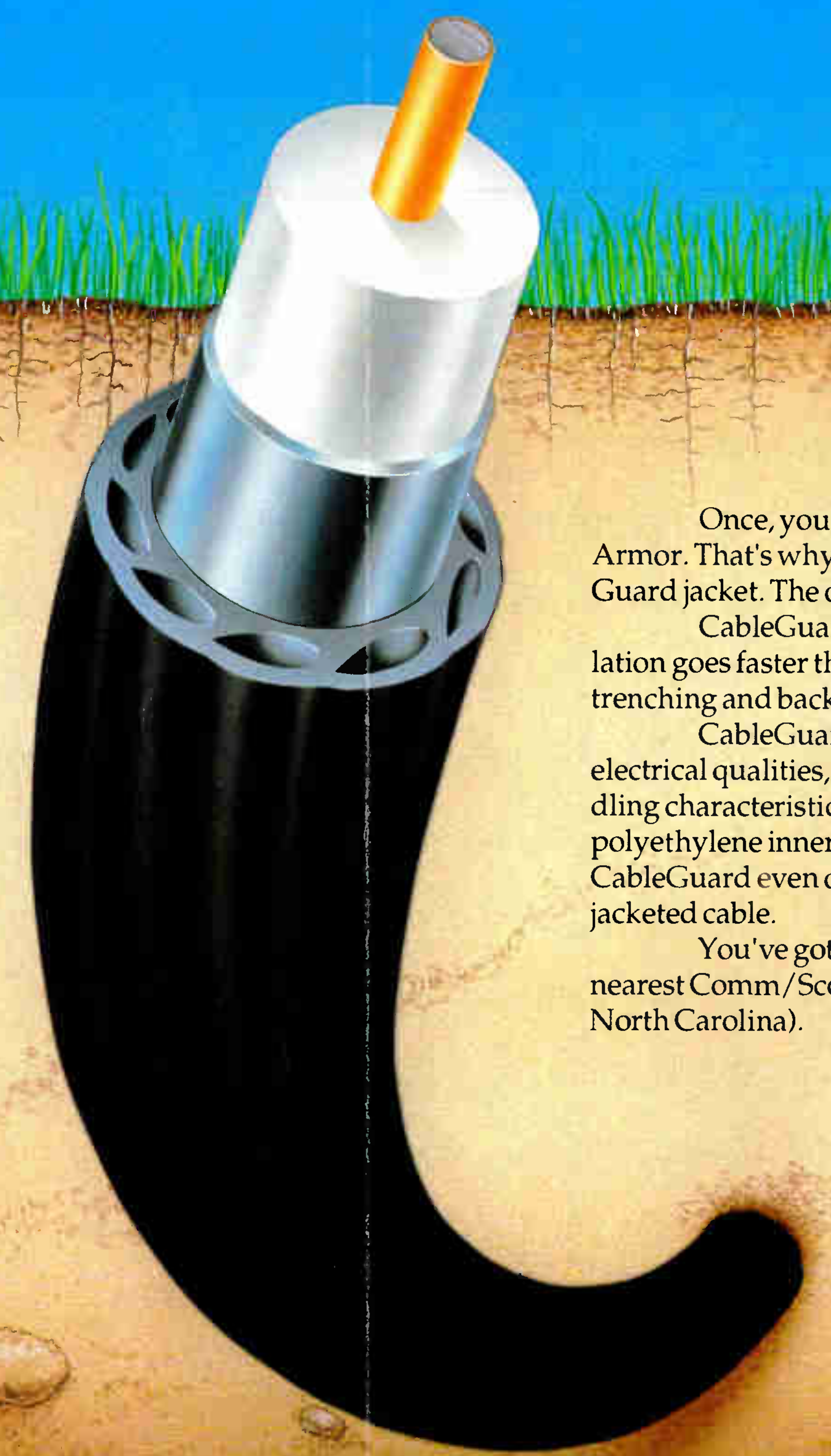
CED

THE MAGAZINE OF BROADBAND TECHNOLOGY

SCTE: Celebrating 20 years of service

COMM/SCOPE HAS CABLEGUARD.



Physical Dimensions	500 Series	625 Series	750 Series
Nominal Center Conductor Diameter	0.109 in. 2.77 mm.	0.137 in. 3.48 mm.	0.167 in. 4.24 mm.
Nominal Diameter Over Dielectric	0.450 in. 11.43 mm.	0.563 in. 14.30 mm.	0.678 in. 17.22 mm.
Nominal Diameter Over Outer Conductor	0.500 in. 13.70 mm.	0.625 in. 15.88 mm.	0.750 in. 19.05 mm.
Nominal Outer Conductor Thickness	0.025 in. 0.64 mm.	0.031 in. 0.79 mm.	0.036 in. 0.91 mm.
Nominal Diameter Over Jacket	0.750 in. 19.05 mm.	0.875 in. 22.23 mm.	1.055 in. 26.80 mm.
Nominal Jacket Wall Thickness - Inside Jacket	0.025 in. 0.64 mm.	0.025 in. 0.64 mm	0.025 in. 0.64 mm.
Nominal Jacket Wall Thickness - Outside Jacket	0.030 in. 0.76 mm.	0.030 in. 0.76 mm.	0.030 in. 0.76 mm
Mechanical Characteristics			
Minimum Bending Radius	8.0 in. 20.3 cm.	9.0 in. 22.9 cm.	10.0 in. 25.4 cm.
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Reader Service Number 1


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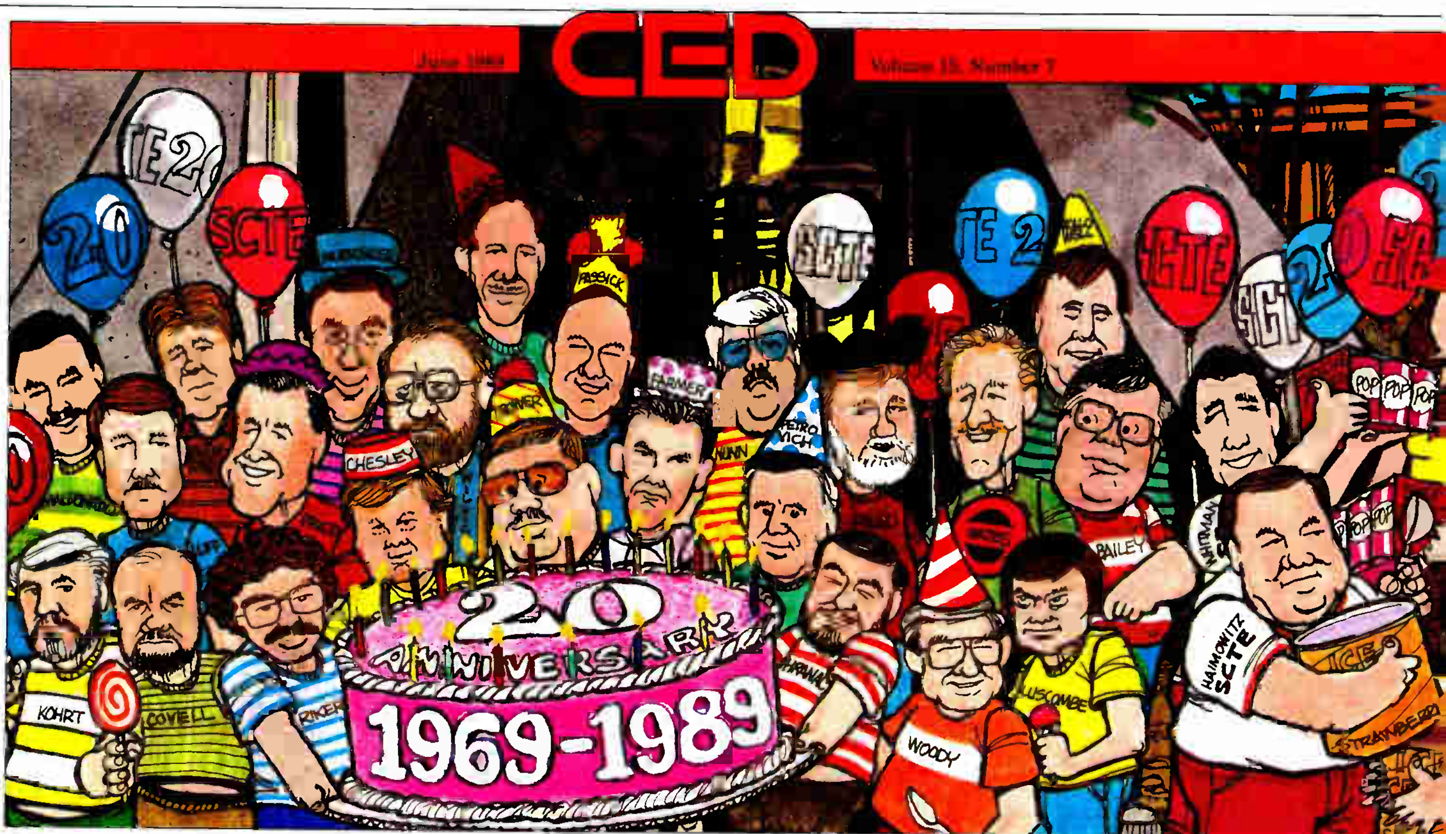
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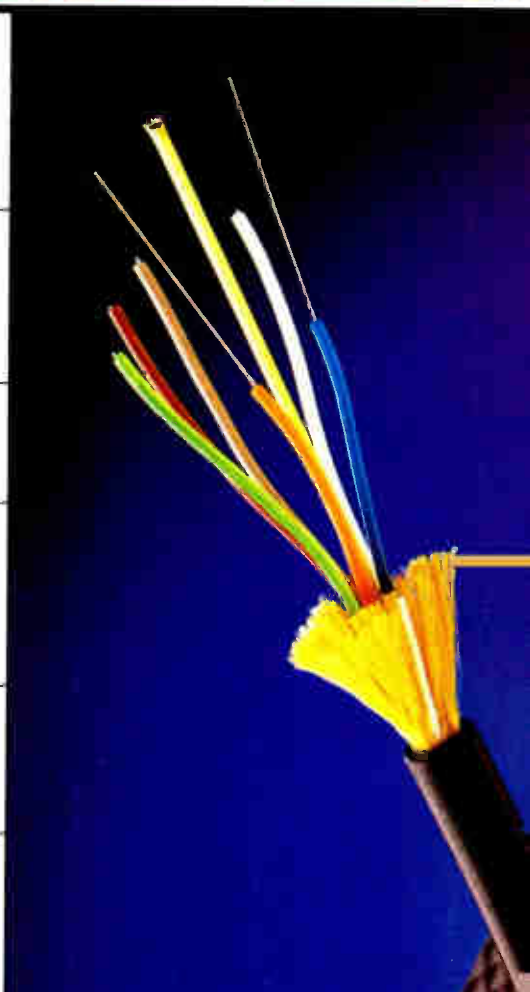

About the Cover:
The Society of Cable Television Engineers will celebrate its 20th year of existence with its largest Cable-Tec Expo ever in Orlando. On this month's cover, we salute those who've made it all happen: the SCTE National Headquarters staff, the Board of Directors and presidents of each of the local chapters and meeting groups.

DEPARTMENTS

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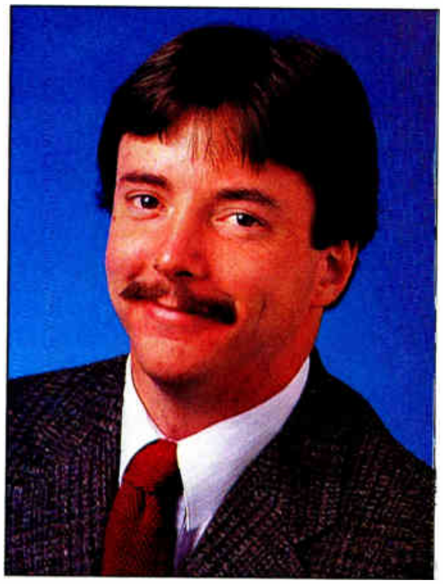
Saluting those with an eye on the future

Just when the manufacturers of distribution electronics thought they had the bandwidth wars settled, along comes the push for 1 GHz electronics. But is there a real *need* to develop the hybrids that would bring subscribers as many as 157 6-MHz channels? When you consider that probably 75 percent of all CATV electronic hardware shipped today is 450 MHz gear, what is likely to occur that will eat up *twice* as much bandwidth as the industry is using today?



At this year's National Cable Show in Dallas, at least four manufacturers showed off the fruits of their R&D labors: Texscan's Pathmaker Plus product line has been based on a 1-GHz platform; Jerrold has already demonstrated a 1 GHz line extender platform and is working on the trunk amp; Scientific-Atlanta was slated to show an entire line of 750 MHz electronics that is integrated into its off-premises addressability system; and C-Cor Electronics was slated to provide details about its research program.

The one unanswered question related to expanded bandwidth centers around the hybrid chips themselves. Can the IC manufacturers be convinced there's a market for 1-GHz chips? How long will it take until they're developed? What approach will be necessary to get to 1 GHz—a single chip or multiple chips? Apparently, the answers aren't clear, nor do they come easily.

Where did this "need" for more bandwidth come from? Cable engineers like Bob Luff of Jones Intercable and Jim Chiddix of American Television and Communications saw the possibilities when they managed to reduce amplifier cascades by implementing fiber. When amp cascades are reduced to a series of four, five or six amps, bandwidth suddenly increases because noise and distortion is reduced. And because fiber has unlimited capacity (in CATV applications), the bandwidth bottleneck was in the electronics.

The simplistic view is to argue that cable operators will never need the kind of capacity 1 GHz will give them. But that assumes the size of video channels won't change—and these days that's not a sure thing. High Definition Television will become a reality, in some form. The Federal Communications Commission has said that whatever terrestrial delivery method is chosen must be compatible with today's 6-MHz NTSC pictures. But the cable industry may decide another approach suits them better and may choose to send 8-MHz, 12-MHz or even full 30-MHz pictures down the pipe. At those rates of consumption, it's easy to see why more bandwidth is necessary.

Some say we still have time before HDTV can give CATV a run for it's money, but this industry's manufacturers should be saluted for their insight and long-term research and development programs that will, ultimately, keep cable competitive.

On a content note, I'd like to bring your attention to three new departments we've added to this, the largest *CED* magazine ever. First, Color Bursts is our way of giving you the previous month's most important news in the front of the magazine; Cable Poll is a temporary service that provides industry feedback on a variety of current issues; and SCTE Focus will bring timely and important presentations from the local level to national recognition. I hope you like the additions.

Roger Brown
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Reader Service Number 2

Texscan, Anixter form alliance

Texscan's long climb back to the forefront of the cable industry took a giant stride recently with the announcement that the El Paso-based company has signed a long-term joint marketing and product development agreement with **Anixter Cable TV**. In addition, both firms have introduced new CATV hardware.

Texscan announced its Pathmaker Plus line of distribution products, all of which are based on a 1 GHz platform. According to Texscan officials, the new line of equipment gives cable operators more flexibility for the future, because the Pathmaker Plus amplifier housing can accommodate future bandwidth needs (up to 1 GHz) and fiber optics by utilizing different plug-in modules.

On the fiber side, the housing can be configured in one of several different ways, depending upon the architecture an operator chooses. For example, redundant RF switching and/or dual outputs can be utilized, which makes both the Jones Intercable Cable Area Network and American Television and Communications' fiber backbone possible. Additionally, a full line of options is available, including power redundancy, status monitoring and advanced amp designs (feedforward and power addition).

In addition to building the housings for its own Pathmaker Plus product line, Texscan will manufacture the housing for Anixter's Laser Link.

Three new Laser Link receivers were announced by Anixter. The LLR 2000, LLR 2100 and LLR 2200 are all available in a 1 GHz platform with optional plug-in modules for design flexibility.

The 2000 is a basic fiber node which allows operators to detect optical signals and feed existing traditional distribution electronics with a 20 dBmV output. The 2100 adds 550 MHz feedforward technology and AGC to the basic unit and the 2200 is a full-featured receiver with an external fiber splice enclosure.

Jerrold previews new gear

The **Jerrold Division** of General Instrument also announced a new, expanded bandwidth amplifier, a new set-top converter designed for the international marketplace and a new business unit focused on developing fiber optic technology for CATV.

The new Starline SX amplifier has been designed to accommodate 750 MHz electronics and is compatible with both the SJ and X series of Jerrold amp designs, says Geoff Roman, vice president of marketing for distribution.

The unit boasts the highest heat dissipation in the industry and features a 3.3-ampere power pack to support future advanced electronics modules, says Roman. Now, the hybrids have to be designed and manufactured to handle the increased channel loading. The units are expected to be available at the end of the year.

On the subscriber product side, a new modular addressable converter aimed at the international market has been introduced. The Intercon 7000 is both PAL B/G and PAL I compatible and is available in 200-, 220- and 240-volt versions with either 50-or 60-Hertz. Also, the unit's downloadable channel map parameters accommodate multiple


CATV
Underground
Television
Cable
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Disturb

channel bandwidths and spacings, says Ed Ebenbach, vice president of marketing for subscriber products.

The modularity of the unit was made possible by performing major modifications to the control firmware and some changes in the RF circuitry, says Dan Moloney, director of product management. The units are presently undergoing field testing and will be available in late summer.

Finally, Jerrold's new business unit, called Cableoptics. The unit will be headed by David Robinson and will have an annual operating budget of between $5 million and $10 million, says Lemuel Tarshis, vice president and general manager of distribution.

The Cableoptics unit will employ 35 staff members and will focus on developing analog lasers. For the short-term, the focus will be on bringing FM supertrunking products to market; in the long run, however, Jerrold plans to develop a fiber-to-the-home system and work with laser vendors to develop an AM laser with the following specifications: a signal-to-noise ratio of 55 dB; composite triple beat and composite second order of -65 dB; and channel loading of 40 over a single fiber.

In addition, Cableoptics will research the practicality of all laser approaches. For example, externally modulated lasers are a possibility, even though it appears there's much development to be done.

"There is nothing we've ruled out," says Tarshis. "We're so early in the development stage that anyone who rules out any approach is absolutely naive. The extent of our research and development program is not to be understated."

Looking even further out, Jerrold eyes a fiber-to-the-home system that carries 80 channels of video over a single fiber, provides for High Definition Television and interactivity. Robinson says it appears the industry is five to 10 years away from having a cost-effective, reliable fiber-to-the-tap system. Research is proceeding on such a low-cost, switched-star system, dubbed System K, which the company promises to show publicly soon.

TCI buys portion of ICT

Tele-Communications Inc. has agreed to purchase 15 percent of **International Cablecasting Technologies**, the creator of the CD 8 premium digital audio service. As part of the agreement, ICT has acquired Tempo Sound from TCI in exchange for ICT common stock.

As a result, TCI will supply Tempo Sound basic service and CD 8 premium audio to more than 4 million homes, or about 70 percent of TCI's subscriber base. Tempo Sound offers six channels of programming. CD 8, which will have no commercial or talking interruptions, will cost listeners between $5 and $7.50 per month for eight different music formats. In addition, subscribers will need digital tuners, which are expected to cost about $100 each.

Other digital music services attempting to gain a toehold with subscribers is Jerrold's Digital Cable Radio and the Digital Radio Channel, from Digital Radio Labs.

MUSE tested over cable system

NHK has tested its MUSE high definition television system to two different cable systems in the Washington, D.C. area. The tests, which were pronounced successful by industry officials, were conducted by NCTA and HBO.

The 12-MHz MUSE signal was uplinked at HBO's Communications Center in Long Island to Satcom K1. They were downlinked at both the state-of-the-art Media General headend and a more traditional 40-channel Jones Intercable headend in suburban Washington. The signal was then sent through the distribution network a total of 28 amplifiers to a subscriber location where the picture was displayed on an NHK monitor.

The results were "fairly encouraging," says Brian James, director of engineering at the NCTA. The Media General system was plagued by beats that resulted from an HRC problem, but the Jones system showed no distortions and a carrier-to-noise ratio in the "high 40s" was measured, James says.

The demonstration was undertaken to show that high-quality, satellite-delivered video can be provided by a typical coaxial system without fiber optics. The demonstration is the first in a series to test the feasibility of the various proposed HDTV systems over cable. Future tests will be conducted in conjunction with Cable Labs.

Sammons, SW Bell team up for test

Southwestern Bell Telephone has teamed with cable operator **Sammons Communications** to test the simultaneous transport of voice and a cable TV signal over fiber to the home.

The trial will be conducted in the Mira Vista subdivision of Fort Worth, Texas and will deliver voice and video to 80 to 100 homes, using fiber installed by SW Bell. Under the plan, SW Bell plans to transport the cable signals from the headend to a node located in the subdivision.

In addition to video, the test will consist of up to two voice telephone lines per home. The test is scheduled to begin in late summer and will last from one to two years.

Orchard looks to CATV for growth

Despite leaving many with the impression it isn't active in the cable market, watch for **Orchard Communications** (formerly Pirelli) to develop AM fiber optic gear designed specifically for CATV use.

The company, when it was part of Pirelli, was the first to develop a 16-channel fiber system and the first to use frequency agile modulators and demodulators, says Dean Bogert, director of systems engineering. Recently, the company has spent most of its time and effort pursuing the educational market.

However, according to Bogert, Orchard is actively researching an AM product that will likely be introduced "early next year." Design goals for that system, dubbed AM 5000, include the delivery of 60 channels over a single fiber; a C/N ratio of 55 dB; -65 dB composite triple beat and -70 dB composite second order. The company is exploring two approaches to reaching its goals: use of a linearization circuit for the laser and external modulation techniques, says Bogert.

"We think the (CATV) market has grown significantly," Bogert says. "It's quite encouraging." ■

—Roger Brown

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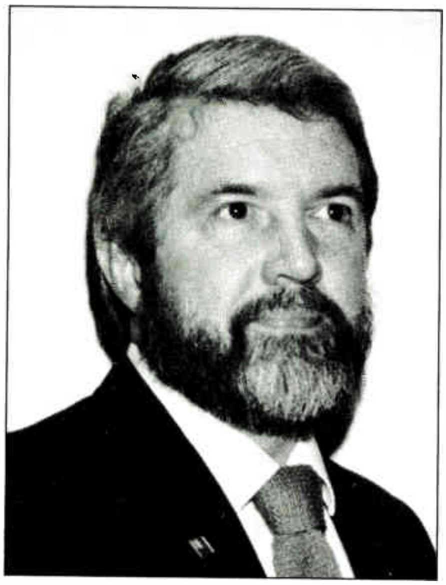

Bill Kohrt

Cable's strength lies in its people

Giving presentations at seminars may seem a frightening experience to many, but not so to Bill Kohrt, owner of Kohrt Communications Inc. and the SCTE eastern vice president and region 6 director. "I like working with people who have a serious attitude about life and who want to learn," says Kohrt.

It is this outlook on life and involvement with people that has prompted many of Kohrt's changes throughout his career. It was also a key issue in his decision to join the cable industry.

From leather to coax

In 1966, after a three year stint with the U.S. Army, Kohrt joined AT&T Long Lines in Missouri where he was responsible for the layout and design of various communications equipment and buildings. Four years later, tired of maintaining AC/DC power plants, microwave radio, multiplex carriers and electronic switching devices, Kohrt wanted to "just goof off for a while" and opened a leather business in Colorado, where he manufactured leather belts and had the free time he desired.

However, in 1977, leather belts were no longer a challenge of any kind and Kohrt decided to "get serious about life again." It was at this point that Kohrt, while visiting family in northwestern Iowa, heard about a job with Kaybl-Vision in Storm Lake. He spoke to the system operator about the opening and got the job the same day.

"Working for a cable system was an experience," says Kohrt, "because I had to cross over the information I had from the telephone company. When I left the phone company, we already had our status monitoring in place so it was different to work in a cable system with very limited resources." Regardless, Kohrt considered it a learning experience and worked at it until 1980 when he moved to Pekin, Ill. to work for Continental Cablevision as regional field engineer.

According to Kohrt, Continental's 60,000-subscriber system was quite a bit different than the smaller system he had just left. "Continental is a very well run organization," says Kohrt. "They had a lot more resources for things like test equipment. And technically," he continued, "their standards were a little bit higher than Kaybl-Vision's."

A change of pace

In 1984, Kohrt made two major changes in his life. One, he left Continental for Comm/Scope, a division of General Instrument, and secondly, Kohrt designed, built and managed his own cable system in Maynard, Iowa under the name of Village Cable Inc. Kohrt's reason for building the system was simple: he wanted to "make money." Two years after completing Village Cable, Kohrt got his wish when he sold the 260-subscriber system. (With one success story under his belt, Kohrt recently completed another small system in Minnesota, about 20 minutes from his home.)

However, Kohrt's reason for leaving Continental to join Comm/Scope was entirely different. Although he viewed it as a move up, Kohrt also considered it a means to make contact with the outside world. The cable community was forging ahead and while Kohrt saw himself as technically competent, his only contact with the industry was through the trade press.

"I felt if I got to work for Comm/Scope I would be talking to and visiting all the people who were in the same position I was before. I would be able to travel around, go to the conventions and get a little closer to the cutting edge," says Kohrt.

And get closer he did. Working for a manufacturer turned out to be "an entirely different job," but Kohrt enjoyed the contrast. "There were different pressures," says Kohrt. "And there was a different timing. It was one that I liked." The one aspect Kohrt did find disarming was the lack of immediate gratification.

"At Continental, when I fixed something, or completed a rebuild, it was over and done and you could see the end," says Kohrt. "When I went to Comm/Scope, the gratification wasn't there because when selling to customers, the relationship took on a long-term aspect, rather than, let's do the job, complete it, here's your 'at-a-boy,' which is what I had with the engineering department."

Personal gratification

In the summer of '88, Kohrt left Comm/Scope for personal reasons and in August formed his own corporation to "service the needs of cable television companies in the Midwest." Kohrt Communications Inc. is a contracting company that offers services such as headend rewire, mapping and design, performance testing, light construction and general contract management. According to Kohrt, "there is a definite need for services that demand timely, high quality results."

Quality is a key issue to Kohrt. Ask him where to find quality in the industry and he'll point you squarely in the direction of the SCTE. "I think the SCTE is a very good organization," says Kohrt. "It offers the technical community a voice, training, a certification program and, as of last year, an insurance package."

SCTE endorsement

Kohrt backs his feelings about the SCTE through his involvement with the organization. He is a past president of the Iowa Heartland Meeting Group, was elected to the National Board of Directors in 1987 (and recently re-elected), is the eastern vice president and has achieved senior membership status.

As director of region 6, Kohrt feels his value is in "supporting and assisting members... to continue to represent region 6 by bringing Midwestern values and ideas to the national board." As Kohrt says, "That's a little bit about who I am." ■

—Kathy Berlin

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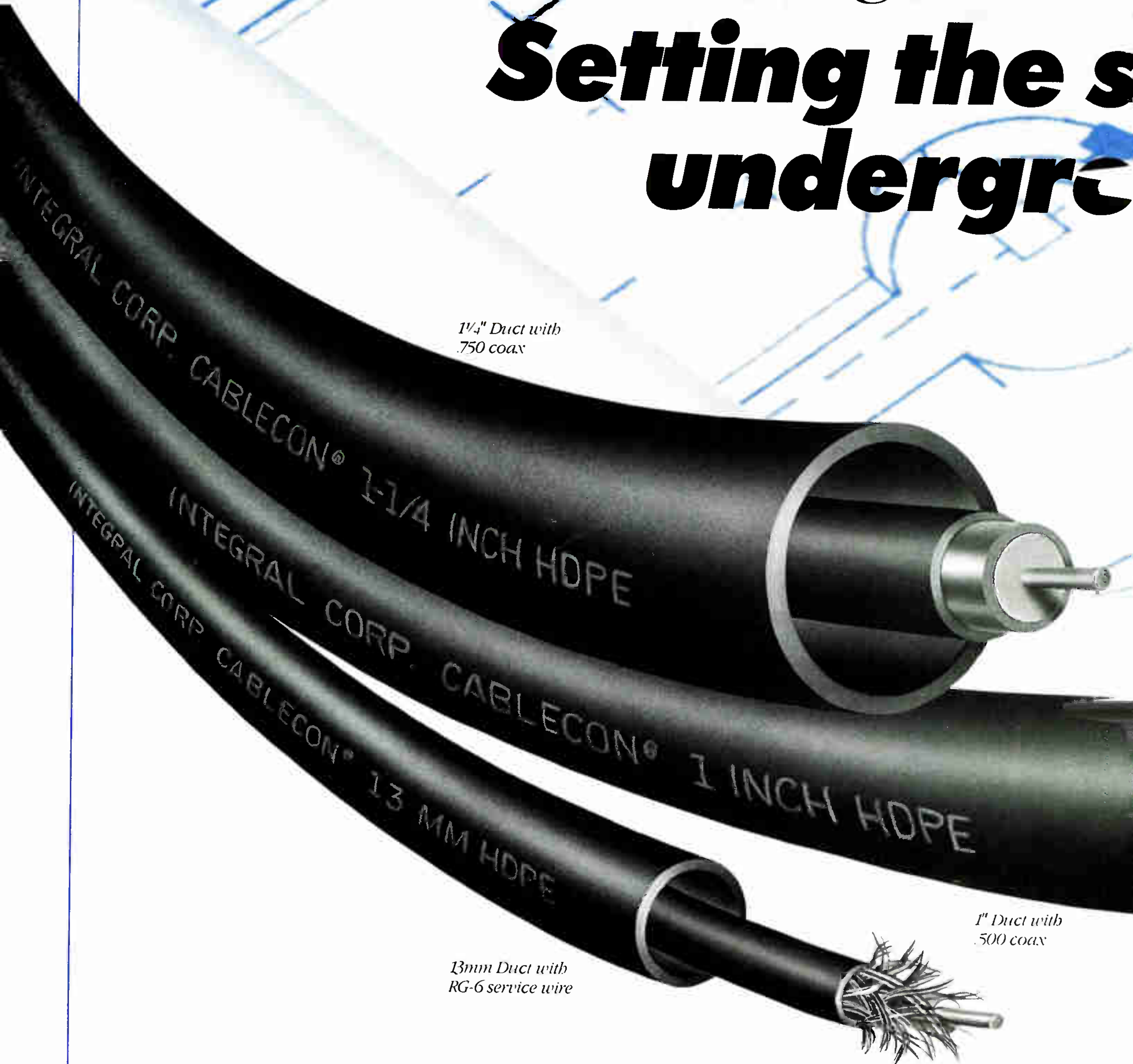

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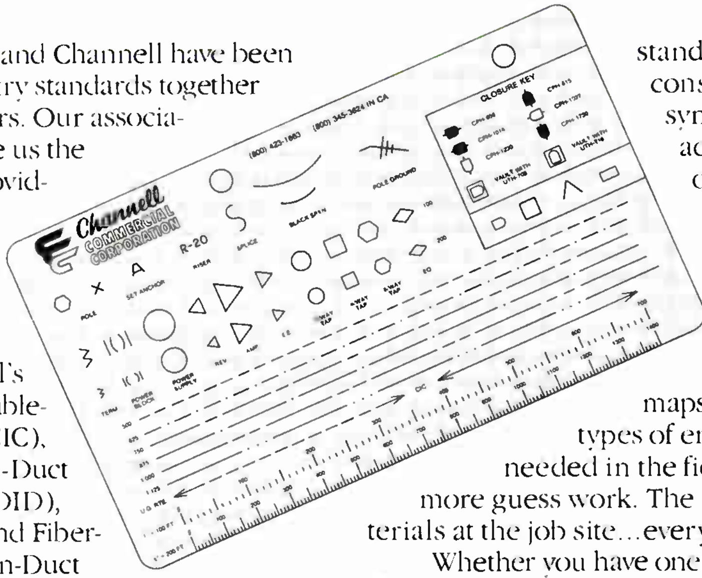

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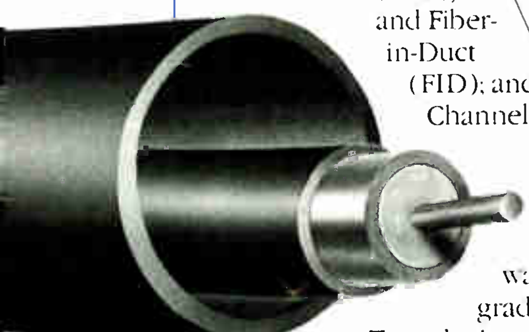

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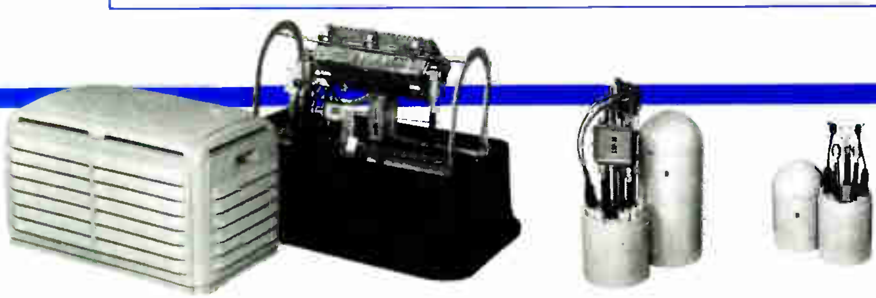


Channell COMMERCIAL CORPORATION

Reader Service Number 6

SCTE: foundation for cable's future

As June approaches, many of us are getting ready to attend the SCTE's (Society of Cable Television Engineers) annual Cable-Tec Expo in Orlando. I think it's proper to pause and reflect on what the society has meant to the growth of the cable industry over the past several years.

It is important to note that the purpose of this monthly column is to bring information to the readers about service in the cable television industry. True, we talk about other issues as well, but the bottom line of virtually every column I write is that service is important for the cable television business now and in the future. And along with a commitment to service must come the ability to competently serve our subscribers.

BCT/E an important resource

At the heart of the SCTE is technical training and the competence that it brings to an individual. Throughout the years, and through a variety of programs, the SCTE has provided the BCT/E Certification Program (Broadband Communications Technician/Engineer) as a vehicle and an opportunity for any cable technician or engineer to increase his competence if he so desires. You'll no doubt read a lot about the SCTE in the trade publications, but you'll rarely see information about the people who spent the time and effort to put together this important program.

These are people who, in virtually every area, were already extremely competent in their own right. They were also competent enough to act as teachers and researchers in gathering information and preparing the courses and material for training. Most of these people were and are old time cable engineers—well qualified, well established in their careers. Both young and old practitioners of the art of engineering in this industry pitched in. They all had a common goal—to see to it that the certification tests were fair, but that they also drew the absolute best from every applicant.

To pass any one of these tests requires that you know what you're doing. It's just that simple. To be half informed, half serious or less than dedicated to understanding the technology just won't do. You don't have to be the world's greatest expert on these technologies to pass the tests, but you do have to know what's going on and how technology works in the cable world. And, you have to know it in some detail.

> The SCTE has done a lot to improve the image of the CATV technical corps.

While not exhaustive, these tests are thorough and anyone who has passed one of these particular categories should be recognized as a person who knows the subject matter. They are worthy of your respect in that regard. Those who fail but continue to study and then try again also should be noted and encouraged.

Too difficult?

The category with the highest failure rate is category 7, titled Engineering Management and Professionalism. It is unique in that the format is essay versus the standard multiple choice, and usually consists of only three questions. As chairman of the curriculum committee, I get a lot of complaints about the high failure rate in this particular category. Frankly, I am not swayed by the arguments I have heard to date.

This test *should* be the hardest to pass. This should be *the* issue that divides those who choose to be professional from those who are good at taking tests or memorizing technical facts. This test requires a persuasive expression of your understanding of a variety of potentially conflicting issues. Taken altogether, the BCT/E program demonstrates an achievement in training that is worthwhile in the cable industry.

Being competent, understanding the technology, showing an interest in and support of a professional society and knowing the issues is useful. Nothing is more important to the future of our industry than the appearance of professional competence we give to consumers.

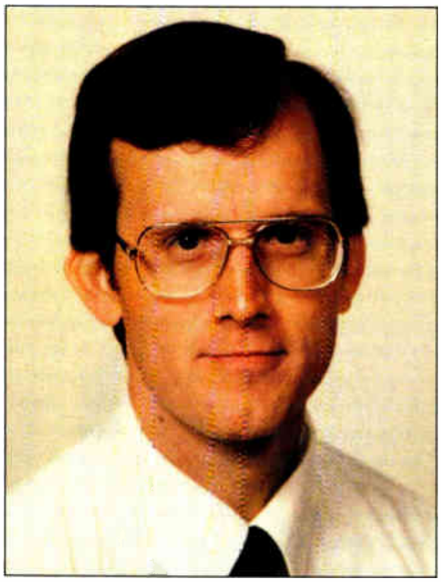
Excellence in service has to be the by-word of everyone in order for us to succeed in our increasingly competitive world. In addition to the training and information that can be provided by the SCTE, the individual must have a personal commitment to doing the best job he can. He/she also should have an understanding of how the subscriber reacts to service issues—individuals must be sensitive to items that aggravate customers.

Sensitivity program

This sensitivity training may be the next program needed by our SCTE membership. If it is, I'm confident the people who work with the SCTE and dedicate countless hours running meetings, giving lectures and researching problems will once again come up with a recommendation for training. And from that recommendation a program will develop.

The SCTE has done a lot to improve the image of the CATV technical corps. You should not only be a member of the SCTE but should donate your time and talent to making it work for the industry. Encourage others to support the society—not just individuals, but companies as well. The people who have face to face contact with our customers need and deserve a professional training program. The ability to compete in the future depends on our training standards and a strong SCTE. ■

By Wendell Bailey, Vice President Science and Technology, NCTA



Combined headend output C/N

Historically, CATV modulator noise performance has been characterized by its carrier-to-noise (C/N) ratio. It has always been assumed that the modulator's "out of channel" or broadband noise performance was "good enough" so as not to significantly impact the C/N ratio of any other channel at the output of the combined headend.

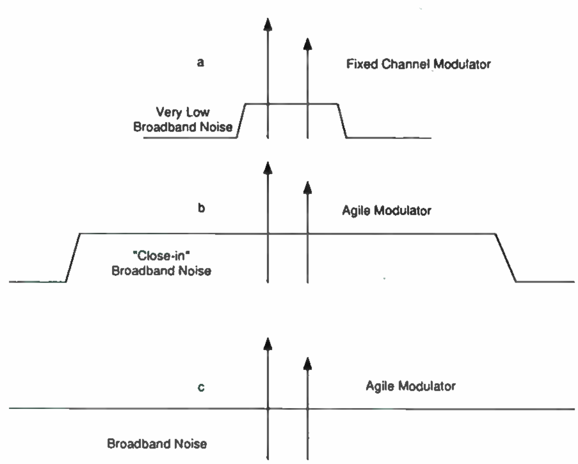
When CATV systems were small, and before agile modulators became popular, this assumption was valid. But because system channel loading has significantly increased from the early days of CATV, and because agile modulators have become more popular in recent years, we all need to understand the implications that this places on the *combined* output C/N of our headend.

Three types of modulators

Over the years, after examining a large number of different modulators, both fixed-channel and agile, I've determined they can be classified into three different categories of broadband noise performance. These three categories are shown, *in simplified form*, in Figure 1.

Figure 1a is a classic example of a fixed-channel modulator's broadband noise floor. Note that its broadband C/N, outside the channel of interest, very quickly approaches a value (greater than 80 dB) which is so high as to be difficult to measure—even with a very good spectrum analyzer. The unit's in-channel C/N performance, on the other hand, might typically range anywhere from 60 dB to greater than 70 dB. Note, for example, that if such a modulator with a 65 dB "in-channel" C/N is used in a headend, then, conservatively, more than 200 modulators could theoretically be combined before the output C/N of the combined headend would degrade below 55 dB.

Figure 1b shows a broadband noise characteristic that you might see in an agile modulator. In this case, the broadband noise floor is shown to exhibit a stairstep function such that its "close-in" C/N at frequencies relatively close to the assigned channel of operation is roughly equal to its "in-channel" C/N, and remains at this level until reaching certain frequencies that are somewhat removed from the modulator's output channel assignment. This is usually accomplished in the modulator's output section through the use of switchable filter networks that will automatically "kick-in" over a range of channels in order to minimize the broadband noise contribution from each modulator.



Not practical

For agile modulators, it's simply not practical to develop an automatically switched filter for each and every channel that would provide it with the characteristic noise floor of a fixed-channel modulator (Figure 1a). Therefore, broadband filters are sometimes developed to cover a range of channels and to offer a compromise solution. Note that the combined C/N for a headend filled with such modulators is dependent upon the bandwidth of the filters. In any event, it will be worse than the combined C/N of a headend full of correctly designed fixed-channel modulators, but will be quite an improvement in comparison with a headend full of modulators exhibiting the broadband noise floor shown in Figure 1c.

If, for example, the "close-in" noise pedestal of Figure 1b were approximately ±24 MHz (roughly ±4 channels), then with an in-channel and close-in C/N of 65 dB, and a broadband C/N of greater than 80 dB, then about 40 modulators could be combined in a headend before the output C/N of the combined headend would degrade to a point below 55 dB.

Squeezing out better numbers

The most often observed agile modulator noise floor characteristic is shown in Figure 1c. Here, the "in-channel" and broadband C/N are identical. There is no attempt within the modulator itself to improve its broadband noise characteristic. Instead, external filters are sometimes added to minimize the broadband noise contribution of each modulator. For such a modulator, with an in-channel and broadband C/N of 65 dB, only nine modulators could be combined in a headend before the output C/N of the combined headend would degrade to a point below 55 dB—unless some external filters are used.

