a marriage

Throughout the past five years, we've immensely enjoyed our relationship with the SCTE. And in many ways, it's been almost like a marriage—a happy one. As the Society's official trade journal, *CT* provides SCTE members with information about the organization. Also, in our very first issue and each one thereafter, we have published the Society's official newsletter, *The Interval*. In addition, we published the past two editions of the *SCTE Membership Directory and Yearbook*. Togetherness has been a boon for both of us.

The Society will celebrate its 20th anniversary in June at the Cable-Tec Expo, one of the most valuable annual events for the engineering community. We are proud to have been an important participant of the SCTE's past five years. And we intend to play an even greater role in the growth of the Society and the CATV industry in the next five years and beyond.

COMMUNICATIONS TECHNOLOGY

Official trade journal of the Society of Cable Television Engineers

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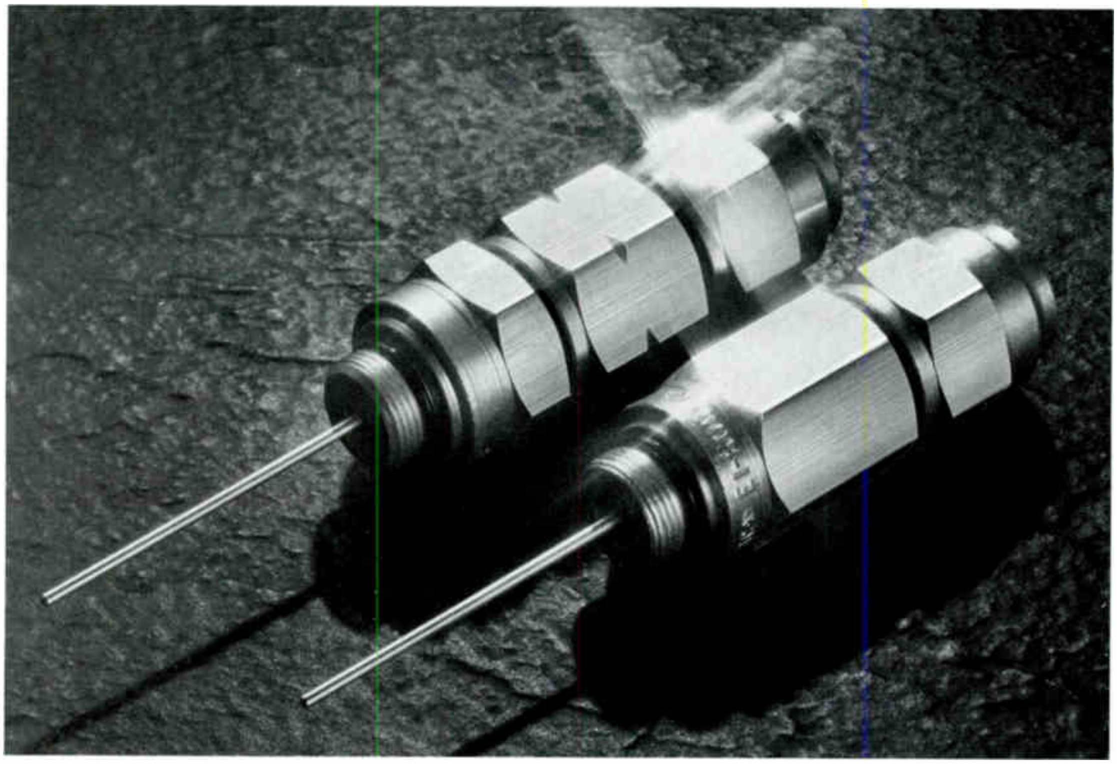

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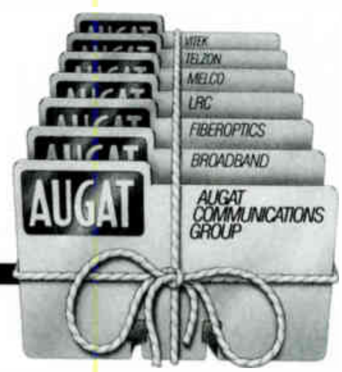


Reader Service Number 10.

SCTE sells out expo exhibit space

EXTON, Pa.—The Society of Cable Television Engineers recently announced that there is no remaining exhibit space available for the 1989 Cable-Tec Expo. This annual conference and trade show will be held June 15-18 at the Orange County Convention Center in Orlando, Fla. Over 100 companies have already rented the exhibit floor to display all types of products, services and equipment and present live technical demonstrations of their products.

According to Bill Riker, SCTE executive vice president, this is the third consecutive year that the floor has sold out, but it has not done so as quickly as it has this year. Companies wishing to exhibit at the expo can contact SCTE national headquarters at (215) 363-6888 to be placed on a waiting list and contacted in the event of an exhibitor cancellation.

Jones, Anixter sign FO rebuild contract

ENGLEWOOD, Colo.—Jones Intercable last month signed a $3 million contract with Anixter Cable TV to supply Jones with fiber-optic products as part of the MSO's $15 million rebuild in Augusta, Ga. The Augusta system is expected to be a modification of the Jones "cable area network" (CAN) fiber design now being built in Broward County, Fla.

According to Bob Luff, Jones group vice president of technology, the CAN design, a hybrid fiber/coax architecture, significantly reduces the number of trunk amplifiers in the cascade; in Augusta, the cascade will be between five and 16. The design also employs signal and path redundancy on all AM fiber paths, while FM paths will be protected by a ring fiber route diversity architecture scheme planned for 1990.

Among the equipment being sold to Jones are six Synchronous Communications FM laser transmitters with 32 optical receivers, 20 Anixter AM LaserLinks, 1,200 miles of AT&T fiber-optic cable, and all related apparatus and accessories. Deliveries are expected to be completed by July. Anixter also will provide technical support services required for combining the AM and FM laser technologies with on-site engineering assistance and corporate product management functions.

Texscan agrees to sell Instruments Division

SCOTTSDALE, Ariz.—Texscan Corp. recently reached an agreement in principle to sell its Instruments Division to a group led by Indiana-based Trilithic Inc. The sale of the Instruments Division, headquartered in Indianapolis, is subject to definitive agreement. The Trilithic group will purchase the inventory, machinery and equipment, and patents and designs held by the Instruments Division.

In another transaction, Texscan will sell the land and building currently housing the Instruments Division to Maytag Corp. This sale is expected to be completed by May.

TFC to enter Canadian market

WALLINGFORD, Conn.—Times Fiber Communications announced an agreement to purchase the cable products unit of Amphenol Canada. Times-Amphenol Canada Ltd., the new subsidiary created to serve the Canadian market, will manufacture drop cable products using Times Fiber manufacturing technology. RG-59 and RG-6 cables will be offered in a variety of construction configurations.

Times-Amphenol manufacturing facilities are located in Renfrew, Ontario, while sales offices are in Scarborough, Ontario.

● The Drop Shop Ltd. signed an agreement to become a master distributor of Indiana Pressed Steel Co.'s complete line of CATV pedestals and accessories. These products are now in stock at Drop Shop's facilities in Hayward, Calif., and will become available at the Union, N.J., and the soon-to-be-opened New Orleans locations.

● CADCO Inc. recently relocated its corporate and manufacturing facility to 2405 S. Shiloh Rd., Garland, Texas 75041. Its phone numbers, (800) 877-2288 and (214) 271-3651, remain the same.

● AM Communications announced sales up $604,000 or 27 percent for the third quarter ended Dec. 29, 1988, over the same period last year, with a net income of $65,000 compared to a loss of $1.41 million for last year's third quarter.

● Telecrafter Corp. reported earnings of $492,000 or 7 cents per share, an increase of 66 percent, for the first quarter of fiscal 1989 ended Dec. 2, 1988. Net sales were $6.84 million, up 29 percent from last year's first quarter.

● Recently a delegation from China's Ministry of Post and Telecommunications visited the Siecor facilities in Hickory, N.C., to train on fiber-optic products purchased from the company. This was the first purchase of U.S. fiber products by the Chinese. It consisted of over 200 miles of cable for an intercity trunk installation for the Huangshi section of the Nanjing-Wuhan-Chongqin Optical Fiber Telecommunications project, as well as splice closures, splice trays, fusion splicers, tool kits and test equipment.

● Scientific-Atlanta reported its net earnings for the second quarter ended December 1988 were $9.2 million, an increase of 16 percent over the same quarter last year. Earnings per share were 38 cents, a 15 percent increase over last year's second quarter.

CATV networks of the future

By Gary Kim
Special Correspondent

Although it has largely been obscured by the current hoopla over fiber optics, a deeper and possibly more important re-examination of network topology is taking place throughout the CATV industry as:

- new backbone architectures are adopted,
- cascades are sliced,
- new forms of network redundancy are created,
- potential bandwidth expands to 1 GHz,
- signal levels are boosted and
- new distortion and noise tradeoffs are considered.

To say that topologies are being re-examined is not to say that the trusty tree-and-branch (T/B) architecture used by the U.S. CATV industry for all these years is about to be abandoned. Unless the industry makes a dramatic near-term bid for non-entertainment or video-on-demand services, T/B is likely to remain the dominant trunk and feeder topology. But backbone topologies will be another story.

The industry has for many years used a point-to-multipoint headend/hub architecture that, strictly speaking, is a star. What's likely is the grafting of star-type (hub/microhub) or bus-type (parallel fiber runs overlaid on short coaxial cascades) backbones that use traditional T/B distribution to subscriber homes.

Several forces are driving the current experimentation with architectures. As consumer electronics devices have gotten better, NTSC picture artifacts caused by long cascades have become more noticeable. And with improved definition and high-definition TV on the horizon, the situation looks to worsen unless the industry can boost delivered picture quality.

At the same time, consumer complaints about reliability have begun to register, and long cascades are a major—but not exclusive—cause of signal outages. Expect more emphasis on status monitoring, intelligent A/B switches and redundancy in plant design as MSOs move to position their networks for heightened competition.

Tomorrow's concerns

A longer-range—but important—concern is the type of network that might be required in the future should the CATV industry decide it wishes to be in the video-on-demand or larger telecommunications markets. Although it may seem far-fetched today, the day may come when the industry wishes to employ switching of various kinds on its networks. Should that day come, the new architectures now being put into place will allow a much easier migration to a new network topology incorporating switching, redundancy, service level metering and control.

Most observers give very short shrift to architectural proposals that break sharply with T/B designs. Nevertheless, work continues on systems that augment the existing operator investment in coaxial plant and can be described as:

- fiber to the home
- fiber to the curb
- fiber to the bridger
- fiber to the tap

These systems are not likely to be cost-competitive with coaxial T/B systems in the next few years. But they will be positioned to extend fiber optics deeper into CATV systems as market forces and business strategy dictate. Most of the systems use a star or double-star topology, although at least two companies are experimenting with bus architectures.

Although the U.S. CATV industry has flirted briefly with star architectures in the past—Times Fiber's Mini-Hub being the most salient example—it has remained fairly happily married to T/B architecture. And for good reason: T/B simply is the most economical method for one-way, wireline distribution of multichannel video programming.

A T/B network concentrates the most expensive electronics at the headend and hubs, distributing the cost of those devices over the entire subscriber base. Coupling and connectorization issues are well-understood while signal splitting and amplification are inexpensive. T/B avoids expensive signal switching, although signal denial or signal permissive techniques such as trapping, addressability and scrambling might be thought of as a sort of low-cost switching.

T/B networks using coax have well-understood limitations, with noise and distortion among them. Coax is a lossy medium and amplifiers add increasing amounts of noise as cascades build to 35 or 40 trunk stations. Those long, serially linked cascades also add reliability problems when stations upstream malfunction. The subscriber and feeder networks, on the other hand, add most of the system distortion. It isn't just the higher signal levels typically run on the portions of the network from the bridger to the house. Most of the passive devices—and therefore most of the impedance mismatching effects—are found in the subscriber network.

This hasn't been an unmanageable problem to date because NTSC won't display many of the artifacts generated by microreflections. But HDTV will show them. So, despite T/B's many advantages, attention recently has turned to possible alternatives as fiber transmission costs have sunk while competitive threats and demands for higher signal quality standards have risen.

Historically, the key wireline architecture that has stood as an alternative to T/B using coaxial cable is the telcos' switched-star network. But switched-star architectures capable of supporting video cost so much more than T/B coaxial networks that the debate was largely academic. Consider drop cable runs. The CATV industry uses drops of 150 feet or less. Telcos routinely run drops of 4,300 feet.

> *"Telco-delivered video to the home necessarily requires massive rewiring of the local loop plant."*

Consider wiring. Despite recent advancements in compression technology, twisted pair simply cannot support bandwidths sufficient to carry video, even when compressed. Bell Communications Research (Bellcore), the regional Bell Operating Company (RBOC) equivalent of AT&T's Bell Laboratories, recently demonstrated compression techniques that reportedly reduce an NTSC signal to a 45 Mbps (megabits per second) bit stream. Bellcore also says it can run baseband MUSE at 130 to 140 Mbps. Even so, coaxial or fiber-optic cabling must be used to transport the bit stream. So telco-delivered video to the home necessarily requires massive rewiring of the local loop plant.

Consider electronics. Telco-delivered video using a switched-star topology necessarily requires that each house support two transmitters and two receivers with attendant electro-optical conversion circuits. It's a lot like putting an off-premise, 100 percent scrambled system into each house. It's very consumer-unfriendly and inflexible as well.

And then there's the switching. A matrix switch capable of handling video, voice and data with the sort of on-demand capabilities telcos tout simply isn't available today at any reasonable price. More limited hybrid systems that restrict switching to voice and data circuits while using a traditional analog bus-type transmission system are available on a test bed basis. Full digital switching remains out of reach.

What's ahead

So don't look for revolutionary upheavals in CATV topology. T/B will be the design of choice for trunk and feeder plant. *Do* look for significant and strategic investments by leading MSOs in new plant designs that provide greater reliability and signal quality today while providing far more flexible migration paths tomorrow if—and when—video-on-demand or other switched services are economically important to the industry.

Those changes in topology will be assisted by the growing integration of optical fiber into CATV plant, new 1 GHz RF technology platforms, improved passives and taps, coaxial cable certified to 1 GHz, new thinking on the benefits of network redundancy and a dramatically heightened industry sensitivity to the need for well-maintained plant.

Should the FCC regulate scrambling?

By Isaac S. Blonder
Chairman, Blonder-Tongue Laboratories Inc.

On Sept. 1, 1988, the Federal Communications Commission announced fundamental policies and defined boundaries for the development of advanced television. Thus, the FCC has once again seized the bit and declared its pre-eminent authority over the TV world and emerging technologies. Indeed, there was even an oblique reference to the need for a common scrambling system in the interest of lowering the cost of premium programming to the public.

What powers have been draped over the commissioners' shoulders in the original act by Congress in 1927? Have they adhered tightly to the dictates of Congress, conceived in the innocent days of the '20s, or have they broadened their charge to include technologies not dreamed of in those electronless halls of Congress? If these questions were answered by an FCC-oriented firm of attorneys, a thick volume would emerge, full of truth and experience but not necessarily indicative of the future policies emanating from 1919 M St. New techologies, the vagaries of Congress and the sporadic indecisiveness of the commission will surely obfuscate the prophetic mirror.

In order to predict the next ruling, as a layman and a long-time thrall to the FCC rules, I tend to look at the original charge by Congress and how the FCC has responded to problems as they have appeared.

General interest of the public

The commission was formed to regulate the use of radio waves in the general interest of the public, at first to assign frequencies for communications with ships at sea, followed by assignments for AM radios and military and amateur activities. Generally, the FCC does not research uses for the radio wave spectrum but acts as a judge and moderator as the inventors and entrepreneurs appear with new systems to improve the services to society through the medium of radio waves.

As an example in which I was personally involved, UHF broadcasting in the '50s was pockmarked with bankruptcies and unused assignments because of the lack of viewers able to tune in UHF stations. My company prospered from manufacturing UHF converters to enable the public to receive the UHF stations on their VHF TV, but the UHF broadcasters could not achieve a market share sufficient to pay their bills.

Courageous Commissioner Bob Lee stepped into the maelstrom with the formation of the Committee for All Channel Broadcasting in 1959, which I joined. For seven years it studied every aspect of the UHF problem from transmitters to receiving antennas. Our best remedy was to eliminate the VHF frequencies; intelligent, adopted abroad, but too late in the game to succeed. The only out was a dictatorial solution—every new TV had to possess a UHF tuner after May 1964. Subsequently, every television sold in the United States, even for other delivery systems than broadcast (satellite, VCR, cable) has carried a UHF tuner, needed or not.

Having experienced the UHF fiasco, the FCC is understandably vigilant on the approach to the new monster—high-definition TV. Thus, the call for a single HDTV system and the desire to confine the bandwidth to 6 MHz. Otherwise, the UHF disease could cripple the broadcasting system, perhaps enough to force our citizens (certainly the low-income sector) to lose even the currently available programming as broadcast stations collapse from lack of advertiser income. Yet, if the FCC demands are met, the promise of HDTV may never materialize and the United States will fall further behind in the international contest for HDTV design and production.

Other immovable problems face the irresistible forces of the FCC: pay-per-view, copyright, exclusive deliveries for profit in sports and other publicly supervised programs. A subset to these dilemmas are the scrambling technologies needed to exclude the non-subscriber. There are four arenas in which scrambling is required: VCR, satellite, broadcast (including MDS) and cable.

"Perhaps the most lucrative field for the inventor is a means of preventing tape copying."

Perhaps the most lucrative field for the inventor is a means of preventing tape copying. Presently, the obstacles to copy protection seem insurmountable; about all that I see coming is unique, unerasable identification for each tape to enable tracing the pirate to his lair.

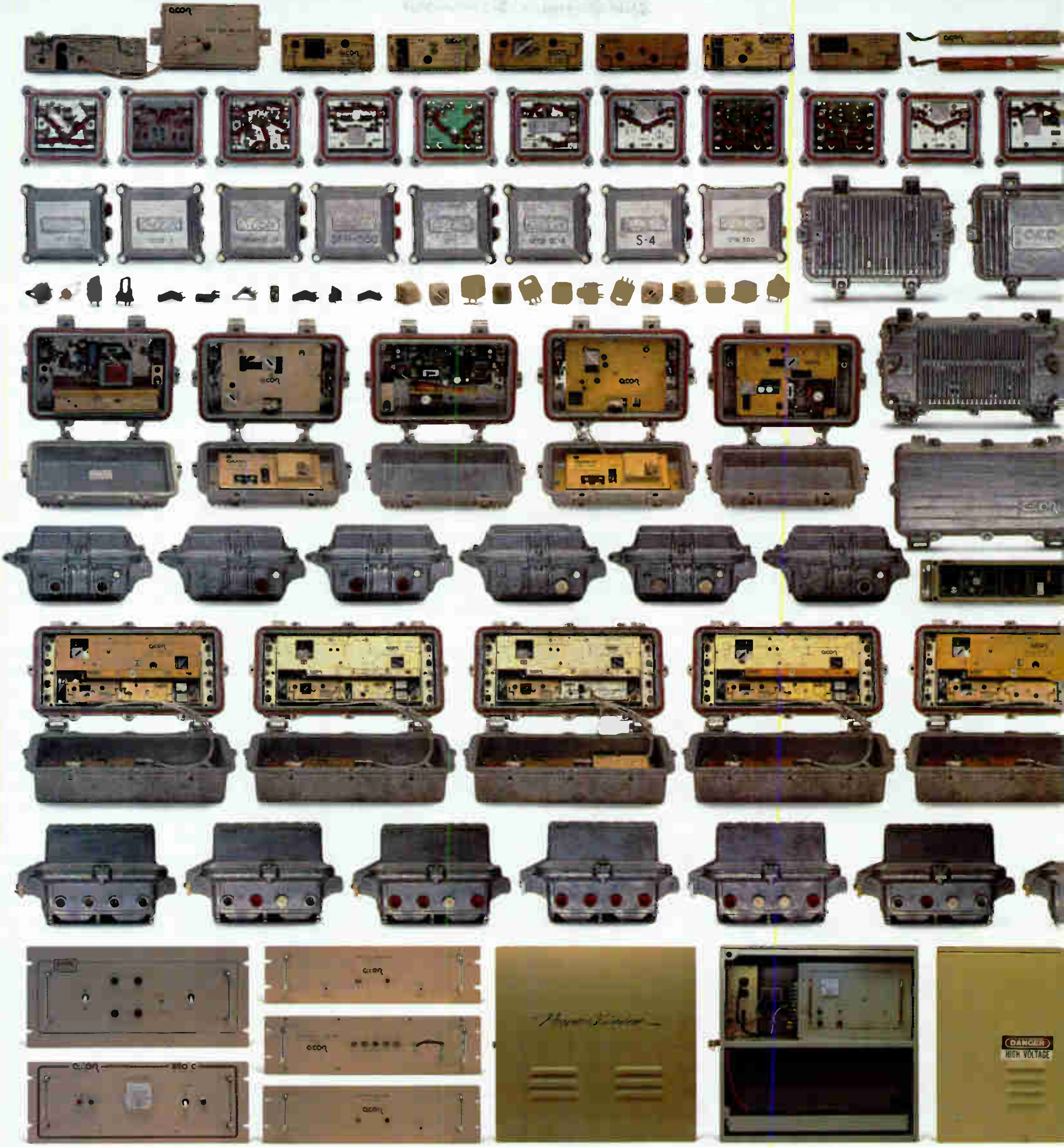
Satellite transmissions of entertainment, although delivered on frequencies assigned by the FCC to common carriers, should not be subject to any regulations at all, as is presently the case for all common carriers. The programmer should be able to scramble in any method and employ any HDTV system.

Broadcast is extremely vulnerable at this stage in the inquiry. If the FCC approves an HDTV system that is not only incompatible but requires spectrum space beyond availability, the demise of broadcasting will be slow-but sure. The other lethal blow to the plexus is the ever changing scene in scrambling technology. It is extremely doubtful that any system of broadcast scrambling can be theft-proof; witness VideoCipher II.

I would recommend that the FCC appoint yet one more blue ribbon committee to design a single cost-effective scrambling method. There is no need to make it more secure than the ability to deny enjoyment of the program with commercially available receivers. An appropriate federal law to punish the pirates will catch the professional criminals and the overall cost should be far less than designing and installing a new technique every few years. The committee should find it simple to come up with a satisfactory system from expired patents.

Cable will eventually be rid of in-house descramblers. As an interim system, the off-premise addressable trap is simple and comparatively theft-proof. But ultimately the large systems will be fiber fed to the home with innumerable program choices on a telephone-style billing system. The smaller systems will remain stand-alone, satellite-fed SMATV entities as the lowest cost option.

However, to preserve broadcasting, the FCC will probably mandate that the HDTV receiver will be a standardized instrument usable for both broadcasting and cable. DBS will be left free to find its own destiny.



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Reader Service Number 13.

Unauthorized reception of cable services

By Andrea C. Sheys
Assistant Director, Office of Cable Signal Theft
National Cable Television Association

Theft-of-service is a serious problem for the industry. According to estimates by the National Cable Television Association, unauthorized reception costs result in losses of over $1.4 billion annually. Over $250 million of this loss is attributable to the sale of illegal decoders.

All active forms of unauthorized reception are expressly prohibited by the Cable Communications Policy Act of 1984. Section 605 of the 1934 Communications Act also has been judicially expanded to cover unauthorized reception and decoder trafficking. The manufacture, sale and distribution of illegal decoders also constitutes violation of the federal prohibition of the possession, production, trafficking and use of counterfeit access devices as well as federal copyright laws. Moreover, where the U.S. mails and interstate wires are used to execute a scheme to manufacture and distribute illegal decoders, violations of the wire and mail fraud statutes may be alleged.

The cable industry has actively engaged in programs to combat unauthorized reception. Numerous cable systems and associations have formed anti-piracy task forces. The NCTA's Office of Cable Signal Theft (OCST) was formed in 1986 to serve as a clearinghouse of information on ways to improve signal security. OCST is advised by the Coalition Opposing Signal Theft (COST), a 24-member board of executives representing system operators, programmers, manufacturers and motion picture studios from across the country.

This article summarizes the nature and effects of the unauthorized reception problem, the way decoder pirates operate and the legal actions that federal authorities have recently taken toward pirates.

"With piracy increasing in scope and effect, the industry must seek new ways to remedy the problem."

Nature of the problem

In order to fully understand the nature of theft-of-service, it is important to break down the problem into its component parts. Unauthorized reception can be classified in two categories: passive and active. Active theft (piracy) can be further subdivided into consumer and commercial subclassifications.

Passive unauthorized reception takes the form of reception by consumers of basic and premium service that results from errors in internal cable operator procedures. In this sense, the consumers really are not taking action to violate any laws. Rather, they simply are viewing what the system has erroneously made available to them. The two most common instances of passive unauthorized viewership arise from improper disconnect procedures and the failure to properly enter work orders.

Active theft can occur at the consumer and commercial levels. Consumer piracy occurs where individuals knowingly and willfully make illegal physical connections to the system or tamper with reception equipment in order to bypass system security. Such actions enable the consumer to intercept or receive services without payment.

At the commercial level, piracy includes unauthorized reception as well as the manufacture and distribution of illegal decoder devices. This occurs in the same manner as individual consumer unauthorized reception with a physical connection to the system or the use of an illegal or tampered reception device. Because the reception of programming is in a commercial establishment, it results in financial gain to the proprietor. The typical violation here occurs in bars and hotels.

There exists another class of active commercial pirates: those involved in the manufacture, sale and distribution of equipment that is intended to defraud operators and programmers of subscription fees. These decoder pirates, in many cases, facilitate the commission of active consumer and commercial theft-of-service by providing the illegal decoder.

One well-known and important case involving piracy is the recent federal case *U.S. v. Kaufmann*. Arthur Brett Kaufmann of Livingston, N.J., was sentenced in U.S. District Court to three years in prison and ordered to pay $1.3 million in restitution to cable companies victimized by his operation. Kaufmann is believed to have been the largest supplier of illegal decoders and descramblers in the United States, defrauding program suppliers of over $5 million during a 3½-year period. It is the first time cable companies were awarded restitution from a pirate, setting an important precedent for future cases. The Kaufmann case also exemplifies how federal authorities have increased involvement to deter signal theft.

Magnitude of the problem

Six years ago, Showtime/The Movie Channel conducted research into the causes and effects of unauthorized reception of services. It found that, on a national basis, unauthorized reception cost the industry nearly $897 million in 1983[1]. The study also concluded that 47 percent of the prob-

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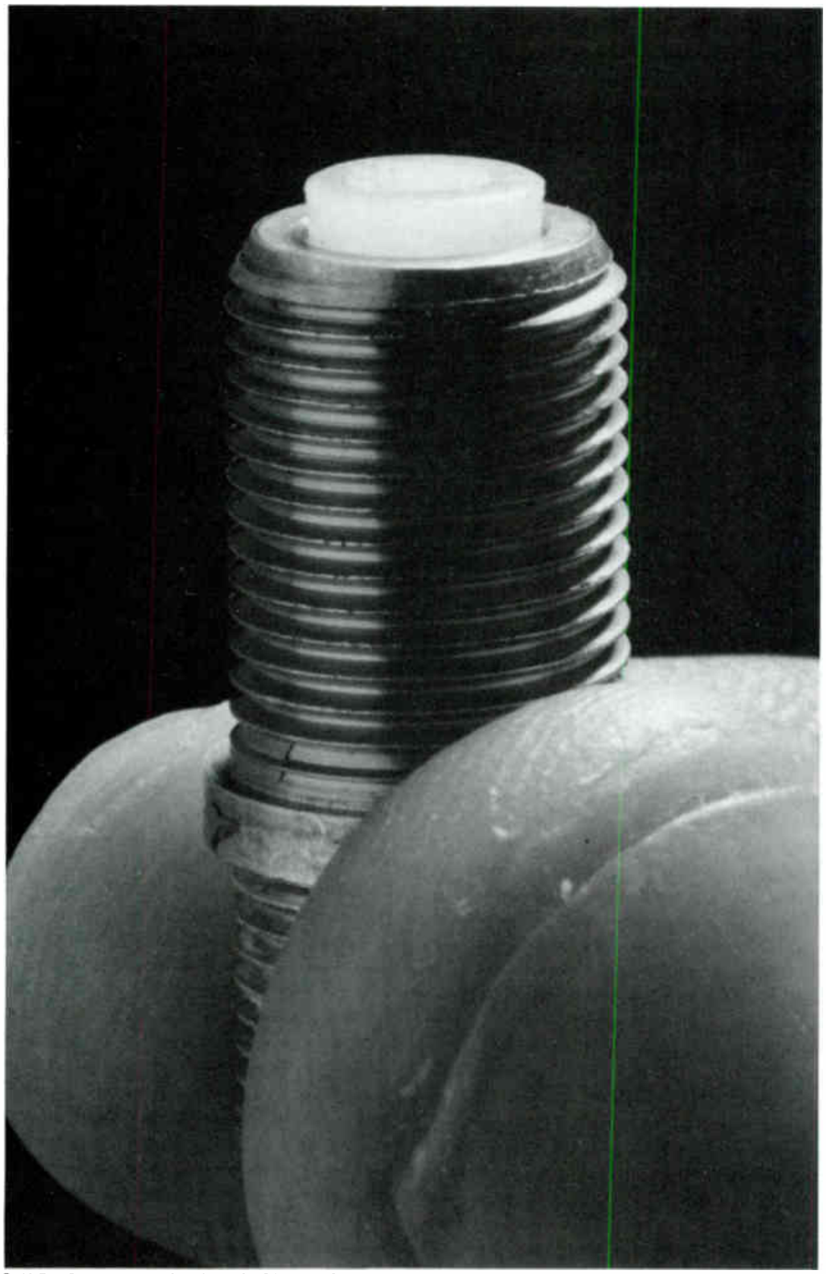

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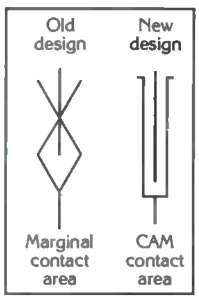

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lem was attributable to passive problems resulting from cable operator error. The remaining 53 percent was the direct result of active piracy. Of the total problem, approximately 18 percent was attributable to organized illegal decoder operations.

In 1986, OCST revisited the Showtime research. Based on the cable marketplace in 1986, OCST found that approximately $1.4 billion is lost to the industry because of theft-of-service. Based on Showtime's finding that 18 percent of all revenue loss may be attributable to illegal decoder distribution rings, it is estimated that in excess of $250 million is lost annually to the industry as a result of these pirates' plundering.

Furthermore, the NCTA has been able to estimate the potential revenue loss to the industry every time an illegal decoder is sold in the consumer marketplace. Each illegal decoder sold costs the industry approximately $2,755 over that decoder's seven-year useful life. We arrived at this figure by developing the following formula:

Average lost revenue per decoder = average pay rate per month × average number of pay services in each system × 12 months × 7 years

The average pay rate per month is $9.94[2]. The average number of pay services per cable system is 3.3. (This figure was arrived at by taking a random sample of approximately 10 percent of the more than 7,000 cable systems around the country[3].) The figure of seven years, the average useful life of a decoder, was established by the NCTA's Office of Science and Technology. The estimate is most likely a conservative one since the advances in decoder technology are resulting in more durable devices.

How decoder pirates operate

Many decoder pirates operate in a questionable fashion. They often cloak their illicit endeavors under a legitimate business front, conceal the true location of the operations and generally conduct their decoder businesses in a suspicious manner that is indicative of culpable activity. Here are several "tricks of the trade" used by decoder pirates:

1) Formation of "shell" companies
2) Use of multiple fictitious names and addresses located in different states
3) Use of post office boxes in order to make personal service more difficult
4) Use of call forwarding techniques aimed at cloaking their identity and location of actual operation
5) Establishment of a mail order business advertising in many industry publications as well as "underground" publications stating that plain converters are for sale yet implying that illegal descramblers are also available
6) Use of written disclaimers denying any intention to break the law yet stating in sales pitches that use of their products facilitates reception of cable services without payment
7) Drop shipping and receiving for purposes of covering the true location and identity of their operation
8) Physically locate and/or obtain a post office box in one state and advertise in another state for the sole purpose of eluding state theft-of-service statutes
9) Non-payment of local, state and federal taxes

Effects of theft

Theft activities also have the effect of eroding investor confidence in the industry[4]. Investors establish the market value of a cable system by multiplying the number of paying subscribers times a factor of an average of $1,600 per sub[5]. Assuming that 20 percent of the unauthorized viewers who have purchased "black boxes" could be converted to paying status once detected, this represents approximately a $3 billion loss in equity value to the industry.

But the effects of illegal decoder sales and other forms of piracy are felt beyond the bottom line of the industry. In systems where the sale of illegal decoders flourishes, the lost cash flow reduces the cable system operator's ability to maintain a high level of service quality. It also impacts the system's ability to reinvest proceeds in the development of programming.

Further, the proliferation of unauthorized devices can damage the technical integrity of the system. The problems manifest themselves in noise, lessening the quality of the cable service for those customers who are legitimately paying for it. It also results in egress, signal leakage that can interfere with Federal Aviation Administration and other radio frequencies used by the public.

Beyond the direct economic injury suffered by the industry, the sale of decoders translates into lost dollars for states and their political subdivisions that often tax cable systems based on gross revenues. The consumer who purchases an illegal decoder also is defrauded of the money used for the purchase. In many instances, the defrauded consumer is unaware that the purchase and use of such an unauthorized device can subject one to criminal or civil liability under both state and federal laws.

The remedies

With piracy increasing in scope and effect, the industry must seek new ways to remedy the problem. Many cable companies have launched amnesty campaigns, continually auditing the plant and tightening internal control procedures at system offices. But at least $250 million is lost to the industry annually as the result of pirates operating for profit. This form of commercial piracy is beyond the cable companies' direct control, and tightening internal procedures simply will not remedy the entire problem.

So the industry must seek relief from law enforcement agencies and the courts to redress the pernicious effects of piracy and to deter future unlawful conduct by pirates. As stated before, federal agencies including the Department of Justice, FBI, Secret Service and customs have recently increased attention to the problem. A number of laws are on the books in various states that specifically enable authorities to prosecute pirates and allow injured parties recourse to recover damages. Numerous investigations are under way, and it is hoped that theft-of-service will decrease as the courts increase their severity toward pirates.

References

[1]Showtime/The Movie Channel research, used with permission.
[2]Paul Kagan Associates Inc., *The Pay TV Newsletter*, Oct. 14, 1988.
[3]The source for the raw data used in this research was *The Kagan Census of Cable and Pay TV*, Dec. 31, 1986, which lists all of the cable systems in the country and the pay services offered by each system.
[4]Showtime/The Movie Channel research.
[5]Paul Kagan Associates Inc. estimates that the average price per subscriber was $1,594. *Cable TV Investor*, April 5, 1988.

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Reader Service Number 17.

How secure is fiber?

"Fiber's almost limitless bandwidth opens the possibility for new bandwidth-hungry encryption schemes."

By Scott A. Esty
Market Development Supervisor
Telecommunications Products Division, Corning Glass Works

Optical fiber is playing a major role in determining the future of CATV. But how will fiber influence the signal security measures of the 1990s and beyond?

Optical fiber is an inherently secure medium. It is extremely difficult to tap without being detected. Few "midnight electricians" may have the confidence to tamper with it once installed. With fiber terminating at a drop point in or near the home, it also is possible to introduce some very theft-resistant remote control concepts.

As fiber is deployed in supertrunk and distribution backbone links today, it is important to understand how these systems will integrate with existing signal security techniques. There are two broad categories of techniques for signal scrambling: analog and digital.

Analog: The common analog techniques for signal protection include RF trapping, interfering carriers and a variety of sine wave and gated sync suppression techniques. These techniques are the principal signal security schemes in operation for multichannel wideband RF signals in local cable systems today.

