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The Queens 1-GHz upgrade: ATC's technological beacon

—page 31

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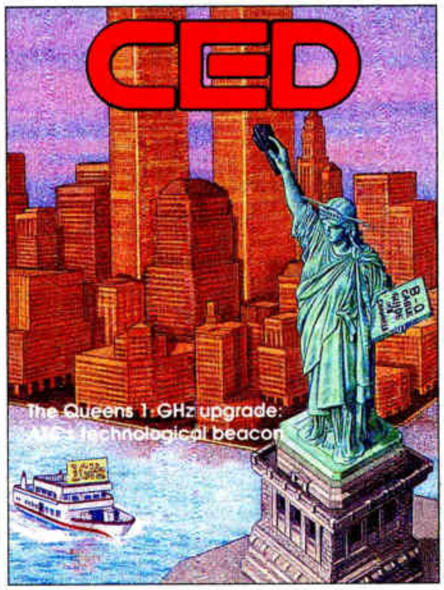
February 1992

CED

Volume 18, Number 2



About the Cover:
A slightly altered Lady Liberty welcomes 1-GHz to New York City. Illustration by Peg Magovern.

DEPARTMENTS

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Circle Reader Service No. 3

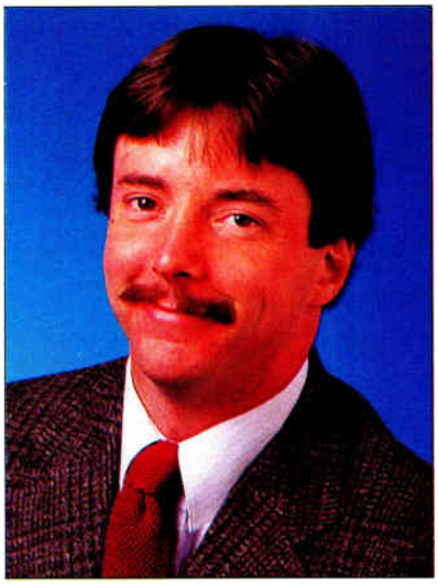
COMMUNICATIONS

A sure-fire way to be a hero

OK, so *you* drew the short straw during the engineering meeting and you've been appointed Safety Manager of your cable system because the law says your company must have one. Chances are you're already overworked and your interest in being a safety cop is, well, less than overwhelming. What do you do next?

Come to Denver in April! The National Cable Television Institute (NCTI) and *CED* magazine have teamed up to offer a two-day seminar on safety designed to help you create, implement and manage safety programs.

No, safety is hardly a headline-grabbing subject (unless something goes wrong and someone is seriously injured or killed, of course). But a cable system that hasn't prepared itself correctly is 1) inviting an OSHA inspection, 2) probably paying excess insurance premiums and 3) potentially risking the health of all its employees.



Roger Keith, the guy who runs NCTI's successful OSHA seminars, says "Safety is not an option." He's right: the federal government mandates that every cable system meet specific legal safety requirements. Do you know what those are? Do you have specific written policies and guidelines related to when and where to wear hardhats or steel-toed shoes? Do you regularly train employees on how to operate safety equipment? Could your existing safety program stand up to close scrutiny by an outside agency?

In fiscal year 1991, Congress endowed OSHA with a $311 million budget. That goes to fund more than 115,000 inspections per year. Cable systems are on the "hit" list, especially when a workman's comp claim is filed.

During 1990, 19,000 fines and citiations were handed out to companies that failed to demonstrate it had a hazard communication program in place. Are you one of them?

Now that you've been scared to death, plan on attending Safety '92 at the Sheraton Denver Tech Center on April 9 and 10. Early registrants can attend for $325 each ($365 if you're not a member of the SCTE). Attendees of Safety '92 can stay at the Sheraton for just $72 a night.

If you're the engineering manager at your system, send someone to the seminar. Find out if your system is doing everything it can do to protect the lives of its employees. You'll even get some tips on how to reduce your insurance bill—and in this day and age, you might be hailed as a hero for saving so much money. Give NCTI a call for more information: (303) 761-8554.

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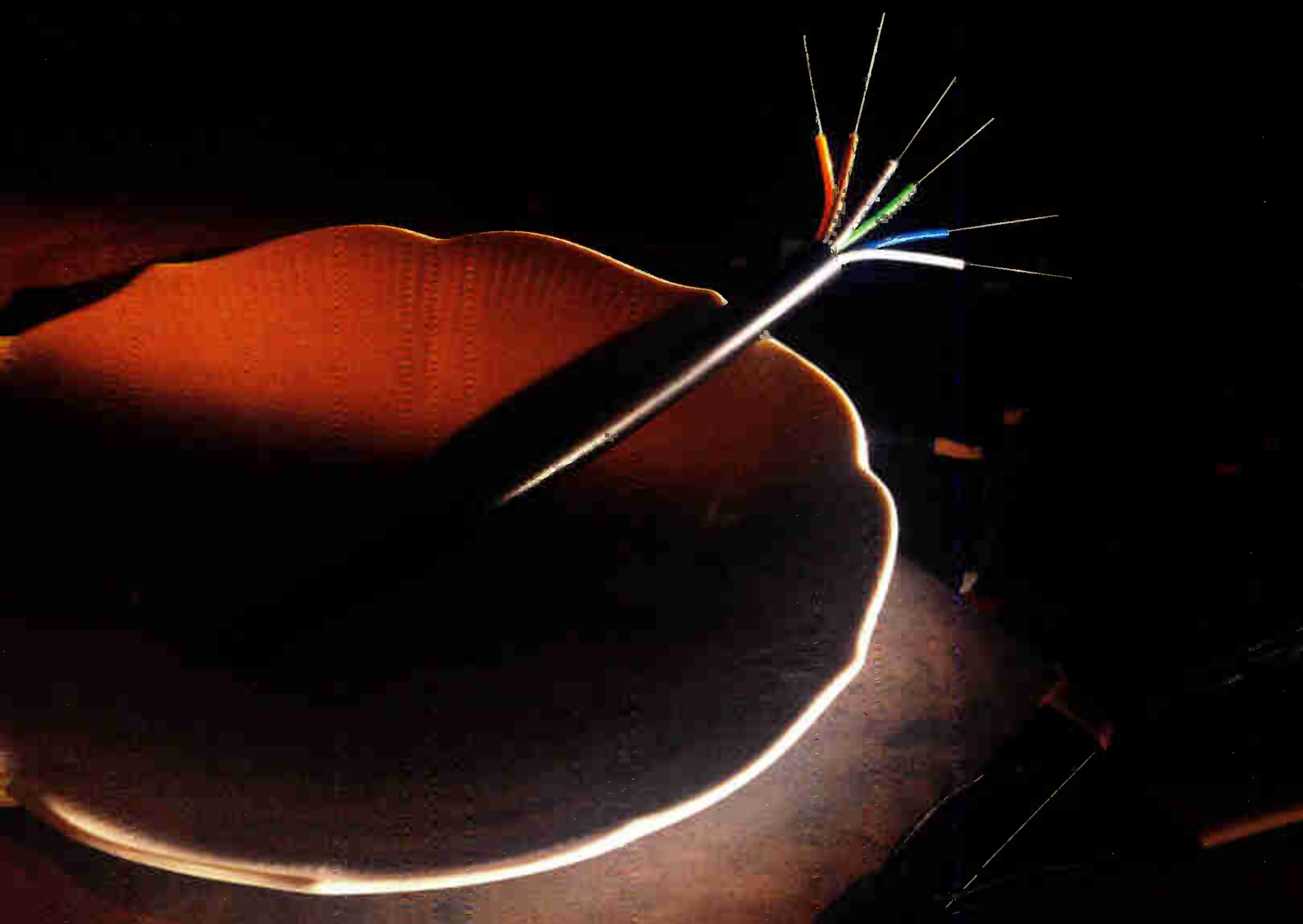

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WAVETEK

Circle Reader Service No. 5

Vic Gates

Not just a field guy

When Vic Gates, regional engineer for MetroVision's Michigan properties, looks in the mirror, what he sees is an "old field guy." But the truth of the matter is, he's a *lot* more than that.

Forget cable television for a moment and consider this: Gates' novel—an autobiographical tale that he laughingly describes as "a Tom Sawyer-ish adventure," goes into print this autumn. He's a patron of the arts. He and his family own a ranch called "Victor's Mountain" in the open country of South Dakota, and as such assisted the movie production of the recent box office smash *Dances with Wolves*.

But in his mind, Gates is "just a field guy." Ha.

Tending the field

Of course, in part Vic's right, particularly in that most all of his energy is directed toward projects that benefit "the people up on the poles."

That's why, for example, Gates says he is proud to be on the team that took such an active interest in cumulative leakage index monitoring (CLI) in the late 1980s—becoming the first company to publicly espouse the preventive maintenance effects of CLI.

Their efforts resulted in a CLI software package (CLIDE), a set of CLI compliance procedures, and a paper that was published in the NCTA Technical Papers and repeatedly delivered at SCTE chapter meetings across the country.

"I would call our CLI procedures one of my biggest challenges," Gates says. "It's not that the specific leaks were tough. It's the procedure and the amount of manpower required to do the work. And in the end, the CLI procedures we developed ended up being a blessing in disguise, because our service calls went down.

Even Gates' management style at MetroVision is field-driven. He calls it "walk around management," which basically means that he doesn't spend a whole lot of time at his desk. "This 'walk around' style has had me up on poles in the middle of the night, in the middle of winter," Gates explains. "It keeps me with a hands-on, working knowledge of the business."

Not that Gates is lacking much in terms of business intuition. In his early cable days—back in the mid-1970s—Gates left his somewhat cushy job as an engineer with Cox Cable and bought a cable system in Alberton, Mont. From there, he won a franchise in nearby St. Regis and was awarded a system maintenance contract on 11 of TCI's Montana properties.

And when city officials in Eaton Rapids, Mich. called Gates three months later to award him yet another franchise, Gates looked to his former Cox colleagues (who had since formed MetroVision and were actively pursuing him to join) for financial help.

"They (MetroVision) put me on a plane to Atlanta that afternoon, and we worked out a deal," Gates remembers. "I sold my Montana systems and went to work on a three-year stint for MetroVision. That was 12 years ago," Gates laughs.

Bypassing Bell

Just last year, Gates was on the team that installed a fiber/ARU phone system that transparently call-forwards all incoming telephone traffic over MetroVisions' existing fiber network. It's the first known project in which a cable operator bypasses telco lines to route telephone traffic to its CSRs.

Interestingly, Gates had an idea to do a project like this in 1985, while laid up in bed with a broken neck. "The idea was a little touchy at first because it dealt with our bread and butter—the customers," Gates says.

Will MetroVision's phone-via-fiber installation translate into more telephony over cable plant? "Not likely," Gates says. Instead, his current focus is "fiber, fiber, fiber."

"Fiber is opening the door to so many things," Gates says, "but my focus right now is to use new technology to solve very basic problems. Like reduction of service calls, for example. I believe—and it's coming true—that as we activate nodes, service calls come down."

Double-barrel shotgun

Even with his systems becoming more reliable as a result of fiber, Gates sees the future as "bleak." "I equate it to a double-barrel shotgun, pointed right at us. One barrel is loaded with legislation, and the other with telco entry," Gates muses.

"But the powder behind both those shells seems to be the customer. And if the customer is getting the service he wants and is satisfied with the price, then he won't complain to the legislators who are in turn crying out for competition. So, my feeling is, we'll do ourselves a big favor if we do a solid, good job every day, and treat each complaint seriously," Gates says.

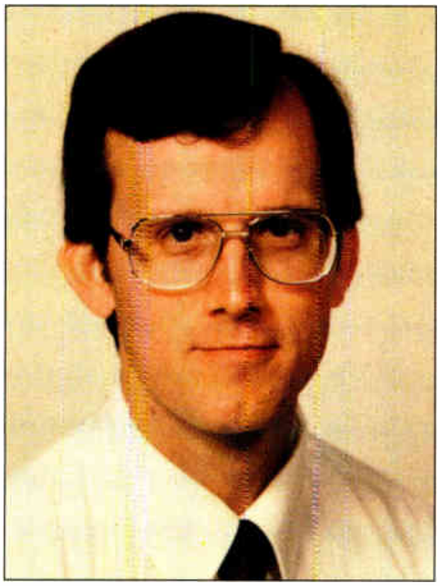
Gates fields some of those complaints himself, he adds, both at MetroVision and as the engineering contact for the Michigan Cable Television Association. And, as an 18-year member and current Region 7 director for the SCTE, he works to further assist his comrades—guess where?—in the field. "Almost everything I do has the word 'field' in front of it," Gates laughs. In the SCTE, for example, Gates heads the committee which selects field operations award every year.

But beneath it all, Gates is a guy—OK, a field guy—trapped in an engineer's body looking forward to that day when he can play Paul Bunyan on his 60-acre ranch in South Dakota. He and his family of five recently planted "about 6,000" trees and more than 1,000 grape vines which he'll eventually use to make jelly (the climate, Gates adds, is much too severe for wine grapes).

His love of the rough Western landscape recently inspired him to commission six paintings, all moviescape-type renditions of different *Dances with Wolves* location shots, which will be put on display at local galleries. All this, and he's only 42 years old.

So what's next, Vic? A symphony, perhaps? CED

By Leslie Ellis



Antenna directivity and front-to-back ratio

A directional or "beam" antenna's front-to-back ratio is simply a measure of its gain in the "forward" direction compared to its gain in the "reverse" direction—and is usually expressed in dB. Thus, a Yagi antenna with an 11 dB front-to-back ratio has 11 dB more gain off of the "front" of the antenna than it does off of the "back" of the antenna. This is certainly simple enough, but how does it do it? How can an antenna have more gain in one direction than another, and what determines the ultimate pattern of the antenna?

The isotropic model

In antenna theory, the concept of an *isotropic* antenna, a purely theoretical antenna to which all other antennas are eventually compared, is often used as a reference, and as an aid in the definition of antenna patterns. An isotropic antenna is one that radiates (or receives) equally in all directions, resulting in a radiation pattern that looks like a perfect sphere. No conductor of any physical size can really create such a pattern.

The problem with an isotropic antenna, besides the fact that you simply can't build one, is that, even if you could, it wouldn't be very practical, because it simply would not make very efficient use of the available RF energy. It would, in effect, transmit or receive signals from all directions equally poorly, including such impractical directions as straight up in the sky and straight down at the ground—directions that we aren't typically interested in for most communications activities.

But even if an isotropic radiator isn't a practical reality, it does help us to explain the performance of other, more practical antenna systems. If, for example, we were to break a conductor down into extremely small segments approaching the size of the conductor's molecular structure, we could think of each one of these segments as being a tiny isotropic radiator, each with the capability of radiating with equal strength in all directions.

In reality, however, when each of these small isotropic radiators is physically connected together to form the actual radiating element of a practical antenna, the element begins to take on some amount of physical length, with a resulting radiation pattern that is the vector sum of each of its individual tiny isotropic radiators. A practical conductor will therefore exhibit some type of non-isotropic radiation pattern.

One way to envision why this is true is to remember that any conductor has a finite propogation velocity, and as a result, each theoretical isotropic radiator within the conductor is radiating with a slightly different phase from each of the other radiators. This is true, of course, because as RF energy begins to excite a small section of the antenna's conductor, this energy must then propogate down the conductor. This propogation takes a finite amount of time, and as a result, each tiny segment along the electrical length of the antenna is radiating slightly out of phase with every other segment.

The resultant pattern of the overall conductor, will be the vector sum of each individual pattern created by each of these tiny quasi-isotropic radiators within the conductor and will be a radiation pattern that is not spherical, but is a function of the physical geometry (length and diameter) of the conductor, as well as the operating frequency. Whew!

For example, a simple Yagi antenna can be constructed by mounting some number of identical elements in the same plane, and driving them such that the rear-most element is attached directly to the down lead, or feedline. An additional length of feedline, introducing some precise amount of phase delay, is then used to connect that element to the next adjacent element, and so forth down the line until all elements are connected by these additional lengths of feedline.

If the phase delay of each short segment of feedline interconnecting each element is chosen such that the energy feeding each element via the feedline is in phase with the energy arriving via the air from its neighbor to the rear, then we can begin to see that as the signal propogates from back to front in the transmit mode (or from front to back in the receive mode), its signal level is increased as it passes each element in the array. On the other hand, energy arriving (or being transmitted) off of the back or sides of the antenna is not offered this same relative gain advantage because the phase relationship between the elements is not correct for any other angle except directly in front of the antenna.