Note that the future of the CATV business will be dependent upon the successful delivery of high-quality video—including extended or high definition television—to the home. To that end, new distribution architectures that include fiber optics in conjunction with shorter (e.g. less noisy) amplifier cascades will be the norm. We will no longer be able to take headend performance for granted. ■

By Chris Bowick, Engineering Dept. Manager, Scientific-Atlanta

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Reader Service Number 8

FCC grants Cerritos waiver

In a case that seems to have veered out of control, the FCC recently granted a waiver of the telephone company-cable television cross-ownership prohibition to allow the local telephone company to participate in the provision of video programming in Cerritos, Calif.

The participation by General Telephone of Calif. in the local cable system, to the extent that it violated the cross-ownership prohibition, was wholly unnecessary to ensure the provision of cable service in Cerritos or to enable the telephone company to experiment with the use of fiber facilities for the provision of video programming. Yet the FCC bent over backwards to find a legal theory and policy rationale for waiving the rule.

Clear violations

The facts in the Cerritos case are complicated, but the violations of the cross-ownership rule are clear. This is not a case in which the local telephone company (General) was to be the cable franchisee. Rather, the city granted a franchise to Apollo Cablevision, a company in which General had no ownership interest at all. General, however, was to own the transmission facilities to be used by Apollo, leasing a portion of the system's capacity to Apollo and reserving some capacity for its own use in "experimenting" with the provision of broadband services.

The cross-ownership rule does not prohibit telephone companies from providing transmission facilities on a common carrier basis to cable operators. But there were two unique elements of the Cerritos leaseback that ran afoul of the rule.

First, the telephone company contracted with an outside construction company to build the facilities, and that company, T.L. Robak, just happened to be the parent company of Apollo. This contractual relationship between the phone company and the cable operator's parent—as well as a $750,000 advance payment by the telephone company to the construction company, which, in effect, made the phone company a financier of the cable company—constituted a prohibited degree of affiliation.

Second, the telephone company intended to use the capacity that it reserved to itself to provide experimental "video-on-demand" service directly to consumers. In this respect, the telco would have directly been engaged in video programming.

These violations of the rules could both have been easily cured. The telephone company could readily have found someone other than Robak to build the facility. And it could have leased capacity to an independent programmer to be the provider of video-on-demand services to consumers. Indeed, the phone company conceded that it could have used an independent programmer for this purpose.

Its apparent unwillingness to find another construction company, on the other hand, suggests that the contractual relationship with Robak was, indeed, simply an indirect way of financing Apollo and subsidizing what would otherwise be an uneconomical cable system.

When NCTA and the California Cable Television Association pointed out these violations of the rules and their anticompetitive potential, the FCC's Common Carrier Bureau agreed that the proposal violated the cross-ownership prohibition. But the Bureau decided the rules should be waived, not just to allow the construction contract but to allow General to provide video-on-demand directly to subscribers.

The Cable Act provides two grounds on which the FCC can waive the cross-ownership rule. It can waive the rule in circumstances where cable service demonstrably could not otherwise exist. And, it can waive the rule for "other good cause."

The Common Carrier Bureau relied on the former, finding that the specific system that the City of Cerritos preferred could only have been provided by the Apollo-General proposal, and that, therefore, cable service, as defined by the city, demonstrably could not exist absent a waiver.

The wrong decision

There were, of course, a multitude of reasons why the Bureau's decision was wrong, both legally and factually. For example, the Cable Act doesn't provide for waivers whenever the system chosen by the city requires telephone company ownership or affiliation.

Moreover, it wasn't even clear that the very same system couldn't have been provided by Apollo, or by someone else, without the illicit construction contract and without direct provision of video-on-demand by the telephone company.

NCTA and CCTA pointed out these and other errors to the FCC in seeking review of the Bureau's decision. The FCC essentially acknowledged that the Bureau's reasoning could not be sustained but decided that there was "other good cause" for granting the waiver. It found that the Apollo-General system would be a useful experiment in the provision of video programming services over telco facilities.

In an effort to narrow the sweeping nature of its waiver, the FCC said that the waiver was intended as a limited five-year experiment with telco provision of cable television. And it required General to contract with an independent programmer—though not necessarily on a common carrier basis—to provide its "video-on-demand" experiment.

Thus, it's unlikely that the FCC can extricate itself from the Cerritos can of worms by labeling it a necessary experiment in cable-telco cross-ownership—the very sort of cross-ownership prohibited by the Cable Act. On the other hand, if the FCC truly views its waiver in Cerritos as a necessary five-year experiment, it would seem to follow that the FCC must wait until the conclusion of that experiment before concluding its separate inquiry into whether or not to recommend repeal of the cross-ownership prohibition. ■

By Michael Schooler, Deputy General Counsel, NCTA

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Reader Service Number 9

Engineering of the other network

A cable television system is a relatively straightforward network. The component parts are simple, but the resulting network can be quite complex.

A cable system is composed, of course, mostly of coaxial cable. Because we employ a tree-and-branch architecture, our goal is to split our coaxial transmission path again and again, until we deliver our broadband RF signal to every subscriber's television set. Along the way, we incur substantial signal loss in the coaxial cable, so we must provide amplification.

To make up for cable loss, we have gain blocks, or amplifiers. To make up for the fact that the loss is greater at higher frequencies than low, we have passive equalizers, and at our various power splits we have directional couplers. On the coaxial cable, we carry 60 volts AC in order to power the amplifiers, and all of this is laid out in a trunk-and-feeder, tree-and-branch configuration. When run throughout a community, this comprises a complex network.

The cascades of many amplifiers in series requires attention to fairly subtle variations in frequency response and impedence match. The amplifiers are sometimes subject to parasitic oscillations, and intermittent connections can throw the entire network into a state of havoc. While we have more work to do, we have managed to master this kind of network to the point where we can effectively operate it as the basis for our business.

By Jim Chiddix, Sr. Vice President, Technology and Engineering, ATC

Cable a small part of the picture

Experienced cable engineers have a fairly good mental picture of what's going on in their network and how the various elements work together to deliver signals of a given quality to our customers. We sometimes forget, however, that our systems exist in the context of a much larger, and in many ways, far more complex, network. That is the unseen electrical world comprised of the electrical utility network and the electrostatic system of the earth and its atmosphere.

The community-wide electrical system is a world which we never model, and usually only vaguely understand. Yet our own system is interconnected with it at thousands of points, and some of our most mysterious and disruptive reliability problems are a direct product of our being an almost unconscious part of this other network.

The electrical environment within which our systems must live is a shadowy world of lightning surges and static discharge; of electrical substation switching transients and phase-to-phase load imbalances causing current to flow through neutral conductors and ground paths. It's a world of large induction motors for pumps and factory machinery being switched on and off, creating momentary shorts and dramatic phase changes. It is a world that engineers for power companies have long dealt with, adding capacitor banks and redistributing loads when needed. They understand the electrical environment well enough to make their networks work very well. Unfortunately, we get included as an afterthought.

Safety, not performance, is key

Traditionally, the cable industry has attempted to design its interconnection with the electrical network around it by following the dictates of the National Electric Safety Code and the National Electric Code, in addition to stipulations which may appear in pole attachment agreements with electric utilities and telephone commpanies. It's all too easy to forget that those rules are established with no regard to the reliability of our cable systems; rather, they are intended to provide a degree of safety for our employees and others who must work near our plant by preventing excessive differences in voltage potential between conductors. That is exceedingly important—the safety of our plant and the working conditions we provide must not be compromised.

Limiting voltage potential differences, however, does little to ensure the reliability of our plant. Indeed, many of the grounding and bonding measures which we use to control voltage hazards actually encourage currents to flow through our plant as those voltage differences are equalized. It is excessive current, not voltage differences, which create problems for us.

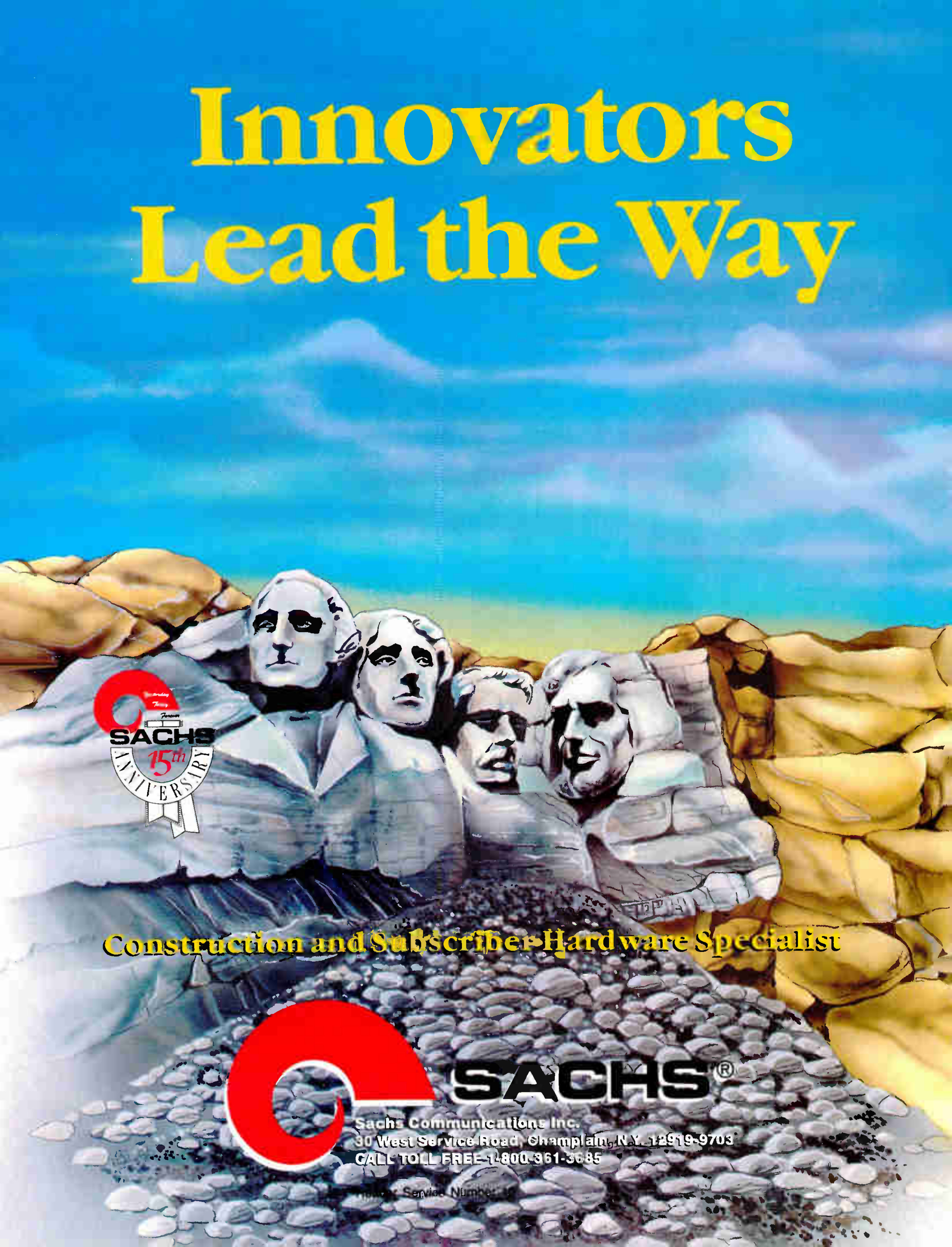
Every cable engineer with operating system experience has had particular plant locations where fuses kept blowing and amplifiers kept failing. A variety of techniques are used to deal with these situations. We often experiment with different grounding schemes near locations that eat amplifers.

But as an industry, we haven't spent nearly enough time understanding the electrical network of which we form a part, and engineering our systems so that our interaction with that network will threaten neither our employees nor the reliability of the service we provide to customers.

Rethinking may provide answers

Austin Coryell of ATC recently undertook some experiments in some of our Florida systems. These systems, with their extreme weather and sandy, barely conductive soil, provide an extreme example of electrical problems our networks can develop. Mr. Coryell found that rethinking grounding and bonding locations in order to reduce the impact of current spikes on our system, and measuring and reducing the resistance of earth grounds, yielded truly spectacular results in terms of the number of outages incurred.

It is only a start, however. Cable engineers, and those designing and building our systems, must gain a greater understanding of the electrical world we live in, and techniques to minimize the damage it can do to us. There is room here for much further work and exploration, but the potential benefit to our customers and operating expenses make pursuing this subject well worth the effort. ■



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Taking a look at the SmartHouse

The April meeting of the NCTA Engineering Committee was preceded by a tour of the Smart House laboratory in Maryland. Attendees were shown the progress that has been made in the development of prototype communications systems which are to be included in the Smart House home of the near future. Demonstration homes are presently being built which will incorporate mass terminated distribution bundles of power, communication and gas services. The development of the cable portion of the home has been done with little industry input, resulting in a number of practicality concerns being expressed by the attendees.

The first item of business for the main committee was a review of the status of MultiPort. Two manufacturers now have decoders available in small quantities and these are being distributed to cable operators. One TV set manufacturer has offered to make available names and addresses of persons purchasing sets which are MultiPort equipped. A problem currently exists in obtaining supplies of the interconnect cable.

The MultiPort appears to be an excellent solution to the customer friendly problem. While it will take a number of years for the sets and decoders to be deployed throughout the industry, operators should begin to now stock the units so they can respond to customer requests for the decoders.

Field tests of the Eidak copy protection system for PPV movies have begun in one city. Three studios are providing the same day release as video stores for copy protected movies. So far, only minor changes have been necessary to the equipment. Movie studios appear to be moving toward accepting the idea of same day release for copy protected movies.

Washington update

The NCTA board has voted to not appeal the syndicated exclusivity ruling. The implementation date is now January 1990. The major impact will probably be on distant terrestrial broadcasters who are dropped because too many shows must be deleted.

Advanced television continues to occupy more of everybody's time as additional government committees are holding hearings on the potential impact of advanced TV. The FCC is under pressure to freeze UHF spectrum allocations until the needs of advanced TV are determined.

Cable Labs has agreed to fund the development of test procedures for cable and fiber optic tests. In addition, it will consider funding the "fair share" of tests that apply to cable. The test procedure may include "gateway" tests with specifications which must be met in order to continue to the next series of tests.

Cable Labs continues to hire staff and begin serious work on various issues. The Boulder temporary office is being set up and proposals for a permanent location are being reviewed. Richard Green, president and CEO, expects to have most of the initial staffing complete by the end of September. The fiber optic study is almost completed.

Part 15 rewrite complete

The text of the Part 15 rewrite has been released, but the total impact on the cable industry has not been determined. Some bands have been assigned for low power, in-home transmission of TV signals so devices like a cordless "Rabbit" will soon become available.

Alex Best reported that a review of the multichannel sound test procedure had resulted in the suggestion that some of the tests be performed with the companding system disabled. This will help determine whether a problem is in the compander, the encoder or the decoder.

Nick Hamilton-Piercy reported that the Mertz echo tolerance curve had been re-examined using current procedure TV sets. A report of the findings will be given at the convention. A meeting of the Advanced Television Testing Center (ATTC) and Cable Labs resulted in a tentative agreement to work toward co-operation in testing proponent systems. Cable Labs will provide a cable simulator and perform the cable portions of the tests. The Canadian Communications Research Council has offered to conduct the subjective portion of the ATV tests.

The NHK Muse system was transmitted from the HBO uplink on Long Island, and received at two cable headends near Washington, D.C. The signal was converted to amplitude modulation, vestigial sideband and transported through 28 amplifiers on each system and then observed. In both instances the signal quality was very good. The tests indicate that high definition signals can be transported over cable and delivered on existing systems that are well designed and maintained.

Henry Cicconi reported that the FCC is reviewing its position of where cable systems can be split for the purposes of CLI reports.

ATSC reorganizing

Judd Hoffman reported that the ATSC was in the midst of reorganizing under two technology groups: distribution and production. Task forces are being set up to address the various issues. A new chairman, James McKinney, had been selected.

The EIA Consumer Electronics Bus committee had a target date of November to complete its specification for CEBus and submit it to the EIA for approval as an interim standard. There has been no change in strategy for the coaxial bus. New manufacturers are continuing to ask to be involved on the committee.

Both the National Electrical Code and National Electrical Safety Codes are going through final review prior to release of the next editions. There is still no requirement for manufacturers to install a ground lug on power meter bases. This is becoming more important as some municipalities are not allowing grounds to be attached to municipal water supply lines for fear of injury to an employee working on the water line.

The meeting was concluded with a talk by John Sie of TCI on processed digital HDTV. He recommended that NTSC be improved and no HDTV transmission system be adopted unless it can fit within a 6 MHz channel. There was general agreement that NTSC should be improved where possible. However, there was little agreement that true HDTV could be compressed into 6 MHz in the near term and, therefore, wider bandwidths should be considered. If other, competing media can deliver HDTV to the home then the cable industry must be prepared to deliver similar quality signals.

The next meeting will be held in Orlando, Fla., June 14, 1989, before the SCTE Engineering Conference. ■

By Brian James, Director of Engineering, NCTA

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Reader Service Number 11

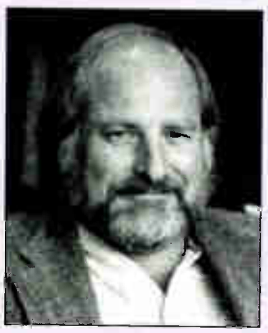
After 20 years, goal is still the same

What a long, strange trip it's been."

Although those words were originally written for a dramatically different purpose, they're certainly appropriate when describing the two decades the SCTE has been in existence.

Through a roller-coaster ride of good times, then bad, then good again, the Society has grown—and flourished, with innovative programs and ways to train front-line industry personnel. Through 20 years, nine different presidents and two executive directors, the organization still is, amazingly, quite similar to what it started out to be.

WHERE IS HE NOW?



Name: Ron Cotten
SCTE President: 1969-1970
Presently vice president of engineering for United Artists Cablesystems, headquartered in Denver, Colo., Ron continues to be active in the SCTE, having most recently sat on the scholarship committee.
Message: "I think participation in an organization such as the SCTE is important both for personal growth and for the industry. I think we ought to support it, especially because of the training opportunities it provides."

Ironic twist

It is perhaps ironic that the SCTE, a society which has become so important to the cable and *video* worlds, was actually started through the impetus of the *printed* word. Back in 1968, Chuck Tepfer, who at that time published *Cablecasting* magazine, wrote an editorial suggesting that CATV technical personnel should be recognized for the contributions they bring to the industry. Tepfer's piece prompted William Karnes of National Trans-Video to write a letter acknowledging the idea. Tepfer then took it one step further and actually published an application for membership in the Society of Cable Television Engineers.

True organization came to fruition during the 1969 National Cable Television Association's annual convention in San Francisco. Seventy-nine charter members of the SCTE, including such pioneers as Rick Clevenger, Earl Quam, Larry Roeshot, Robert Veness, Paul Rowan, Dick Ashpol, Israel "Sruki" Switzer, Garth Pither and Cliff Beyersdoerfer, met. The members elected Ron Cotten, who at that time worked for Concord Cable TV, as the Society's first president. Karnes was chosen as vice president and Tepfer was named secretary/treasurer. The others mentioned above became the Society's first Board of Directors.

During that meeting, temporary bylaws were presented and approved and the U.S. and Canada were carved up geographically in order to establish regional chapter locations. Spirit and enthusiasm had indeed accomplished plenty in just one meeting.

Was this a union?

It wasn't long before the organization was met with considerable resistance from various management factions, however. The perception was that the SCTE was formed as a method to unionize the technical personnel, recalls Cotten.

In fact, nothing could have been further from the truth. The Society had been formed because the idea of a forum for the free exchange of ideas, knowledge and support was attractive to the technicians. "Back then, you learned (about RF technology) as you went along," says Cotten. "To be good in this industry, you had to sometimes be an inventor because there wasn't the amount of knowledge about RF technology that there is today. Everyone—including the manufacturers—was struggling to learn how it all worked. That's what was fun about it."

Despite the fact there was no strong central management team or national headquarters, the all-volunteer organization flourished in the early days. "The spirit of creativity and enthusiasm couldn't be held back," Cotten says, "we were all pioneering."

Although Cotten's tenure didn't last long, he can be properly credited with getting the Society out of the starting gate and encouraging local chapters to keep the momentum going. "It was one of those things where it took a person to get the ball rolling. I was just one of a core of about 30 people who literally got it all off the ground."

Focus on knowledge sharing

SCTE was originally conceived to be

WHERE IS HE NOW?

Name: William Karnes
SCTE President: 1971-1973
Currently dividing his time between consulting activities and doing some cable equipment repair, Karnes plans to sell off his repair business to another entity.
Message: "I'd like to think my contribution was to serve as one of the original providers of ideas concerning the SCTE. I offered an early impetus to getting it off the ground."

like the Society of Broadcast Engineers, according to Karnes, who sat as SCTE president from 1971 to 1973. The entire organization was based on local meetings where local technicians could talk and share ideas. It's a concept that's still held today.

"The idea was to hold local meetings so the technical guys could get together and talk," says Karnes. "It also gave the industry a chance to recognize the contributions that were being made by the technicians."

Despite the early enthusiasm, it wasn't long before the Society reached a "make-or-break" point. While several local chapters were started, some languished and died. Membership seemed to reach a peak and leveled off. There was no budget—no money to promote the Society or recognize the members in any tangible way. Until Robert Bilodeau became president in 1973 and started what turned out to be a six-year tenure in the top spot.

When Bilodeau took over, the Society had 200 members and was administered out of Tepfer's living room. By 1979, when Bilodeau turned the gavel over to Harold Null, the SCTE boasted 2,000 members, had become an incorporated, non-profit educational organization, established a national headquarters and was administered by a paid, professional staff.

"I worked hard at growing the organization and increasing its credibility within the industry," says Bilodeau, who is credited by many as the one who took the Society from infancy into adolescence.

Society took off

And grow it did. A relationship with the National Ca-

Milestones

1969: First SCTE meeting is held during NCTA Convention in San Francisco; 79 organizing members attend. Ron Cotten of Concord Cable TV is elected first president.

1971: William Karnes is elected president of SCTE, succeeding Cotten.

1973: Robert Bilodeau is elected president of SCTE, succeeding Karnes.

1974: LRC Electronics becomes the first sustaining member of SCTE.

1975: SCTE's monthly newsletter, *The Interval*, is published for the first time.

1976: SCTE holds its first National Engineering Conference.

1977: SCTE opens its first full-time office in Washington, D.C. and hires its first paid employees.

1978: First membership directory is published and distributed to the Society's 1,000 active members.

1979: Harold Null is elected president of SCTE, succeeding Bilodeau.

1980: Lawrence Dolan is elected president of SCTE, succeeding Null.

1981: Thomas Polis is elected president of SCTE, succeeding Dolan.

1983: First Cable-Tec Expo is held in Dallas in May. National headquarters moves to Communications Construction Group offices in Philadelphia area. Financial hard times hit Society.

1984: James Emerson is elected president of SCTE, succeeding Polis. Satellite Tele-Seminar program is launched. William Riker is hired as executive vice president.

1985: Thomas Polis is re-elected as president of SCTE, succeeding Emerson. Broadband Communications Technician and Engineer (BCT/E) certification program is introduced at Cable-Tec Expo. Technical Tuition Assistance Program is created to provide scholarship opportunities for NCTI courses to the membership. SCTE National headquarters moves into separate facility in Exton, Pa.

1986: Robert Luff is elected president of SCTE, succeeding Polis. Number of SCTE chapters and meeting groups reaches 30, doubling the number from one year before.

1987: SCTE purchases its own office space, setting up the national headquarters in Exton, Pa. Ron Hranac of Jones Intercable becomes the first certified technician and Les Read of Sammons Communications becomes the first certified engineer.

1988: Ron Hranac is elected president of SCTE, succeeding Luff. An SCTE Hall of Fame is created and Cliff Paul is the first inductee. More than 1,300 technicians and engineers attend the Cable-Tec Expo in San Francisco. Group life insurance is offered to the members.

1989: National membership totals 5,000 for the first time.

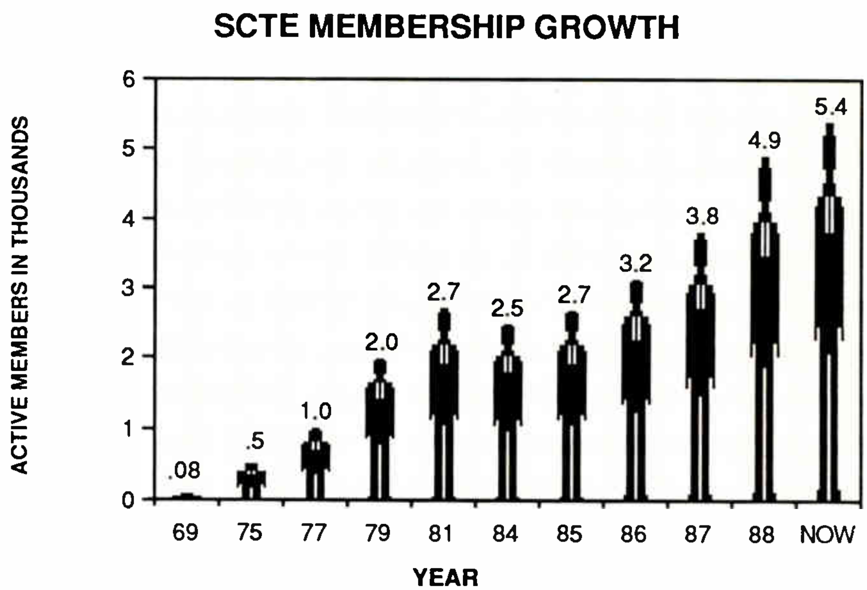
WHERE IS HE NOW?

Name: Robert Bilodeau

SCTE President: 1973-1979

Bilodeau is presently president of 360 Corp., a small MSO with about 45,000 subscribers. He is not currently active in the SCTE.

Message: "Hang in there, you're doing great."



ble Television Association resulted in the SCTE sponsoring technical seminars at convention sites, annual technical and engineering conferences were begun and *Communications Engineering Digest*, a technical publication, was started.

Although he was the spark, Bilodeau certainly had help. In the mid-'70s, he hired Judy Baer as the Society's first executive director and opened a national headquarters in Washington, D.C. Baer came to Bilodeau's attention during her work with the FCC's Cable Television Advisory Committee (a temporary body that was established and charged with the task of advising the FCC on cable television technical standards). "I tried to the give the Society formality and structure and, as part of that, I felt a paid office staff and help was essential," says Bilodeau.

Other highlights of Bilodeau's tenure included: the establishment of *The Interval* newsletter as the Society's monthly voice; the start of a membership awards program; bylaws were altered to establish Senior and Student memberships; and affiliation with a new society within the IEEE (which later dissolved).

The entrance of the '80s saw the helm of the Society being passed from Bilodeau to Null to Lawrence Dolan, who spent much of his time overseeing the establishment of local chapters. "It was a very exciting time technically," recalls Dolan. "It seemed like every six months bandwidth (limits) changed. Every time we had a meeting, the rules changed."

WHERE IS HE NOW?

Name: Harold Null
SCTE President: 1979-1980
Mr. Null is presently employed by Valco Inc. of Dallas.

A sense of business

Dolan recalls his year in office and four years of Board service fondly. "I think the thing I enjoyed the most was the fact that I met so many people. And I'd like to think I helped bring a business sense to the organization."

As the Society continued to grow in size and expertise, new programs were developed to enhance the Society's prestige and credibility with other professionals. After Tom Polis became president in 1981, the initial meeting to establish BCT/E (Broadband Communications Technician/Engineer) certification guidelines were held. Sixty people came to a two-day meeting, where eight committees were established to oversee the various categories. Although the program was not actually introduced to the membership until 1985, the groundwork had been laid.

The following year, table-top exhibits began appearing at the National Engineering Conference in Boston. And, in 1983, the first Cable-Tec Expo was held in Dallas in May. John Kurpinski had put forth considerable effort to establish new chapters and meeting groups. It was a heady time and optimism permeated the air.

Loose ends everywhere

Shortly after that first Expo, however, the organization began to unravel. Baer resigned her position with the SCTE and took her possessions (which amounted to just about everything the SCTE had in its headquarters) with her. Suddenly, the Society was without a home, a staff and

WHERE IS HE NOW?

Name: Lawrence Dolan
SCTE President: 1980-1981

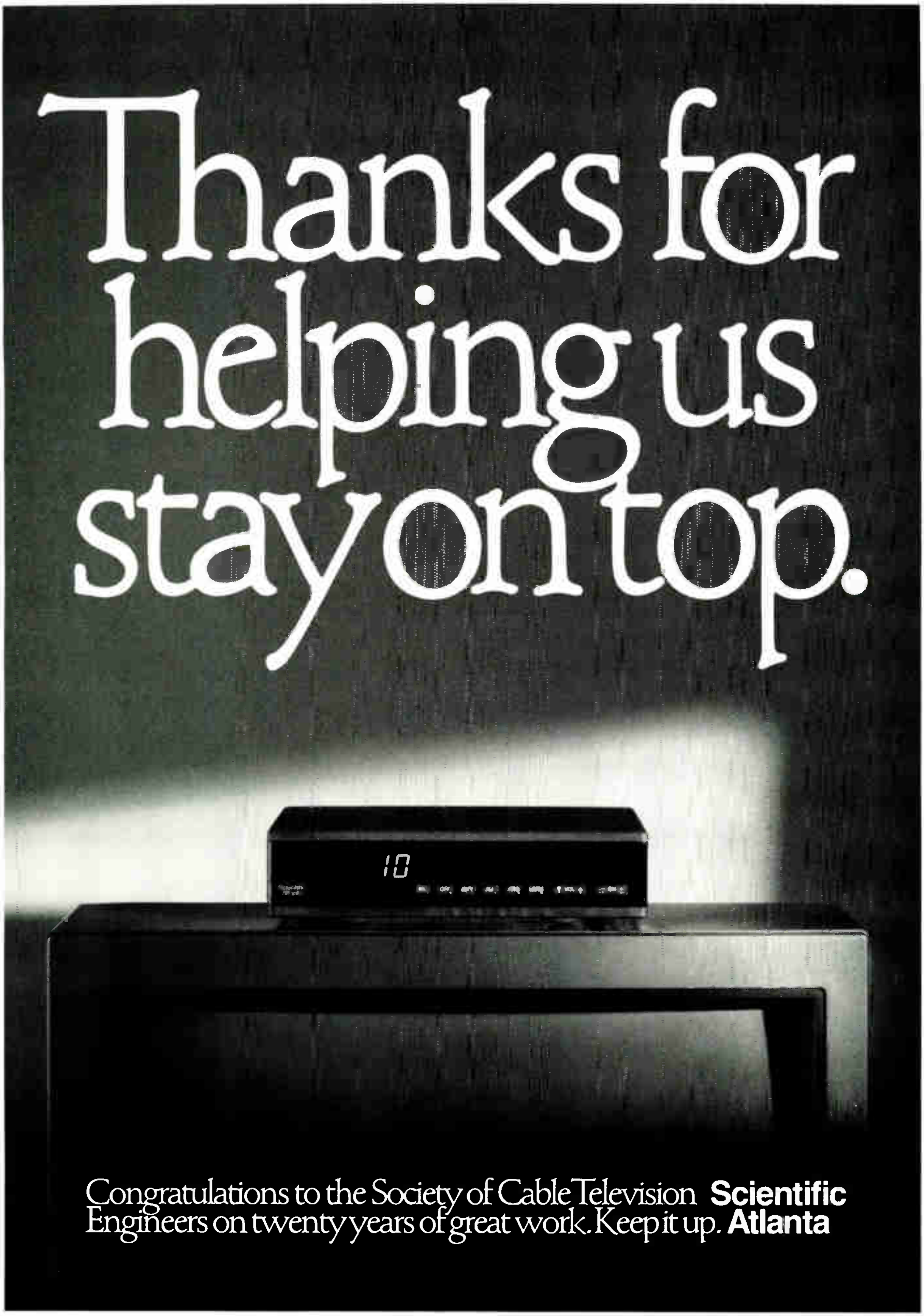
Presently employed by Wavetek Corp. and based in San Diego, Dolan is vice president of sales and marketing. In addition, he is acting general manager of the Indiana facility.

WHERE IS HE NOW?

Name: Thomas Polis
SCTE President: 1981-1984; 1985-1986

Polis is presently executive vice president at Communications Construction Group Inc., a turnkey CATV construction and design organization.

Message: "The true strength of the organization lies in its membership. The members who stuck with the organization speaks well for it. The Society could never have flourished without the members—even during the dark times, you could call on the members and get the support you needed."


Thanks for helping us stay on top.
Congratulations to the Society of Cable Television Engineers on twenty years of great work. Keep it up.
Scientific Atlanta

resources.

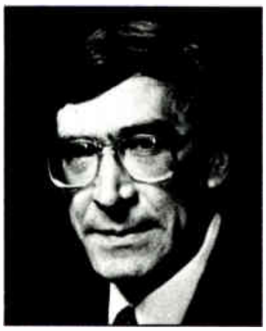
Polis, as a principal with CCG (Communications Construction Group), continued to administer the organization out of his company's offices in the Philadelphia area. He called on CCG personnel (most notably Teddie Zentz) and members of his Board to make phone calls, do mailings, handle membership receipts and put on the 1984 Expo in Nashville. It was, in general, a chaotic time.

Polis reacted to the circumstances without panic. He was now spending as much as 30 percent of his time with SCTE-related business. He traveled to the local chapters to deliver pep talks and remind the members that the organization's strength relied on their support. He acted as liaison between the SCTE and the NCTA. "In general, I tried to keep a lid on the whole thing," Polis says.

But it was clear Polis couldn't do it all alone. Steven Cox was named acting executive director, a position he held for six months (and during the Nashville Expo). The first satellite tele-seminars were produced and distributed over a satellite transponder provided by HBO. Then, in late 1984, William Riker was brought in as the new full-time executive director by then-president James Emerson.

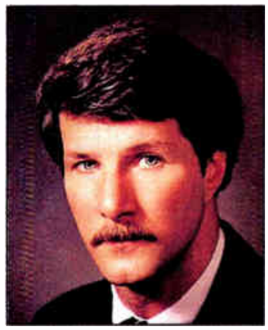
With Riker came new stability. In 1985, rented space in Exton, Pa. was located and the Society again had a separate headquarters facility. Riker came in "and really ran with the ball," says Polis. He "put the SCTE back on

WHERE IS HE NOW?



Name: James Emerson
SCTE President: 1984-1985
Mr. Emerson presently operates out of Sarasota, Fla. where he does some technical marketing consulting and some local area network contracting. He remains active in CATV, having contributed to the white paper on Cable Labs.

WHERE IS HE NOW?



Name: Robert Luff
SCTE President: 1986-1988
Still very much active, Mr. Luff is vice president of engineering and technology at Jones Intercable. He most recently made news by announcing the Cable Area Network concept of fiber optic delivery of CATV signals.
Message: "The next 5 years will probably see more change and challenge than we've seen in the first 20 years. We'll need the membership's support and participation even more in these transition years."

the road to recovery."

Despite the hard times he experienced, Polis recalls Baer as a valuable asset. "A lot of programs that are in place today were her brainstorms," Polis says. "She deserves a lot of credit for her contributions. She did quite a bit" to enhance the Society.

As for himself, Polis would like to be remembered as the glue which held the whole thing together. "My biggest contribution was holding the ends of the strings together. I tried to provide continuity in times of turmoil."

In 1985, the BCT/E Certification Program made its debut at the Expo in Washington, D.C. Also, the Technical Tuition Assistance Program was created to provide the membership with tuition assistance for NCTI courses. And the Society kept growing. In 1986, the number of chapters and meeting groups topped 30, doubling the number from the year prior.

After Polis' tenure, Robert Luff was elected the Society's president. Luff oversaw the grand opening of the Society's own headquarters building in Exton, Pa. and began the process of creating an installer certification program, which will be launched soon. He also updated the bylaws to tighten accounting and budgeting procedures.

Luff was succeeded by Ron Hranac, the first person to be certified at the technician level, in 1988. During this time, the Society opened a Hall of Fame to recognize individual contributions to the organization. The Expo has become the fourth-largest cable trade show and membership has topped 5,000.

"I'm proud of the organization," says Cotten. It's become a real focal point of training and recognition of excellence in people. It used to have to fight for respect, now it's worthy of it. Maybe the climate has been right in the last few years, but the people in charge deserve a lot of credit for moving the SCTE forward.

"Personally, what I like most is that the organization hasn't lost its focus—which is on the guys in the trenches," Cotten adds. "I think that's marvelous. It's a great organization and it's programs *work*."

Maybe that just says it all. ■

—Roger Brown

WHERE IS HE NOW?

Name: Ron Hranac
SCTE President: 1988-present
Mr. Hranac is currently employed by Jones Intercable of Englewood, Colo., where he is senior staff engineer. He, of course, is very active in the SCTE, serving on several committees.
Message: "It has been a genuine pleasure to serve at the helm of the cable industry's leading technical organization. The incredible growth of the Society is fueled by its three major goals: technical training and education, certification and recommended practices. These goals will be the cornerstone of making *technical excellence, quality* and *reliability* the buzzwords of cable television."

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Performance advantages of depressed-cladding fiber

There has been considerable discussion, and some confusion, about the relative merits of depressed-cladding single mode fiber and matched-cladding single mode fiber.

The significant distinctions between these two designs, as well as the advantages of depressed-cladding fiber, deserve careful evaluation. Figure 1 shows the schematic refractive index profiles of depressed- and matched-cladding fiber.

Depressed-cladding fiber has a smaller mode field diameter than matched-cladding fibers. This makes depressed fiber much more resistant to added losses in two important ways. First, it reduces *microbending* losses; second, it minimizes losses due to *macrobending* with small loop diameters (i.e., diameters where losses can be high in matched-cladding fibers). Moreover, depressed-cladding fiber is more "robust" with respect to incurring high system power penalties due to modal noise.

Single Mode Fiber Refractive Index Profiles

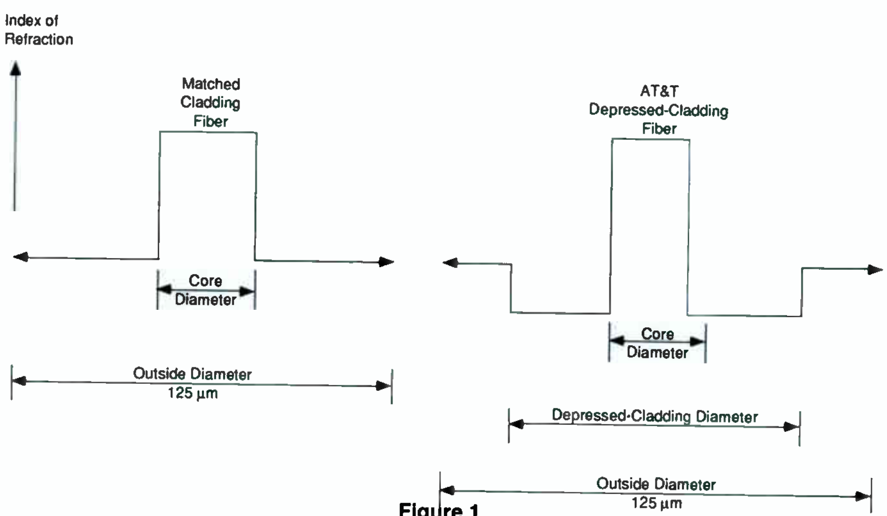

Figure 1

A brief historical overview

AT&T invented and employs the MCVD (Modified Chemical Vapor Deposition) process to make the preforms that are drawn into optical fiber. The MCVD process deposits high purity glass from a vapor on the inside of a high purity silica tube. This tube becomes part of the fiber, but is separated from the optically active part of the fiber by a deposited cladding.

Although this process is suitable for making either depressed-cladding or matched-cladding single mode fiber, AT&T selected the depressed-cladding design in the early 1980s, based on the fact that depressed-cladding fiber can be made with a smaller mode field diameter than matched-cladding fiber, while maintaining the desirable values for all other critical properties such as intrinsic loss, dispersion and cutoff wavelength. The mode field diameter of AT&T fiber is 8.8 microns.

> AT&T invented and employs the MCVD process to make the preforms that are drawn into optical fiber.

The OVD (Outside Vapor Deposition) process, utilized by some manufacturers, deposits high purity glass from a vapor on the outside of a ceramic rod, which is removed before fiber is drawn. The OVD process is not well suited for the manufacture of depressed cladding fibers. Consequently, the fiber produced by those who employ the OVD process has been of the matched-cladding design.

The penalty that is paid with matched-cladding fiber is that all of the important light-guiding properties cannot be optimized to the same extent as with depressed-cladding fiber. The compromise that the designers of matched-cladding fiber have been forced to accept is a larger mode field diameter. The first OVD matched-cladding fiber to be widely deployed had a 10.0-micron mode size.

A 9.5-micron mode version was subsequently developed to partially compensate for the deficiencies of the 10.0-micron design. A 9.5-micron mode size seems to be about the limit to which the mode field diameter of matched-cladding fiber can be lowered without an unacceptable compromise in other properties.

Benefits of depressed-cladding fiber

The characteristic properties of depressed-cladding fiber make it the preferred choice for many applications. In cable manufacturing, both depressed-cladding and matched-cladding fibers meet most end-user specifications. However, the depressed-cladding fiber provides a substantial advantage in cable design and manufacturing due to its superior resistance to microbending losses.

Similarly, for a telecommunications carrier or CATV carrier installing a fiber optic cable system, both depressed-cladding and matched-cladding fibers will satisfy end-to-end spliced cable transmission requirements; however, the depressed-cladding fiber is superior in that it can withstand many unusual, and often, unforeseen, field environmental conditions. Evaluated in this context, installation of depressed-

By David Kalish, Supervisor, Lightguide Systems and Application Engineering, AT&T Bell Laboratories


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cladding fiber may be considered added insurance against: 1) additional *microbending* losses due to severe handling or environmental conditions; 2) added *macrobending* losses due to kinks in installed cable or small bends that might inadvertently be found in equipment bays, devices, closures, terminals or pedestals; and 3) excessive modal noise power penalties.