Optical transmission current is being deployed in two formats: amplitude modulation (AM) and frequency modulation (FM). AM optical transmission is identical to CATV RF coaxial transmission or AML microwave. The fiber is totally "transparent" to whatever security scheme is operating in the system. No new procedures need to be introduced to accommodate analog scrambling schemes on an optical AM link.

Frequency modulated systems also can accommodate common analog security methods but the sync suppression techniques require some extra measures. This is true for both FM coax and FM fiber links. One method transmits an additional pilot reference signal, requiring an extra slice of bandwidth. Special clamping or AFC circuits also are used. It is possible to compromise the resultant video quality if compensation for suppressing the sync is not done correctly. The sync suppression signals also can be introduced at the supertrunk terminals or hubsite.

Digital: There are three families of commercially developed digital scrambling techniques, including MAC (multiplexed analog component), line dicing/rotation and line shuffling. These schemes sometimes are used in local distribution of programming but principally are the protection methods for satellite distribution. Digital encoding schemes are recognized as offering the highest level of signal security.

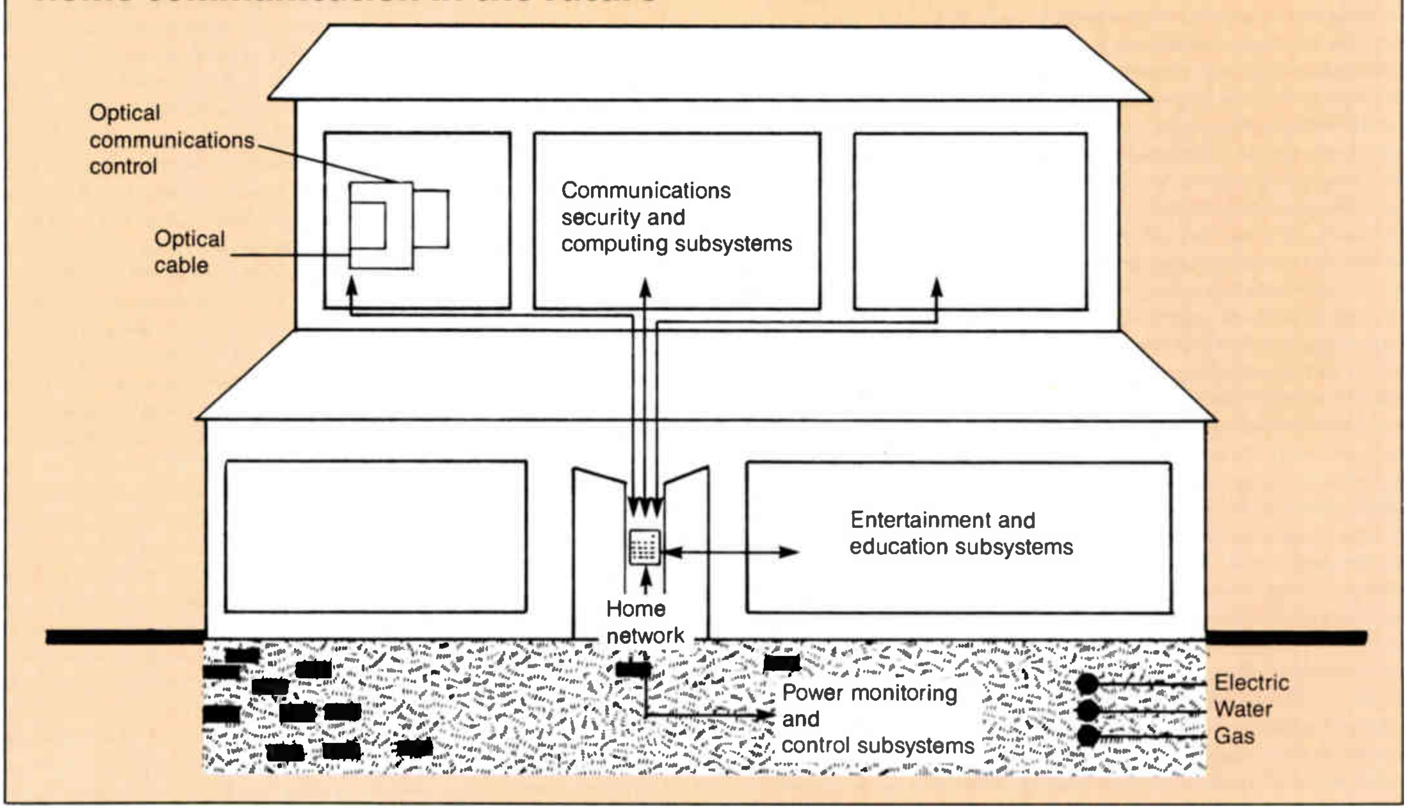
Each of these techniques requires digitizing the analog video signal for processing. All the scrambling is introduced while the signal is digitized. The resultant encrypted signal then is decoded back to analog for transmission. At the receive end, the process is reversed, repeating the dual analog-to-digital and digital-to-analog format conversions before the system can be viewed.

Optical systems easily can transmit digitized signals, which could eliminate these two intermediate format conversions that add expense and can degenerate the signal quality. Digital transmission also is recognized for its precise reproduction of signal quality, on par with the compact disc player.

Future directions

In the future, as fiber migrates closer to the home, driven by bandwidth requirements for more channels and high-definition TV, the interactive capacity of optical systems can open new possibilities for program protection. Marketing visionaries are anticipating possible new revenue enhancers such as pay-per-view Olympic events and a la carte purchases from the complete channel lineup. As cable introduces new interactive services, privacy and signal protection will be needed for sensitive communications, such as banking and future home management control systems (see accompanying figure).

The interface between today's signal security schemes and fiber presents no problems. Tomorrow, fiber's almost limitless bandwidth opens the possibility for new bandwidth-hungry encryption schemes. Fiber drops to the home would present a tap-resistant cable that the amateur bandit will have a difficult time cracking.



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Reader Service Number 18.

A new approach to video inversion

By Blair Schodowski
Senior Engineer, Scientific-Atlanta

Essentially, video inversion is a process in which white levels become black and black levels become white. When viewing a video-inverted picture you might think you're looking at a film negative. In other words, when a video signal is inverted the light and dark levels are swapped. In theory the NTSC video signal is rotated around a reference located between peak white and sync tip. The reference establishes an axis of inversion that is an essential component in the process of reinversion. In the reinversion process the identical axis must be used to obtain the original signal.

Figure 1a illustrates an example of a non-inverted waveform, while Figure 1b shows the waveform inverted between points A and B. The axis of inversion was chosen such that it would be centered between the example waveform's peaks. Figure 1c shows the consequence of re-inverting around an axis that is +10 IRE units greater than the original axis of inversion. Note that the reinverted waveform has been expanded with respect to the non-inverted waveform. The amount of expansion is equal to twice the difference between the inversion axis and reinversion axis. If the axis error was negative with respect to the inversion axis, the reinverted waveform would have been compressed by two times the axis error.

Figure 1: Inversion error

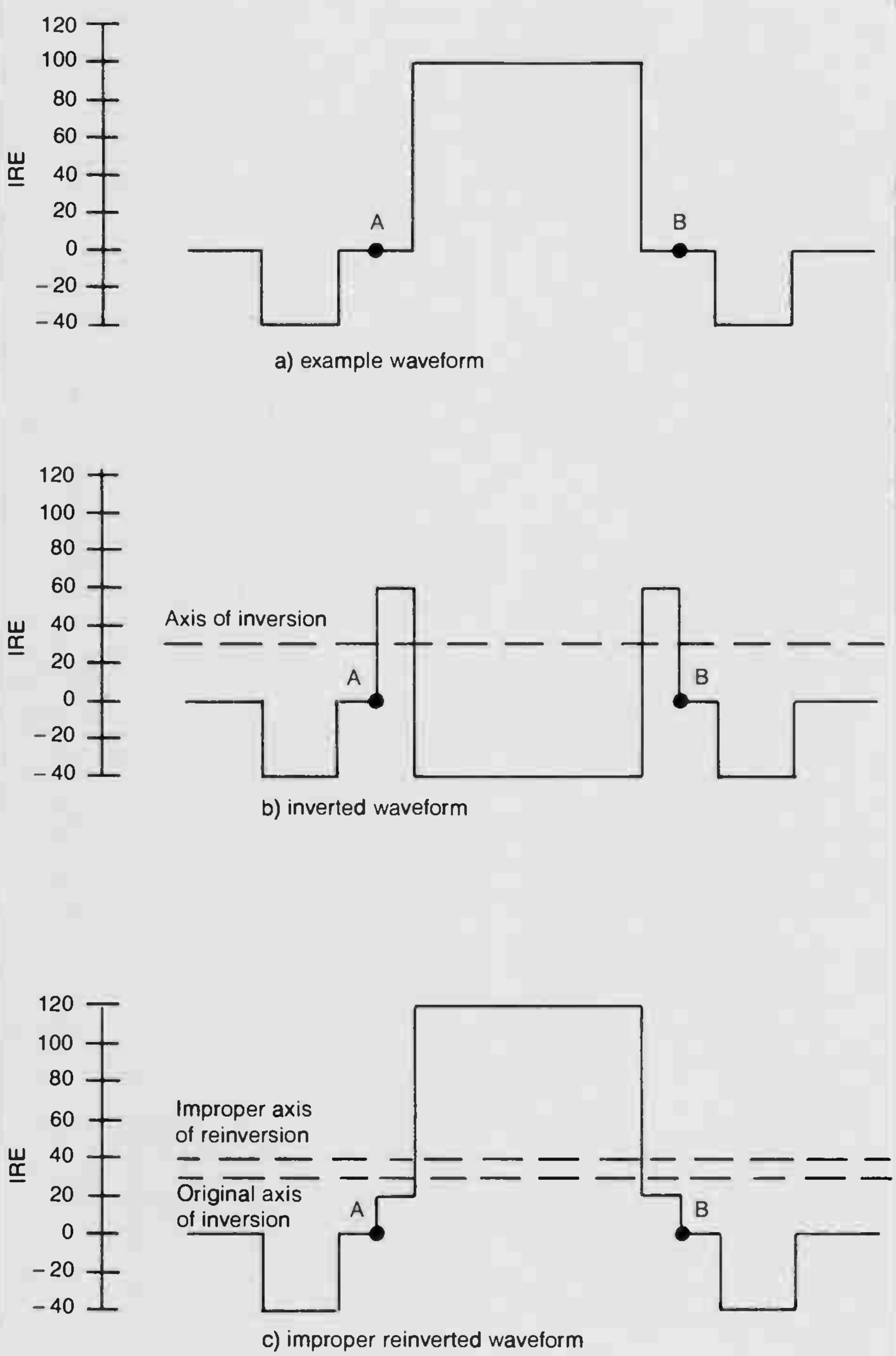
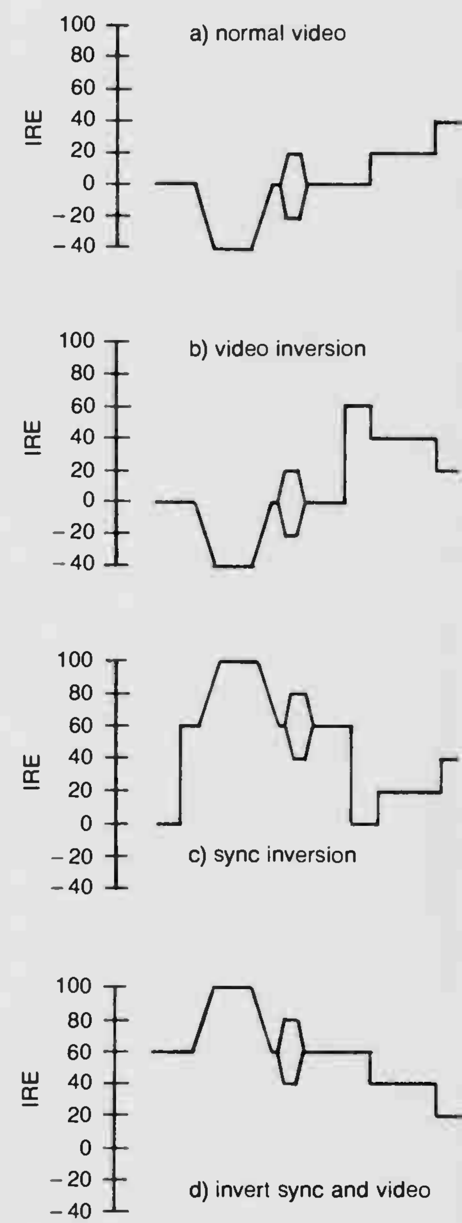


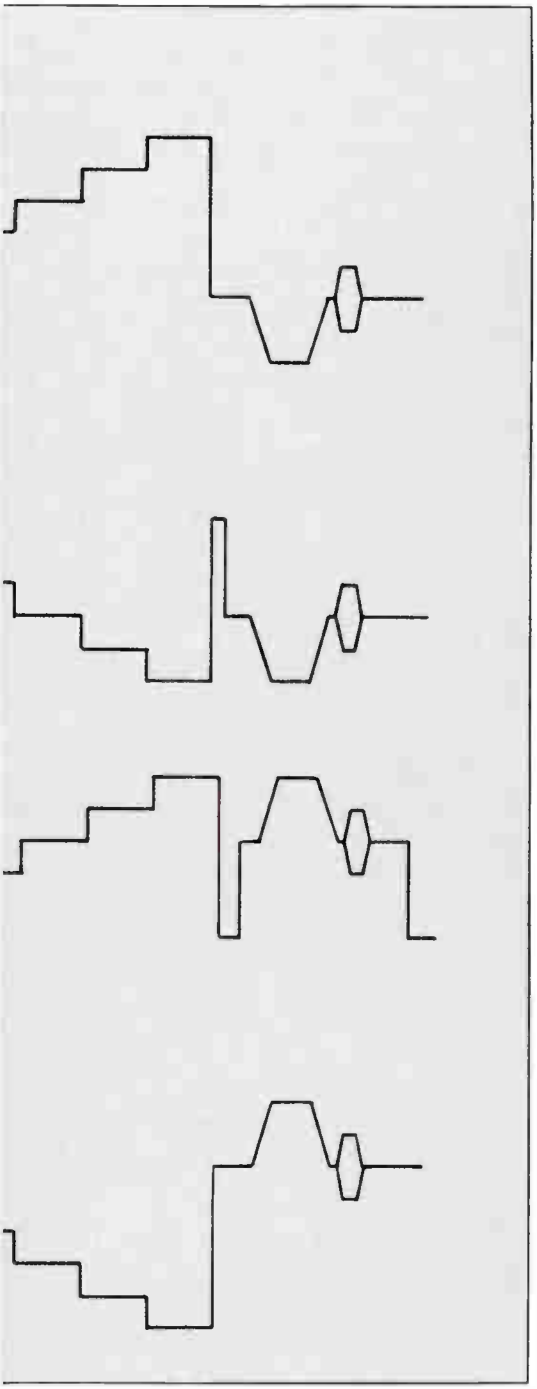
Figure 2: Inversion modes

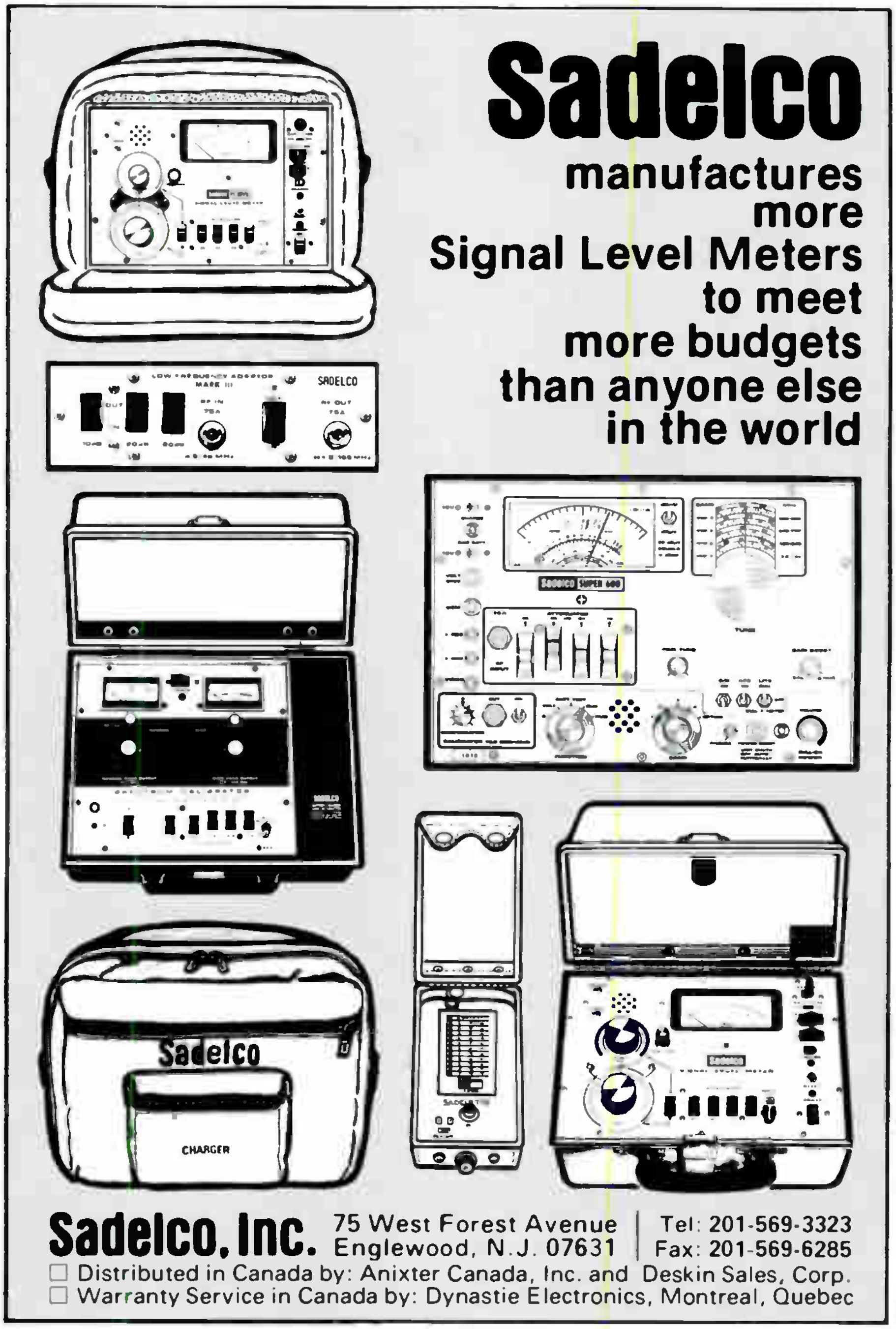


"There is an economical method for overcoming the deficiencies of past video inversion systems."

The axis of inversion of a video signal is typically centered somewhere between sync tip and reference peak white. However, it is also possible to invert the video signal about any axis the system desires, providing the reinversion is around the same axis.

Figure 2 shows the basic inversion modes





possible for a video signal. The example video, Figure 2a, consists of horizontal blanking along with six levels of luminance followed by horizontal blanking. The mode shown in Figure 2b represents active video inversion with normal horizontal blanking. Figure 2c shows inverted horizontal blanking with normal active video. Finally, Figure 2d illustrates both active video and horizontal blanking inverted. Examination of Figure 2b shows that inverted active video could become the most negative level of the video signal.

Since sync recovery circuits in TV receivers rely on the most negative level of video for synchronization, reliable synchronization is virtually impossible. Without horizontal synchronization the TV picture will tear. In the event synchronization is established, the recovered video will appear to be the negative of the original signal (again similar to the photograph negative). Also, the color information will be rendered incorrect because the phase of the color subcarrier is reversed in the inversion process. Since horizontal sync is inverted in the modes represented by Figures 2c and 2d, there is no possibility of synchronization. With the absence of horizontal sync the recovered signal is rendered useless to TV receivers.

Deficiencies of past systems

Video inversion systems incorporating past technology suffer from at least two deficiencies. The first deficiency arises when horizontal blanking is inverted and modulated, as indicated in Figure 3. After modulation, sync tips are no longer the highest amplitude of the RF envelope. Video demodulators rely on the highest RF amplitudes for automatic gain control (AGC) to establish proper video levels. Systems have been developed that compensate for this deficiency by incorporating very slow time constant AGC circuits that respond to the non-inverted sync pulses in the vertical interval.

However, objectionable artifacts can be generated in the recovered signal when utilizing such a measure. The most obvious is a blooming of luminance level when changing channels or scrambling modes. Due to the nature of scrambling systems in which non-inverted sync pulses and inverted sync pulses are used, a video demodulator that AGCs to the most negative amplitude level will not work. Dual video demodulators can be used but basic economics and the inability to match gains and clamping level make this approach impractical.

The second deficiency manifests itself when the descrambled axis of inversion fails to equal the scrambled axis of inversion. With changing headend or descrambling conditions, some systems do not have the dynamic capability of maintaining identical inversion between scrambling and descrambling.

Axis integrity is lost because past systems relied on factory calibration settings to match inversion and reinversion. Consider a calibration signal from the factory's headend that is inverted about a 30 IRE axis and transmitted at a set depth of modulation (DOM). The descrambler can then be calibrated to measure from sync tip a set axis of reinversion, which equals a voltage level one-half the voltage from peak white to sync tip. If the peak-to-peak amplitude of the recovered video remains equal to the level of video when calibrated, the descrambled signal will match the original signal before inversion.

However, if the field modulator's DOM differs from the calibration modulator's DOM, the recovered peak-to-peak signal will no longer equal the recovered calibration signal. Since the axis reference voltage is fixed in the descrambler and

Figure 4: Example waveform with split sync reference pulse

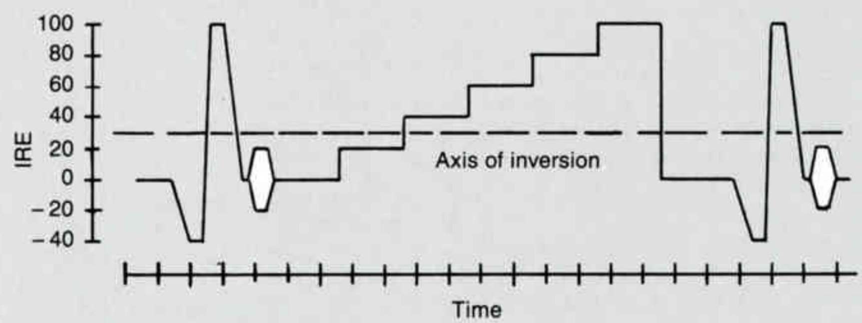


Figure 5: Generation of reinversion axis

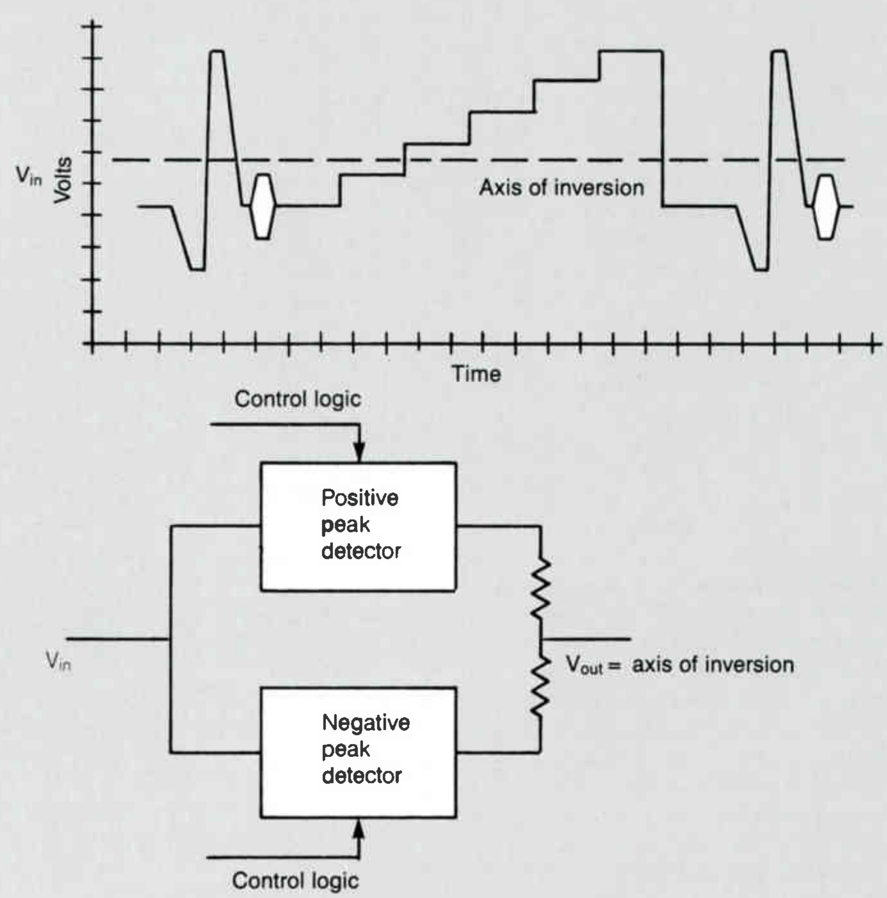
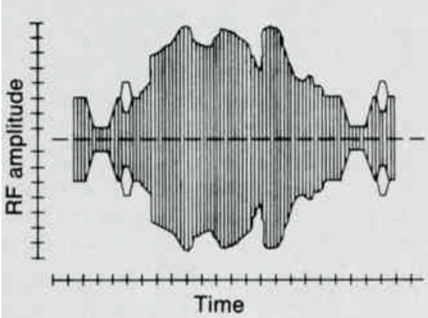


Figure 3: Inverted horizontal blanking RF envelope



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A new approach

Fortunately, there is an economical method for overcoming the deficiencies of past video inversion systems. The new method involves utilizing a technology that transmits a modified sync signal during the conventional sync time of a video signal. The signal is transmitted by splitting the sync interval into two components. Figure 4 illustrates an example waveform that incorporates the split sync signal. The first component of the signal is the conventionally transmitted −40 IRE sync. After a time equal to about 2 μs the −40 IRE signal level increases to the peak amplitude of 100 IRE. The 100 IRE signal pulse remains at 100 IRE for about 2 μs before returning to 0 IRE.

The split sync signal is processed at the descrambler to calculate an axis of reinversion to ensure axis integrity between scrambling and descrambling. Axis integrity is maintained by the descrambler's ability to sample the modified sync's −40 and 100 IRE signals. The sampled voltages are then used to determine the average voltage between −40 and 100 IRE. The average voltage that represents a 30 IRE axis of inversion is halfway between −40 IRE and 100 IRE. By averaging the sampled signal peaks the relative axis of reinversion will always be 30 IRE.

The illustration in Figure 5 demonstrates how an axis voltage might be generated. This dynamic method of determining the required axis of reinversion is no longer dependent on factory DOM calibrations. Therefore, the descrambler will accurately restore the scrambled signal regardless of the headend's DOM.

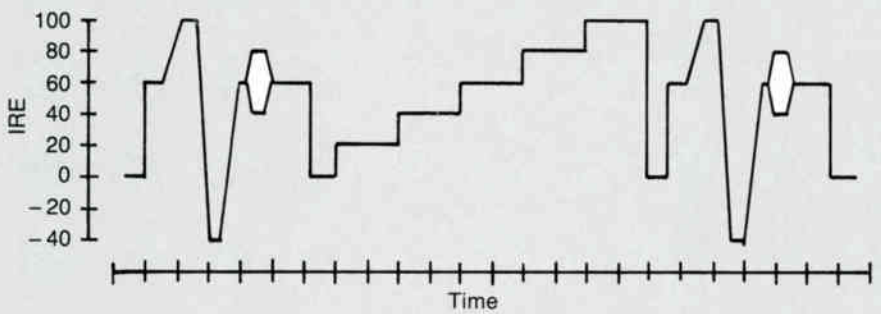
The example waveform in Figure 6a illustrates inverted horizontal blanking (sync inversion) incorporating the modified split sync signal. Figure 6b shows sync and video inversion (invert-all), also incorporating the modified split sync signal. Note that when the 100 IRE pulse is inverted around a 30 IRE axis the pulse becomes −40 IRE. The −40 IRE signal allows clamp circuits in headend modulators to function properly. Therefore, costly modifications to headend modulators are not needed.

The inverted 100 IRE pulse also establishes the required signal needed for proper demodulator AGC operation. Figure 7 shows an example of an RF envelope that has been modulated with an all-inverted split sync video signal. Note that when modulating the inverted 100 IRE pulse it becomes the most positive amplitude of the RF envelope. By always having a −40 IRE signal, reliable demodulator performance is maintained in all methods of scrambling.

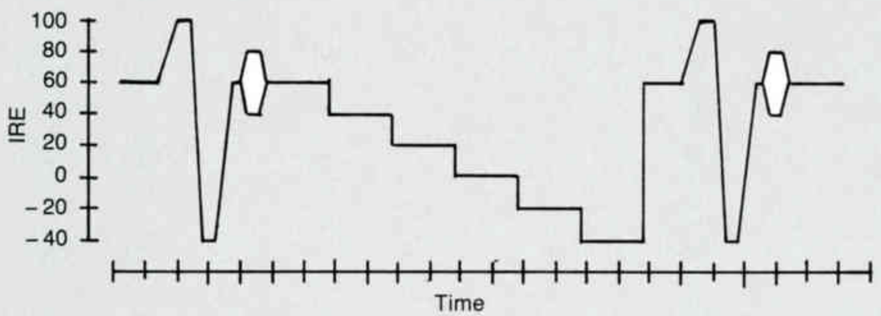
Another advantage of transmitting split sync is that many TV receivers require the entire 4.7 μs sync pulse to establish synchronization. The dynamic scrambling capability of the system shifts the synchronization edge of sync by 2 μs when changing inversion modes. The dynamically varying sync edge causes an annoying picture shift when viewing the scrambled picture. In addition to horizontal shifting the color information also will be changing from mode to mode. This is because the color burst is inverted during sync inversion or invert-all scrambling.

This improved method of video inversion eliminates many of the limitations affecting previous video inversion systems. Besides eliminating deficiencies, the improved inversion system increases overall system performance and capability. Dynamic generation of the reinversion axis eliminates the need for precise factory modulator adjustments. Axis integrity in all modes of inversion allows for dynamic changing of scrambling modes without any chrominance or luminance artifacts. The ability to dynamically scramble increases system security, which is a major concern throughout the industry. The new technology increases security further when integrated with older scrambler techniques such as sync suppression.

Figure 6

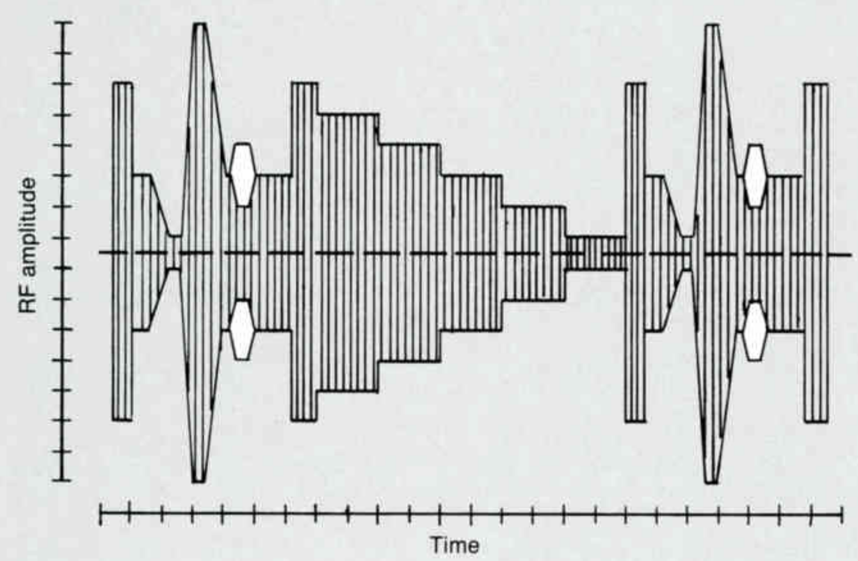


a) sync inversion with split sync

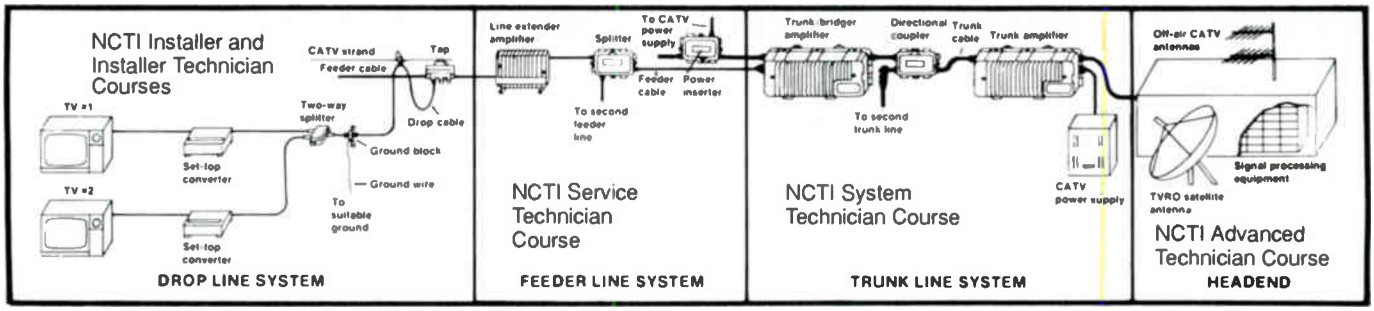


b) invert all with split sync

Figure 7: RF envelope of inverted sync and video with split sync reference



From Headend to Drop



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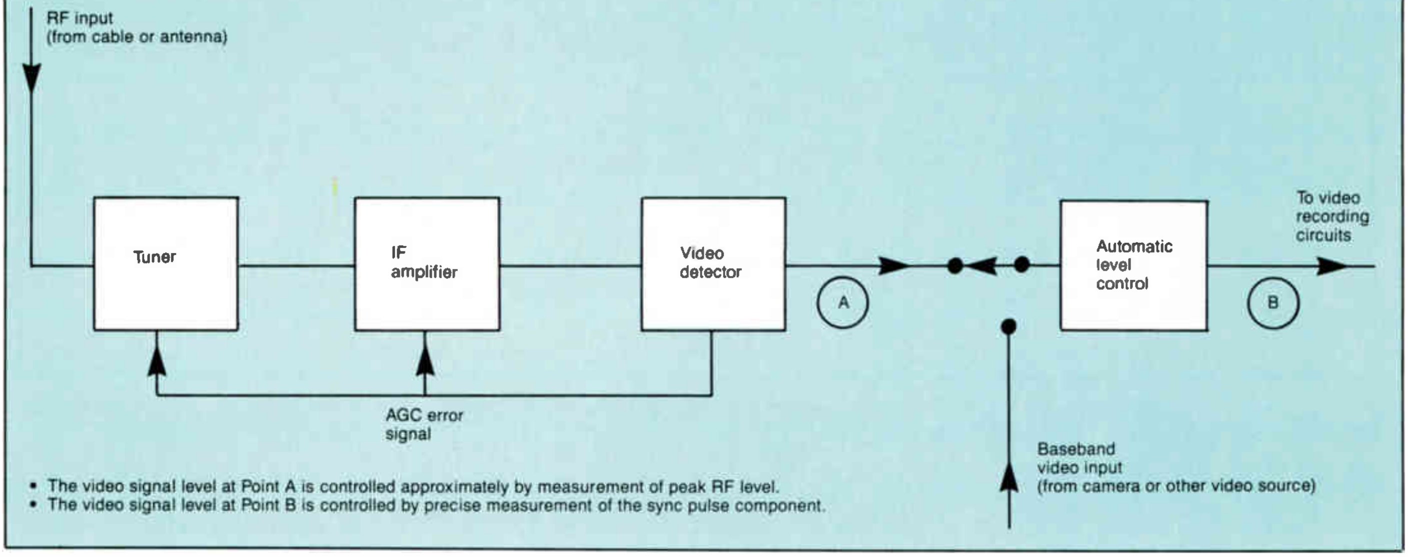

Figure 1: AGC/ALC system of a VCR

Pay-per-view copy protection

By Graham S. Stubbs
Executive Vice President, Eidak Corp.