Driven and parasitic arrays

Hence the antenna's gain (relative to isotropic) in the forward direction is much greater than its "gain" off the back or sides of the antenna—thus defining its front-to-back-ratio. This type of antenna is called a "driven" array, since each element is actually driven by (attached to) a feedline. Another type of array, called a "parasitic" array can also be used with the same result. A parasitic array is one in which only one of the elements is actually connected to the feedline, while the rest of the elements pick up their energy by radiation from that driven element.

Phasing of each element, which was accomplished in the driven array by the length of the short interconnecting feedline between elements, is accomplished in the parasitic array by tuning (cutting to length) the parasitic (non-driven) elements to frequencies that are slightly different from that at which the antenna is designed to operate. Progressively shorter elements (tuned to a higher frequency), called "directors", are located toward the front of the antenna, and progressively longer elements (tuned to a lower frequency), called "reflectors", are toward the rear. CED

By Chris Bowick, Group Vice President/Technology, Jones Intercable

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Finding the interface solution

This year's winter CES was not all goodness and light for the cable television industry. Indeed, the reason I was in attendance was not so that I could walk the exhibit floor and gaze longingly at the computers, cellular phones and Nintendo games. No, I was there to represent the cable industry on a panel designed to air the controversy over the problems that cable scrambling causes to the many features available to consumers of TVs and VCRs.

The panel had a moderator (a magazine editor), a consumer electronics manufacturer (one of the largest in the U.S. and the world), A U.S. senator and little old me. If I harbored any doubts about the attitude of the audience or the co-panelists, they were put firmly to rest when an EIA vice president introduced me and said that I probably felt a lot like a germ at a penicillin convention.

Needless to say, this intro did not do much to make me feel as if I had the home-court advantage. The audience was filled with a variety of people representing consumer electronics companies, retailers, cable companies (but not nearly enough), broadcasters, politicians, the press and just plain folks (the ones who buy our products and services).

The theme of the talk started out to be confrontational: The cable industry scrambles channels in order to make monopoly profit, while the poor consumers (and by extension, the poor consumer equipment manufacturers) lose the value and convenience of all the built-in features of their TVs and VCRs, said the other panelists.

I'm glad to say, however, that the initial concern I harbored about being captured and held for ransom (probably a poor strategic move) faded quickly as I began to sense that, notwithstanding, the audience wasn't there to make war, but to suggest solutions, seek answers, offer advice and encouragement, and just generally show their constructive concern for all to see.

The issue of how we secure our signals was discussed, but before anyone had a chance to ascribe nefarious motives to our industry for using one or more of these techniques, it was pointed out that we, like anyone with a product or service to sell, have a right to protect ourselves from the loss of potential revenue as well as protect legal subscribers from subsidizing those who take the services but do not pay.

Engineering efforts

The conversation quickly turned to the efforts on behalf of the EIA/NCTA joint engineering committee to develop and promote solutions to this basic compatibility problem. While the achievements of this committee, founded in 1981, have laid some groundwork for dealing with this problem, its greatest challenge and most worthwhile contribution is potentially embodied by the MultiPort, officially known as the ANSI/EIA 563 standard.

The creation of this standard spanned four years and created a product that is waiting for its time to come. The fact that MultiPort is languishing behind the advances of the consumer electronic industry's new features is a great disappointment to all the engineers who worked to bring it to life. The need for this type of interface has never been greater.

All of the participants on the EIA panel (myself included) agreed that the MultiPort is a fine example of an engineering effort that failed to take hold because it lacked involvement of upper-level, non-technical managers. This error in judgment belongs to the engineers but I can all but guarantee that it will not be repeated.

The MultiPort-type design is still valid today. Televisions and VCRs would all be manufactured with a slot which would accept a circuit interface card. The customer who purchased such a device and who also desired a cable television connection would contact the local cable operator and would be told to purchase a cable interface module. These could be sold in blister packs and color coded for different cable systems in a given geographical area. Once the correct unit was obtained, the customer would provide the serial number of the unit to the cable operator and plug the card into the TV and/or VCR and connect the cable.

The cable operator, armed with the customer's serial number, would authorize the chosen level of service. The need for color-coding the modules is that it is likely that more than one scrambling system will be in place in the future. As long as the cable operators have confidence they can properly control access to the programming they deliver, they'll be willing to let the customer own the addressable descrambler.

More work needed

The need for a MultiPort-type solution to the consumer electronics interface problem has never been greater. The introduction of digital TV signals, compressed signals and HDTV signals is going to require some accommodation for the 150 million to 200 million TV sets already in place. The number of installed TVs increases by about 25 million per year, and the thought of having to visit every single cable subscriber to put a new box on the TV is unsettling.

The sooner we derive a universally agreed-upon security system that the cable operator feels he can control, the sooner we can begin to make the proper transition to a friendly interface for the future.

MultiPort is not complete as it stands. In order for it to move ahead in the coming world of digitally compressed HDTV signals, more work by the joint committee is needed. This time, it won't be just the engineers who get involved; managers and marketers will be there too.

The future is too close to allow our two industries to move into open conflict when we can work together to solve this problem. CED

By Wendell Bailey, Vice President Science & Technology, NCTA

The following highlights are from Optical Networks International's quarterly newsletter.

Optical Network News

Will digital really play on an analog system?

AT&T Bell Labs has begun concentrating on the real world effects of digital on analog. Does a digital signal interfere with the current analog system, or vice versa? What is the optimum level at which a digital signal can be transmitted below the analog signal? What are the capabilities of each of the various modulation schemes? Answers to these and other questions are imperative for the industry's seamless integration of digital technology into existing systems. (See related story in the Spring 1992 issue of ONN.)

How much better is better?

Reliability is a key factor in the customer's perceived value of cable service. With fiber optic deployment becoming the norm, we know that system reliability is being improved. But by how much? Longitudinal studies must be undertaken to quantify improvements in many areas of system operations. Results of these studies will provide operators with the empirical data required for business customers with alternative access applications, and will also assist in planning and budgeting for efficient system maintenance. (See related story in the Spring 1992 issue of ONN.)

The cart or the horse?

As the cable industry continues to focus on new technology, its implications for new business and marketing opportunities must be explored. To what extent will market demand drive the deployment of advanced technology? For example, if near video-on-demand trials are successful, will compression development be accelerated? What about "smart" headends? Fiber deployment? Addressing these issues will ensure that technologies are being developed in support of business objectives. (See related story in the Spring 1992 issue of ONN.)

Winter ONN issue just released

The Winter issue of the Optical Network News features an article by Tom Jokerst of CableLabs and an introduction to ONI's new Digital Services Group (DSG). If you would like a FREE copy please return the coupon below.

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Interconnection options for AM fiber systems

The interconnection of the various components in a fiber optic system plays a significant role in the overall system operation and performance. Interconnections, or more commonly, "splices and connectors," couple fibers to sources, photodetectors and other fibers throughout a communication system. To determine the proper interconnection best suited for an AM application, one must first consider such factors as return loss, insertion loss, ease of installation and cost.

Before continuing, let us first understand the basic definitions of connectors and splices. The term "connector" refers to a disconnectable device used to connect a fiber to an optical transmitter, receiver or another fiber. Connectors are designed for low insertion loss and to be easily connected and disconnected many times without a change in loss. There are many different types of standardized connectors (ST, SMA, FC and SC, to name a few) each with differing performance and cost.

A "splice," on the other hand, is a device used to "permanently" connect one fiber to another. There are, however, some vendors offering disconnectable splices that can be disconnected and reconnected to allow for repairs or system reconfigurations. Splices are also designed for low loss and generally have less insertion loss than connectors Splicing can be performed two ways: through fusing the two ends together with a fusion splicer machine, or by securing the two fibers mechanically (a "mechanical" splice).

Interconnection losses, performance

As two fibers are joined together, misalignment of either center axis will lead to interconnection losses. Interconnections require precise alignment of the mated fiber cores such that most of the light is coupled from one fiber to the other. Three factors contribute to loss in a fiber optic connection: intrinsic factors related to fiber variations, extrinsic factors related to connector design and system-related factors. A thorough discussion on each of these areas can be found in most any good book on fiber optic basics.

By Robert W. Harris, Product Manager-Fiber Optics, C-Cor Electronics

An important extrinsic factor considered here is end separation. The end separation of two fibers causes a Fresnel reflection loss. Fresnel reflections occur when light passes from a medium of one refractive index to another. This change in index of refraction can be thought of as an optical boundary at which the continuity of the optical path is interrupted—as in a glass-to-air interface. The amount of light reflected depends upon the difference in refractive index between the two materials and can be expressed as a dB loss of optical power.

When reflected light is guided back to the laser diode, the result is an increase in intensity noise and nonlinear distortion.

The loss, therefore, results from the difference in index of refraction of the two fibers and the air in the gap between the fibers. These reflections occur as light exits the first fiber and enters the second fiber. With air between two glass fibers, the Fresnel reflection loss is about 0.34 dB. Additionally, as the distance between the fibers increases, loss increases as a function of core diameter, numerical aperature and separation distance.

Reflection losses can be greatly reduced by the use of an index-matching gel between the two fibers. Index-matching gel is an optically transparent fluid that "matches" or nearly matches the index of refraction of the two fibers. While index-matching gel is used in many mechanical splices, it is not generally used with connectors. Because the connectors may be disconnected and reconnected many times, the index-matching gel can be exposed to airborne contaminants such as dust. Unless both connectors are thoroughly cleaned after each separation (and then have the gel reapplied), dirt particles can cause an additional optical power loss.

Reflections

At a glass-to-air interface, such as at the end of a fiber or connector, the Fresnel reflection is about four percent—meaning that four percent of the light is reflected. When reflected light is guided back to the laser diode, the result is an increase in intensity noise and nonlinear distortion generated by the laser. In AM fiber optic systems, this translates to a decrease in CNR and an increase in intermodulation distortion.

To examine or evaluate these reflections, it is necessary to quantify the amount of light reflected. This is known as "return loss" and is a ratio of the reflected power to transmitted power. A typical interconnection, with an air gap present, will exhibit about 15 dB of return loss. This is not adequate in AM fiber systems. Ideally, a return loss of more than 50 dB is desired. This is similar to the return loss of passive components in a link such as couplers and the singlemode optical fiber.

AM connectors

The high performance requirements of AM fiber systems (and high speed digital systems) has led to an improvement in alignment and coupling techniques. These connectors must have low insertion loss, high

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return loss, repeatability and high mechanical stability.

One method for enhancing performance is by using a termination technique called PC (physical contact). This provides a convex polished surface that allows the two fibers at an interface to optically touch. This effectively eliminates the air gap between the two fibers. The result is an elimination of the Fresnel reflections. As a consequence, the PC connector has an improved performance in return loss. The PC interface reduces the reflected power to less than 0.01 percent providing a return loss of more than 40 dB. Another version of the PC is the SPC, or super physical contact.

Angled physical contact (APC)

Angled PC connectors are used in fiber optic transmission systems where return loss is a critical system parameter. APC connectors combine an eight degree angled polish end finish together with convex polishing. The eight degree angle maintains an extremely low back reflection whether connected or disconnected. Any reflection that is present at the interface will be reflected away at an angle greater than the numerical aperture of the fiber. The convex polishing provides low loss through physical contact between the two mated pairs. These connectors are available in type FC connectors (FC/APC) and are compatible with standard FC and FC/PC connectors.

Insertion loss at both 1310 nm and 1550 nm wavelengths can range from 0.05 dB to a maximum 0.5 dB with a typical insertion loss of 0.2 dB. Return loss for both optical windows is greater than 60 dB.

AM splices

Until recently, AM fiber optic systems employed fusion or mechanical splices exclusively. Their low insertion loss and low reflectivity make these types of connections a very good choice. Fusion splicing, if done properly, provides the highest performance of any interconnection. Insertion losses achieved can consistently be 0.01 dB or less.

Return loss is greater than 50 dB. This can be accomplished since both fibers are fused together—there is no end separation, hence no reflection. Before performing the splice, both fiber ends must be cleaved (cut) using a specialized cleaving tool. The entire process to complete one splice can take several minutes or longer. Once the splice is finished it is permanent, unless the fiber is cut or broken.

There are a variety of mechanical splicing techniques available that rely on applying an external physical stress to achieve fiber alignment. With some, the bare fibers (after cleaving) are inserted directly into a mechanical assembly while others require a type of connector installed first.

In either case, index-matching gel is usually used since there is an air gap present. The bare fiber mechanical splices are inexpensive, are usually provided with index-matching gel within it and can be completed in less than two minutes. The performance of these splices, if done properly, can rival the fusion splice performance in both insertion and return loss.

Connectorization of electronic components offers the quickest way in which to reactivate a link in the event of failure.

Best interconnection for you?

When selecting an interconnection for an AM application, several questions must first be asked: What system performance is required? How easy is the interconnection completed? What is the interconnection cost in terms of equipment, specialized training, etc.? Will that interconnection need to be unfastened (or broken) in the event of a component failure?

In the event of a component failure, immediate replacement of the defective equipment is the first and highest priority. If you are relying solely upon fusion splicing, you must consider the amount of time required to prepare the fiber ends and perform the splice. Also consider having to bring the splicer out into inclement weather.

Many operators have opted for fusion splicing throughout the network and have the inexpensive, easy-to-use mechanical splices on hand in the event of a component failure or cut in the fiber. Fibers and components can usually be reconnected in less than several minutes with performance adequate enough until fusion splicing can be done at a more convenient time.

Another option that operators are applying is the use of connectors. Connectorization of electronic components offers the quickest way in which to reactivate a link in the event of failure. Simply disconnect the defective component, remove it, install the replacement, clean both connector ends and reconnect. The connector of choice at the transmitter is the FC/APC since the laser diode in the transmitter is highly sensitive to reflections. At the optical receiver, the SC/SPC connector is gaining widespread use because of its high performance and low cost (about half of that for the FC/APC).

One argument for not using connectors is the insertion loss. If connectors are used at both the transmit and receive sites, a total loss due to connectors alone can be as much as 1 dB—or equivalently 2 km or 3 km of additional reach. Also, because of the stringent polishing requirements of PC, APC and SPC connectors, these connectors must be factory polished and therefore, field installation kits are not available. However, most manufacturers are willing to install connectors (of your choice) on the optical components. The mating connector can then be fusion-spliced onto the system fiber.

In order to meet performance requirements, AM fiber optic systems require low loss and low reflective interconnections. This can be obtained through the use of fusion and/or mechanical splicing. However, in the event of a component failure, splicing may prove to be too time consuming—even if it takes only several minutes to complete. In this case, connectorizing the transmitter with an FC/APC and the receiver with an SC/SPC could prove to be more effective in terms of cost, ease of installation and overall system downtime. CED

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Digital characterization at CableLabs

The cable industry has set its sights on digital compression as the likely pathway to greater channel capacity, enhanced services, greater reliability and a new versatility and precision in dealing with customers.

Predictably, Cable Television Laboratories Inc., as the industry's R&D consortium, is smack in the middle of major engineering efforts to make the much-heralded "digital overlay"—dozens of channels of compressed digital video coexisting with existing analog channels—a reality sometime soon.

The digital project

A Digital Transmission Development Project at CableLabs, headed by Craig Tanner, VP of advanced television projects, and Rich Prodan, director, advanced television laboratory, is the nexus of these efforts.

That project's goals, briefly stated, are threefold:

1. Determining how well cable systems can transmit high-speed digital data. This stage relies on extensive testing at CableLabs' test systems in Alexandria, Va. and Boulder, Colo., followed by tests on operating cable systems.

2. Gauging the maximum bit rate that can *reliably* transmit compressed video and audio, both NTSC and HDTV. This involves using custom digital transmission hardware to test a large variety of real-world conditions.

3. Identifying the optimum modulation techniques for achieving three goals: Maximum data rates, minimum data errors and minimum costs for terminal equipment.

By December, CableLabs had received proposals for digital compression and transmission systems from eight competing manufacturers and consortiums. With two MSOs standing by with the intent to place equipment orders based upon analysis done in conjunction with CableLabs, and other MSOs eager to move ahead with creating digital "overlays," there's a sense of excitement and urgency to CableLabs' evaluation efforts.

By the CableLabs staff

Testing for reliability

How much digital video can be reliably transmitted in a given amount of bandwidth of a cable system? That depends on the *characteristics* of that system—such factors as the impairments and noise present in that channel. That's why the process Prodan is overseeing is called "digital characterization."