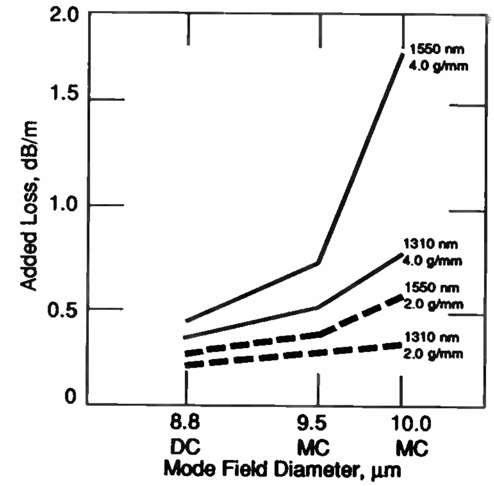
The critical issue for a customer, whether a cable manufacturer, a telecommunications provider, or a CATV provider, is simply which fiber design provides the most benefits. The preform manufacturing process, MCVD or OVD, is transparent in the use of fiber or cable. The preform process is only of interest in that it determines which fiber design a fiber manufacturer is free or forced to select.

Demonstrated strength

The MCVD process is capable of producing long lengths

Figure 2

EIA Sandpaper Test FOTP-68



Pin Array Test

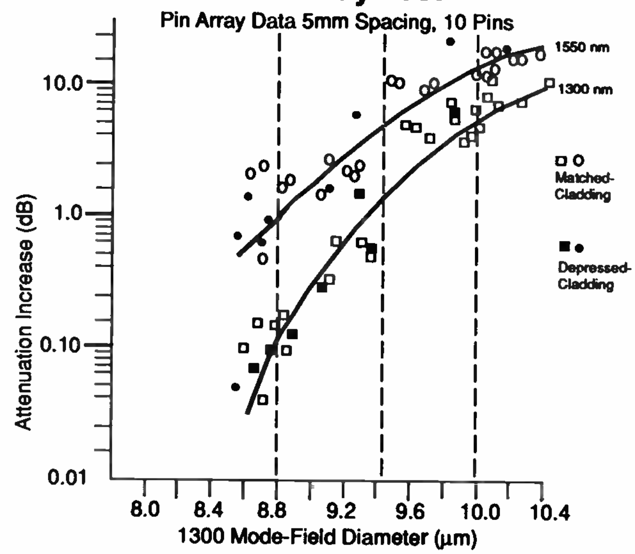


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Figure 3

Microbending Loss Due to Tension Winding

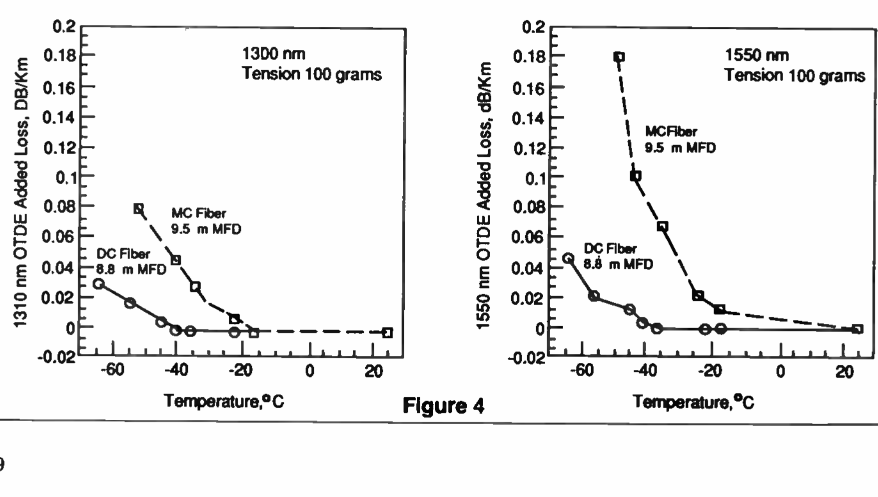

Figure 4

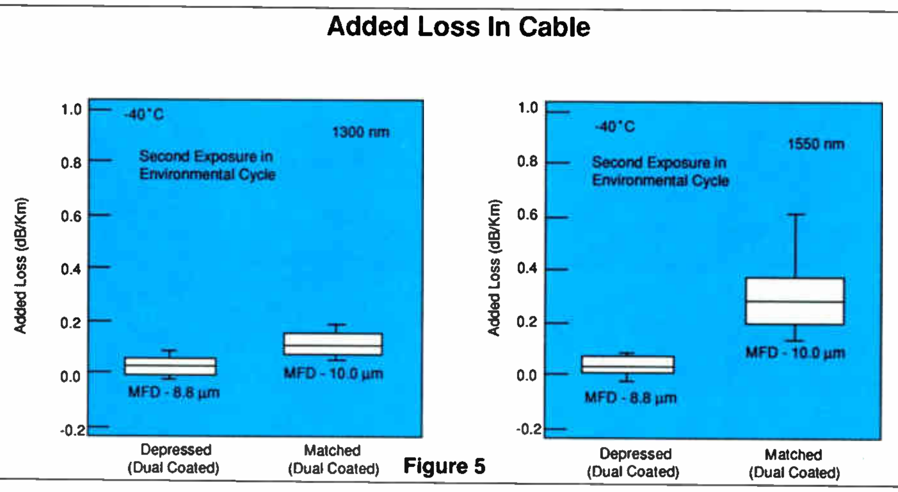

Figure 5

of proof tested fiber which satisfy the most stringent customer requirements. The short-length strength of AT&T fiber tends to be about 800 kpsi, much higher than the proof test value. The TAT-8 transatlantic lightguide cable recently installed, and cables now in production to span the Pacific Ocean, contain AT&T fibers proof tested to 200 kpsi, with splices proof tested to 300 kpsi.

Any suggestion that MCVD fiber cannot be made to high strength is obviously incorrect. The truth of the matter is that both MCVD and OVD processes require extensive quality control of materials, the manufacturing environment, and glass handling to ensure the mechanical reliability of the fiber.

Microbending performance

Microbends are difficult to visualize. They are local deflections of the fiber axis, with amplitudes much less than the fiber diameter, and at spacings on the order of the fiber diameter. Microbends can arise from very small variations in the fiber, coating, or cable dimensions, from cable deformation during plowing or pulling into ducts, or from cable materials contracting and expanding during seasonal changes in temperature. Telecommunications carriers, for instance, encounter microbending-induced losses in the field when they observe a uniform increase in loss over the length of installed cables compared to loss values when shipped.

When microbends are present, the increase in loss will typically be higher at 1550 nm than at 1310 nm by a factor of 3-to-5. All cable designers and manufacturers are familiar with microbending induced losses, and they select materials, designs and procedures in order to avoid or minimize them.

Microbends: a critical difference

A small numerical difference in the mode field diameter can translate into a large numerical difference in resistance to microbending loss. Consequently, the difference between 8.8 microns (for depressed-cladding fiber) and 9.5 or 10.0 microns (for matched-cladding fiber) is quite significant.

A number of tests have been used to demonstrate microbending induced losses in fibers. Figure 2 shows the results of a sandpaper test, per EIA FOTP-68, where fiber is sandwiched between two sheets of sandpaper and the papers are pressed together with a controlled load to cause microbends. Figure 3 reflects results of a pin array test which is reported to stimulate microbending effects in cables. The fiber is wound through an array of closely spaced, small diameter pins. Figures 2 and 3 show that microbending losses increase rapidly as the mode field diameter is increased from 8.8 to 9.5 to 10.0 microns.

Figure 4 shows the combined efforts of tension and lowered temperatures on microbending. Fibers are wound on spools with about 100 grams of tension. This does not produce added loss at 23 degrees Centigrade; however, added microbending loss is observed as the temperature is lowered. The 8.8-micron mode field diameter of AT&T depressed-cladding fiber is clearly superior to the 9.5-micron mode field diameter of the matched-cladding fiber.

Similarly, Figure 5 shows the results of putting 8.8-micron mode field diameter depressed-cladding fiber and 10.0-micron mode field diameter depressed-cladding fiber and 10.0-micron mode field diameter matched-cladding fiber

in a cable that was temperature cycled according to standard procedures, with a low temperature exposure of -40 degrees Centigrade following a +65-degree Centigrade cycle. The box plot shows the median line; the bounds of the box are the 25 and 75 percentile, and the brackets are the zero and 100 percentile. The 10.0-micron mode field diameter fiber has more added loss and more scatter in the added loss than the 8.8-micron mode field diameter fiber; a 9.5-micron mode field diameter fiber can reasonably be expected to fall in between these two behaviors based on the trends in Figures 2 to 4.

The "depressed" and the "matched" features of single mode fibers, in themselves, are not the controlling factors in the results of Figures 2 through 5. The critical point is that the depressed-cladding feature allows a practical fiber with a smaller mode field diameter. This, in turn, gives the depressed-cladding fiber the microbending advantage over matched-cladding fiber.

Macrobends and depressed-cladding

Simply stated, macrobends are loops in the fiber with a radius of curvature of several millimeters or more. Such loops or bends are typically found when excess length of fiber is stored in closures, terminals or pedestals. Curved fibers may also be found where fibers are terminated or interconnected on equipment bays or on optoelectronic packages.

High macrobend losses are typically avoided with both depressed-cladding and matched-cladding fiber by specifying bend radius limitations for installation. However, these specifications are not always adhered to in the field. Unforeseen conditions such as cable kinks in difficult installations can lead to high macrobending loss. To complicate the problem of macrobends, such losses are extremely wavelength sensitive. A fiber could be transmitting at 1310 nm but could be dark at 1550 nm. A single turn or kink could cause a significant increase in loss, depending on the radius of curvature.

In evaluating the behavior of both depressed-cladding and matched-cladding fiber, it should be noted that there is excellent agreement between calculated and measured added losses. Figure 6 shows that depressed-cladding fiber has much less added loss per loop for diameters up to about two inches than the common matched-cladding fiber, while the matched-cladding fiber has less added loss at bend diameters of about two inches or greater.

It is important to note, however, that below two-inch diameters, the loss per loop is large, with a single loop often adding a critical amount of loss. In contrast, loops with diameters larger than two inches result in only negligible loss, and even multiple loops do not add significant loss.

Table 1 compares depressed-cladding fiber with a common matched-cladding fiber at a 10.0-micron mode field diameter. A 9.5-micron mode field diameter matched-cladding fiber can be expected to have added losses intermediate to those of the two fibers shown.

To summarize, added macrobending loss at large diameters is a non-issue for both depressed-cladding and matched-cladding fibers, but depressed-cladding fiber has macrobend loss resistance at small loop diameters where even a

partial loop or cable kink could be critical to system operation.

Loop diameter and static fatigue

The probability of a static fatigue failure in a single loop of fiber immersed in water is essentially zero for loop diameters of 0.7-inch or greater. In normal cable environments or normal humidities, the probability of a static fatigue failure is essentially zero for loop diameters of 0.4-inch or greater. Therefore, significant macrobend loss can occur in loops where static fatigue is not an issue.

Depressed-cladding and modal noise

There has been considerable discussion concerning depressed-cladding fiber and modal noise. Modal noise is generated at the second of two closely spaced splices (or connections) by the time varying interference of coherent light propagating in the first two fiber modes. For a detectible level of modal noise to be generated, however, at least four additional conditions must exist: 1) the loss of both splices must be high; 2) the cutoff wavelength of the fiber between the splices must be high; 3) the laser wavelength must be very low; and 4) the laser must produce a significant amount of mode-partitioning noise.

If we consider the splice and laser performance to be fixed, then good modal noise performance may be ensured by providing sufficient higher-order mode attenuation between the splices, which will fully suppress any higher-order mode power launched at the first splice before it reaches the second splice. From a fiber standpoint, this can be done by controlling: 1) the cutoff wavelength; 2) the fiber length between the splices; and 3) the fiber curvature (storage loops of excess fiber) in the splice case.

The higher order mode cutoff characteristics of matched-cladding and depressed-cladding design are different in important ways. Depressed-cladding fiber cutoff is relatively insensitive to bending, but the cutoff wavelength decreases rapidly with increasing fiber length. Modal noise is avoided by a combination of providing sufficient fiber length, and by selecting the appropriate maximum cutoff wavelength for the application. Matched-cladding fiber, on the other hand, is less sensitive to fiber length, but is very sensitive to bending; modal noise is controlled primarily by fiber curvant in splice cases.

Table 2 lists recommended splicing distances, under worst case assumptions about splice loss and system characteristics. The 10-meter minimum splicing distance is very conservative, and applies to cables that have fiber with a 1350 nm cutoff wavelength in the standard 2 meter test. As a practical matter, repair lengths in long haul and trunk applications are always specified by telecommunications carriers to be more than 10 meters. If the current Bellcore recommendation for cable cutoff is used (a 1250 nm maximum cutoff wavelength in 22 meters of cable) then this is equivalent to a 1300 nm maximum fiber cutoff in AT&T fiber. The minimum spacing to avoid modal noise under worst case conditions is merely 2 meters. As a practical matter, this is the grade of fiber being used for all trunk, loop feeder and loop distribution applications today. Finally, all AT&T buried and

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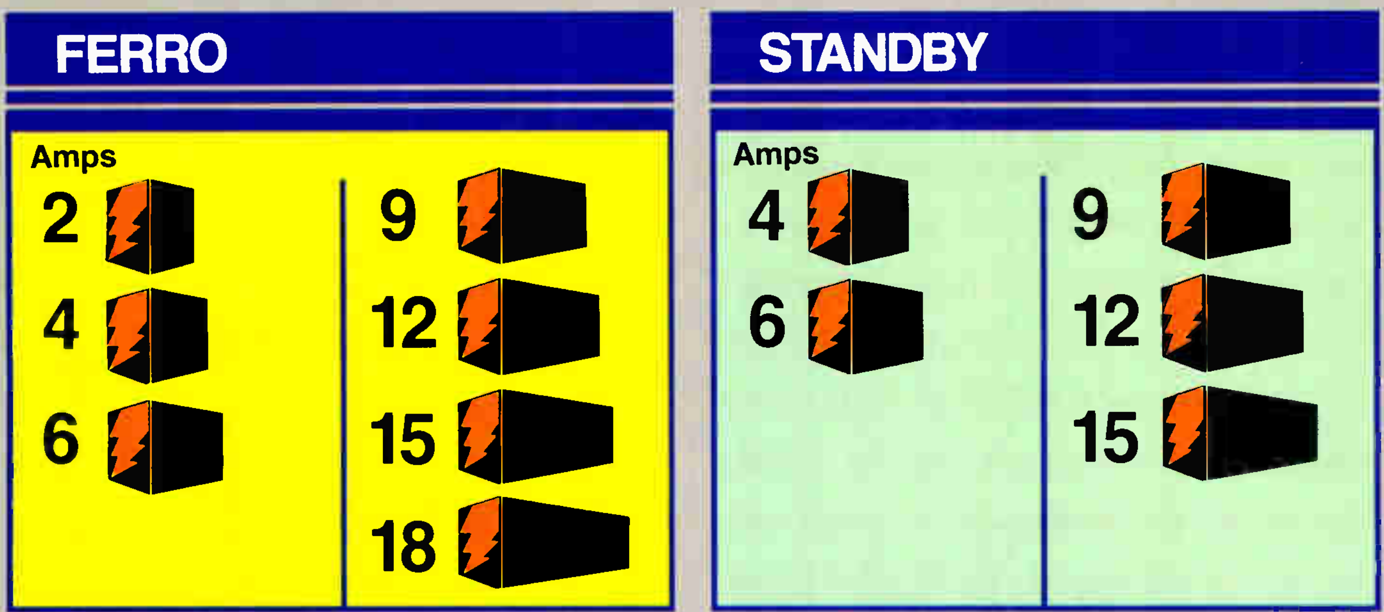

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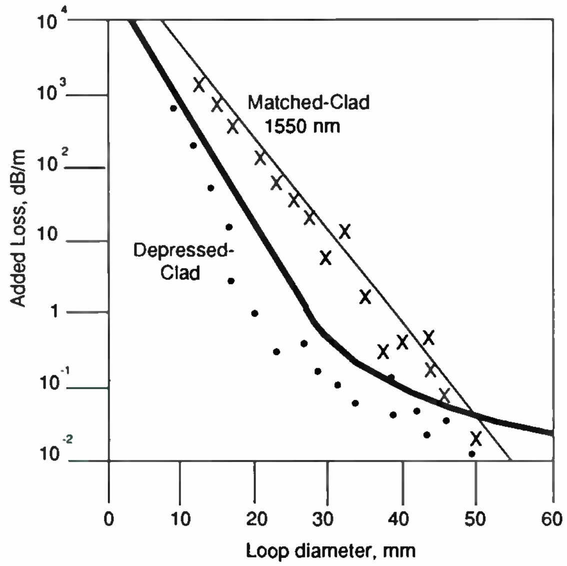

Figure 6

Modal Noise Power Penalty

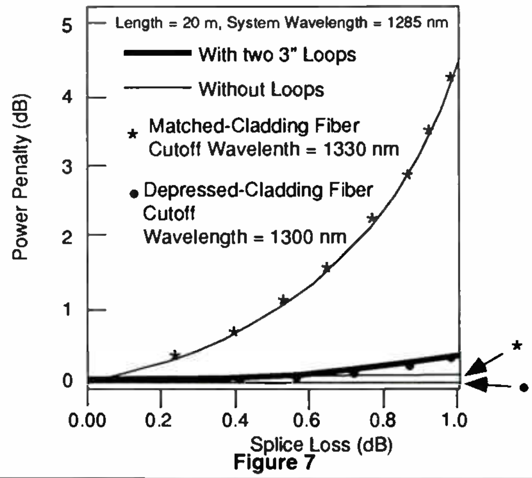

Figure 7

aerial service cables and jumper cables use a 1240 nm maximum cutoff fiber where the minimum repair length drops to 0.5 meter.

Recommended repair lengths for this fiber are quite short, and are substantially below common practice. Moreover, as shown in Table 2, the recommended lengths are for straight fiber. Consequently, the customer does not have to be concerned about whether storage loops have been inadvertently left out or insufficient fiber is available to install the loops, such as when fiber is broken while handling during sheath stripping or splicing.

Under normal conditions, depressed-cladding and matched-cladding fibers perform adequately with insignificant levels of modal noise, and in fact extreme measures are required to observe power penalties. However, depressed-cladding fiber has the real world advantage of not requiring mode suppression loops between splices to achieve good modal noise performance. Unless these loops are present in matched-cladding fiber or the splice spacing is greater than 100 meters, the power penalty could be substantial, as Figure 7 demonstrates. ■

TABLE 1

Macrobending Loss dB/Loop

Wavelength	Diameter	DC fiber 8.8 μm MFD	MC fiber 10.0 μm UFD
1300 nm	0.44 inch	1.0 dB	17 dB
	0.55	0.1	4.8
	0.80	0.01	0.24
1550	0.62	1.0	25
	0.80	0.1	8.5
	1.25	0.01	0.77

TABLE 2

Recommended Minimum Splicing Distances For AT&T Depressed-Cladding Fiber

System Type	Minimum Splice Spacing for Fiber without Loops	2 Meter Cutoff Wavelength (EIA RS(455-80)
Long haul, trunk	10m	1350 nm
Trunk, Feeder & Distribution	2m	1300 nm*
Buried & Aerial Service Cables & Jumper Cables	0.5 m	1240 nm

*Corresponds to Bellcore 1250 nm cable cutoff wavelength requirement


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Reader Service Number 28

Straight talk about fiber bending

Is fiber in your future? If you're a cable television engineer, the answer is likely to be a resounding "yes." The 1990s should herald the dawning of cable television's optical fiber decade. With a proven track record, and a growing number of fiber-based systems off the drawing board and in the field, many of the questions that had surrounded this advanced transmission medium have been answered.

Still, certain inaccuracies about fiber performance remain. One of the most common of these misconceptions concerns the optical performance of fiber at small bend diameters.

Simply stated, if fiber is bent tighter than the industry recommended minimum of two inches (50 mm), two problems can occur. First, attenuation (the loss of signal strength as light travels through a fiber) can be brought to unacceptably high levels. Next, the likelihood of premature fiber breakage is significantly increased.

Why is bending an issue?

As fiber migrates from cable television supertrunk applications through the feeder and into the drop, it will require additional interconnections by installation crews. That's why fiber bending is an issue.

When splicing fiber, an installer typically removes the cable jacket and loops lengths of exposed fiber into the splice tray. If bent beyond the established minimum bend diameters, an otherwise properly cabled and installed fiber could break before the end of its expected lifespan. The result: unexpected service disruptions, customer dissatisfaction and high repair bills.

Nevertheless, certain fiber manufacturers have promoted their products as optically superior at bend diameters tighter than the industry's standard practices dictate, despite the increase in life-limiting stresses.

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

Tighter bends mean greater loss

Single-mode optical fiber consists of core glass—the principal light path of the fiber—and cladding glass—the outer glass layer of the fiber. In single-mode optical transmission, part of the light travels within the cladding as well as the core.

When traveling around fiber bends, the light on the outer part of the bend must go a longer distance and actually faster than the light on the inner bend. However, in tight diameter bends, usually about one and one-half inches or less, some of the light traveling in the cladding radiates out.

Bending induced light loss occurs in a way that might be compared to a motorcycle racing around a curve. The motorcycles on the outer curve travel a longer distance, so they must go faster just to stay even. If a racer tries to make a turn too sharp for that speed, the motorcycle may "radiate" off, or spin out and crash.

Just as sharper curves in a track or road can cause a speeding vehicle to spin-out, tighter fiber bends cause greater light loss (Figure 1).

Macrobends and microbends

There are two main types of fiber bends that can affect optical transmission: macrobends and microbends. Macrobends are large-scale bends that naturally occur in splice trays or at cable termination points. However, problem macrobends—those of one to two inches—can result in light loss. When fiber is bent too tightly, part of the light at the bend no longer is guided, but is radiated out from the fiber. Bend loss is primarily apparent at 1550 nanometers, less so at 1310 nanometers.

Years of empirical and theoretical study on fiber strength has led to a recommendation of a two-inch (50 mm) minimum bend diameter. This parameter was chosen because bends below two inches in diameter induce more than the maximum recommended bend stress on fiber. Fiber subjected to stress beyond this maximum faces a much higher risk of breakage.

Microbends are small deviations—

Figure 1. Bending-induced light loss can be compared to motorcycles racing around a curve. Just as sharp curves in a track may cause a motorcycle to "radiate" off and spin out, too-tight fiber bends cause greater light loss.

on the order of a few microns in amplitude—that occur along the length of the fiber. Depending on their frequency and magnitude, these disturbances induce different levels of power loss.

Microbending-induced loss can be caused by the stress that cable exerts against a fiber at extremely low temperature—as low as -60 degrees Centigrade. At such low temperatures, different contraction rates for the cable and the fiber exert enough stress to cause microbends. In cable television applications, microbending-related problems may occur if extremely high point pressures are exerted on the cable, such as a trench backfill in rocky soil.

Mode-field diameter and bend loss

As discussed, in single-mode fiber, some of the light pulse exists in the cladding glass that surrounds the optical core. Mode-field diameter—or the diameter of the spot of light traveling down the fiber—is the critical parameter for determining bend loss, for both macrobending and microbending.

Mode-field diameter also is important for determining splice loss. Larger mode-field diameter is best, while a smaller mode-field diameter is preferred to limit bend loss. In practical application, it is best to choose a mode-field diameter that is optimized to meet both requirements (Figure 2).

The effect of fiber designs on optical bend performance is a secondary parameter, and only becomes significant at practical bend diameters of three inches and above.

Fiber design distinctions

As many cable TV engineers know, there are two different single-mode fiber designs: depressed-clad and matched-clad.

Depressed-clad fiber is manufactured through the Inside Vapor Deposition (IVD) process, which was invented and patented by Corning in 1970. The IVD process uses a pre-made silica glass tube to confine and direct the glass forming reaction process. Layers of ultra-fine silica "soot" are deposited on the inside of the tube. When the tube is full, the preform is heated and consolidated into a clear glass "blank." The glass tube thus forms the outside cladding of the fiber.

However, fibers with an outer surface made from glass contain impurities, or flaws, which can significantly weaken their mechanical strength.

Today, the most commonly used IVD process is the Modified Chemical Vapor Deposition (MCVD) process. As fiber-making technology continued to evolve, Corning overcame the limitations inherent in this processing approach through the development of the Outside Vapor Deposition (OVD) process.

In the OVD process, the ultra-pure silica soot is deposited onto the outside of a rotating rod, beginning with the core glass and then changing the chemical formula for the cladding glass. The rod is removed and the completed preform is consolidated to a clear glass blank by heating it to very high temperature.

By eliminating the glass tube, the OVD process yields a matched-clad fiber with fewer flaws and better geometric control of physical parameters, such as core concentricity, which allows for more efficient splicing.

It has been implied that depressed-clad fiber was specifically developed for enhanced bending performance. In fact, the depressed-clad fiber design is the result of manufacturing limitations of the MCVD process.

Depressed-clad fiber's smaller mode-field diameter allows it to exhibit low losses at 1550 nm in bend diameters below one inch. But these losses are still unacceptably high for most cable TV applications. And, as we've seen, tiny bends can lead to premature fiber breakage.

The smaller mode-field diameter of depressed-clad fiber allows it to approach comparable optical performance of matched-clad fiber, with its largest mode-field diameter.

Turning theory into practice

Even the most proficient installers can accidentally create dangerously tight bends when splicing. To avoid this problem, consider the following fiber handling tips.

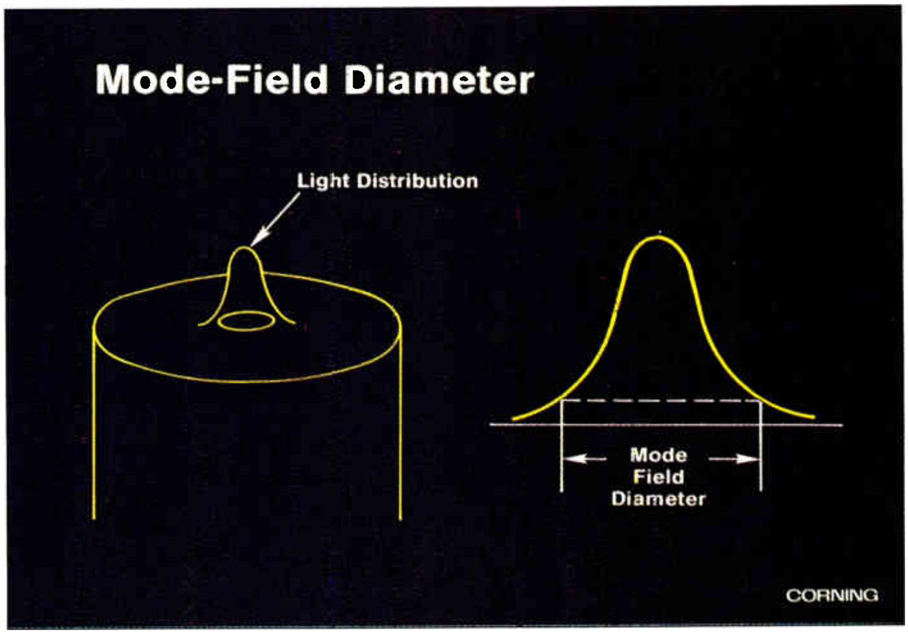


Figure 2. Mode-field diameter is critical in determining bend loss. In single-mode fiber, some of the light pulse exists in the cladding glass that surrounds the optical core.

First, investigate the possibility of enrolling selected technicians in fiber-splicing courses. Many fiber/cable companies offer them regularly.

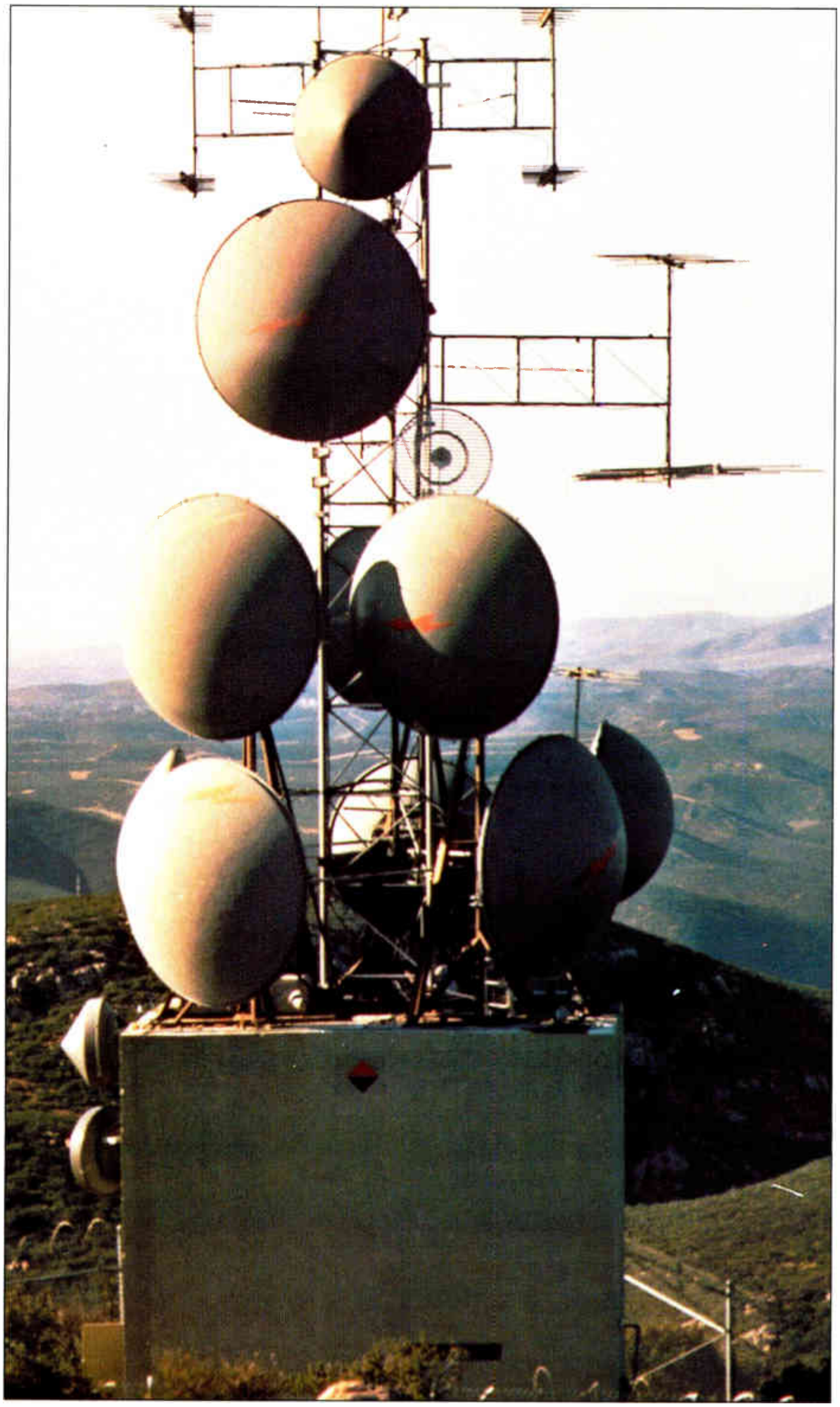
In the field, make certain that loops in a splice tray loosely fill the allocated space. The loops shouldn't be so large, however, that they're forced against the sides of the tray. If the fiber ends up jammed in the corner of the tray, trouble may result.

Some splice trays have built-in fiber placement guides that define the appropriate looping path for the fiber.

With matched-clad fiber, if an installer discovers that the fiber has accidentaly been bent below the recommended two-inch minimum, he or she simply can enlarge the bend to avoid compromising the life of the fiber. The installation crew can be notified of the dangerous bend by the high-loss indicated on an optical time domain reflectometer (OTDR) at 1550 nm.

There is virtually no way to detect excessively tight bends with depressed-clad fiber, except by visually inspecting all fiber terminations. ■

The future of microwave: Good, bad and uncertain



With all the attention being placed on fiber optics, what's the future for microwave? Will this field-proven technology become obsolete and disappear, or will CATV continue to use it? Like most everything else, it depends upon who you ask.

For years, microwave has been the most cost-effective method of transporting video signals over long distances. Because of its ability to carry large amounts of information with little signal degradation, microwave long ago established itself as a method to provide distant and local signal distribution for cable television applications.

Now, fiber optic technology is dramatically changing the situation. The inherent characteristics of fiber demand that it be considered in applications where microwave once dominated. Both are capable of long-haul signal transmission with limited investment in electronics. Each technique has the capacity to carry large numbers of channels with signal performance that exceeds outputs from amplifier cascades. And both technologies have distinct economic advantages.

Because of these similarities, and adding some significant benefits of fiber, microwave is no longer seen as the only alternative to providing relatively low cost, point-to-point or point-to-multipoint signal distribution. As rumors of "microwave is out" circulate through the industry, perhaps it's time to take a look at these technologies and see where each stands as a method to provide signal distribution today—and where microwave may be two to three years from now.

The 'first' technology

Microwave has been used for long-distance transport for decades. However, it wasn't until the late '60s that it was implemented for local distribution. Hughes Aircraft Company began manufacturing the AML (amplitude modulated link) in 1970 because certain hilly and mountainous terrains necessitated an alternative to traditional antenna delivery methods.

Microwave is usually considered by

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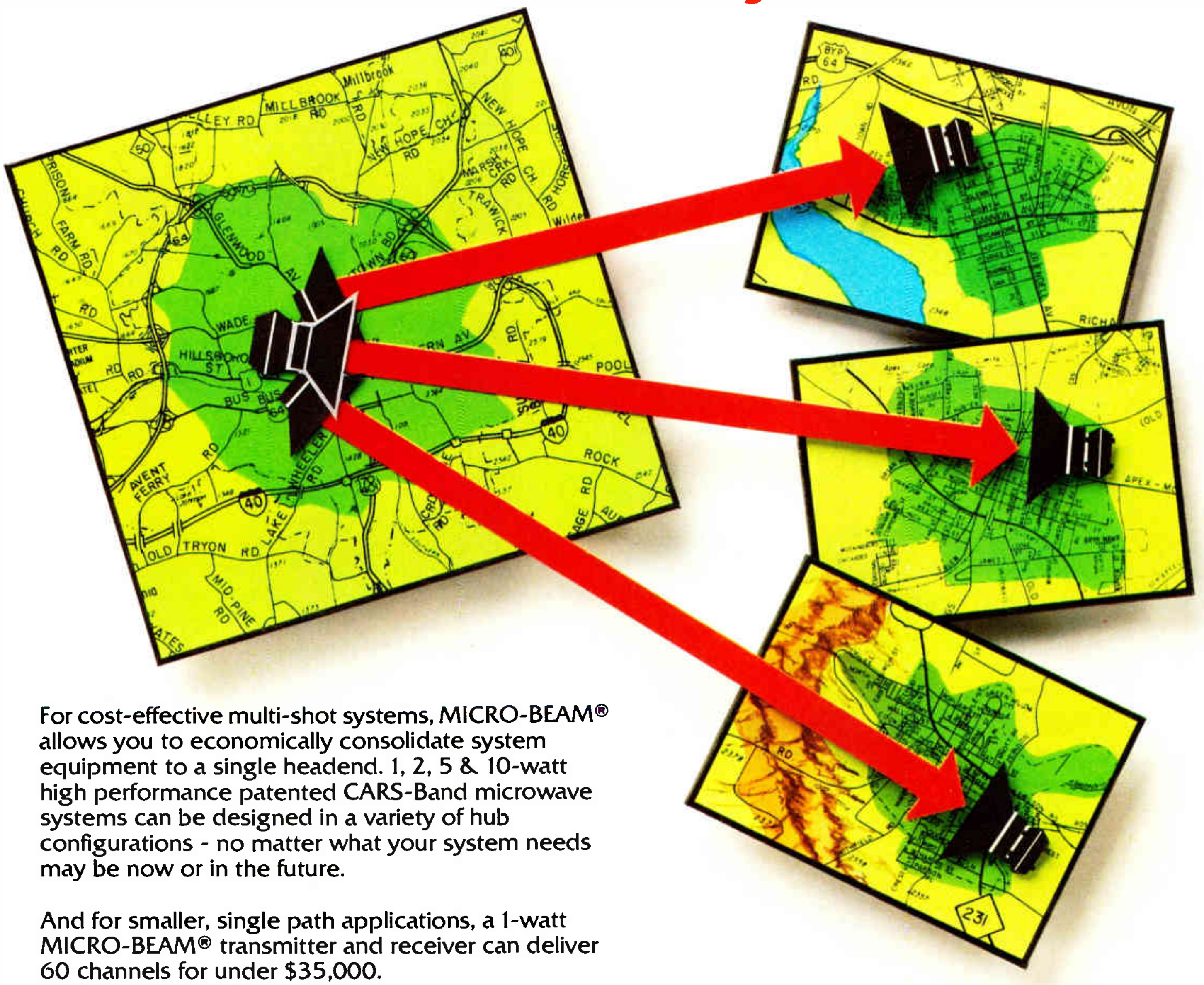

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cable operators for at least one of two reasons, including: 1) breaking a large cable system into several hubs in order to keep amplifier cascades short and 2) feeding several nearby cable systems from a common headend. Both applications involve getting from point "A" to point "B" without a lot of expensive construction.

While this is clearly one of the major advantages with microwave, there are significant disadvantages to the technology. One of the first to come to mind is rain fade. Because microwave operates at such high frequencies, 12.7 GHz to 13.2 GHz, it is subject to distortions and outages during heavy storms. According to Bob Luff, vice president of engineering and technology for Jones Intercable, this reflects negatively on microwave.

"As the industry becomes more focused on customer service, signal reliability and picture quality," says Luff, "microwave, as opposed to fiber as a closed medium, doesn't give you control over the environment. The microwave just doesn't measure up to the reliability that fiber now offers."

Another problem with microwave is that it requires line-of-sight from the transmitter to the receiver. Although it is less a problem with fiber, Abe Sonnenschein, manager-AML for Hughes Microwave, feels it (line-of-sight restrictions) "obviously hasn't been that big a problem because more than half of the subscribers in the country get their signal through microwave. It's just a complication sometimes," says Sonnenschein.

Others echo Sonnenschein's thoughts on microwave's history. "Microwave is pretty much a proven technology," says Bob O'Hara, president of Westec Communications. "It's currently installed and has been for some time. If I were a cable operator, I'd say 'the stuff is paid for and I know its problems. I've lived with them, I know how to cope with them.' So I'm not going through a learning curve with a new technology."

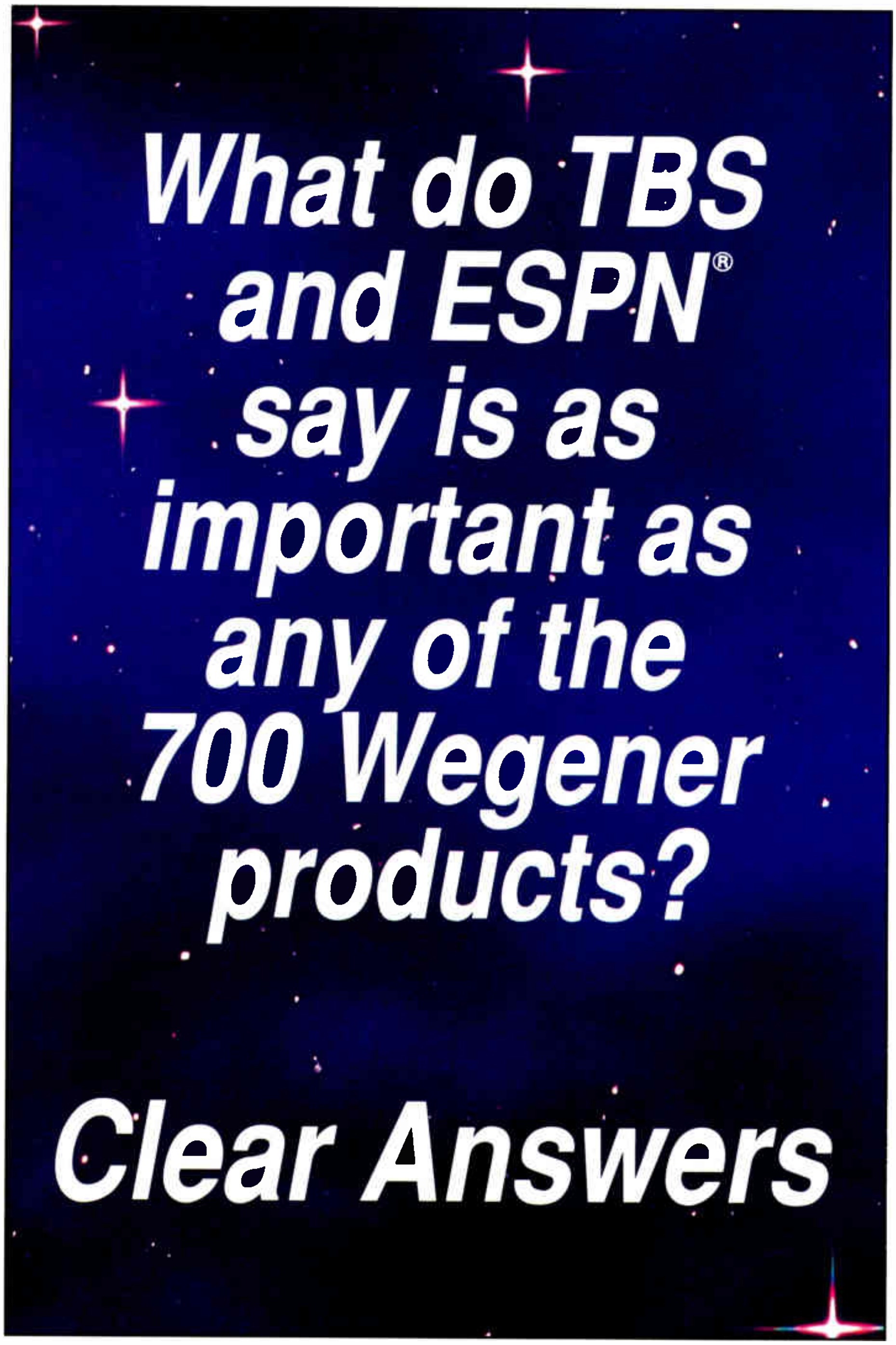
No towers please

Knowing microwave's problems means facing two additional potential obstacles. One, microwave requires FCC licensing and two, zoning is also an issue to consider when it's necessary to hang dishes on pre-existing structures or actually build a new tower. Zoning is becoming increasingly difficult, says Luff. Because cable is primarily a residential service, communities are more fickle about putting in "200-foot towers with lights and red and white stripes," says Luff. "And you lose control of the timing of your project," he adds. "Even if you win a tough zoning battle, it sometimes can take a year or more to gain permission—and we can't afford to wait."