Timely availability of movies and special events is a critical element in the successful growth of pay-per-view (PPV) in cable TV. The sequence of releases of program material to theatrical, PPV, video rental, subscription premium TV and broadcast networks is determined in part by the program copyright holders' view of the effect on the rest of the distribution channels of releasing program material to any one distribution medium.

Distribution of movies through video rental stores has become the dominant method of retailing movies following theatrical release. Program material released to any other distribution channel is thus evaluated very carefully for its effect upon the videocassette rental business. In the case of absent effective copyright protection, the release of movies or other programs to PPV, either simultaneously with or ahead of video rental release, has the potential to negatively impact rental revenues.

Copyright owners can manage the legitimate competition between distribution channels and can design their release programs to maximize revenues. They are not, however, prepared to permit illegitimate competition in the form of theft of copyright, either unauthorized viewing (theft-of-service) or unauthorized copying and distribution (illegal taping).

Developments in satellite and cable scrambling techniques deal with the first of these issues. Copy protection of PPV signals deals with the second and is essential for PPV to regain a competitive release window position. In discussing copy protection of video signals, there are two basic distinctions to make: PPV vs. tape and bilateral vs. unilateral methods of copy protection.

"The security requirements for copy protection are somewhat different than for prevention of unauthorizing viewing."

PPV vs. tape: The requirements for PPV copy protection are quite different than the requirements to inhibit duplication of tapes. PPV is a *transmitted* medium, while videotape is a *stored* medium. A protection method for PPV must be technically compatible with all the elements of the transmission medium—in this case, cable and all its components, including scrambling systems. But it is not required to be VCR-compatible.

In contrast, a protection system for tapes needs to be inherently compatible with VCR playback, but the playback signal is normally required to be connected directly into a TV receiver or monitor. Both PPV and tape copy protection methods are intended to deny unauthorized copying and to permit authorized viewing without perceptible degradation.

Bilateral vs. unilateral methods: Bilateral copy protection implies a process occurring both at the headend and in the home. Examples of bilateral schemes are:

- Modification of the VCR with a device to recognize programs it is authorized to record and authorization codes sent from the head-

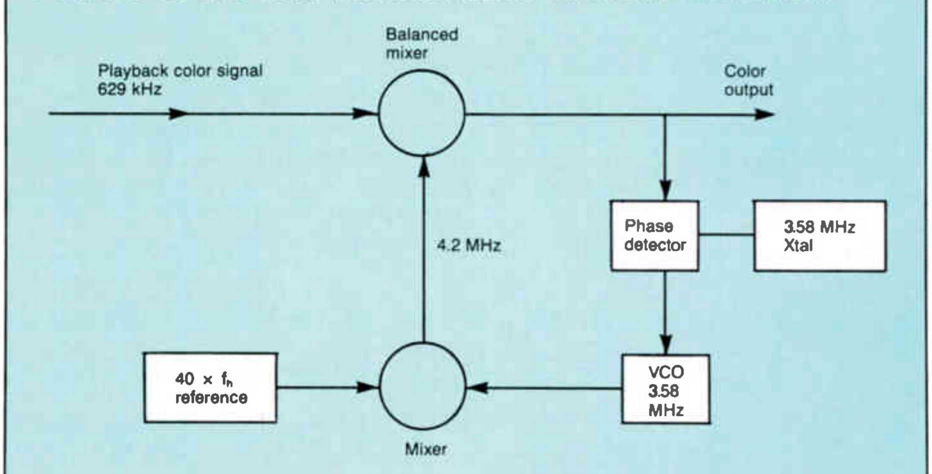

Figure 2: VHS color playback/color time base correction

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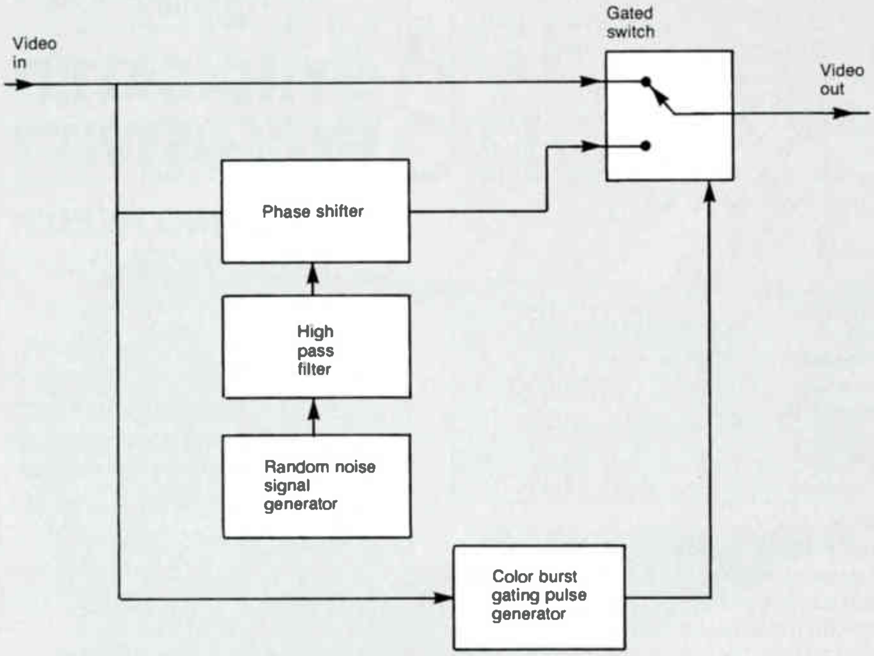
Figure 5: Color burst phase modulation to perturb VCR color playback



tial threats: an inexpensive device that could be used to remove the treatment, modification of equipment available (e.g., TV receiver), modification of VCRs, recording with a camera directly from the TV screen and access to unprotected signals in the distribution path. An effective system must put cost of piracy well beyond the benefit to the would-be copy pirate.

Because of the very different purposes of videocassette recorders and TV receivers, there are some fundamental differences in the way TV signals are processed. The VCR is a storage/retrieval device; the TV receiver displays program material. Compared with the TV receiver, signal processing is optimized in the VCR in the following ways:

1) It is primarily a baseband video system (although frequently equipped with an RF tuner). Precise control of video signal levels (automatic level control, ALC) is required for high quality recording.

2) For bandwidth-efficient recording, the VCR separates out the color component of video and records it in a different manner than the luminance components.

3) For efficient use of tape and to minimize tape velocity, a mechanical scanning system is used to record in diagonal stripes across the tape. (See Reference 1 for more details of VCR operation.)

There are thus three basic differences in signal processing that can be exploited to make TV signals non-recordable but still viewable. Let's discuss each in more detail.

AGC/ALC: A consumer VCR typically uses two forms of automatic signal level control (Figure 1). The tuner, IF and demodulator section normally uses AGC (automatic gain control) to provide control of peak video signal delivered from the demodulator. This AGC is similar in function to that in a TV set. Measurement of peak video level is subject to errors due to imperfect setting of modulation depth and variations in scene content. It is not sufficiently precise for VCR recording circuits. The VCR employs a second ALC circuit that measures the sync pulse component of the video signal as a precise indication of video level. The measurement is made by examining sync tip level and back porch (black) level. This measurement is compared with a precision reference and fed back to adjust system gain.

Color processing: In order to minimize the bandwidth of the video signal actually recorded on tape and to provide optimum noise performance, the color and luminance components of a TV signal are separated in the VCR and recorded in different manners (Figure 2). The luminance signal modulates an FM carrier in the 3 MHz to 4 MHz range.

The color component is frequency shifted to 629 kHz and applied to the recording head directly. In replay, the color and luminance signals are recovered from the tape and separated. The recovered signals have frequency and phase variations caused by mechanical imperfections inherent in the tape and tape drive mechanism. In order to drive a monitor or receiver, the chrominance signal must be precisely restored to its original 3.58 MHz state. (Precise restoration of the luminance signal is not as critical.) The playback color signal is mixed with a 4.2 MHz signal derived from a voltage-controlled oscillator (VCO). The mixing signal is obtained by phase comparison of the restored 3.58 MHz color output signal with a precise crystal reference. The phase comparison measures the phase of the color burst on a line-by-line basis. Phase variations are interpreted as velocity errors and result in phase correction fed back through the VCO.

Synchronized mechanical scanning: The high-frequency components inherent in video require a high writing speed for information recorded on tape (Figure 3). This problem is solved in the VCR by recording in narrow diagonal stripes across the tape. Thus, for a given tape speed, the writing speed is much higher. In the helical scan system, the tape is literally wrapped around a spinning drum in the form of a helix (spiral). The combined motion of the tape and the spinning drum produces the diagonal scan. The tape is in contact with only part of the drum at any one time. This means typically two or more heads are used for scanning with the video signal switching back and forth between them to avoid the break in continuity that would otherwise occur when the head momentarily leaves the tape. The switching between heads is achieved during the vertical blanking interval (VBI) so that any switching artifact occurs off-screen. Synchronization of head switching on both record and playback requires precise servo control of both drum speed and tape velocity.

Non-recordability methods

Various techniques have been devised to exploit each of these differences between VCRs and TV receivers. Some have met with little success because they made use of a narrow range of characteristics peculiar to only relatively few machines. Three methods will be described, each making use of one of the previously mentioned differences. These techniques can in some cases be used in tandem for greater effectiveness.

Pseudosync AGC method[2]*:* This method exploits the unique AGC/ALC characteristics of the VCR by adding additional pseudosync pulses during several lines in the VBI (Figure 4). The VCR has trouble distinguishing real sync pulses from any other pulse that goes from blanking level to sync. Each pseudosync pulse is immediately followed by a white level pulse rather than black level back porch. The VCR's ALC, therefore, measures the difference between sync tip and white level as sync height and "assumes" that the incoming video signal is three or four times larger than normal.

Typically, five pulse pairs are added to each of seven lines in the VBI. The pseudosync pulses are added only during the VBI; however, the VCR's AGC system can be confused even if only a fraction of the sync pulses in a field are interpreted as indicating excessive video level. This technique is also applicable to protection of tapes. The effect of an attempted recording is a weak video signal on replay. The effectiveness is quite dependent upon the specific VCRs used for recording and playback. To increase effectiveness against recording, sometimes sync is reduced to a level two-thirds of normal.

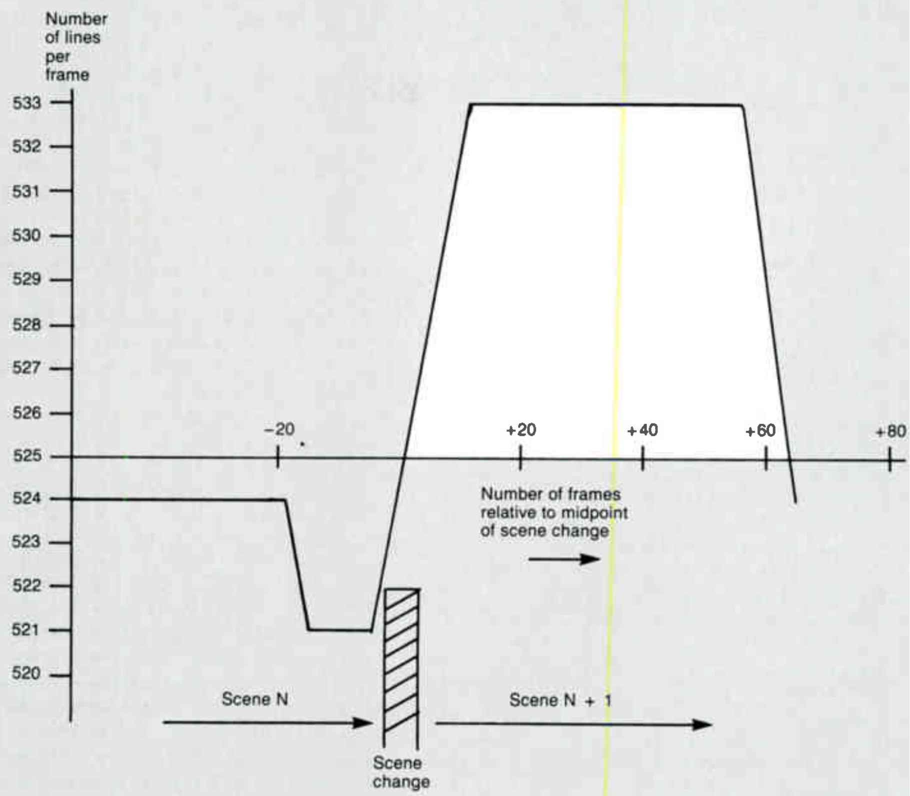
Color stripe method[3]*:* The VCR's color signal restoration system can be confused by altering or selectively removing the back porch color burst signal (Figure 5). The color stripe method applies random phase perturbations to the color burst component and are applied in such a way that the average phase of the color burst remains unchanged. The VCR interprets these color burst phase changes as velocity errors and transfers corresponding phase errors to the chrominance signal on replay. The subcarrier regenerator of the TV receiver has a relatively long time constant and tends to ignore color burst phase perturbations.

On replay of an attempted recording, horizontal colored stripes are seen, complementary to the color in the background against which they appear; sometimes color is lost altogether. This method cannot be used to protect tapes. An attempted recording of material protected by this method can be viewed in black and white by turning off the color of the TV receiver.

Time base variation method[4,5]: The vertical time base of the copy-protected video signal is time-varied by adding or deleting lines from frames (Figure 6). A change of vertical frame rate of up to ±3 percent disrupts the drum synchronization and servo systems of the VCR, causing it to miswrite the video recording, disturb control track information and switch between heads other than during the VBI. The effects on playback are intermittent breakup of the picture, distortion of audio and head-switching artifacts (moving horizontal bars).

The manner in which the number of lines varies with time is chosen for maximum disruption of recording with a wide range of VCRs. The number of lines per frame is kept close to (but not exactly at) 525, with intermittent cycles (or profiles) of added and reduced numbers of lines. The long-term average number of lines per frame is maintained at 525. Several different profiles are used for maximum effectiveness with different kinds of VCRs. The TV receiver is relatively impervious to the time base modification because its picture scanning is all electronic. The profile cycle occurs typically at, or close to, scene changes in order to mask any minor display artifacts on the TV receiver. The method is not usable (in this form) for protecting tapes.

Figure 6: Variation of lines/frame vs. time



For PPV, the method has a number of specific advantages:

1) It is effective against VCR recording.—The wide range of time-varying patterns confuses electromechanical scanning of VCRs and causes breakup of picture on playback.

2) There is no noticeable effect on subscriber's TV picture.—TV picture scanning is all electronic.

3) It is costly to defeat.—There is no simple method to remove the treatment.

4) It cannot be recorded from signals inside the TV set.—Treatment is not removed by TV receiver signal processing.

5) It is effective against camera recording of TV screen.—It leaves objectionable moving pattern on camera recording.

6) It is compatible with cable TV.—It does not disturb VBI and is cable scrambler-compatible.

The Eidak system

The time base variation technique was selected by Eidak Corp. as combining the most desirable characteristics of security and cable compatibility. The Eidak system optimizes the time base variation method for PPV. The goals for this system are:

- non-recordability for both movies and live events
- high degree of copy protection
- security throughout the distribution system
- no hardware in the subscribers' homes (i.e., it is a unilateral system)
- compatibility with the wide range of makes and models of TV receivers used by the subscribers
- ease of installation and operation
- system transparency

The Eidak process requires modification of the video signal in processing equipment located at the headend. Before passing through the processor, the program material is analyzed to determine the appropriate timing and type of profiles to be used. This analysis can be performed either off-line or in real time. In either case, control code data, which relates the timing to SMPTE time code signal, accompanies the video. Within the Eidak processor, the control code reader separates this data and uses it to control the variation in number of lines per frame.

Variation of frame length is accomplished digitally by changing the rates at which frames of digitized video are written into and out of a multiple frame store buffer memory. A refinement of this signal processing adjusts the active picture location within a frame to keep the displayed picture centered on the TV screen. A modified sync waveform of the appropriate frame length is generated and reassociated with the time-shifted active video.

An important function is a cable scrambler interface reset signal. Scramblers in general provide signalling at a vertical field rate; circuits are typically implemented using line counting to determine field location. The scramblers are modified to utilize a reset signal that anticipates the VBI.

When PPV signals are distributed by satellite, some pre-processing is performed at the satellite uplink. Control data that determines profile characteristics and timing is transmitted over the satellite link. Additionally, a scrambling overlay is applied at the uplink, which can only be removed by the Eidak processor at the headend. The scrambling overlay protects against unauthorized copying at the headend (or at unauthorized downlinks). The overlay also assures copy protection processing of all satellite-delivered program material intended by the program supplier to be copy-protected for distribution. Through extensive field testing, the system has been shown to work with the wide range of equipment (including the various scramblers) and operational constraints found in cable systems. ■

Acknowledgments: The author would like to acknowledge the creative development work of Eugene Leonard, Bill Perlman and their engineering team in Roslyn, N.Y.

References

1 *Video Techniques*, Gordon White, Heinemann, 1988.

2 U.S. Patent No. 4,631,603, John O. Ryan, issued Dec. 23, 1986.

3 U.S. Patent No. 4,577,216, John O. Ryan, issued March 18, 1986.

4 U.S. Patent No. 4,673,981, A. Lippman, V. Bove, J. Wiesner, issued June 1987.

5 "Unrecordable Video," Andrew Lippman and Tareq Hoque, *IEEE Transactions on Broadcasting*, September 1987.

Phase modulation system–Past, present and future

"The PM system is currently operating over conventional coax, AM microwave links and on fiber-optic trunks."

By Vito Brugliera
Vice President, Marketing and Product Planning
Zenith Electronics Corp., Cable Products Group

RF scrambling is a well-known technology with all the advantages of low cost, simplicity and relatively few parts. Ironically, familiarity has been RF scrambling's only major drawback: Signal pirates learned how to beat many approaches. But by using a multisegment surface acoustic wave (SAW) filter, RF scrambling becomes more effective than sync suppression alone, more secure and less costly.

Since the first days, CATV technology has tried to control subscriber access to basic and pay services in a variety of ways. The most primitive form was by simply connecting to the cable. As tiering and pay services evolved, plain converters began to translate signals into mid- and super-band portions of the spectrum, where they were beyond tuning reach of the TV receivers of unauthorized subs. Additional levels of control came about with programmable read-only memory (PROM) converters that blocked unauthorized service. Cable-compatible TVs circumvented these approaches and required new ways to protect signals, beginning with filters or traps between the plant and the drop.

Negative traps rejected certain portions of the spectrum unless the customer paid for services on that part of the spectrum. If most of the local population subscribed, negative traps were the most economical solution, since they'd only be used for the minority of non-subs. Another variation was to place an interfering carrier near the desired picture carrier. A positive trap filtered out interference for authorized customers; unfortunately, it took out some picture information, too.

And, as premium and tiered services became more prevalent, so did problems with traps. Every time a sub changed status, a technician had to make a service call.

Sync suppression, deployed in the mid-1970s, offered cable operators another way to ensure that unauthorized viewers received distorted pictures. By attenuating the horizontal sync pulse to a level at or below video, operators could prevent the TV receiver from locking onto the signal. The unauthorized viewer received tearing, rolling pictures as the video level varied.

Subs could tune in clear pictures on designated channels that were initially programmed into converters. But again, every time a sub changed status the tech had to come back. In the late '70s, addressable converters ended the need for service calls. A data channel from the headend simply communicated data to the home terminal, allowing or denying services.

Predictably, pirates tried to defeat the scrambling technology. In response, various means of sync suppression evolved, including sine wave (a resurrection of Zenith Phonevision scrambling technology from the '50s) and a variety of gated sync approaches, sometimes combined with multiple levels of sync attenuation.

Scrambling at baseband instead of RF was the next step. In the '80s, video inversion and digital audio scrambling raised the level of technology. And while the pirate's job became more difficult, addressable converters became more expensive.

Economic considerations

Cost increases grew as subs became less interested in the smorgasbord of pay services. Pay-to-basic ratios declined and, in many cases, subscriptions to specialized pay services dropped appreciably. Subs had discovered videocassette rentals.

By 1985 financial considerations were challenging the premises that made addressability desirable. Traps looked more attractive. And just as important, they seemed more friendly to subs than the box on top of the TV.

Meanwhile, addressability found a new market in pay-per-view (PPV). As an incremental service in an existing addressable system, PPV was a new source of income. But in non-addressable systems, PPV didn't generate enough revenue —especially at the levels of security desired— to warrant purchase of addressable converters for as much as $130 apiece. Suppliers had to find a way to deliver performance and security without crossing the $100 price barrier.

RF, rather than baseband, was a less costly approach because the additional signal processing required for baseband was not needed. Conventional RF technology used a separate out-of-band (typically in the FM band) channel for communication from the headend to the addressable converter. This required a separate receiver and demodulator.

Baseband approaches inserted data in the vertical blanking interval (VBI) and ended the need for an out-of-band receiver. This consequently offset some of the additional cost of baseband. Clearly, the industry needed a system that could somehow combine the advantages of RF and baseband techniques.

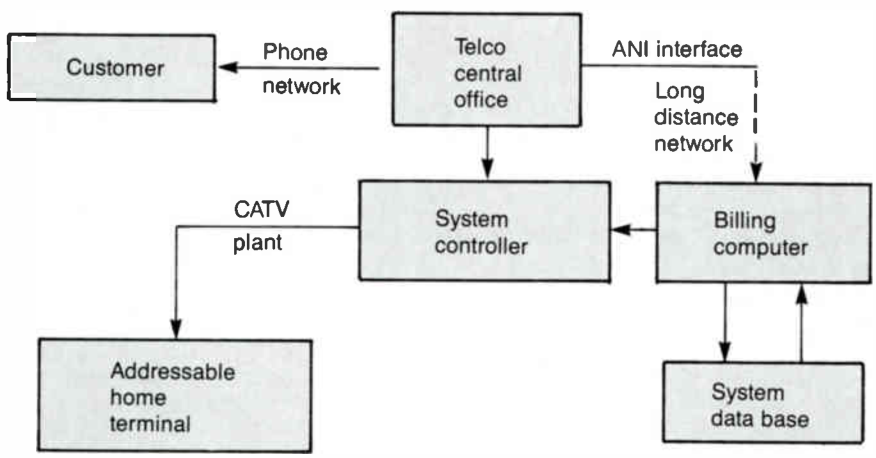
So, roughly four years ago Zenith engineers applied their background in synchronous detection and familiarity with RF integrated circuits to develop a design approach radically different from conventional sync suppression and data retrieval techniques.

Phase modulation system

The solution—the PM (phase modulation) system—is based on the unique characteristics of SAW filters. A SAW filter can be designed with independent phase and amplitude responses, unlike conventional filters using ordinary discrete components. The heart of the new scrambling system was a multisegment SAW filter. The horizontal sync pulse is switched randomly between two of the SAW filter segments to provide phase changes at the beginning and end of the pulse as well as two levels of amplitude attenuation. Timing of the interval between phase changes provides differentiation for a zero or 1 digital bit.

Thus, two things are accomplished by passing the horizontal pulse through the SAW filter: transmission of one bit of data per horizontal line and amplitude attenuation of the horizontal pulse. In-

Figure 1: ANI via billing computer



verse filters are used in the headend and addressable decoder. Authorization is accomplished by having the decoder pass the RF signal through the correct SAW segment in synchronization with the headend. (A detailed description of this approach appeared in CT, September 1987.) This technology is called "phase reversal of carrier-encrypted sync suppression" (PROCESS).

Two other phenomena occur besides sync suppression. The changing phase relationships of the signal components, picture carrier and chroma and audio subcarriers invert chroma and mask audio. The latter is caused by large phase changes between picture carrier and audio subcarrier twice per horizontal line that drive typical intercarrier sound systems into non-linear operation. This operation generates large amounts of cross-modulation products, thereby distorting and effectively masking the audio portion of the unauthorized signal.

As a further means of increasing security and reducing cost, the active portions of the signal processing circuitry are within two proprietary large-scale integrated circuits (ICs). A substantial parts count reduction makes the system cost-effective and more secure. Tampering opportunities are further minimized because the sensitive circuits are contained within ICs. Security is most often breached by tampering with circuit implementation rather than defeat of the scrambling or encoding system.

The net result is an addressable converter consisting primarily of a tuner, two ICs, a SAW filter and power supply. No factory adjustments are needed for the scrambling portions of the circuit. This makes a very cost-effective package that falls below the $100 price barrier and offers a new generation of scrambling technology.

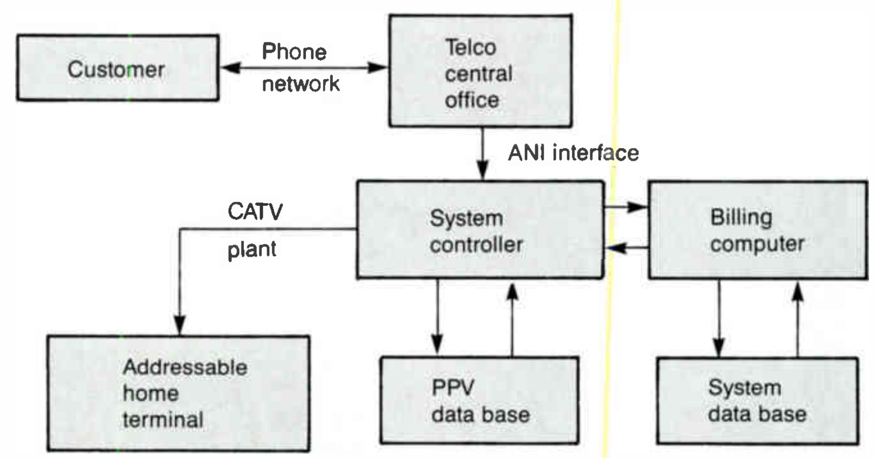
Options for addressability

Most cable systems are not addressable. Despite the prospect of PPV revenues, many non-addressable systems haven't been able to justify upgrading. Adding a decoder, with an in-place cost of about $50, may justify an upgrade. Placing the decoder in series between the output of a "plain vanilla" converter and the input of a TV receiver makes the converter/decoder combination functionally an addressable converter. Installation requires only a short piece of coax and is easily done by the subscriber. The decoder can be mailed or made available at the main office.

Order taking for PPV has relied on telephone store-and-forward systems because of technological constraints, not economics. Store-and-forward is one method for peak-load order taking, which most system controllers, management systems and phone voice network switches cannot handle in real time.

As a result, subscriber self-authorization is necessary. This requires incremental hardware to store the transaction until the data are retrieved by polling via phone modem return. Costs include incremental hardware (a sidecar or internal module), installation of a phone jack and a service call. Security precautions also are needed so that valuable order data remain immune to pirate attacks while on the subscriber premises.

Figure 2: IPPV with ANI



Recovery of this incremental cost centers on the subscriber population with buy rates high enough to amortize the investment (typically 20 percent of subscribers). A club or equipment fee is often charged to defray costs.

Automatic number identification (ANI) is a real-time technology that relates the subscriber phone number and the addressable converter in the system controller data base. Since ANI operates outside the voice network, it avoids the problem of voice network loading in real time. New system controllers, based on PC AT architecture, can handle throughputs of 10 per second, driven by a management computer (Figure 1). Using Phonevision software, the new system controllers can accept ANI data directly from the phone network or interexchange carrier at rates of up to 100 per second. These rates are fast enough for peak loads on the largest systems.

ANI order taking requires no incremental investment for subscriber on-premise hardware and only a modest headend investment beyond normal one-way requirements for system controller impulse PPV upgrading (Figure 2). Upfront costs are low, making PPV more easily available to smaller systems. Most important, PPV is available to all of the subscriber population by way of either rotary or touch-tone phone.

Future applications

The data protocol in the PM system has 64 bits (providing error detection, encryption and control commands) and a large number of available data bits for future applications. A connector at the back of the addressable converter provides a low-speed and a high-speed data bus. Data and converter status changes can be delivered to an external box through one of the buses. This connector also can be used for applications such as audience metering or data downloading.

The PM system is currently operating over conventional coax, AM microwave links and on fiber-optic trunks. The in-band data channel, which operates at a carrier-to-noise ratio of less than 12 dB, has been especially well received. Unlike the conventional sync suppression technologies now at maturity, PM will continue to evolve with more subscriber features and enhancements for new revenue opportunities such as PPV.

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Digital coding: An HDTV solution?

By Ed Burzycki
Engineer
And Ron Holeman
Senior Engineer, Rela Inc.

CATV's relationship with the various entertainment options the viewer has to choose from is changing. The novelty of receiving a TV program has been replaced by concern for the quality of the entertainment experience. A 1984 study by G. Chouinard and J. Barry[3] shows that the public sensitivity for poor video signal-to-noise ratio (SNR) has increased 5-9 dB since a similar study was done in 1960. The HDTV (high-definition TV) formats currently under consideration by the Federal Communications Commission all assume that a top quality SNR will be available at the subscriber set. Quality in 1989 is interpreted as CD quality sound and VHS quality video.

There is an opportunity for the CATV industry to transmit studio quality video. The same study indicates that a "perceptible noise but not annoying" NTSC picture in the 1980s must have a carrier-to-noise ratio (CNR) of at least 42 dB. Of particular note is that the distributed pictures at the recent Western Cable Show in Anaheim, Calif., were substantially substandard to a "perceptible noise but not annoying" assessment. Many exhibitors used VHS tapes to demonstrate the quality of their equipment.

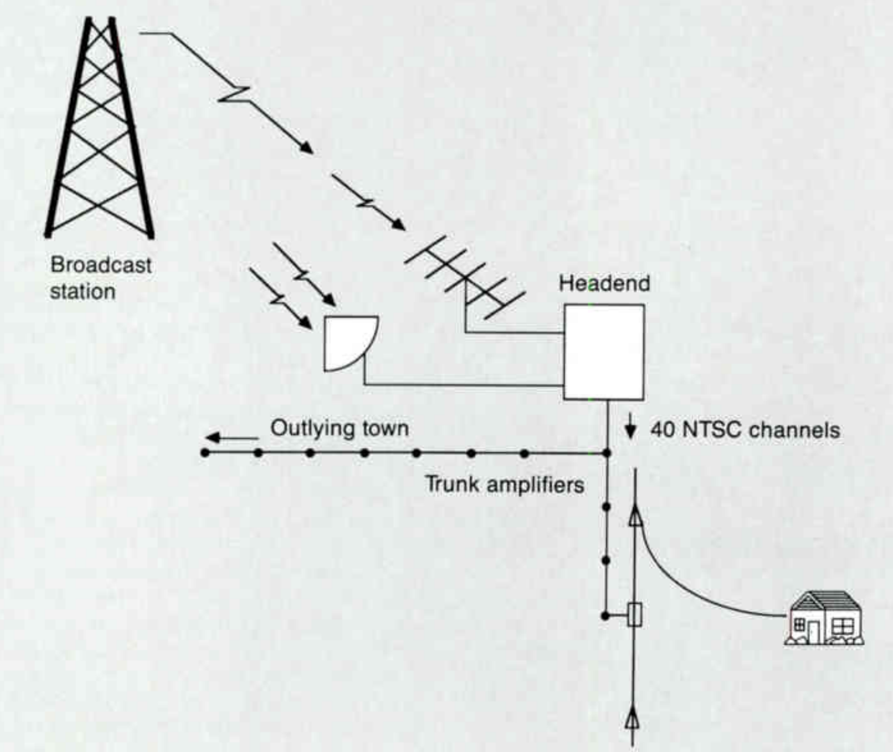
The time has come, therefore, to suggest that a quantum leap in cable transmission performance is in order. This leap would relaunch the credibility of the medium and re-establish that the best signals do come from cable. Broadcast TV needs high performance cable TV to bring the HDTV experience alive. The new architectures necessary to support HDTV can be in place in time for CATV to rise to the challenge.

This article outlines the architectural possibilities for advanced distribution systems to distribute TV signals with CNRs of at least 50 dB. The architectures described are theoretically based; they may or may not have been realized for NTSC and/or HDTV video. All of the transmission schemes have been realized successfully for audio and data transmission.

Figure 1 is the standard tree-and-branch architecture that has changed little over the last 40 years. It is bandwidth-efficient in that each channel occupies only 6 MHz. All the TV channels are amplitude modulated and therefore sensitive to thermal noise. State-of-the-art broadband CATV amplifiers have relatively low noise figures, but the cascade of amplifiers causes the thermal noise power of each amplifier to accumulate. This means that a 20-amplifier cascade would result in a 13 dB reduction in CNR (10log N). Besides the total noise degradation is intermodulation distortion, which is additive on a voltage basis. A 20-amplifier cascade results in a 26 dB loss in composite triple beat (CTB) performance.

The FM (frequency modulation) transmission of video signals is generally regarded as a mature technology. Market testing of studio quality video would educate subscribers that a better signal is available and determine whether they would perceive an improvement in the quality of their entertainment experience. Over the long term the number of studio quality FM signals delivered could be flexibly controlled by the local cable operator.

Figure 1: Traditional tree-and-branch architecture



Hermann Gysel of Synchronous Communications estimates that he can deliver a 60 dB CNR over a 10-mile fiber link using FM technology. Set-top converters are in use by a large percentage of cable households. Figure 2 shows a tree-and-branch FM architecture that could be used to raise the CNR above 50 dB at the home receiver for a studio quality group of channels. At this time no CATV manufacturer offers an FM set-top converter. Dedicated single-channel FM decoders are available for supertrunking. They could be used for site-specific market testing of high performance video transmission. Over the long term the number of studio quality FM signals delivered could be flexibly controlled by the local cable operator. Detractors point out that current FM transmission technologies require approximately 40 MHz spacing per channel and that the cost of the FM modulator and demodulator are expensive. It should be noted that the added advantage of transferring the FM signal directly to the consumer's set-top helps to control technical degradation in the final signal distribution at the tap and drop cables.

One of the interesting aspects of FM transmission is the noise improvement that is obtained at demodulation. Above a CNR of approximately 12 dB, the SNR of the demodulated signal is ratiometrically improved over an equivalent AM signal[13]:

$$SNR/CNR = 3\left(\frac{\Delta F}{f_m}\right)^2 \quad (1)$$

for a system with an FM discriminator, where:
ΔF = the frequency deviation and
f_m = the baseband bandwidth

Further improvement in SNR can be realized using pre-emphasis and de-emphasis. For an FM system with a 4.2 MHz baseband bandwidth and a ±10 MHz deviation, the improvement would be a theoretical 36 dB in SNR. A 60 dB SNR is then obtainable with only a 24 dB CNR signal. The CTB would be of greater relevance here but certainly a cascade of 100 amplifiers is conceivable.