Because of compression, these reliability tests are crucial. Digitizing an analog signal increases its bandwidth by roughly a factor of 10. So packing 10 digitized channels into the bandwidth once occupied by one analog channel would require a hefty 100:1 compression ratio, notes Prodan.

If just a few characters are lost in transmission, Prodan says, "the signal may become totally incomprehensible at the other end."

Digital characterization—making a model of this transmission process—requires carefully assessing any interference that may occur between the existing analog signal and the digital video that's overlaid at a higher frequency. "Hopefully, the interference is benign—but that's not guaranteed," Prodan says.

In theory, engineers can create a precise model of the so-called Shannon limit of a channel: Given a desired level of reliability, the model reveals the maximum data rate and maximum noise or interference possible in a power-constrained channel.

But theory also dictates that drawing closer and closer to that Shannon limit requires increasingly complex digital modulation techniques. But that added complexity comes at an added dollar cost. An approach that's ideal in theory is bound to be unaffordable.

As mentioned, digital compression is often so aggressively utilized that losing even a single bit of data could be a disaster—turning blue sky into grey mosiac, for example. Similarly, the system has to be robust enough to deliver an uncompromised signal to the most distant subscriber on the farthest drop from the headend.

Big-picture view of costs

Prodan says the system ultimately selected by CableLabs may use a relatively costly approach in transmission, but more than recover that cost elsewhere.

For example, it could be more reliable, with lower customer service costs, and it could deliver more channel capacity more cheaply than a design that requires building expensive physical plant (for example, pushing fiber upgrades farther out into the distribution network).

Thus, Prodan says, digital overlay designs "may provide a big benefit to the industry in terms of reliability, and eventually, even the overall cost." The "how" of selecting the best transmission system, Prodan explains, does not involve building actual modulators and demodulators to physically transmit data.

Rather, it consists of evaluating what complexity has to go into a modem design without building the modem, instead of relying on generic transmission tests with high-quality instrumentation and on designing custom digital signal processors to evaluate different transmitter and receiver designs.

Using these tools, CableLabs engineers can simulate a "perfect" carrier recovery technique which serves as a reference point for evaluating various demodulation approaches. Modem designs of varying complexity and cost can then tested against this ideal model in laboratory simulations to evaluate the *implementation loss* sustained using different designs.

The tradeoffs involved

The modulation technique that CableLabs decides can be successfully employed could range anywhere from BPSK, a two-carrier carrier signaling approach, to 64 QAM with trellis-coded states, an approach with much greater capacity but one requiring a transmission environment that is much more friendly and benign to the data-modulated carrier.

Another series of trade-offs revolves around how to package all these digital channels into the cable system—as individual channels, like analog? Or bundled via time-division multiplexing into one huge single channel? There is also a trangle of tradeoffs here, relating not only to cost, complexity and capacity but also to specifics of the services being offered, which may dictate the need for independent channels.

"How much compression is used in a given situation will be determined by the modulator and the characteristics of the channel," Prodan says. "Then, the question is the quality: At what compression rate can you still get a decent and even a high-quality picture? So our digital transmission study will say, 'here is a window the encoder must operate in. Will a given system be able, at that rate, to produce high quality pictures?' "

Compressed NTSC before HDTV

Prodan thinks digital NTSC service will become available "several years" before digital HDTV hits the market. The engineers at work now, he adds, must be visionary enough to design a system that will easily accommodate HDTV later, yet be affordable near term. The big cost of adding HDTV "will be the cost of the receivers, which is not our line of business."

The success of "overlaying" digital video onto analog cable systems will be determined by the marketplace, Prodan thinks. Namely, how much more will customers pay for the higher-quality pictures and greater programming options?

Going even further, Prodan says he believes the enterprise will flourish only if the industry develops whole new categories of products—from PCN telephony to "video on demand" to videoteleconferencing, computer data and multimedia, and maybe including other products that are yet to be even contemplated.

"We are an information-rich society," Prodan concludes. "To the extent that the cable system is used to get all of this information from point to point, to the extent we'll continue to enjoy the success we've enjoyed in the 1980s." CED

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GIGO

Garbage In - Garbage Out

Computers come as close to perfection as anything created by man could hope to be. Error rates are so small they have to be designated in exponential notation. For example the table (middle column) shows typical average bit error rates (BER) for various types of media.

For computers, only one out of more than a trillion bits might be incorrect. And forward error correction can still further reduce the probability of error by several orders of magnitude. It can never be perfect, but it sure beats people.

Computers are so accurate they do precisely what they are told. And therein lies the problem.

The computer problem

The equations in my December 1991 *CED* column (My View) did not come out at all like I wrote them. Computers are the reason. As usual, our graphics expert sent *CED* a floppy disk which had been converted to the word processing software used by *CED* along with a hard copy of the page which looked indistinguishable from the magazine's printed page (except that it was a laser proof).

Channel	BER
Subvoice grade	10^{-3} - 10^{-4}
Voice grade, switched	10^{-3} - 10^{-5}
Leased	10^{-4} - 10^{-5}
Digital, terrestrial	10^{-6} - 10^{-7}
Satellite	10^{-7} - 10^{-9}
With forward error control	10^{-9} - 10^{-12}
Computer channel	10^{-12}

The input definitely was not garbage.

Unfortunately, *CED* had meanwhile switched word processing software and their computer platform as well. The new software required different embedded codes for fonts, subscripts, superscripts, math characters, etc. There was nothing wrong with the new *CED* computer software. There was nothing wrong with the files sent to *CED*. They were simply talking to each other in different languages, and missed the codes for subscripts and superscripts.

So if you will refer to my column on the Composite Triple Beat (December 1991, page 24), I will try to straighten things out.

At the bottom of the first column, the power series equation is:

$E = k_1e + k_2e^2 + k_3e^3 + ... k_ne^n$

(e is the instantaneous input voltage)

In the next paragraph, the even ordered products that are cancelled out in push-pull amplifiers are k_2, k_4, etc. It is the k_3e^3 term that provides the controlling contribution to intermodulation in amplifier cascades.

The instantaneous input voltage, considering any three carriers in the system, is:

$$e = A \cos f_1 + B \cos f_2 + c \cos f_3$$

The complex algebraic computations performed by Ken Simons and others show that the third power expansion of the k_3e^3 term results in sets of trigonometric functions of the following combinations of f_1, f_2, and f_3.

(1) f_1^3; f_2^3; f_3^3. Third harmonics.

(2) $2f_1 \pm f_2$. Sometimes called intermodulation.

(3) $f_1 - f_2 + f_3$. The triple beat.

The rest of the column printed all right, except for an occasional ± problem.

So you see, I did know what I was doing afterall. Our graphics expert did use the correct language for the former *CED* composition software. Everyone's computer works just fine. We just didn't have the right translator for the job. The computers simply were not talking together intelligently.

Result: garbage. CED

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

Air dielectric

Your December issue featured an article written by Kevin Collins of Century Communications ("Eight years later: 99 percent of rebuilt cable still intact" p.51). The purpose of that article was to emphasize the importance of preventive maintenance in a CATV cable plant. This "back to the basics" concept certainly needs to be practiced on a regular basis.

In Mr. Collins' article, he referred to his durable coaxial cable as "fused disc." Using the term "fused disk" to describe today's air dielectric cable is as antiquated as calling a Cadillac a "horseless carriage." After several generations of "fused disc" cable, the air dielectric engineers went back to the drawing board.

The result is that, since 1983, the radically redesigned cable became Trilogy's MC_2 and is the cable of choice for today's cost/performance conscious design engineers. Cable operators throughout the industry are now able to take advantage of the superior attenuation values of air dielectric cable without the concern of water migration or handling difficulties.

To carry the car analogy even further, I'm sure Henry Ford's descendents hate to hear, "How 'bout that Edsel."

Kevin, thanks for your vote of confidence, but in the future, please try to avoid the *f*____ *d*___ words.

Rick Jubeck
Trilogy Communications Inc.

Broadcast or cable?

First off, I enjoy reading your magazine. It carries a lot of information that we use every day.

The question I have is that of an article in the November 1991 issue under Capital Currents—"Leakage rules: What do they protect?" by Jeffrey Krauss. Under the last bold printed heading, it states that channels 14 through 20 are 470 MHz to 512 MHz. Unless I'm missing something, aren't the frequencies for channels 14 through 20 121.5 to 156.25 MHz and the channels for 470 MHz to 512 MHz 65 through 72?

David Pond
Chief Technician
Marcus Cable
Ladysmith, Wis.

Jeffrey Krauss replies:

Sorry if I wasn't totally clear in using the term "channel." I think in terms of over-the-air frequencies and channel plans, not cable frequencies, even though CED *is a cable TV technology magazine. The frequencies 470 MHz to 512 MHz are designated by the FCC as TV channels 14 through 20 for over-the-air broadcasting, and that's how I was using the term. The cable channels are indeed different frequencies. Thanks for pointing out the need for clarification.*

Thanks

I received a copy of the *CED* cover story on CableLabs and would like to thank you for such great coverage of the Lab. I have to admit I was pleasantly overwhelmed to see so much coverage on CableLabs in one issue. We really appreciate your efforts in making us look so good.

I know that I speak for everyone here at CableLabs when I say that we are flattered by the thorough and accurate job you did discussing the various projects and issues.

Richard Green
President and CEO
CableLabs

Questions? Comments?

Please send your letters to:
CED Magazine
600 South Cherry St.
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Attn: Roger Brown, Editor

Behind the scenes in Queens

A shade under a year ago—March 6, 1991, to be exact—Time Warner officials issued a press statement that made the nation sit up and take notice. "Time Warner subscribers in Queens, N.Y. will receive the world's first 150-channel, two-way interactive cable television system, before compression," the statement read.

Two things made the announcement notable. First, the fact that Time Warner's cable arm, ATC, was actually going to *do* a 1-GHz project. For years, manufacturers have been discussing such products; Regal Technologies introduced its gigahertz passive line as early as 1989. Secondly, the project completion date had been set for December 1991—a mere eight months after it was announced.

Short fuse

This short timeframe is perhaps the most intriguing aspect of the Brooklyn/Queens saga. Now, two months after the December launch, ATC officials are almost blase about how quickly the project came together. "There were no major glitches that I recall. On a macro level, there wasn't a great deal that had to be overcome," says Jim Chiddix, senior VP of engineering and technology for ATC. "All of the basic technologies were available. Of course, on a micro level, there were lots of individual challenges that the various equipment suppliers overcame."

The most notable of those individual challenges was the development of a 1-GHz tuner and amplifier, Chiddix says. After all, prior to ATC's decision to put 150 channels in Queens, there was no such thing as a 1-GHz tuner, or a 1-GHz amplifier. And, says Paul Dempsey, director of marketing and new technology for Pioneer Communications, the manufacturer selected to provide the converters for the project, "One of the greatest challenges was the time frame alone. Generally, new product development takes anywhere from 16 to 20 months, from development to delivery. So to pull this together in eight months was quite a feat."

Even though Pioneer had just unveiled an 870 MHz converter at the 1991 National Cable Show and had a 1-GHz converter on a drawing board, the short fuse on ATC's Queens project presented some clear hurdles. "One of the more difficult challenges," Dempsey recalls, "was the on-screen menuing functions for near-video-on-demand (NVOD) and the converter-resident, on-screen requirements, like a VCR program timer, a parental control code with passcode options and favorite channel memory. We just didn't have any of that stuff at the time.

"The gigahertz tuner was a difficult hurdle because of the distortion issues associated with delivering 150 channels in the front end of a converter,"

Dempsey continues. How did Pioneer get product ready in such a short time span? "The bottom line is, we worked *very* closely with the Time Warner people, both on the ATC side and the Brooklyn/Queens side in development of the product," Dempsey explains.

C-Cor's development of gigahertz amplifier wasn't exactly a walk in the park, either, says Hamid Heidary, director of engineering for C-Cor. "Traditionally, increases in bandwidth have been no more than 10 or 20 percent at a time. Historically, 270 MHz went to 300 MHz; then to 330 MHz and so on. In this case, the step was a complete octave—almost double the bandwidth," Heidary says.

Plus, Heidary says, since a gigahertz amplifier had never been designed before, the project was "a moving target." "Parameters for the product changed, almost on a daily basis. Not because they (ATC) couldn't make up their minds, but simply because this had never been done before."

Hi-tech, hi-touch

Interestingly, all of the interviewed manufacturers agree that the cooperation between them and ATC was the glue that enabled the 1-GHz project to stick. "This was Tom Peters (management style) at its best," says John Cryer, VP/sales and marketing for Nexus Engineering, the company that supplied all the headend gear for ATC Queens. "It is the one case I've seen where the vendor and the customer worked so closely together.

"In all, it was more of a partnership than a vendor/customer relationship, because if we failed, they failed," Cryer continues. "Actually, the ATC people had to become surrogate designers. They sat in on our design review, which is typically the time when all the skeletons come out of the closet. That's not normal."

Another abnormal aspect associated with the tight deadline was actual shipping of product. After a prototype was ready, manufacturers sent it off to ATC's Denver-based laboratory, where design engineers tested it on 1-GHz equipment. After approval from the Denver lab, the product went into production. "But it was gradual shipment," Cryer says. "As we produced (a batch of) it, we shipped it."

One interesting hurdle faced by Nexus' engineers was encountered at the component level. "Trying to get parts for a 1-GHz series of products put a lot of constraints on our design," comments Gary Zywiecki, VP of engineering for Nexus. "It wasn't like we could go to Motorola and say, 'we need this chip,' and then wait two years to get it." And, Zywiecki says, managing 150 carriers is "an awful lot of RF to control. Modulating 150 carriers is a lot like the difference between having two children and 10."

Plus, many of the products for the 150-channel system came from multiple vendors, but still had to be interoperable. For example, Nexus' modulation system had to work with Pioneer's encoding system. "It was like a race," Cryer says.

Relocated twice in one week

At the helm of the Queens project was Jim Ludington, chartered to pull together all of the pieces of the 1-GHz puzzle, make it work and make it work *on time*.

Interestingly, when Time Warner first decided to put the project into motion, Ludington had just been relocated to Austin, Texas by ATC. A few days after his arrival in Texas, Chiddix called him and advised Ludington "not to buy a house or anything just yet," Ludington recalls.

Being a native of the Big Apple himself—and not particularly fond of the place—Ludington initially declined Chiddix's offer. But things have a way of reversing themselves. "After I heard what the project was all about, I couldn't refuse," Ludington says. "It was the opportunity of a lifetime."

Ludington says one of the biggest hurdles in pulling the 150-channel project together was scheduling. "One hitch, and you lose a day," Ludington says. Giving manufacturers enough time to design and manufacture products was also a top priority. He used "a complex sort of Gantt chart/critical path scheduling" to keep the project flowing. But even so, Ludington says, "there are points in every schedule where you can just throw (the schedule) out the window. I call that crisis management."

Were there snags? "Of course," Ludington says. "Not everything went as scheduled; it never does. That's why there are project managers." One such snag, Ludington recounts, relates to the urban nature of Queens. In many cases, urban thoroughfares mandated that cable and its associated electronics be placed at exact, predetermined spots—which required "a lot of forethought,"Ludington says.

ATC officials won't discuss how much the project cost, saying that R&D costs and the union nature of New York City labor only convolutes the matter. But Jay Vaughan, a senior project manager for ATC, says that "it costs almost as much to go from 330 MHz to 550 MHz as it does to go from 330 MHz to 1 GHz. Maybe 20 to 25 percent more."

A business trial

The heart of the matter, Chiddix says, is not technical. "This really is a business trial. And obviously, we think we know the answer: There is significant demand for a more varied movie product," Chiddix says.

In the upgraded system, which Brooklyn/Queens is marketing under the name "Quantum," subscribers will receive roughly 85 channels of basic and pay TV, plus an additional 60 channels of pay-per-view. Movie selections will be offered on an ongoing basis, in a "single source fashion," Ludington explains. "For example, one channel is dedicated to a movie for a week. That movie is made available every half hour for viewing.

"The next step is to evaluate and fine-tune," Ludington says. Fine-tuning includes determining what programming mixes work, which price point is best, and what effect now being able to control the playback of the movie has on buy-rates. Either way, Time Warner comes out a winner, because now it has a broader avenue for its stockpile of Warner Bros. titles.

Ludington and Chiddix are quick to point out that the Queens project is *not* a technical experiment. "This is not a technical project. It's a pay-per-view (PPV) test," Ludington says. "The fact that we used a 1-GHz platform is incidental to PPV, in this case."