As for the FCC licensing, microwave is limited to its high frequencies, which puts the bandwidth capacity at 70, possibly 80, channels. This in itself is not an extreme problem but it does signify a major disadvantage for operators considering two-way capability or a return path. According to Paul Barth, FCC coordinator for United Cable, the biggest advantage of fiber versus microwave is the flexibility a return path offers.

Luff couldn't agree more. "With the way the industry is on pay-per-view (PPV) and impulse PPV, the two-way aspect of fiber is a sleeper," says Luff. "I mean, it's probably not valued as much today as it will be a couple of years from now."

Because fiber technology is maturing, its costs, when compared with microwave, has become a moot point in most applications. However, there



are other disadvantages of the optical technology. One—and a familiar one to those used to dealing with coaxial cable—is its physical entity. If a vehicle hits a telephone pole with fiber attached or digs up the fiber, operators are faced with down time while fixing the damage. Another problem, and the reason many operators go to microwave, is the terrain. Fiber cannot cross water or mountains as cost-effectively as microwave. And, at this point in time, most fiber installations utilize FM technology—which can be cost-prohibitive in certain instances.

"Here you get into a discussion of FM versus AM on fiber," says a high-ranking industry engineer who asked to remain anonymous. "With FM over fiber you can go much greater distances with higher reliability. With AM over fiber, the table turns and you can go, for the same quality factor, further with microwave, *today*. But (when the day comes) when you can go further with AM over fiber with the same quality level at the other end, that's when AML is really in trouble. Because that's when the quality factor switches heavily in favor of fiber."

Barth agrees. "As soon as this AM takes off, and yes, it will take off, fiber's going to be the future. I believe we're not going to entirely get away from microwave," says Barth, "but we'll use fiber now where we would have used microwave in the past."

Dave Willis, director of engineering for Tele-Communications Inc., doesn't see such clear-cut answers. Willis looks at it as "they're both techniques for signal delivery and both have their good attributes and their bad. Therefore, they simply become two more alternatives on how you can get your signal where you want it to go." While Luff agrees that both fiber and microwave are "tools in the designer's and engineer's toolbox," his tendency is to go with fiber in more and more situations.

"We're already comfortable with fiber," says Luff. "Given that our experience is improving our comfort zone even more...we are finding that we are more comfortable with fiber as the choice over microwave."

Microwave not obsolete

Although this all seems to paint a bleak future for microwave, no one is ruling out the technology. There will always be situations where microwave will come into play. "There are features and there are trade-offs," says Luff. "One has to carefully analyze the new application. Every decision being done here, and I hope in the whole industry, is on a case-by-case basis."

Those directly involved with the manufacturing or servicing of microwave systems admit each situation should be carefully analyzed before choosing a technology. However, fiber's newness compared to microwave's established base puts optimism higher in their ranks. "Because fiber is so new," says Jim Crownover, sales manager for Channel Master, "we have not seen any effect on our sales due to fiber optics. Really, most of it is just the top MSOs that are looking at it and trying fiber. They're not going full bore, the way I see it."

Sonnenschein has seen a small amount of diversion from the AML market to fiber but credits the low attrition to the fact that most cable systems are already built. Where fiber has become competitive with AML is in supertrunking applications and even here Sonnenschein sees it as a different type of consideration. "The decision was made in a number of cases to go with fiber, not because it was better or cheaper, in fact in many cases it was more costly, but because there's a great deal of publicity and interest in fiber and the various cable operators like to gain some experience with it," says Sonnenschein.

This lack of experience, or learning curve as O'Hara terms it, is what is actually keeping fiber decisions minimal in some situations. The fact still remains that FM fiber is prohibitively costly when there are many hubs to be fed. Although AM fiber has overcome some of these cost disadvantages, unless there are many paths to be fed over long distances, many in the industry see the performance of AM as inferior to microwave.

"Some of the signal-to-noise (S/N) ratios," says Bill Margiotta, director of engineering and chief executive officer for AML Specialties, "some of the quality of fiber, as an AM signal, hasn't been quite up to snuff." To Margiotta, microwave systems as they are made to work at a better carrier-to-noise (C/N) or S/N ratio, will be "able to provide the quality of signal to the customer without having to lay or hang tremendous amounts of fiber to get the signal there."

Improved systems needed

But Margiotta doesn't think current microwave systems are capable of delivering improved noise ratios. "The systems have to be brought up to the new specifications that are demanded by the cable industry," says Margiotta. "Driving a better product into the marketplace, making it work longer and bringing the price down, is going to take business away from fiber."

Luff concurs with Margiotta. "Microwave is a technology that, in its present configuration, is somewhere nearing its mature placement on its life cycle," says Luff. "Something needs to happen. It needs to get better or it needs to modify and embrace the new option (fiber) or at least blend in with the new option available now."

The "blending" is already happening in some instances. "Sometimes what is being done," says Sonnenschein, "is the microwave and fiber are being used as a backup to each other." Instead of laying fiber to the same points via different routes, an alternative is to use microwave as a backup, or vice versa. "Where the AM signal had worse quality," says Sonnenschein, "a higher quality may be delivered by microwave. When the microwave signal fades, then the operator can switch over to fiber for backup."

What ultimately happens between the two technologies remains to be seen. According to industry engineers, this decade and the next will see a decrease in the application of microwave. Although no one is predicting the demise of the technology, some see microwave becoming a "niche business" once AM over fiber reaches the same quality level for the same distance as microwave. Until then, microwave is being looked at as an alternative—not a means—of providing quality signals to consumers.

"Like everything else," says Willis, "this isn't black and white, it's kind of gray. That's exactly the story." ■

Inside a CATV amplifier

With much of the modern system distribution being centered on AML multipoint microwave and satellite distribution, we tend to overlook the fact that the heart of the cable system is the cascaded trunk line. In many cases, the cascade theory was applied to the system only once, at the initial design stage, after which input and output levels were established. From then on, all alignment of amplifiers is a routine operation based on these derived levels.

As we will see, the application of cascade theory to system design levels will fix the maximum possible performance, but unless it is carried through on a day-to-day basis, it does not guarantee the minimum performance of the system. In order to more fully understand this aspect of cable systems, we will review the basics of cascade theory and its application.

The cascade theory is based on several significant items. The first of these is what is known as the well behaved amplifier. For clarification purposes, a well behaved amplifier does not relate to user behavior or ease of use, but rather, an amplifier which is being operated within its linear region, whereby distortion generations can be mathematically predicted. Cascade theory is the set of rules which determines what an amplifier will do when operated within this well behaved region.

Distortions are a natural by-product of the amplifier process. What we want to do with an amplifier is to have the input augmented in power and delivered to the output. However, this process is of necessity distorted in every amplifier of any time. In order to deliver television signals we have an allowable range of distortions, which are in the area between the distortion level accompanying the signal (as initially generated) and a tolerable amount of distortion at the delivery end.

The primary problem in television signal delivery is how far can we go without exceeding this window. This is approached in different manners by different technologies. For example, a broadcast station will use up the entire distortion window in a single large high-powered amplifier, whereas a cable system tends to use up the distortion window by small increases in distortion as generated by a large number of low power amplifiers. The type and amount of distortion generated is a function of the amplifier technology and how closely to the amplifier linearity limit we operate.

By Karl Poirier, VP Corporate Development, Triple Crown Electronics

Originally published in Cable Communications Magazine, Canada
Part 2

Distortions

The distortions which we encounter in any amplifier fall into four basic categories. There are:

- Thermal noise
- Modulation distortion
- Discrete intermodulation distortions
- Composite intermodulation distortions.

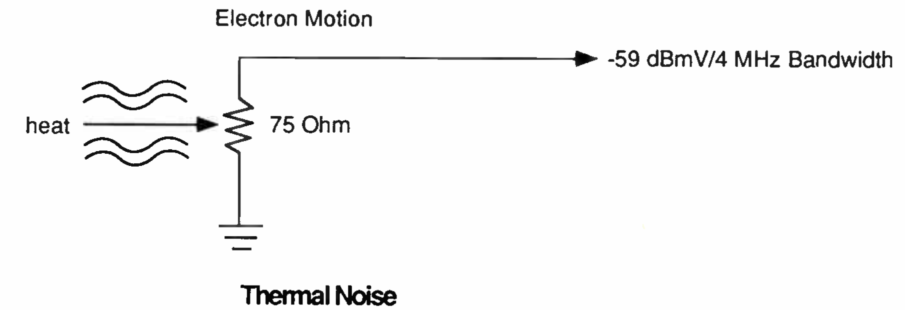


Figure 1

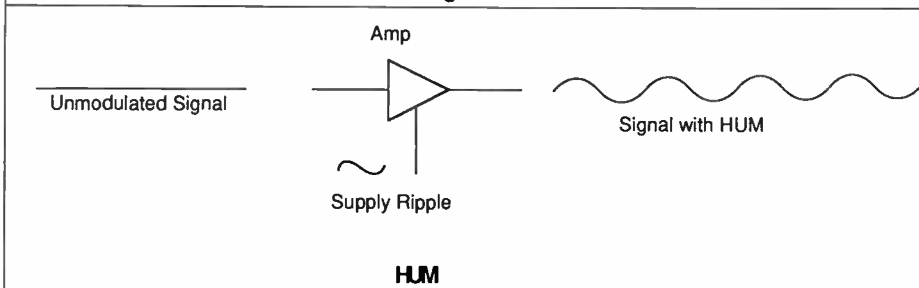


Figure 2

These distortions can be described as follows:

Thermal noise. Thermal noise is radio energy generated as a result of random motions of electrons within the amplification system. Thermal noise performances can be improved by using low noise amplifier technologies but there are certain finite limits to this possible improvement. (See Figure 1.)

Modulation distortions. Modulation distortions, most commonly characterized in cable television by hum modulation, are in effect the transference of unwanted modulation to the signal being amplified (Figure 2). In the case of hum modulation, the modulation transferred is the power supply ripple which causes periodic performance changes in the amplifier at the ripple rate.

Discrete intermodulation distortions. When two or more carriers are passed through an RF amplifier, there is always a certain amount of interaction between the two carriers. The amplifier, depending upon its linearity, will operate in some ways like an RF mixer and will generate multiples of the products being amplified (Figure 3).

Composite intermodulation distortions. As we carry more signals through an amplifier, the discrete intermodulation distortions will, at times, occur in the same portion of the RF spectrum, where they add together. (Figure 4). This is commonly known as composite triple beat or composite second order distortion.

Cumulative distortions. The maximum distortion and noise performance capability of an individual amplifier is determined by the technology employed,

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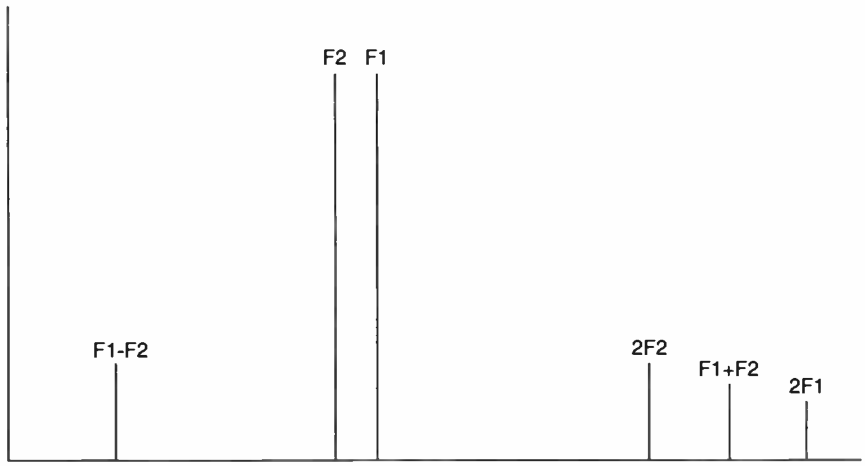
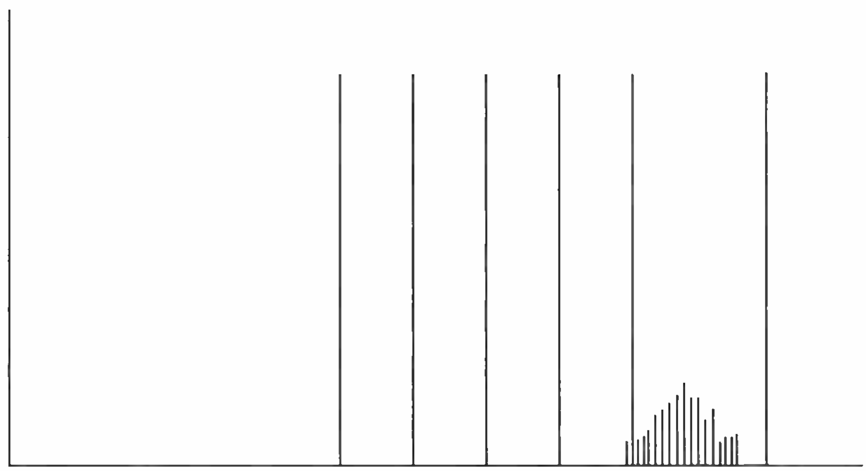


Discrete Distortions
Figure 3



Composite Distortions
Figure 4

as well as the quality of manufacturing and components. The distortion capability of a single amplifier is then modified by three basic factors, in order to determine the system performance of an amplifier cascade. The factors which effect the overall distortion performance are:

- The system operating levels.
- The system channel loading; and
- The number of amplifiers in cascade.

Not all distortions are equally affected by these three items. For example:

- Thermal noise is essentially a function of operating level and number of amplifiers in casade. Thermal noise is not affected by channel loading.
- The second distortion form, of "modulation distortion" is essentially affected by the number of amplifiers in cascade.
- The third distortion type—discrete intermodulation products—is affected essentially by the operating level of the amplifier and the number of amplifiers in cascade, while being little affected by the channel loading of the amplifier.
- The fourth distortion type—composite intermodulation distortion—is affected by the operating level of the amplifiers, the loading of the amplifiers and the number of amplifiers in cascade.

Application of cascade theory

All of the foregoing considerations regarding the degradation of performance of amplifiers as a function of level, loading and cascade lengths, are taken into account at the initial design stage. Here the optimum operating levels are determined. The performance of the

DERATING FACTORS

$^{10}Log^{N}$	No. of Amps in Cascade	$^{20}Log^{N}$
0	1	0
3.01	2	6.02
4.77	3	9.54
6.02	4	12.04
7.00	5	14.00
7.78	6	15.56
8.45	7	16.90
9.03	8	18.06
9.54	9	19.09
10.00	10	20.00
10.41	11	20.82
10.79	12	21.58
11.14	13	22.28
11.43	14	22.86
11.76	15	23.52
12.04	16	24.08
12.30	17	24.60
12.55	18	25.10
12.79	19	25.58
13.01	20	26.02
13.22	21	26.44
13.42	22	26.84
13.62	23	27.24
13.80	24	27.60
13.98	25	27.96
14.15	26	28.30
14.31	27	28.62
14.47	28	28.94
14.62	29	29.24
14.77	30	29.54
14.91	31	29.82
15.05	32	30.10
15.18	33	30.36
15.31	34	30.62
15.44	35	30.88
15.56	36	31.12
15.68	37	31.36
15.80	38	31.60
15.91	39	31.82
16.02	40	32.04
16.13	41	32.26
16.23	42	32.46
16.33	43	32.66
16.43	44	32.86
16.53	45	33.06
16.63	46	33.26
16.72	47	33.44
16.81	48	33.62
16.90	49	33.80
17.00	50	34.00

Figure 5

entire system is based on having appropriate sections of the system operated within their design windows of maximum output level, and minimum input level. This application of cascade theory, commonly known as amplifier derating, is performed by the system designer and is then expected to hold true for all future applications within the system, provided that the windows are not exceeded.

Practical applications

The following are some practical applications of the cascade derating factors:

Note: As amplifier performances are specified logarithmically, the effect of cascade length must also be specified in these terms. Without entering into a detailed math lesson, we can state that the relationships are as follows:

cascade length	vs noise addition	)
cascade length	vs output capability	) $10\ \mathrm{Log}^{(N)}$
output capability	vs channel loading	)
distortion	vs channel loading	) $20\ \mathrm{Log}^{(n)}$
cascade length	vs distortion	)

In order to simplifiy this discussion, a chart of cascade derating factors for 10_{Log} and 20_{Log} is provided (See Figure 5).

Noise

The simplest illustration of the application of derating can be seen in the calculation of noise performance of an amplifier system. All that is required in order to perform a noise window calculation is to have an estimation of the maximum number of amplifiers which will be cascaded, the noise figure of the individual amplifier and a derating chart. The calculation involved is shown in Figure 6.

We know that the noise in a cable television system is normally referred to in a 4 MHz bandwidth. We are also aware that a 75-ohm termination at room temperature delivers a noise level of -59 dBmV. If we have a system design requiring a maximum number of amplifiers of 30, and we have an amplifier with a noise figure of 9 dB, it becomes fairly simple to calculate the noise level at the last amplifier in the system. (For this calculation, we consider each amplifier and its associated cable as a unit with a gain of 0.) From the cascade chart we see that the power addition or (10_{Log}) column for 30 amplifiers in cascade is approximately 15 dB. Thus the calculation is:

	-59 dBmV	Basic Noise Level
minus	9 dB	Amplifier Noise Figure
minus	15 dB	Cascade Derating Factor

EQUALS	-35 dBmV	Total Noise At Final Amplifier

If we desire 42 dB carrier/noise ratio at the end of the system then

minimum amplifier levels	-35 dBmV	
plus	42 dB	

EQUALS	+ 7dBmV	Carrier

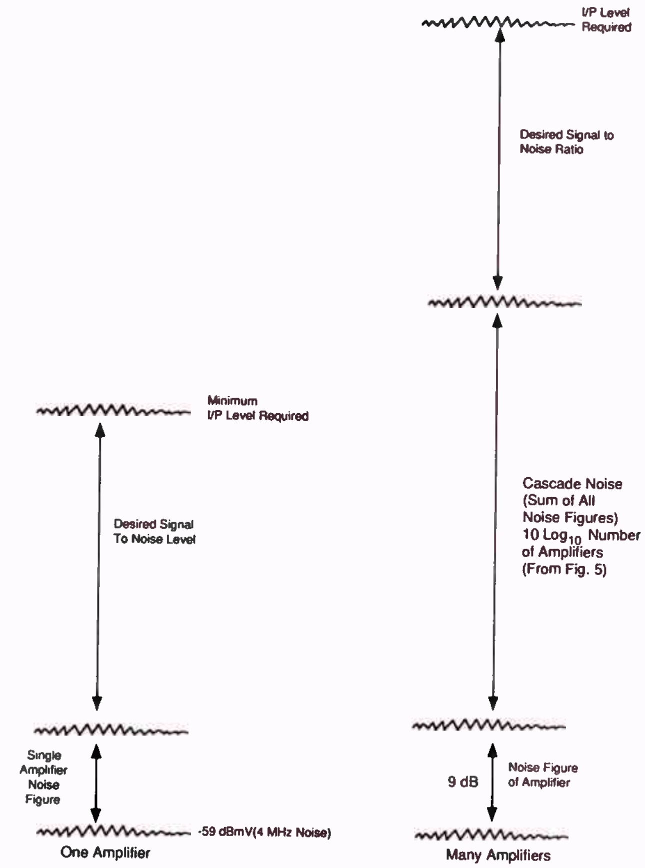
We have now quite simply established the minimum signal level within the amplifier cascade required to maintain the signal-to-noise ratio of 42 dB.

Intermodulation

Intermodulation distortions are calculated and derated in the same fashion as noise with several small variations. First, the manufacturers' rating on distortion capability for amplifiers is not a universal number like noise figure, and is normally rated in one of two distinct manners:

- Output level to derive a standard distortion level.
- Distortion level developed at a standard output level.

For example, an amplifier may be



Cascade Noise

Figure 6

rated as:

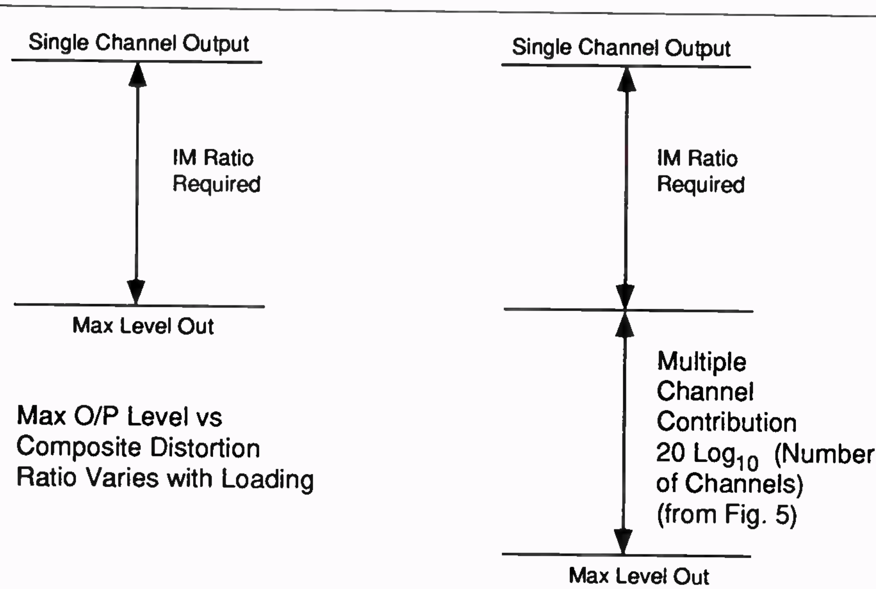
- Composite triple beat -89 dB at 35 channels at +33 dBmV output, or it may be rated as:
- Composite trible beat -57 dB at 35 channels for +49 dBmV output.

(Note: Manufacturers also normally qualify their performance specs at a particular operating slope, which will be discussed later.)

Both these ratings are identical. In order to determine the cascade derating for either of these specified methods, the following calculation is normally employed. For example, given that we wish to use a maximum number of amplifiers totaling 30 and we know that the specification required for composite triple beat is a minimum of -57 dB, we can then simply determine the maximum allowable operating levels as depicted in the fol lowing:

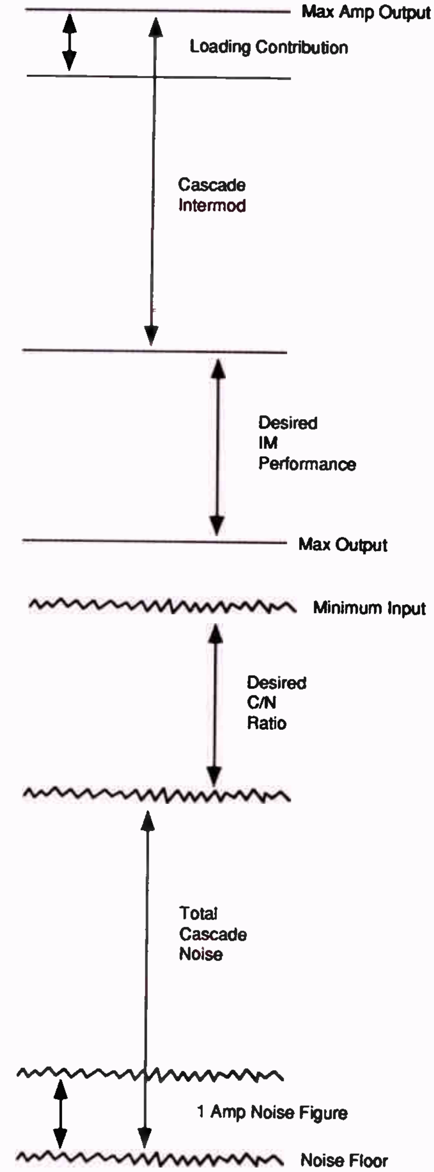
Example of distortion calculation (trunk only) set at -57,

Cascade factor of 30 amplifiers (20_{Log}column on chart)	30 dB
Desired composite triple beat ratio	57 dB
Number of channels	27



Loading

Figure 7



Amplifier Derating
Figure 8

With an amplifier specified as in (a), the calculation is as follows:

First: the loading improvement (Figure 7).

The amplifier is specified at 35 channels, but composite distortion will show an improvement due to reduced load.

the calculation is simply $20_{Log} \frac{27}{35} = 2.2$ dB

	improvement	~2 dB
plus manufacturers spec	(-89 dB)	distortion
equals	(-91 dB)	
less cascade factor	30 dB	
equals an end spec of	-61dB	composite triple beat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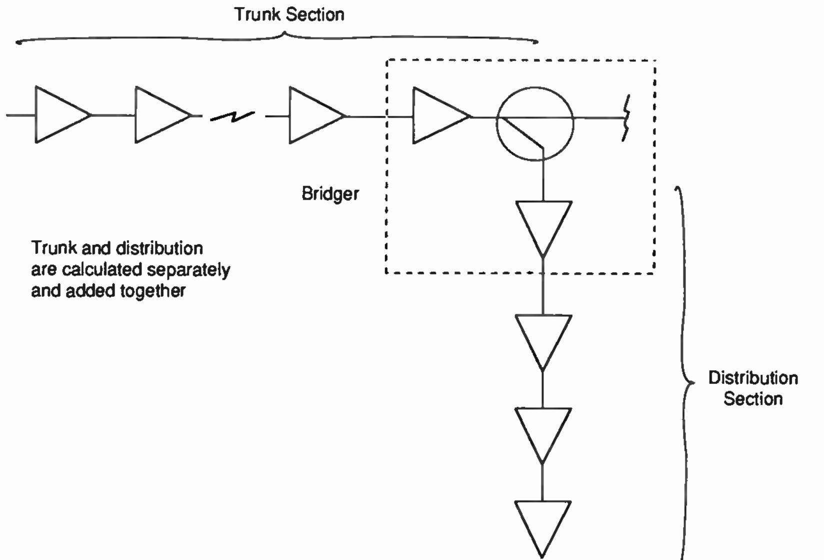


Figure 9

While the distortion improvement with load reduction is actually somewhat better, it is difficult to accurately predict. $20\text{Log}\frac{\text{Reduced}}{\text{Specified}}$ is a worst case figure and can always be used safely.

As this spec held for output level of +33 dBmV, we have a margin of

61	
-57	required composite triple beat ratio
------	
4 dB margin	

We could operate the trunk at 4/2 (2 dB higher than 33 or 35 dB and still meet the desired -57 dB composite spec).

With an amplifier specified as in (b) the calculation is as follows:

Specified composite ratio	(-57 dB)
Plus loading improvement	(2 dB)
equals	(-59 dB)
Less cascade factor	30 dB

	-29 dB

We now have a composite triple beat spec of -29 which is short of the required -57 dB by 28 dB.

In order to recover this difference, we now reduce the amplifier output levels by

28/2 = 14 dB	thus	+49 dBmV
	less	14 dB

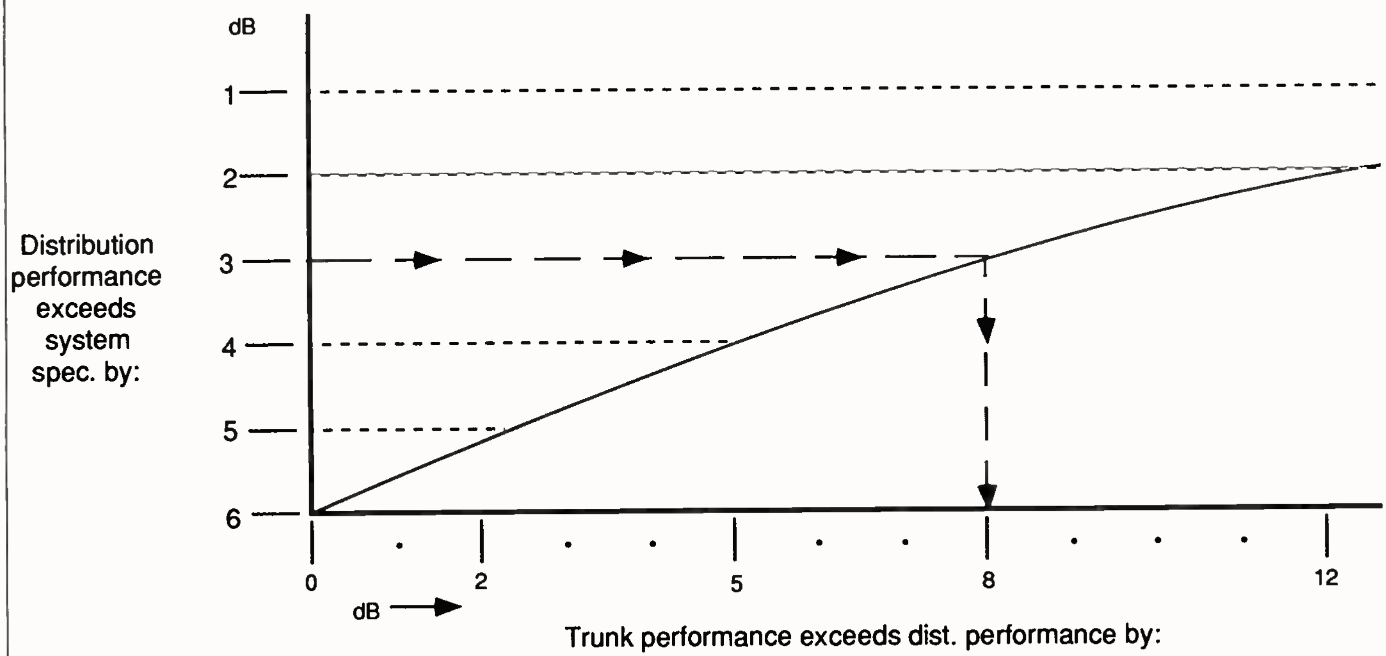
	EQUALS	+35 dBmV

We can, therefore, operate at +35 dBmV output and achieve -57 dB composite triple beat.

In both cases (a) and (b), the calculation is based on the same sequence:

- Modify the spec for loading
- Subtract the cascade factor
- Subtract the desired performance ratio
- Modify the output level to accommodate.

We have now set our minimum and maximum system operating levels for the distortion required (Figure 8).



System Performance: Dist. O/P level vs trunk performance

Figure 10

This rather simplistic view must be modified by the real world applications. We can see how the composite distortions are a direct two-for-one ratio to the system operating levels. Various areas of the system have different requirements for level/distortion performance which makes a constant operating level impossible. For example, the trunk objective of long reach and therefore low distortion implies low operating levels. The distribution problem of tap losses implies high operating levels.

When meeting these criteria, we can fall back onto a simple operational fact. *Groups of similar amplifiers in similar operational alignment can be separately calculated, and their overall performances added together.* For example, let us assume the following scenario:

Amplifier performance : output capability
550 MHz 77 channels
CTB = -57 @ +50 dBmV
NF = 7 dB.
System performance requirement : CTB -53
C/N 45 dB
System layout Trunk Length to final bridger 300 dB
Distribution Length to final line extender 60 dB.

What operating levels and how many amplifiers are required to build this system.

Bearing in mind the fact that we face two different level/distortion requirements, we will consider this scenario in two phases: the trunk up to the final bridger amplifier input as a section, and the distribution from bridger module input to final extender output as a section. The sum performance of the two sections will be the net system performance (Figure 9).

The sum of these two section performances is done on a voltage addition basis and has been simplified in Figure 10. In this figure, the vertical scale represents the amount by which our distribution system performance exceeds our overall system performance. The horizontal scale shows the amount by which the trunk performance must exceed the distribution performance in order to achieve the desired overall. For example: Desired system performance CTB -54,

Distribution performance :
4 amplifiers @ +44 O/P = CTB -57.

In this example, the distribution performance exceeds the system by 3 dB. On the graph in Figure 10, we see

No. of Amplifiers	I/P	Gain	O/P	No. x Gain
1	-7 dBmV	53 dB	+46 dBmV	53 dB
2 (derated I/P-O/P by 3 dB)	-4 dBmV	47 dB	+43 dBmV	94 dB
4 "	-1 dBmV	41 dB	+40 dBmV	164 dB
8 " (300 dB)	+2 dBmV	35 dB	+37 dBmV	280 dB
16 "	+5 dBmV	29 dB	+34 dBmV	464 dB

Table 1

No. of Amplifiers	Input	Gain	Output	No. x Gain
1	15	35	+50 dBmV	35 dB
2 (80 dB of system)	15	32	+47 dBmV	64 dB
4	15	29	+44 dBmV	116 dB

Table 2

that a line on the vertical scale at 3 dB intersects the curve at the 8 dB point. Thus, in order to achieve a system CTB of -54, the trunk performance must exceed the distribution performance by 8 dB (-57 + 8 = -65 CTB).

We therefore require a trunk of 300 dB length with performance of CTB -65 dB and C/N -45 dB.

The basic criteria for this trunk is determined as follows:

(1) determine the single amplifier parameters to achieve this performance.

(2) derate this performance until 300 dB of gain is achieved.

Step 1: Basic amplifier performance -57 dB CTB at +50 dBmV O/P

CTB = 65 dB at +47 dBmV O/P

Amplifier output maximum level +46 dBmV.

: I/P -59 dBmV + 7 dB (nf) +45 dB (desired C/N) = - 7 dBmV

Thus the performance desired (-65 CTB, 45 dB C/N) could be achieved in a *single amplifier* operating at -7 dBmV in and +46 dBmV out.

Step 2: We will now extrapolate this single amplifier performance to achieve 300 dB of gain (Table 1).

Thus we see immediately that in order to drive 300 dB of trunk at the desired performance, we must operate at:

minimum level input + 5 dBmV
maximum level output +34 dBmV
maximum station gain 29 dB

actual number of amplifiers in cascade (300 29 = 10.34) = 11 amplifiers (in actuality we will use 11 to 16 amplifiers due to passive losses, splitting, spacing problems, etc.).

> ...to achieve a system CTB of -54, the trunk performance must exceed the distribution performance by 8 dB.

The preceding calculation is shown graphically in Figure 11.

Now, the distribution section can be calculated. Earlier on, I did a quick guess that the distribution would require four amplifiers. This can now be checked out as follows, in a manner similar to the trunk calculation with one major difference.

Our preview calculation on trunk showed a minimum input to achieve desired C/N of +5 dBmV. In fact, the need for multitaps will probably not allow us to employ levels this low, and a number such as +15 dBmV is more realistic.

As our trunk performance was designed to accommodate a minimum distribution performance of -57 CTB, we can begin by defining, as previously, our single amplifier parameters. See Table 2.

Thus, we will need at least three amplifiers operating at +44 dBmV output, 15 dBmV input, in order to feed 80 dB of distribution.

So, our system of 300 dB trunk and 80 dB of distribution length will achieve an overall -54 CTB and +45 C/N when:

The amplifiers: output capability -57 CTB at +50 dBmV and N.F. 7 dB are operated in the trunk within the level window of:

−5 dBmV minimum
+34 dBmV maximum

and the distribution operated within the window of:

−5 dBmV minimum
and +44 dBmV maximum

Note that there are absolute minimum and maximum levels occurring anywhere including inside the amplifier and not merely at the amplifier input and output ports. ■

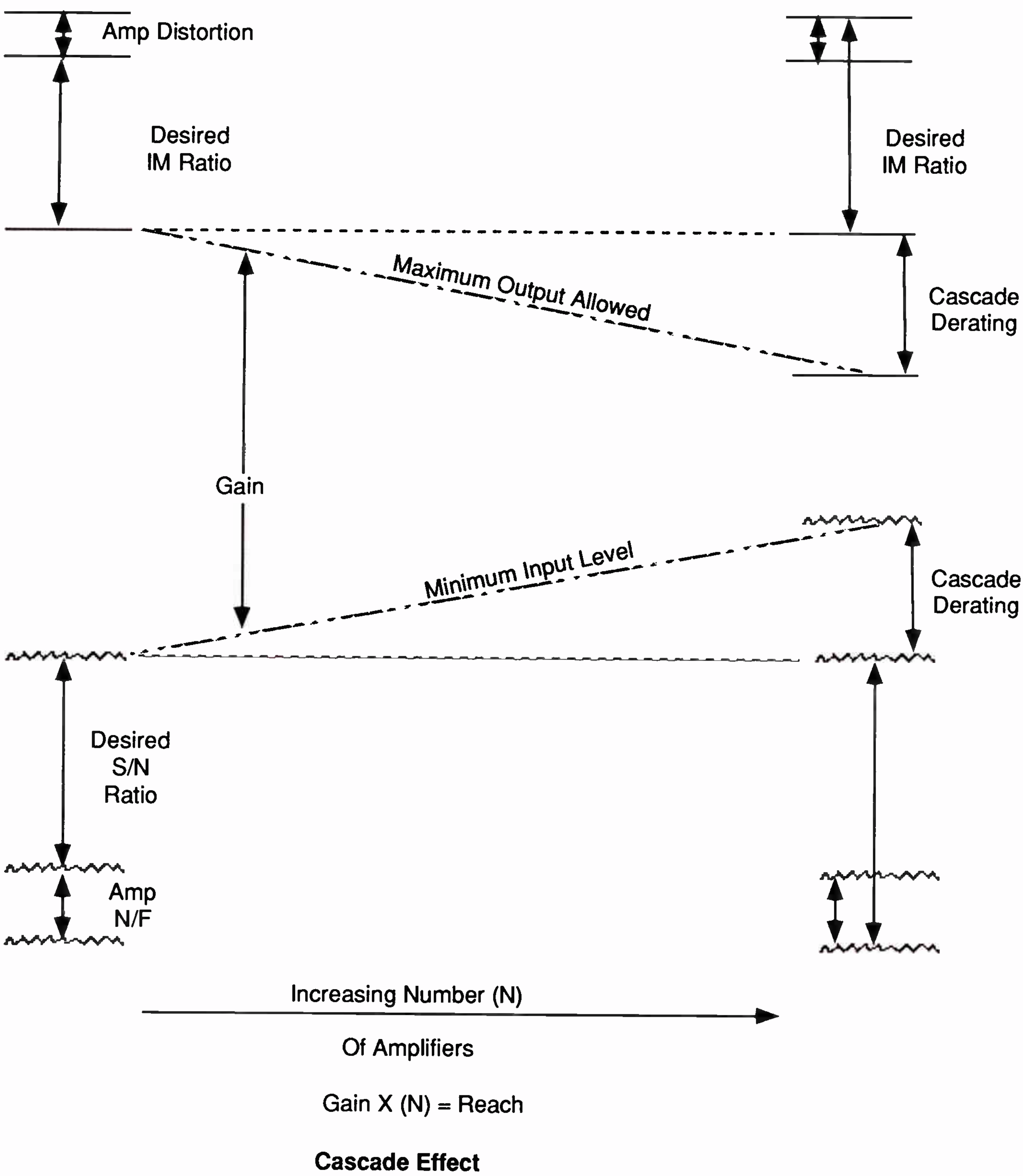

Amp Distortion
Desired
IM Ratio
Desired
IM Ratio
Maximum Output Allowed
Cascade
Derating
Gain
Minimum Input Level
Cascade
Derating
Desired
S/N
Ratio
Amp
N/F
Increasing Number (N)
Of Amplifiers
Gain X (N) = Reach
Cascade Effect

Figure 11

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An objective review of the HDTV proposals

What follows is the first section of the HDTV System Subcommittee/Working Party 1 Interim Progress Report to the Advisory Committee on Advanced Television Service. The report offers insight into the current status of the various HDTV transmission system proposals. Mr. Dayton is the chairman of the subcommittee.—Ed.

Since its inception, the focus of Systems Subcommittee/Working Party 1 (SS/WP1) has been to develop a methodology to provide the FCC and the concerned public with a clear view of the technical merits of the numerous proposals being offered to provide an advanced television service in North America.

In this effort, we have had excellent cooperation from many members of the broadcast community and the proponents themselves, as well as from the cable television industry, Bellcore, and several regional operating companies. Additionally, Canada, represented by members of the Canadian Advanced Broadcast Systems Committee, has contributed to the development of the rigorous process, and has provided the time of several key technical experts during the course of our evaluations.

After considerable deliberation, the method we have chosen to extract the best ideas from the many that are being offered is to hold concentrated technical sessions on a periodic basis to provide a forum wherein North America's best television engineers can ask the hard questions of the proponents. The second and not so subtle objective of the concentrated session approach is to encourage the proponents themselves to bring their best technical minds and put them "on stage" in turn, in order to promote a cross-flow of ideas between those individuals and organizations most committed to the development of a new system.

The first session of this kind was held in Springfield, Va. during the week of Nov. 14 through 18, 1988. The information yielded at that meeting provides much of the basis for this report. WP1 is chaired by Birney Dayton of Grass Valley Group. The three vice chairmen are Carl Eilers of Zenith Electronics Corp., David Kettler of Bellsouth Services, and John Swanson of Cox Enterprises. Hugo Gaggioni of Sony Advanced Systems is the secretary.