The digital transmission of TV information is a largely untapped resource for the CATV industry. The conversion of TV information to digital has by far the highest bandwidth cost. In return, digital provides the following advantages:

1) CNR thresholds that are similar to FM. In the case of digital, there is little further degradation of the signal once the minimum CNR is met. The SNR is replaced by a "probability of error" term that describes the probability that any of the data bits will be incorrect. The probability of error is described by the error function[14]:

$$P_e = \frac{1}{2}\left[1 - \mathrm{erf}\left(\frac{i_s}{2\sqrt{2}<i_N>}\right)\right] \quad (2)$$

Figure 2: Tree-and-branch architecture with mixed FM and AM

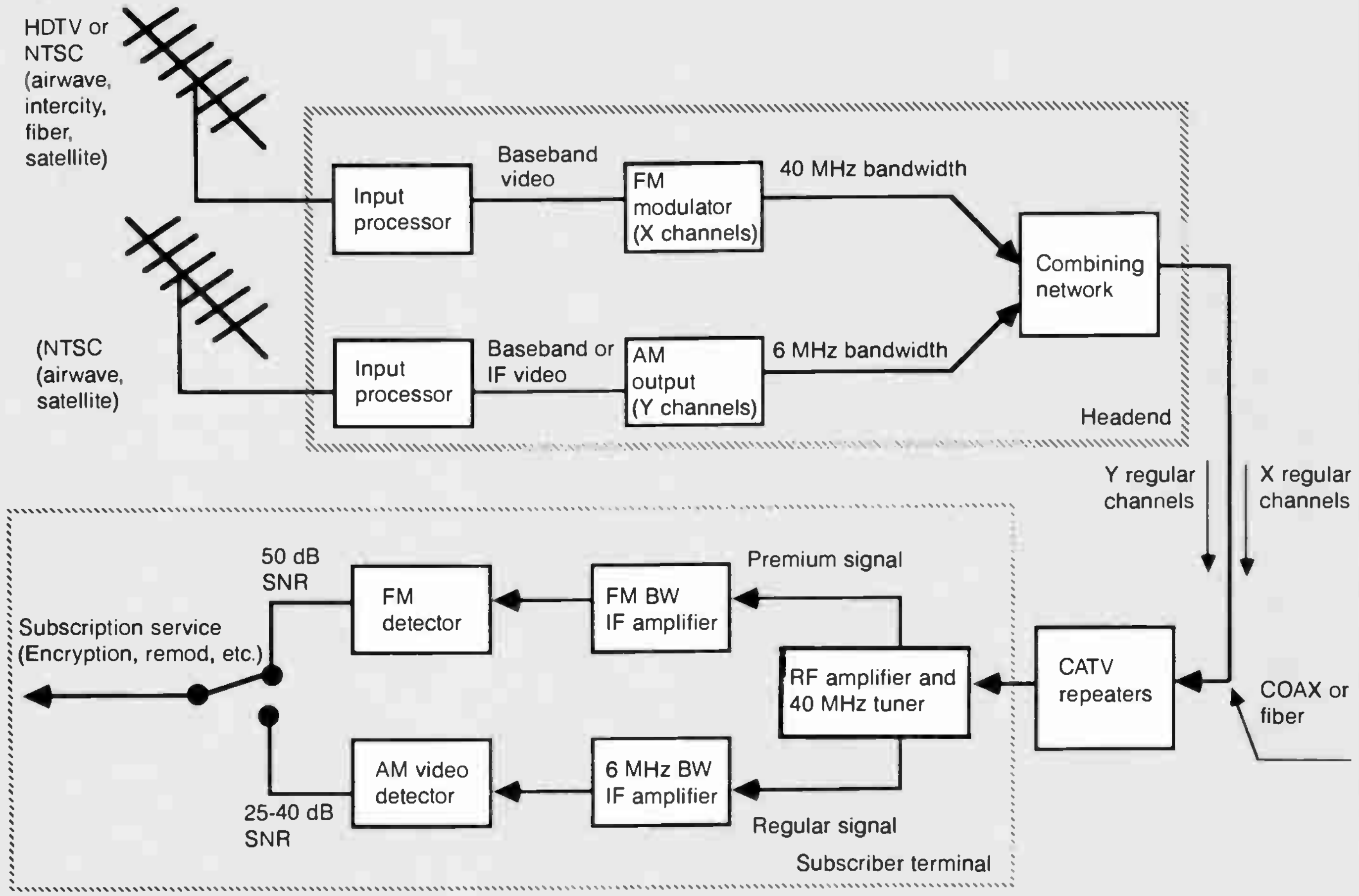
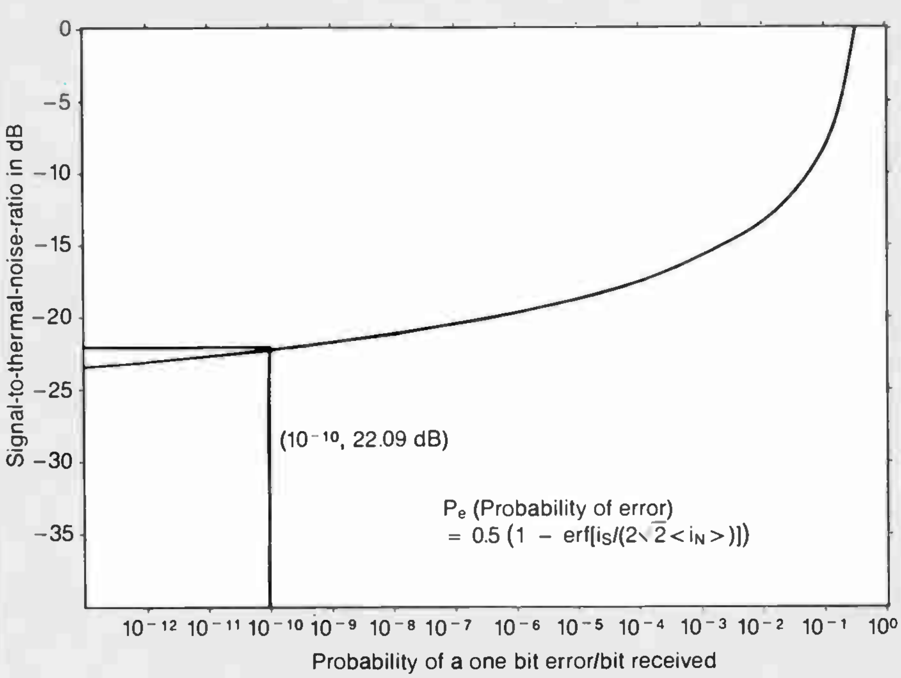


Figure 3: Probability of a bit detection error vs. SNR for a PCM signaling scheme (thermal noise effects)



where:

$$\text{erf } z = \frac{2}{\sqrt{\pi}} \int_0^z e^{-x^2}\, dx$$

P_e = the probability that a received bit will be wrong

i_s = the signal current at the measurement point

$<i_N>$ = the RMS noise current

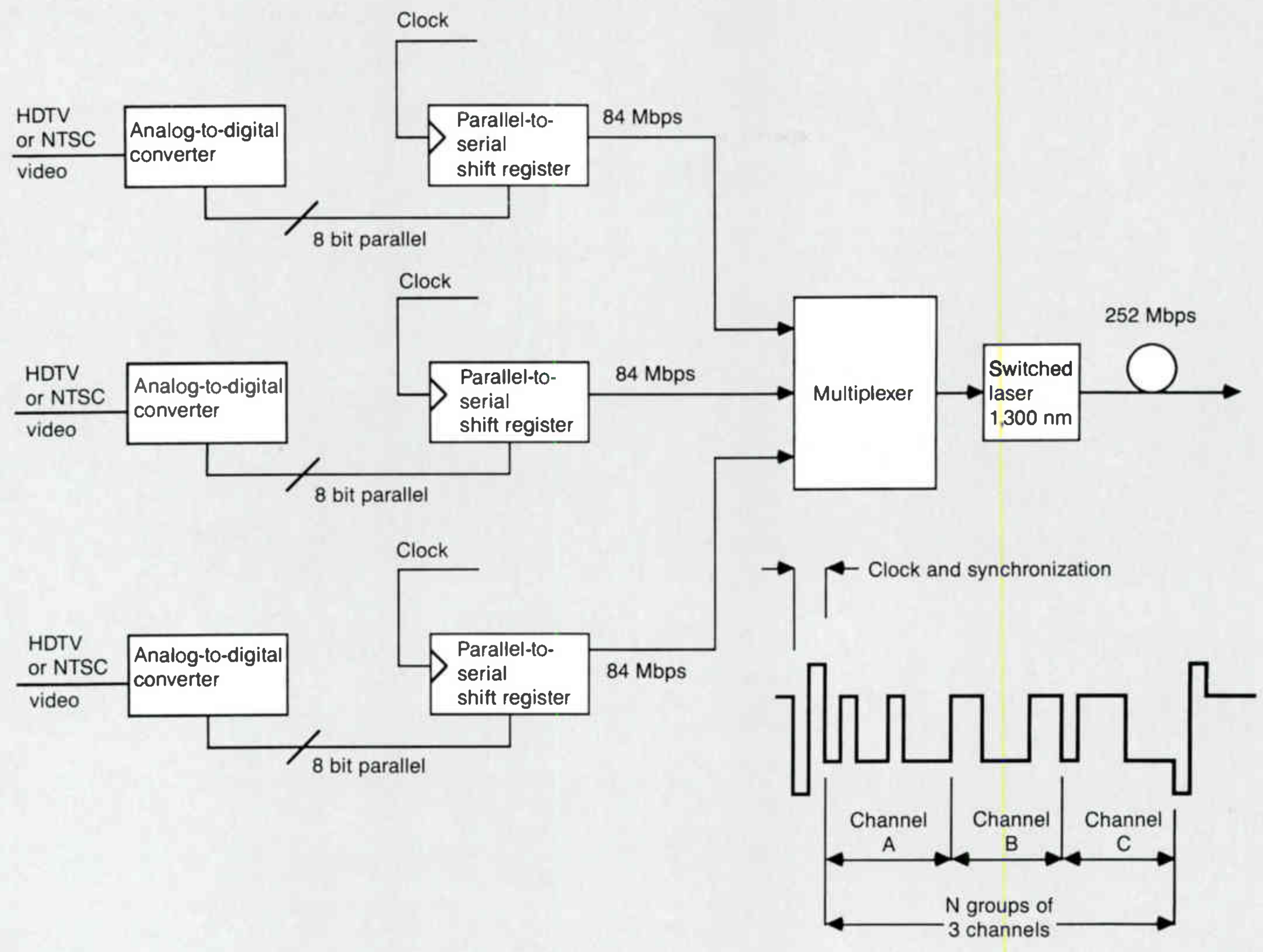
Figure 3 shows a graph of the probability of error as a function of SNR in a typical digital fiber-optic communications system.

2) Error detecting algorithms can be attached to the digital encoding. This implies a nearly unlimited regeneration of the video picture with no loss of data precision. Error correction schemes also can report back to the central management site any errors detected. CATV currently relies on customers to decide what constitutes an unacceptable signal. A higher quality, more reliable and more convenient service would therefore be available to the consumer.

3) The worldwide interest in digital technology has resulted in substantial improvements in the cost of attaching digital technology to the analog issues of television.

4) The conversion of analog TV to digital for transmission causes the concentration of linearity issues in a small number of pre- and post-processing components.

Figure 4a: Time division multiplex serial video transmission



Digital techniques

While a detailed discussion of digital techniques is beyond the scope of this article, there will be an introduction to some of the most relevant terms associated with digital coding schemes in use today.

Pulse code modulation (PCM) is the digital representation of an analog signal by a sequence of numbers. Each time slot of the analog signal is replaced by a single number with only discrete integral and fractional numbers being allowed to exist. The difference between two adjacent numbers is called the *resolution* of the set of numbers. The transition between two adjacent numbers is one step. The process of representing the analog signal by the finite number of steps is called *quantization*. This introduces an initial coding error (quantization noise) closely associated with the resolution and proportional to it. The process of transmitting a PCM-encoded signal is actually the process of recovering the numbers transmitted without error.

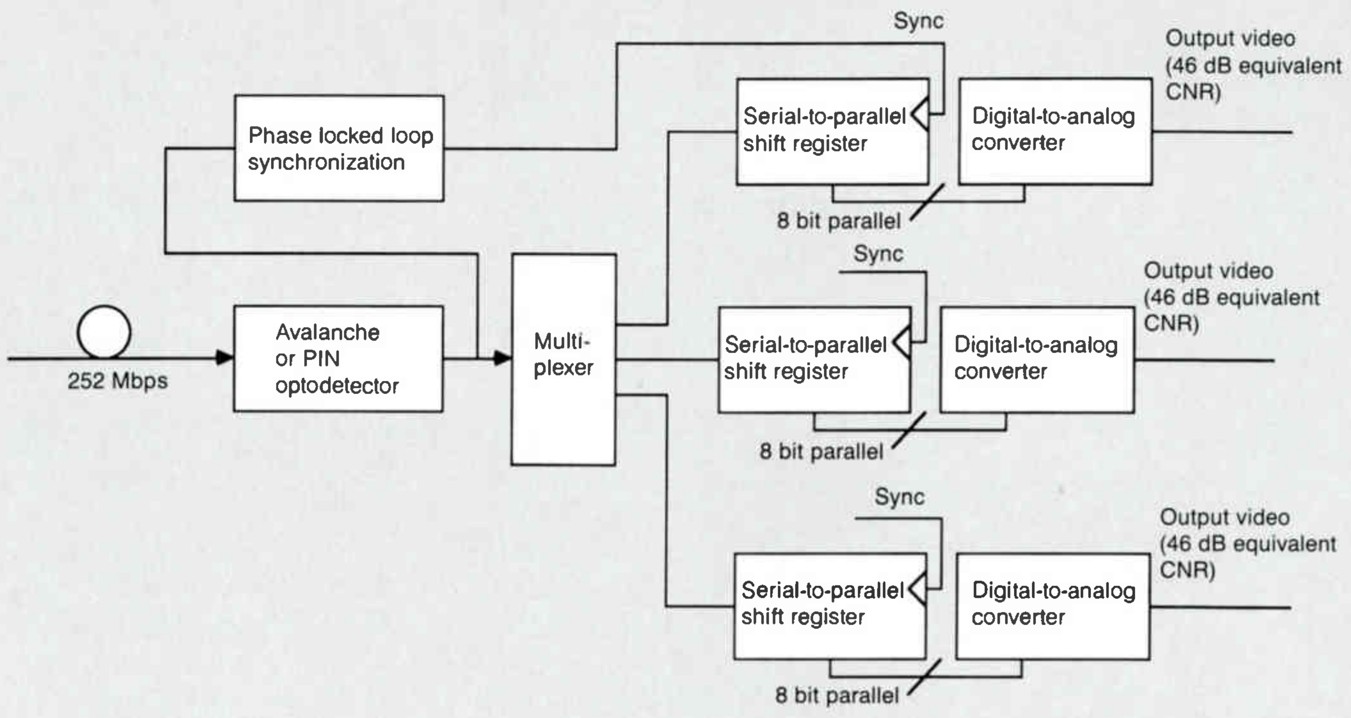
In a digital transmission scheme, the maximum noise and distortion is determined almost solely by the number of steps in the digitizing set, the input amplifiers and the output amplifiers. In analog transmission, the primary signal transfer characteristics are determined by the transmission media. For digital coding techniques such as PCM, the SNR is dominated by signal-to-quantizing-noise. This ratio improves linearly with the number of digits in the sample. Analog transmissions require significantly better SNR than the equivalent digital representation because of amplifier cascade degradation. In general, digital systems require additional bandwidth to transmit the numerical data. The progress of technology has shown us that greater bandwidth is more easily found.

The Nyquist digital sampling theorem says that if a target signal is measured at least twice as fast as the maximum bandwidth desired, then enough information is encoded to completely describe the sampled signal. For NTSC the minimum bandwidth is 4.2 MHz, making the minimum sample frequency 8.4 MHz. Since phase information for the color subcarrier is desired as well, a further doubling of the sample frequency above the color subcarrier harmonic at 7.16 MHz is needed. The minimum NTSC sample frequency is therefore 14.32 MHz. A 30 MHz HDTV signal would require a 60 MHz sample rate by digital sampling theorem rules. Studio quality NTSC composite color actually has a wider bandwidth than over-the-air NTSC. Additional information could be passed to the home receiver if the bandwidth and SNR were available. At the present time there are 22 HDTV proposals before the FCC. It is not possible or even sensible to determine a coding scheme for each. Any further analysis in this article will use a generic 16 MHz sampling frequency, which has a usable bandwidth of 8 MHz.

The simplest structure to encode video signals would be a direct conversion to PCM data. To produce a 50 dB CNR at the subscriber's home a sensible CNR/amplifier cascade of the system plant would be 60 dB. This number is reasonable as long as the complete cascade to the home is four or under. To convert the composite analog video signal to PCM it is therefore suggested that the step size (resolution) be no more than 0.1 percent or −60 dB or 1,024 steps or 10 bits total. Adding error correction codes and syncing information would require an additional six bits. The total information bandwidth is then 16 bits × 16 MHz or 256 megabits per second (Mbps).

In order to maximize the efficient use of hardware, channel compression schemes are often used, such as time division multiplex (TDM). With TDM, several PCM channels are encoded onto

Figure 4b: Typical time division multiplex video receiver



a single transmitter output; a regular time slot is assigned to each PCM channel. The PCM channels can then be grouped together into a time sequential format (serial). A complete sequence that samples each of the input analog channels is called a *frame*.

A typical serial architecture is shown in Figures 4a and 4b. Recent demonstration projects involving digital TV have involved the conversion of NTSC color in either composite or component form into a serial bit stream at rates of up to 252 Mbps. In the case of Personick, et al.[7], six channels were multiplexed on a single fiber at a total bit rate of 504 Mbps. The sampling rate of 10.5 MHz and single-channel transmission rate of 84 Mbps would be insufficient for HDTV applications. In the case of HDTV, transmission rates for one channel have been reported as high as 1.188 gigabits per second[4].

On the lower end of the scale and of particular interest to CATV operators is the recent efforts by AT&T[2] to encourage the broadcast networks to use a companding box as a gateway to the AT&T DS3 network lines that operate at 45 Mbps. Informed sources report the results showed motion artifacts to the experienced observer.

Cost-effective solutions

As a market-driven industry, CATV operators have always opted for solutions that are cost-effective in the distribution of signals from a central source to many subscribers. It is suggested that the route to digital TV will utilize an architecture that is a simple solution to the distribution of PCM signals. In the telephone industry, highly sophisticated data compression algorithms are used to compress as many customers onto a line as possible. The number one issue is how best to manage the billions of connection possibilities that the consumers may request. Fitting digital TV into the CATV format is a non-issue because there is no established digital CATV format. Customer multiplexing is also a relative non-issue because a connection once made lasts for hours and even years. In addition, bandwidth is relatively cheap now and due to become more so as the AM fiber laser manufacturers actually bring a fully usable product to market.

Schottky and CMOS ICs are relatively low cost when compared to ECL with its high heat dissipation. In particular, 1 ns/gate CMOS gate arrays are available today with a further order of magnitude in improvement reported in the laboratory. A suitable CATV digital TV architecture could take advantage of cost savings in all of these areas.

Figure 5 shows a wavelength division multiplex architecture. Multiple lasers are used at different wavelengths to encode a serial data stream containing one or more digital television channels. The laser outputs are then combined using a dichroic interference filter. The resulting composite waveform is injected into a single-mode fiber. At the receiving end another dichroic filter is used to split the signals and send them to separate detectors. Since the data streams are sent digitally a relatively high CNR and crosstalk tolerance is allowed.

It will be shown that a 16-bit parallel transmission system takes advantage of the things that CATV does and knows well. Such an architecture is shown in Figure 6. Current high density modems use a spectrum division multiplex architecture to rework the SNR and information density issues. Specifically, it would be possible to attach an AM-type carrier to each one of the 16 data bits. Using a 16 MHz sample rate, the binary value of each of the carriers would be changed at 16 Mbps rate. It also makes possible the use of moderate to low cost, well-understood semiconductor technologies.

In the case of AM encoding for each bit, a third harmonic bandwidth would be preferred for each channel. This translates into 96 MHz/channel, which is not acceptable. 1.54 GHz would be required to transmit the full digital video picture.

It is possible to decode a bandwidth limited signal completely as long as the bandwidth exceeds twice the data transmission rate.[1] The minimum bandwidth/transmission channel would therefore be 32 MHz/digital channel or 512 MHz. To achieve such a low bandwidth would require either quadrature AM or single-sideband transmission. The bandwidth and hardware cost could be controlled by using a hybrid mix between analog transmission methods and digital theory.

When the data channel bandwidth requirements are high and the SNR is controllable, it is appropriate to use more than one threshold per time sample in the signalling scheme. Such a scheme is pulse amplitude modulation (PAM). Figure 7b shows how bits are encoded in a PAM scheme, based on the Grey Code, in which an error in detection cannot result in a shift of data of more than one bit. Traditionally, digital signals have been encoded using only two signal levels, as in Figure 7a. Encoding two bits/channel would result in a 50 percent reduction in bandwidth per video channel, for a 2:1 improvement in cable cost. The minimum channel SNR would be reduced by one-half; the number of RF transmitters and receivers would be reduced by one-half. The tradeoff would be increased encoding/decoding complexity. The total system bandwidth to transmit one NTSC/HDTV channel would then

(Continued on page 65)

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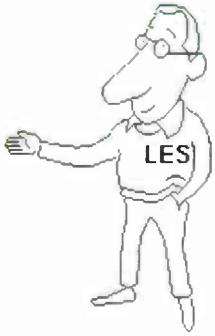

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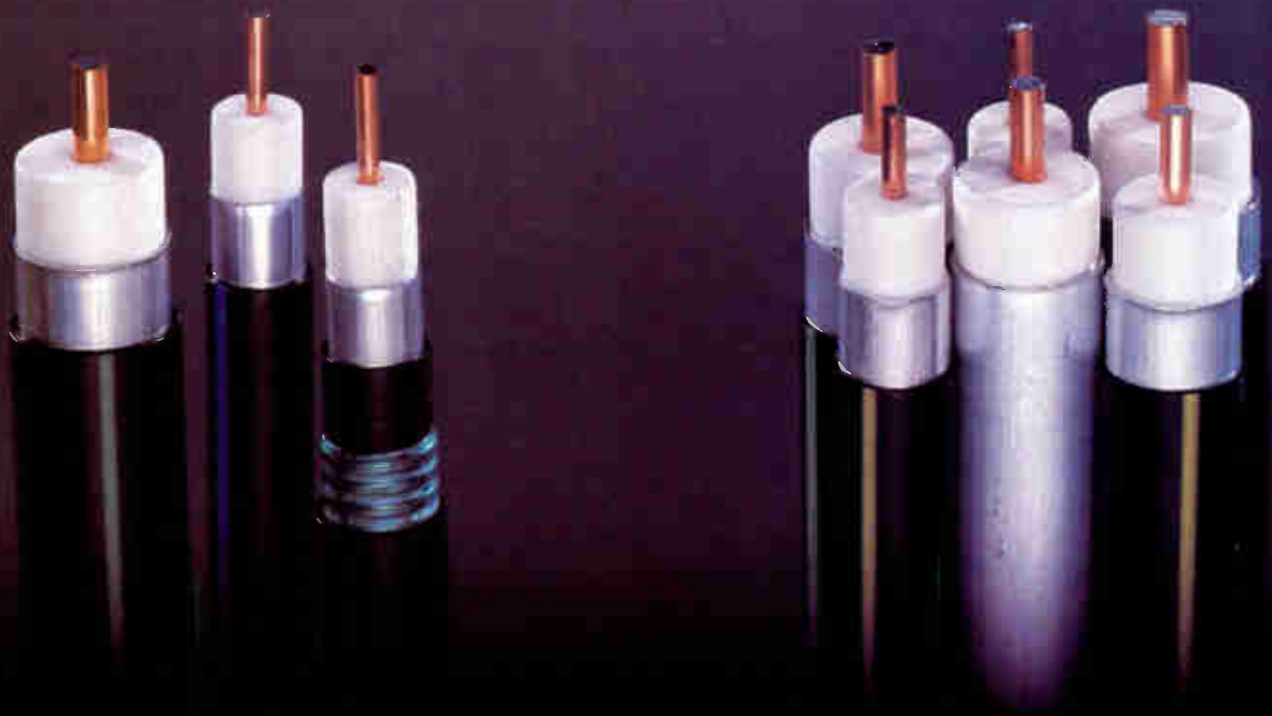

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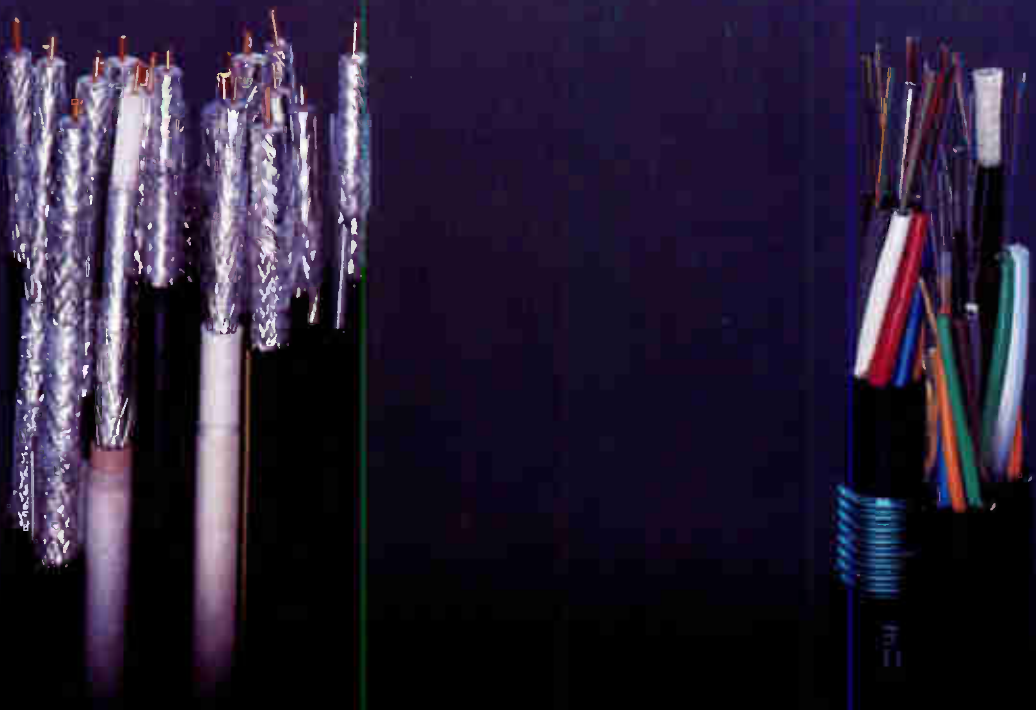

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(Continued from page 44)

be 256 MHz. The system would be able to correct single-bit errors and detect multiple bit errors.

Under a quadrature AM (QAM) transmission scheme, the data would be transmitted in the form of the vector sum of two carriers. The two carriers are 90° offset in phase as shown in Figure 8b. An interesting implication of the four point "star" approach is that the amplitude of the resulting sum is constant. Under a QAM transmission scheme, the 0° reference must be transmitted periodically for synchronization of the demodulator to the carrier signal. A typical implementation is shown in Figure 8a. Here the peak 30 percent of the carrier amplitude is used to provide synchronization once each 16 data spaces. A phase locked loop (PLL) would be used to recover synchronization at the demodulator. Since the reference frequency is constant, the capture range of the PLL could be made very narrowband and thus noise tolerant.

It should be noted that the QAM transmission scheme just described is essentially error detecting. By placing test bits in the 90°, 180° and 270° positions, the crosstalk between the two quadrature carriers can be tested regularly and at any time. Reports of poor transmission performance and impending failures can be returned to the central control position at minimal time delay from the occurrence, improving the scheduling of the most qualified personnel. They would be able to detect lines most in need of repair well in advance of a service breakdown. The channel separation test also would nearly eliminate the need to regularly sweep the line and/or rely on customer complaints to detect system deterioration.

From the error probability curve in Figure 3, a minimum CNR can be determined. A 10^{-10} error probability implies that the TV picture will have one bit of error each 70 full frames for an HDTV-scale picture. A CNR of 22 dB is theoretically required to achieve the goal. The peak carrier level is 6 dB higher than the data stream. Therefore, a minimum CNR of 28 dB would be desired for the system. The probability of a double-bit (uncorrectable) error for the system would be 10^{-20} or once each 740 years of continuous HDTV broadcasting. Clearly the transmission system accuracy is no longer an issue if the minimum CNR is maintained. The full system performance would be determined solely by the input and output conversion performance.

Using 40 MHz spacing/data channel for the HDTV signal with a basic sampling speed of 16 MHz yields 12 data channels in the 50-550 MHz band. In this case the total bandwidth for one HDTV signal would be 320 MHz. The noise power for a broadband amplifier is normally specified relative to a single NTSC video bandwidth of 4 MHz. Since noise is additive on a power basis, a 50 dB CNR using 40 NTSC channels translates into a 40 dB CNR when using 12 data channels of 40 MHz bandwidth. Recalling the minimum CNR of 28 dB shows that there is plenty of room for additional data compaction.

Running spectrum division multiplex (SDM) signals through a coaxial cable is not recommended. The propagation characteristic of coax is not constant with frequency nor temperature. A 16 MHz pulse transmission speed implies that data groups are spaced 62.5 ns apart or 15 meters (50 feet) in physical distance using foam dielectric cable. A 2,000 foot standard cable run implies that the propagation delay over the 256 MHz bandwidth of a video data channel must be accurate to 5 feet (6.25 ns) or 0.25 percent. Although fixed time delays could be added to compensate at installation time, the temperature coefficients of propagation delay would be troublesome.

The single-mode optical fiber is an ideal transmission medium for an SDM digital TV format:

a) Current single-mode technology permits amplitude loss for single-mode fibers at about 0.5 dB/km. A 10 mile (16 km) run would have an amplitude loss of 8 dB. There is a thermal attenuation parameter that would affect signal-to-thermal-noise.

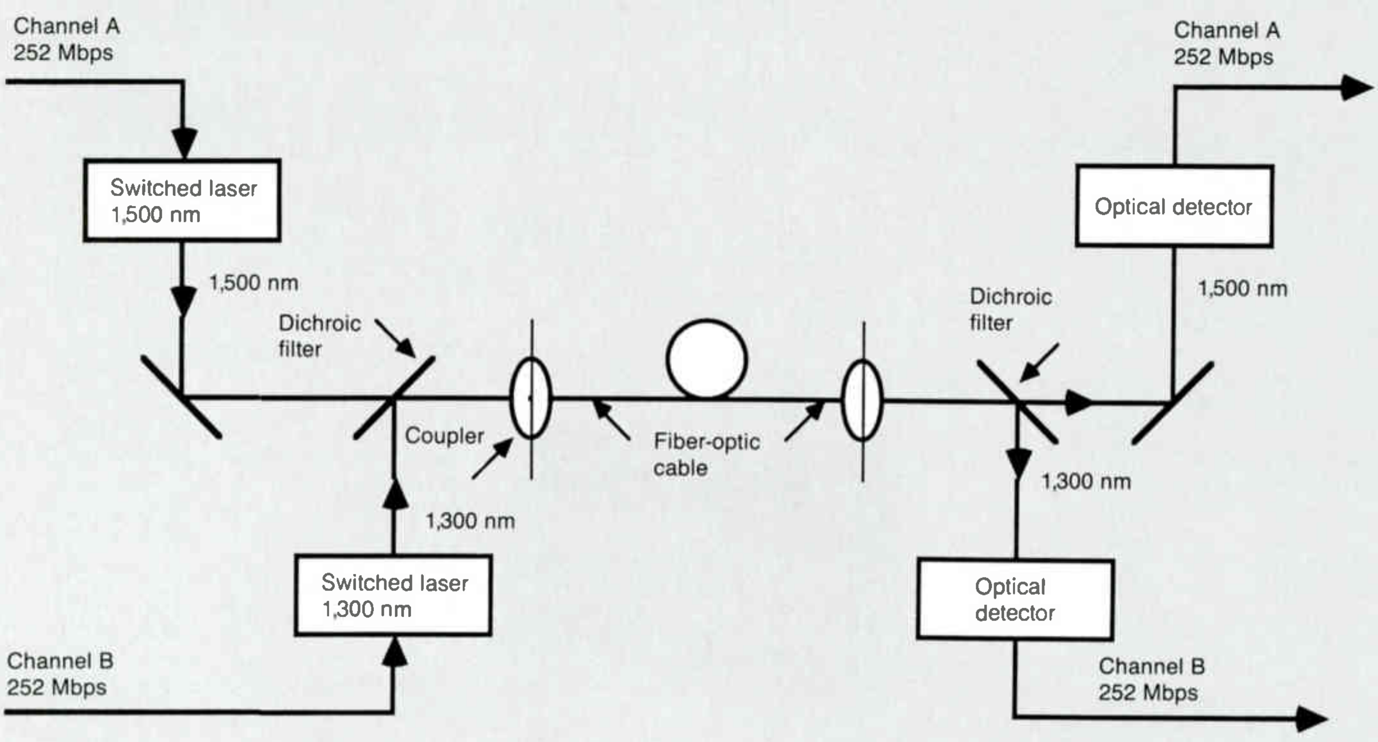
b) Excellent pulse dispersion qualities. The computation of pulse dispersion or "pulse softening" in an optical fiber is determined by the spectral bandwidth of the optical source and by the dispersion coefficient of the optical fiber involved:

$$\Delta T = D(\lambda) \times L \times \Delta\lambda \quad (3)$$

where:

ΔT = pulse dispersion in picoseconds (ps)
$D(\lambda)$ = fiber dispersion coefficient in ps/nm-km
L = length of the fiber in kilometers

Figure 5: Typical wave division multiplex data transmission scheme



$\Delta\lambda$ = linewidth of the driving laser in nanometers

Typical numbers for an NEC laser and 10 miles of Corning single-mode fiber are 200 ps of dispersion at 1,310 nm center frequency. Using dispersion-shifted fiber at 1,550 nm the 16 km length would show a pulse dispersion of 21.6 ps. Clearly one can expect all data from a 16 km single-mode fiber to arrive within 1 ns. Thermal drift would be essentially non-existent as a pulse dispersion parameter.

c) The transmission of 40 video channels with eight data channels for each video channel would require 10 GHz of total bandwidth. Such a colossal bandwidth could be easily handled with eight single-mode fibers. Each fiber would have a data channel CNR requirement (thermal and CTB) of 28 dB for a 10^{-10} bit error rate. The bandwidth/fiber would be 1.25 GHz. Additional channel packing density can be obtained by wavelength division multiplex in which a second group of channels is placed at an alternate optical wavelength. The WDM scheme can also be expanded to cover bidirectional transmission.

d) The linearity required for the transmitting laser is substantially reduced (> 10 dB) from that required for the AM fiber systems being promoted as a solution for the CATV fiber backbone. The improved noise and distortion requirement would obviously improve the yield and lower the cost of the distributed feedback (DFB) and Fabry-Perot lasers appropriate for single-mode operation.

The SDM approach is a solid solution to the higher performance video needs of HDTV, the 1990s and through the turn of the century:

- It is low cost. No high performance interpolators are required to compress bandwidth. Construction is via 1980's performance Advanced Schottky, CMOS or ECL circuitry.
- The digital format provides for virtually unlimited reproducibility. The noise susceptibility is low and improves by a factor of 10 for each 0.5 dB CNR above 22 dB. Error correction codes will reduce transmission errors below one per year.
- The SDM format includes features for performance testing automatically and regularly. Reports can be issued on command. Marginal performance can be detected in advance of a breakdown and/or customer complaint.
- The fiber-optic link would have little if any temperature dependence.
- Lower cost lasers can be used than what is required for AM fiber backbone performance.