What's next, now that Queens is well underway? "For now, we're going to focus on converting the folks within the 10,000 (Queens) passings," Chiddix says. Other future possibilities at Queens include PCN experimentation (Time Warner's telecommunications arm holds five FCC experimental licenses) and alternate access.

And, Ludington says, other portions of the New York metropolitan area may be next. "But that's not definite, because the Queens system hasn't run long enough. If the number of subscribers increases and the incremental PPV revenues go up, though, as a result of this project, I think you'll see a lot of green lights for future 1-GHz projects." CED

By Leslie Ellis

"OUR GOAL...TO M
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SYSTEM USI
TECHNOLO

Jerry Neal
Senior Software Engineer
Pioneer Communications of America
Cable Systems Division

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One GHz passives: Extending the operating frequency of cable television components

In a cable television system, two to three separate signals are passed through a common coaxial cable. One signal is comprised of the TV channels themselves, ranging in frequency from 50 MHz to 550 MHz. The second signal is comprised of return data in the frequency range of 5 MHz to 30 MHz.

The third signal, and the one this article will address, is the 60 volts, 60 Hz power signal that is used to supply power to amplifiers used in the cable system. Passive components contained in the cable system — line splitters, power inserters and directional couplers — must have appropriate internal circuitry to keep the 60 Hz power signal out of the circuitry that passes the 5 MHz to 550 MHz forward and return RF signals. This is particularly difficult to achieve in line passives since the power current can easily run as high as 10 to 15 amperes.

This is done by using capacitors and inductors. Capacitors provide a low impedance to the RF signals and a high impedance to the 60 Hz power signal, thus allowing only the RF signals to pass in and out of the RF section of the unit. Inductors provide a low impedance to the 60 Hz power signal and a high impedance to the RF signals, thus allowing only the 60 Hz signal to pass through the power passing section of the unit.

It should be noted at this point that a cable television system tries to maintain flat signal response of an appropriate power level in order to deliver the best picture possible to its subscribers. The insertion loss signature of a component should fit in a 0.5 dB to 1 dB window and have few up and down swings to avoid problems for the cable operator.

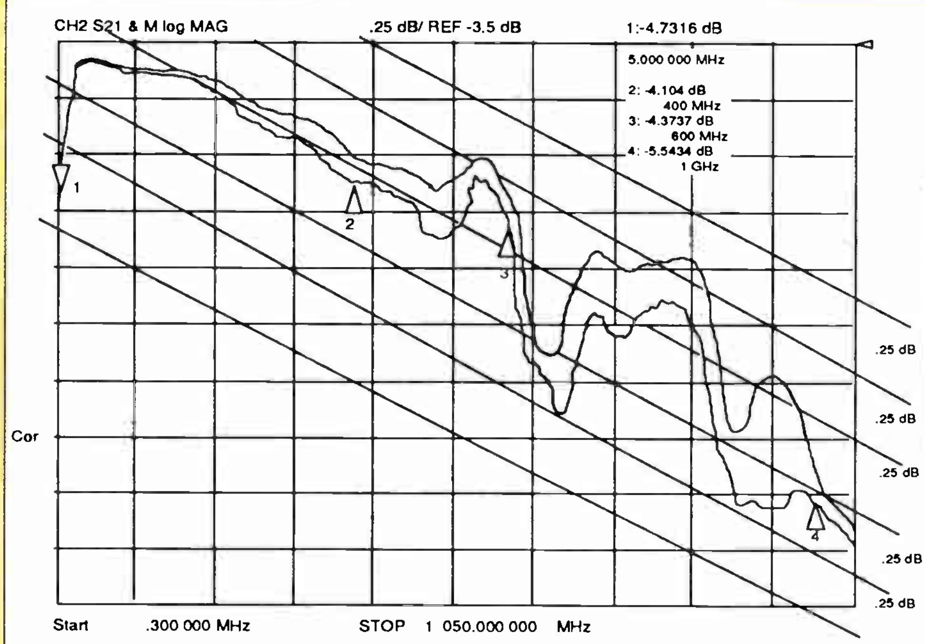
Present power passing inductors used to build cable television components work well and provide a smooth signal response to approximately 600 MHz. This is adequate for systems that operate to 550 MHz or lower in frequency.

Above 600 MHz, because of winding to winding capacitance reacting with the inductance of the power passing inductor, stray resonances are set up and the component frequency response becomes very unflat as well as unpredictable and uncontrollable.

In the past two years, interest in extending the upper frequency limit of cable TV systems has grown in the U.S. as well as in Europe where cable television systems extend to 890 MHz.

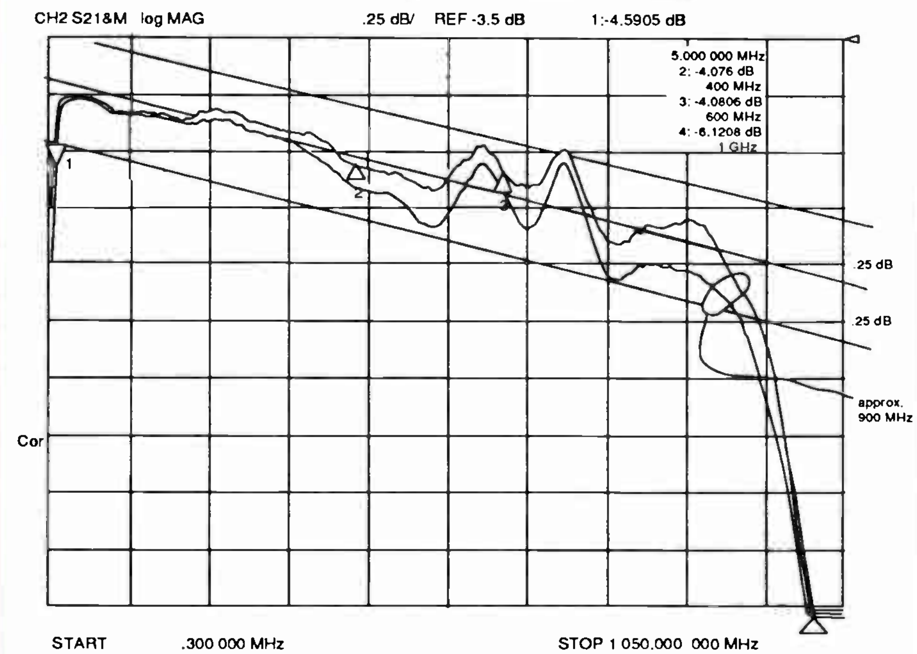
The challenge now is to extend the operating frequency of the cable television components to 1 GHz while still providing good operating performance. To do this, the components must be able to pass the 60 Hz power signal without the power passing

By Don Reddick, Engineering Manager, Regal Technologies Ltd.



Above 600 MHz, the frequency response of present power passing inductors becomes unpredictable.

Figure 1



Insertion loss using Texscan power passing inductor

Figure 2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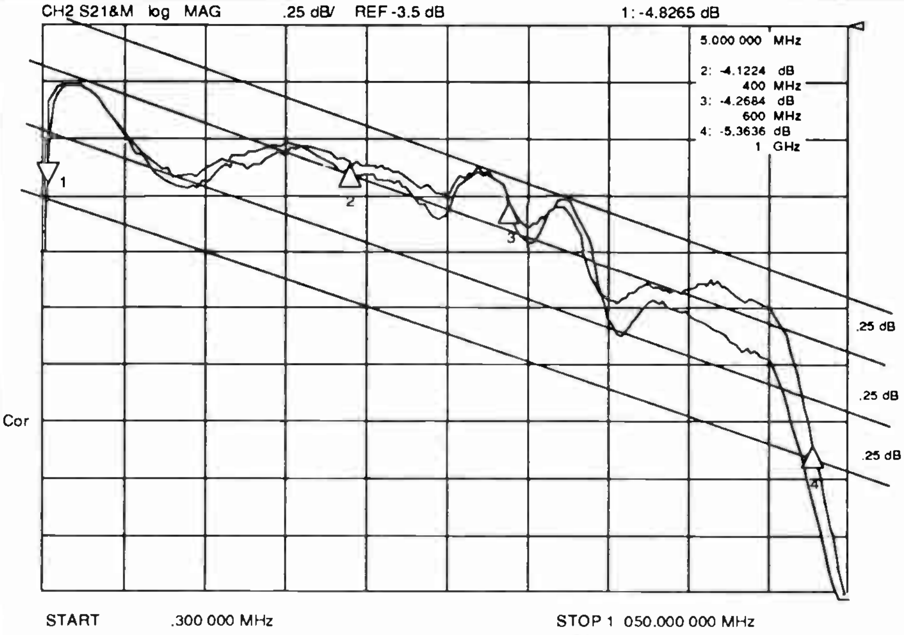

Insertion loss using new style of power passing inductor developed for good insertion loss response to 1 GHz.

Figure 3

inductors interfering with the performance of the RF circuitry.

The most widely used power passing inductor today consists of four inductors that are wound on a circular rod of ferrite material. The first two inductors are connected in series and wound in the same direction. The second two inductors are also connected in series and wound in the same direction but their windings are opposite those of the first two sets.

There is a resistor connected in parallel across each inductor. The purpose of the resistors is to help prevent the resonances that produce undesirable response characteristics.

A second style of power passing inductor is similar to the first power passing inductor except the resistors are connected across separate windings, which are wound over the main coils.

Through experimentation, this style of inductor is found to work well to 900 MHz. However, above 900 MHz, the slope of the insertion loss becomes unacceptable for use in a cable TV system. (See Figure 2.)

Meeting future needs

A new style of power passing inductor was developed to meet the need for good insertion loss response to 1 GHz. In analyzing the more widely used power passing inductor previously described, it was found that below 600 MHz, the parallel resistors did a good job of suppressing unwanted resonances in the power passing coil. Above 600 MHz, the resistors would allow resonances to occur between windings in the upper half of the coil as you moved away from the resistor.

The physical presence of the resistor also increased the overall insertion loss of the unit. A coil was developed that in effect surrounded the main inductor coils with a distributed resistance that suppresses inductor resonances around the entire power passing inductor. (The exact construction of the inductor is not described in this article as it is considered proprietary.)

This inductor was found to have the desired qualities — suppression of unwanted resonances without increasing the insertion loss of the unit. An insertion loss experiment was then conducted to prove the superiority of the inductor for 1 GHz operation.

For the experiment, a two way line splitter, using 1 GHz RF circuitry, was constructed. The insertion loss and slope of the unit was measured using the three styles of power passing inductors.

Figure 3 shows performance of the device using the new power passing inductor. Not only does the slope of the line meet the desired criteria all the way to 1 GHz, but the inductors are very repeatable, and the shape of the insertion loss response becomes predictable. CED

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Putting the dish in the 'boonies'

Throw away old concepts about having to locate the satellite antenna near the headend. With high-speed analog fiber optics, the antenna can be placed miles away from city RF noise, with the headend at the service hub—right in the heart of the community.

Greatly increased bandwidths of fiber optic devices now make this technology an economical means of antenna remoting, particularly in CATV and broadcast applications. Standard LNA (low noise amplifier) and LNB (low noise block converter) analog outputs from the receiver can be converted to analog optical signals at the antenna site, then transmitted up to 20 miles over lightweight fiber to an optical receiver at a distant headend.

The result is that both locations—antenna and headend—can now be optimized for different requirements. Antennas can be placed in rural areas—ideally behind hills that obscure them from interference, such as telecommunications traffic. Miles away, the headend can be located for optimum CATV distribution—near the center of the community, equidistant from the fringes of the service area.

Traditional problems

In the past, it was necessary to locate a satellite receiving antenna as close as possible to the receivers and modulators in the headend. A typical link uses coax or heliax cable, for which the length can be about 500 to 1,000 feet. Even over these short distances, there is some signal loss, and equalizers may be needed to compensate for attenuation slope due to the cable. To use the less expensive coax, the signal must be converted at the antenna to lower frequencies, such as L band.

A complication of using heliax cable to handle the higher frequencies is its susceptibility to moisture. The air gap surrounding the central conductor retains some humidity. As the outside temperature drops, there is a danger of condensation at the dew point, and at lower temperatures, freezing. The solution often is to circulate heated air through the cable continuously.

However, this approach can simply trade one problem for another, since the air can also pick up dust and dirt and so must be filtered as it's recirculated. This is usually done with a mesh-type mechanical filter, which can become clogged if not changed often enough. If the filter clogs, it can permit condensation and freezing—the very problems that it was put there to prevent. Changing the filter regularly is an extra maintenance chore added to the difficulties of looking after the equipment at the headend.

Polarizations and frequencies for satellite C- and Ku-bands are shown in Figures 1 and 2. Most communications in North America are at C-band with some Ku-band, whereas most communications in Europe are at Ku-band. If the antenna operates in the Ku band, the signal frequency is too high for cable, and the conventional

by W. Gary Grimes, Product Marketing Engineer, Ortel Corp.

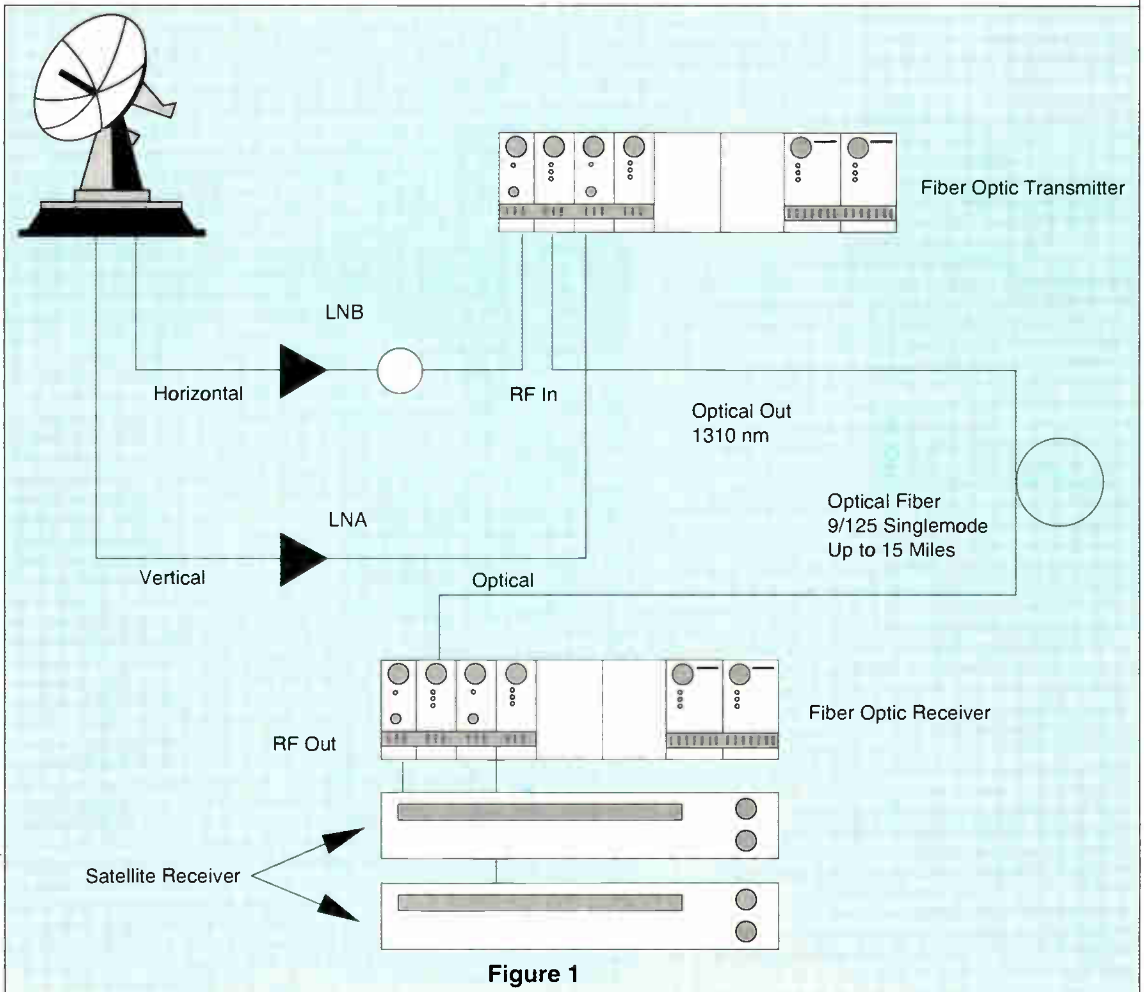

Figure 1

alternative for a physical link is a waveguide. The expense here is even greater than for cable, and the moisture problems remain.