By Birney Dayton, Vice President of Engineering, Grass Valley Group

Evaluations

In the interest of achieving the twin goals of providing some insight on proponent readiness to WP2 and the Advanced Television Testing Center (ATTC), and continuing to promote the cross-flow of information between proponents, this report...has been prepared by the chairman, and looks at the quality of submission to date and the apparent level of readiness of each proponent. The report necessarily contain(s) the judgments of the preparers which will no doubt be subject to discussion, but it should be noted that none of the preparers has a differential interest in the ultimate selection of one proponent over another other than to provide the best possible television system for North America.

Avelex

Submission to date is a copy of a paper by G. William Meeker published in the September 1988 edition of the *IEEE Transactions on Broadcasting*. Avelex was scheduled to make a presentation at the November meeting, but dropped out the day before the presentation. At this time, it is not clear whether Avelex intends to pursue its submission, but the visible level of commitment to date would suggest not.

Based on the submission, Avelex's proposal appears to be a receiver-compatible 6 MHz system which uses sub-sampling techniques in the center portion of the picture and compressed transform coding techniques modulated in quadrature on the picture carrier to transmit the side panels of a wide aspect ratio picture.

Broadcast Technology Assoc. (Japan)

BTA has to date submitted a proposal, EDTV I, and indicated an intent to pursue development of a further proposal, EDTV II. The EDTV I proposal was presented at the November meeting, and consists of a number of incremental improvements to NTSC, many of which are being implemented by broadcasters in Japan now. A full implementation of EDTV I will likely require a wideband 525/59.94/2 or a 525/59.94/1 source, and most likely will be available for test soon.

BTA's further pursuit (EDTV II) is still in the study phase and involves techniques for compatibly expanding the aspect ratio and the resolution of the picture. The date of completion of EDTV II is not clear, but there is evidence of considerable resource being applied to the investigation, so some testable output is probable. The final system will likely require a 525/59.94 test source with wide aspect ratio.

Del Rey Group

The Del Rey Group has submitted a proposal, called HD-NTSC and made a presentation. The proposal appears to be at the paper concept level, with some work proceeding on simulation. It is not clear at what point operational hardware might be available.

The Del Rey proposal is a 6 MHz receiver compatible system with a 5-by-3 aspect ratio which uses sub-sampling at a 10 MHz frame rate to produce higher resolution. The most probable implementation of this system will likely require a progressively scanned test source of at least 900 lines at a frame rate of 29.97 Hz.

Digideck

Digideck is an audio proponent that has been computer simulated with some sample tapes available. Development of real-time hardware is intended. Digideck's proposal uses error-protected adaptive DPCM with entropy encoding and bit truncation on overload to transmit two near-CD quality channels of audio in less than 500 Kb/s.

Dolby Laboratories

Dolby is an audio proponent propos-

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ing the use of its digital MP matrix (two channel with matrixed quad) audio. This is available in hardware. Additionally, it is proposing the use of a QPSK carrier at 4.85 MHz separation from the visual carrier for upgrade of NTSC audio. This technique should also be available, but will need to be evaluated in light of the video system it is used with. One system proponent has indicated an interest in this technique. Others are proposing embedded data capacity for sound.

The Dolby digital MP matrix system is an adaptive delta modulation system using approximately 500 kb/s and a 4-to-2 channel matrix approach widely used in the distribution of motion pictures and consumer video tape.

Faroudja Laboratories

Faroudja has submitted a two-phase proposal called SuperNTSC which in its first phase has a 4-by-3 aspect ratio, and is available in hardware form. The second phase, which has a 1.61-to-1 aspect ratio, should be available soon.

Both phases of the proposal require a progressively scanned source at either 525 lines or 1,050 lines with a 29.97 Hz frame rate. The second phase requires the source to have an aspect ratio of 1.61-to-1. The first phase is strictly NTSC compatible from a transmission standpoint. The second phase will impinge on NTSC horizontal blanking, and produce 3 percent to 4 percent black bands at the top and bottom of an NTSC picture. The Faroudja system uses signal processing and a reduced temporal capture rate (29.97) to improve horizontal and vertical resolution.

High Resolution Sciences

HRS has submitted a proposal called HRS-CCF (Chroma Crawl Free). Additionally, the HRS submission talks about a spot wobble system to improve definition. This proposal was not mentioned during the November presentation.

The HRS-CCF system raises the field frequency of NTSC to 60.07 Hz and the line frequency accordingly, without changing the subcarrier frequency. Subcarrier now becomes a harmonic (227) of the line frequency instead of an odd harmonic of half the line frequency. This may reduce the visual effect of color crawl, but in the process also removes the possibility of separating the color information from luminance since both signals are now on the "teeth of the comb." A direct effect also is the RMS addition of chrominance and luminance power which may cause transmitter clipping at conventional color modulation levels. Depending on the choice of implementation, the CCF system could be tested with a 525/59.94/2 or a 525/60.07/2 component source. The spot wobble system alluded to in HRS's written submission is an unknown to the working party at this time since no technical detail has been submitted.

Massachusetts Institute of Technology

MIT has formally submitted two proposals, and presented some additional information at the November meeting. One of the submissions is for a receiver compatible system that uses a letterbox format to gain information space for an enhancement signal. The second submission is a channel compatible system which uses spatio-temporal trade-offs and digital transmission techniques. From the information submitted, both of these systems seem to be evolving. For the presentation, Dr. Schreiber showed simulations of a scrambled Pulse Amplitude Modu-

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lation technique intended to improve performance in channels with noise and ghosting, and which may be applicable to his channel compatible submission. It is not clear at this time whether MIT intends to build a hardware implementation of either system.

MIT has a good simulator, and has put a number of interesting ideas forward, some of which have been adopted by other proponents. The base assumption has been that a significant reduction of detail for moving portions of the picture is possible without a loss of picture quality. There is also a consistent theme around 12 Hz as a base frame rate (or sub-band increment) based on the integer relationship of 12, 24 (film rate), and 60 (television rate.)

NHK (Japan Broadcasting Corp.)

NHK has submitted four systems. The first, Wide Muse, or Original Muse, has been widely demonstrated, and used over satellite during the 1988 Summer Olympics. This system has a contiguous bandwidth requirement that falls outside the bounds of the last FCC decision.

The second submission is Narrow Muse (a narrowband variant of Wide Muse). This system is channel compatible and uses VSB-AM modulation. The third system is Compatible Muse 6. The fourth system is Compatible Muse 9. All four systems include digital audio. Wide Muse is relatively mature, and hardware exists. The other three systems are clearly in gestation, and more information is becoming available as this report is being written. Given NHK's demonstrated commitment to HDTV, there is a high probability of all these systems being available in hardware by summer.

New York Institute of Technology

NYIT has submitted the Vista system which is a receiver compatible system with a 6 MHz or possibly 3 MHz augmentation channel. This system uses the NTSC channel for high temporal resolution, and adds spatial resolution at a low frame rate through the augmentation channel. Bill and Karen Glenn have been consistent contributors to the theory of HDTV distribution for a number of years. Based on information to date, the Vista system will be ready for test by mid-1990.

North American Philips

North American Philips has submitted two systems under one general system name of HDS-NA (High Definition System for North America.) The first system, HDMAC-60, is a DBS system or a satellite feeder system for a terrestrial broadcast system. The second system, HDNTSC, is a receiver compatible system requiring a 3 MHz or 6 MHz augmentation channel.

The DBS system uses MAC techniques. The broadcast system was presented with three different augmentation channel approaches (multi-carrier, time-compression and digital.) It is not clear at this time which of the augmentation approaches will be submitted for test. Based on Philip's high level of participation in the working party to date, both of these systems will likely be available for test soon, and will require at least a 525/59.94/1 (with 16-to-9 aspect ratio) source for test.

Osborne Associates

Osborne has submitted a receiver-compatible system that requires a 6 MHz augmentation channel. The system uses the second channel to send a digital signal that represents the difference between an artificial HDTV image extrapolated from the NTSC image and the actual HDTV image. Two significant questions arise with respect to this proposal. One, will the receiver be able to re-create an artificial HDTV image in the presence of noise and distortion that is sufficiently like the encoder synthesis for the system to be effective? And two, can digital signals be reliably transmitted over a broadcast channel at a 64 QAM rate?

The next major review meeting may give answers, and prediction of the availability of a testable system is difficult until the above questions are answered.

Production Services Inc. (PSI)

PSI has submitted several techniques including an IF modulation process, and a bit compression technique. Based on the material supplied to the Working Party, it is difficult to determine the validity of this proposal. The modulation technique appears to challenge the known laws of information theory, and the rest of the techniques have not been presented in sufficient detail to determine their usefulness. Unless the next review meeting yields considerably more detail and a supportable theory, a testable system is unlikely to emerge.

Quanticon

Quanticon has submitted a video compression technique, as opposed to a full system. The technique involves the use of video signal quantization combined with ordered dither to reduce the visibility of the quantization. The technique was demonstrated on a monochrome 240-by-175 raster in an 80-by-66 window at the November meeting. The effect of quantization was visible at sufficient distance from the screen to generate considerable doubt regarding the relevance of the technique for entertainment applications. In any case, this proposal is not expected for test unless one of the system proponents chooses to include it in its proposal.

David Sarnoff Research Center

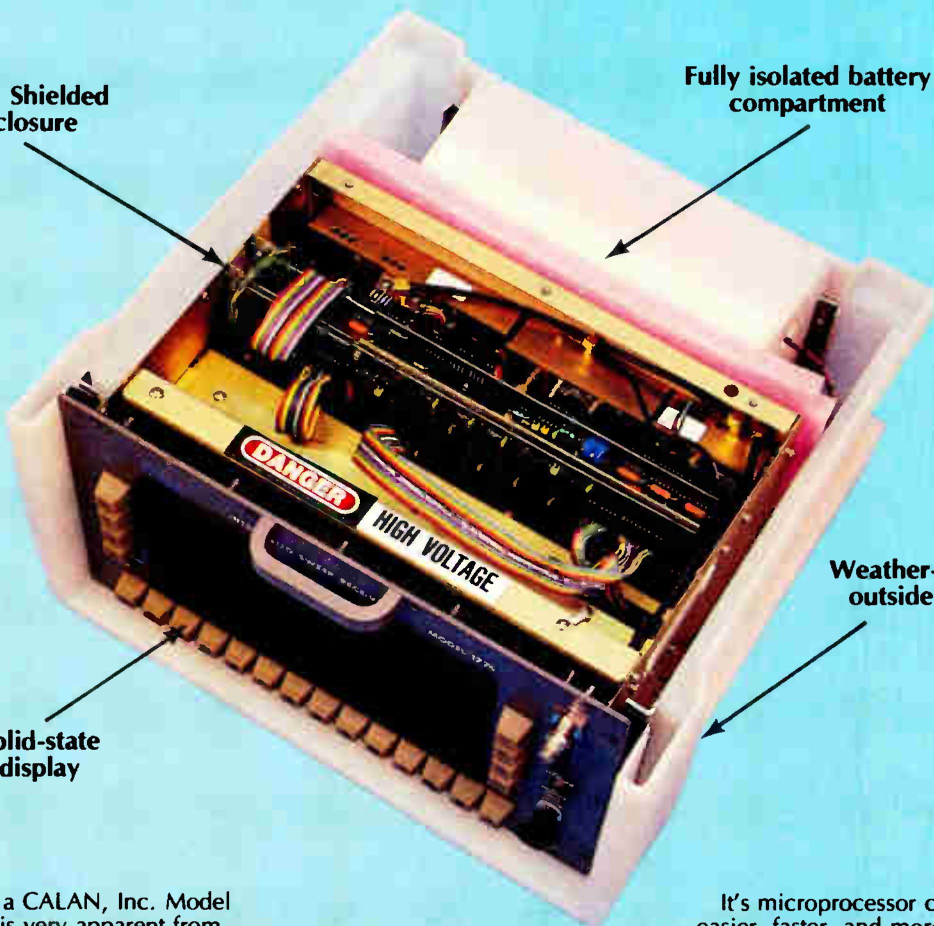
Sarnoff has submitted two proposals, ACTV-I and ACTV-II. ACTV-I was presented in some depth at the November meeting and ACTV-E (an entry level variant of ACTV-I) was also discussed. ACTV-II was identified as a future development of the ACTV program. ACTV-I is a receiver compatible 16-to-9 aspect ratio system, and ACTV-II adds a 6 MHz augmentation channel to ACTV-I for higher quality. All systems take advantage of spectral holes in the NTSC system, use temporal filtering, and (except ACTV-E) employ quadrature modulation of the visual carrier for additional information space.

ACTV-I and possibly ACTV-E should be available for testing later this year. Based on information presented to date, ACTV-II will likely not be available for test until next year. ACTV-I will require a 525/59.94/1 source for testing. ACTV-E is an implementation of ACTV-I that can use a 525/59.94/2 source and does not use quadrature modulation of the visual carrier. For a full evaluation, ACTV-II will require a 1050/59.94/2 source. All sources need to have a 16-to-9 aspect ratio.

Scientific-Atlanta

Scientific-Atlanta has submitted a system called HDB-MAC which is an extension of its B-MAC system. The system is intended as a satellite feeder to broadcast stations, cable headends or for direct reception. Spectrum folding and time compression are used to increase horizontal definition. Motion-adaptive scan-conversion is used to increase vertical resolution. The display format is 525/59.94/1 and the

The Inside Story on Reliability



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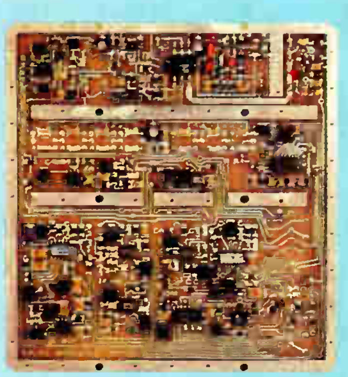

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optimum source format is 525/59.94/1 with 20 MHz bandwidth. The system hardware will likely be available later this year and will accept a number of source formats including 1125/60/2. The system includes conditional access and six digital audio channels.

Zenith Corporation

Zenith has submitted a channel-compatible simulcast system. This proposal is notable in that Zenith has submitted the results of an extensive interference survey which has been entered into the record of Planning Subcommittee, WP3, and will be of great use to all proponents.

Additionally, Zenith brought all its design leaders to the November meeting and laid out a solid theoretical description of its proposal that was clear to the audience. The merits or demerits of their system aside, this group of people showed everyone how to lay a proposal on the table for better or for worse, and how to answer questions to the best of their knowledge with an absolute minimum of issue-ducking and hyperbole.

The Zenith system uses a combination of signal processing and modulation techniques to transmit a 787.5/59.94/1 wide screen (5-to-3 or possibly 16-to-9) high definition image with a minimum of interference to and from existing NTSC channels. So far, Zenith is the only proponent who has publicly addressed the issues of channel signal-to-noise and interference in a quantitative fashion.

The hardware implementation of this system may be available late this year and likely will require at least a 787.5/59.94/1 source with an aspect ratio to match the system when completed (more data should be available at the next review meeting).

Others

Several other organizations have indicated the possibility of submission to WP1. The Institut Fur Rundfunktechnik (IRT) in Munich, Germany has submitted a copy of its satellite mobile audio system for consideration of audio compression techniques. It is expected that IRT will participate in future meetings and provide further information on its audio system.

The IRT audio system uses sub-band coding techniques to compress high quality audio into as little as 64 kb/s/channel.

A-Vision of Boston, Mass. has often indicated an intent to propose a system, but to date has made no submission, other than sending a cover copy of a comment filed with the FCC. The comment offers virtually no insight into the nature of a possible A-Vision system if one is intended.

General Instrument filed a letter of intent to submit a system, and later stated that it had no intent to submit at that time. However, it indicated a desire to keep the opportunity to submit a system in the future. Viento Labs from New York filed a letter of intent, but has submitted no information on its proposal.

> The most promising systems depend on the inability of the human visual system to observe fine detail in the presence of motion.

An individual, Bob Ducret, from southern California has submitted a technique for the chairman's perusal. This technique involves the transformation of image information from the time domain to the frequency domain by analog techniques (presumably chip filters) and subsequent compression of the frequency domain information. Mr. Ducret may want to participate in the process in the future.

Audio considerations

Those system proponents who have not proposed a specific audio system have designed their systems to transport approximately 500 Kb/s of audio data to support the separate audio proposals submitted.

Conclusions

Based on the information submitted to date, the organizations most likely to offer terrestrial *High* Definition systems for test early in 1990 are, in alphabetical order: New York Institute of Technology, NHK, North American Philips, and Zenith Electronics Corp.

David Sarnoff Research Center (ACTV 1), Broadcast Technology Association (Japan), and Faroudja Labs will be the most likely to submit terrestrial *Enhanced* Definition system for early test. NHK, North American Philips and Scientific-Atlanta are the most likely to submit satellite systems in timely working order. Some dialogue needs to occur between WP1 and WP2 to determine the time frame and rationale for testing satellite systems, given that the central goal of the advisory committee is to recommend a terrestrial HDTV methodology.

The most promising systems all depend on the inability of the human visual system to observe fine detail in the presence of motion. To date, there has been no demonstration of the visual effect of temporal detail processing when using a large screen on the order of 6-foot diagonal. The closest approximation has been the large screen demonstrations of NHK's MUSE system, and these demos have all been implemented with a bandwidth considerably greater than 6 MHz. Even with the large bandwidth of the MUSE demos, the temporal filtering is quite noticeable. It will be important to test the human response to temporal suppression of detail information before final conclusions are drawn.

Time line

If any one discovery stood out on top at the November meeting, it was that virtually none of the proponents' systems were as far along in development as earlier public relations releases would have led us to believe. In the long run, this may be very beneficial in the ultimate development of the best HDTV broadcast system for North America. Proponents did not arrive at the November meeting as heavily invested as they would have if their systems had been further developed.

The next review session will provide insight into the level of concept transfer that can be expected to occur in the future. Based on the current level of development of the proponent systems, and the lack of availability of standards translation hardware to provide an equitable test bench for relative evaluation, the work of WP1 will likely need to continue for at least another year. This is not to say that WP2 cannot start testing this summer, but that the analytical process of WP1 will be needed for some time yet to assist in the process. Comprehensive review meetings will be needed on four- to six-month intervals to review theoretical and practical progress. ■

Tomorrow's converters: Tuning in the future

Probably the single most important factor that will determine the future of cable television converters is high definition television (HDTV) or some form of advanced television. Whatever transmission format will eventually be utilized, HDTV will, as it slowly comes to market, sweep away whatever is in it's path, like a relentless glacier on its way to the lowlands. If existing cable equipment and signal control and manipulation schemes can't handle the requirements for increased bandwidth, better noise performance, higher picture quality and less signal processing, they will have to go the way of the dinosaurs.

High level efforts are underway to make sure whatever proponent HDTV system is adopted as the terrestrial broadcast standard will be friendly to the cable industry. But there are limits to what can be asserted. For one thing, the standards setting process going on at the Federal Communications Commission is limited to looking at HDTV for the broadcast industry. While cable television has a legitimate voice in what transpires, it is still a voice from outside the immediate circle.

Put at a disadvantage

And, even if the standard chosen does not put cable TV at a disadvantage relative to broadcasters, it could put both broadcasters and cable at a disadvantage relative to videotape or videodiscs. As Vito Brugliera, vice president of marketing for Zenith Cable Products says, "They are all vying for the consumers."

The possibility of a *de facto* standard emerging still exists. "It depends on how deep somebody's pockets are," says Brugliera. "There's a lot more at stake here than just television."

There are no answers yet. But experts can speculate on what might be some of the issues and impacts on a circumscribed but important category of cable transmission equipment, namely the converter. While few answers are known, many of the issues involved can be defined and the opinions of experts on those issues expressed.

Several of the proponent HDTV systems require the use of a main channel of 6 MHz and a separate augmentation channel. Under these plans the augmentation channel will be either contiguous with the main channel or located somewhere else in the VHF or UHF spectrum.

Hal Krisbergh, president of the Jerrold Division of General Instrument, says the converter would have to deal with the larger bandwidth and the RF module and the tuning functions would have to be modified. He points out that, apart from sophisticated pay-per-view and addressable technology which is not a function of bandwidth, the tuning functions are all that would be impacted.

"What will happen here is we have to have a tuner which is a little more sophisticated to distinguish between a HDTV signal and a regular signal, and whether it's 6 MHz or 12 MHz or whatever it is," says Krisbergh. But he suggests the change will not be revolutionary.

Dual tuners

But what if an augmentation channel is placed at various distances in the spectrum from the main channel? "Under those circumstances you would literally have to have two tuners in the converter, one to find the augmentation and one for the main NTSC compatible channel," says Gaylord Hart of Anixter, who is a member of Working Party 3 of the FCC's Advisory Committee on HDTV. "If that's the case, you would see a significant rise in the cost of a converter."

While accepting that dual tuners may be necessary given certain worst case scenarios, Krisbergh points out, "The tuner is about 15 to 20 percent of the cost of the converter. If you had to put two in, you would add another 20 percent to the cost of the converter. We are not talking about a fundamental architecture change."

For over-the-air broadcasters in a given locale, "The other possibility is either the immediate upper or lower adjacent channel will be used for the augmentation channel," says Hart.

If an augmentation channel type format is chosen as the standard for broadcasters, the FCC will probably assign the specific channel allocations in a given locale and the local stations will have to conform to the assignments, the experts speculate.

"My guess is in almost all of these systems, the baseband type of converter is going to be too expensive to work with," Hart suggests, "because I just think that throwing in an additional tuner and then trying to work with a baseband system is going to be prohibitive."

But cable operators in a given location may not have to conform to the same channel allocation schemes as broadcasters would have to. "The cable systems probably, at least in that respect, have a tremendous advantage over broadcasters," Hart believes. "The broadcasters have absolutely no flexibility on adjacent channels."

Dave Wachob, director of advanced technology for Jerrold, echos that assumption: "In some respects cable has the advantage of probably having it easier to put contiguous channels on, versus broadcasters. If they're lucky, they'll get one here and one there." Krisbergh elaborates, "The broadcasters may be forced to broadcast in a dismembered way, where cable at the headend could reassemble. The ability of the cable operator to take a signal that is disembodied and reconstruct it in the contiguous cable bandwidth is certainly possible."

Scrambling and HDTV

"I don't think any of the scrambling systems, as we know today, will be suitable for HDTV," claims Michael Hayashi, marketing manager for Pioneer Communications. "The current analog scrambling systems have to maintain picture quality in an HDTV situation."

"I think that is a real mess," says Tony Wechselberger, vice president of engineering with Oak Communications, "looking at it from the consumer standpoint, anyway." Wechselberger urges that whatever HDTV system is adopted, it should have within it a

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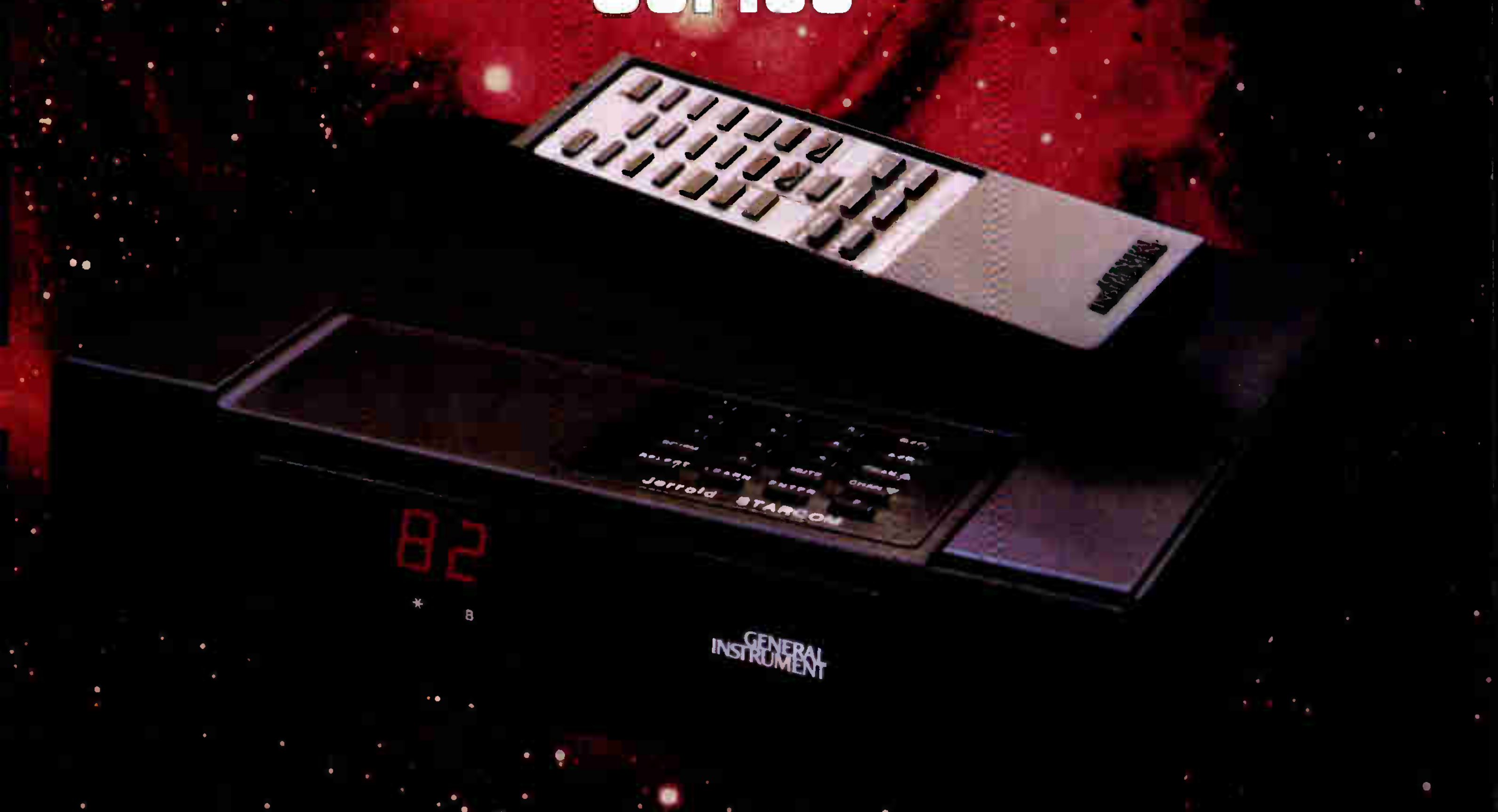

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basic standard format for scrambling. Since HDTV may be bandwidth hungry and expensive in terms of signal processing, Wechselberger feels economies of scale would benefit everyone if a single scrambling approach was taken. "If you have to have scrambling, let's have a single approach and everybody handle that approach. Unfortunately, what is ideal is typically never accomplishable in the marketplace."

Taking a somewhat different tone, Hart says, "On an NTSC-compatible system, I don't see a problem because all you have to do is scramble the primary channel. The sync-suppression system should still work." But this depends on how much the primary NTSC signal is modified. "The in-band system is likely to suffer more than an out-of-band because anything embedded in the signal that may interfere with the HDTV specs (may add conflicts)," adds Hart.

Hart points out, however, that HDTV systems using digital techniques provide for some relatively inexpensive means of scrambling and descrambling. Wechselberger agrees, "Once you are in the digital domain, scrambling is a piece of cake."

Zenith's Brugliera believes the Zenith HDTV proposal provides some interesting advantages for scrambling. "Because we both digitally and analog process the picture, we can encrypt the digital portion and we now have a conditional access system. And if you delve further into our system, the digital processing is done in the television sets so that all you need as a MultiPort type interface is digital circuitry that will rearrange the digital signal so it can be processed by the TV set. It makes for a very friendly cable environment," he says.

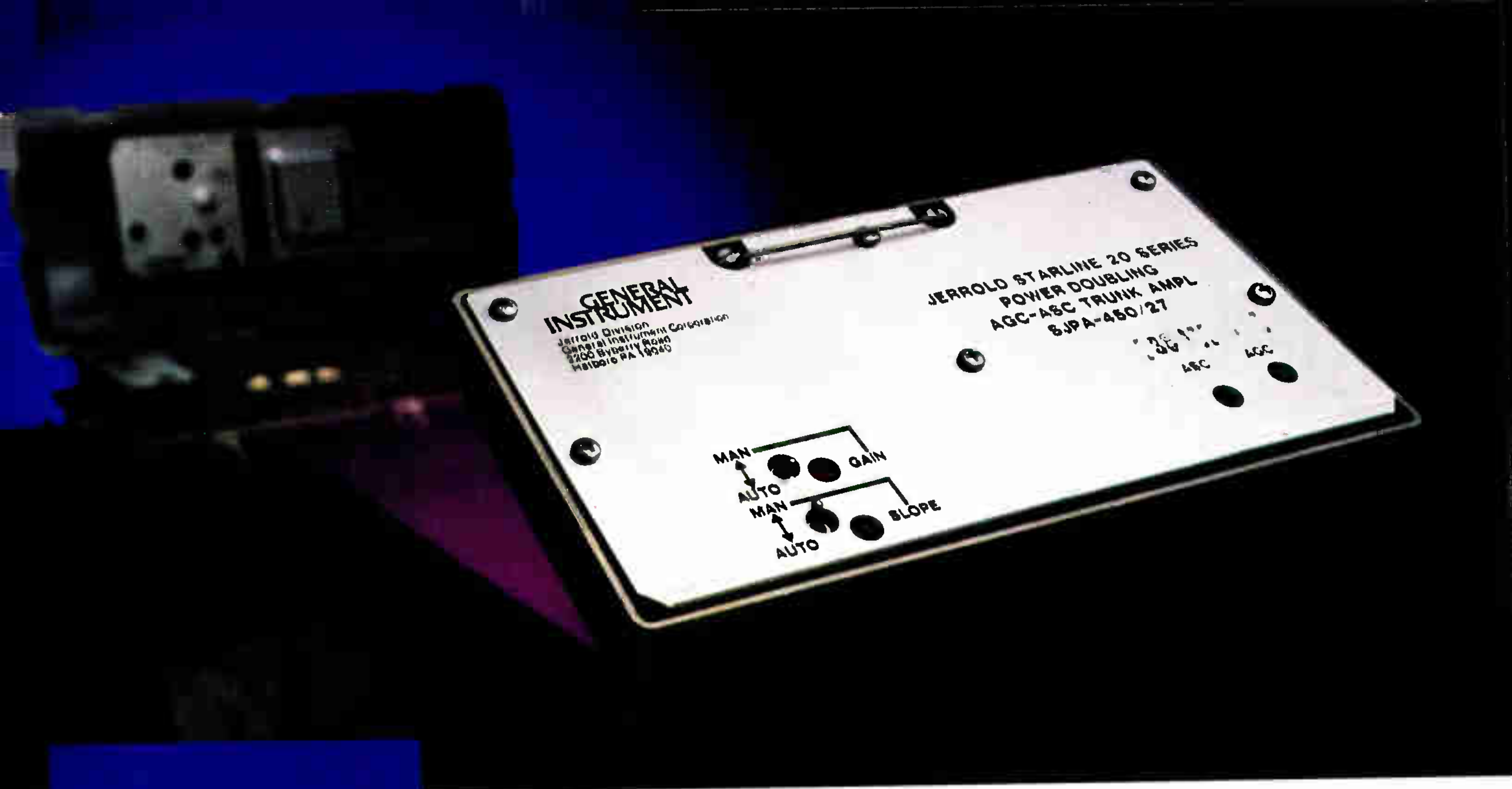
Multiports in a storm

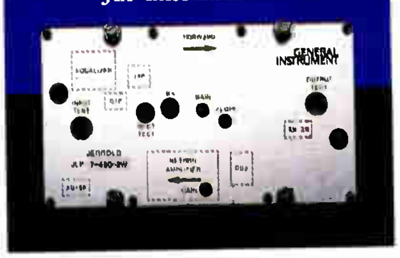
The possibility of multiple HDTV standards and a variety of formats that would have to be input to the TV set still looms large. "If we go through that," says Hayashi of Pioneer, "we may be better off to look into a device within the TV set which has the ability to adjust, to descramble and be encoded."

"I think MultiPort is essentially mandatory if we are to have a rational move forward into HDTV," says Walt Ciciora, vice president of technology at American Television and Communications (ATC). Ciciora is the chairman of the EIA-NCTA Joint Engineering Committee which coordinates consumer electronics issues to fit cable needs. Established seven years ago, it's this joint committee's subcommittees that generated specifications for IS-6, the tuning standard, IS-15, the "MultiPort" baseband decoder interface standard, and is continuing to develop IS-23, the RF interface standard.

Ciciora believes converters, as traditionally used in cable television, have to be done away with. "Converters process the signal one more time and in an environment where very high quality is required. I think that the additional degradation generated by the tuner and remodulator, or the heterodyning device, depending on whether it is a baseband converter or an RF converter, just won't be acceptable. The technology of putting great pictures on a large screen is going to be so demanding that there won't be room for the damage that a converter would do. That's why IS-15 or MultiPort becomes important because that allows you to avoid a converter/descrambler ahead of the TV set's tuner."

Descrambling in a MultiPort approach would be handled after the

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tuning function. "The TV set's tuner tunes the channel, demodulates, creates the baseband signal," explains Ciciora. The signal is looped out to a descrambling device. "And then, at baseband, it is descrambled and reinjected into the TV set at baseband without modulation. So, instead of putting two tuners in cascade and a modulator, we will have just one tuner and no remodulator." IS-15 also allows the consumer to use the remote control and the VCR in ways they were designed to be used. And the EIA members are in favor of the MultiPort approach, says Ciciora, "because that allows the consumer electronics industry to sell high-end products with fancy tuners and timers and all kinds of features that get spoiled when you put a converter ahead of a TV set."

Krisbergh feels it is a strategic issue and to design TV sets with all the intelligence built inside rather than having a box outside the TV set do it, decreases the flexibility of the configuration. "If you have an outside converter which can be changed and altered to deal with different security requirements and high definition standards that come along, and just let the TV set be a standard monitor," it would be more ideal, in Krisbergh's view.

And then there are those who are pessimistic about whether set manufacturers will provide the necessary outputs on HDTV sets for MultiPort to function. Anixter's Hart says, "What I have heard from the set manufacturers is that they are not intending to do that, but ... it's still very open to discussion. What I heard was it was their intention to provide a chrominance and a luminance output, a Y/C output and an audio output, on the back of the TV set."

Hart points out, "There was so much difficulty trying to reach a standard for IS-15 just for NTSC TV sets, I'm not sure the TV set manufacturers want to hold up production for a year or two or however long it takes to do that. I think they'd go to market with the TV sets first, especially since no one really knows what the descrambling units are going to have to do."

On- and off-premise

Another alternative to the converter box, with all it's signal processing complexities and possibly redundant functions, is the off-premise approach to controlling access and removing expensive converter functions outside the home. "That argument has been on-going now for 10 years," Wechselberger points out, "and I still think there's not a resolution."

Hart says, "It seems to me that off-premise technology can provide more flexibility in the long run, both for HDTV and for existing NTSC. It can also provide addressable capabilities." Hart feels off-premise approaches could be more compatible with HDTV than scrambling methods, and easier."

According to Krisbergh, "The key issue is the need to individually control a home with sophisticated addressable hardware. By putting an addressable technology in the home, you in effect are more consumer unfriendly. You require multiple handhelds. You increase the requirement for converters per TV set, and so on. The argument for off-premise really deals with improving that consumer friendliness. By doing it outside the home and feeding into the home a clean, unscrambled, uncontrolled signal, it allows multiple TV sets to have the signal without having a converter on each set."

Ciciora takes a different view. "I think off-premise converters will prob-

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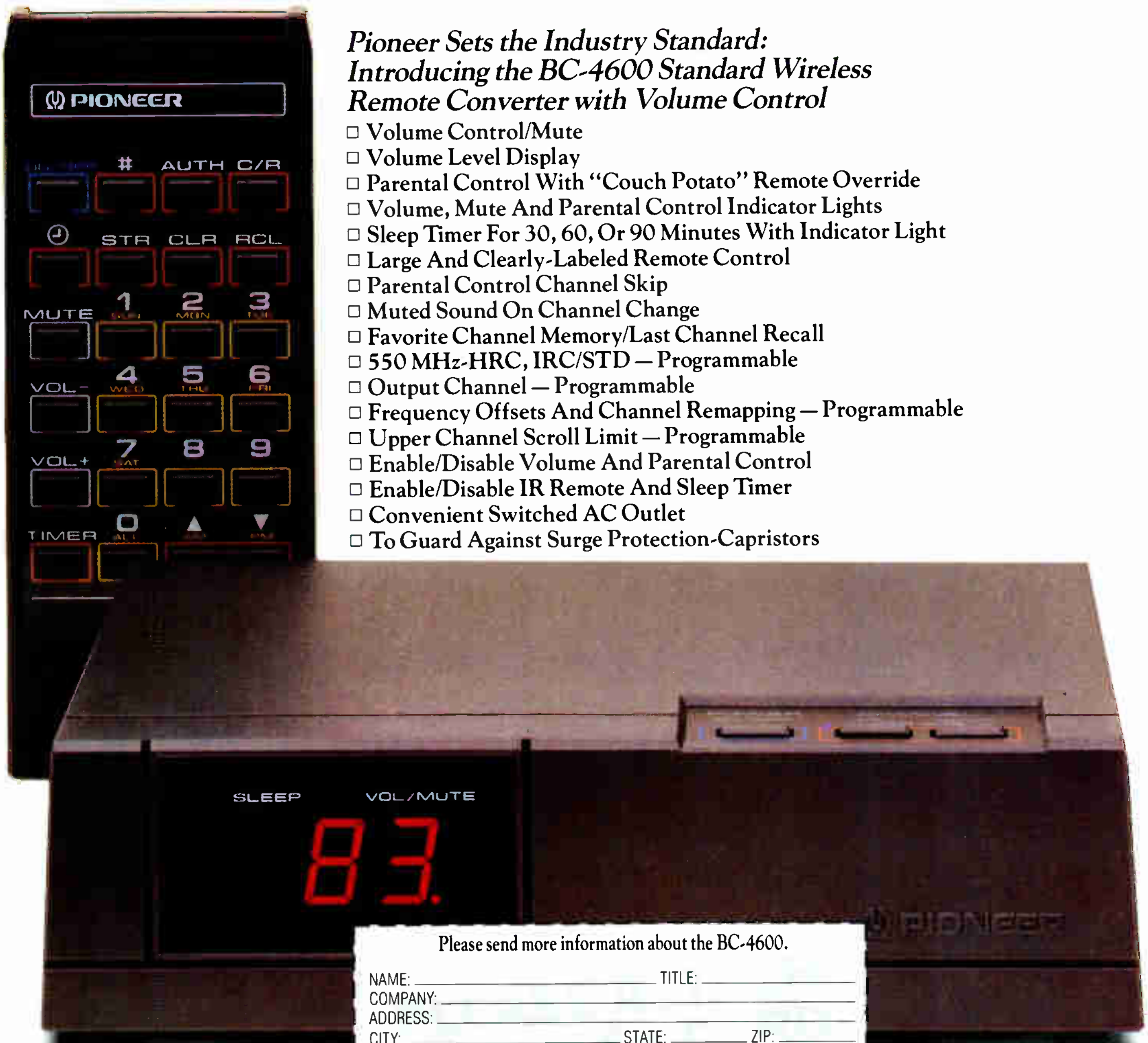

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ably never see the light of day again. Off-premise jammers, interdiction devices, might very well. The off-premise approach is probably the most consumer friendly approach you can imagine—next to traps."

"An interdiction approach is very similar (to traps) in that it allows that same capability and, in addition, it is addressable. So it helps with the pay-per-view needs, and so forth." Ciciora feels it would be attractive from a consumer electronics interface standpoint as well.

But an off-premise interdiction system could also help in reducing the processing of a signal, which would be desireable in an HDTV environment. According to Steve Nussrallah of Scientific-Atlanta, "The beauty of it as we look forward to HDTV, is that the off-premise technology is a program denial system which is independent of any transmission format."

Steve Necessary, also of S-A, points out, "The off-premise system that we are developing now, and announced at the Western Show last December, involves sending the signal through the distribution plant in the clear." At a point outside the subscriber's home, typically in a strand- or pedestal-mounted device, any signal carrying programming that the subscriber is not purchasing will be jammed by a carrier injected directly on that signal.

Necessary adds, "The beauty of that as we move into HDTV is that regardless of whatever method of HDTV is chosen, be it the augmented channel approach or the simulcast approach, we can move those jamming carriers dynamically between a variety of frequencies so that we obliterate or deny that channel as needed."

But off-premise technology, including interdiction approaches, involve significant costs both for the equipment and installation. Says Ciciora, "It's important that the cost be understood and dealt with." It is questionable whether the cable industry will accept the additional up-front costs.

"The thing about off-premise is it is an up-front cost right at the very beginning and you have to install it essentially outside all homes. Whereas, with an IS-15 approach," Ciciora claims, "or even with a set-top converter/descrambler, you install a box only when you add a customer who's taking a premium service. So, your capital investment tracks your increase in revenue, which is a very nice way to have things happen, versus the other approach (off-premise) where you have a huge capital investment up-front even outside homes of people who aren't subscribers."

In the Interim

We will be waiting for true HDTV for many years. Experts hold various timetables for it's introduction and market penetration. "In general, our view of high definition is that it will be longer in implementation than shorter," says Jerrold's Krisbergh. "There's a lot of optimism in the market that HDTV will happen tomorrow. We feel that it's impact will be in the five to 10 year frame." If pressed, Krisbergh will admit that if we have to wait for increased spectrum space, for the broadcasters to sort it out, and for people to buy HDTV sets, we could be waiting 20 years. But Krisbergh assumes that either cable or videotapes will provide the early introduction.

The chicken-and-egg question revolves primarily around the diffusion of HDTV sets and that's tied to cost. Brugliera at Zenith points out, "If you want the technology to diffuse fast, then you continue with existing display technology. If longer term, you feel that for aesthetic and other reasons you want the wider aspect ratio, you are obviously going to incur a larger cost for displays."