Simple and appropriate

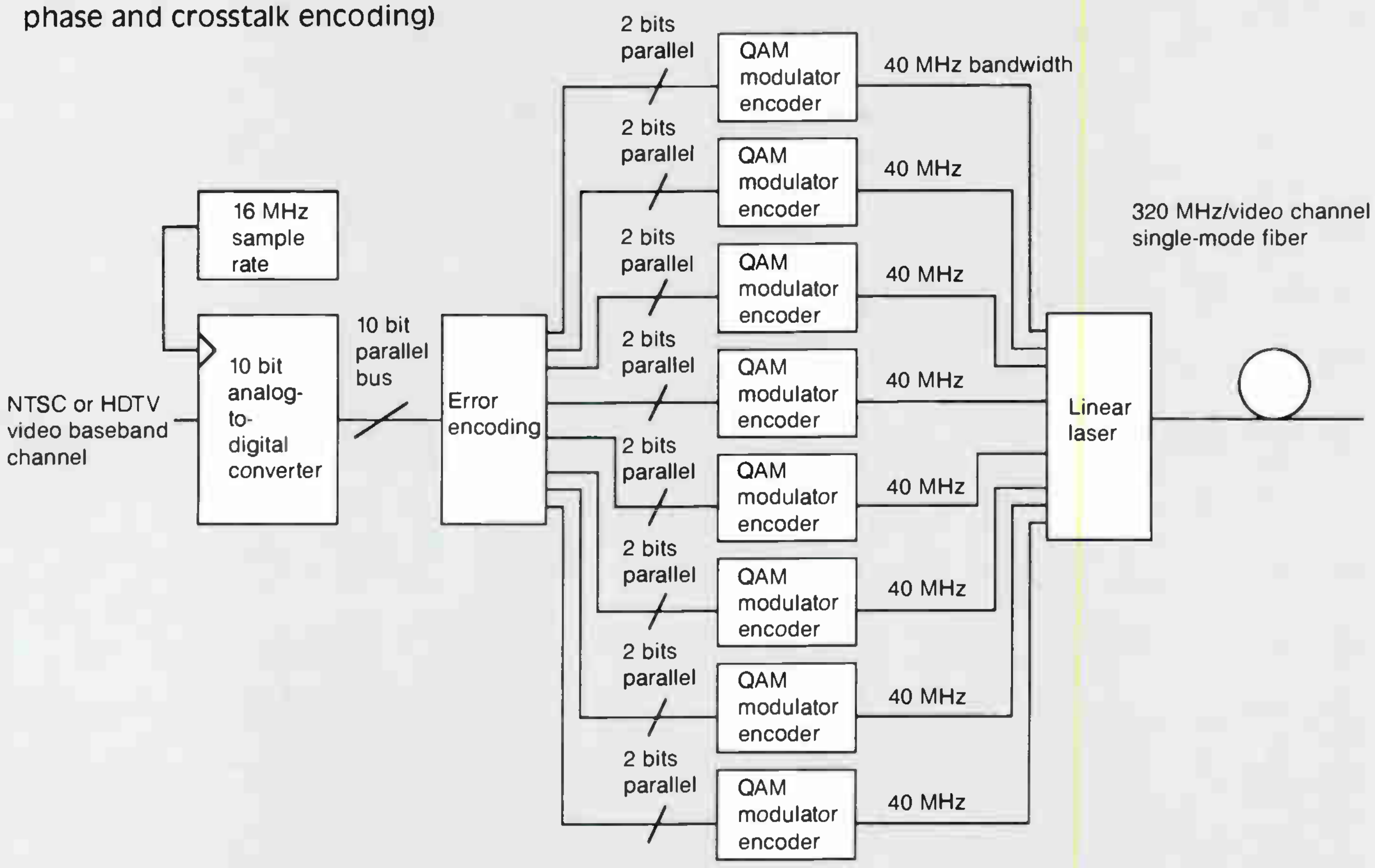
Several digital coding schemes have been presented that are structurally simple and therefore appropriate to a future CATV system architecture. Many schemes have been left out, particularly those that use extensive and therefore costly data compression. The reader is referred to the references for telco PFM[12] and Japanese TCM[11].

There is convincing evidence that the AM tree-and-branch architecture is inadequate to the task of raising the 1990's CATV system to a studio quality (medium-haul) signal. The AM fiber backbone system can reduce the effective cascade count when new generations of laser transmitters appear in coming months and years. The relentless cost-cutting in the digital IC industry suggests that the costs for digital TV transmission will be commercially viable soon. A continued commitment to AM would only result in obsolescence as transmission equipment is replaced by FM and digital in the next decade. In particular, with current linear lasers showing a manufacturing yield at 1 percent, major cost reductions can be expected as the technology is better understood.

A cable operator can respond to the challenge of high performance TV transmission today by the use of FM transmission in reserved channel space. The superb performance would be attractive to local public gathering places that normally have large display TVs. A coordinated market test would provide valuable information about whether subscribers would pay to have studio quality and/or high-definition TV in their homes. The progress of HDTV issues could be determined locally by such market tests.

The strength of digital TV lies in intercity transmission. CATV has traditionally derived its TV signals from the broadcast airwaves because they were initially free and later low-cost. There is additional quality and improved noise performance to be had from the broadcast studio if a direct connection were made. Now that cable operators are required to pay copyright fees for the signals they transmit there is no longer a substantial reason why operators should not get their signals at the studio, ahead of the vestigial sideband transmitter filters. This would result in freedom from ghosts and co-channel plus a more detailed signal than is presently received. Digital TV transmission would ensure that the same high quality picture would be reproduced at the consumer's terminal, be it HDTV or NTSC. There is no better picture than one that is infinitely reproducible without degradation.

Figure 6: 16 bit video transmission scheme with quadrature amplitude modulation (2 levels/ phase and crosstalk encoding)



Acknowledgments: This article is dedicated to Matthew Burzycki, who spent most of his life committed to the reception of a higher quality picture at a reasonable price. Longin Burzycki provided inspiration and essential review of the manuscript. Dave Large of Raynet and Hermann Gysel of Synchronous Communications provided valuable insight into the current state of CATV transmission technology. Barbara Bliss of Siecor provided up-to-date information on fiber-optic bandwidth capabilities. F. Younglove created the figures and provided consultation. Many thanks also to Rela Inc. of Boulder, Colo., for providing technical support.

Figure 7a: Biphase binary encoding of transmission levels

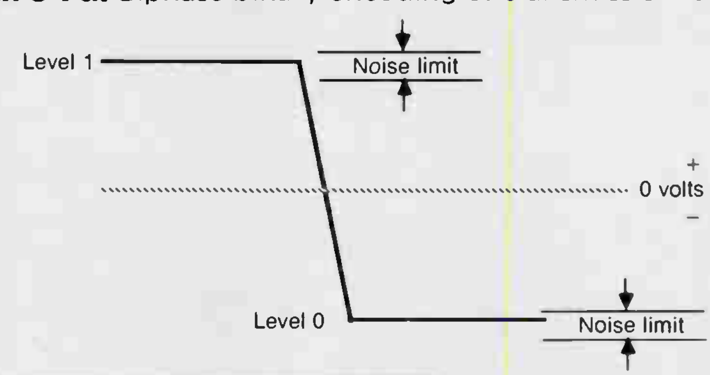
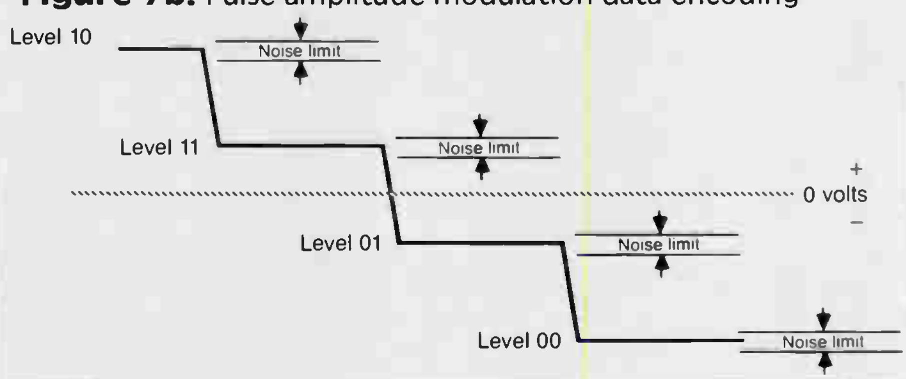


Figure 7b: Pulse amplitude modulation data encoding



References

1 Benedetto, S., Biglieri, E. and Castellani, V., *Digital Transmission Theory*, Prentice-Hall, 1987, Chapter 5.

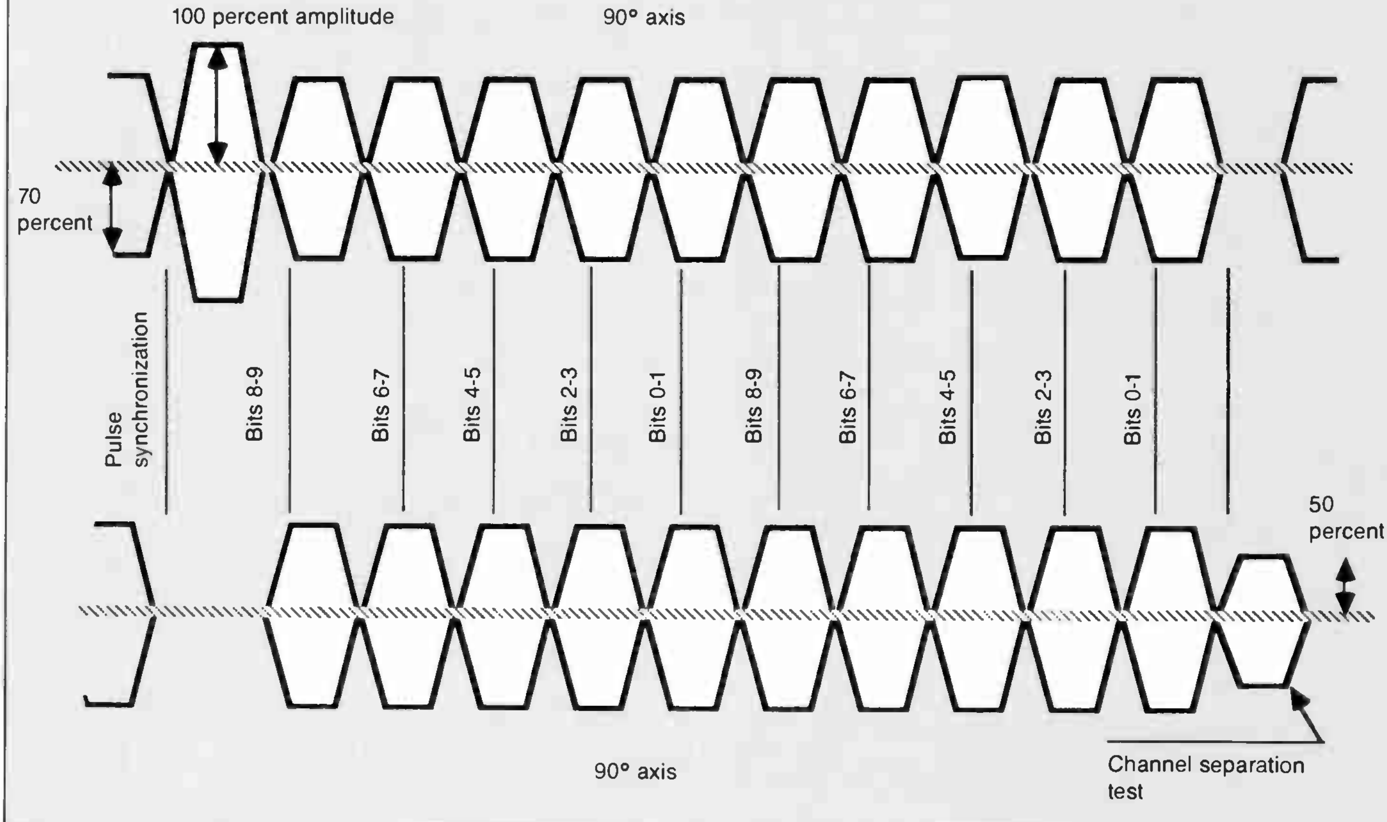
2 Blackburn, R.J. and Hessler, P., "DS3-Rate (45 Mbit/sec.), Customer Controllable Multipoint Networks for Broadcast Television Distribution/Collection," *SMPTE Journal*, Vol. 97 No. 9, September 1988.

3 Chouinard, G. and Barry, J., "NTSC and MAC Television Signals in Noise and Interference Environments," *SMPTE Journal*, October 1984, Vol. 93 No. 10, pp. 930-942.

4 Hashimoto, M., "An Experimental VTR with a Bit Rate of 1.188 Gbps," *IEEE Transactions on Broadcasting*, Vol. BC-33 No. 4, December 1987.

5 IEEE Press, "Special Issue on High Definition Television," *IEEE Transactions on Broad-*

Figure 8a: Typical quadrature AM bit encoding scheme



casting, Vol. BC-33 No. 4, December 1987.

[6] Institution of Electrical Engineers, "Proceedings of the 1986 International Broadcasting Convention," London, 1986.

[7] Personick, et al., "Digital Video Supertrunking on Single Mode Optical Fibers," *SMPTE Journal*, Vol. 94 No. 1, January 1985.

[8] Rzeszewski, T.S., *Color Television*, IEEE Press, 1984.

[9] Rzeszewski, T.S., *Television Technology Today*, IEEE Press, 1985.

[10] Schreiber, W.F., "Psychophysics and the Improvement of Television Image Quality," *SMPTE Journal*, Vol. 93 No. 8, August 1984.

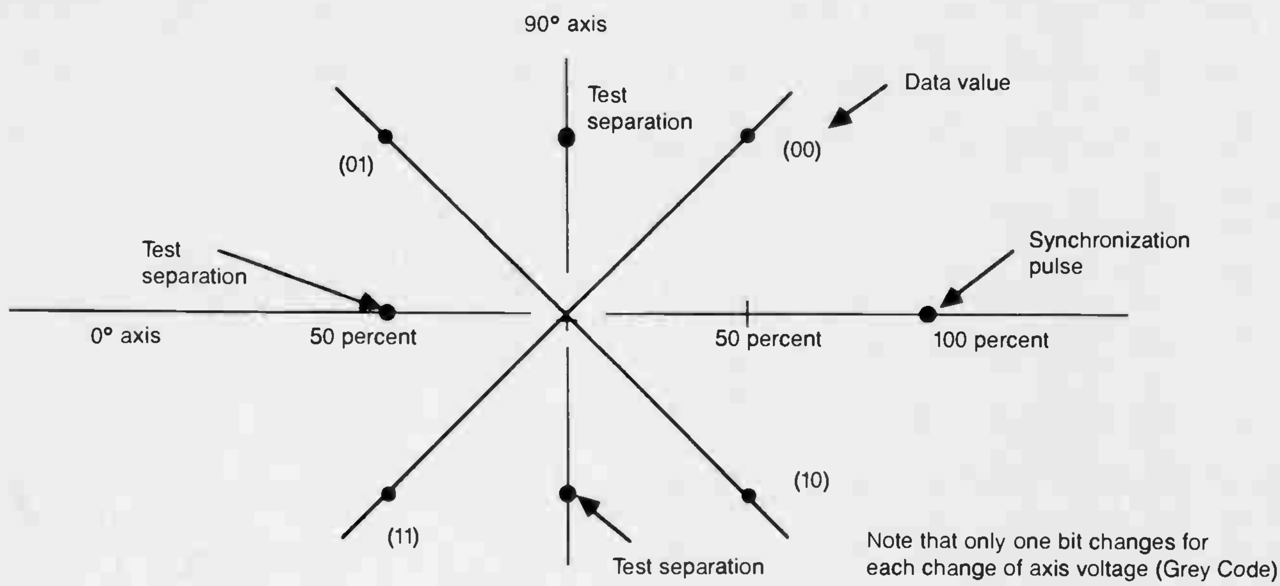
[11] Tsuboi, T., et al., "Fiber Optic HDTV Transmission Technology," *SMPTE Journal*, Vol. 94 No. 1, January 1985.

[12] Vlack, D. and Lehman, H.R., "An Experimental Digital Video Switching Architecture," *Television Technology Today*, IEEE Press, 1985.

[13] Westman, H.P., *Reference Data for Radio Engineers*, Howard W. Sams & Co., 1972, pg. 21-11.

[14] Yariv, A., *Optical Electronics*, Holt, Rinehart and Winston, Third Edition, 1985, pg. 340-1.

Figure 8b: QAM phase encoding scheme



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Optical return loss

By Todd Jennings
Product Specialist, Siecor Corp.

The benefits of transmission using fiber optics have led to great interest and aggressive plans for the design and implementation of lightwave systems for cable TV applications. In the past, conventional fiber-optic systems were designed almost completely based on optical attenuation, specified as a link loss budget. However, with the recent development and installation of equipment for transmitting high quality analog signals, potential limitations associated with reflections in an optical system also require attention.

Reflections are a concern for analog transmission in particular, since they can lead to significant degradation of signal quality. When light is reflected back into the laser cavity it causes interference that can create instabilities in signal output power and spectral behavior. The resultant noise will introduce power penalties and reduce the system signal-to-noise ratio.

The system designer's goal, therefore, is to minimize the source of this optical feedback and reduce its impact on laser performance. A well-planned system will maintain optimum signal quality and allow for future growth and flexibility. This goal is achieved by: a) specifying components based in part on their reflective qualities and b) testing the installed system for its combined reflections or system return loss.

"Specification of return loss for a given system is a function of the transmission equipment."

In order to optimize a system's design and selection of its components it will be helpful to understand the two basic types of reflections:

1) *Fresnel reflections*—These occur at points in the cable where the continuity of the glass is interrupted: at connectors, mechanical splices, splitters, couplers and other fiber-optic components. These points of localized change in the light's medium are commonly seen on an optical time domain reflectometer (OTDR) as spikes.

2) *Rayleigh backscattering*—Backscattering is low-level reflection from the fiber itself. It is inherent in the glass structure and minimized by the design and manufacturing process of the fiber. This backscattered light is distributed over the entire length of fiber and seen as a linear trace on an OTDR.

Quantifying return loss

In order to examine or evaluate these reflective components either individually or collectively in an installed cable system, it is necessary to quantify the amount of reflected light. This is referred to as "return loss"—simply a ratio of how much light is reflected back toward the transmitter compared to how much is transmitted out of it.

The Electronic Industries Association recently published a fiber-optic test procedure (FOTP-107, "Return Loss") that defines its test method. Bell Communications Research also outlines this same procedure in its technical reference TR-TSY-000326 on fiber-optic connector specifications.

Return loss is calculated as follows:

$$\text{Return loss} = -10\log_{10}\left(\frac{P_t - P_r}{P_o}\right) + c$$

where:

P_o = optical power incident on fiber
P_r = reflected optical power—reference
P_t = reflected optical power—test
c = constant determined by the characteristics of the test setup

Notice that return loss is measured in dB and defined so that the smaller the amount of reflection, the larger the return loss. As a result, efforts to minimize reflections and construct a better system will actually maximize the return loss reading in dB.

Minimizing reflections

Putting together a system with the least amount of reflection is accomplished by first evaluating and selecting individual components with small reflections. Efforts to minimize reflections are focused on the primary contributors: connectors and mechanical splices. The accompanying table lists typical return loss values of com-

Typical optical return loss

• Connectors	
Conventional	15-25 dB
Physical contact (PC or super PC)	30-50 dB
• Mechanical splices	20 to >40 dB
• Fusion splices	>50 dB
• Single-mode fiber	>50 dB

Actual system return loss:
1) is based on the combined effects of the above system components.
2) cannot be mathematically added or calculated but is dependent on the number, magnitude and locations of the reflections.
3) must be measured to accurately determine the combined effect of the individual components.

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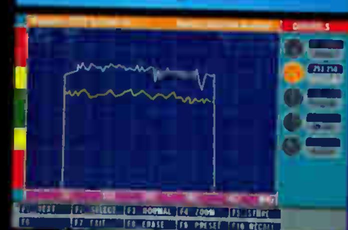

MLM display showing sweep response. White is actual response; yellow is stored response.

MLM display showing the video, color and sound carriers of Channel 3 with upper adjacent channel picture carrier and lower adjacent sound and color carrier also shown.

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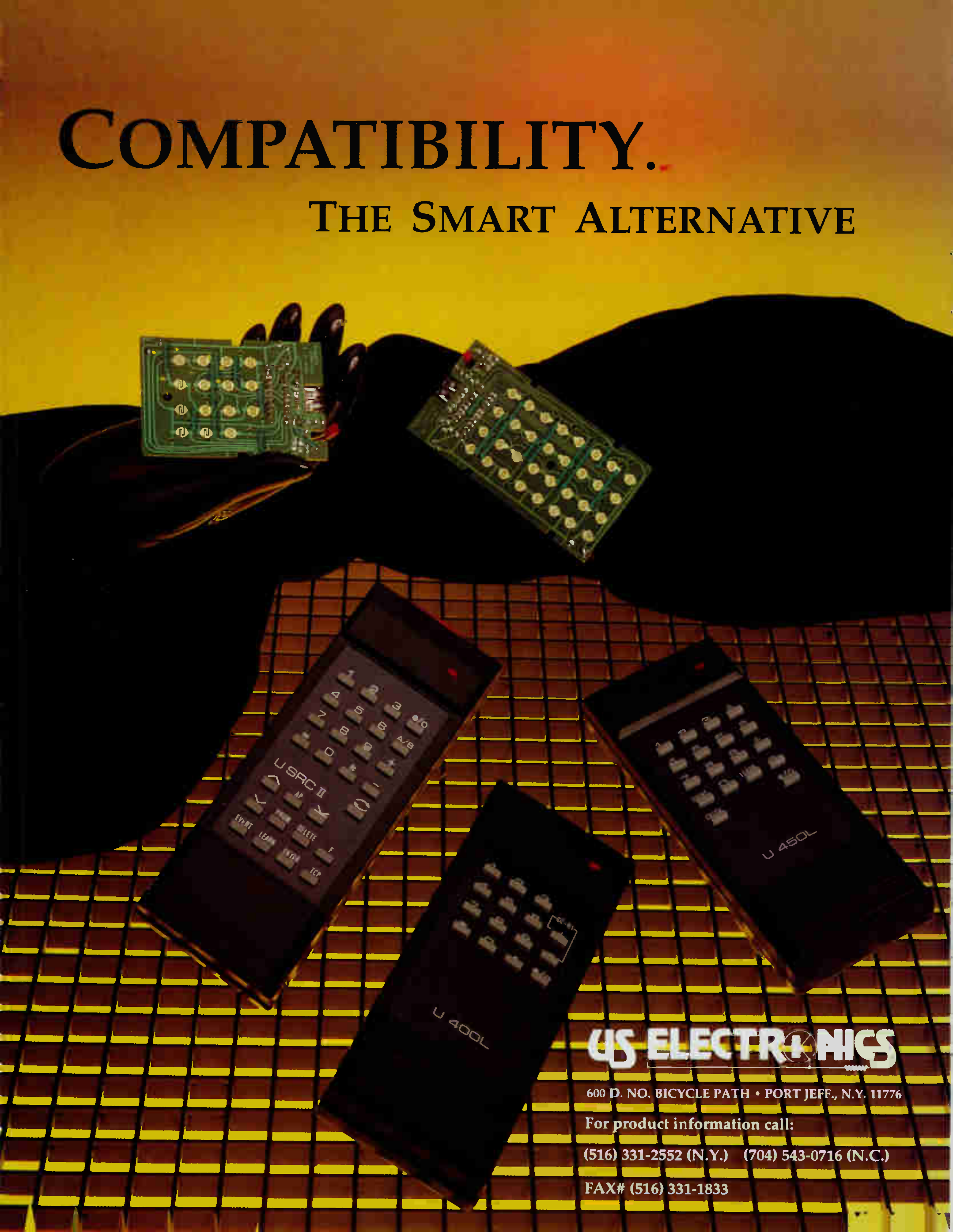
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ponents used in fiber systems.

Development of modified polishing techniques, anti-reflection coatings and methods of reducing the air gap between two connectors has resulted in PC (physical contact) and super PC connectors with higher return loss as is seen by the high upper range for connectors in the accompanying table.

Several mechanical splices now utilize index matching materials, tighter tolerances and polishing steps similar to connectors in attempts to maximize return loss. There also has been developmental work done recently on optical isolators. An isolator attempts to mask the amount of light actually reflected back into the laser cavity. As it stands, even when isolators are used, the combination of reflections can result in noise that can significantly degrade the signal quality of the lightwave transmission system.

Determining system return loss

Each of the system components can be evaluated individually for its return loss performance. However, the overall system return loss is the combined effect of each Fresnel reflection (e.g., connectors and splices) and the backscatter of the fiber itself. These reflections cannot simply be added together or calculated. Their combined effect is interdependent upon the number, magnitude and location of all the reflections as well as the attenuation of the fiber.

The amount of Rayleigh backscatter is based on the fiber's intrinsic scattering factor, attenuation and response to the optical signal energy. These variables, along with the effects of attenuation of reflections on the return trip and multiple reflections between fiber joints, make measurement of the actual system return loss a key to predicting system performance.

Note that Rayleigh backscattering caused by the fiber plays a minor role in overall system return loss when connectors or mechanical splices are present. Therefore the system designer can maximize return loss by attempting to minimize the number and magnitude of Fresnel reflections. This is most easily and best accomplished by utilizing fusion splicing and PC connectors at fiber joints. (Reference the table for a comparison of splicing and connection methods.)

System performance

Specification of return loss for a given system is a function of the transmission equipment, indicating how much reflection it can handle while maintaining its standard of signal quality. Vendors of the equipment being used should be able to provide guidance in establishing a system specification. Measurement of system return loss allows reliable prediction of its performance based on comparing test values with the system specification.

In addition to meeting the current return loss specification, consideration should be given to adding margin for potential future enhancements such as link extension, signal splitting, wave division multiplexing and other enhancements requiring a minimum level of signal quality.

Recommendations

Reflections in fiber-optic CATV transmission systems can cause noise that leads to significant degradation of signal quality. Evaluation of system components and measurement of installed systems can help ensure the proper operation of the system with the required standard of signal quality. After examination of return loss—its causes, effects and measurement—the following practical guidelines should be considered for system design and testing:

- Evaluation and specification of return loss of individual components prior to installation. (One of the criterion for selection should be return loss.)
- Testing the overall system return loss after installation as an acceptance test for designed system return loss specification.
- Considering the impact of potential future enhancements on overall system reflection in the original design and specification.

Taking these steps will lead to designing and implementing a system with optimum signal quality while maintaining flexibility for smooth growth and enhancement.

References

1) Choy, M.M., Gimlett, J.L., Welter, R., Kazovsky, L.G. and Cheung, N.K., "Interferometric Conversion of Laser Phase Noise by Single-Mode Fiber-Optic Components," *Electron. Lett.* 23, pp., 1151-1152 (1987).
2) Gimlett, J.L., Young, J., Spicer, R.E. and Cheung, N.K., "Degradations in Gbits/s DFB Laser Transmission Systems Due to Phase-to-Intensity Noise Conversion by Multiple Reflection Points," *Electron. Lett.* 24, p. 406 (1988).
3) Mazurcyzk, V.J., "Sensitivity of Single-Mode Buried Heterostructure Lasers to Reflected Power at 274 Mbit/s," *Electron. Lett.* 17, p. 143 (1981).
4) Hirota, O., Suematsu, Y. and Kwok, K.S., "Properties of Intensity Noises of Laser Diodes Due to Reflected Waves from Single-Mode Optical Fibers and Its Reduction," *IEEE J. Quantum Electron.*, QE-17, p. 1024 (1980).
5) Peters, J.W., "Field Measurements of Fiber Optics Systems," submitted to 1988 National Communications Forum.
6) Mulkey, O.R., "Return Loss," EIA FOTP-107, FO 6.3/6.4, pp. 1-7 (1988).
7) Bell Communications Research, "Fiber Optic Connectors," Technical Reference TR-TSY-000326.
8) Young, W.C., Shah, V.S., and Curtis, L., "Optimization of Return Loss and Insertion Loss Performance of Single-Mode Fiber Mechanical Splices," submitted to International Wire and Cable Symposium '88, *Proceedings*, pp. 395-400 (1988).
9) Wagner, R.E., Sandahl, C.R., "Interference Effects in Optical Fiber Connections," *Appl. Opt.* 21. p. 1384 (1982).
10) Suzuki, N. and Nagano, O., "Low Insertion Loss and High Return-Loss Optical Connector for Use in Analog Video Transmission," IOOC '83, 30A p. 3-5 (1983).

New FCC equipment authorization rules

By Christopher C. Smallwood
Attorney-at-Law

The Federal Communications Commission has revised some aspects of its equipment authorization rules. Those rules, as manufacturers in the communications industry know (or should know), apply to most devices capable of causing RF interference, such as CATV converters. The rulemaking proceeding was known as "Gen. Docket No. 87-212" and dealt mainly with the FCC's identification and labeling standards. These changes were made after a so-called "notice and comment" rulemaking proceeding, under which manufacturers had a chance to comment before the rules were adopted. The FCC released its Report and Order in the proceeding Jan. 5, 1989. The new rules, summarized as follows, took effect Feb. 21, 1989.

Deletion of the manufacturer code from the ID: Formerly, the FCC identifier was of the format "FCC ID: XXXYYY1234A." The first portion, "XXX," was the "grantee code," a three-character alphanumeric code assigned by the FCC to identify the grantee (that is, the applicant for an equipment authorization). "YYY" was a second three-character alphanumeric code, also assigned by the FCC, to identify the manufacturer. The remaining characters were assigned by the applicant to identify the particular device. Under the former rules, the grantee applied for a new authorization each time the manufacturing source changed (that is, because a new FCC ID was required). At any rate, the grantee was supposed to.

The FCC has now eliminated the manufacturer code from the FCC ID. This was a concession to the real world where a single grantee may use several different manufacturers as need or market conditions dictate. As before, the applicant/grantee is responsible for monitoring the equipment for compliance with the rules no matter who manufactures it.

New format

The new format for the FCC ID is "FCC ID: XXX123456789ABCDE." "XXX," as before, is the grantee code assigned by the FCC. (To avoid delay, the grantee should apply for a code before filing an application for equipment authorization.) In this example, "123456789ABCDE" is the grantee's own code to identify the device. Of course, that part of the code need not be 14 characters in length. On the contrary, the FCC encourages manufacturers to make that part of the FCC ID as short as possible, with 14 characters the maximum length.

The code identifying the device can consist only of capital letters, Arabic numerals (0 through 9) and the dash sign (-), in any combination. No other punctuation marks can be used. The applicant should not, of course, use the FCC ID of another product or one filed with the FCC as part of an equipment authorization application the FCC denied. As an example, "FCC ID: XXX123.45/AA" would not be accepted by the FCC as an FCC ID because the period (.) and slash mark (/) are not allowed. "FCC ID: XXX123 45 AA" is also no good: Spaces are not allowed. However, "FCC ID: XXX123-45-AA" is in proper form. Using an improper FCC ID in an application is begging for administrative delay.

It is not necessary for grantees to eliminate the old manufacturer code from the ID. Those three letters or numbers can be considered belonging to the device identifier part of the ID.

Trade names: Previously, the FCC required that it be notified of changes in a device's trade name. Typically, the only production changes were cosmetic and had no impact on the electrical characteristics of the device. The old requirement was burdensome and the FCC decided not to require it any longer. So a new rule (Section 2.924) lets grantees market approved equipment under any trade name without additional filings with the FCC, if two conditions are met. First, the equipment must be electrically identical (that is, any change is a "Class 1 permissive change") with the equipment already approved by the FCC. Second, the equipment must be marked with the appropriate label.

Format of identification label: The FCC also

> *"Using an improper FCC ID in an application is begging for administrative delay."*

changed its former requirements regarding the information that has to be on the identification label. Those changes are as follows:

1) Trade names need no longer be on the FCC ID label, although they may be if desired.
2) The FCC information on the label does not have to be surrounded by a box or line.
3) The FCC ID label can be combined with any other labels required on the device; it does not have to be a separate label.
4) For imported equipment, the country of origin no longer must be on the label. But importers should know that the U.S. Customs Service has its own system of regulations for labeling of foreign products.

The FCC continues to require the FCC ID label to be on the outside of the device so it can be easily seen at the time of purchase.

Equipment sampling by the FCC: The FCC always has the option to sample electronic equipment to check if the devices being marketed conform to the specifications in the application for equipment authorization. Under the former rules, when the FCC requested a sample of an electronic device for testing, there was no deadline for responding to the request. Now, the FCC requires that equipment selected for testing must be submitted within 60 days (or even earlier, if it so specifies, with 14 days at the earliest). In case of failure to meet the deadline, the FCC hints it might delay processing any pending applications by the grantee. In most cases the FCC will allow the grantee to select whichever sample the grantee wishes to send in for testing purposes.

Name and address changes: Grantees must now notify the FCC in writing of changes in their name or address within 30 days of the change, not 60 as formerly. Why is this requirement important? Because when an application for equipment authorization is filed, the FCC checks the name and address on the application against its own data base of grantees. If the names and addresses don't match, there will be delay while the agency tries to figure out what is happening. As always, don't confuse the FCC: at least not if your want your equipment authorization application to go through the pipeline quickly and painlessly.

Don't like some aspects of the new rules? Did you file comments in the proceeding? The FCC is required by law to consider all timely filed comments in a rulemaking.

Christopher Smallwood is the author of "Electronic Equipment Authorization: A Guide," from which this article is adapted.