For longer links, perhaps across town, it is possible to upconvert the antenna signals to the CARS band (Commercial Access Relay System, 13 GHz) for line-of-sight transmission over a dedicated AM microwave supertrunk. This is certainly the most expensive of all the alternatives (about $500,000 for the transmitter alone), although it does permit longer-distance separation of the antenna and headend. The microwave signal, however, is subject to interference and multipath effects, such as reflections from nearby buildings. In urban areas that are already noisy with microwave traffic and where new high-rise buildings are coming up like weeds, this solution can be a costly experiment.

Antenna location

In a CATV system, the ideal location for the headend is at the center of the service area, equidistant from the furthest transmission nodes. However, there are two major reasons not to choose this location for the receiving antenna:

* Terrestrial interference (TI)
* Real estate costs.

The TI problem is particularly troublesome in North America, where the C-band is also used by telephone utilities for microwave ground links. If an antenna must be located in an area that is already noisy with traffic, the location must be chosen carefully. Usually this means placing it in the RF shadow of a tall building or hill. For the following reason, this isn't always practical.

Determining the ideal site for an antenna from the standpoint of minimizing interference is only the first part of the site-selection problem. Just as difficult may be the task of acquiring the rights to a desired location. Again, the problem is particularly acute in urban areas, where carriers must compete for the right to put their antennas on sites such as the tallest buildings, where access, if available at all, often must be shared with other carriers. The economics of real estate supply and demand will assure that these costs continue to escalate.

TVRO system configuration

An economical solution to the antenna-headend paradox is shown in Figure 1. The diagram shows a CATV earth station. The satellite receiving dish is in a remote location, such as a rural area where TI is not a problem and land costs are relatively cheap, and the headend is located miles away in the service area.

The antenna configuration is set up to receive all 24 channels from the satellite transponder. The 12 C-band channels in vertical polarization are LNA outputs, and the other 12 C-band channels in horizontal polarization are converted to LNB and output as L band. The C- and L-band signals are sent over a short coax link to a fiber optic transmitter, typically located in an enclosure or shack just a few feet from the antenna.

The RF signals are plugged into an input gain control (IGC) in the fiber optic transmitter. The IGC regulates the incoming RF levels to drive a semiconductor laser at a level for optimum noise and linearity. Through modulation of the laser, the C- and L-band signals are converted to a 1310 nm optical signal. As a side benefit, the power supply for the RF stage of the fiber optic transmitter provides bias for the LNA and LNB units on the antenna.

> A complication of using heliax cable to handle the higher frequencies is its susceptibility to moisture.

The optical signal is transmitted over 9/125 μm singlemode fiber to a distant headend, which can be as far as 20 miles distant (depending on the input passband frequency).

At the headend, the optical signal is input to a fiber optic receiver located next to the satellite receivers. In the fiber optic receiver, the optical signal is converted back to the C- and L-band RF signals by a microwave PIN photodiode. An output gain control (OGC) provides the optimum output level for the satellite receivers. The OGC also has an RF test port to sample the output signal.

To assure system reliability, the power supplies of both the rack-mounted fiber optic transmitter and receiver units are redundant. In each unit, an auxiliary power supply remains idle unless the main power supply fails, at which point it takes over instantaneously. The power supplies are plug-in units that can be replaced while the system is on-line. An everyday benefit of this design is to minimize field service requirements at the remote antenna site, which need not be staffed. Furthermore, unit performance can be checked remotely using alarms and monitors available at the rear panel connectors.

Economy

Inexpensive installation is an immediately attractive benefit of this fiber optic solution. Because of the excellent transmission characteristics of the fiber, no repeaters or equalizers are needed. The singlemode optical fiber is the same as might be used for an intra-campus LAN or telecom application, with conventional tools and routing. The small size and light weight of the fiber make the task of handling and installing it much easier than laying cable, especially heliax.

Maintenance costs tend to be lower than the alternatives because of the inherent reliability of the fiber system. There is no need for the remote site to be staffed, since system performance can be monitored remotely at the headend by making use of the alarms and monitors on each unit. Redundant power supplies in transmitter/receiver units assure unattended automatic cutover.

Using fiber for the link also brings inherent benefits in the quality and reliability of the signal. The excellent transmission characteristics of fiber include exceptionally low signal loss over long distances, immunity to EMI, as well as resistance to tapping and snooping. Of course, the primary benefit is the ability to separate the physical distance between the antenna and the headend. The result is both to eliminate TI and to greatly reduce the real estate costs associated with the antenna site.

Performance

Even more impressive performance can be realized in high loss applications, either for long links (up to about 35 km) or where the optical signal must be split among multiple receivers. A high-quality signal can be assured by using a TVRO link with a distributed feedback (DFB) laser that has a built-in optical isolator. The graph in Figure 2 compares the performance of such a system to a standard Fabry-Perot (FP) laser.

In this graph, the carrier-to-noise ratio in a 36 MHz bandwidth for 12 FM satellite channels is plotted against the left Y axis for each type of laser. The equivalent baseband video signal-to-noise ratio can be found by reading the curves instead according to the right Y axis, assuming an FM improvement of 38 dB. Although the built-in optical isolation feature of the DFB laser is somewhat more expensive than a standard link, its superior performance as compared with the FP device makes it the preferred choice for such high loss applications.

Applications

In the following case histories, TVRO fiber optic technology is applied to currently operating satellite earth stations and teleports:

Viacom Cablevision (Brent Bayon, regional engineering manager). Viacom International Inc. has an earth station and headend in Everett, Wash., just outside of Seattle. The CATV signal is distributed from there to various communities via an AML system (CARS band microwave distribution).

Because of TI at the headend/AML site, the decision was made to relocate the Simulsat antenna 1.5 miles away. A coaxial cable link was considered for sending the C- and L-band signals from the dish back to the headend, which could not be relocated. This would have required equalizers, which are nonstandard equipment, and a string of amplifiers to prevent signal loss. Ultimately, this approach was found to be virtually impossible because of unpredictable environmental effects on the cable.

Other options that were considered included coax or optical fiber in an FM supertrunk or a point-to-point microwave link in the CARS band. But there were two big obstacles. First, the FCC will not license this kind of transmission over distances less than five miles and will question the need up to 10 miles. Second, the equipment cost is high, since all of these FM approaches involve a lot of satellite receivers, modulators and multiplexers at the remote site, as well as racks of demultiplexers and demodulators at the headend.

Remoting the received satellite C- and L-band signals directly across optical fiber proved to be the most economical solution, with the added benefit of low maintenance.

IDB Communications Group (Stavros Hilaris, engineering manager). IDB chose a TVRO fiberoptic system to monitor the antennas at its teleport on Staten Island. The objective was to provide six C-band links, one to monitor each of the polarizations of three antennas. The entire antenna farm at the site is surrounded by a high wall to block TI. The distance to the monitoring station is 1,200 feet, and the cables had to lie in a tray along the inside of the wall.

It was decided that the link had to be C-band because the phase jitter introduced by converting the signals through an LNB would cause an unacceptable degradation in phase modulated channels. In this frequency range, the choices are heliax or optical fiber.

In C-band, heliax cable has a signal loss of 3 dB per 100 feet. At this short distance (1,200 feet), the heliax loss is comparable to that of fiber. The bigger concern, however, was the considerable bulk of six heliax cables, as compared with a single optical cable containing numerous fibers. Not only would fiber be easier to install initially, but future expansion would require no new cabling, as long as there were more than six fibers in the optical cable.

In this case, the installed cost of heliax was comparable to that of analog C-band fiber optic links. The inherent advantages of optical fiber—and especially the ease of expansion—made it the logical choice.

WIPB-TV (Jim Miller, Ball State University). This PBS broadcaster is located on the campus of this university in Indiana. While the station is broadcasting the local PBS channel, it must simultaneously record other PBS programming that is coming in over a number of satellite channels. The downlink antennas are located about 0.7-mile from the facility that currently houses the satellite receivers, studio and TV broadcast transmitter.

In the past, the tunable satellite receivers were located instead at the antenna site. The receiver output (70 MHz IF) was sent over coaxial lines to the studio. This required remote control of the tuners from the studio, with some signal loss.

Signal quality was improved when the 70 MHz lines were replaced with a baseband video fiber optic link. However, remote control of the tuners was still required.

In the next upgrade of the system, TVRO fiber optic transmitter/receiver units were placed at the ends of the link. The tuners were moved back to the studio, on the output side of the fiber optic receiver. This eliminated the need for remotely controlled tuning. The only equipment at the antenna site is now the fiber optic transmitter, which also provides bias for an LNB. In this configuration, the station now has access to all 12 channels on that polarization.

The TVRO system also fits nicely with WIPB-TV's plans for expansion. Getting 12 more satellite channels in the other polarization will require only the addition of plug-in modules to the existing fiber optic transmitter/receiver units. CED

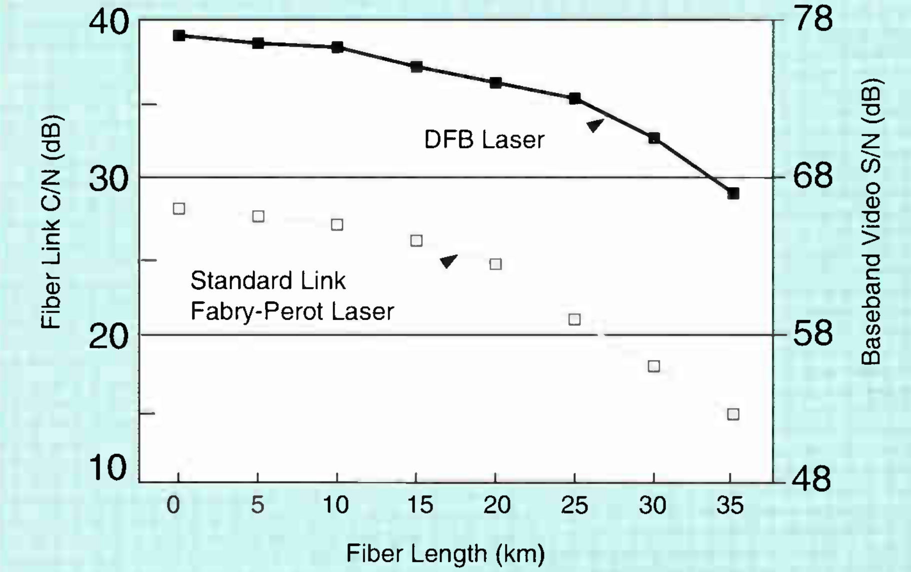

Figure 2

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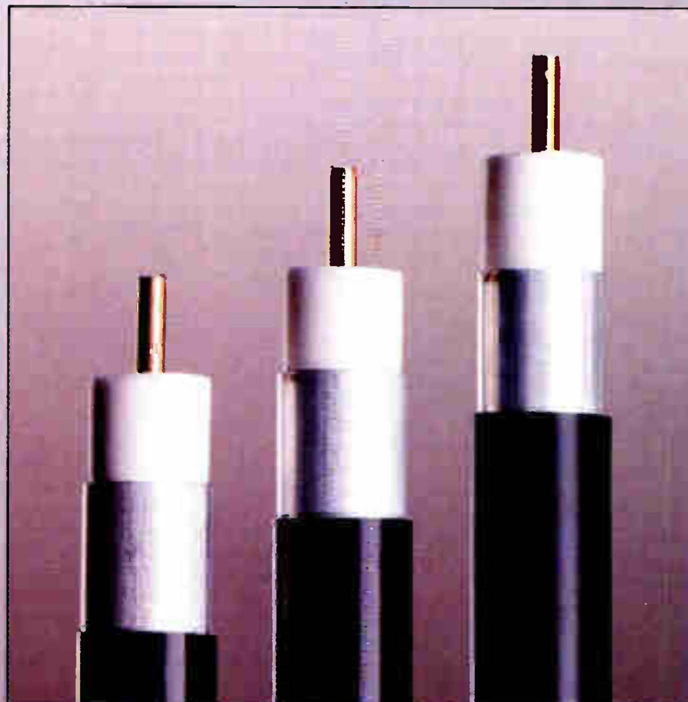

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Video scrambling: A new look at an old problem

Editor's note: *This article describes only the video scrambling component of the Code-Vision System, and not the details of the security codes, for obvious reasons.*

Traditional video scrambling systems modify a signal at the transmitter to prevent it from being viewed on television receivers without the aid of special decoders. A large part of the market is consumer-oriented, where the cost of decoders is a significant factor. Price and security are usually conflicting requirements, the former preventing very high security systems from being used in subscriber homes.

In general, scrambling systems consist of two primary components:

(a) A technique for scrambling the video signal, and

(b) A mechanism for transferring the security code information, necessary for unscrambling the signal, from the transmitter to individual decoders.

However, a new approach to video scrambling, called Code Vision, seeks to break price/security barriers by employing a rather simple technique. The system uses the fact that television receivers can lock on to the uncorrected signal from VCRs. At the transmitter, random time-delays are introduced into the signal (similar to those produced by a VCR) and these delays are not removed at the decoder.

Scrambling details

The accompanying diagrams outline the basic concepts of the system. In Figure 3 the sync and burst are completely removed and replaced with a camouflage signal derived from the video itself. The camouflage signal is a smooth interpolation of the two lines between which it spans. To further improve the confusion, a small portion of the middle of one of the lines is mixed into the camouflage signal. The result is a camouflage signal which closely resembles the video in its immediate vicinity, and contains nothing to permit differentiation between itself and video.

By H. George Pires, Code-Vision Corp.

Figure 2 shows the entire signal shifted in time. The amount of this shift is changed every field. Before transmission, the video content of the signal is inverted, (not shown in the figures for clarity). The sync polarity remains unchanged. The value of the time shift is conveyed to the decoders, in a very secure manner, by means of code pulses in the vertical interval. The incremental shift in each field is in most cases relatively small.

Time-shifting

Large shifts are achieved by a series of small increments. The maximum variation is six lines. Larger shifts are possible by shifting the vertical pulse train, in addition to the horizontal shift described above.

The time-shift is different every field. This prevents a legitimate decoder from being modified with a single "fix" that leaves it in a permanently "enabled" state.

Figure 8 shows the vertical component of the scrambled signal. Code pulses are inserted on lines 10 to 15. The pre-equalizing pulses and all sync pulses from line 16 are removed. Camouflage lines are inserted from line 16 to the position occupied by the pre-equalizing pulses. Color bursts are retained only on the back porch of lines 10 to 15.

Key to low cost

The delay introduced at the encoder is not removed in the decoders. This is the key to their low cost. Instead of moving the video back to its original position, accurately timed sync and burst are regenerated in the decoders, and gated into the signal after removing the camouflage information. The resulting decoded signal is randomly time-shifted, but otherwise identical to the original video. It is similar to the signal from a VCR, except that it has far greater timing precision. The television receiver reproduces the original picture.

The implementation of the decoders comprises an LSI chip, which regenerates all the necessary pulses, including a black burst signal (shown in Figure 5). The sync generator in the LSI chip locks on to the pulses in the vertical interval of the scrambled signal and uses that as a datum for measuring the time delay in any given field. The active portion of the video is inverted to restore the correct polarity (not shown in the figures). An analog gate deletes the camouflage signal and replaces it with the locally regenerated black burst signal, thus repro-

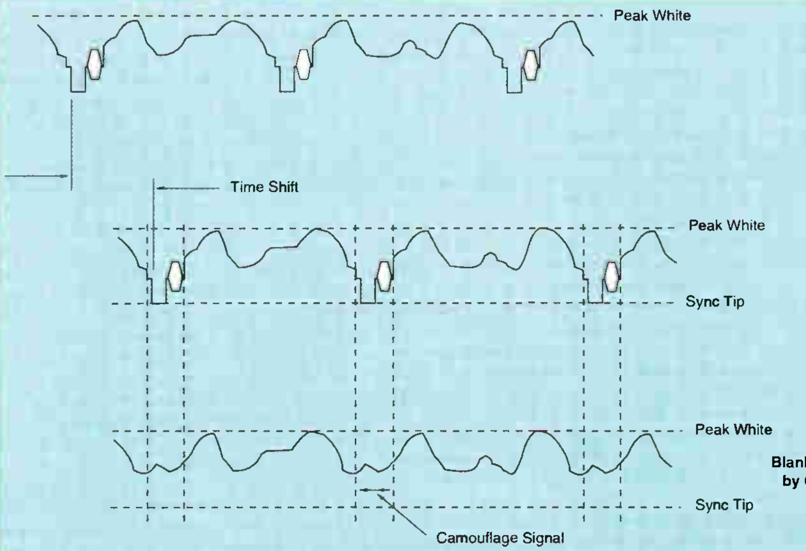

Figure 1 Standard Video Signal

Figure 2 Time Shifted Signal

Figure 3 Blanking Replaced by Camouflage Signal

The time-shift is the same for all lines in the same field. It changes from field to field with a maximum value of six lines.