In the meantime, there is still a traditional converter market with new services coming on-line that will impact design, such as pay-per-view and the necessary addressability. With the slow advance of HDTV, Hayashi doesn't think the technology will be a problem for converter manufacturers. "There are many things that could be done and would have to be done to today's addressable converter design that would make it better than it is today, not even considering HDTV."

Enhanced NTSC

Something else that many people are positive about for the interim is enhanced NTSC. The leading enhanced NTSC system is the one designed by Yves Faroudja of Faroudja Labs. "I think there are merits to his approach," says Hart. The Faroudja strategy would be to improve NTSC signals for the interim and wait until we have truly digital high definition television before rolling out a new transmission format.

"If digital is coming, it will come later than analog," advises Krisbergh. "Should the industry wait the extra years it will take for digital to become economical, or jump now with the analog approaches that are more short-term? The answer is that Faroudja provides an interim stopgap."

But if cable waits for digital technology, the telephone industry may sieze the opportunity to compete. "I've seen people take both stands, that if we don't move forward with high definition, the telcos will and we will be left out," offers Hart. "But I think it's probably equally valid to say if we go with a high definition standard and the telcos come out with a digital one, that we'll be the ones left out."

But others hold other views. "I don't see any significant penetration in a real sense of fiber for the telephone industry into our business," says Wechselberger. "I see a significant penetration by telephone companies into our business in the next eight years, but it won't be through fiber. It's because they are smart businessmen and they are going to buy their way in and they are going to learn to become operators."

"To simply link high definition and fiber to telcos," explains Krisbergh, "a year ago was a big issue. What has happened in the past year is it is a dog with no bite, a snake with no poison. To do video switching, digital switching, and do it on a mass basis across the country, is in the $500 billion range in terms of investment, and we are talking 20 or 30 years to implement such a strategy. So, I think the issue of telco-cable," continues Krisbergh, "in terms of fiber coming in and overwhelming cable has been proven to be moot at best and ridiculous at worst. My own feeling is that the issue of what makes sense for the American consumer is probably whether we should delay HDTV an extra few years for digital, and I would say there are merits in that strategy." ■

—George Sell

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National Wats: . . . .(800) 336-ACES
FAX: . . . .(512) 331-8676
505 Cypress Creek
Cedar Park, TX 78613
PERSONNEL: Jim Jennings, VP/Operations, CATV; Jack Hooper, General Manager/ACES.
DESCRIPTION: Converter service for the cable television industry throughout the United States. Qualified for service on Jerrold, Hamlin, Regal, Scientific-Atlanta and Oak converters, specializing in digital and addressable converter repair. ACES also repairs headend and line equipment, and sells remanufactured converters to the CATV industry.

CBA CABLE BUSINESS ASSOCIATES, INC.

Cable Business . . . .(312) 237-2400
Associates
FAX: . . . .(312) 237-8605
A subsidiary of Cable Exchange, Inc.
1944 N. Naragansett Ave.
Chicago, IL 60639
PERSONNEL: Harold Bjorklund, President; Mike Harnett, Vice President, Sales.
DESCRIPTION: Cable Business Associates operates multiple full service repair and modification centers, concentrating on CATV converters and line equipment. We specialize in Jerrold addressable (digital and analog), Zenith Z-Tac, Pioneer, Scientific-Atlanta, Oak, RCA, Texscan and Hamlin. We are a Panasonic factory authorized repair center and parts distribution center.

Cable Link Inc.

Cable Link, Inc. . . . .(614) 221-3131
280 Cozzins St.
Columbus, OH 43215
PERSONNEL: Jack Davis, President; Bill Holehouse, Director of Sales.
DESCRIPTION: Cable Link Inc. **buys, refurbishes** and **sells CATV equipment**. We sell and service line amplifiers, line extenders, passives, positive/negative traps, plain and descrambling converters, addressable converters (Jerrold, Oak and Scientific-Atlanta), character generators and parts. Services offered include: complete system design, strand mapping, make ready survey, walk-out service, base mapping, and Computer Aided Design (CAD).

ColorView

Colorview . . . .(800) 824-1943
Services Inc.
FAX: . . . .(505) 884-0145
4946 Jefferson N.E.
Albuquerque, New Mexico 87109
PERSONNEL: Tony Grundler, General Manager; Kathy Cooper, Marketing Director.
DESCRIPTION: Established 1953. Converter repair service, all phases. We pay freight both ways. Six month warranty. Programmable/addressable Jerrold, Oak, Hamlin, Scientific-Atlanta.

L.C.E.

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L.C.E.—Long Cable Electronics, Inc.
Converter repair: . . .(518) 393-5415
Parts: . . . .(518) 393-7976
FAX: . . . .(518) 393-7977
112 Erie Blvd.
Schenectady, N.Y. 12305
PERSONNEL: Dale Hedman, Vice President, Repair/Sales; Ned Zibro, Parts.
DESCRIPTION: Converter repair—low cost, flat rate billing, quick turnaround on most brands. Up to date facility specializes in addressable repair. Sales—large inventory of rebuilt converters available. Parts—many hard to find parts available, cosmetics, semiconductors, hardware. FREE catalog—useful substitution guide.

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FAX: . . . .(609) 547-5032
141 Shreve Ave.
Barrington, NJ 08007
PERSONNEL: Robert Mai, Jr.; Tom Girard.
DESCRIPTION: Has serviced the cable industry since 1980. Repairs and sells converters for major MSOs in the United States and Canada.

SCI CATV Services

SCI CATV Services . .(619) 438-1518
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2245 Camino Vida Roble
Carlsbad, CA 92009
PERSONNEL: Tim Mullennix, General Manager; Tom O'Brien, Sales Manager.
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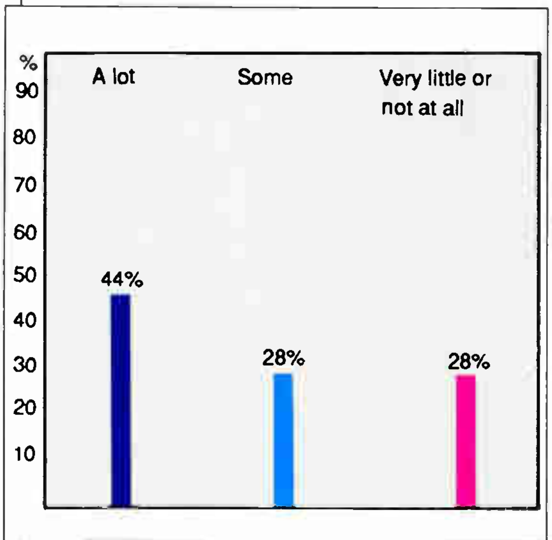
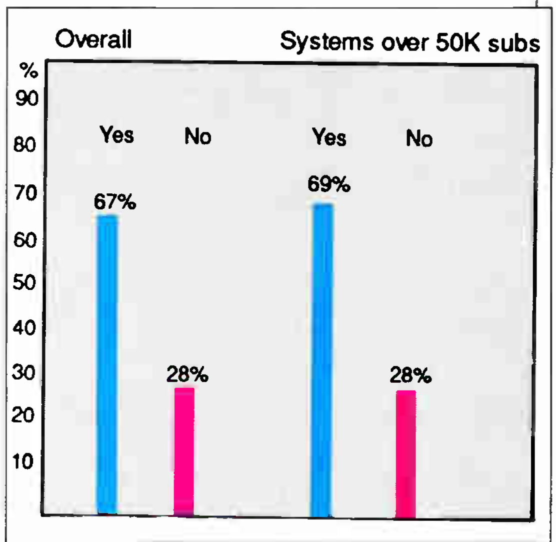
Fiber is the future for CATV



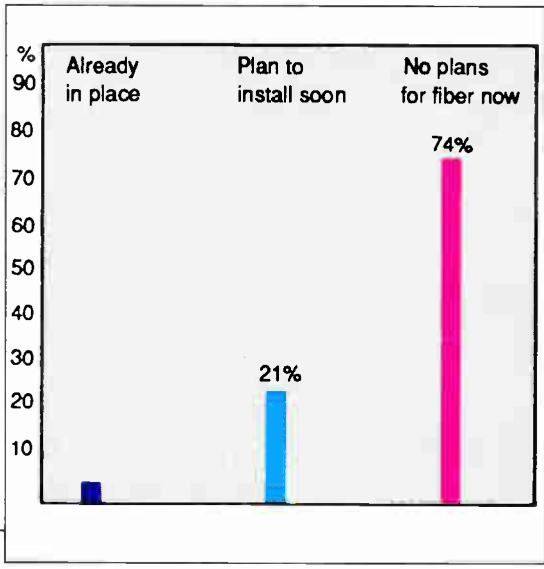


Two out of every three managers believe that fiber optics eventually will replace coaxial cable throughout the distribution network, a surprisingly large percentage that holds whether the question is put to executives at large or small systems, those affiliated with major MSOs or small companies.

According to data from the Cable Poll©, 67 percent of respondents see fiber as the technology of the future while 28 percent believe coaxial cable will continue to play some role in signal distribution. But somewhat perplexingly, 74 percent of the same sample said they have no present plans to install fiber optic technology. Three percent of those asked said they already have installed some fiber in their systems while 21 percent said they plan to install fiber in the near future.

The percentage of respondents saying they plan to install fiber doubles from 14 percent at systems serving fewer than 10,000 subs to 28 percent at systems with between 10,000 and 50,000 subs. At larger systems, 41 percent responded positively.

The cost of fiber technology is much on the minds of managers, with 44 percent of all respondents saying it concerns them "a lot." Twenty-eight percent say cost is of "some" concern, while 28 percent said cost concerns them little or not at all.



Just as in the question about whether fiber eventually will replace coax, the relative concerns about cost deviate little from large to small systems or from large to small MSOs.

Forty-one percent of respondents from Top-25 MSOs claim the price tag for implemented fiber is an important concern, compared with 43 percent among those surveyed from other Top-100 operators; and 47 percent from MSOs below the Top-100 ranking. Holding no concerns about cost whatsoever: 16 percent of respondents from the Top-25 and 26-100 brackets, and 19 percent of other operators surveyed.

The CABLE POLL

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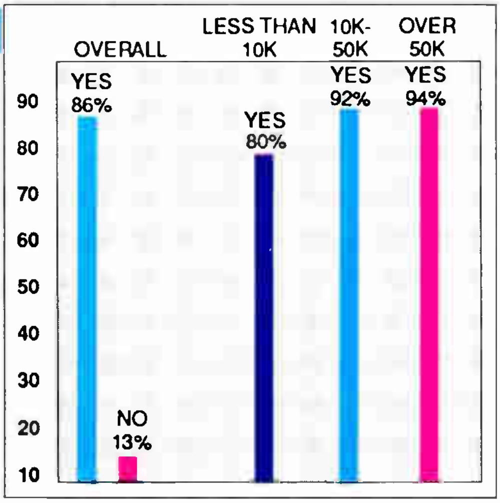
Hectic rebuild pace thru '89

More than half of all cable systems will undergo a rebuild or upgrade in the coming year or have completed one in the past year, according to Cable Poll© data.

This hectic pace of plant improvements is more prevalent at smaller systems. While five out of every 10 systems owned by a top-25 MSO have a rebuild planned or have completed one recently, six in 10 systems owned by MSOs outside the Top-100 are in the same situation. Overall, 56 percent of systems have recently completed a rebuild or plan one, according to Cable Poll© data.

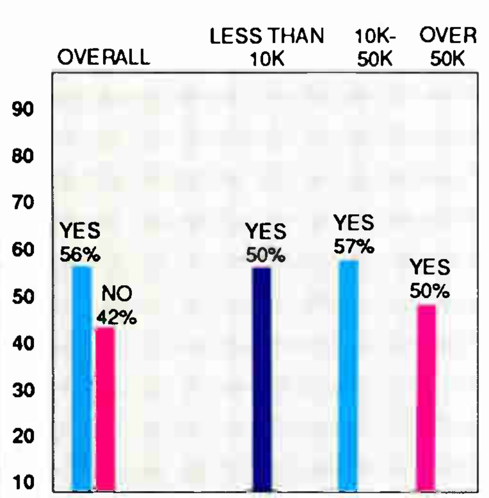
Coming through loud and clear from the responses is that the need for increased channel capacity is a significant reason why operators are rebuilding their plants. Overall, 86 percent of systems at which upgrades or rebuilds have occurred or are planned mentioned channel capacity as a factor, a figure that rises to 92 percent of systems consisting of 10,000 to 50,000 subscribers, and to 94 percent of systems with more than 50,000 subs.



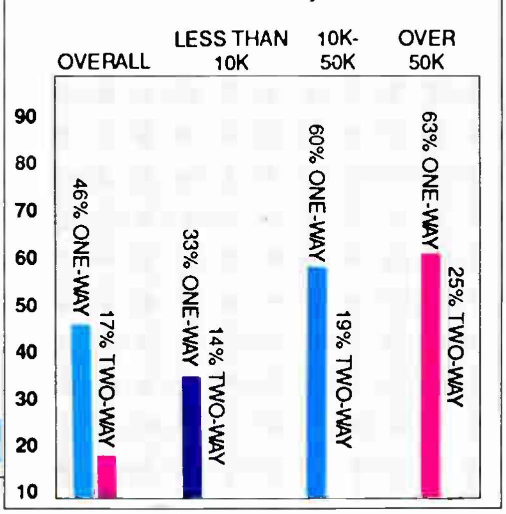
Beyond adding channel capacity, systems are focusing on addressability. Overall, 46 percent of respondents said their plant improvement includes one-way addressability, but that percentage rises noticeably at larger systems or at systems owned by large MSOs. At systems owned by Top-25 MSOs where a rebuild is planned or was completed in the last year, 57 percent of the projects include one-way addressability, a figure that rises to 63 percent of systems with more than 50,000 subs.

The Cable Poll© is a sampling of industry opinion conducted on a regular basis by Ryan/Samples Research Inc. for Midwest CATV and *CableVision* magazine. Telephone interviews for these two editions of the poll were conducted March 13-23; a total of 400 interviews were completed using a listing of system management personnel obtained from CableFile Research. Cable Poll© researchers are 95 percent confident that the results are accurate within ±4.9 percentage points. ■

In the past year or the year ahead, will your system be rebuilt?



Does your rebuild include one-way or two-way addressability?



Fiber optic cable design: What to consider

Cable television engineers are deploying fiber optics in a variety of applications ranging from point-to-point links to the most complex point to multi-point systems. While the electronics used in these projects have received much of the attention to date, the role of the optical cable is just as important from the perspective of total installed cost, expected system performance and long-term reliability. This article presents those cable design parameters and performance specifications critical to a properly designed system. These basic guidelines should be considered in building an optical system that will meet the performance and reliability requirements necessary to insure decades of useful system life.

Basic cable design

The purpose of an optical cable is to protect the fibers from damage due to the rigors of both installation and environmental conditions. There are three main applications for optical cable and specific cable designs should generally be used to address each one: non-armored cable for underground (duct); armored cable for direct buried; and all-dielectric cable for use in aerial plant. These different designs each offer distinct advantages in the applications for which they are intended. If a single design is used for all applications, reliability and overall system performance will ultimately suffer due to the lack of optimization inherent in the "one size fits all" concept.

By Gary Lyons, CATV Sales Engineer, and Jay Scott, Senior Project Specialist, Siecor Corp.

Cable construction

The most widely accepted design manufactured today for outdoor use is the loose tube cable design. This design has been proven in more than 10 years of actual field experience. For a typical cross-sectional view of a loose tube cable, see Figure 1.

The loose tube cable should employ color-coded plastic buffer tubes to house and protect the optical fibers. The tubes are filled with a filling compound to impede water ingress and cushion the fibers from stress by allowing them to "float" within their respective buffer tubes. Most manufacturers extrude a single layer of buffer tube material around each fiber bundle. Other manufacturers employ a dual layer tube to provide superior crush and kink resistance by using differently optimized materials for the inner and outer layer of the tube.

In order to allow the optical fibers to remain in a relatively stress free state, a percentage of fiber overlength relative to sheath length is provided by the stranding process. This "helizing" of the fibers allows the fibers to be insulated from the stresses that the cable experiences during installation and under environmental loading. Refer to Figure 2 for a cross-sectional view of a stranded loose tube cable under various load conditions.

Another method of accomplishing the same goal is to utilize rigid steel or dielectric strength members within the cable. This approach greatly reduces the cable's ability to elongate under load or contract at low temperatures, thus eliminating the need for fiber overlength in the cable. While in principle this is a sound design option, it results in a very stiff cable that is difficult to handle and strip.

To construct the cable core of a stranded loose tube cable, the buffer tubes are stranded around a steel or dielectric central member). The central member serves as an anti-buckling element to protect the cable from contraction forces at low temperatures. Some manufacturers will utilize the central member as a strength element, but this is a cost consideration, not an optimal design approach.

The strength element normally consists of an aramid yarn or an aramid yarn/fiberglass combination applied directly over the stranded cable core. The standard tensile rating is 600 pounds but can vary depending on the specific application (customer requirements).

If a layer of armoring is required because of concerns about wildlife damage, a corrugated steel tape is formed around a single polyethylene jacketed cable. An outer polyethylene sheath is then extruded over the armor. The sheath (jacket) enhances the cable's

36-Fiber Loose Tube Cable Dielectric Central Member/Armored

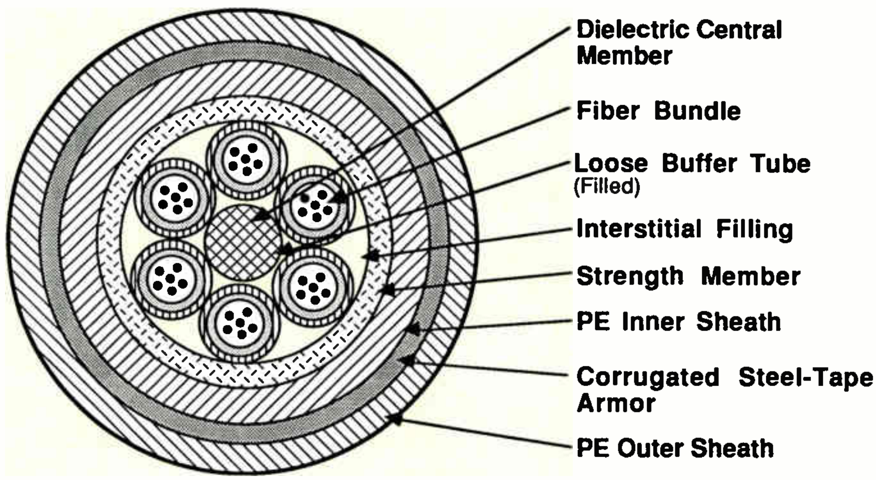


Figure 1

resistance to moisture penetration and provides protection from ultraviolet radiation.

Cable design considerations

Just as different applications for coax require different sizes and types of cable, applications for optical cable will require different sheath and/or core designs and fiber counts.

Within aerial plant, unless there is a significant potential for wildlife damage, a non-armored fiber optic cable should be used (preferably all-dielectric cable). See Figure 3 for an example of an all-dielectric cable. This type of cable significantly reduces the concern over possible lightning damage. Historically, almost all of the aerial fiber optic cable that has been installed is of a non-armored design.

This same non-armored cable with either a dielectric or steel central member should be deployed in underground (duct) applications. It is lighter and more flexible than armored cable and can be pulled into conduit quickly.

If armoring is a requirement because of a known wildlife problem, it is recommended that an armored cable with a copolymer coating be used (preferably with a dielectric central member). This type of armored cable will provide maximum lightning protection. Bell Communications Research Inc. (Bellcore), the organization that performs testing for the Bell Operating Companies, has established a lightning test for outdoor fiber optic cables that rates cables as to their susceptibility to lightning damage. The highest rated cables perform at a Category 1 level (those cables that pass the test at 105 kiloamperes).

Apparently, it is felt that since less than 3 percent of all measured lightning strikes on aerial cable are greater

Fiber Optic Cable Under Various Load Conditions

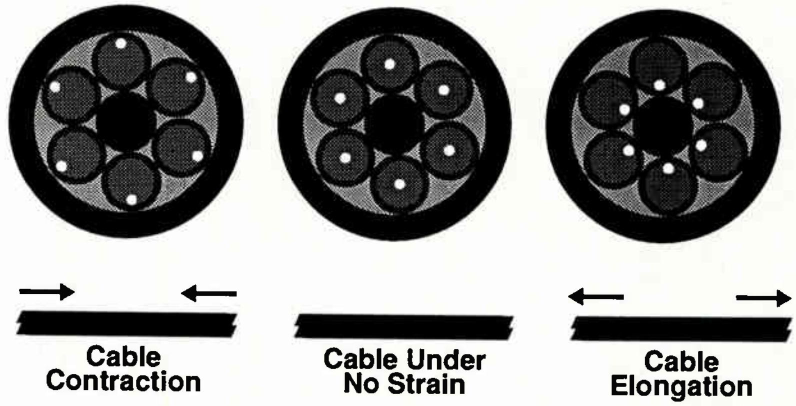


Figure 2

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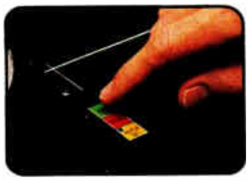

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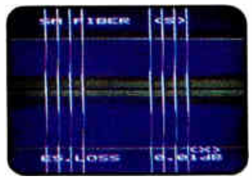

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10:06

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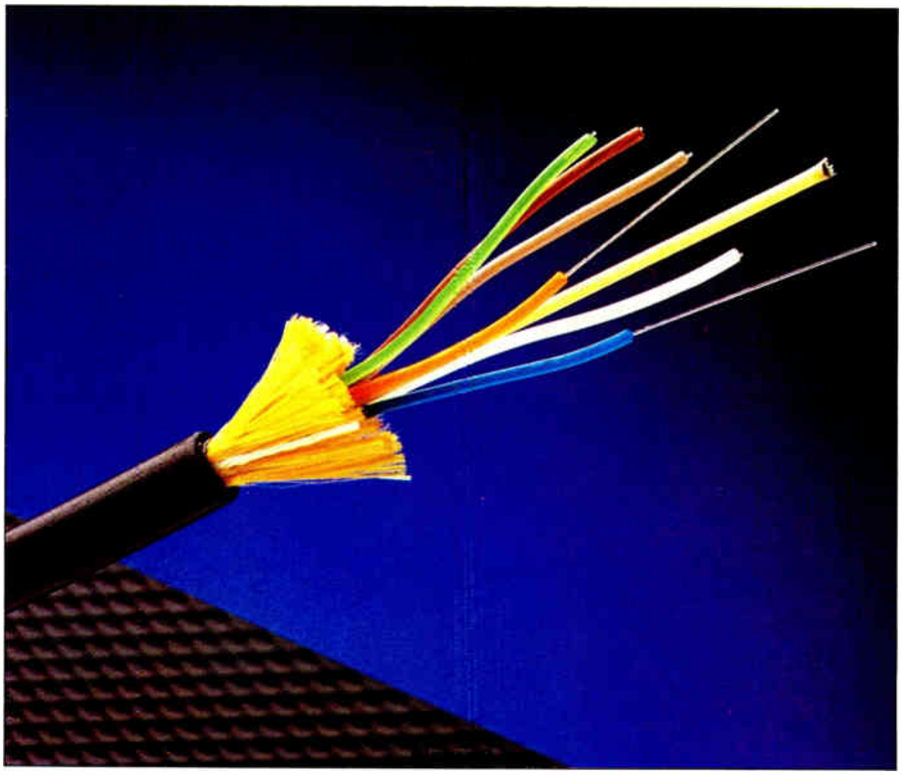


than 105 kA, those cables that can pass at this level have the highest probability of surviving in a lightning environment (see Figure 4). From a reliability standpoint, when considering an armored cable for aerial use, the lightning damage susceptibility of the various available cable designs should be closely examined. (Refer to Figure 5 for different cable performance levels.)

Fiber count selection can be a difficult task given the current uncertainty within the CATV industry relative to channel loading, optimum architecture and future system requirements. Fiber count requirements may range from as low as one fiber to as high as 192. Past experience has shown, however, that typical fiber counts have been eight to 12 for point-to-point projects and eight to 60 or more for larger point to multi-point systems with multiple drops.

In order to accurately determine the number of fibers needed, it must first be determined how many channels will be transmitted on each fiber. This number will vary depending on the electronics being used, the required end-of-line signal specifications and the architecture being employed.

Once the channel loading has been determined it is generally accepted that anywhere from two additional fibers to total fiber redundancy (one spare fiber for every one active) be built into the cable to accommodate additional growth and/or revenue opportunitites. This methodology has proven cost effective because the incremental cost of fiber decreases with the increase in fiber count and installation costs are such that placement of an additional parallel cable in the future should be avoided if possible.

When higher fiber counts are required, proper selection of a cable design that can gracefully accommodate and segregate the fibers will prove beneficial in the construction and maintenance of the cable plant. For most systems, particularly those with multiple break-out (drop) locations, a cable which houses the fibers in multiple colored buffer tubes will simplify fiber splicing and administration. This type of cable design is most beneficial during initial splicing and restoration splicing since only fibers in one buffer tube need be exposed at any one time. Conversely, if all of the fibers in the cable are contained within a single core tube, every fiber will be exposed each time splicing is performed, thus increasing the potential for fiber damage.

Another feature available from some manufacturers of loose tube cable is the ability to package varying number of fibers in each buffer tube. This results in maximum flexibility in planning the fiber route by allowing the design engineer to drop specific buffer tubes containing a specified number of fibers at the required locations within the system. All other fibers in the cable remain protected with only those fibers designated for each drop location being exposed.

As with most new technologies and products, few people realize the significant difference in product performance available from different manufacturers. In some cases the differences are obvious after a simple review of the product specifications but in other cases one must look more closely at

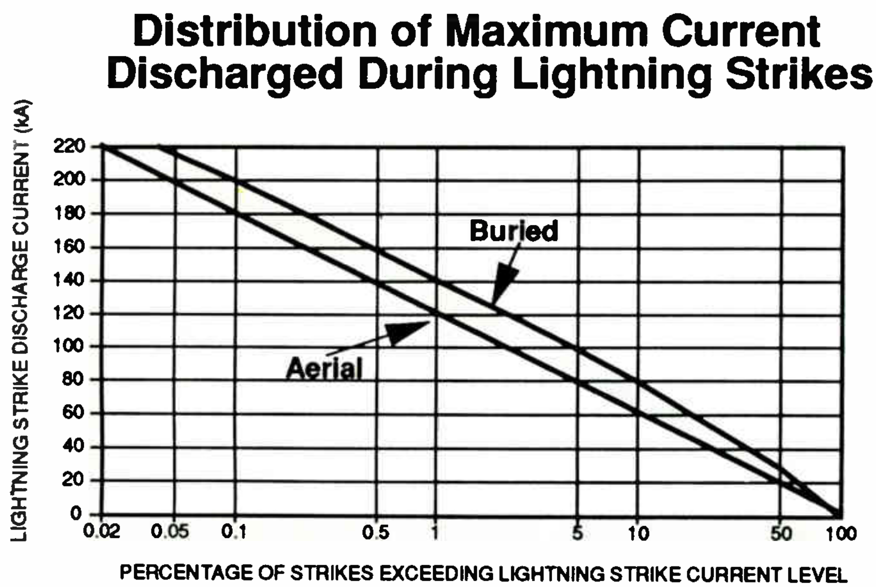
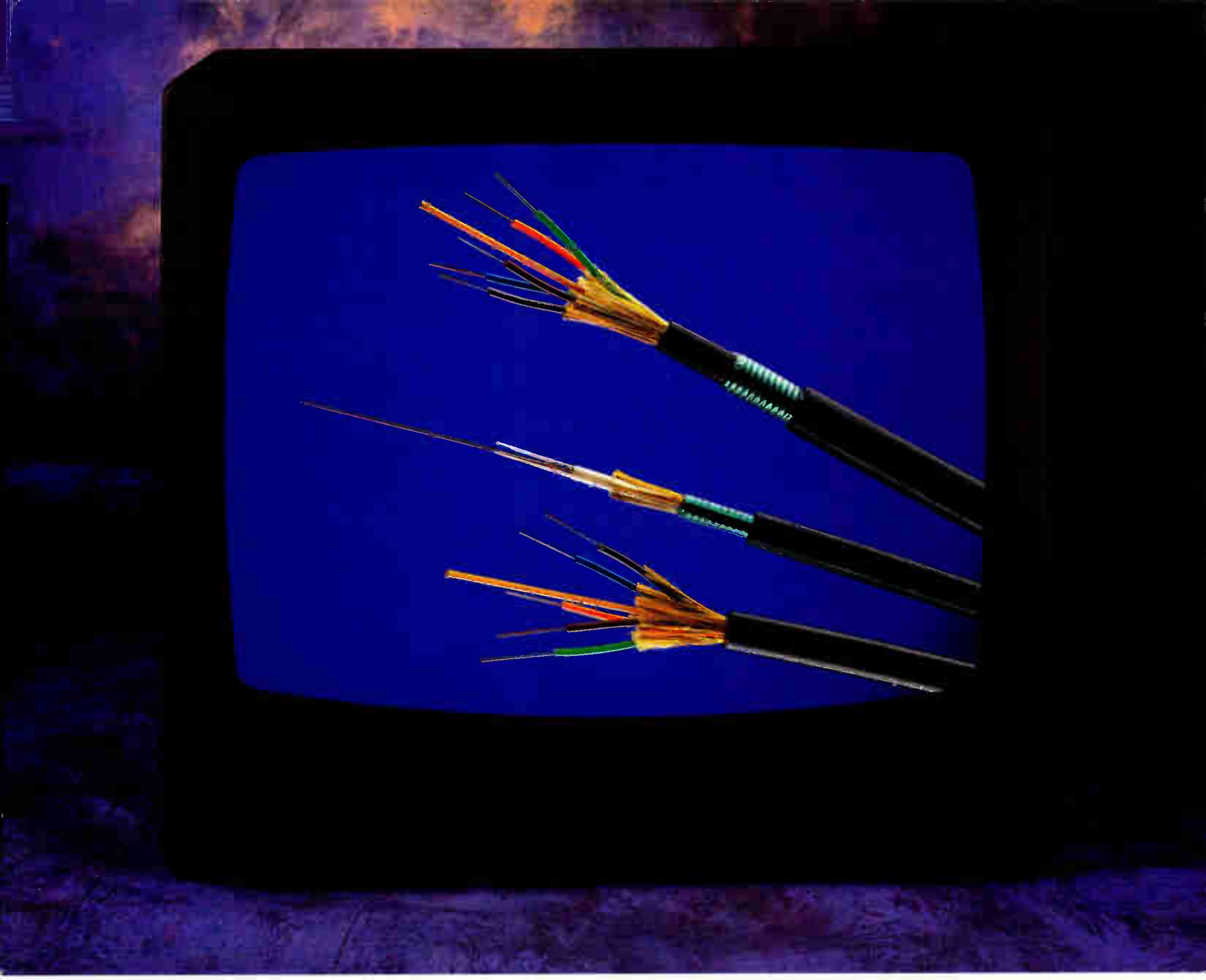


Figure 4



have more confidence in a cable that has been shown to have excellent performance characteristics at both 1310 nm and 1550 nm.

Dispersion, which is another important fiber parameter, is the normal "tendency of the fiber to distort the shape of the transmitted signal." Most of the signal distortion is caused by chromatic dispersion which is determined by the fiber's material composition, structure and design as well as by the source's operating wavelength. Chromatic dispersion is measured in units of picoseconds (10^{-12}) of light pulse spread per nanometer (10^{-9} meters) of laser spectral width and per kilometer of fiber length (psec/nm-km). Standard singlemode fibers are optimized for zero dispersion characteristics near 1310 nm.

Changes to the structure of the fiber (i.e. variations in refractive index and core geometry) will shift the zero dispersion point. Some fiber manufacturers have developed a special dispersion-shifted fiber which has its zero dispersion wavelength centered at 1550 nm. It is important to recognize that most lasers are not yet capable of continuous transmission at a single discrete wavelength; hence the requirement for specifying dispersion over a wavelength range.

The last parameter that can have significant implications on the performance and maintenance of a single mode fiber system is the fiber's cut-off wavelength. This is the wavelength at which the fiber transmits a single mode (or ray) of light as opposed to multiple modes. Typically, the fiber will have a cut-off wavelength between 1150 and 1330 nm, although it may be as high as 1350 nm.

The fact that the cut-off wavelength may be higher than the operating wavelength does not pose a problem in cables utilizing matched clad fiber since the typical two- to three-inch bend in the splice enclosures attenuates any higher order modes leaving the single fundamental mode unaffected. With a depressed clad fiber, however, the higher order modes are not as easily attenuated; in those cases where the fiber's cut-off wavelength is above the transmission wavelength, the system may experience modal noise. This phenomenon has been encountered where two fiber splices are in close proximity to one another (i.e. less than 60 feet). This can result in a more time consuming, costly and cumbersome restoration process since an extra length of repair cable is required. ■

Figure 6

Spectral Attenuation

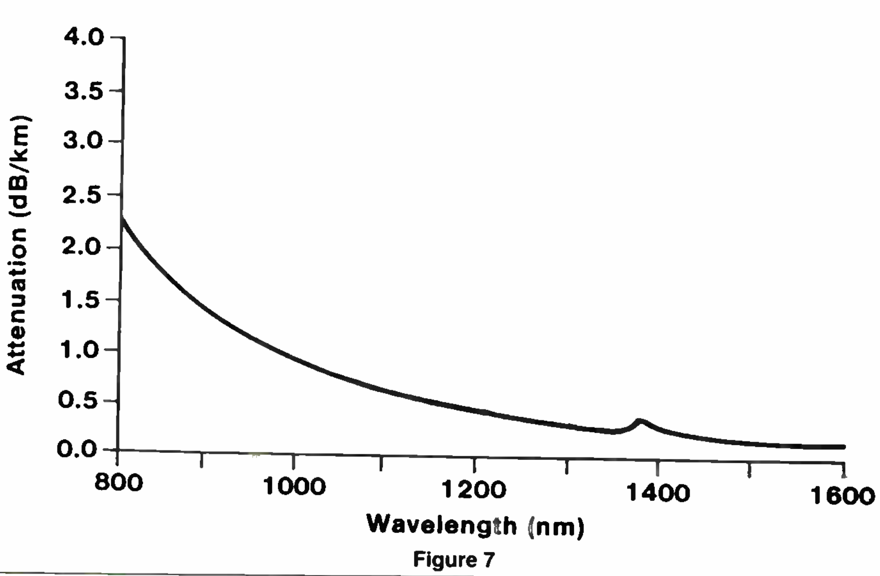


Figure 7

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Reader Service Number 64

How to spec an optical receiver

From all indications, CATV system operators seem to be split into two groups—those who are already using optical fiber and those who will be.

What has hampered the use of optical fiber in CATV systems has been the lack of suitable optoelectronic components for optical transmitters and receivers. This is especially true for AM fiber optic systems.

The accepted goal for AM optical link performance is that which has been promulgated by ATC's Jim Chiddix, i.e., transmission of 40 channels with 55 dB carrier-to-noise ratio (CNR), and 65 dB composite triple beat (CTB) and composite second order (CSO). This goal had yet to be demonstrated, but probably will be achieved before too long.

In the quest toward achieving this performance goal, most of the work has focused on the laser used in the optical transmitter. As optical transmitters have been progressively improved, attention has been shifted toward the optical receivers to make sure that they do not degrade the optical system performance. Optical receiver designs originally intended for digital, FM or medium quality AM systems have been found unsuitable for use in high performance AM systems. Further complicating the situation is a lack of quantitative measures of receiver performance to enable the system designer or user to properly ascertain the effect the receiver has on system performance.

Laser noise

The basic elements of an AM fiber optic transmission system are shown in Figure 1. The transmitter consists of a laser diode that has been biased into its linear region. The RF input modulates the current through the laser and thereby directly modulates the optical output. The optical output of a laser is of course not a perfectly linear function of its drive current. As a result, the laser is usually the primary source of distortion in an optical link.

In addition, the optical output of the laser fluctuates in a random fashion as shown in Figure 2. These fluctuations are over and above the fundamental quantum mechanical "shot noise" (described below) which will show up in the optical detector no matter how perfect the laser. The laser noise is usually described by a quantity called the "Relative Intensity Noise" (RIN). The word "relative" refers to the fact that the optical output power is fluctuating by a certain percentage. Mathematically the RIN is expressed as:

$$RIN = \frac{<P_{in}^2>}{P^2 \cdot B} \quad \text{(dB/Hz)}$$

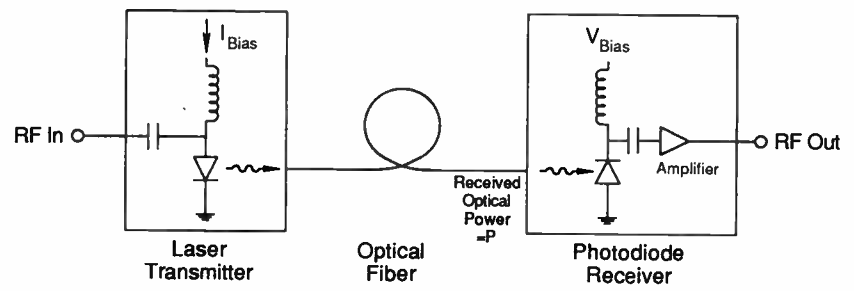
In other words, the RIN is equal to the mean square power fluctuations divided by the product of the square of power and the bandwidth over which the noise measurement was made. The RIN is generally expressed in units of dB/Hz. As an example, the RIN of an AM laser is usually at least as low as -150 dB/Hz.

To illustrate the utility of the RIN, it is interesting to calculate the CNR of an optical link as if the laser noise would be the only source of noise in the optical link.

In the optical detector, the laser's optical power and its fluctuations are converted to electrical currents. If the light is modulated by an RF carrier to a modulation depth m, then the detected RF power will be proportional to $\frac{1}{2} m^2 P^2$. If we put all this together we get,

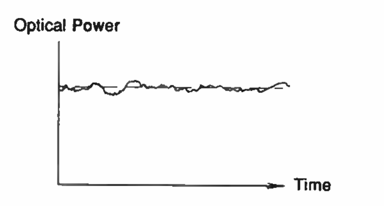
$$CNR = \frac{\frac{1}{2} m^2 P^2}{<P_{in}^2>} = \frac{m^2}{2 \cdot RIN \cdot B}$$

This is a very important expression since it sets an upper limit on the CNR that can be obtained from a given laser. For example, if a laser with a RIN of -150 dB/Hz is operated at a modulation depth of 5 percent per channel, then the CNR in a 4 MHz bandwidth is easily calculated to be 55 dB.



Basic elements of an AM fiber optic transmission system.

Figure 1



Fluctuations about the average optical power.

Figure 2

Shot noise

The most fundamental limitation to CNR in an optical link is determined by quantum shot noise. This arises from the fact that light consists of quanta of energy known as photons. The random arrival of individual photons is the direct cause of shot noise. The mean square shot noise fluctuation is given by (see "Reference"): $<P_{sn}^2> = 2h\nu PB$

By Dr. Israel Ury, Chief Technology Officer, and Dr. Henry Blauvelt, Director Long Wavelength Systems, Ortel Corp.