Cable Exchange

Item Number	Description	Item Number	Description
PCTB-6	TRUNK TERMINATING BRIDGER	FFT4-17D	TAP 4W 17DB
PH	HOUSING—P SERIES TRUNKS	FFT4-17F	TAP 4W 17DB
T3LE	LINE EXTENDER NH	FFT4-20	TAP 4W 20DB
T4CM	CONTINUITY MOD. NH	FFT4-20D	TAP 4W 20DB
TFAV	TRUNK AMP AGC	FFT4-20F	TAP 4W 20DB
TFM	TRUNK AMP MGC	FFT4-23	TAP 4W 23DB
TFPS	POWER SUPPLY	FFT4-23D	TAP 4W 23DB
TH	HOUSING FOR T SERIES L.E.	FFT4-23F	TAP 4W 23DB
XH	HOUSING FOR X SERIES L.E.	FFT4-23H	TAP 4W 23DB
XR2A	FORWARD AGC MOD.	FFT4-26	TAP 4W 26DB
XR2B	BRIDGER INTERMEDIATE	FFT4-26D	TAP 4W 26DB
XR2B-2	BRIDGER 2 OUTPUT	FFT4-29	TAP 4W 29DB
XR2B-4	BRIDGER 4 OUTPUT	FFT4-29D	TAP 4W 29DB
XR2DA	DIST AMP HYBRID AGC	FFT4-32D	TAP 4W 32DB
XR2DM	DIST AMP HYBRID MGC	FFT4-7T	TAP 4W 7DB
XR2F-1	INPUT MOD.	FFT4-7TD	TAP 4W 7DB
XR2F-13	INPUT MOD.	FFT8-4D	TAP 8W 4DB
XR2F-14	OUTPUT MOD.	SHS-2	HYBRID SPLITTER
XR2F-19	OUTPUT MOD.	SO-2	FEEDER MAKER
XR2F-3/110	INPUT MOD.	SO-4	FEEDER MAKER 4DB
XR2F-4	INPUT MOD.	SPJ-2	POWER COMBINER
XR2F-5	OUTPUT MOD.	SPJ-3C	DIRECTIONAL COUPLER 3DB
XR2F-7/110	OUTPUT MOD.	SPX-0.5	PAD 0.5DB
XR2F-8	OUTPUT MOD.	SPX-00	PAD 00 DB
XR2HA	LINE AMP HYBRID HRC	SPX-01	PAD 01 DB
XR2HM	LINE AMP HYBRID HRC	SPX-02	PAD 02 DB
XR2LA-PS	POWER SUPPLY	SPX-03	PAD 03 DB
XR2LAF-1	POWER INPUT MOD.	SPX-06	PAD 06 DB
XR2LAF-2	POWER INPUT MOD.	SPX-09	PAD 09 DB
XR2LAF-3	POWER OUTPUT MOD.	SPX-1.5	PAD 1.5 DB
XR2LAF-4	POWER OUTPUT MOD.	SPX-12	PAD 12 DB
XR2LARA	REVERSE AMP MOD.	SSP-12	POWER INSERTER
XR2LS-3	LINE EXT.	STC-12	DIRECTIONAL COUPLER
XR2M	FORWARD MGC MOD.	STC-12C	DIRECTIONAL COUPLER 12DB
XR2PS	POWER SUPPLY	STC-16	DIRECTIONAL COUPLER
XR2RHA110	REVERSE AGC MOD.	STC-3	DIRECTIONAL COUPLER
XR2SPH	HOUSING FOR XR2SP	STC-3B	DATA LINE
XRBI	INTERMEDIATE BRIDGER	STC-3C	DATA LINE
XRCE-3	LINE EXT.	STC-3D	DIRECTIONAL COUPLER 3DB
XRCE-6	LINE EXT.	STC-8	DIRECTIONAL COUPLER
XRDC-16	LINE EXT.	STC-8B	DIRECTIONAL COUPLER 8DB
XRDC-8	LINE EXT.	STC-8C	DIRECTIONAL COUPLER 8DB
XRLA	LINE EXT.	STC-8D	DIRECTIONAL COUPLER 8DB
XRLS-2	LINE EXT.	DCW-06DB	MINITAP 06 DB
XRLS-3	LINE EXT.	DCW-09DB	MINITAP 09 DB
XRPR	POWER SUPPLY	DCW-12DB	MINITAP 12 DB
XRRP	LINE EXT.	DCW-16DB	MINITAP 16 DB
XRSP	LINE EXT.	DCW-20DB	MINITAP 20 DB
N4-S5	TRAP CH. 5	2-14BW	TAP
BPF-B	BAND PASS FILTER CH. 8	2-17BW	TAP
BADC	B.A. DIRECTIONAL COUPLER	2-20BW	TAP
BAEQ-12-1	B.A. EQUALIZER	2-23BW	TAP
BAEQ-3-3	B.A. EQUALIZER	2-26BW	TAP
BAEQ-8-1	B.A. EQUALIZER	4-08BW	TAP
BASP	B.A. SPLITTER	4-14BW	TAP
CSA-300-3	EQUALIZER T4XX	4-26BW	TAP
DISP-3	DISTRIBUTION SPLITTER 3-3	4-32BW	TAP
EQ-450/13	EQUALIZER 450 MHZ 13DB	8-17BW	TAP
EQ-450/15	EQUALIZER 450 MHZ 15DB	8-20BW	TAP
EQ-450/8	EQUALIZER 450 MHZ 8DB	8-26BW	TAP
EQA-1A	EQUALIZER T4XX	8-29BW	TAP
EQA-220-2	EQUALIZER T4XX	8-32BW	TAP
EQA-220-4	EQUALIZER T4XX	EQ-04DB	EQUALIZER 450MHZ
EQA-220-6	EQUALIZER T4XX	EQ-08/250	EQUALIZER
EQS-0	EQUALIZER LAN 0DB	EQ-08/300	EQUALIZER
EQS-186-4	EQUALIZER LAN 4DB	EQ-08DB	EQUALIZER 450 MHZ
EQT-450/10	EQUALIZER 450 MHZ 10DB	EQ-12/300	EQUALIZER
PB-0	PAD 0DB	EQ-15DB	EQUALIZER 450MHZ
PB-1	PAD 1DB	EQ-16DB	EQUALIZER 450MHZ
PB-2	PAD 2DB	EQ-18DB	EQUALIZER 450MHZ
PB-5	PAD 5DB	PCSPL-1	SPLITTER
PB-6	PAD 6DB	PCSPL-2	SPLITTER
PPLUG	POWER PLUG T4XX	PCSPL-3	SPLITTER
DS-200	SPLITTER 2-WAY 3.5 DB	PD-0	PLUG-IN PAD 0DB
DS-300	SPLITTER 3-WAY 5.5 DB	PD-3	PLUG-IN PAD 3DB
DS-3EL	SPLITTER 3-WAY 5.5 DB	PD-6	PLUG-IN PAD 6DB
DS-400	SPLITTER 4-WAY 6.5 DB	PD-9	PLUG-IN PAD 9DB
DS-4GB	SPLITTER 4-WAY 6.5 DB	PPLUG	POWER PLUG
DS-800	SPLITTER 8-WAY 11DB	T4BDC-8	PLUG-IN PAD
FFT4-10D	TAP 4W 10DB	T4BDL-12	PLUG-IN PAD
FFT4-10F	TAP 4W 10DB	T4SPL	PLUG-IN PAD
FFT4-14	TAP 4W 14DB	VEQ-08/300	EQUALIZER
FFT4-14D	TAP 4W 14DB	VEQ-12/250	EQUALIZER
FFT4-14F	TAP 4W 14DB	VEQ-12/300	EQUALIZER
FFT4-17	TAP 4W 17DB	XR2-13	TAP 4WAY 13DB

CLI: A total proven approach

This is the first of a two-part article dealing with cumulative leakage index (CLI) testing, outlining the practices employed by one particular MSO. Part II will discuss the processing of drive-out measurements.

By Victor B. Gates
Chief Regional Engineer

And Clayton A. Collins
Chief Engineer, MetroVision Inc.

MetroVision systems uses a ground-based, computer-aided procedure to monitor, log, repair and document leaks. We compile data showing the cause of the leak and method of repair. The procedures have been used in 1,100 miles of plant in the Detroit area systems since Jan. 1, 1987. All of our systems now utilize these procedures to control signal leakage.

FCC requirements

Signal leakage is like lust; we all have it. Just don't let the Federal

Figure 1: Drive-out leakage log

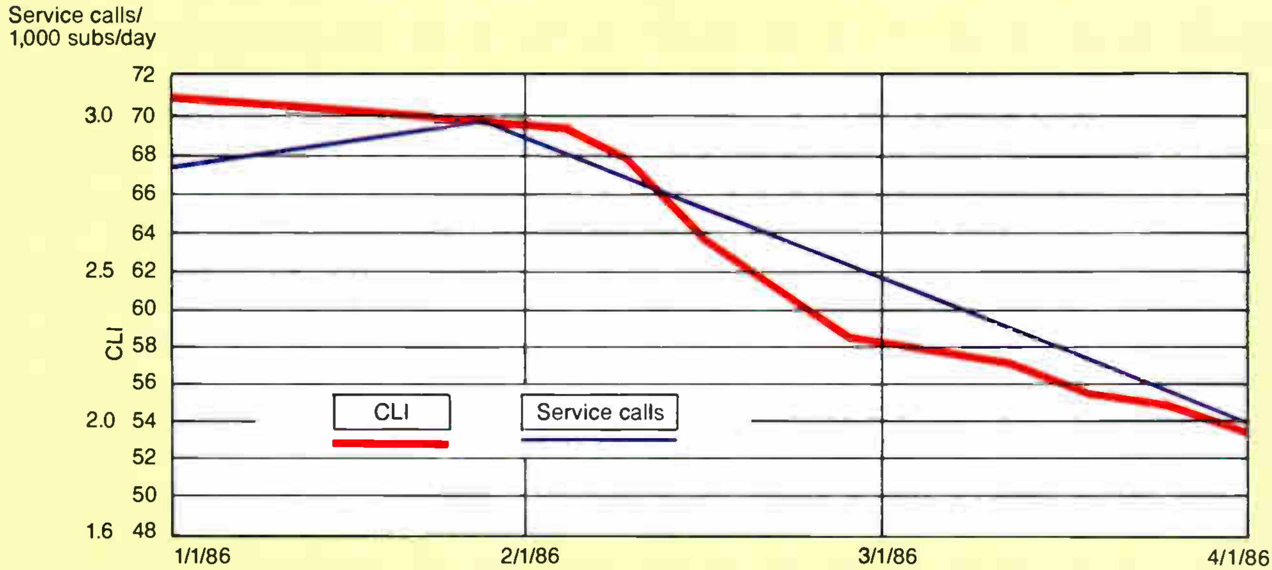
System name

Map no.	Level in dB	Estimate distance	Reported by tech #	Date reported	Leakage location

Communications Commission catch you with signal leakage. Current FCC rules require leakage measurements to be taken three meters from the cable with a field strength meter of adequate accuracy and a horizontal dipole antenna. Systems operating in the frequency bands of 108-137 and 225-400 MHz must be in compliance with a cumulative leak index by July 1, 1990. The CLI measurement technique was developed several years ago to assure cable operators that leakage from their system would not present a hazard to the safety of aircraft flying overhead.

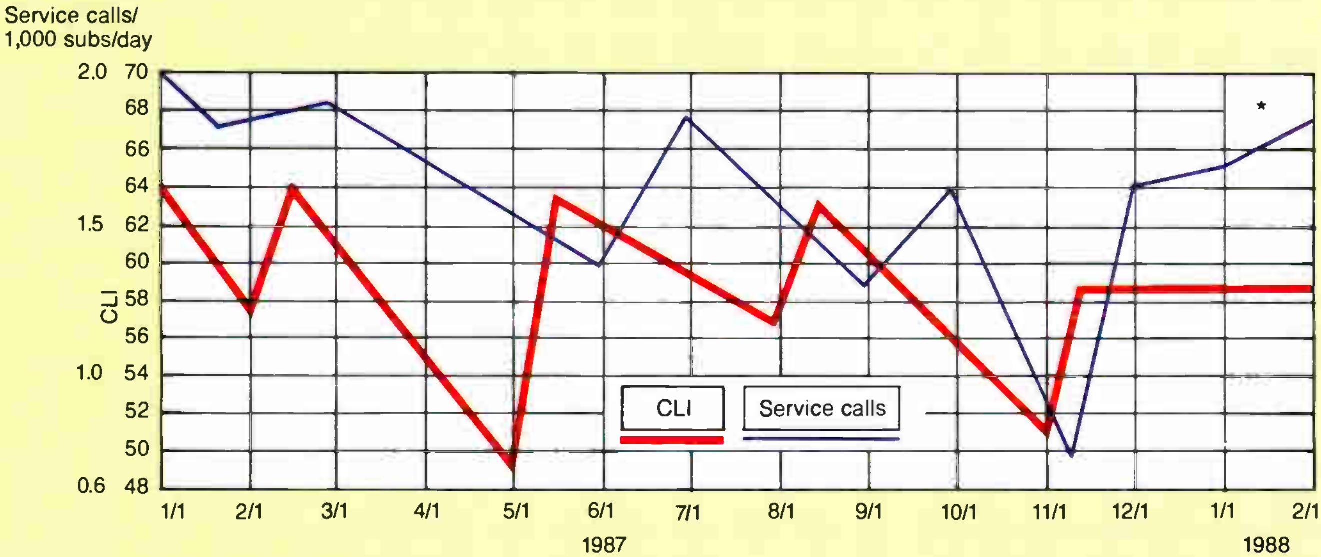
Ground-based CLI is calculated using all leaks equal to or greater than 50 microvolts per meter (μV/m). The value of each reportable leak found is squared; the squared values of all leaks are summed. This sum is multiplied by the result of total plant mileage divided by the driven mileage to compensate for partial drive-outs. CLI is equal to 10 times the logarithm of this number; the maximum allowable legal limit is 64. All individual leaks found of 20 μV/m or greater must be logged showing the date found, the location of the leak, the date of repair and the cause of the leakage. The log must be kept on file for two years and be made available to authorized FCC representatives upon request. We use a large three-ring binder labeled

Figure 2



1) CLI—The first drive-out period will indicate your most dramatic changes.
2) The overall trend for this drive-out period indicates that service calls per 1,000 subs is directly proportional to our CLI.

Figure 3



1) Service calls per 1,000 subs—You'll see an overall downward trend in service calls as CLI is maintained.
2) CLI—You'll see a rise and fall as drive-outs are completed. After service has been done, there is an overall decline in CLI to an average of 59.
3) The * indicates an increase in service calls when no leaks have been repaired over a period of a month.

"FCC Signal Leakage Records" for each drive-out. At the end of each drive-out the unrepaired leak file is purged and the repaired leak information is retained in the FCC public file for two years. The new repaired leak report is added to the existing file and kept in the three-ring binder. The binder is used as a current reference should there be an inspection by the FCC.

The current FCC regulations are that the entire cable system must be monitored once each calendar year. (Non-grandfathered status systems must monitor substantially all their plant every three months.) The cable operator shall annually notify the FCC of their calculated CLI on Form 325.

In our program we don't specifically measure each leak at three meters on a monitoring basis. We use the computer program to do the calculations based on an estimated footage from the leak and the direct reading of the meter. If we limited ourselves to a three-meter measurement on each leak during the first drive-out, it wouldn't be completed until June 30, 1990. But, as will be shown, we meet the three-meter measurement requirement as the repairs are completed.

Getting started

The key to any good maintenance program is getting your schedules, tools, forms and people together.

1) *Personnel:* We use existing personnel; a team of one CSR (customer service representative), salesperson or installer as well as one technician. The technician records the leaks while the other person drives.
2) *Time:* Although this seems to be the only commodity impossible to make available, it can be done relatively quickly on a Saturday or in slow time. We have found a team can drive eight miles of plant per hour with a six-hour time limit due to fatigue.
3) *Schedule:* This has to be a practical schedule—one that can be attained and maintained.
4) *Tools:* Get detection equipment. We use a leakage detection meter with a cut dipole at 139.25 MHz (one meter per 68 miles of plant). The antenna is on a magnetic base and mounted on the top of each vehicle. The meter is sensitive and should be used at a temperature as constant as possible. Calibration is absolutely necessary all through the day of the drive-out. When a leak is detected the meter has to be peaked.
5) *System prints:* We use 11- × 17-inch prints in plastic covers; these will be used for tracing the route while the drive-out is being performed. The prints have to be updated as the plant grows or changes are made.
6) *Forms:* Signal leakage logs (Figure 1) are the most important source for field information and will have to be treated as such. Careful attention to detail is not only easy, but very important.

The drive-out

On the day of the drive-out, the coordinator put the prints in groups of 48 miles per team. The technicians calibrate their meters to a known signal in the headend. They use non-permanent markers to follow their route. When a leak is detected, the tech instructs the driver to slow down from 10 to 5 mph. At the strongest indication on the meter, the driver stops to write down the level and estimate the footage to the cable plant (the leak level is calculated by the computer for the three-meter intensity). The driver then records the nearest address or the system print location on the signal leakage log and continues this until 48 miles is complete.

At the end of each day the coordinator gathers all of the logs and system prints to verify that all the assigned prints were driven out, the logs are legible and all blanks are filled in. This is done to ensure that the data entry person can enter accurate information, the equipment is working properly and the drive-out team was paying attention. At this point, we make sure there is plenty of pizza and other refreshments for everyone taking part in the drive-out.

Seeing the results of the drive-out is clearly the most discouraging part of the process. Figure 2 indicates our service call ratio before the introduction of this program and after the first drive-out and repair period (CLI and service calls vs. time), while Figure 3 shows our current CLI and service calls vs. time graph after one year with this program.

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Fifth Anniversary

Cable systems— Yesterday, today and tomorrow

Five years ago, TCI's Dave Willis wrote an essay for our premiere issue, where he examined the past, present and future of the industry. The following is his original article, as well as an update five years later (see accompanying sidebar).

By Dave Willis
Vice President of Engineering, Tele-Communications Inc.

Initial cable systems were simply an extension of the TV antenna. Electronic equipment limitations, relatively high loss cable and a paucity of channels resulted in many of these systems having a capacity of only five channels. As the public appetite for television was whet and the number of broadcast stations increased, cable technology kept pace. The 12-channel system quickly became a reality and was followed shortly by the "single octave" amplifier. Next came the "push-pull" amplifier, which propelled us into the modern era of cable line equipment.

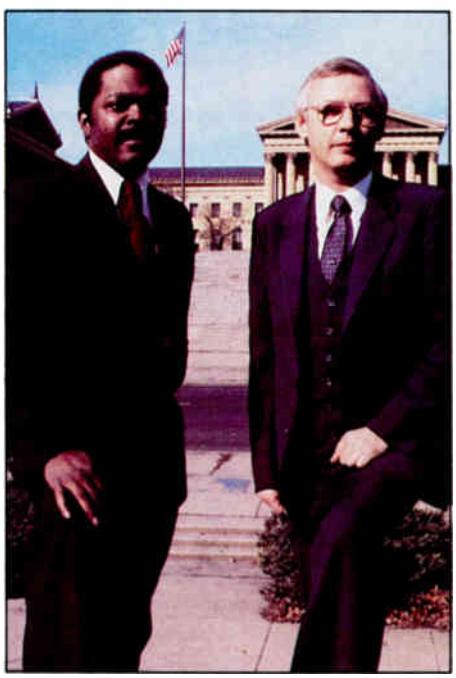
The perception that cable technology has led the industry into today's extremely broadband systems is erroneous. The truth is that cable technology responded to ever-increasing spectrum demands. The advent of non-broadcast cable services such as weather channels, information channels and access channels highly influenced the requirement for increased channel space. This expansion also was driven by franchise applicants seeking to enhance their specific proposals by offering more channels. The advent of satellite-delivered video services added fuel to the flames of channel proliferation, and "more is better" became firmly implanted in the minds of many franchisers, regulatory body members and franchise consultants.

We have reached a point now where some metro area systems boast over 100-channel capacity. The reality is that there are only 20 to 25 channels today that make up the programming fare that the cable subscriber wants to see. Placing large numbers of automated channels on the cable increases the number of video services available but contributes little to the value of cable as perceived by the subscriber. Public access has been less than a roaring success and many of the multiple channels dedicated to this use lie fallow.

The zealous pursuit of franchises has caused many newer systems to be placed in the double jeopardy of having overspent to build a system that, on completion, requires excessive maintenance expenditures. The economic problems that ensue are of extreme concern to the entire industry. The perception of the industry as a dynamic, growing business with almost unlimited promise for the future can be shattered by this kind of experience. These excesses will, I believe, largely be resolved through both operators and franchising entities facing up to economic realities. This does not imply a regression from the current state-of-the-art but certainly calls for far more sensible application of current technology.

The true futurist might focus on the promise cable holds in the areas of data distribution, institutional communications, interactive applications, traffic control, security, etc. The reality is that cable was founded on the basis of providing entertainment television to the subscriber. That has been the basis for its expansion and will be the economic basis for its existence in the foreseeable future. Cable must not shy away from grasping new revenue possibilities but must do so in a fashion that does not impair the economic viability of the entertainment network.

When we hear someone extolling the tremendous demand for computer software to be delivered by cable or the huge audience awaiting teletext delivery, we should remember that about



Ben Robinson

SCTE President Tom Polis and Vice President Steve Cox (March 1984 issue).

Review and reprise

Five years ago *CT* published a brief article in which I assessed the technological history of the cable TV industry and attempted to look a short distance into the future technology of our industry. Inevitably the future becomes the past and here we are again, poised to assess the recent past and prognosticate about the near-term future.

Five years ago we said that cable would remain an entertainment business in its "traditional role." We said a DBS service was likely in the C-band. We discounted direct cable competition by either DBS or MDS. We accented the increasing need for technical training. These perceptions have, in general, proven to be accurate. The "traditional role" of cable has remained intact. Ad revenue is increasing dramatically but no new services are contemplated that will change the basic role of cable in the near term. A DBS service in the C-band exists today with several entities vending program packages. MDS has been supplanted by MMDS and the future of this service is not yet resolved.

The discussion of emerging technologies in cable such as feedforward and power doubling, and the optimizing of systems by intermixing technologies, was on target.

Fiber optics for the future

The glaring omission, of course, was fiber optics. The implementation of fiber in cable systems is still not commonplace and will be spotty at most for some time, the prime application being point-to-point transportation of signal. Fiber-to-the-home concepts are not near-term propositions and will remain experimental for some time.

Looking ahead we can anticipate further fiber developments, particularly in attempting to reach the home. We also can look for line equipment vendors to push

50 percent of the residents with cable access elect not to buy it. Few of them are economically prohibited from having cable TV; it's their choice not to have it. Even fewer elect to buy a pay channel and fewer still a second pay. What is the percentage then who will buy the more exotic services that are as yet primarily concepts? Probably a very low percentage. Thus, a dramatic leap away from the traditional role of cable does not seem likely in the near future.

Most pressure for near-term change comes from the emerging technologies of DBS and MDS. Recently, HBO and Turner announced their intent to establish what is, in effect, a C-band DBS service. Reception of the Galaxy signals has been the subject of considerable research and the earth terminal cost appears to have been reduced to the point of broad appeal. Does this imply bad times for cable distribution? Probably not. Pricing, distribution, service and contractual territorial agreements will almost certainly evolve to permit comfortable co-existence. It should also be remembered that cable has the future advantage that it delivers local and regional signals along with entertainment channels. This service aspect is not present in either DBS or MDS. MDS appears to be somewhat more viable in that the investment is more linear.

Cable technology today is not nearly so much a case of giant steps into the future as it is the subtle evolvement of both product and technique. Cable technology is now taking the time to examine the various components of our distribution systems and is saying, "How can this be improved?" "How can it be installed better?" These questions quite frequently involve the cable itself and the connectors used on that cable. Radio interference problems and FAA problems brought about by system radiation have focused attention on the component make-up of the distribution system as never before. Both these components and the skill with which they are installed are areas where significant improvements are at hand. Increased quality of test equipment, broad awareness of the basic problems and added emphasis on technician training will be major factors in the future.

System configurations combining feedforward, power doubling and standard hybrid amplifiers in various combinations promise greatly enhanced system performance. Uninterruptible power supplies are adding substantially to the reliability of the modern system. To support these more sophisticated systems, technician development must keep pace. While modern cable system maintenance personnel must concern themselves with the most mundane of system aspects such as loose connectors, damaged cable and moisture ingress, they also must be prepared to maintain systems using data modems, bridger switching, status monitors and bidirectional transmission.

Cable technology is enigmatic in that while it wasn't the leading element that propelled cable into millions of homes, it also has had no real lag in meeting the programming demands that have developed. CATV technology can adequately support today's demands. It has the vigor to respond to new demands and in its current evolvement into maturity holds out the promise of attaining superior quality in the future. ■

bandwidth expansion dramatically. This bandwidth expansion will be predicated on the development of an expanded bandwidth for higher definition video signals. Since there is no current standard for HDTV and the resolution of a standard appears to be some time off, this development would seem to be premature. I feel strongly, however, that the basic engineering to accommodate this expansion is best resolved at the earliest possible time.

Technician training needs have been exacerbated by the emergence of fiber optics and by the fast approaching requirement for cumulative leakage index (CLI) measurements. The CLI requirements place a radiation leakage control requirement on the system that will involve significant manpower. Most systems should pass the CLI readily and the manpower requirement will result primarily from making the necessary measurements to verify compliance.

In the closing paragraph of 1984's article I was optimistic about the technical community of the cable industry. I am even more optimistic today. Cable technicians and engineers have always been a "can do" lot and they remain so today.

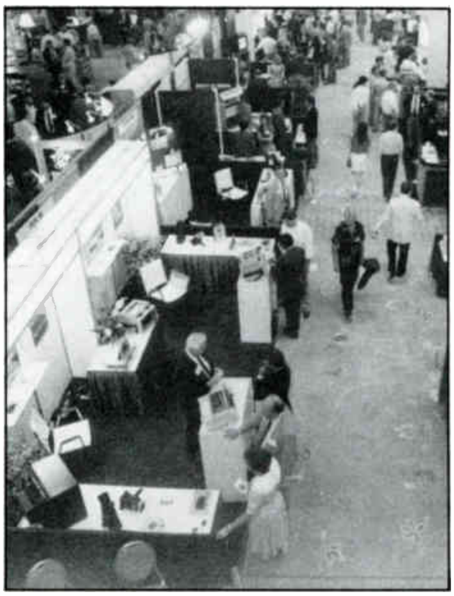
The brief history of cable TV has seen dramatic changes in technology, technical regulation and system capability. The industry has met these changes without breaking stride and has gained substantial capacity to deal with such changes. We will continue to meet tomorrow's challenges with progressive solutions as long as we refuse to succumb to complacency and recognize that rapid changes are inevitable in a fledgling industry. ■

Five years in the making

By Rikki T. Lee

On March 4-7, 1984, the Society of Cable Television Engineers held its annual Spring Reliability Conference and Cable-Tec Expo at the Opryland Hotel in Nashville. Technical sessions during the conference (which occurred on the first day) included encryption, signal leakage and system reliability, satellite reliability, teletext and data communications. The expo (on the remaining three days) drew about 1,100 attendees and 85 exhibitors, featured workshops on TVRO maintenance, digital basics, FCC compliance, using and maintaining feedforward and elements of system design.

Introduced at the expo was the first issue of the SCTE's official trade journal *Communications Technology*. Among the articles in the March 1984 issue were: "550 MHz—The new bandwidth plateau" and "Cable systems—Yesterday, today and tomorrow" (reprinted in this issue with an update on page 84). *The Interval* contained a report from SCTE Vice President Stephen Cox, Expo '84 abstracts and a list of 58 Society publications, tapes and other merchandise (a list of 129 products appears in this month's *Interval*).



Bob Sullivan

Attendees at the 1988 Cable-Tec Expo in San Francisco...

Five years ago:

- the U.S. CATV industry boasted 65 percent of homes passed and a 37 percent penetration.
- the U.S. Supreme Court ruled that home videotaping was legal.
- the Federal Communications Commission approved telcos' construction of cable systems outside of their service area.
- engineers avidly discussed such topics as videotex, two-way addressability and MDS.
- the *1984 NCTA Technical Papers* included sections on the "new blue skies" (900 MHz transmission and the first hints of high-definition TV) and radiation measurement and protection.

Invitation to an anniversary

In celebrating *CT*'s fifth anniversary, we sent out invitations to a number of people we have served over the years. Each person was asked to respond to this question: "In your opinion, how has the CATV industry changed in the past five years (since March 1984)?" In the mail, via the phone and over the fax machine came quite a lot of RSVPs; the following are among the many answers we received, in alphabetical order by each respondent's company.

Jim Chiddix, senior vice president of engineering and technology, American Television and Communications Corp.: "In the past five years, the cable industry has made marked progress toward maturity. As a business, I believe that we have achieved some kind of critical mass as we passed the 50 percent penetration level for all

U.S. households. We've gone through a period with lots of properties changing hands, but ownership is beginning to consolidate in the hands of companies that seem destined to hold and operate cable systems rather than look for short-term appreciation.

"From a technical point of view, this maturity is beginning to show as well. There is a realization that we need to spend substantially more time and money on the basics of our business. I believe that this will translate into an increasing emphasis on training, improved materials, improved supervisory structures within operating companies and an emphasis on long-term profits and savings that sometimes requires investment in the near term.

"I also believe that we are at the dawn of the most important fundamental technical change in our delivery systems since the invention of the solid-state broadband amplifier, in the form of practical cost-effective optical fiber CATV transmission equipment. I believe that in the coming decade we will look back to this time as the initial period of introduction of technology that fundamentally changed the cable business and its ability to compete with emerging alternate video delivery technologies.

"Many in the industry have felt the impact of the last five tumultuous years but I firmly believe that, while change will certainly continue, the best is yet to come."

Dave Pangrac, director of engineering and technology, ATC: "There have been a number of changes in the industry since 1984, but the most notable thing for me has been the increasing use of fiber-optic technology in our plants. This event has created new excitement in the technical ranks and a desire to 'get involved' in learning a new technology. Not only has this event produced an interesting recent past but assures a bright future for the industry."

Raleigh Stelle, vice president of engineering, Austin Cablevision: "Late '83 and early '84 were pivotal in the cable industry. Great things were happening. The franchising/bandwidth races were in full force. We were building systems of 100+ channel capability and operators were offering interactive services (Qube and others). Addressability (and particularly off-premise addressability) was a hot topic. In fact, anything that even appeared 'high tech' was wonderful and 'in.' Then along came Drew Lewis of Warner Amex who rode into Dallas, franchise papers in hand. He declared that there would be no more dual-cable super-duper interactive systems because the subscriber didn't like them and wouldn't pay the price for them. So either change the franchise back to POCS (plain old cable service) or we'll take it off the poles. He fired a shot heard 'round the world and led the charge in a mad rush 'back to basics.'

"So, we have spent the last five years devolving, melting tiers, experimenting with pay-per-view (cautiously...*that's* high tech) and in general attempting to harvest and recoup the enormous investments required to build and rebuild cable systems. But these five years have not been technologically dormant (witness the advent of HDTV and the fiber backbone) nor quiescent in the business sense (cable caught the 'merger mania' disease with a vengeance). All in all, a very interesting five years."

George Scherer, chief engineer, Blonder-Tongue Laboratories: "The changes that have occurred in the CATV industry since 1984 have been to a large extent evolutionary. Such things as scrambling of satellite transmissions and the gradual introduction of pay-per-view have really been reactions by the technical community to programming and financial requirements, rather than drastic new departures in the way the industry serves its customer base. Probably the last such great 'sea change' was the introduction of satellite-delivered programming, which changed the very nature of the industry.

"However, I feel that we are now on the threshold of another leap of similar importance. This will result from the application of two new technologies presently being perfected and will help the industry penetrate two customer bases heretofore on the fringes.

"The first is fiber-optic transmission, which will allow 'wired' penetration of communities too small to support dedicated headends of modern channel capacity and in areas unsuited to terrestrial microwave. The other is off-premise security, which promises an economically viable means of serving those multiunit dwellings that have been considered poor business risks until now."


Bob Sullivan

...were given an opportunity to test the latest hardware (August 1988 issue).

Bob Price, senior vice president, BradPTS: "My primary experience has been related to servicing converters and selling rebuilt equipment. I've seen the technology pendulum swing toward addressable, away from addressable and back toward addressable. Converters are much more reliable now and cable companies recognize and appreciate this. Mechanical converters no longer are in much demand. More and more cable companies are expanding beyond 36 channels and asking for pay-per-view capabilities. Our industry is very mature now and the technology is more dependable."

John Hastings, national market manager-CATV, C-COR: "The CATV industry has changed substantially since 1984. Five years ago, the entertainment cable TV market was shrinking, whereas today it's expanding. Whereas today cable companies are installing fiber-optic cable, five years ago optical fibers were made into decorator table lights. Feed-forward technology in CATV amplifiers was beginning to come into its own in 1984. Today, feedforward is almost a standard for higher bandwidth systems. In 1984, the talk was about future 550 MHz systems and today the talk is about 800-1,000 MHz future systems."

Alex Best, vice president of technical operations, Cox Cable Communications: "There have never been as exciting times as exist today in the cable industry. The factors contributing to this include completion of the 'cabling of America,' deregulation driving up the value of cable subscribers and the competitive threats of telco entry, overbuilders and DBS. In addition, there is the concern on Capitol Hill that cable has won too much freedom over the past several years.

"These factors, when added to the proliferation of cable programming, PPV and the promise of HDTV, have forced the industry to focus on three issues: cabling of low density areas, increased channel capacity and improved customer service. From a technological viewpoint this means upgrades, rebuilds and improvement in picture quality and reliability through the use of fiber optics. From an operational standpoint this means an increase in preventive maintenance and technical training programs. For customers this means that cable TV will continue to be the best entertainment value for the dollar for the foreseeable future."

Graham Stubbs, executive vice president, Eidak Corp.: "In my view, there has been a marked decrease in investment and technology development and R&D, particularly by manufacturers who have carried most of the burden in the past. As the franchising battles have died down, there has been a parallel reduction in emphasis in R&D on the part of cable operators and a resulting departure of some senior and very capable people.

"But some very positive things have happened, such as the recognition of the need for a coordinated industry approach to R&D and the formation in 1988 of Cable Labs. Also, quality has matured as a cable discipline in both products and services; as an example, addressable converters have improved tenfold in repair rates. And much of the technological infrastructure necessary for PPV is now in place, with 10 million addressable converters in the subscribers' homes and ordering technologies such as ANI now in widespread use. The remaining hurdle, copy protection, also has been shown to be feasible and available.

"Although some would have predicted otherwise five years ago, it is good to see that the equipment business is still dominated by U.S. suppliers. Let's work hard to make sure it remains so."

Dane Walker, microwave systems engineer, Hughes Aircraft Co.'s Microwave Products Division: "Perhaps the biggest change is the wide acceptance of training in the industry. SCTE chapters and meeting groups used to plan their seminars for the weekend; now, these seminars take place Monday through Friday as well. And five years ago, the attendees were system managers and vice presidents of engineering; now, we see more lower level technical people there. This indicates more importance being placed on education.

"Another change: CATV has increased its potential to move more and more data and information than any other individual industry. Yet, even though CATV transmission methods are complex, we as an industry still tend to have an 'informal apprenticeship' approach to training our technical people."

Jon Ridley, applications engineer, Jerrold Division of General Instrument: "Several significant changes took place in the cable industry since 1984. Specifically, we developed a stronger commitment to excellence in our day-to-day relationship with the subscriber. We now can, and do, deliver a higher quality picture and a greater diversity of programming.

"Impulse pay-per-view, VCR compatibility, digital audio and other ancillary services allow the cable operator to compete with traditional entertainment services. Our industry's technological advances are being integrated into the systems, giving engineers and technicians increasingly higher quality and reliability with less maintenance. We have not yet felt the full impact of some of these improvements.

"Fiber-optic transmission of signals will, with advances in lasers and photo receivers, provide even better picture quality and greater long-term reliability.

"The last five years have had an impact on the redefinition of customer service, quality, program diversity and reliability. We've achieved as much in the last decade as we did in the two preceding it."

Ron Hranac, senior staff engineer, Jones Intercable (and SCTE president): "The evolution of the cable industry during the past five years has seen our business become increasingly market-driven. That direction has been beneficial, considering the variety of services and programming we now provide to our subscribers.

"At the same time, we must not lose sight of the fact that our industry also is very much a technology-driven one. While recognizing that technology changes almost daily and what is state-of-the-art today may well be obsolete tomorrow, we must make *quality, reliability* and *technical excellence* the new and permanent buzzwords of cable TV. That will be the road to a successful future."

Dieter Brauer, vice president of engineering, Magnavox CATV Systems: "Although fiber optics is the technology of the future, in this cost-conscious industry, are we passing improvements in silicon and leaping past gallium arsenide too quickly?"

Chris Sophinos, vice president and chief operating officer, Midwest CATV: "The most significant change has come in the demand and supply sides of the industry. On the demand side, the industry has responded to the consumer needs for programming and equipment. The user-friendly converters and off-premise devices are tangible proof that as an industry we've changed. Try lining up an old electromechanical converter with today's all-function digital types. On the supply side, the industry has lost some competitive choices for product. This is a worrisome change. Consider the distributor business. It provides a multitude of products direct to operators that manufacturers don't sell themselves, like strand, tools and hardware. Yet look at the companies that no longer compete: SAL, Wexco, Cable TV Supply, Telewire."

SCTE Executive Vice President Bill Riker and President Jim Emerson (March 1985 issue).

Roland Hieb, president, National Cable Television Institute: "From our perspective dealing with the technical training side of the cable industry, over the last five years we've seen a dramatic shift in attitude toward training. Five years ago, technical education was often viewed as a luxury; it was something you probably should invest in but only after everything else was taken care of. Today technical training is seen much more often as a necessary element of a well-run system operating at peak profitability.