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ducing the original signal (as shown in Figure 6). Special characteristics of the scrambling technique ensure that the phases of the regenerated horizontal sync and back porch color bursts are inherently precise.

The reference for the demodulator AGC is derived from sync tips in the vertical interval. The quality of the decoded signal is very high, because the scrambling process does not affect or distort the active component of the video signal.

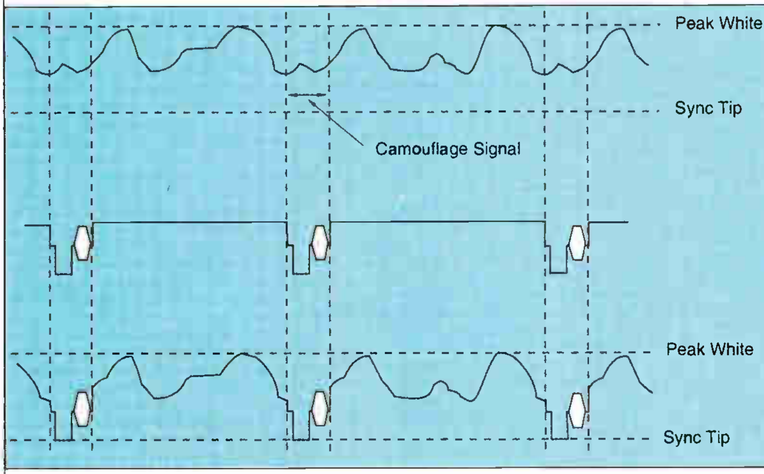

Figure 4
Demodulated Signal (Still Scrambled)

Figure 5
Regenerated Black Burst

Figure 6
Decoded Signal (Camouflage Signal Replaced by Black Burst)

Defeating the system

To defeat the system without using the codes in the vertical interval, hackers have to rely on information present in the scrambled signal itself. The problem they face is identifying the location of blanking (in other words, differentiating between the camouflage signal and video). It is difficult to conceive of any hardware circuitry which could do this.

Any attempt to tackle the problem would necessarily have to involve sophisticated software. One method might involve an automatic means for removing the scrambling time-shift.

This would create more problems than it solves, since there is a great deal of movement within most video programs (panning, zooming and cuts), and automatic systems will tend to remove those too, bringing the camouflage signal into the raster area. The scrambling time-shifts in the encoder are deliberately related to the natural movements in the program itself; rapid scene switches are associated by large abrupt time-shifts.

Potential problems

Even if a method of differentiating between normal movement and the scrambling shift is found, one has (a) the problem of producing relatively inexpensive boxes capable of doing the same, and (b) an even bigger problem of establishing exactly which part of the signal has to be replaced by blanking, since the camouflage signal is almost identical to video.

Figure 3 illustrates this point. Imagine the difficulty of establishing the position of the camouflage signal if the dotted lines were absent. In the unlikely event that someone does discover a revealing characteristic in the camouflage signal and manufactures a number of boxes using this quirk, a simple change in the encoder will render the pirate boxes obsolete, without the necessity for making any changes to the legitimate boxes already in the field.

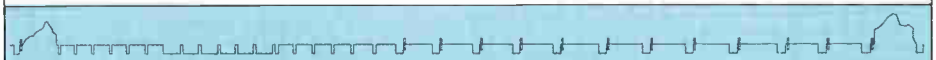

Figure 7
Standard Vertical Interval

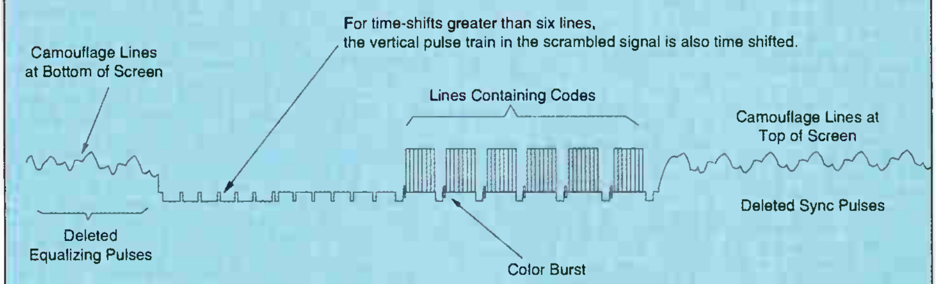

Figure 8
Scrambled Vertical Interval

The incremental amplitude of the time-shifts determines whether or not VCRs will be capable of locking to the signal. To prevent VCRs from recording, the time shifts are made too large to be tolerated by the servo loops in VCRs, yet small enough to allow television receivers (which are all electronic) to follow the shifts.

A simple analysis shows that any horizontal time shift is accompanied by an equal time shift in the vertical pulse train of the decoded signal (though the vertical pulse train of the scrambled signal may remain unshifted). The system can accommodate a six line time-shift without moving the vertical pulse train (in the scrambled signal), as shown in the diagrams.

For larger shift, the vertical signal in the scrambled signal is also time-shifted. A switch on the encoder determines whether VCRs are to be permitted or prevented from recording. The switch can be actuated at any time, even in the middle of a program.

Coding and billing

A unique approach was taken. It is based on the premise that system operators are concerned with loss of revenue, not the attainment of perfect security. No attempt was made to design a system so complex that cannot be defeated by any isolated individual. It is clearly impossible to design a completely unbeatable system. Instead, the emphasis was placed on making the cost of proliferation high enough to render it impractical for hackers to implement it on a large scale. The technique involves a continuous process of updating legitimate decoders, individually.

Even if occasional hackers do succeed in designing a complex arrangement to unravel the codes, they have

Continued on page 60

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* Patent Pending

Circle Reader Service No. 23

Non-interfering method of CTB measurement

System sweeping may, to some systems, be a luxury or even a waste of time, manpower and monies. But at its best, a sweep crew is the vanguard of a preventive maintenance program. One of the tasks that a sweep technician does best is to discover, pinpoint and rectify distortion problems.

Taking CTB measurements

In a coaxial cable system, the two distortion parameters that must be considered in the design are carrier-to-noise (C/N) and composite triple beast (CTB). Although hum and cross-modulation can cause ugly pictures if some equipment has been set up incorrectly and broken down, a discussion on testing for all distortions is beyond the scope of this article. For now, let us focus on one small facet of a sweep tech's job; taking measurements of composite triple beat.

Many types of equipment will measure composite triple beat. The method is rather simple. Because CTB is a cluster of third-order distortions that fall on or near the visual carrier, the usual method is to measure the desired carrier, shut it off, then measure it again on the same frequency to obtain the level of distortion.

If the goal is to determine the level of CTB in the midst of a system's bandwidth, there is not much that can be done except to turn off a channel. However, because cable operators are becoming increasingly concerned about customer complaints, a method that would be "transparent" to our subscribers was sought.

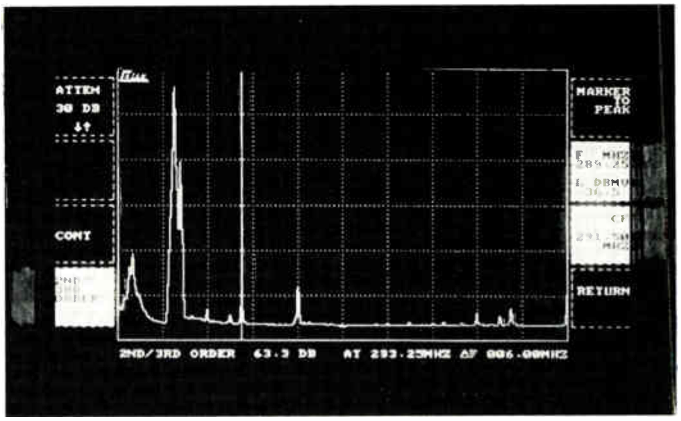

Illustration #2: The level of composite triple beat is shown on the left. On the right is the reference frequency followed by the change in frequency for the final measurement.

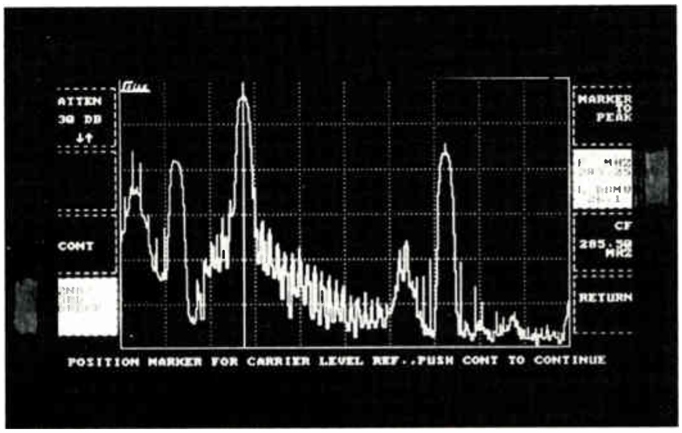

Illustration #1: The highlighted window on the right indicates the cursor frequency. Notice the center frequency, "CF", is 2.25 MHz higher.

Being primarily concerned with preventive maintenance, a sweep crew is always seeking new and effective ways to avoid signal interruption. What good does it do to find and correct distortion problems before customers call in to complain if, in the testing process, customers call to complain? We began using a method that, although it will not give an exact measurement in one frequency, will provide a close approximation of the level of CTB at a test location.

We first saw this method of measuring CTB while using a Hewlett-Packard analyzer. In this article, we describe the exact procedures for this measurement using a CALAN 1776-1 integrated sweep receiver/analyzer because of our familiarity with this equipment. This basic idea may be just as compatible to many other types of equipment.

Worst at high frequencies

Because the level of CTB will be worst at the highest frequency in a cable system, the idea is to measure the carrier level of the highest channel in the system and then jump up exactly 6 MHz to obtain the difference in levels of CTB. Unless there is a

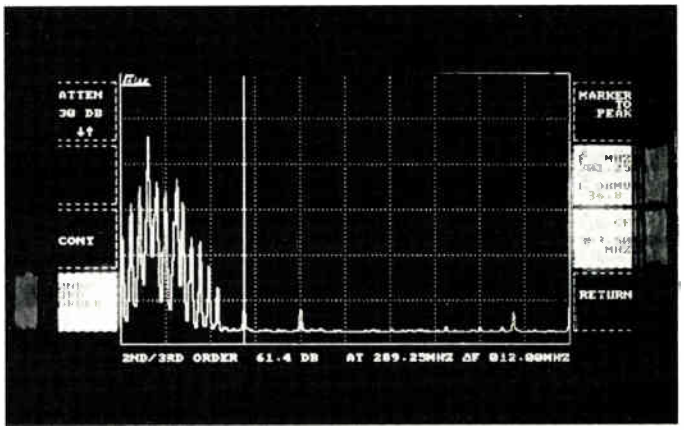

Illustration #3: The cluster of signals that appears to the left of the frequency cursor are data carriers that fall at 295.25 MHz and above. They make channel 36 unusable for this measurement. Note the change in frequency for the final measurement of 12 MHz.

By Greg Bawdon and Woody Cash, System Maintenance Engineering Division, Heritage Cablevision

roll-off of the response at the higher frequencies, this should provide a very close, but inexact, approximation of the level of CTB distortion at the test point.

Here is how we do it with our receivers.

Requirements: *Calan sweep receiver, model 1776 or 1776-1; a bandpass tunable filter, and a cable TV signal source (minimum 20 dBmV for accuracy).*

Step by step procedure

1. Turn on receiver.
2. Press the "CALAN" softkey.
3. Press the "CAL" softkey
4. Press the "GO TO ANL" softkey (if not in analyzer mode).
5. Press the "CALAN" softkey.
6. Connect the receiver and filter to the test point.
7. Press the numeric hardkeys for the channel to be measured (highest channel of system).
8. Press the "Channel Entry 2-86" softkey.
9. Press "Mrkrs to peak" softkey.
10. Ensure that frequency cursor is on video peak.
11. Tune the filter.
12. Press the "ATTN xx DB" softkey.
13. Adjust to position carrier peak near the top of the screen (highest quadrant).
14. Press the "MEAS" softkey.
15. Press the "2nd/3rd Order" softkey.
16. Verify that the frequency cursor is on the video peak. (See Figure 1).
17. Press "CONT" softkey.
18. Note center frequency, "CF."
19. Press numeric hardkeys to add 6 MHz to center frequency.
20. Press "CF" softkey.
21. Retune filter.
22. Record the displayed 2nd/3rd order number (found at the bottom of the screen; see Figure 2.)

Remember that you are making a measurement where the next higher channel would fall if you added one at the next higher frequency. You can make the final measurement even higher, in increments of 6 MHz, but each step up decreases the accuracy. It may be necessary to jump up 12 or 18 MHz. In our system, channel 36 is occupied by a group of data signals. They would interfere with measuring CTB on channel 36, after referencing channel 35, so we must step up two increments, or 12 MHz, to channel 37 (see Figure 3). Although there is the corresponding degrading of accuracy, we are looking for the indication of a problem with CTB.

> One of the tasks that a sweep technician does best is to discover, pinpoint and rectify distortion problems.

This technique will only measure one type of distortion. It is merely one tool available to help maintain our systems. All distortions must be monitored during system sweeping to be thorough. Until you learn to utilize all functions of the receiver/analyzer, potential troubleshooting power is wasted. CED

Operators prove fiber saves money

Annual SCTE fiber conference draws nearly 600 attendees

Maybe it was the idea of spending a couple days in sunny Southern California in January that caused so many cable engineers to venture to San Diego for Fiber Optics Plus '92, sponsored by the Society of Cable Television Engineers.

Whatever the motivation, 585 attendees registered for the conference, up from the 570 who made the trip to Orlando last year. That surprised the SCTE staff, which assumed that reduced travel budgets would translate into lower attendance figures. As usual, the attendance list read like a Who's Who in Cable Engineering; MSO vice presidents, regional engineers, consultants and nearly all major equipment vendors were on hand.

The two-day conference was divided into four main sessions: the operational impact of fiber, new developments in fiber, new applications for fiber and emerging technologies. Out of those discussions came the following major themes:

* Fiber optics absolutely, positively results in greater reliability and fewer service calls, which save operators money in the long run;
* Fiber optic transmitters and receivers continue to improve;
* Cable system operators can effectively choose to use 1310 nm or 1550 nm systems, or both, and meet high performance specifications
* The adoption of digital transmission methods over fiber optics is coming sooner than most would guess.

Fiber pays for itself

Rising young star Kevin Casey, director of engineering for Continental Cablevision of New England, analyzed the performance of the more than 300 miles of fiber plant already installed in New England to determine if fiber contributed any improvements or benefits to the operation of those systems.

Annual outages. The first parameter of the study compared the number of annual outages incurred per 100 miles of fiber plant to that of the coaxial plant. The fiber plant averaged 52 devices per 100 miles and the average plant age was a shade over 14 months. The coax plant averaged 4,928 devices per 100 miles and the average age was 6.7 years.

The results showed that the fiber plant was 1,600 times less likely to fail when compared to a coaxial system. Furthermore, the average coaxial system exhibited one failure in 246 devices, while the fiber systems exhibited one failure in 4,521 devices per year.

> Fiber-based systems experience outage frequency rates 27 percent lower than coaxial systems.

By comparing the outage statistics between distributed fiber systems and traditional tree-and-branch systems, it was shown that fiber-based systems experience outage frequency rates 27 percent lower than coaxial systems, said Casey.

Size of outages. Continental's goal is to reduce the number of subscribers affected by any one outage. Fiber apparently makes that possible, according to Casey. He said that in 1991, outages in systems served by coaxial systems affected more than four times as many subscribers per average outage than fiber-based systems.

Service call rates. In order to fairly compare fiber and coax systems, Continental looked at the overall service comparison between 1990 and 1991 (which revealed a reduction of 52 calls per 1,000 subscribers) and viewed those as a result of normal operating improvements gained as a result of better training, equipment and converters. Casey then compared the reduction in service call rates in the fiber systems (99 per 1,000 subs) and concluded that fiber has reduced service call rates by an average of 47 per 1,000 subs (99 minus 52).