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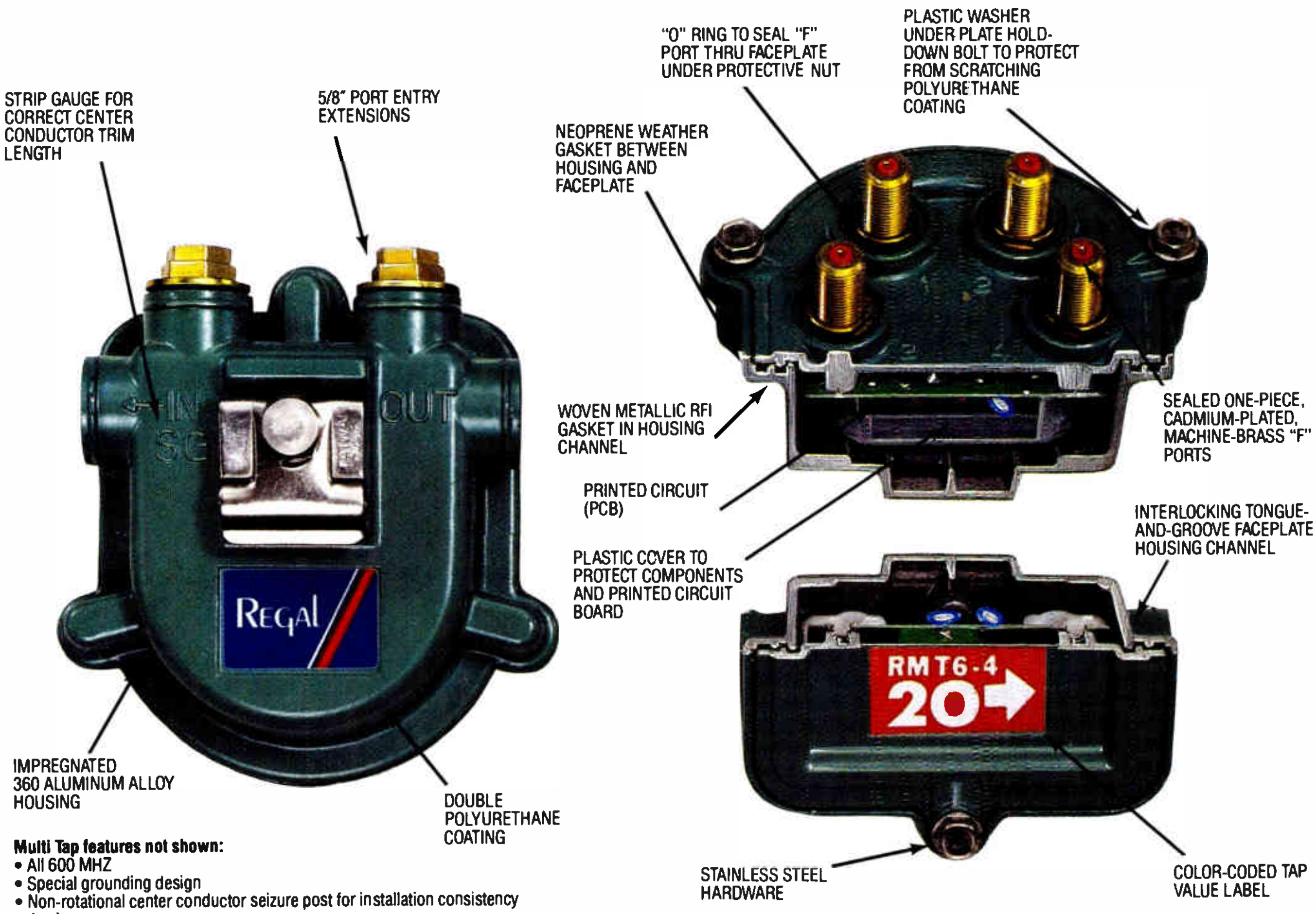

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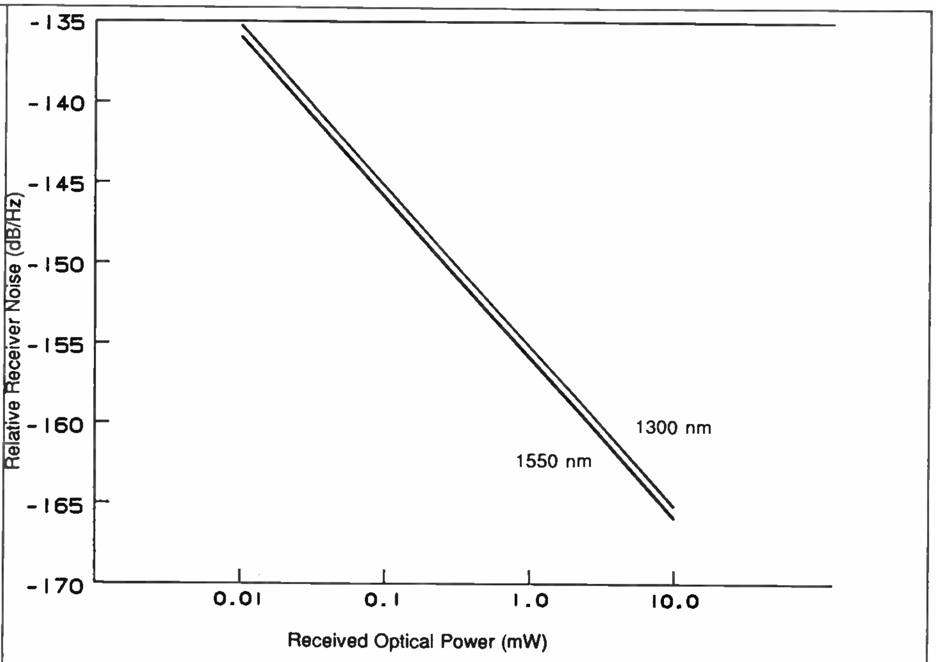
where $h\nu$ is the photon energy (the product of Planck's constant and the optical frequency).

We can calculate the theoretically best CNR obtainable for an RF modulated optical carrier by performing a similar calculation to the one we carried out for the case of laser noise. In the same way as before, we get

$$CNR = \frac{\frac{1}{2} m^2 P^2}{\langle P_{sn}^2 \rangle} = \frac{m^2}{2 \cdot (2h\nu/P) \cdot B}$$

By comparing the expression for CNR derived for shot noise to the one derived for laser noise, we see that we can define a quantity which we might call "shot noise RIN" which has the value $2h\nu/P$. This value depends only on optical frequency and on the received optical power. An example, and a worthwhile bit of information to remember, is that 1 mW of received optical power at 1300 nm corresponds to a "shot noise RIN" of approximately -155 dB/Hz. A graph of the theoretically best "shot noise RIN" versus received optical power is shown in Figure 3.



Theoretical limit to RRN (Relative Receiver Noise, or "Shot Noise RIN") Figure 3

Besides laser noise, there are two other reasons why the theoretical performance of Figure 3 cannot be obtained. First, optical detectors are not 100 percent efficient, and hence a fraction of the incident optical power does not contribute to lowering the "shot noise RIN." Secondly, the electronic amplifier that follows the photodiode can significantly degrade the link noise performance.

If we add in the contributions of laser noise, shot noise and amplifier noise, we get,

$$CNR = \frac{\frac{1}{2} m^2 P^2}{\langle P_{ln}^2 \rangle + \langle P_{sn}^2 \rangle + \langle P_{an}^2 \rangle}$$

where denotes the mean square equivalent optical noise that would lead to the perceived amplifier noise. Once the detector quantum efficiency is properly taken into account, the expression becomes,

$$CNR = \frac{m^2}{2 \cdot [\, RIN + (2h\nu/\eta P) + (h\nu/q\eta P)^2 \; (\langle i_{an}^2 \rangle /B)] \cdot B}$$

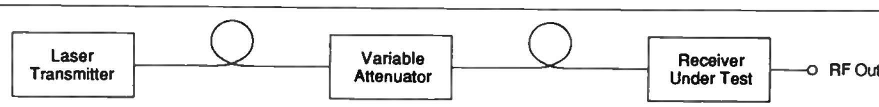
where $\langle i_{an}^2 \rangle$ is the mean square amplifier equivalent input noise current.

It is convenient to combine the last two quantities in the brackets, which correspond to shot noise and amplifier noise, into one quantity which can be termed the "RRN," or Relative Receiver Noise. This one quantity is the sought after measure of receiver noise performance. If we use this definition, the CNR can easily be calculated by means of,

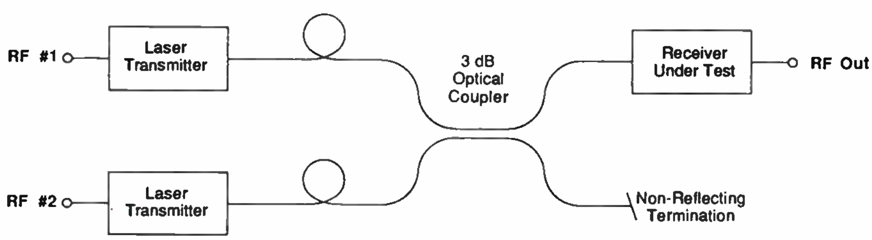
$$CNR = \frac{m^2}{2 \cdot [RIN + RRN] \cdot B}$$

This deceptively simple expression provides the CNR for the optical link if one knows the laser RIN, the modulation depth per channel, the receiver RRN, and of course the bandwidth.

A word of caution is in order in using this equation. It should be understood that the values of RIN and RRN are in this case numbers as opposed to decibels. For example, if the RIN and RRN are each -153 dB/Hz, then $RIN + RRN = 10^{-15}$. Another useful lesson to be learned is that it doesn't make much sense to have the RRN substantially worse than the RIN, since the full laser performance would not be utilized.



Setup for measuring RRN (Relative Receiver Noise)
Figure 4



Setup for measuring receiver distortion

Figure 5

Measuring RRN

Now that we have laboriously developed the concept of the RRN, the question becomes, how does one go about measuring it? The answer is provided by using the test set-up shown in Figure 4 along with our theoretical knowledge of how the RRN behaves with variation in the optical power.

The procedure for measuring the RRN versus power consists of performing several CNR measurements at various received average optical power levels. The received power is adjusted by means of a variable optical attenuator and is measured by means of an independent optical power meter.

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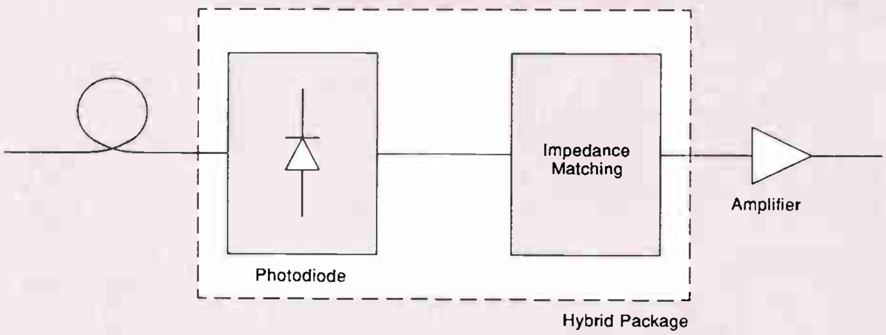
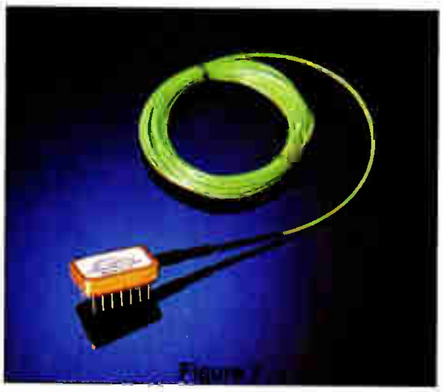


Using impedance matching to improve noise performance

Figure 6

Measuring receiver distortion

Unfortunately, it is not yet a simple matter to measure distortion in optical receivers. This is truly unfortunate because as CNR values have of neces-



sity increased, received power levels have improved, and hence the chance of distorting the receiver has become very real. In fact, most of the designs initially intended for digital or FM use, such as simple transimpedance amplifiers, do not provide adequate distortion performance at the optical power levels that are needed to achieve adequate RRN values.

The ideal solution for testing receiver distortion would be a multichannel modulated optical source that exhibited almost no distortion. A single laser diode, unfortunately, cannot achieve this level of performance.

An alternative test which has been proposed is the two-laser, two-tone test shown in Figure 5. Two lasers are modulated at two different RF frequencies, and their outputs are optically combined. The resultant optical output is applied to the receiver under test and the fundamental, second order and third order products are measured.

It is important that the lasers operate at slightly different wavelengths to prevent optical beat notes from obscuring the measurement.

A difficulty with interpreting the measurement is that it has not conclusively been determined how two-tone measurements should be used to predict multichannel performance. The requirement to maintain the wavelengths distinct, and the cost, make it impractical to construct a multi-laser multi-channel tester with any significant number of channels.

Impedance matched receiver

As mentioned above, it is challenging to design an optical receiver with very good RRN which does not distort the signal. Ortel's approach (patent pending) is to use impedance matching to more efficiently couple power from the photodiode into a low distortion electronic amplifier, as shown in Figure 6. The passive impedance matching network transforms the low input impedance of the amplifier to a higher impedance, which itself is more characteristic of the photodiode which behaves very much like a current source. To counteract the effect of parasitics, the impedance matching circuitry must be housed in a hybrid package in close proximity to the photodiode as shown in Figure 7.

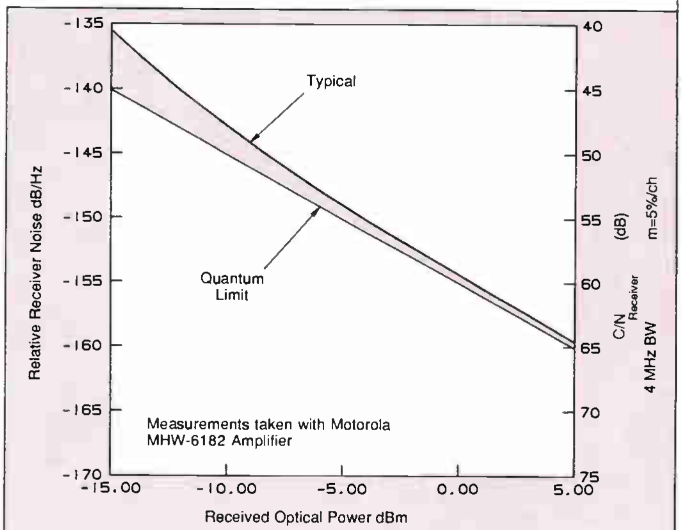
There are two ways of understanding the improvement offered by the impedance matching circuitry. The first way is to imagine the impedance matching network as part of the amplifier. The resulting composite amplifier has a higher input impedance and hence a lower equivalent input noise current. This improves the RRN as per our earlier derivation.

The second way of understanding its operation is that the passive network boosts the RF signal above the noise of the amplifier. A "gain" for the network can be defined in terms of the ratio of the RF signal at the output of the amplifier with the network included, to the output of the amplifier with the photodiode directly connected to its input. For the receiver module shown in Figure 7, the matching gain is approximately 10 dB.

The improvement in noise performance afforded by the impedance matching network is apparent from the graph of RRN versus received power shown in Figure 8. ■

Reference

Yariv, A., Optical Electronics, Holt, Rinehart and Winston, Inc., New York, 1985, Chapter 11.



Relative receiver noise of the receiver module shown in Fig 7 when used in conjuction with a Motorola MHW-6182 amplifier

Figure 8

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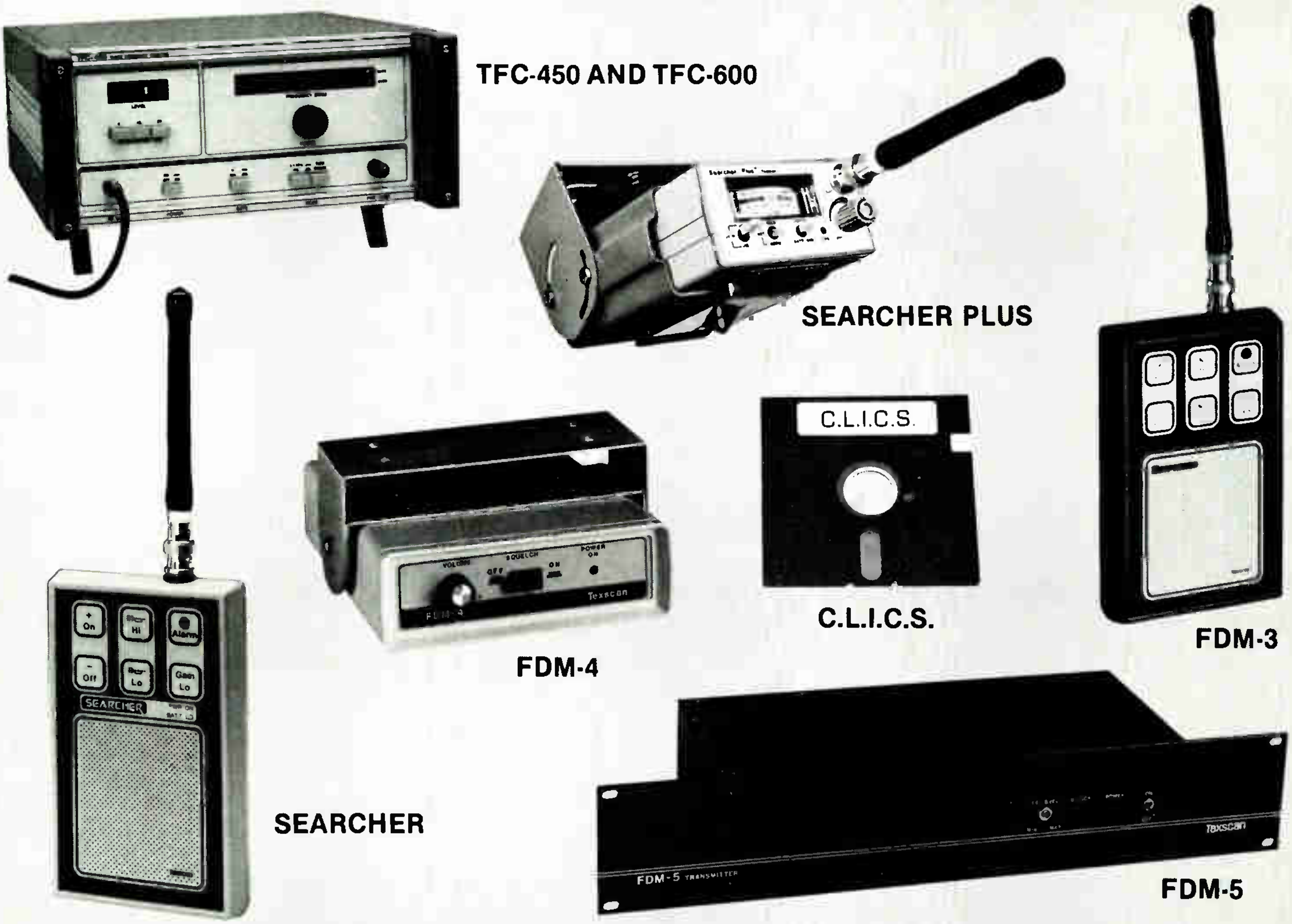

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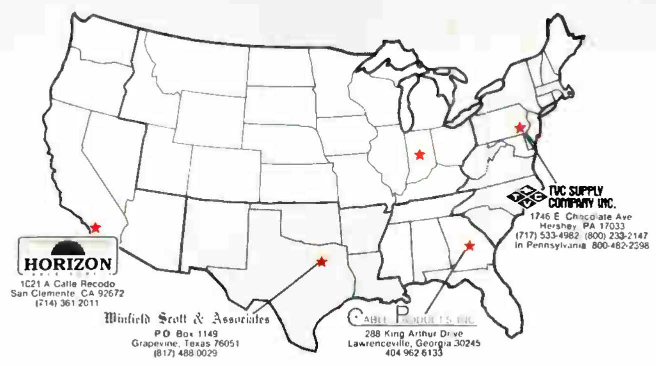

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Reducing distortions using video timing techniques

Cable television amplifiers degrade television signals in two ways: by the addition of noise and by the creation of intermodulation (IM) distortion products. While the relative detriment from each of these factors can be controlled by adjusting signal levels, the best that can be done is still a compromise. As bandwidths increase, the compromise becomes more difficult since the IM products increase rapidly in number and amplitude as the number of carriers increase.

Producing ever more linear amplifiers is technically difficult and as a result they are expensive and use more electrical power. For this reason, system designers have also explored ways of using the unique characteristics of the visual signal to make system distortions less apparent to the viewer and so allow higher system nonlinearities. The use of harmonically related carriers (HRC), for instance, causes second- and third-order products to be coincident with visual carriers, thereby trading low frequency video beats for phase modulation of the visual carrier. Experimental results suggest that operating levels can be increased by approximately 5 dB using this technique.[1]

Modulation-related effects

An additional technique that can be used is to time-lock the video modulation. To understand this we need to review NTSC video modulation.

The modulation technique used to produce standard AM/VSB television signals is downward amplitude modulation. The result is that the signal is only at full carrier power during the horizontal and vertical synchronizing pulses. The various television signals present in a cable system are generally asynchronous with the result that the total peak power varies considerably over time as the signals drift in timing such that a greater or lesser number of sync signals overlap. Since the peak power present in the system directly determines the distortion, the result is that the Carrier-to-Triple-Beat (CTB or third-order distortion) and Carrier-to-Second-Order (CSO) distortion vary over time.

Figure 1 is a simplified diagram of one line of a video waveform. As shown, the signal is at full power for only 4.75/63.56 = 7.5 percent of the time. It is at the blanking level (75 percent of full power) for an additional 11-4.75/63.56 = 9.8 percent of the time. The remainder of the time, the signal varies between 75 percent full power and 12.5 percent of full power, depending on video content.

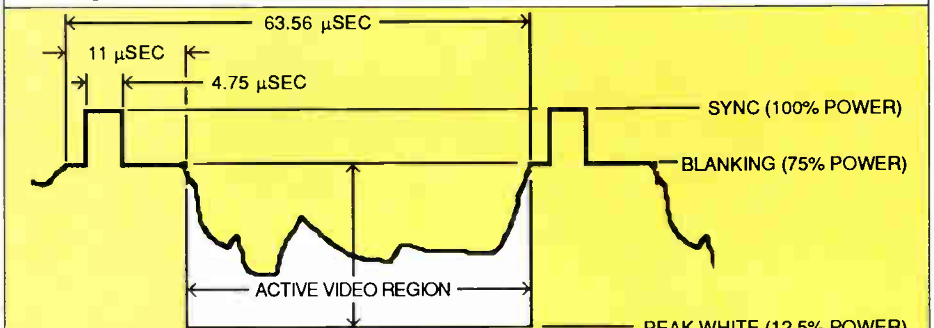

Figure 1

In addition to the individual line synchronizing pulses, a longer vertical pulse is used. Of the 262.5 lines which make up a full television field, three lines are at full sync amplitude with three lines on each side of that pulse at blanking amplitude. Additionally, the first six or so lines after vertical sync are typically unused and so are at blanking amplitude also.

The combined effect of the peak amplitude of all signals present determines the measured (and visual) signal impairment of video signals due to amplitude non-linearities in a non-synchronous cable system. Since the instantaneous peak amplitude is thus ill-defined at any time, cable systems are specified and measured using unmodulated signals whose frequencies correspond to the visual carrier frequencies and whose amplitudes are set to video sync level.

With unmodulated carriers, the total power is:

$$P_{ttl} = 10 \text{ Log } (n) + P_i \qquad [1]$$

where: P_{ttl} is the total peak power

n is the number of channels present

P_i is the peak sync power of a single channel

Obviously, this is a worst case situation, but it gives consistent results and, equally important in a typical cable system, gives results bad enough to be measurable with inexpensive equipment. For example, the NCTA recommends a minimum performance level of 53 dB CTB using CW carriers at the equivalent of peak sync power level and the equivalent of 65 dB for randomly modulated carriers as measured on a spectrum analyzer.[2] The 12 dB difference implies average modulated carrier power levels 6 dB below sync level which is not possible as will be shown below.

Random modulation

In order to evaluate the advantage to be gained by the power optimization technique to be proposed, we need to first evaluate the situation if video timing is optimally random.

One full television field is transmitted in 262.5 lines of 63.56 µsec each or a total of 16,684 µsec.

Each channel is at full amplitude for 4.75 µsec each of 259 lines and 63.56 µsec for each of three lines for a total of 1420.93 µsec/field. Thus, the probability of any one channel being at sync amplitude at any given time is 1420.93/16684 = 8.52 percent. If the channels are truly random, then the probability is that 0.0852n channels are at sync at any given time.

Similarly, each channel is at blanking amplitude 11-4.75 = 6.25 µsec each

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of 259 lines and 63.56 μsec for each of 12 lines for a total of 2328.34 μsec/field. Thus, the probability of any one channel being at blanking amplitude at any given time is 2328.34/16684 = 13.96 percent. If the channels are truly random, then the probability is that 0.1396n channels are at blanking amplitude at any given time.

The remaining channels (77.52 percent) are in the active video region between 75 percent and 12.5 percent of full power. The average for typical video will be estimated at -6 dB (25 percent of sync power level).

Adding up the total power we get:

$$0.0852n(1) + 0.1395n(0.75) + 0.7752n(0.25) = 0.3836n \quad [2]$$

= 4.16 dB lower than with [1] above which represents the simultaneous modulation case.

This is the theoretically best case possible. Unfortunately, the actual situation is not random. Television sync signals are derived from the color subcarrier frequencies which are derived from highly stable and accurate sources. The result is that the offset timing between any two channels will drift very slowly with the result that the number of channels whose sync signals overlap will vary over a wide range and change continuously and slowly. The resultant peak total power will vary over a considerable range.

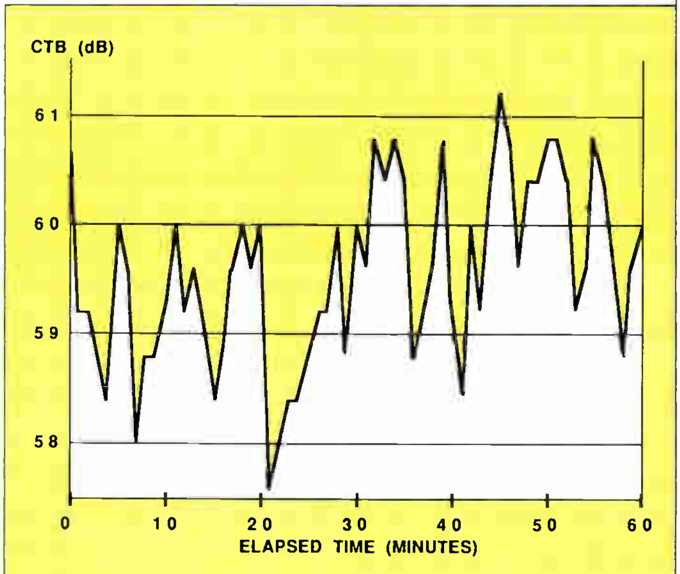

Figure 2

The situation in a typical cable system is even worse. For example, each of the 11 signals uplinked from the Viacom Networks facility on Long Island is derived from a common sync source. Even though they have their horizontal syncs offset to improve scrambling security, the offset is not sufficient to prevent all of them from hitting vertical sync simultaneously. Additionally, locally generated channels and multi-channel character generators are also typically sync-locked. If a cable operator with a 40-channel system had the sync from just two five-channel groups overlap, his peak power could not be more than 2.7 dB below the simultaneous case, even if all other signals were truly randomly distributed. Afsar experimentally measured a 2.5 dB reduction for the case of 35 channels divided into five groups of seven synchronously modulated signals.[3]

Measured data on a local 80-channel cable system is shown in Figure 2, above. As can be seen, the CTB varied by approximately 3.5 dB over a relatively short period. Since only one data point was taken each minute, it is quite possible that short-term excursions were even greater.

The implication of this data is quite alarming: assuming a normal 2:1 relationship between carrier level and distortion products, it says that the effective total carrier power varied over nearly a 2 dB range or half the distance between simultaneous modulation and optimum power spreading. If we assume that the best data recorded is no closer than, say, 2 dB to the optimal case for the reasons outlined above, then we must accept that several times each hour, distortion levels get uncomfortably close to worst-case simultaneous modulation levels.

Previous approaches to the problem

Two approaches have been previously suggested to solve this problem. Each has at least one shortcoming.

One technique is to time-synchronize all channels at the cable system headend, then remove or suppress both horizontal and vertical synchronizing pulses and transmit only a single

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3	12	21	30	39	48	57	66	75	84	93	102	111	120
4	13	22	31	40	49	58	67	76	85	94	103	112	121
5	14	23	32	41	50	59	68	77	86	95	104	113	122
6	15	24	33	42	51	60	69	78	87	96	105	114	123
7	16	25	34	43	52	61	70	79	88	97	106	115	124
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synchronizing channel along with many channels of unrelated video. This reduces the peak transmitted power of each channel by 1.25 dB. Unfortunately, it requires processing at each terminal point to reconstitute the signal. This is practical in a mandatory converter environment, but difficult where full authorized bandwidth must be delivered. If RF sync-keyed suppression is applied to the entire channel rather than sync removal (making the re-insertion very simple as it is now for sync suppression scrambling schemes), there are potential problems with BTSC stereo sound as well.

Finally, if the system uses FM trunking or microwave, it is even more complicated as the conversion to AM is difficult without the amplitude reference that the sync signal provides.

Another approach is to use simultaneous synchronization of all signals and accept the resultant distortion. The reason that this works in an NTSC-only environment is that, while the system is driven into non-linearity at the peak power point, the distortion is invisible to the viewers since all TV sets are blanked.[4] Homiller reports a subjective operating range improvement (for NTSC signals) of 1.2 dB when this technique is employed alone and 2.1 dB when combined with HRC.[5]

The "gotcha" in this approach is that the system now has problems if required to carry non-NTSC signals. Thus HDTV, data and audio signals might all be affected by cross-modulation and second- and third-order distortion products occurring at a 15 kHz rate.

Independent of the technical drawbacks of these approaches, they were proposed several years ago when the cost of the required video synchronizers were very high ($10,000 to $25,000/channel).

In the last year however, the cost has dropped to the point that next year many high-end TV sets will use field store circuitry as a means of achieving better performance. While the quality of these TV set chips may not be sufficient for headend use (I believe they use 7-bit quantization), it is indicative of the rapidly decreasing cost of digital video processing. The cost of commercial quality framestore units have dropped to $3,000 to $5,000 in the same time period.

Optimum power spreading proposal

Field store units can be used in a different way to achieve optimal power distribution and reduced non-linearities as opposed to masking high distortion levels. Figure 3 shows a suggested configuration for a 40-channel headend using *offset synchronization.*

Each channel is synchronized with a field or frame store, however the reference synchronizing pulse for each channel is offset by 417 µsec (16,684/40). The result is to spread out both horizontal and vertical synchronizing pulses uniformly in time. A power calculation shows that the peak power is 4.11 dB below the synchronous case. The difference is that the distortion reduction is real (as opposed to video synchronization where it is worse, but hidden) and constant (as opposed to random video modulation). Assuming that Asfar's data is typical of "real" cable systems, the proposed system represents a further improvement of 4.1 - 2.5 = 1.6 dB in system operating levels.

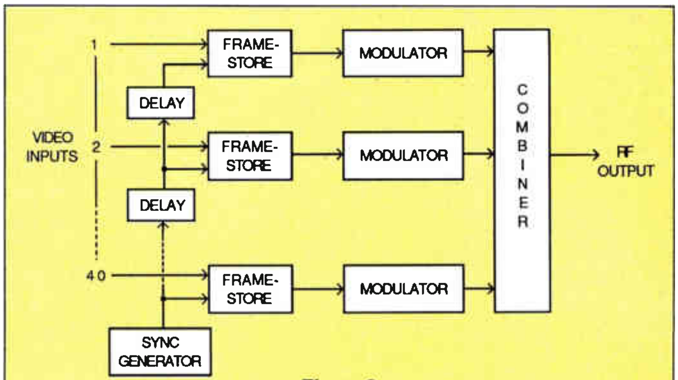

Figure3

The resultant peak power savings compared with non-synchronized signals can be "spent" in several ways:

- If the power per channel and channel count are held constant, CSO and CTB should decrease by 4.1 and 8.2 dB, respectively, from the synchronous case and 1.6 and 3.2 dB from the quasi random case.
- The power per channel can be increased, resulting in C/N improvement while the distortions will be the same as before.
- Additional channels can be added without a penalty in C/N or distortions.

Costs

Given that commercial frame store units perform functions not required for this application, it should be possible to design and build specialized multi-channel units for this application for $1,000 to $2,000/channel. Assuming that a willing vendor can be found, the cost of adding frame stores to a 40-channel headend would be no more than $80,000. Additionally, perhaps 10 channels in such a headend might be received off-air and run through channel-processors. Converting those to demod/remod channels would add another $30,000. Allowing $10,000 for the sync timing network brings the total cost to $120,000. This is a one-time headend cost that is shared among all subscribers.

Conclusion

Power spreading, as a technique, is totally compatible with any cable system. It:

- Is indifferent to scrambling technology, microwave or supertrunk modulation or signal sources.
- Can be used in conjunction with other techniques such as HRC.
- Need only be done once at the master headend in a multi-hub system.
- Offers an opportunity to economically improve the performance of any cable system.

Unlike techniques such as HRC or video synchronization which, at best, hide distortions, Power Spreading results in a real reduction of system nonlinearities. Such improvements may very well be required if we are to successfully carry HDTV signals that might not be NTSC synchronous. It seems worthwhile comparing the cost and complexity of this technique compared with getting those same dBs any other way. ■

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3. Erdal Afsar, "Technical Options for Increasing the Frequency Range and the Channel Capacity of Existing CATV Networks," Symposium Record, 15th International T.V. Symposium, Montreux, Switzerland, 1987.
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5. William T. Homiller, *op cit*

EIA MultiPort: An idea whose time has come

The cable industry is quickly discovering the importance of satisfied customers. In addition to having interesting programming at reasonable prices, operators are also looking for ways to make the service easier to use. For years we have been providing customers with converters and descramblers to make more channels available. Many had remote control features that were attractive to customers whose sets lacked remote control.

But all that is changing. Now, most new TV sets are cable-ready and have remote control. Some even have universal remotes that operate VCRs and cable converters as well as the TV receiver. Consumer dissatisfaction with set-top converter/descramblers is increasing. Many operators are actively seeking ways of eliminating set-top converters and converter/descramblers.

Some operators are using traps to meet the challenge, but they are only an interim solution in a world that is moving toward on-demand programming and *a la carte* service offerings. Improved security systems must be convenient for both operators and customers. Fortunately, after several years of development work, a solution is now available. Called MultiPort, it provides all the features of addressable systems without the need for set-top converters/descramblers.

What are the issues?

Some of the issues surrounding MultiPort implementation are discussed below in a series of challenges. Some have said the process is taking too long. But history is being made! For the first time, the cable and consumer electronics industries are working together to solve problems. The problems are not simple and the solutions are like good wine—they take time.

HDTV is coming. Why would I invest in a new scrambling system now?

What if HDTV is digital? Will your existing security system still work?

First, MultiPort is not a new scrambling system. Most operators can continue to use existing descramblers. For customers with MultiPort sets, you would just provide a compatible MultiPort decoder.

Many engineers now believe HDTV will include at least some digital processing and the first significant penetration is at least 10 to 12 years away. If TV signals are digital, the security systems in use now will probably not be satisfactory. A new, more secure scrambling system will undoubtedly emerge. Existing TV receivers and decoders will still be usable long after HDTV makes its debut.

But I already have an RF scrambling system in place.

What if your RF scrambling system could be descrambled by baseband decoders?

Every major descrambler manufacturer has built and tested prototypes of their units, including RF units. General Instrument-Jerrold has MultiPort descramblers which are compatible with both RF and baseband scrambling systems.

Yes, but there aren't enough sets out there yet.

What if every customer had a MultiPort set tomorrow?

An orderly staged introduction is best. We have a chicken and egg situation now. Consumer electronics manufacturers are holding back awaiting some sign of acceptance by the cable industry. Some box manufacturers want to wait until there are many MultiPort sets in homes so they can tap a high volume market. Cable operators are caught in the middle. If every customer already had a MultiPort TV set or VCR, cable operators would face massive decoder changeouts that would be disruptive and expensive. The changeover will take about 7 to 10 years to complete if you begin purchasing MultiPort decoders at the same rate customers purchase new TV receivers. If you begin now, none of your existing decoders would be obsolete before their time. You only need to stock a supply of decoders for customers who have already purchased the sets.

In some cases, set manufacturers

WHAT IS EIA MULTIPORT?

- It is a standard for interfacing cable TV descramblers directly with consumers' TV sets and VCRs. It is a technical specification which enables decoder manufacturers to produce set-back (rather than set-top) descramblers which plug into a socket behind TV receivers and VCRs made to the specification.
- Jointly developed by the National Cable Television Association (NCTA) and an association of consumer electronics manufacturers called the Electronic Industries Association (EIA), the decoder interface standard is called the EIA MultiPort. The NCTA Engineering Committee has officially endorsed it.
- Cable subscribers who purchase cable compatible TV sets or VCRs equipped with MultiPort will be able to connect directly to cable, provided cable operators supply MultiPort descramblers.
- Several TV manufacturers, including RCA, General Electric, Panasonic and Quasar, have introduced TVs incorporating the MultiPort standard. Both 20-inch and larger models are available.
- Most descrambler manufacturers have developed and tested prototypes. Both General Instrument-Jerrold and Zenith are supplying units to cable operators now.
- MultiPort is also known as the "baseband" interface because it functions with baseband, i.e., unmodulated video and audio signals. This does not restrict its application to baseband scrambling. MultiPort decoders that are compatible with RF descramblers are available from General Instrument-Jerrold.

By Joseph Van Loan, P.E., Industry Consultant

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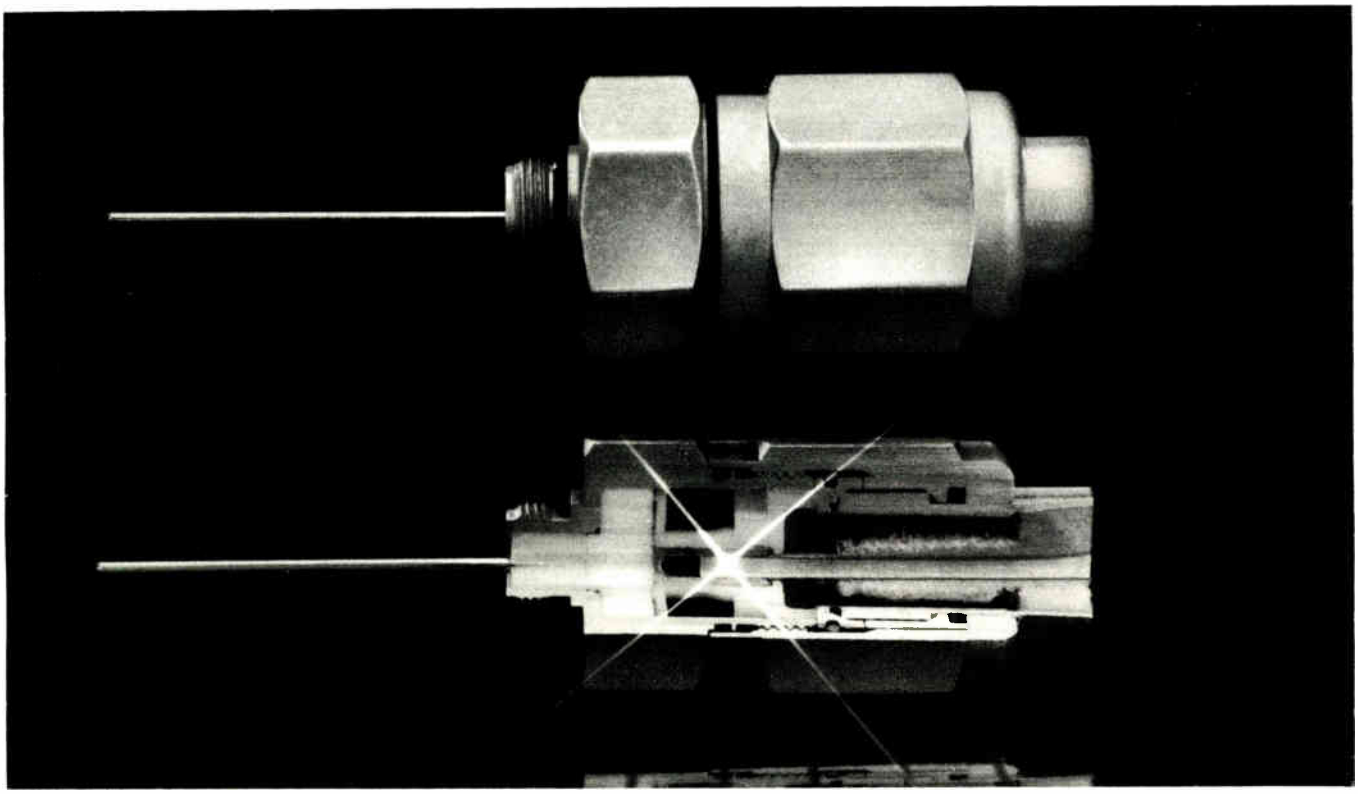

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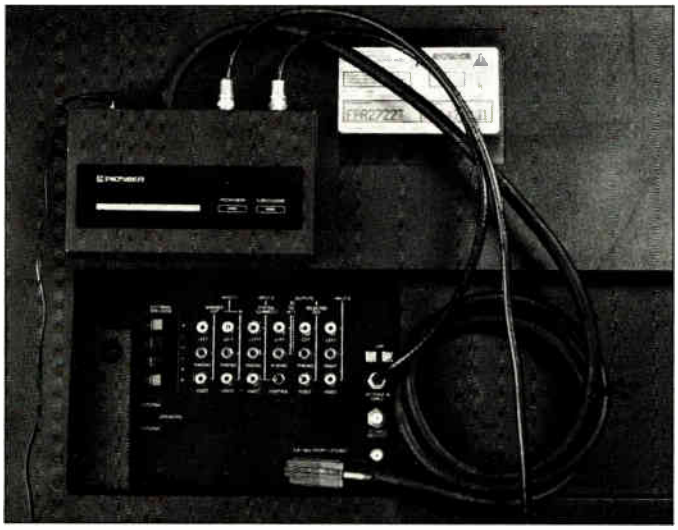
Pioneer's MultiPort decoder mock-up

have cooperated by making names and addresses of MultiPort set owners available to cable operators. Several MSOs are using those lists to get a head start on customer friendly decoders. So far, customers with the units are very pleased with them.

Yes, but remote control rental revenues will be lost.

What if 20 percent to 30 percent of new sets sold had universal remote controls which could operate both the set-top descrambler and the TV set?

That's what current estimates are. Eventually, most customers will have universal remotes and remote control rental revenues will be lost anyway. Some cable operators have said they will disable the remote control feature in the decoder if subscribers aren't paying rental fees. They will have very unhappy customers and eventually they will suffer from adverse publicity. Remote rental revenues were wonderful while they lasted, but we must recognize the changing times.

Yes, but addressability is expensive.

What if the decoder cost $25 to $35?

Once the converter portion and all the associated circuits of a set-top descrambler have been eliminated, only a few components using custom integrated circuits will remain. In the fully developed MultiPort environment, it is estimated prices can drop to this range rapidly.

Yes, but my system uses traps.

What if traps really cost more than MultiPort addressable descramblers?

Studies have shown that in systems offering four or more premium channels, traps can actually be more costly than addressability, especially where customers still need a costly set-top converter. When the cost of upgrades, downgrades and system audits to locate and replace defective traps are considered, addressability is promising. When low cost addressability as promised by MultiPort is considered, traps are more costly.

More system operators are discovering the importance of meeting the challenge of competition from VCR rental, telcos, MMDS and DBS with impulse pay-per-view service offerings. Many operators expect to offer an expanded version of the 1992 Olympics on a pay-per-view basis. MultiPort promises a low cost way of making IPPV possible.

Yes, but off-premise is the promise of the future.

What if it cost $100 per home passed and $400 per pay subscriber? Would it still be the promise of the future?