"A couple of factors stand out in my mind as contributing to this change in thought. First, a few key groups, including SCTE, CTAM and Women In Cable, took up the educational torch. From their influential roles in the industry they were able to focus a great deal of attention on the subject. Second, and possibly even more importantly, a couple of major MSOs unveiled internal research that showed that a high proportion of the industry's service calls was directly related to poor workmanship at the drop. This research made it obvious for the first time that technical training wasn't a luxury but a necessity. It saved service-related truck rolls that could be assigned a real dollar value. Once this was established, the initial cost of training began to be viewed as an investment rather than an expense.

"The net result has been positive for all parties concerned. The MSOs and systems have benefitted from better run, more efficient systems. Technical employees have benefitted from a more professional career path. And cable customers have enjoyed better picture quality and fewer service problems."

Rex Porter, director of CATV sales, Pyramid Industries: "Bigness. Since 1984, the whole level of technical competence has improved to the point that it's almost unbelievable. I travel everywhere and, unlike the old days when CATV pictures in hotels and motels were snowy, cross-mod'ed and co-channeled, today's pictures are top-grade. And today's CATV technician is smarter, more self-assured and willing to try the new, unusual and the different. I salute them all."

Fred Rogers, president, Quality RF Services: "In 1984 most operators would not build systems or extensions that averaged less than 45 house passings per mile. Today we are building every cross road with 20 houses per mile average. We have perceived values of $2,000 or more per subscriber today from a value of $1,000 or less when

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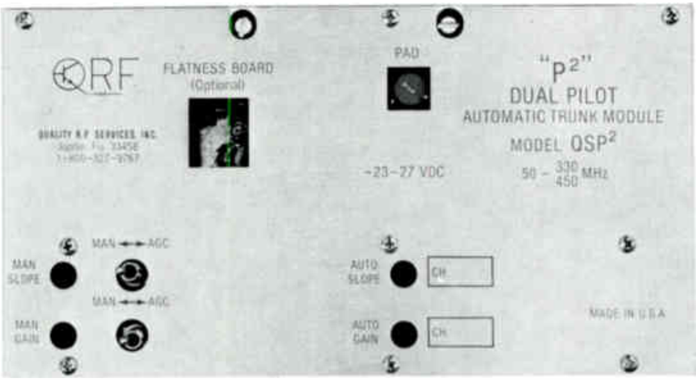

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Passband MHz	50-300	50-300	50-330	50-330	50-400	50-400	50-450	50-450
Flatness ± dB	0.2	0.2	0.2	0.2	0.25	0.25	0.25	0.25
Min. Full Gain dB	29 or 30	29 or 30	29 or 30	29 or 30	30	30	30	30
Gain Control Range dB	8	8	8	8	8	8	8	8
Slope Control Range dB	-1 to -7	-1 to -7	-1 to -7	-1 to -7	-2 to -8	-2 to -8	-2 to -8	-2 to -8
Control Pilots ASC: Turned to Ch.	"Q"	"Q"	"W"	"W"	"W"	"W"	"W"	"W"
Oper. Range dB	Selectable	Selectable	Selectable	Selectable	Selectable	Selectable	Selectable	Selectable
AGC: Turned to Ch.	4	4	4	4	—	—	—	—
Oper. Range dB	Selectable	Selectable	Selectable	Selectable	Selectable	Selectable	Selectable	Selectable
Return Loss dB	16	16	16	16	16	16	16	16
Noise Figure dB	6	6	6	6	6	6	6.5	6.5
Typical Oper. Level dBmV	34/30	34/30	34/30	34/30	35/30	35/30	35/30	35/30
Distortion at C/CTB	-93dB	-88dB	-92dB	-87dB	-91dB	-86dB	-89dB	-84dB
Typical Oper. XMod	-94dB	-89dB	-93dB	-88dB	-91dB	-86dB	-89dB	-84dB
levels 2nd order	-85dB	-82dB	-85dB	-82dB	-85dB	-82dB	-85dB	-82dB
DC Requirement mA at -23 VDC Note 1	630-730	420-500	630-730	420-500	650-750	430-500	650-750	430-500

Note 1: DC requirements are stated as typical to maximum.
Note 2: Specifications should be referenced to the modules, not the connector chassis.

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the Cable Communications Act of 1984 was made law. Doubling the perceived value of subscribers from 1984 to date has allowed cable TV to pass more than 80 percent of all homes in the United States, and I believe 90 percent may be obtained.

"Purchasing $2,000+ subscribers allows little money for system rebuilds. In 1981 many operators totally rebuilt existing CATV plants; today's engineer must retain the usable parts, minimize labor and add services at the same time. Engineers in 1989 must be masters at upgrading CATV systems for minimum investments today to afford tomorrow's advanced technologies."

Dave Large, director of video product planning, Raynet: "The cable industry has passed through several growth phases in the process of maturing: the development of its own efficient broadband technology, overcoming numerous regulatory hurdles and developing unique sources of programming. It has emerged as the major provider of video entertainment in the country, passing over 80 percent of U.S. homes and serving over 50 percent.

"Technologically, however, cable is still a comparative midget and in the past five years has found itself reacting (often inadequately) to threats and developments not of its own making: changes in consumer electronics, stereo, EDTV, HDTV and fiber-optic transmission. I believe that, as cable reaches the end of its rapid growth period, there is a growing awareness of a need to reinvest some of its cash flow in the technologies necessary to maintain leadership in broadband distribution networks."

Jim Farmer, principal engineer, Scientific-Atlanta: "The past five years have been a time of semi-maturation for the CATV industry. We have been changing from technology-driven to market-driven. This is both good and bad from the engineers' perspective but mostly is inevitable. The formative years of any technology are characterized by applications driven primarily from the viewpoint of 'Here is what we can do, so let's do it.' During more mature phases the technology is taken for granted to a large extent and is called upon as appropriate to solve customer requirements. How long has it been since you wondered if you could make an earth station work?

"I used the term 'semi-maturation' because I worry that the industry has matured too quickly for its good. We seem to not expect technology to deliver up to capability, being satisfied all too often for 'good enough.' Let me cite an example of what we should be doing. I recently witnessed a demonstration conducted by Steve Raimondi (vice president of engineering, United Artists Cablesystems), in which he showed many of his managers why the standards we expect for signal-to-noise ratio are unsatisfactory. He has led bottom line-oriented managers to understand why they need to spend money for a 46 dB carrier-to-noise ratio. And he has showed them how they really can get there from here, with technology available today."

Bill Riker, executive vice president, Society of Cable Television Engineers: "Throughout cable's history, emphasis appears to have been placed on different aspects of the business in a cyclic rotation. During my career in cable, I have seen

Howard Gordon

Ribbon-cutting at the SCTE's national headquarters (March 1987 issue).

the industry's attention focus on sales, then marketing and, in recent years, to engineering.

"Current emphasis on the technology employed by cable is directed principally in two areas. First has been a move by system operators to better train technicians in the field who perform installations, service calls and system maintenance in an effort to provide improved service to subscribers. Secondly, now that cable must be marketed against other video entertainment media with potentially superior quality, the industry has turned toward the development of technologies such as fiber optics and HDTV, which will allow cable to better compete in an ever-evolving consumer marketplace.

"This return of the industry's focus toward communications technology is evidenced by the recent growth of the Society of Cable Television Engineers, whose sole purpose is the dissemination of technical knowledge throughout our industry. In the past four years, membership in the Society has doubled and participation in its national conferences and local seminars is at an all-time high."

Tom Elliot, director of research and development, Tele-Communications Inc.: "The CATV industry has continued to grow and mature in the past five years. We served 32 million subs in 1984; today we serve 46 million. 1987 brought deregulation and a chance to determine our own fate. Customer-friendly methods to deliver our service have become an increasingly important issue. The industry is striving to identify what causes the customer problems and apply 'lifecycle cost' solutions where possible. Cable Labs is under way and will help the CATV industry deal with the wide spectrum of exciting but difficult technical issues we face. Fiber optics is coming of age as a very low loss, high bandwidth distribution medium. High-definition TV is a hotly debated issue that we need to learn how to handle. All in all, the industry has taken major strides in the last five years. I am sure the momentum we have created will carry us forward as we grow and deal with the inevitable challenges the future will bring."

Jerry Laufer, director of engineering, Texscan Corp.: "It seems to me the industry has evolved and matured more than it has changed. System performance requirements have increased. More channel capacity, higher quality pictures and better reliability have been the primary areas of evolution. Increased system performance has placed higher demands on technical personnel in equipment design, system design, system construction and system maintenance. These demands have contributed to increased professionalism in all areas.

"The CATV subscriber has become more demanding of excellent quality pictures and less tolerant of service interruptions. The subscriber knows what good quality can be because of VCRs and expects reliable service when paying $30-$50 per month.

"AM fiber has certainly been a rapidly growing phenomenon. This has expanded our view of possibilities and added more excitement than we have seen since TVROs.

"SCTE has grown in influence and is responsible, in many ways, for the higher level of professionalism that is spreading throughout the industry. Cable-Tec Expo, the BCT/E program and 'how-to' videotapes are some examples of SCTE's contribution."

Ed Callahan, vice president of research and development, United Cable TV Corp.: "1) There has been an increase in the use of fiber optics to improve system quality, especially in the areas of distortion and carrier-to-noise. Fiber has made a major impact on the industry.

"2) There has been an overall improvement in signal quality in both new-builds and rebuilds. Nowadays, you'll find an increase in participation and involvement from technical people at the bimonthly NCTA Engineering Committee meetings. With HDTV coming in our future, people are worried about improving their signals.

"3) In the past five years, there has been an increase in cable systems offering transactional services, such as impulse pay-per-view. Perhaps the next step is impulse home shopping services.

"4) Finally, test equipment has improved, making proof-of-performance easier. Today's automated test equipment can generate printouts and significantly reduce operator error."

Pat McDonough, corporate chief engineer, United Cable TV Corp.: "Obviously, the technology in CATV has changed significantly over the past five years, most notably in the area of fiber optics. But I believe it is the overall environment in which the modern cable engineer is working that has changed the most and will continue to affect the way engineering is approached. The difficult part is that a lot of this is in the form of potential at this point. HDTV, possible phone company entry into cable and even fiber (which is only in its infancy) have combined with issues like the need for additional channel capacity, IPPV capability, customer friendliness and overall quality to place unprecedented demands on the creativity and resourcefulness of the engineer.

"The most compelling change, with immediate impact throughout the industry, is the emphasis on CLI. I think all of this is good since the industry as a whole is moving toward a more reliable, higher quality product."

Sam Street, president and general manager, United Cable of Baltimore: "Cable technology has become more complicated. There is a greater demand for technical people with higher skill levels and the ability to adapt to new technologies. The last five years in cable have made fiber optics, impulse pay-per-view, mega channel capacity and 'consumer-friendly' equipment a reality.

"Today's cable technical person must not only have good technical skills, but be able to handle people. Working with fellow employees and handling cable subscribers is now a necessity in today's cable market."

Paul Beeman, vice president of engineering services, Viacom Network Enterprises: "1984 to 1989: Development at the speed of light. In the past five years the cable industry—and it is an 'industry'—has seen evolution and changes possibly unparalleled since the first piece of cable was brought down from a mountaintop. Like the Ten Commandments brought down from a mountaintop, rules, ideas and practices have been codified to define the cable industry. Possibly the foremost is: 'Thou shall educate and train your staff.' If a cable operator thought training was expensive, try ignorance! CLI, fiber optics, consumer interface (IS-15), HDTV, future satellites—all require an active knowledge.

"In the past five years we have seen major satellite changes, discussion and limited deployment of Ku-band technology. There also has been a resurgence of the fact that the FCC does care what a cable operator *puts into* the air (CLI). High-definition TV (HDTV) looms in the future. We must learn from our early lessons with BTSC that we must actively participate in the evaluation and testing phases of HDTV's development. And lastly, fiber optics...'light years ahead of its time?'

"Fiber optics can be a catalyst to the cable operator to increase plant performance or a nemesis if he takes the 'ostrich' approach and allows only telcos to develop and market this technology directly to *our* subscribers.

"In closing, the cable industry must continue to control and invest in its future. This involves time, money and trained personnel."

Mike Aloisi, director of engineering services, Viacom Network Enterprises: "As I look back over the last five years, our industry has begun to make changes, especially in our attitude toward the cable subscriber, whom we now call our customer.

"We have learned that better trained personnel are not just a maybe, they are a must; just ask our friends in the telephone industry. We have addressed the consumer interface issues with diagrams, splitters and A/B switches; however, the real answer is the proposed IS-15. With the advent of BTSC stereo, our customers can now enjoy their favorite programs with a little more appreciation of audio quality.

"Certainly video quality is extremely important, hastening the efforts of HDTV development. Not forgetting the need to increase channel capacity without compromising picture quality, AM fiber is the beginning of the next five years of technological advancement."

Ken Leffingwell, manager of marketing services, Wegener Communications: "In the past five years we have seen the cable industry maturing from a production orientation (plant and equipment) toward a marketing orientation. From a technical aspect this realignment is forcing the industry to do all that is possible to continue to improve the quality of the services it offers.

"Our industry is beginning to realize the multifaceted 'pipeline' it has to the subscriber. Advanced audio transmission such as stereo and second language programming are becoming more important. Digital and analog audio network services are proliferating, while information services are on the rise. Local commercial insertion ad sales revenues are at an all-time high.

"However, as we move forward, the demands on the technical expertise of the people who make this industry work will continue to grow. I think that the one predominant trend with the furthest reaching effects has been the efforts of leaders within the industry who strive to raise the technical level of the rest of us."

Vito Brugliera, vice president of marketing and product planning, Zenith Electronics Corp.: "The most significant changes have been industry concentration, pay-per-view, customer satisfaction, plant architecture and the new challenges raised by advanced television (ATV) and telcos.

Rikki Lee

Tom Hall (U.K. SCTE secretary), Ray Seacombe (president) and Paul Levine at the 1988 Western Show (February 1989 issue).

"Consolidation is occurring at both the operating and vendor portions of the industry. The industry is becoming concentrated by acquisition, with fewer and larger MSOs as a result. The resulting debt load places severe restraints on capital investment and more concern with cash flow. The swing to financial emphasis has taken its toll on the engineering side of the business—a number of familiar engineering faces have 'consultant' on their business cards. The vendor side of the business is undergoing consolidation and shrinkage. In the last downturn, only those companies with faith in the future of cable introduced any new technology.

"Pay-per-view has been a bright spot, not only as a new source of incremental revenue but as a catalyst for addressability. Many of the reasons for addressability changed and a trend toward other approaches, including traps, developed. This was inspired by a desire for being customer-friendly and utilizing cable-compatible TV receivers to decrease upfront capital costs in the home. PPV changed that. Along with addressability, emphasis was given to order-taking technology and system controllers. Automatic number identification, two-way and store-and-forward technology advances are the result.

"Customer satisfaction has become a driving force in the cable industry. Customers' alternatives to cable, the VCR and cassette rental growth, are sober reminders that having 53 percent penetration of TV households does not mean that we have won the battle. Part of customer satisfaction is having better pictures. The laws of physics tell us that sending a signal through 25 to 30 amplifiers before it gets to the customer is not going to help picture quality. Picture quality is important; Super-VHS VCRs and larger screen sizes make it even more important. Picture quality is improved with fiber distribution technologies that reduce the number of intervening amplifiers to three or four between the headend and the customer drop.

"Picture quality improvement by using fiber in plant architecture is important because fiber technology is one of the arguments that telcos are using to justify their entry into cable's turf. Fiber will be crucial to meeting the challenge of high-definition TV. HDTV is going to be a large-screen environment, and cable will require better carrier-to-noise ratios to have customers receive all the benefits of this technology. If cable does not, telcos will be more than willing.

"How has the industry changed? For the better because our customers are getting more and better products and services. Our customers' satisfaction is what it's all about."

A glimpse into our future?

By Ron Hranac
President, Society of Cable Television Engineers

Technical certification is fairly new in cable TV. The SCTE introduced its Broadband Communications Technician/Engineer (BCT/E) Professional Designation Certification Program to the cable industry in 1985 and, to date, 21 individuals have become certified at the technician level and 11 at the engineer level. Over 1,200 SCTE members—about 25 percent of the national membership—are enrolled in the program. Support of BCT/E certification has been overwhelming, especially when one considers the short period of time it has been around.

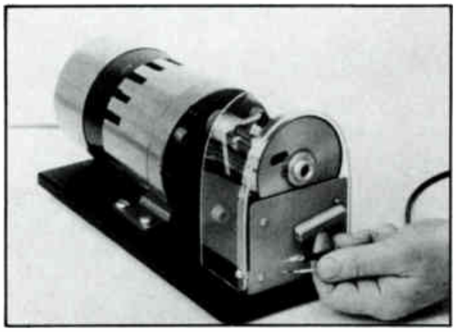
The Society of Broadcast Engineers (SBE), on the other hand, has had a technical certification program for several years. Because the SBE and the SCTE serve somewhat similar purposes to each organization's respective industries, I thought a look at the success of the SBE program might give us an indication where our program is headed. More specifically, is there a chance that being BCT/E certified will directly affect *your* bottom line?

"BCT/E certification will be a valuable tool used by management to ensure successful system operation."

If SBE's program is in fact an indication of how certification helps in that area, then the answer is a resounding yes! In the October 1988 issue of *Broadcast Engineering* magazine, an interesting sidebar accompanied the results of *BE*'s annual salary survey. The sidebar presented data on the salaries of certified vs. non-certified broadcast engineers.

According to the article, "When combined radio and TV categories are compared across all markets, the salaries of SBE-certified engineers are 11 percent above those of non-certified employees." A detailed breakdown showed that certified radio engineers are paid 24 percent higher median salaries and certified TV engineers 16 percent more. Apparently broadcast management recognizes that a technical certification program—albeit one that has been around awhile—is a valuable tool in station operation.

Is this a glimpse into our future? Perhaps. I predict that we will see a similar trend in CATV. In an era of deregulation, one where quality is becoming more and more important, BCT/E certification will be a valuable tool used by management to ensure successful system operation. Becoming certified may not immediately result in a raise, but in the long run it surely can't hurt. It may just be the edge that will land you that promotion. If you would like to find out more about BCT/E certification, contact SCTE national headquarters at (215) 363-6888 or write to the Society at 669 Exton Commons, Exton, Pa. 19341.



Wire stripper

Western Electronic Products' Model CX-2 coaxial wire stripper is designed to remove all layers of a cable in one action. The latest version has a 150 RPM motor for quick cycle time (about one cycle each five seconds). The product has three independent cutting members with precision screw adjustments for the depth of cut.

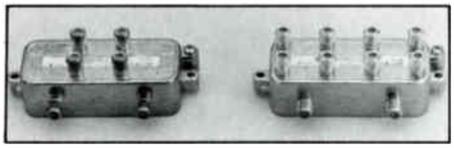
The Model CX-2 is said to be capable of stripping most shielded coaxial cable within the range of .075- to .435-inch outer diameter. All eight sizes of cable holders are provided to accommodate the full range of cable sizes.

For further details, contact Western Electronic Products, 915-G Amenecer St., San Clemente, Calif. 92672, (714) 492-4677; or circle #128 on the reader service card.

Switcher

Novadyne is introducing the Model 8X16 audio/video routing system, completely self-contained in a 3½- by 19-inch rack-mountable chassis (a desktop chassis is also available). The design incorporates a single motherboard onto which between one to 16 output channel boards plus an options board are mounted. Each output channel board accepts up to eight external composite video signals, each coupled with two audio channels.

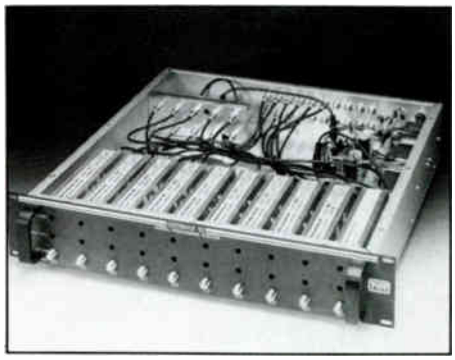
For more information, contact Novadyne, P.O. Box 5508, San Mateo, Calif. 94402-0508, (415) 349-3241; or circle #118 on the reader service card.



Taps

Viewsonics introduced its VSTREL-4 and VSTRE-8 indoor/outdoor F-type directional coupler/taps. The weather- and RF-sealed die cast zinc housings are said to be corrosion-free and ingress/egress resistant. The tap-to-tap isolation is 30 dB minimum at 5-450 MHz and a 25 dB minimum at 45-550 MHz. Return loss is 20 dB minimum at 5-450 MHz and 18 dB minimum at 450-550 MHz. Tap values are ±1 maximum at 5-450 MHz and ±1.5 dB maximum at 450-550 MHz. The applicable temperature range is −40 to +140°F.

For more information, contact Viewsonics Inc., 170 Eileen Way, Syosset, N.Y. 11791, (516) 921-7080; or circle #123 on the reader service card.



Off-air modules

Pico Macom introduced a new UHF-to-VHF converter module for its Geomax-10 off-air processing system. The module comes in three versions: Model GUV-L for low-band, Model GUV-M for mid-band and Model GUV-H for high-band applications. The modules can convert any UHF channel to VHF (excluding prohibited channel versions). According to the company, the modules are effective in adjacent channel configurations since they feature frequency stability using a crystal locked PLL design.

For more details, contact Pico Macom, 12500 Foothill Blvd., Lakeview Terrace, Calif. 91342, (818) 897-0028; or circle #127 on the reader service card.

FO modulators

Orchard Communications is introducing a line of FM modulation equipment for fiber-optic transmission of video and audio. The 1000 Series delivers up to 16 channels per fiber, with video channels allocated between 100 and 700 MHz, and audio between 15 and 75 MHz. It has microprocessor-controlled frequency agility and the ability to accept NTSC or composite video inputs from sources such as computers, VCRs and video cameras. According to the company, the 1000 Series delivers crisp video and high fidelity audio, making it ideal for CATV headend-to-hub connections and antenna-to-headend trunks.

For further information, contact Orchard Communications Inc., 2 Tower Dr., P.O. Box 5031, Wallingford, Conn. 06492, (203) 284-1680; or circle #129 on the reader service card.

Transformer

Now available from North Hills Electronics, the Humstopper isolation transformer is designed to provide a solution to hum bars and related interference problems. Models covering ranges from 3.5 Hz to 300 MHz are available and are equipped with standard insulated BNC connectors. Features include flat frequency and linear phase response, 120 dB isolation at power frequencies and 500 VRMS winding to winding to case.

For further information, contact North Hills Electronics, 1 Alexander Pl., Glen Cove, N.Y. 11542-3796, (516) 671-5700; or circle #133 on the reader service card.

Waveform analysis

Tektronix announced the introduction of the 2402 TekMate software and hardware product, designed to offer waveform processing, storage and communication capabilities. When linked with any Tektronix 2400 Series digital oscilloscope, the product allows the user to perform complex waveform analyses and store over 500 waveforms, logging date and time information with the waveform data. Users also can make immediate waveform comparisons, establish pass/fail waveshape tests or view derived functions (such as FFT) on the scope screen.

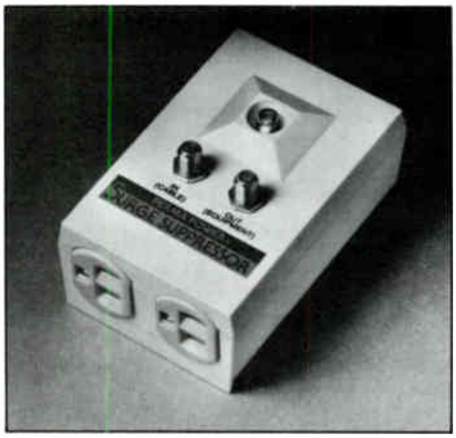
The product includes two 3½-inch 720K floppy disks for storing of waveform procedures and system software. It comes with GPIB, parallel and serial ports and supports a wide variety of printers and plotters, including the Tektronix color plotter HC-100.

For additional details, contact Tektronix Inc., Portable Instruments Division, P.O. Box 1700, Beaverton, Ore. 97075, (800) 426-2200; or circle #130 on the reader service card.

Protective belt

The Softee, a general purpose ANSI Class I occupational protective belt, is now available from Klein Tools. The belt's soft nylon back pad has rounded edges and is three inches wide to distribute pressure over a wide body area. The special non-abrasive material and design is said to minimize the major cause of user discomfort and fatigue.

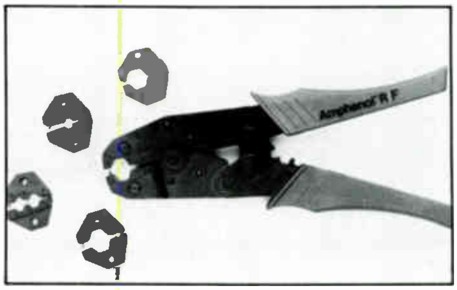
For more details, contact Klein Tools, 7200 McCormick Blvd., Chicago, Ill. 60645-2791, (312) 677-9500; or circle #136 on the reader service card.



Surge suppressor

The Model PTC-209 Cable-Line surge suppressor from Perma Power Electronics is designed to protect sensitive electronic equipment from transient voltage surges on the TV cable, antenna line or power line. It was developed to safeguard newer TV sets, VCRs, converters, satellite receivers and stereo equipment. The circuitry of the product was designed to protect against surges on the coax line without causing meaningful loss of signal.

For more information, contact Perma Power Electronics, 5601 W. Howard Ave., Chicago, Ill. 60648, (312) 647-9414; or circle #125 on the reader service card.



Crimp tool

Amphenol Corp.'s RF Division introduced its Econohex hand crimp tool and die sets designed to terminate RF connectors on most RG/U coaxial cables. The tool features a full cycle, reinforced ratchet control that is said to provide the high repeatability and reliability benefit of crimp-terminated connectors. Four die sets are available and provide the same crimp cavity sizes as MIL-T-22520 die sets /5-09, -11, -13, and -25.

For additional information, contact Amphenol Corp., 1 Kennedy Ave., Danbury, Conn. 06810, (203) 743-9272; or circle #119 on the reader service card.

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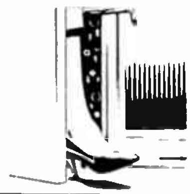

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Off-air Ch. 3

By Steven I. Biro
President, Biro Engineering

This is the second in a series of maps with technical and program parameter listings for off-air Channels 2-69, designed to be used when the cable system experiences co-channel interference. With this information, the headend technician can pinpoint the closest (i.e., the most probable) offenders, determine their directions and start the verification process with the rotor-mounted search antenna. Based on the tabulated technical information, the search can be concentrated on the most powerful stations or those that have the highest transmitting antenna towers.

The computer program for the maps was developed and data for the listings was collected by the staff of Biro Engineering, Princeton, N.J. The information is accurate as of Sept. 1, 1988.

Key to listing
Call letters: Ch. 3 station identification

City: Station location or the area served by the station

Network affiliation:

A/C	ABC and CBS programming
C/N	CBS and NBC programming
A/N	ABC and NBC programming
ACN	ABC, CBS and NBC programming
ED	Educational station (PBS)
IND	Independent station
CBC	Canadian Broadcasting Corp.
CTV	Canadian Television Network
TVA	Canadian Independent Programming
SRC	Societe Radio-Canada
SP	Spanish language programming

Power: The effective visual radiated output power (in kilowatts)

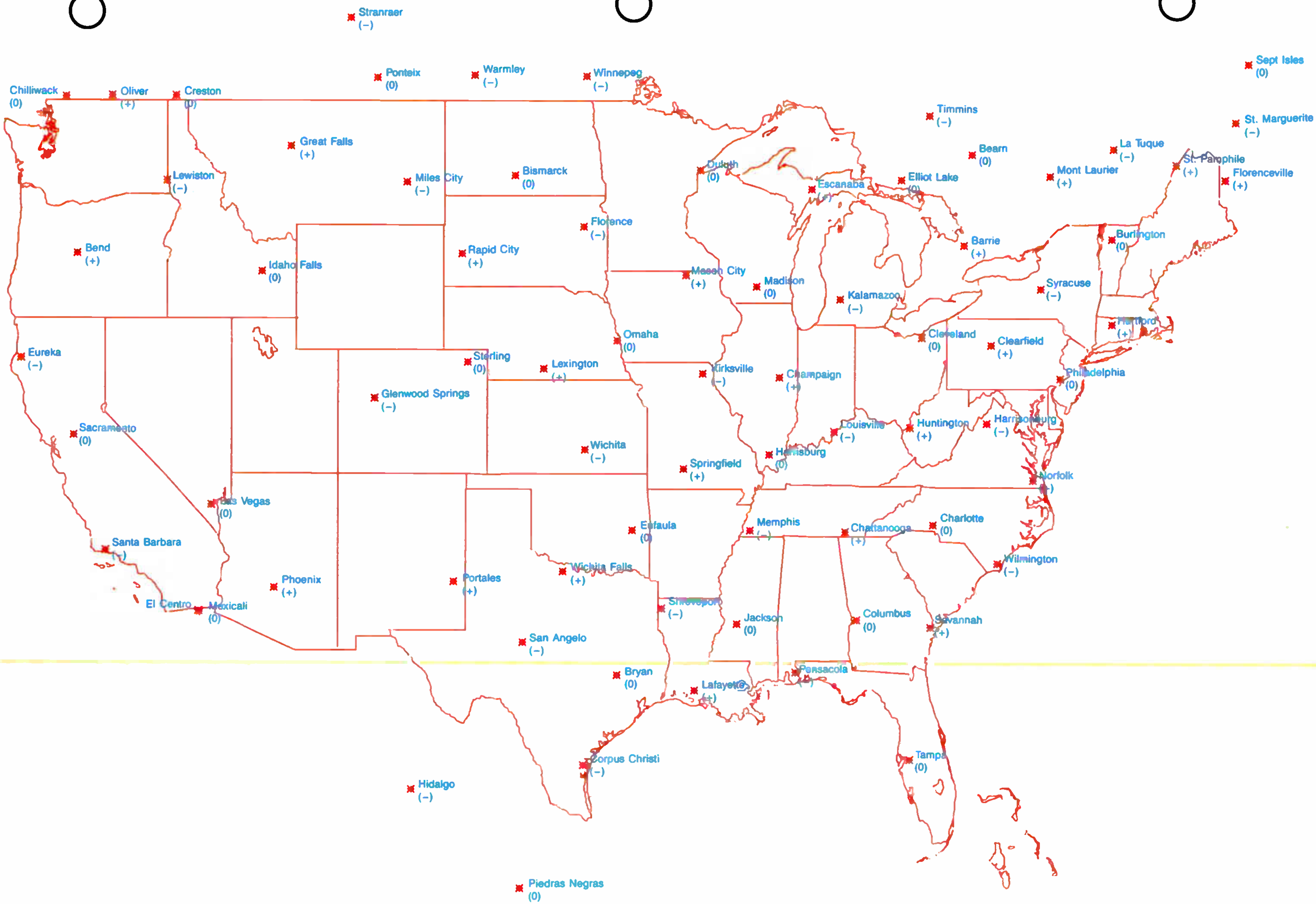
Offset: The offset frequency of the station

0	No offset
–	−10 kHz offset
+	+10 kHz offset

HAAT: Transmitting antenna height above average terrain (in feet)

Call letters	City	Network affiliation	Power	Offset	HAAT
KTOO	Juneau, Alaska	ED	3	0	1
KTVK	Phoenix	ABC	100	+	1670
KIEM	Eureka, Calif.	NBC	100	–	1650
KCRA	Sacramento, Calif.	NBC	100	0	1940
KEYT	Santa Barbara, Calif.	ABC	50	–	3010
KREG	Glenwood Springs, Colo.	C/N	67	–	2530
KTVS	Sterling, Colo.	C/N	61	0	730
WFSB	Hartford, Conn.	CBS	100	+	910
WEAR	Pensacola, Fla.	ABC	100	–	1220
WEDU	Tampa, Fla.	ED	100	0	935
WRBL	Columbus, Ga.	CBS	100	0	1790
WSAV	Savannah, Ga.	NBC	100	+	1476
KGMV	Wailuku, Hawaii	CBS	14	0	5950
KIDK	Idaho Falls, Idaho	CBS	100	0	1600
KLEW	Lewiston, Idaho	CBS	14	–	1260
WCIA	Champaign, Ill.	CBS	100	+	940
WSIL	Harrisburg, Ill.	ABC	100	0	994
KIMT	Mason City, Iowa	CBS	100	+	1550
KSNW	Wichita, Kan.	NBC	100	–	1071

Call letters	City	Network affiliation	Power	Offset	HAAT
WAVE	Louisville, Ky.	NBC	100	–	914
KATC	Lafayette, La.	ABC	100	+	1740
KTBS	Shreveport, La.	ABC	100	–	1781
WJMN	Escanaba, Mich.	ABC	100	+	1192
WWMT	Kalamazoo, Mich.	CBS	100	–	1000
KDLH	Duluth, Minn.	CBS	100	0	990
WLBT	Jackson, Miss.	NBC	100	0	2050
KTVO	Kirksville, Mo.	ABC	389	–	600
KYTV	Springfield, Mo.	NBC	95	+	2040
KRTV	Great Falls, Mont.	CBS	100	+	586
KYUS	Miles City, Mont.	NBC	10	–	125
KLNE	Lexington, Neb.	ED	100	+	1062
KMTV	Omaha, Neb.	CBS	100	0	1370
KVBC	Las Vegas	NBC	100	0	1275
KENW	Portales, N.M.	ED	100	+	1150
WSTM	Syracuse, N.Y.	NBC	100	–	1000
WBTV	Charlotte, N.C.	CBS	100	0	1873
WWAY	Wilmington, N.C.	ABC	100	–	1935
KBME	Bismarck, N.D.	ED	100	0	1393
WKYC	Cleveland	NBC	100	0	1000
KOET	Eufaula, Okla.	ED	100	0	1310
KOAB	Bend, Ore.	ED	20	+	750
WPSX	Clearfield, Pa.	ED	100	+	880
KYW	Philadelphia	NBC	100	0	1000
KDLO	Florence, S.D.	CBS	100	–	1684
KOTA	Rapid City, S.D.	ABC	100	+	659
WRCB	Chattanooga, Tenn.	NBC	100	+	1050
WREG	Memphis, Tenn.	CBS	100	–	1000
KBTX	Bryan, Texas	CBS	70	0	1687
KIII	Corpus Christi, Texas	ABC	100	–	860
KACB	San Angelo, Texas	NBC	18	–	600
KFDX	Wichita Falls, Texas	NBC	100	+	997
WCAX	Burlington, Vt.	CBS	38	0	2740
WHSV	Harrisonburg, Va.	ABC	9	–	2120
WTKR	Norfolk, Va.	CBS	100	+	980
WSAZ	Huntington, W. Va.	NBC	47	+	1253
WISC	Madison, Wis.	CBS	56	0	1190
CFRN	Edmonton, Alberta	CTV	250	0	720
CFRN	Peace River, Alberta	CTV	3	–	559
CBUT	Chilliwack, British Columbia	CBC	2	0	700
CBUC	Creston, British Columbia	CBC	1	0	2000
CKKM	Oliver, British Columbia	CTV	1	+	3164
CITM	100 Mile House, British Columbia	IND	2	0	1925
CFTK	Terrace, British Columbia	CBC	14	0	1488
CBWF	Winnipeg, Manitoba	SRC	59	–	930
CBAF	Allardville, Maritime Provinces	CBC	94	0	545
CKLT	Florenceville, Maritime Provinces	CTV	35	+	639
CBHT	Halifax, Maritime Provinces	CBC	100	0	866
CBHF	Yarmouth, Maritime Provinces	CBC	6	–	558
CJAP	Argentia, Newfoundland	CTV	14		558
CBNA	Baie Verte, Newfoundland	CBC	3		907
CKVR	Barrie, Ontario	CBC	100	+	1118
CICI	Elliot Lake, Ontario	CTV	19	0	532
CICO	Timmins, Ontario	ED	100	–	575
CKRN	Bearn, Quebec	CTV	3	0	545
CBVT	La Tuque, Quebec	CBC	28	–	407
CBFT	Mont Laurier, Quebec	CBC	28	+	509
CHAU	St. Marguerite, Quebec	CBC	8	–	700
CBSP	St. Pamphile, Quebec	CTV	1	+	400
CBSE	Sept Isles, Quebec	CBC	4	0	770
CBCP	Ponteix, Saskatchewan	CBC	19	0	900
CFQC	Stranraer, Saskatchewan	CTV	10	–	930
CFSS	Warmley, Saskatchewan	CTV	100	–	1285
XHBC	El Centro, Mexico	SP	15		678
XHJM	Hidalgo, Mexico	SP	1	–	100
XHBC	Mexicali, Mexico	SP	84	0	500
XEPN	Piedras Negras, Mexico	SP	5	0	300
WIPM	Mayaguez, Puerto Rico	SP	81	+	2380


Stranraer (–)
Ponteix (0)
Warmley (–)
Winnepeg (–)
Sept Isles (0)
Chilliwack (0)
Oliver (+)
Creston (0)
Timmins (–)
St. Marguerite (–)
Great Falls (+)
Bearn (0)
La Tuque (–)
Lewiston (–)
Miles City (–)
Bismarck (0)
Duluth (0)
St. Pamphile (+)
Mont Laurier (+)
Florenceville (+)
Elliot Lake (0)
Escanaba (+)
Bend (+)
Florence (–)
Barrie (+)
Burlington (0)
Rapid City (+)
Idaho Falls (0)
Mason City (+)
Madison (0)
Syracuse (–)
Kalamazoo (–)
Hartford (+)
Eureka (–)
Omaha (0)
Cleveland (0)
Clearfield (+)
Sterling (0)
Lexington (+)
Kirksville (–)
Champaign (+)
Philadelphia (0)
Glenwood Springs (–)
Sacramento (0)
Louisville (–)
Huntington (+)
Harrisonburg (–)
Wichita (–)
Harrisburg (0)
Springfield (+)
Norfolk
Las Vegas (0)
Eufaula (0)
Memphis (–)
Chattanooga (+)
Charlotte (0)
Santa Barbara (–)
Phoenix (+)
Portales (+)
Wichita Falls (+)
Wilmington (–)
El Centro
Mexicali (0)
Shreveport (–)
Jackson (0)
Columbus (0)
Savannah (+)
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G-Line troubleshooting procedure

By Ron Hranac
Jones Intercable Inc.