Signal quality. Market research of subscriber perceptions of signal quality and continuity of service was then compared between fiber and coax systems. The fiber systems scored 6 percent to 12 percent higher.

Economics. The reduction of service call rates by 13 percent (at $28 per service call) represents an annual savings of $1.31 per subscriber, according to Casey; the reduction of 5.5 outages per year per 100 miles (at an average cost of $78 per occurrence) saved another 15 cents per sub per year; and the 8 percent savings in power costs translated to another 53 cents per sub—all because fiber was installed.

Extrapolating those figures over the entire 55 million subscribers served by cable, Casey surmises that fiber could save cable operators at least $110 million per year.

Dick Mueller of Cox Cable Communications explained his approach to determining system reliability and how fiber affects it. Mueller said there are three critical issues involved in outage measurement: duration, frequency and number of subscribers affected. To track them, Cox uses two methods of information gathering and checks them against annual customer service surveys.

By installing fiber to the serving area-type topologies, Cox is able to improve network availability (reliability) to 99.995 percent, up from 99.971 percent (a critical difference if one plans on business use of the network). This translates into an improvement from 2.5 hours of downtime per sub-

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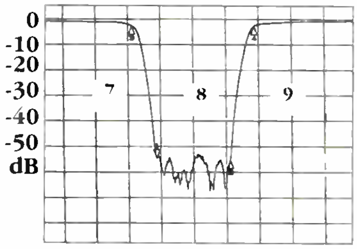
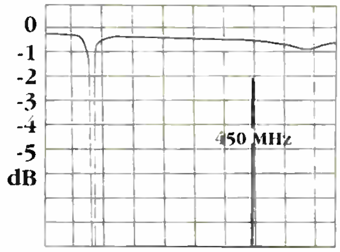


Single Channel 50 dB Notch, Leaves Adjacents In Service 3271ABH-8



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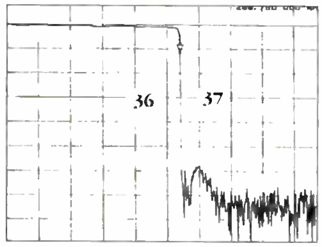
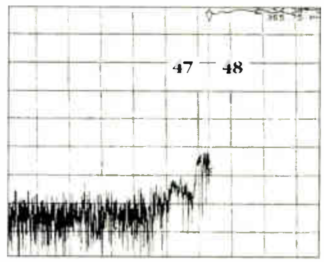
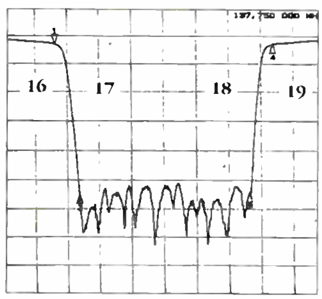


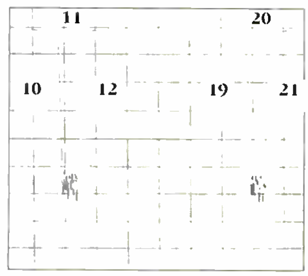
Brickwall LPF 6211LP-36/37 Passes Channel 36 Down, 50 dB Channel 37 Up



Brickwall HPF 6211HP-47/48 Passes Channel 48 Up, 50 dB Channel 47 Down



Contiguous Multichannel Type 7964-17/18



Scattered, Multichannel Type 6971-(2)(11,20)(450)

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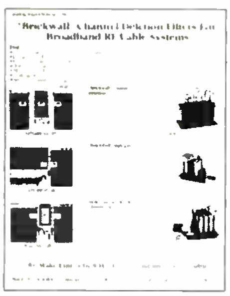

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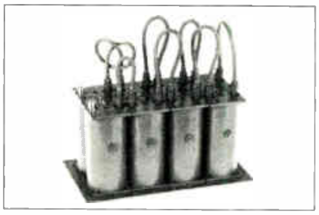

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scriber per year to just 25 minutes of outage per sub per annum.

Meanwhile, Tom Staniec of Newchannels Corp. presented his rationale for using digital supertrunks to interconnect headends, replace high-power microwave equipment and provide distance learning opportunities for rural school districts.

New developments

The next part of the program was devoted to a discussion of wave division multiplexing, external modulation, optical amplifiers, improved laser devices and the advent of new transmission methods.

Hermann Gysel of Synchronous Communications told the operators that wave division multiplexing video signals in both 1310 nm and 1550 nm windows can be done and is advantageous to those desiring good carrier-to-noise ratios and low fiber counts. Of course, limitations are set by laser chirp and dispersion inherent in the fiber itself, but those problems can be overcome by: lowering the number of channels used in the 1550 window (keeping them within an octave so that composite second order caused by laser chirp is not an issue); precompensating for the CSO at the transmitter site; and using externally modulated devices.

Israel Levi of Harmonic Lightwaves explained how external modulation works and the benefits of such a system. With proper predistortion, a linear externally modulated device can deliver 80 channels down a single fiber a distance of 25 kilometers and yet still meet cable operators' performance specifications, said Levi.

Tests conducted on erbium-doped fiber amplifiers by both AT&T and Corning showed that system performance can be enhanced through the use of such devices, either to extend the reach of cable systems or for efficiently splitting the transmitted signal to several receivers. However, distortion remains a problem if path distances are unequal or too long.

But everyone's hope that researchers will be able to develop a fiber amplifier for use in the 1310 nm window were mostly dashed by GTE Laboratories scientists. They wrote that the rare-earth elements neodymium and praseodymium hold out the most promise to amplify signals at that wavelength, but would require a different glass. "Erbium will always be the best amplifier," said William Miniscalco of GTE.

New applications

The cable's industry's embrace of fiber optics has led vendors to create new products specifically for CATV use. Because every cable system is different and each operator stresses different needs, there is no single "correct" approach when it comes to design and implementation.

For example, to help cable operators reduce the number of cables and splices in their fiber networks, Siecor Corp. has designed a new tapered cable that delivers only the number of fibers an operator specifies to each node. This contrasts the fully-fibered cable, which forces cable operators to buy more fiber than they need or splice different-sized bundles together to get the proper fiber counts. Buying more fibers than you need is expensive and too many splices can impact reliability and/or system reach.

Of course, precise pre-engineering of the fiber route is extremely important should a cable operator choose to use tapered cable, said Marvin Ashby of Siecor. The maximum savings is achieved when a high fiber-count cable has fibers terminated at equal intervals. And, of course, the total project cost is reduced by avoiding the need to splice the express buffer tubes into a separate lower fiber-count cable.

Al Johnson of Cablevision Systems again gave his rationale for choosing to deliver AM signals in the 1550 nm window. Because of the unique geography of Long Island (long and narrow), it was decided that 1550's inherent lower loss should be taken advantage of, said Johnson. Consequently, it is being used to tie together nodes that are 18 kilometers apart.

Cablevision intends to utilize fiber amplifiers and expects to announce which vendor it has selected within a matter of weeks, said Johnson. The MSO plans to reserve the 1310-nm window for future services and has installed fiber cable that has been spec'd at both wavelengths.

The uniqueness of being the first cable operator to design, build and fully load a 1-GHz system placed some new demands on ATC, which recently completed the first phase of its Brooklyn-Queens build.

The system uses three lasers to drive 150 channels. A bundle of six fibers are home-runned from the headend to each node location and all optical couplers have been installed at the headend, providing flexibility for future switching of the upper band of channels on a node-by-node basis, said Jim Ludington, project coordinator.

Because of the high fiber counts required in a home-run design and considering the high cost of labor in New York, ATC chose to use ribbon fiber and a mass array fusion splicer to achieve labor cost savings.

The system was designed to provide 52 dB C/N, 65 dBc CTB and 62 dBc CSO. This was accomplished in the lower band (50 MHz to 450 MHz) with a 9 dB optical loss budget and with a 6 dB loss budget in the two upper bands.

Emerging technologies

The second half of the second day of the conference was devoted to other technolgies, including digital video compression, large screen video displays and subjective tests of picture quality.

Representatives of both General Instrument and Scientific-Atlanta took the podium to explain how their particular systems operate. "The arrival of digital compression technology is imminent," according to Geoff Roman, VP of new business development at Jerrold. This new technology will impact many headend and distribution design considerations, resulting in headends becoming high-speed digital routers.

David Fellows followed Roman with an explanation of how S-A's vector quantization system compresses video signals. He also explained how S-A's alliance with Zenith/AT&T provides both terrestrial and satellite methods of signal delivery.

Lawrence Tannas explained how viewers are impacted by screen size and viewing distance. He noted that the optimum viewing distance from any television receiver is seven times the screen height.

He was followed by the final speaker, Bronwen Lindsay-Jones, who summarized the results of the subjective testing that was performed by CableLabs and Jerrold last year. Her conclusions were simple: Viewers are demanding better resolution with fewer distortions and less noise. She predicted that cable operators will soon be forced to deliver pictures with carrier-to-noise ratios much higher than those delivered today. CED

By Roger Brown

SCTE®

Following is a list of SCTE technical seminars with contact name. If known, location and seminar topic are listed.

February 5 *Ark-La-Tex Chapter* To be held in Shreveport, La. Contact Robert Hagan II, (903) 758-9991.

February 6 *Great Plains Chapter* "Data Networking and Architecture" and "Engineering Management and Professionalism" with Dale Kirk and Randy Parker of United Artists Cable. To be held at the Crown Court Quality Inn, Bellevue, Neb. Contact Jennifer Hays, (402) 333-6484.

February 11 *Desert Chapter* Contact Chris Middleton, (619) 340-1312, ext.258.

February 11-12 *Dakota Territories Chapter* "Installer seminar" presented by Kent Binkerd and A.J. VandeKamp of Sioux Falls Cable. Consecutive meetings to be held February 11 at the Ramkota Inn in Pierre, S.D. and February 12 at the Radisson Inn in Bismarck, N.D. Contact Kent Binkerd at (605) 339-3339.

February 12 *Delaware Valley Chapter* "Distribution Systems—Theory and Maintenance," and "System Design Theory." To be held at Williamson's Restaurant, Willow Grove, Pa. Contact Lou Aurely, (215) 675-2053.

February 14 *Wheat State Chapter* BCT/E exams to be administered in categories I, III, V and VII at both levels. To be held at Multimedia Cablevision offices, Wichita, Kan. Contact Mark Wilson, (316) 262-4270.

Scientific Atlanta

Scientific-Atlanta will hold a series of seminars in the Chicago, Ill. area on February 11-13. The seminars are open to any local cable operators and those who install, maintain and troubleshoot cable TV equipment.

Cost for the program is $215 per person for each session. The sessions will be held at the Chicago Oakbrook Marriott Hotel. Contact Dan Pruitt at (800) 722-2009 to make reservations or for more information. The seminar schedule is as follows:

February 11 *Headend and Earth Station Systems*

February 12 *Distribution Systems*

February 13 *Fiber Optic Systems*

FC²

FC₂ has announced its 1992 schedule for hands-on fiber optic workshops. The workshop, titled "Fiberoptic Splicing and Termination," is five days in duration and will be held at the company's Sturbridge, Mass. headquarters.

The workshop is college accredited and is intended for people who wish to develop an in-depth understanding of practical communications fiberoptic technology.

Topics covered include a comprehensive, hands-on approach to the basic aspects of splicing, termination, and testing fiberoptic communications cables. Dates for the workshop are as follows:

February 17-21
March 16-20
April 20-24
May 18-22
June 15-19

Trade shows

February 2-7 *IEEE Optical Fiber Conference '92* San Jose Convention Center, San Jose, Calif. For technical information, call (202) 416-1980; for exhibit information call (202) 416-1950.

February 26-28 *Texas Show* Convention Center, San Antonio, Texas. Contact (512) 474-2082.

May 3-6 *National Show* Convention Center, Dallas, Texas. Contact (202) 775-3669.

May 3-June 3 *Canadian Cable Television Association* To be held in Vancouver, B.C. Call (613) 232-2631.

June 3-5 *International Conference on Consumer Electronics*, Chicago, Ill. Call Diane Williams, (716) 392-3862.

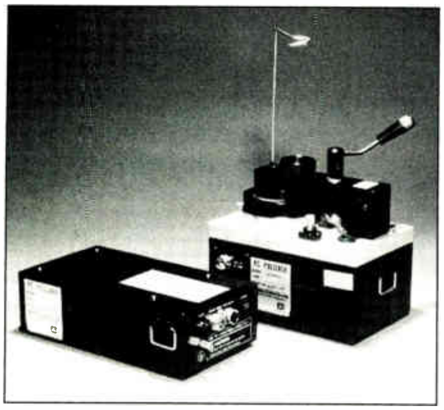
June 14-16 *SCTE Show* San Antonio Convention Center, San Antonio, Texas. Contact (215) 363-6888.

August 25-27 *Eastern Show* Inforum Exhibit Hall, Atlanta, Ga. Contact (404) 255-1608.

New products

Fiber optics

Ferrule polishing machine



Alcoa's ferrule polishing machines

Alcoa Fujikura Ltd. has developed three polishing machines for use with SC, FC, ST or D4 optical fiber connectors equipped with a zirconia or alumina ceramic ferrule.

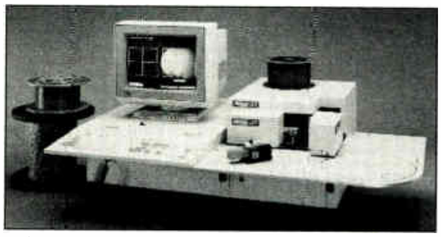
The company's portable model SP-202 is available in two compact one-piece models, each engineered specifically for simple field polishing of one connector ferrule at a time. The basic model SP-202 is designed for PC polishing; the Model SP-202-APC provides additional polishing for super PC ferrules required for higher return loss.

The new rotary model SF-105 is a larger one-piece unit for higher production, in-plant polishing of three connector ferrules simultaneously. Both models feature a screw-type, quick-change wheel with polishing film and diamond-suspension polishing liquid. Each sheet of polishing film will process 50 connectors. Either machine can polish the spherical convex endface of a ferrule or convert a flat-end ferrule to precision convex PC within one minute, company officials submit.

For more information call (800) 866-3953 or fax inquiries to (803) 433-5353.

Test system for fiber ribbon

Photon Kinetics Inc. has introduced an optical fiber analysis system called the model 2220 Fiber Ribbon Test System. The system makes it possible to prepare and test fiber ribbons quickly, company officials say, and thereby increases productivity and streamlines test procedures for manufacturers and cablers of optical fiber ribbons.



Photon Kinetics,Inc.'s 2220

Photon Kinetics,Inc.'s 6000

The unit performs spectral attenuation and cutoff wavelength measurements on ribbon fibers with up to 12 fibers per ribbon.

Also new from Photon Kinetics is the Model 6000 all-purpose OTDR, which is designed to provide cable television operators with an instrument that can perform high resolution, long distance measurements in one optical module, eliminating the need for more than one OTDR.

The OTDR features a 4 meter event dead zone and 25.5dB long range capability, which is "what our customers have been seeking in OTDR performance," says Tom Moore, senior VP of sales and marketing.

For more information call (503) 644-1960 or fax inquiries to (503) 526-4700.

Multi-services distant terminal

New from **AT&T** is a fiber-optic based distant terminal, the SLC-2000MSDT, which uses singlemode fiber and laser optics for bidirectional transmission. The terminal houses plug-in channel units which provide a full range of narrowband services, from plain old telephone service (POTS) to special services. An optional AM CATV adjunct is also available.

The terminal is hardened for outside plant applications and meets

AT&T's SLC-2000 MSDT

FCC electromagnetic compliance. It can effectively serve private homes, multi-unit dwellings, small and mid-size businesses, colleges and shopping centers. It can also be used to modernize rural routes.

The terminal permits fiber cable to be extended into a distribution area from a SLC Series 5 remote terminal. Fiber distribution cable is used to connect a remote terminal to an MDST at or near a customer's location. Standard copper drops are used to connect the MSTD to customer equipment.

The metal enclose is approximately 24 inches high, 10 inches wide and 16 inches deep. It is designed to be pole, wall or pedestal mounted, and can be supported by either aerial or underground distribution. A companion enclosure houses a high performance CATV system which allows the integration of plant design, alarming and powering of both narrowband and video equipment.

For more information write to AT&T Customer Information Center, P.O. Box 19901, Indianapolis, Ind. 46219.

Test equipment

Tunable bandpass filter

New from **Trilithic** is the VF series of tunable filters, which provide the preselection needed for the measurement of CTB, cross modulation and other spurious signals in a working cable system.

Placing a VF series filter between the test instrument and the system test point blocks all unneeded signals, eliminating measurement overload and extending the measurement range of a signal level meter or spectrum analyzer by as much as 30 dB, company officials say. Also, officials say, the high resolution of the filters makes them well-suited for CSO and system noise measurements in AM fiber systems.

The filters can be purchased individually for an 2:1 frequency range between 55 MHz and 880 MHz, or in a bank of up to four tunable filters, housed in a rugged field case with a hinged dustcover. For more information call (800) 344-2412.

Spectrum analyzer

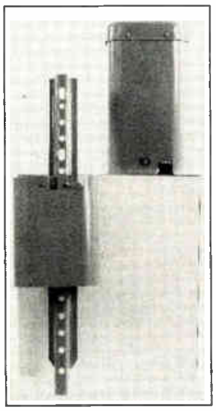
New from **Tektronix** is the 2711 spectrum analyzer, which officials says is economically priced for bench or field applications. Positive-feel push buttons and controls are functionally grouped, making basic setups and menu selections quick, officials say.

Also, the unit offers 9-kHz to 1.8 GHz of bandwidth for observations and measurements in a variety of applications including broadcast, broadband networks and communications. The unit includes -129 dBm of sensitivity, 80 dB of dynamic range and spans as low as 10 kHz/div. Resolution bandwidth filters are selectable from 3 kHz to 5 MHz, which make it easier to zoom in on weak signals mixed in with strong signals.

Spectral activity can be viewed either in true analog display mode, or up to four digitally stored displays can be compared and measured. The unit includes an AM/FM audio demodulator with a speaker and headphone jack to aid signal identification and monitoring. For more information, call Tek officials at (800) 426-2200.

Other new products

Round corner cabinet enclosure



Champion's CATV-XX360 Cabinets

Champion Products has introduced its CATV-XX360 line of round corner, square design cabinets designed to give total access to internally mounted cable television equipment.

The units are available in a variety of sizes, from six to 10 inches to provide equipment handling for all buried distribution requirements. Suitable mounting

Continued on page 62

People making news

David M. Pangrac has been appointed VP of engineering of **American Television and Communications (ATC)**. He was previously director of engineering and technology for the company, and held that position since 1987. Pangrac has been a leader in ATC's development of fiber optic applications for cable television. In 1989, he was presented with the Vanguard Award of the NCTA for his contributions in this area.

Pangrac, who has been in the cable television business for 24 years, joined ATC in 1982 as VP of engineering for ATC's Kansas City division. He joined ATC from Cox Cable.

Wilt Hildenbrand has been appointed VP of technology for Cablevision Systems Corp. Previously, Hildenbrand was VP of engineering support and customer relations for the company.

Hildenbrand joined Cablevision in 1976 and two years later was named chief engineer for the company's Long Island, N.Y. system. In 1986 he became the company's VP, engineering.

Cablevision president James A. Kolfalt, says the move to VP of technology "demonstrates that Wilt has been instrumental in keeping Cablevision in step with the latest technologies, including fiber optics and spread spectrum technology. His experience becomes even more valuable as the pace of technological change continues to accelerate."

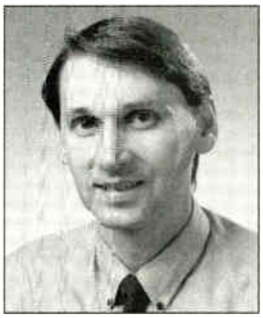

Diana Riley

Jerry Conn Associates has promoted **Diana Riley** to senior account manager. In her new role, Riley will coordinate corporate MSOs with regional and system operators.

She was previously sales manager for the company. The sales management position has been taken on by **Trav Neumann**, who is a degreed electrical engineer and comes to JCA from a major test equipment manufacturer.


Trav Neumann

Tektronix Television Division has named **Tim Slade** marketing manager for its video processing products. In his new role, Slade will develop and implement strategies to expand the company's existing video and audio synchronizer lines.


Tim Slade

Magnavox CATV Systems has announced the appointment of **Charles Conner** to manager, major accounts. In this capacity, Conner will develop sales strategies in an effort to increase visibility and sales among major cable MSOs. Before joining Magnavox, Conner was VP of sales for C.J. Electronics in Atlanta, Ga.

Scrambling

Continued from page 50

to update their own "customers" continuously. They will not have prior knowledge of the codes, so they may have to convey the information to their clients in the middle of a program. They also do not have the avenue of access to the decoders, which is available to the system operator.

The transmitted signal does not contain the full decoding information. This, in addition to the dynamic nature of the system, precludes any one time fix or modification from permanently enabling legitimate decoders. Decoders are addressable at a rate of 300 per second. Impulse purchases can be made by pushing a button on the decoder or remote control. A significant advantage is that the system operator receives full information on each customer's individual viewing record, and is thus able to insure that program originators are paid correctly. Details on this system are the subject of pending patents.

This technology is covered by US Patent 5,003,592 and several pending applications.

Continued from page 60

facilities are included for mounting of splitters, taps and filters. And, a removable top gives additional working room and allows for the mounting of extra equipment.

For more information call (417) 736-2135 or fax inquiries to (417) 736-2662.

Tek adds H and V drive outputs

Tektronix has announced the inclusion of horizontal (H) and vertical (V) drive outputs as a no-cost enhancement to its TSG 1001 programmable test signal generator.

The enhancement includes both new software and new hardware. The software includes signal drive libraries for most HDTV signal formats and for the 525 and 625-line component digital formats. Drive signals for other formats can still be user-defined with a personal computer-based software tool for that enables custom test signals. The new hardware supports the software update and is transparent to the user.

Officials say the programmability of the TSG 1001 makes it especially versatile in multiformat environments. The enhancement was added in response to requests from customers, many in HDTV research facilities. For more information, call (800) TEK-WIDE.

Network amps

Magnavox CATV Systems has introduced its new network amplifiers, designed specifically for cable TV applications. The amps are available in two configurations: a Trunk Network Amplifier and a Global Network Amplifier. Both offer more RF power and added reach while reducing the total number of active components required in a cable system. They are designed to fit a variety of system architectures and applications, and can accommodate upgrades to as high as 1 GHz.

Both amplifiers are well-suited for fiber optic applications, officials say. The trunk network amplifier is designed for express feed or mini-trunking environments and provides performance comparable to a full size trunk station.

It also allows delivery of more economical service into lower density areas. The global network amplifier, with its dedicated hybrids-per-output port design, is designed to maximize reach and design flexibility in high density areas. For more information call (315) 682-9105.

Offers and deals

Test instrument rental

IFR Systems Inc. has announced a new rental program for selected test instruments including spectrum analyzers, communications service monitors and associated options and accessories.

Under the plan, instruments can be rented for a minimum of 30 days. Rental agreements are automatically renewed each month, indefinitely, for as long as the equipment is needed. All rental agreements include a purchase provision which allows 80 percent of paid-in rental payments to be applied toward the purchase of the rented equipment.

For more information call (316) 522-4981 or fax inquiries to (316) 524-2633.

–Compiled by Leslie Ellis

AD INDEX

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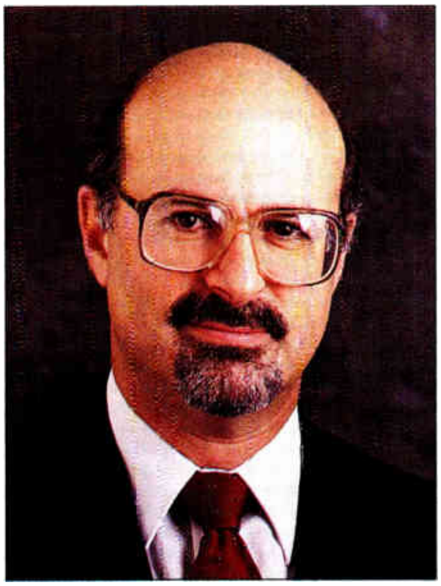
ENGINEERING/DESIGN/CONSTRUCTION



Radio broadcasting to airplanes

Here's an intriguing idea: live broadcasting of news and sports events to airline passengers. Two different companies have come up with this idea at the same time, and they plan to use very different technical approaches. One plans to use terrestrial radio transmissions from 48 different locations, while the other plans to use satellite transmissions.

In-Flight Phone Corporation

In-Flight Phone Corporation is already licensed to provide air-to-ground telephone service, and is building a network of 48 terrestrial transmission towers throughout the country. In-Flight wants to use these same towers to transmit 12 channels of broadcast programming to airline passengers.

In-Flight has asked the FCC for an experimental radio license to use frequencies in the 901.75 MHz to 902.00 MHz and 940.75 MHz to 941.00 MHz range for this service. This total of 500 kHz of spectrum would be divided into blocks of 50 kHz, which would each be subdivided into six 8-kHz radio channels. At each of its ground stations, In-Flight would use two of the 50-kHz blocks to carry 12 channels of programming. The frequency blocks could be reused nationally.

In-Flight plans to use single sideband AM modulation, which means it will have a technical quality comparable to AM radio.

In-Flight has asked the FCC for an experimental license, but the scope of the request is far more extensive than a mere experiment. In-Flight hopes to bootstrap itself into a permanent license by making the investment and getting the service into operation, and then arguing that the FCC should not deprive airline passengers of this service by ending the experiment.

In-Flight's founder, Jack Goeken, played precisely the same game when he founded Airfone and got FCC experimental authority to build a nationwide air-to-ground network. Goeken later sold Airfone to Western Union who sold it to GTE. GTE and Goeken had a falling-out, so Goeken then started In-Flight to compete with Airfone.

Sky Radio

Sky Radio is a partnership of Gannett, the publisher of *USA Today* newspaper, and several entrepreneurs. It plans to deliver news, weather and financial reports, and live play-by-play sports coverage to airplane passengers.

Sky Radio will use Ku-band satellite technology for this service. Broadcasts will originate at a studio in Arlington, Va. Analog programming channels will be digitally coded, combined using time division multiplexing, and transmitted to the GSTAR III satellite. The satellite downlink will be received with a specially designed steerable phased-array antenna mounted on the aircraft hull. The antenna has a height of less than 7 centimeters, and is 53 centimeters in length.

Sky Radio has asked the FCC for permission to install receive-only antennas on up to 2,000 aircraft. Since this frequency band is allocated for communications with fixed earth stations, special authorization is needed. Sky Radio hopes to begin operations in April 1992. The first units will be installed on Delta Air Lines Boeing 757 jets.

Regulatory issues

The In-Flight proposal has a number of serious regulatory hurdles to overcome. First, the proposed experiment is huge in scope—it covers the entire country. An experimental license from the FCC is intended to cover experiments, such as technical tests and limited market tests. In reality, the In-Flight experiment is more than just an experiment—it is a full-blown service offering.

The frequencies requested by In-Flight are now allocated for land mobile communications. Radio broadcasting to airline passengers certainly isn't land mobile communications. You can expect land mobile interests to oppose In-Flight, even though there are no other concrete proposals to use these frequencies now pending.

Finally, there is the problem of interference from Navy radars. There is a type of shipboard air surveillance radar in this frequency range that is widely used by the U.S. Navy. It has caused some interference to land mobile operations, and is likely to cause interference to In-Flight. In-Flight has said it can live with that interference, but the Navy worries that if the In-Flight service becomes successful, there will be political pressure from Congress for the Navy to shut down these radars.

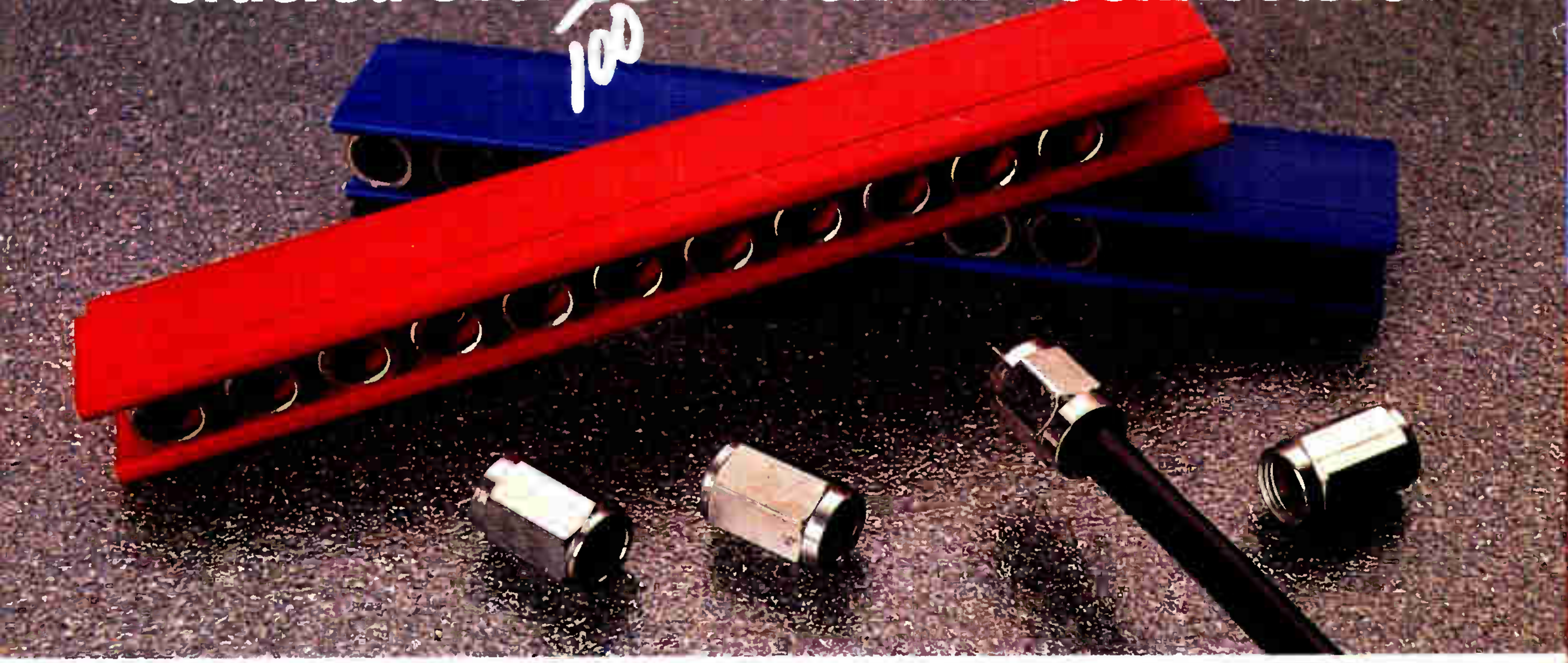
The Sky Radio proposal has fewer regulatory problems. Ku-band satellites are licensed for two-way communication with fixed ground-based earth stations, not mobile earth stations. There are networks of thousands of VSATs operating with these satellites. But the FCC has previously authorized Qualcomm to use these satellites for two-way communications with trucks and other mobile vehicles, so long as there would be no interference to the VSATs.

In order to get FCC approval, Sky Radio has to show that its technology will work as designed, and will not cause interference to fixed earth stations. In particular, it must show no interference to the VSATs working with the SBS-3 and SBS-4 satellites, which are two degrees to the east and west of GSTAR III. It has designed its system using a signal spreading technique, and has chosen its operating frequency to minimize interference to VSATs looking at the two adjacent satellites.

In my view, Sky Radio is likely to be a winner in Washington, and the only real question is whether it can be offered at a reasonable cost. In-Flight, on the other hand, has serious regulatory problems, and I doubt that it will ever get full FCC approval. CED

By Jeffrey Krauss, Independent Telecommunications Policy Consultant and President of Telecommunications and Technology

Why have cable system operators ordered over ~~63~~ 100 million EZF Connectors?



Lower Maintenance Costs and Improved Customer Satisfaction

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

PROVEN: Fewer problems occur during installation

- One color-coded connector for each cable size minimizes connector selection problems.
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- Only a 7/16 inch wrench is needed for installation.
- Cassette packaging facilitates proper installation and reduces connector loss.
- Immediate inspection for proper installation by installers and QC inspectors.

PROVEN: Fewer problems occur during service life

- A circumferential, environmental seal is automatically made at the connector/cable interface during installation.
- The EZF sealing sleeve supplied with the connector prevents moisture penetration at the connector/port interface.
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- Rugged connector design and consistent installation quality contribute to reduced RF leakage and reliable performance.

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