The data herein appears courtesy M/A-COM MAC Inc. This is the second of a two-part series.

This procedure assumes that the antennas are aligned correctly and that polarization has been set and line-of-sight exists between the end sites. Also, that the meter readings have been logged prior to failure. If not, typical values are indicated. *Apparatus:* digital multimeter, frequency counter (12 GHz or 200 MHz), scope (10 MHz), spectrum analyzer (70 MHz or 12 GHz), field strength meter, microwatt power meter, video generator, video monitor, audio test set, RMS voltmeter, 60 to 120 dB attenuator set (at frequency range of unit), waveguide-to-N adapter, TNC-to-N adapter, SMA-to-N adapter, OSM-to-N adapter, BNC-to-N adapter and two BNC-to-BNC jumpers (2').

Procedure:
Step 1) Look up the indicated alarm or failure mode (A).
Step 2) When alarm or failure is located, move to B for possible fault cause.
Step 3) Select a cause and move to C and locate evaluation parameter.
Step 4) If evaluation parameter is incorrect, move to D for corrective action.
Step 5) If evaluation parameter is correct, move to E for next step or cause.

A: Failure mode/alarm—TX fault lamp ON. *(Continued from Part I)*

B POSSIBLE CAUSE	C EVALUATION	D CORRECTIVE ACTION	E NEXT STEP
(1) b Defective TX Logic	1) Confirm 0V on E6 of AFC module	1) See AFC alignment procedure	1) Confirm 0V at TP8
	2) Confirm 0V at TP8	2) Adjust R32 for correct level	2) Replace U2 and U3
(1) c Defective AFC Loop	c Place AFC module disable switch OFF and measure volts on E1 of AFC module (25 to 27V)	1) Adjust for 26V ± 0.5V 802396-1 R65 802396-2 R12 842756-1 R19	c See defective Reference Oscillator (If system has no Reference Oscillator, check AFC module
		2) Adjust Master Oscillator for correct frequency by tuning line tuning screw on bottom of Oscillator. If incorrect, repair or replace Oscillator. If correct, turn AFC switch ON and remeasure frequency. If incorrect, align AFC	
(1) d Defective Reference Oscillator	d Verify Reference Oscillator output frequency (50 MHz below 2 GHz frequency at 2 mW	d Defective Reference Oscillator	d Check Reference Oscillator output cable
(1) e Defective Reference Oscillator output cable	e Confirm output cable continuity	e Repair or replace	e See defective Oscillator/Mixer
(1) f Defective Oscillator Mixer	f Confirm presence of 50 MHz at J1 of AFC unit (5 dBm) (0.5 Vdc)	f Replace Mixer	f See defective AFC module
(1) g Defective AFC module (842756-1)	g Measure input level at J1 (+7 dBm)	g Adjust SMA adapter on Oscillator for +7 dBm	g Repair or replace AFC
(1) h Defective AFC module (802396-1 or -2)	h Measure input level at J1 (5 dBm)	h Replace Mixer	h Repair or replace AFC
(2) i Defective RF system *	i Confirm TX frequency. If incorrect, see TX off frequency #1		
(2) j Incorrect PA CURRENT	j Confirm PA CURRENT 10 to 20 mV on meter)	j See defective RF Source and check wiring to Power Amp	j See defective RF Source
(2) k Defective RF Source	k Confirm power level to RF Amp from 2 GHz Oscillator. 2G TX 300 to 400 mW, 6G-7G-12G TX 0.8 to 1.2W	k Confirm input cable and connector to RF Amp. If correct, replace 2 GHz Oscillator	k See defective Power Amp.
(2) l Defective Power Amp	l Measure current on the +24 or +28V lead (TB1 Pin 2) or power output of Amp Band / Current / Power Output (dBm) 2G 1.6-1.9A +40 6G 500-600mA +37 6GW 1.9-2.2A +44 7G 1.6-1.9A +40 12G 500-600mA +37 15G 500-600mA +37	Repair or replace Repair or replace Repair or replace Repair or replace Repair or replace Repair or replace	Confirm +24 or +28V Confirm +24 or +28V Confirm +24 or +28V Confirm +24 or +28V Confirm +24 or +28V Confirm +24 or +28V Note: If good, see incorrect RF output meter indication
(2) m Incorrect RF output meter indication	m Confirm RF output level 30 to 40 μA). Note this is adjustable Potentiometer located on back of front meter	m Defective RF monitor diode. Measure front-to-back resistance (6:1 ratio). If incorrect, replace	m See defective TX Logic card

B POSSIBLE CAUSE	C EVALUATION	D CORRECTIVE ACTION	E NEXT STEP
(2) n Defective TX Logic Card	n Confirm RF threshold. Adjust R9 on TX Logic counter-clockwise (ccw) until fault lamp extinguish- and continue for 1 and 1/2 turns	n Replace U1	n See defective RF Multiplier or interconnect cable
(2) o Defective RF Multiplier	o Confirm Multiplier diode front-to-back ratio and out-power Band / 1st Stage Mult / Diode Ratio (K:1) / Power (dBm) / 1.8W Resistor Value (K) 6G X4 20 +30 33 GW X2 50 40 200 7G X2 20 37 50 12G X3 20 33 33 15G X4 20 27 33 Band / 2nd Stage Mult / Diode Ratio (K:1) / Power (dBm) / 1.8W Resistor Value (K) GW X2 50 +36 100 7G X2 20 34 100 12G X2 20 27 50-100 15G X2 20 +22 50-100	o If diode ratio or power is incorrect, see bias resistor. If good, replace Multiplier. If incorrect, replace bias resistor 1.8W	o See defective RF Amp
(3) p No pilot indication (optional)	1) Confirm presence of pilot crystal on TX BB Amp * 2) Confirm pilot switch on TX BB Amp is ON and level is set *		
(3) q Defective BB Amp (802362)	q Confirm pilot frequency and level (26 dB below video level at output of the Pre-Emphasis card) with a 2.33 MHz test tone applied to J2 of TX)	q Adjust R11 for correct level. Replace BB Amp if incorrect	q See defective TX Logic
(3) r Defective BB Amp (1841920)	r Confirm pilot frequency and level (26 dB below video level at TP5 with a test tone applied to J2 of TX)	r Adjust R42 for correct level. Replace BB Amp if incorrect	r See defective TX Logic
(3) s Defective TX Logic (803068)	s Adjust R58 for 3V on TP18. Adjust R47 for lamp threshold 3 to 6 dB below pilot level	s Check Y1, U5, U4, Q8, CR23 and CR24	s Confirm TX deviation. Attach TX RF output to a spectrum analyzer. Apply a 2.33 MHz test tone (1V P-P video input jack. Adjust TX BB Amp video gain adjustment for first bezel zero

A: Failure mode/alarm—RX fault lamp ON.

a Confirm operation of TX Pilot and TX Pilot meter indication (25 to 35 μA)			
b Confirm DC Power Supply voltages *			
c See RX squelch fault. See Section 5 of manual *			
d Defective Pilot Demodulator	1) Read pilot level on front meter (25 to 35 μA)	1) Adjust R47 to fault at 3 to 6 dB below level	
	2) Remove the Pilot Demodulator card off the RX squelch board	2) If the RX fault clears, check Y1, Q1 through Q7	2) See squelch fault

A: Failure mode/alarm—Incorrect XTAL current.

a See RX squelch fault *			
b Defective Mixer diodes	b Measure front-to-back resistance of the Mixer diodes (8 1)	b If 12G, replace diodes If other, replace Mixer (89440-60)	b See defective LO
c Defective LO	c Confirm output power of LO If low, replace unit 2G 2-4 mW 6G 2-4 mW 6GW 2-4 mW 7G 2-4 mW 12G 1-2 mW 15G 1-2 mW	c Replace	c Check LO output cable

A: Failure mode/alarm—Incorrect disc reading.

a Confirm TX frequency *			
b Confirm presence of AGC (25 to 40 normal) *			
c Defective LO	c Measure LO frequency 70 MHz below RF carrier 70 MHz may be read at J6 of IF Network or RF frequency off the LO	1) If 2G, replace unit 2) 6G, 6GW, 7G, or 12G If frequency is within 100 MHz, adjust Gunn tuning for correct frequency (5/32 Allen) If greater than 100 MHz, replace unit	1) See defective IF Discriminator
d Defective IF Discriminator	1) Confirm 0V on wiper arm of R39 with 70 MHz input if 802461-13 to -15 (IF Network)	1) Adjust R39 for 0V	1) See defective meter circuit
	2) Confirm 0V on wiper arm of R15 with 70 MHz input if 802461-2 to -10 (IF Network)	2) Adjust R15 for 0V at U3	2) See defective meter circuit

A: Failure mode/alarm—Incorrect AGC reading.

a Confirm TX output power *			
b Confirm TX output frequency *			
c Confirm RX IF frequency *			
d Confirm path *			
e See RX squelch fault #1, #2, and #3 *			
f Defective IF Amp AGC circuit	1) Check L1, CR7, Q9, and CR8 2) If 802461-2 to -15 IF Network, check Q8, Q9, and AGC detector	f Replace defective item	f Check AGC meter circuit and interconnect wiring

A: Failure mode/alarm—RX squelch lamp ON.

Note This alarm lamp is an AGC alarm A number prior to the possible cause will indicate start of that particular fault procedure (1) RX off frequency (see incorrect disc reading) (2) defective IF system (3) defective squelch *

a Confirm TX frequency and power *			
(1) b Confirm path *			
(2) c Defective IF system			
(2) d Defective LO	d If XTAL readings exist measure frequency only If incorrect, confirm output power of LO If low replace unit 2G 2-4 mW 6G 2-4 mW 6GW 2-4 mW 7G 2-4 mW 12G 1-2 mW	d Repair or replace	d See defective Mixer-Preamplifier
(2) e Defective Mixer-Preamplifier	e Measure front-to-back resistance of the Mixer diodes (8 1)	e If 12G replace diodes	e See defective Mixer-Preamplifier
(2) f Defective Mixer-Preamplifier	f Measure level of IF signal at J1 from Mixer (level 20 dB greater than RCL)	f Repair or replace	f See defective IF Filter
(2) g Defective IF Filter	g Measure IF level at J4 (0 5 dB) less than Mixer output	g Repair or replace	g See defective IF Amp
(2) h Defective IF Amp	1) Check W1-W3 jumpers on IF Network	1) Replace	
	2) Check IF Amp output J6 (0 to 3 dBm)	2) Check Q1 through Q7	2) See defective IF Filter If 802461-13 to 15 (IF Network) end procedure
(2) i Defective IF Filter (Optional)	i Measure IF level at J10 (0 5 dB) less than IF Amp output	i Repair or replace	i See defective IF Limiter
(2) j Defective IF Limiter (802461-2 to -10)	j Check W4-W6 jumpers on IF Network	j Replace	j See defective IF Limiter
(2) k Defective IF Limiter (802461-2 to -10)	k Measure IF level at J13 (3 dB greater than input)	k Check CR1 through CR8 and Q1 through Q6 Repair or replace	k See defective IF Discriminator
(2) l Defective IF Discriminator (802461-2 to -10)	l Measure BB output level at J12 on IF Network with a 2 33 MHz test tone (1V) applied to TX video input jack BB output level should be 250 mV P-P	l Repair or replace	l Check all interconnecting jumpers wiring and cables
(3) m Defective squelch	m Confirm presence of AGC sense at Pin 21	m Check IF Amp and interconnect wiring	m See defective squelch card
(3) n Defective squelch card	n If RX signal-to-noise is greater than 37 dB or AGC meter greater than - 25 reset squelch adjustment Adjust R21 to illuminate lamp at 37 dB signal-to-noise EIA weighted	n Check U1 U2 Q1 Q2 Q3 and Q4 Replace defective item	n Adjust R21 to set squelch lamp at 37 dB signal-to-noise

*Indicates see noted procedure first

A: Failure mode/alarm—Low or no video.

a Confirm TX frequency *			
b Confirm RX AGC and DISC readings *			
c Confirm Power Supply voltages *			
d Confirm video input at J1 J2 (1V P-P) of TX *			
e Check all external video interconnect cables *			
f Defective TX BB Amp	f Measure video level on Pin 23 (J1) 1 to 1 5V with a 1V P-P video signal applied to TX J2	f Set TX deviation 802362* R17 1841920* R2 Adjust RF carrier or IF for first bezel zero on a spectrum analyzer with a 2 33 MHz test tone at 0 dBm (1V P-P) applied to J2 of TX	f See Pre-Emphasis Network or see RX IF Video Demodulator
g Defective Pre-Emphasis Network	g Measure video level (pre-emphasized) at BNC output (7 to 1 2V) with 1V P-P signal applied to TX J2	g Repair or replace	g See defective RX IF Discriminator
h Defective IF Video Demodulator	h Measure output level at J12 (25 to 35 mV) IF Network with a 2 33 MHz (1V) test tone applied to TX video input	h Check Q1, Q2, U3, Q3, Q4 Q5, and Q8 Replace defective item	h See defective BB Amp
i Defective IF Discriminator	i Measure output level at J12 (25 to 35 mV) IF Network with a 2 33 MHz (1V) test tone applied to TX video input	i Check Q3, Q4, Q5, Q6, Q7, Q8, CR5, and CR6 Replace defective item	i See defective BB Amp
j Defective BB Amp	j Measure video level at J2 (1V P-P) with a test tone of 2 33 MHz (1V) applied to TX video input	j Adjust AT1 for 1V If incorrect, check Q6 through Q13	j Check all cabling and interconnections

A: Failure mode/alarm—Poor video response.

a Confirm TX and IF frequencies *			
b Check all interconnect cables *	b Measure or confirm waveguide cable VSWR	b Align or replace	b See high response
c High response	c Adjust C17 on RX BB Amp Adjust C28 on TX BB Amp On 1841920 C3*	c IF Equalizer alignment L6 and L7, C14	c 2 GHz Oscillator linearity incorrect, replace unit
d Low response	d Adjust R25 on RX BB Amp Adjust C28 on TX BB Amp On 1841920 C3*	d IF Equalizer alignment L6 and L7, C14	d 2 GHz Oscillator linearity incorrect, replace unit

A: Failure mode/alarm—Herringbone, beats or hum bars in video.

a Confirm TX and IF frequencies *			
b Defective Power Supply	b Display individual dc volts on a 10 MHz scope DC level should be flat with less than 20 mV of ripple may be measured on meter switch	b Check regulator and filter caps	b See defective audio system
c Defective audio system	c Remove audio input to system If more than one audio channel, remove all, then reattach one at a time	c Check audio deviation, levels, and for beats caused between audio channels	c See incorrect system configuration
d Incorrect frequency spacing	d If more than one RF channel in system configuration, shut-down one channel at a time	d Confirm operating frequency and spacing diplex (50 MHz) separation, duplex (75 MHz) separation	d See external interference
e External interference	e Remove the cable or waveguide feed from the RX rack and attach to a spectrum analyzer Shut-down all but one TX channel	e Observe all frequencies displayed If other than TX signal displayed, confirm frequency and contact factory	e See defective AFC
f Defective AFC module (802396-1 only)	f Place AFC switch in OFF position	f Replace U1 and U3	f See defective AFC regulator
g Defective AFC Regulator (802396-1 only)	g Display AFC output (E1) volts on a 10 MHz scope DC level should be flat with less than 20 mV of ripple	g Replace U2	g See unregulated ac input
h Video inverted or scrambled	1) Relocate the video input cable from J3 on back of TX to J2 J3 is a Service Channel input and will invert the video signal 2) Confirm TX and RX frequencies RX frequency must be 70 MHz below the TX RF frequency 3) Confirm presence of TX and RX emphasis Both must be the same		
i Unregulated ac input	i Check ac input for level and noise	i Insert an isolation transformer or consider a UPS	i See poor station ground
j Poor station ground	j Check for ground loops and confirm equipment grounding	j Ground and bond all equipment to the equipment rack and common ground bus	j See hum
k Hum	k Confirm ground potential between the equipment rack and station ground	k Install a hum stop filter between the video feed and the TX video input	k Check all grounds and bond all equipment together

*Indicates see noted procedure first

KEEPING TRACK

Anixter Bros. named **Dave Long** regional sales vice president for its Midwest region. Most recently, he was Chicago branch manager for General Electric Supply. Contact: 4711 Golf Rd., 1 Concourse Plaza, Skokie, Ill. 60076, (312) 677-2600.

Chambers

Sylvia Chambers was promoted to major account manager for **Antenna Specialists Co.** She was previously area systems engineer and AVL product planner for Motorola. Contact: 30500 Bruce Industrial Pkwy., Cleveland, Ohio 44139-3996, (216) 349-8400.

Hamill

Dennis Hamill was named marketing operations and international director for the **3M Dynatel Systems Division**. He was formerly marketing operations director for the TelComm Products Division. Contact: P.O. Box 2963, Austin, Texas 78769-2963, (512) 984-3272.

C-COR Electronics elected **John Omlor** to its board of directors. He is currently president of the consulting firm John J. Omlor and Associates Ltd. Contact: 60 Decibel Rd., State College, Pa. 16801, (814) 238-2461.

Summit Cable named **Glyndell Moore** director of technical operations for Summit Cable Services of Georgia. He was formerly vice president of engineering for Storer Cable Communications. Contact: 115 Perimeter Center Pl., Suite 1150, Atlanta, Ga. 30346, (404) 394-0707.

Tektronix appointed **Steve Kerman** managing director of all international sales for Tektronix in the Americas Pacific area. He is currently television division director of sales. Contact: P.O. Box 500, Beaverton, Ore. 97077, (503) 627-2230.

David Kirchheimer joined **IDB Communications**' board of directors. He is currently vice president and chief financial officer of Republic Pictures Corp. Contact: 10525 W. Washington Blvd., Culver City, Calif. 90232-3380, (213) 870-9000.

Victor Palousek was appointed manager, cable products for **EF Industries**. He was previously manager of the Victorville, Calif., plant of Anixter Manufacturing Co. Contact: 12624 Daphne Ave., Hawthorne, Calif. 90250, (213) 777-4070.

Cullen

Stainless Enterprises, which designs and manufactures communications towers, promoted **John Cullen** to president and chief executive officer. Before this, he was treasurer for the company. Contact: North Wales, Pa. 19454, (215) 699-4871.

Winter Consumer Electronics Show II

By Walter S. Ciciora, Ph.D.
Vice President of Technology
American Television and Communications Corp.

Last month we covered about half of the things of interest to cable TV from the 1989 Electronic Industries Association (EIA) Winter Consumer Electronics Show (WCES) held in Las Vegas, Nev., Jan. 7-10. Topics included home automation and improved definition TV (IDTV). This month we'll finish the job by discussing high-definition TV (HDTV), liquid crystal displays, personal video and universal remote controls.

High-definition TV

Two demonstrations of HDTV images were in easy public view. Sanyo/Fisher displayed the startling pictures that come from the full 30 MHz production standard developed by NHK, the Japanese Public Broadcasting Corp. This booth was at the very front of the main exhibit hall. Philips showed its transmission standard proposal for the United States outside its private suite in a side building. As with all demonstrations of HDTV, special measures were taken to reduce ambient light. This is because current HDTV displays are not nearly as bright as NTSC pictures. Those who could get close were impressed, while those back five or more picture heights from the screen wondered what all the fuss was about.

There were three panel sessions on HDTV. Alex Felker, Federal Communications Commission Mass Media Bureau Chief, probably made the most important statement about HDTV standards: "...We're already about 18 months into this process...and in many ways we haven't come all that far....We're looking at somewhere around another 18 months, perhaps two years, before testing is complete and the commission would be in a position to select a transmission standard." After testing is complete, a few months will be required by the FCC to digest the results and make its decision. A year or so longer and the first products will be introduced. Brenda Fox of the NCTA represented cable's case well on this panel.

A second HDTV panel delved into the political and trade issues. HDTV and consumer electronics were painted as critical to the nation's defense by one panelist. The argument was simply that without a viable consumer electronics business, semiconductor production in the United States will be severely impacted by a lack of volume. And, of course, semiconductors are critical to defense. The point also was made that currently more innovation comes from consumer electronics than almost any other segment. The call was made for government support of HDTV R&D. Other panelists decried the tough choices facing Congress. Yet another panelist claimed that if we can afford $10 billion to bail out the savings and loan industry, we should be able to find $50 million to $200 million for consumer electronics research.

The third panel reviewed projections for the HDTV business. The EIA's Nathan Report on HDTV was discussed. It is wildly optimistic about HDTV penetration, claiming 25 percent by the year 2000. This is very controversial and even dubious. But to the extent that there is any validity to it, cable has to get moving to prepare for HDTV. This same panel discussed the ATV multiport, which is an extension of the EIA multiport concept. This is seen as the way in which cable can have its own HDTV standard to compete with other media if that becomes necessary.

Liquid crystal displays

Color liquid crystal displays (LCDs) were everywhere. Quality and size were up and pricing down. The so-called "active matrix" technology has improved the contrast ratio and reduced the lag prevalent in early models. The active matrix approach includes a thin film transistor (TFT) at each picture location. The extra complexity is definitely worth it. Many camcorders now come with color LCD displays replacing the tiny black-and-white picture tubes.

Personal TVs are commonplace. Instead of just 2-inch displays, up to 6-inch pictures are available with quite reasonable image quality. Sharp displayed a prototype 14-inch color LCD that really looked good. This may be a product at the June show or early next year. The really interesting question is whether this will eventually lead to the large-screen on-the-wall HDTV display. Progress so far is encouraging but don't expect jumbos for at least five to 10 years.

Personal video

The most interesting application of LCDs is in the products called "personal video." This is the combination of a miniaturized VCR, an LCD and TV receiver circuitry. One panelist called 1989 the "year of personal video." While that's undoubtedly an exaggeration, most manufacturers had at least one model. The units based on the 8mm tape format were the smallest; Sony's is almost pocket-sized. These products are currently very expensive, but production can't keep up with the demand from gadget freaks. Real volume sales won't happen until pricing is well below $500.

The significance of personal video for cable is that it may change the way people watch movies. Rather than being tied to their living room TV, where cable is present, consumers may take rental tapes or videos previously recorded at home on the train, plane or wherever they may have previously read a book or magazine. If cable can become the convenient source of this video, this will be to cable's advantage. This once again increases the importance of the consumer electronics interface with cable. If the video store is the source, personal video becomes a problem.

Universal remote controls

Universal remotes are units that control multiple products from the same hand-held device.

"More innovation comes from consumer electronics than almost any other segment."

Nearly all include the ability to control most cable converters. They are now pervasive in two ways. First, they are included in many top-of-the-line TV receiver purchases. One estimate is that 20 percent of remote TVs sold this year will come with universal remotes. Second, after-market universal remotes are being offered by both traditional and non-traditional sources. Both versions come in a wide variety of styles, sophistication and capability. As you might expect some are more "universal" than others. Failure at universality comes in two ways: Some units don't cover all products and other units don't do all functions. In fairness, many of the units don't really claim to be "universal."

There seem to be three types. The original approach to this type of product was by General Electric, employing the "head-to-head" learning technique. Infrared receivers in the GE unit analyze and copy the emissions from the consumer's existing control and then transmit them when the appropriate buttons are pushed. The Memorex unit also uses this method, but with one difference: It is "head-to-tail." That little change means all the buttons are right side up!

These types of units are perhaps the most universal since they can learn just about any signals. However, it's been rumored that at least one consumer electronics manufacturer uses differing signals for the same function so that "universal" remotes won't always work with its products. Many users had difficulty getting the original GE units to "learn."

The second type of unit is like the Philips or Magnavox products. The hand unit is sequenced through code sets until the device to be controlled responds. Then the control unit "memorizes" which signal set worked. The third type uses either switches or buttons to enter a product identification number to tell the hand unit which con-

(Continued on page 106)

CALENDAR

March

March 12-13: SCTE Old Dominion Chapter technical seminar on FCC rules, fiber optics and BCT/E Categories II and III, Holiday Inn, Richmond, Va. Contact Margaret Harvey, (703) 248-3400.

March 12-14: SCTE Razorback Chapter technical seminar and BCT/E testing, Convention Center, Hot Springs, Ark. Contact Jim Dickerson, (501) 777-4684.

March 12-14: Louisiana/Arkansas Cable Television Associations' L'Ark Show, Convention Center, Hot Springs, Ark. Contact (501) 724-6273 or (504) 387-5960.

March 13-14: Trellis Communications seminar on fiber-optic networks, Embassy Suites, Secaucus, N.J. Contact Richard Cerny, (603) 898-3434.

March 14: SCTE Chattahoochee Chapter technical seminar on grounding and bonding. Contact Jack Connolly, (912) 741-5068.

March 14-15: National Cable Television Association seminar on FCC's signal leakage regulations, Memphis, Tenn. Contact (202) 775-3637.

March 14-15: InfoLAN seminar on broadband local area networks, Orrington Hotel, Chicago. Contact (800) 526-7469.

March 18: SCTE Cactus Chapter technical seminar. Contact Harold Mackey Jr., (602) 866-0072.

March 18: SCTE Florida Chapter's South Florida Group technical seminar. Contact Denise Turner, (800) 282-9164.

March 18: SCTE Florida Chapter's Central Florida Group technical seminar. Contact Denise Turner, (800) 282-9164.

March 18: SCTE Great Plains Meeting Group technical seminar on signal leakage, Best Western, Council Bluffs, Iowa. Contact Jennifer Hays, (402) 333-6484.

March 21-23: Magnavox CATV technical seminar, Milwaukee. Contact Amy Haube, (315) 682-9105.

March 21-23: C-COR Electronics technical seminar, Orlando, Fla. Contact Shelley Parker, (800) 233-2267.

March 22: SCTE Ohio Valley Chapter technical seminar on data networking and architecture and BCT/E testing. Contact Bill Ricker, (614) 236-1292.

Planning ahead

May 21-24: NCTA Show, Convention Center, Dallas.

June 15-18: Cable-Tec Expo '89, Orange County Convention Center, Orlando, Fla.

Aug. 27-29: Eastern Show, Atlanta Merchandise Mart, Atlanta.

Sept. 20-22: Great Lakes Expo, Convention Center, Columbus, Ohio.

March 22: SCTE Piedmont Chapter technical seminar. Contact Rick Hollowell, (919) 968-4661.

March 28: SCTE Satellite Tele-Seminar Program, "The future of the CATV business (Part I)," 12-1 p.m. ET on Transponder 7 of Satcom F3R. Contact (215) 363-6888.

March 28-30: Magnavox CATV technical seminar, Minneapolis. Contact Amy Haube, (315) 682-9105.

March 29: SCTE Great Lakes Chapter technical seminar. Contact Daniel Leith, (313) 549-8288.

March 31: SCTE Rocky Mountain Chapter BCT/E exams, Clarion Hotel, Englewood, Colo. Contact Rikki Lee, (303) 792-0023.

April

April 3-6: Siecor Corp. technical seminar on fiber-optic installation and splicing for LAN, building and campus applications, Hickory, N.C. Contact (704) 327-5998.

April 4-5: InfoLAN seminar on broadband local area networks, Park Plaza Hotel, Boston. Contact (800) 526-7469.

April 4-6: Magnavox CATV technical seminar, Rapid City, S.D. Contact Amy Haube, (315) 682-9105.

April 8: SCTE Razorback Chapter technical seminar for installers, Days Inn, Little Rock, Ark. Contact Jim Dickerson, (501) 777-4684.

April 10: SCTE Florida Chapter's South Florida Group technical seminar on high-definition television. Contact Denise Turner, (800) 282-9164.

April 11-12: Trellis Communications seminar on fiber-optic networks, Marina Beach Hotel, Marina Del Rey, Calif. Contact Richard Cerny, (603) 898-3434.

AD INDEX

Carrier-to-interference ratios

By Archer S. Taylor
Senior Vice President of Engineering, Malarkey-Taylor Associates

In the beginning, when the world was young and we still had 300 ohms, TV signals were measured in millivolts. As our culture became more unbalanced, the shift to 75 ohms was inevitable and we lost half our millivolts. When any situation seems to be too hard to comprehend, we tend to organize our ignorance along statistical lines. When the situation simply boggles the mind, we convert it into logarithms. That is just what the godfather of cable TV and former governor of Pennsylvania, Milton J. (for Jerrold) Shapp, did about the loss of half of our millivolts.

Actually, while we lost half of our millivolts, we did not lose any of our nanowatts. Figure it out: 1 millivolt across 300 ohms is $(0.001)^2/300$ or 3.3 nanowatts. One-half millivolt across 75 ohms $(0.0005)^2/75$ is also 3.3 nanowatts.

So the engineers at Jerrold Electronics Co. decided it would be more professional and less amateurish to talk about decibels as they do at Bell Telephone Laboratories. As you know, 1 millivolt received off a 75 ohm antenna represents a reasonably good TV signal. Yet Bell Labs would express it as −48.75 dBm; i.e., nearly 50 decibels below 1 milliwatt. You see, 1 millivolt across 75 ohms is only 0.000013 milliwatts. Clearly dBm is an awkward way to talk about TV signal level. "Hey! I got 13.3 millionths of a milliwatt on TV last night!" So why not set up a new expression more nearly representative of TV signal level?

Instead of dBm, Jerrold called it the dBj. No one ever accused Milt Shapp of missing a good promotional opportunity.

That worked well until sales engineers for International Telemeter, Entron, Ameco and C-COR gagged over immortalizing their competitor's name in the dBj unit. They switched, by almost unspoken concurrence, to the dBmV or decibels re 1 millivolt. Although they all understood very well that the dBmV terminology was always applied in a 75 ohm environment, that important fact sort of got lost in the noise.

Then some test equipment suppliers became interested in developing a market for instrumentation in the emerging CATV field. They routinely specified signal generator output in millivolts, which logically could be expressed in the cable TV terms of dBmV; i.e., dB relative to 1 millivolt. This got them in real trouble because their millivolts were measured across 100,000 ohms!

Some time in the early 1970s, the NCTA Engineering Committee decided to try to devise a less misleading way of expressing cable TV signal levels. Maybe it would be better to use an arbitrary term that bore no suggestion of the reference level. Why not use dBc for signal levels in cable TV, meaning decibels relative to 1 millivolt across 75 ohms?

Hold on a minute. During several months just preceding this meeting, three Canadian cable TV equipment suppliers had merged to form Delta-Benco-Cascade, using the logo "DBC" for promotional purposes. Were we about to jump out of the "dBj" frying pan into the "dBc" fire? The committee gave up.

Now we see the expression "dBc" being used to define intermodulation levels, particularly composite triple beats, with reference to the carrier level. Apparently we are no longer worried about the commercial implications.

Always a negative number

But there is another issue. The dBc, as the ratio of a tiny amount of triple beat to the much greater carrier level, must always be a negative number. A positive number would be real bad news. It would mean the triple beat is actually a whole lot stronger than the carrier itself.

I have pleaded for years that all types of interference be specified in positive terms: carrier-to-interference (C/I) regardless of the nature of the interference. Every cable TV equipment supplier agreed; some of them actually did use positive numbers for C/CTB and C/XMOD and still do. But there has been some backsliding, and whether you realize it or not the trend toward the use of dBc is backsliding.

I deplore the use of dBc. Maybe I am just a nit-picking purist. Nevertheless, mixing positive C/N ratios and negative CTB/C ratios can easily lead to incorrect computations and conclusions.

"When the situation simply boggles the mind, we convert it into logarithms."

Think about it: −50 dB is a smaller number than +50 dB. Is bigger better? Or is smaller better? Isn't it better to have a bigger number for the carrier-to-noise ratio and a bigger number for carrier-to-composite triple beat? Isn't −45 dB bigger than −50 dB? Then why isn't 45 dBc better than 50 dBc? See what I mean? You can get quite tangled up when you use C/I for one specification and I/C for another.

Then there was the fellow who was so used to expressing cross-mod as minus so many dB that he listed C/N as −44 dB! What a snowstorm that would be if the carrier were actually 44 dB below the noise level!

Please, let's drop the dBc stuff. C/I is in fact a genuine ratio and needs no power reference. Call it C/CTB or C/N, and all you need is dB; forget the minus sign.

The worst of it is that you guys have ruined the "dBc." Now we cannot use it as the signal voltage relative to 1 millivolt in 75 ohm systems or the signal power level above 13.33 nanowatts.

Should we say dBmV75? How clumsy can you get! But it *would* be more accurate.

Ciciora's Forum

(Continued from page 104)

trol set to use. (The Zenith product operates this way.) A few of the more elaborate units can have new code sets "downloaded" into them from a personal computer. It is usually intended that a dealer or distributor do this.

The big problems with these units is that they are still way too complicated to set up and to use. In fact, the more "universal" they are, the more complicated they seem to be. If someone can come up with a unit whose use is obvious, it'll quickly become dominant. In the meanwhile, the slow erosion of remote control revenues because of universal remotes is something cable has to plan for. The subscriber without a remote control TV set welcomes the cable company's remote, while the sub with such a set is upset at not being able to use it. The sub who bought a "universal" remote either with the TV set or as an after-market item will be angry if it can't be used.

Consumer electronics continue to evolve and provide new challenges for cable. If we master the interface with these products, we'll have a substantial competitive edge over telco and DBS. If we fail, we'll have squandered an important opportunity.

Reader Service Number 48.