For the cable system with 50 percent basic penetration and 50 percent pay households, that's $200 per basic customer and $400 per pay household. Those prices promise to make your off-premise supplier rich—and you have to pay the electricity bill, too.

Most off-premise systems offered to date have too few channels that can be controlled, and they are often clustered together at the high end of the dial. Cable marketing professionals are discovering the importance of "dial position" for cable services. Present off-premise systems limit dial position options; with MultiPort any channel that can be tuned by the TV receivers can be scrambled.

Off-premise technology could be a viable alternative to MultiPort if a versatile, reliable, low cost system were available. In the meantime, MultiPort provides a no risk solution for subscribers trying to use cable-ready features on addressable systems. Units are available now, so there is no waiting for new technology to be developed and deployed.

Yes, but off-premise is more accessible.

What if you could send decoders by mail for less than a dollar? Could you send a truck to service an off-premise unit for less than a dollar?

No need to make an expensive truck roll to service a defective unit. Your customers can install MultiPort decoders using a single plug. No tools are needed and usually there are no other connections. Many customers are willing to pick up new units or they can be sent using small package delivery services.

In some systems more than 60 percent of the defective and disconnected set-top units are already returned to the cable office by customers. What's more accessible than that?

Yes, but the VCRs need a regular converter/descrambler.

What if MultiPort VCRs were available?

That would be ideal. It would be a recording converter/decoder. Units are expected in stores later this year. Since Americans are buying VCRs faster than TV sets, the VCR is ideal for MultiPort. When both TV sets and VCRs are MultiPort equipped, then customers can view and record any programming for which they are authorized.

Yes, but manufacturers will lose business.

MULTIPORT COMPARISONS

Pluses

- Customer convenience
- Better pictures-less signal processing
- More reliable
- TV set or VCR retains control
- Retailers can sell high-end sets
- Sell premium services to customers who refuse boxes
- Allows more sophisticated scrambling
- Facilitates cooperation between TV industry and cable
- Put fern back on TV
- Makes addressability more attractive
- Single cable connection to box & between VCR & TV-no mess
- Longer subscriber life

Negatives

- VCRs not available yet
- Has taken a long time to arrive
- Point-of-sale demo is difficult
- Decoder manufacturers concerned their profits will be reduced

What if it were throw-away technology and operators put one on each outlet and VCR?

It costs about $25 to make a service call to change a defective set-top unit and about $20 or more to repair it. At these rates you might throw defective units in the trash rather than repair them. There are other prospects which would increase decoder sales volumes.

If units are inexpensive, operators will be more willing to make them available on second and third sets at reasonable prices. Many operators are unwilling to include a $100 set-top decoder on additional outlets and VCRs at low costs. With more homes getting VCRs and second or third sets, viewership and customer satisfaction will increase with premium services available on all outlets. Cable operators will buy more decoders if they are less expensive. Increases in manufacturers' sales volumes and improved profit margins will offset the lower selling price.

Yes, but my decoder manufacturer is holding back.

What if your customers want it?

Have you told your descrambler supplier what your subscribers are saying about unfriendly boxes? Have you noticed more subscribers are using cable-ready TV sets? We must start now, even if it means using only a few units where there are already sets.

Conclusion

MultiPort makes it possible to have user friendly addressability now. If customers are willing to buy MultiPort sets, they can enjoy all the benefits of addressability, including IPPV and instant upgrades and downgrades. The cable industry has made progress in getting the attention of consumer electronics manufacturers. If we can jointly make MultiPort succeed, we can move forward together solving other common problems such as programmed recording VCRs and simplified IPPV ordering using the TV sets. If MultiPort is not supported by the cable industry, cable subscribers will continue to be frustrated by unfriendly descramblers.

What can you do now? Support those manufacturers who have committed to producing the decoders by placing orders for MultiPort decoders. Make your customers aware of products that have MultiPort connectors. Work with your TV dealers to educate the public about MultiPort. Place MultiPort sets with decoders in prominent locations so your employees and customers are aware of their features. ■

Alternate amplifier technologies

This article will review various amplifier technologies and their application in cable TV system upgrades. It will examine conventional (push-pull), power doubling, quadrapower and feedforward technologies.

Figure 1 (pg. 126) describes the differences between these four technologies. In each case the amplifier has a single pre-amp, hybrid IC, gain block followed by flatness, gain and slope circuitry. For clarity, the automatic gain control (AGC) and automatic slope control (ASC) feedback loops are not shown. The performance differences establish themselves at the output stage of these amplifiers. While the pre-amp dominates the amplifier's noise figure, it is the output stage that dictates the unit's distortion performance.

Conventional Technology

Conventional technology uses a single output hybrid. Therefore, the IC itself establishes the amplifier's performance. Power doubling amplifiers obtain their distortion improvement by operating two push-pull ICs in parallel. By recombining the parallel outputs, each IC can operate at a 3 dBmV lower level than the combined output.

The lower level of each IC provides a theoretical 6 dB distortion improvement. Splitting losses reduce this improvement to 5 dB. Power doubling technology is available either as two separate conventional gain blocks or a single hybrid gain block, where the two ICs and splitter/combiner are produced in an integrated package.

By Robert Young, Director of Product Marketing, Jerrold Distribution Systems Division

BACK TO BASICS

With so much talk centering around 750 MHz amplifiers, perhaps now is the time to look at current amplifier technologies and their capabilities. Robert Young, with Jerrold Distribution Systems Division, examines the four current technologies and their application in system upgrades in this month's "Back to Basics—Alternate Amplifier Technologies."

Quadrapower technology uses the same distortion technique as power doubling. In quadrapower, however, two power doubling devices operate in parallel to obtain an additional 5 dB distortion improvement over power doubling (10 dB over conventional). Quadrapower and power doubling also provide the additional advantage of higher comprehension points. Because each gain block operates at a lower level than the overall amplifier, higher output levels are possible without leaving the linear operating zone of the hybrid IC.

Rather than parallel operation, feedforward technology uses a distortion cancellation technique to obtain improved performance. Through the use of two 34 dB gain blocks, delay lines and directional couplers, the distortion generated in the main amp feeds forward and partially cancels itself out. This cancellation technique produces exceptional distortion performance (minimum of 15 dB over conventional) and less power consumption than quadrapower.

	Conventional Push/Pull	Power Doubling	Quadrapower	Feedforward
Pre-Amp		Standard	Push/Pull Hybrid	
Post-Amp	Push/Pull	Parallel Push/Pull	Parallel Power Doubling	Feedforward Gain Block
CTB Improvement Compared to Push/Pull	---	5 DB	10 DB	15 DB
Power Requirement Compared to Push/Pull	---	+50%	+125%	+95A%
Compression Point at 80 Channel Load	48 dBmV	50 dBmV	53 dBmV	47 dBmV

Table 1

Feedforward disadvantage

The disadvantage of the feedforward approach, however, is its lower compression point. Due to the directional couplers required for the feedforward circuitry, the hybrid devices operate at levels above those of the amplifier itself.

Therefore, feedforward's distortion technique lowers the safe operating level of the amplifier while power doubling and quadrapower raises the output capability. For this reason, feedforward technology is not recommended for bridger and line feeder ap-

Upgrade module alternatives

	Noise Figure	Oper. Gain	CTB Rating CTB	CTB Rating dBmV	CTB Rating Ch. Load
1. **Trunk Modules**					
Push/Push	10	27	88	34	40
Power Doubling	9	27	86	35	60
Feedforward	10	27	92	38	60
2. **Bridger Modules**					
Push/Pull	13	30	63	50	40
Power Doubling	11	31	67	47	60
Quadrapower	11	33	70	48	60
3. **Line Extenders**					
Push/Pull	13	28	63	47	60
Power Doubling	13	30	68	47	60
Quadrapower	15.5	32	73	47	60

Table 2

plications requiring the high output levels typical in most upgrade situations.

Table 1 provides an overview comparison of the four amplifier technologies.

Amplifier Application

For purposes of demonstrating the applications of the various amplifier technologies, three separate 35-channel (300 MHz) systems were investigated. In each case, an upgrade (maintain all trunk and line extender locations) to 330, 400 and 450 MHz was analyzed. Targeted system performance was C/N: 44 dB, CTB: -53 dB.

All three of the 35-channel systems use the standard 300 MHz push-pull technology which was available in the late 1970s and early 1980s. Table 2 provides the specifications for the upgrade modules used in each analysis. For simplicity assume that existing tap levels do not have to change.

System 'A' has cascade lengths of 20 trunk amps with two cascaded line extenders. Operating levels for trunk (in/out), bridger and line extenders are 9/31 dBmV, 47 dBmV and 44 dBmV respectively.

System 'B' has 30 amp cascades with trunk levels the same as System 'A' (9/31 dBmV) and distribution levels lowered by 3 dBmV (bridge: 44dB, line extender 41 dB).

System 'C' was originally designed like System 'A' but has extended cascades to 30 amps deep without adjusting trunk and bridger levels. Therefore, System 'C' has the same operating levels as System 'A.'

System 'A' can be upgraded to 330 MHz using push-pull technology. Upgrading to 400 MHz requires power doubling amplifiers, while a 450 MHz upgrade requires feedforward trunk and quadrapower distribution. In addition, the system will be required to relocate the second line extender.

System 'B' has margin with power doubling trunk and conventional distribution amplifiers in a 330 MHz upgrade. Conventional push-pull trunk amps may be applicable in shorter cascades. Upgrades to 400 and 450 MHz require the same technologies as upgrades to system 'A.' Due to lower bridger and line extender levels, however, the line extender placements need not be altered in the 450 MHz upgrade.

Table 3 provides a summary of the three system upgrade scenarios.

Using Fiber

Although outside the scope of this paper, a 450 MHz upgrade to System 'C' was analyzed using an AM fibernode. The AM receiver was located to break the 30 amp cascade into one of 20 amps from the headend (same as System 'A') and one 12 km fiber optic AM backbone trunk feeding a 10 amp cascade with feedforward trunk, quadrapower bridgers and line extenders.

By using the AM fiber optic technology, the upgrade is achieveable with minor relocation of second line extenders in the longest cascade. ■

Amplifier Technologies

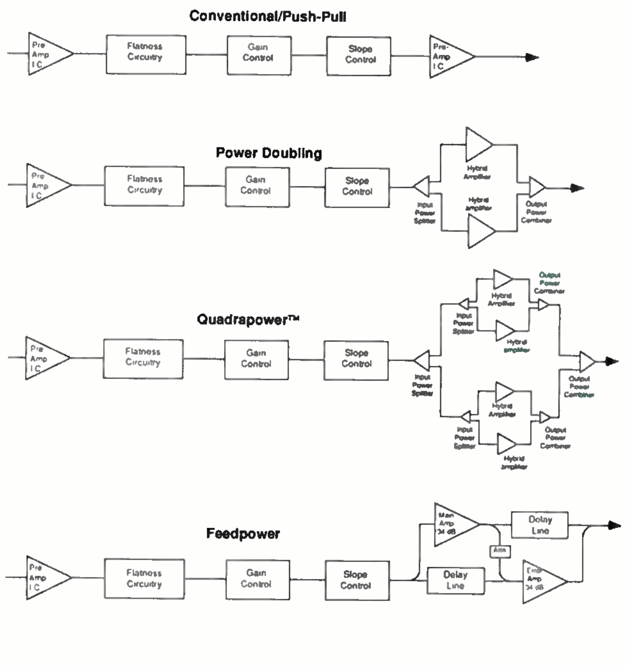

Figure 1

Minimum Technology Requirements for Drop-In Upgrades

	300 MHZ Existing	330 MHz Upgrade	400 MHz Upgrade	450 MHz Upgrade
SYSTEM A				
Amp Cascade	20	20	20	20
Trunk	P/P	P/P	PD	FF
Bridger	P/P	P/P	PD	QP
Line Extender	P/P	P/P	P/P	QP*
System Performance				
CTB (dB)	53	53	53	51
C/N (dB)	45	45	44	45
SYSTEM B				
Amp Cascade	30	30	30	30
Trunk	P/P	PD	PD	FF
Bridger	P/P	P/P	PD	QP
Line Extender	P/P	P/P	PD	QP
System Performance				
CTB (dB)	53	56	53	55
C/N (dB)	44	46	45	44
SYSTEM C				
Amp Cascade	30	30	30	30
Trunk	P/P	PD	FF	**
Bridger	P/P	P/P	QP	**
Line Extender	P/P	P/P	QP	**
System Performance				
CTB (dB)	51	55	54	**
C/N (dB)	44	45	44	**

*: System performance of CTB -53dB can be achieved, however, second line extender must be relocated
**: Cannot hold either line extender location.
P/P —Push/Pull; PD—Power Doubling; QP—Quadrapower; FF—Feedforward

Table 3

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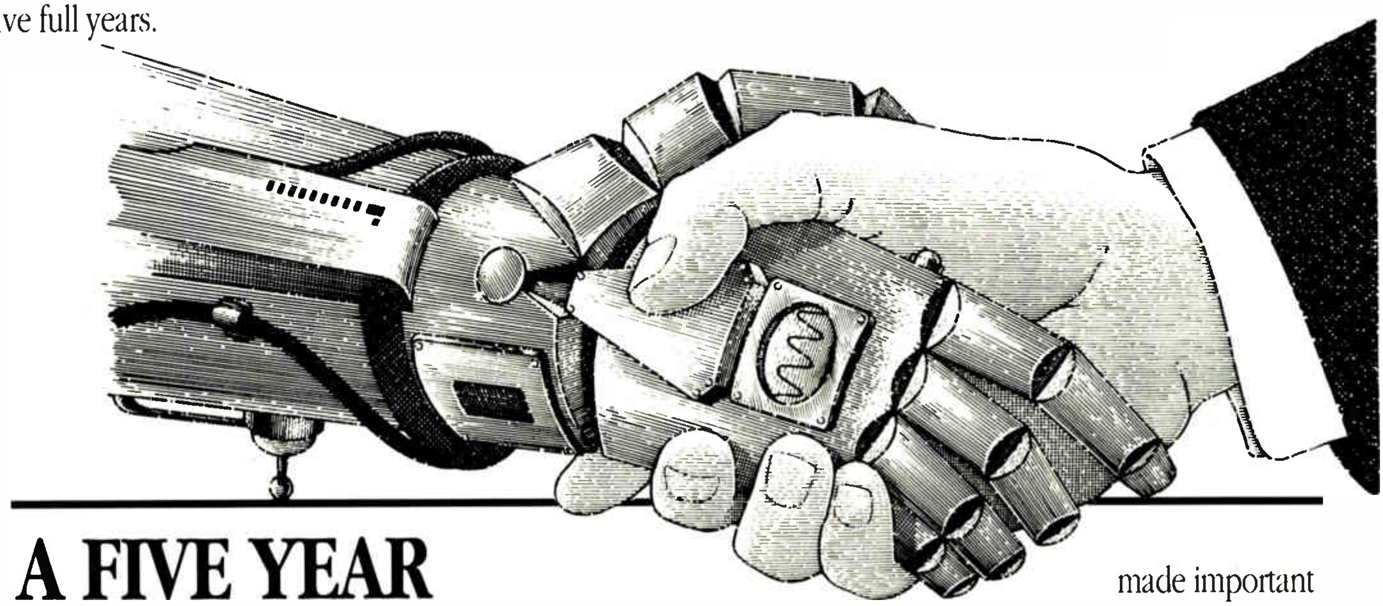

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Reader Service Number 73

System sweeping

The following article has been derived from numerous local SCTE chapter meetings where the issue of cable system sweeping was the focus.—Ed.

Let's talk about why we sweep our systems. The main reason is to ensure that the system is operating according to its design. The design holds the system operation within theoretical constraints that limit the carrier-to-noise and intermodulation degradation as seen by subscribers. As cascade length increases, the carrier-to-noise naturally gets worse, and so does the potential for intermodulation. The graph in Figure 1 shows the interactive effect these distortions have on the optimal signal level tolerance.

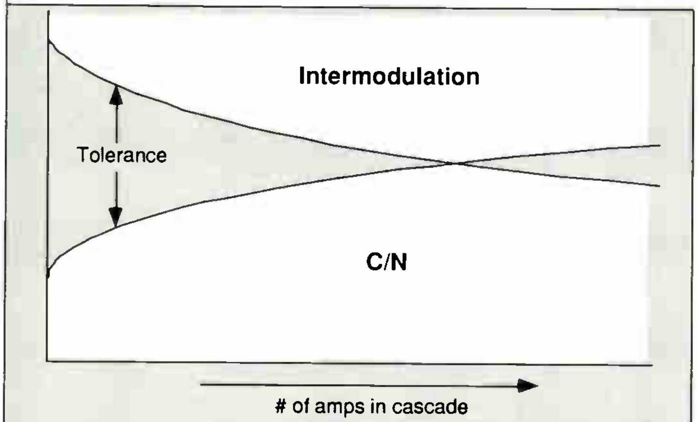


Figure 1

Evolution of the high level sweep

Frequency response on cable TV systems can be tested in a variety of ways. One way is to measure the levels of the carriers throughout the spectrum with a signal level meter or a spectrum analyzer. Using a signal level meter to perform this task would be very time consuming, and especially difficult if response alignments are required. Spectrum analyzers speed up the measurement, but don't provide the amplitude accuracy required. (Analyzers with special sweep normalization software eliminate the accuracy problem.)

Cable TV systems have special characteristics that make sweep equipment designed specifically for the application necessary. Let's consider how the common bench sweep system works (Figure 2).

The RF output of the sweep generator is connected to the device under test. The output of the device under test is connected to an RF detector, or is fed back to the sweep generator for detection. The RF detector provides a DC voltage output proportional to the RF input to the detector. This is the vertical (Y) deflection voltage for the scope display. A horizontal output from the sweep generator is connected to the horizontal (X) input on the scope. This horizontal output from the sweep generator is directly proportional to the sweep drive voltage for the oscillator in the sweep generator. As the horizontal output voltage ramps up in level, the sweeping carrier moves across the spectrum proportionately.

Could this system work on a cable TV system? Well, the device under test changes considerably. Since the point of .measurement is remote from the sweep generator there can be no horizontal ramp connection to the scope. A test set up at the test point could be configured as seen in Figure 3.

The RF at the test point is connected to a detector, and the detector to the scope vertical (Y). This will provide an amplitude deflection to indicate the frequency response of the system, but there is nothing to tell the scope when to begin its horizontal deflection.

A SAM could be coupled in prior to the detector, with the video detect output connected to the external trigger on the scope. The SAM is tuned to the start frequency of the sweep. When the sweep passes through the tuned frequency of the SAM, a pulse is sent out on the video detect, which triggers the horizontal deflection of the scope.

There are a few obvious disadvantages to this method of system sweeping. For one thing, this is a lot of equipment. (I haven't discussed yet the need for attenuators to bring the RF into measurable range on the scope, or the extra SAM that's needed if you want to identify a specific frequency on the response.)

Another drawback is that since the sweep is high level (sweeping carrier RF level is higher than video carrier level), it must be sent at 5-second intervals to avoid subscriber interference. This makes it necessary to use a long persistence phosphor scope, or a storage scope to display the sweep response. Either this, or turn off the channels and sweep in the wee hours of the morning.

Finally, the scope is calibrated in volts per division, which makes it hard to relate to our conventional (and much easier to manipulate) logarithmic standards.

This system may sound pretty unrealistic, but our forefathers in this industry actually worked with systems very much like this. Obviously some test equipment manufacturers saw an opportunity and provided sweep systems that made this essential test easier to perform. A high level sweep commonly used today sweeps at intervals programmed by the operator, is synchronized by use of a PSK modulated pilot carrier, and uses sophisticated digital circuitry to provide detailed information about the sweep response displayed.

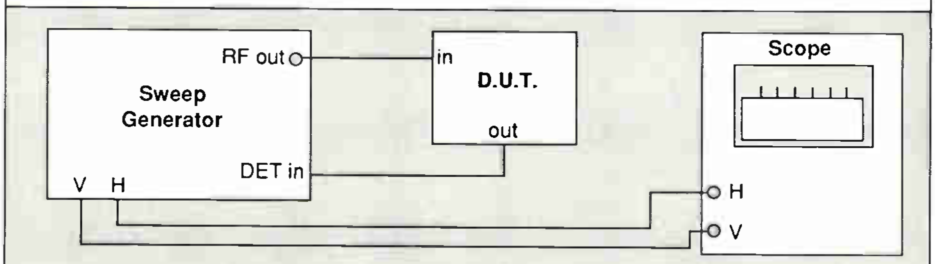


Figure 2

By Steve Windle, Senior Application Engineer, Wavetek RF Products Inc.

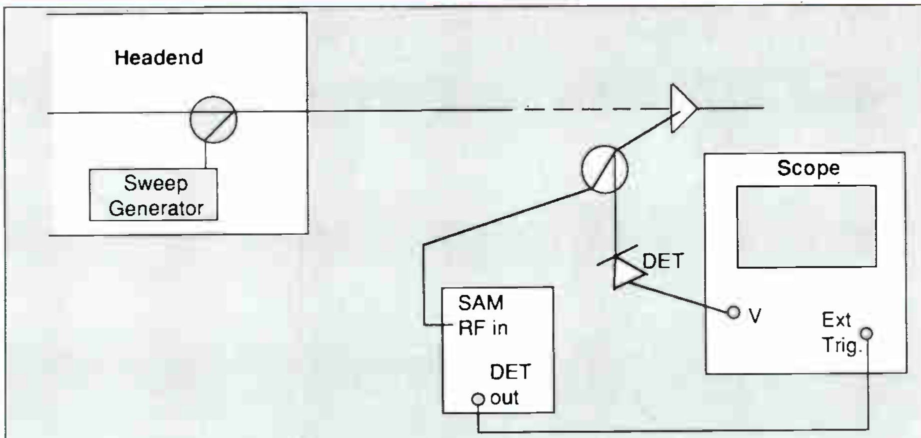


Figure 3

High level theory of operation

A special process used by this sweep system cancels out changing response amplitudes due to video modulation (amplitude changes dependent on picture content). This process, occuring each time a new sweep is sent by the sweep transmitter, consists of two "passes."

The first pass, which is the beginning process of each sweep interval, begins with the sweep transmitter sending a message via the pilot (sweep data carrier with PSK modulation) to the sweep receiver. The transmitter tells the receiver to look at the spectrum for the duration of one sweep, but on the first pass no sweep is sent. The receiver, which uses broadband detection (similar to a power meter), breaks the sweep time into 250 segments and stores a measurement of the RF power for each of the 250 segments into a short term memory.

The second pass occurs 16.7 milliseconds later, meaning this sample will occur one field later at the same point in the picture where the first sample was taken. (The picture content, and therefore the modulation level, doesn't change dramatically from one field to the next.) On the second pass, the sweep transmitter sends out the sweeping carrier, and the level of the sweeping carrier is detected along with any modulation present. For each of the 250 segments of the sweep time, a measurement is made, the first pass results are subtracted from the second pass results, and the response is displayed on the CRT. This method effectively cancels out any synchronized modulation and eliminates its effect on the frequency response display.

This sweep receiver, in addition to providing this sophisticated cancellation process, is easy to use. Display markers can be located horizontally or vertically to identify any level or frequency on the reponse, with the level or frequency read out at the bottom of the display in alphanumerics. A max/min key automatically moves the markers to the peak and valley of the response, making it easy to tell if you're within specification.

Low level theory of operation

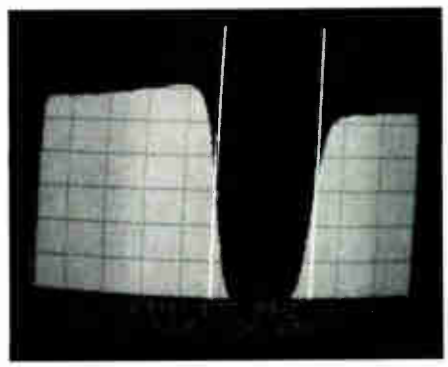
Probably before the high level sweep just described was available there was a low level sweep on the market. Many of these sweeps are still in use today, although the manufacturer no longer produces them. This low level sweep has some significant advantages. The narrow band detection scheme permits both spectrum analysis and sweep response test capability in one instrument. The sweep transmitter communicates in a similar fashion to the high level sweep previously described, using a pilot to send sweep synchronization information to the receiver. Since the sweep is operated at a low level relative to the video carriers on the system, the subscriber interference potential is minimized, and a continuous sweep can be used. This permits a "real time" display, shortening the "rubber screwdriver" effect.

There were also some disadvantages to this method. On long cascades, carrier-to-noise related measurement accuracy problems would arise, prompting the operator to increase the level of the sweeping carrier relative to video carriers, causing an increase in subscriber interference. The amplitude resolution was not as good as the high level sweep, and sweep information had to be discerned around other active carriers in the spectrum.

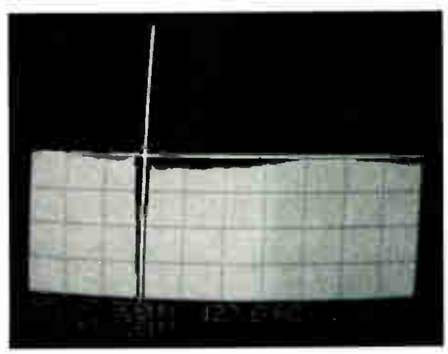
A "no level" sweep uses a traditional measurement method called normalization to enable accurate measurement of frequency response with a spectrum analyzer. The normalization process fits in well for the cable TV system sweep application, since these systems are designed for unity gain. Each amplifier's output should be (theoretically) identical. The normalization process enables a direct comparison between the first amplifier (headend reference) response, and any successive amplifier response.

This analyzer stores the system's channel plan into non-volatile memory (backed up by a separate lithium battery). A reference measurement of all of the carriers in the channel plan is made with the results stored in one of eight reference memories (also non-volatile). At each successive test point a comparison (normalization) mode is

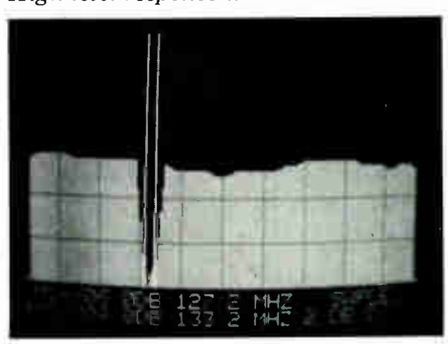
Figure 4



Swept response of notch filter (6.4 MHz suck-out).



High level response with a suck-out.



Sweepless response with a suck-out.

entered, and the difference between the stored reference and the response at that test point is displayed. The center line represents no change, and any changes in the response (peak-to-valley) are represented by deviations from the center line on a 2 dB or 10 dB per division display.

'No level' sweep benefits

There are some significant benefits to this sweep method. The normalization method cancels out any errors inherent in the measurement process, such as instrument error, lead loss, probe signature, etc. This method is totally non-interfering—no sweep transmitter is required. Vacant spectrum can be swept using a generic sweep generator blanked from the active video portions of the spectrum.

One disadvantage of this method is that frequency resolution is limited to the number of points in the response to be sampled (the channel plan). (Although this resolution can be as fine as 100 kHz in portions of the spectrum that are continuously swept.)

The main problem that limited frequency resolution would seem to present is that it may not show when there is a suck-out or may not show standing waves clearly. A test using a tunable notch filter was performed in the lab which showed the worst case, where the notch was centered in the channel bandwidth between two of the carriers sampled for the response (see Figure 4).

This test showed that the resolution was good enough to uncover the suck-out. Even with a high level sweep, if the suck-out is extremely narrow it could be missed due to the high sweep rate. There is no scan loss with the "no level" sweep method.

Headend sweep system calibration

Probably the trickiest part of system sweeping is getting ready, which means setting the sweep system up in the headend. The sweep should be configured as seen in Figure 5.

Note that the insertion directional coupler is installed "backwards" from its normal configuration. This provides isolation from the headend, and the sweep is injected, minus tap loss, into the system. The directional coupler value should be chosen carefully, to enable the RF output of the sweep transmitter to be at the appropriate level relative to the video carriers. (High level sweeps are typically 20 dB above video carrier level, low level sweeps are 15 dB to 20 dB below video carrier level.)

It is a good practice to verify sweep to video carrier level relationship at a sweep test point or at the first amplifier test point (if it's in the headend). A quick way to do this is to measure the 50 MHz pilot carrier, and compare its level to channel 2 video carrier level. The pilot is approximatley 20 dB below sweep level, so for a sweep level 20 dB above video carrier level the pilot level should be at the same level as the channel 2 video carrier.

A more precise method is to set the sweep generator in the CW mode (a single frequency carrier output) and then compare this signal's level with the channel 2 video carrier level. Once a relationship is set up in the headend between the sweep level and the system carrier levels, this relationship should not change anywhere in the system. Any changes in level seen on the frequency response display should coincide with changes in system carrier levels.

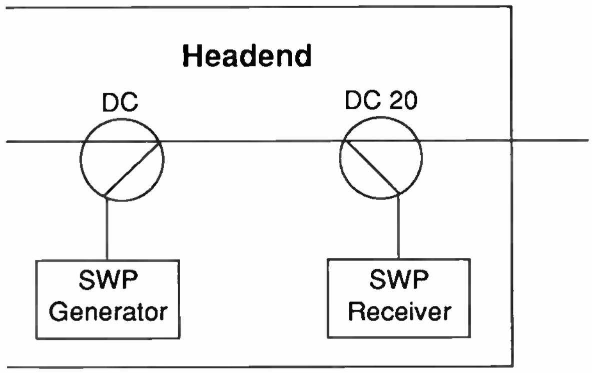


Figure 5

When using a high level sweep it's a good practice to set the start and stop frequencies such that the sweep starts 10 MHz to 20 MHz before the frequency you desire to measure. This insures that any scan loss inherent in the test equipment is not mistaken for diplex filter roll-off.

With the headend set to desired parameters and flatness of less than 1.0 dB at the headend test point (if the equipment you're using has normalization capability), now's the time to store a reference. Ideally the stored reference will be at the first amplifier output test point, since this is the response you'll want to duplicate at every other amplifier output test point. You want that to be your normal response.

System tilt complication

In at least one instance, it gets a little complicated setting up the sweep. When the headend carriers are set up flat, and the system is flat or when the headend is tilted and the system is tilted, there is usually no problem inserting the sweep so the test points can be aligned for a flat response. The problem arises when the headend is set up for a flat output, and the equalization at the first amplifier (remote from the headend in the worst case) induces the system tilt.

In this case, if the sweep is inserted flat over the flat system carriers in the headend, it gets tilted along with the system carriers at the first amplifier and the response at every test point is tilted. It's pretty hard to tell response peak-to-valley on a tilted response trace! The simplest solution is to use a tilt box that simulates cable loss in line with the receiver or between the transmitter and the insertion point. For those with sweep systems with normalization capability, there is no problem with tilts, because the tilt is normalized, or cancelled out of the displayed response.

Amplifier characteristics

The cable TV system is designed according to a unity gain principle. Every amplifier output (on the trunk) is ideally identical. Natural limitations make it impossible to have perfect spacing between amplifiers to enable each amplifier to be set up identically. Each amplifier may need to be set up with its own individual set of pads and/or equalizers.

Pads provide flat attenuation to the input signals to the amplifier to bring the signals down to the recommended input level. Equalizers accommodate cable loss by attenuating more at the low end and not so much at the high frequencies. Response equalizers provide frequency specific attenuation, usually adjustable within a limited frequency range.

Amplifier test points are different depending on the amplifier manufacturer. Some test points are 20 dB down, some require special probes with 30 dB insertion loss. Usually the amplifier manufacturer has an application book

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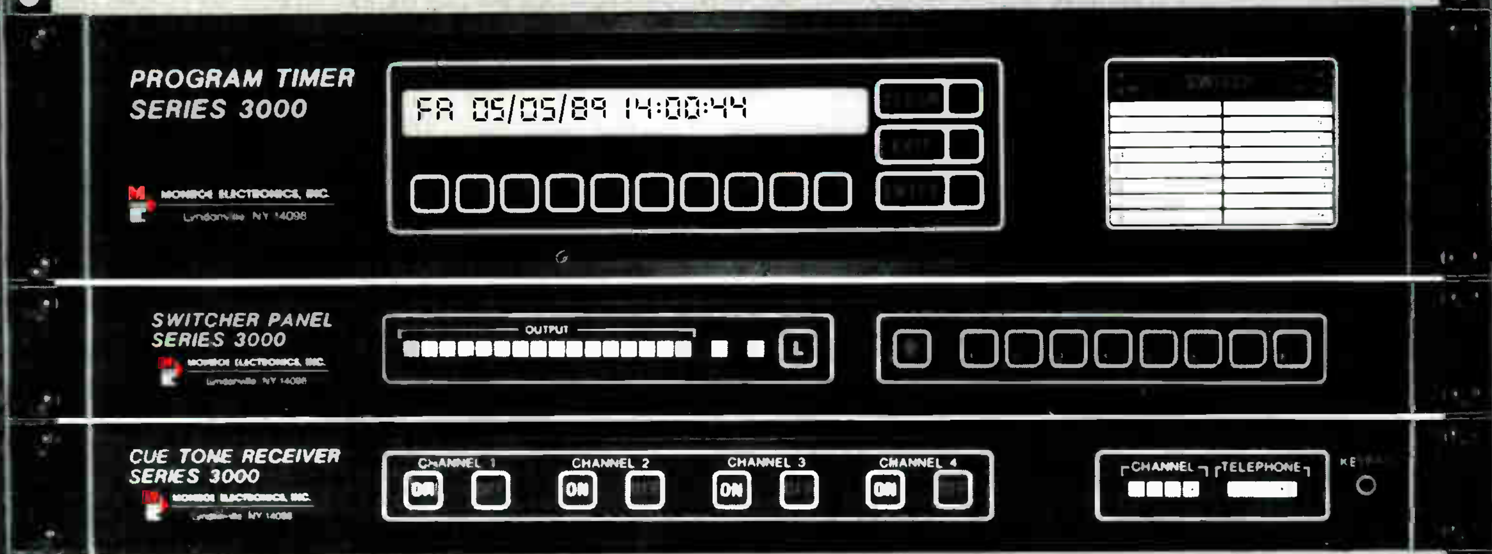

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describing the best places for making the connection for sweep response test and alignment.

Most amplifiers have gain and slope adjustments. Usually the first step is to adjust the gain, while monitoring the high end sweep level. Then the slope is adjusted, while monitoring the low end. The controls interact to a degree so usually some toggling of adjustment is required.

The desired response is specified in terms of maximum peak-to-valley ratio. Each amplifier manufacturer may have a different rule of thumb for this, and it varies depending on the maximum frequency range capability of the system. For a 450 MHz system the rule is usually n/10 + 1, with n being the number of amplifiers in cascade. The variation is in the constant (1) value, which tends to increase to 1.5 or 2.0 as high end frequency capability increases.

Testing problems

One of the most common problems encountered while sweeping is signature build-up. This is a natural occurance, and each amplifier manufacturer tends to have a different characteristic signature. The cause of this build-up (bumps or dips at specific frequencies in the response) is the manufactured identicalness of the diplex filters that are built into each amplifier housing. The goal of manufacturing is to build each product exactly the same, and quality control assures that this will happen. A filter naturally has some ripple in the pass band. When these filters are manufactured, this ripple is identical on each filter. When the amplifiers are cascaded, the bumps and dips in the pass band of the filter cause the sweep response to bump and dip.

Some manufacturers combat this problem by intentionally making the pass band response of each diplex filter different. Another way to solve the problem is to use a frequency specific response equalizer. These equalizers are adjustable within certain ranges, and attenuate at specific frequencies to flatten out the response. It is usually recommended that these devices not be used more frequently than every fifth amplifier, since they do attenuate the entire response to some degree (but much more at the specific adjusted frequency). More frequent use could cause carrier-to-noise problems near the end of the cascade.

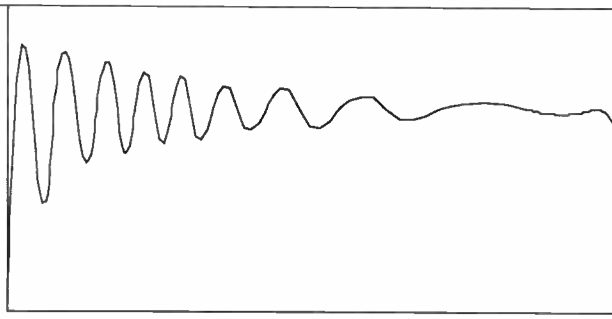
Another problem encountered while sweeping, related to diplex filters, is diplex filter roll-off. This can be seen as a roll-off at the low end of the response. In drastic cases it could cause the high level sweep receiver to stop triggering (accepting sweep updates), by attenuating the pilot (sweep data carrier) beyond the capture range of the receiver demodulator.

Standing waves are usually found at some point during the process of sweeping a system. This is an indication of some fault or RF discontinuity causing RF to reflect back to the receiver from some point beyond the test point. The distance to the fault can be determined using the following equation:

$$\frac{492 * VP}{f\ (MHz)} = \text{Distance to fault in feet}$$

where: VP = the velocity of propagation factor of the cable (specified by cable manufacturer, varies depending on cable size and dielectric).

f(MHz) = the frequency of one cycle of the standing wave.



Distant fault--High end standing waves attenuated by cable length

Figure 6

The closer the fault, the higher the frequency range covered by one cycle of the standing wave will be. This means that the closer the fault the farther apart the standing wave peaks will be. When a fault is far away, the standing waves will be close together, and may be hard to discern, especially at the high frequency end of the sweep response. The high end standing waves will be attenuated by cable loss when the fault is far away (Figure 6). To make the analysis easier, it may be desirable to narrow the sweep range to analyze only the range from 50 MHz to 100 MHz. This will make the standing waves stand out more, enabling the determination of the period of the wave.

Another phenomenon that is specific to high level sweeping is a high end roll-off due to instantaneous AGC action. What happens is, as the high level sweep passes through the AGC detection range, if the circuitry reacts too quickly, it may respond as though the pilot signal had suddenly increased in level by 20 dB. Can you imagine the temperature change that would cause this to happen naturally (or supernaturally)?

The reaction can be so quick that before the sweep gets to the end of the swept frequency range, the sweep response has rolled-off at the high end. This gradual roll-off in level is not corroborated when a signal level measurement is made on the system carriers at the high end.

There are two ways to solve this problem. The easiest is to notch out (blank) the sweep from the AGC and ASC frequencies using a special tunable notch available for the sweep transmitter. Probably much harder is to ask the manufacturer of the amplifier to slow down the AGC (ASC) circuit reaction time.

This problem is not encountered with other than the high level sweep method, and it is not always seen with the high level sweep. The recommendation is to try sweeping and see if you run into the problem before notching out the AGC (ASC) frequencies.

Another problem that sometimes occurs specifically when using the high level sweep is subscriber interference. This picture interference can be limited to some extent by setting the transmitter parameters properly. The major contributor to interference is the existence of the sweeping carrier within the video bandwidth of the channel. Whatever can be done to limit the time that the sweeping carrier is within the video bandwidth should be done to avoid interference problems. The sweep rate should be set as fast as possible. The start and stop frequenices should be as far apart as possible. The repetition interval (time between sweep transmissions) should be set to at least 5 seconds.

System sweeping is a way to insure that the signals throughout the spectrum and throughout the cascade, stay within the tolerance window. System sweeping helps to verify the RF integrity of the plant, and results in better performance throughout the system. This can be translated into fewer service calls and more satisfied customers. ■

WHAT'S AHEAD

SCTE

The Tennessee meeting group has been officially elevated to full chapter status. The new SCTE Tennessee chapter is based out of Memphis, Tenn. The group was recognized as an official chapter at its April 25 meeting at the Vanderbilt Plaza Hotel in Nashville, Tenn.

June 10 *Wyoming Meeting Group* will present a technical seminar. For more information call Matt Forgas, (307) 324-2286.

June 14 *The Mount Rainier Meeting Group* will sponsor a technical seminar on "Data." Call Sally Kinsman, (206) 867-1433 for more details.

June 15 *Central California Meeting Group* will hold a technical seminar on "Microwave vs. Hard Cabling" with Hughes Microwave. For details call Andrew Valles, (209) 453-7791.

June 15-18 *SCTE Cable-Tec Expo '89* will be held at the Orange County Convention Center, Orlando, Fla. Call SCTE national headquarters, (215) 363-6888 for registration or info.

June 16 *Heart of America Chapter* is sponsoring a technical seminar at the Holiday Inn Sports Complex, Kansas City, Mo. For topic info or details call Wayne Hall, (816) 942-3715.

June 20 *The Hudson Valley Chapter* will hold a technical seminar on "CATV Analyzer Measurement Seminar" with John Cecil of Hewlett-Packard's Signal Anaysis Division at the Hewlett-Packard offices, Albany, N.Y. For info call Robert Price, (518) 382-8000.

June 22 *Florida Chapter, South Florida Group* will sponsor a technical seminar at the Holiday Inn, Fort Lauderdale, Fla. Call Denise Turner, (813) 626-7115 for details.

June 23 *The Miss-Lou Chapter* will present a technical seminar in Biloxi, Mo. For seminar details call Charles Thibodeaux, (504) 641-9251.

June 27 *Satellite Tele-Seminar Program* will air "Fiber Optics—Here and Now" with Jim Chiddix of ATC, David Grubb of General Instrument/Jerrold Division, James Hood of Catel, Vince Borelli of Synchronous Communications and Lawrence Stark of Ortel. Videotaped at Cable-Tec Expo '88 in San Francisco, the program will air from noon to 1 p.m. Eastern time on Satcom F3R, transponder 7.

June 29 *Wheat State Meeting Group* will hold a technical seminar at the Canterbury Inn, Wichita, Kan. Call Mark Wilson, (316) 262-4270 for more info.

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The Magnavox CATV Systems mobile training center is a fully-equipped laboratory on wheels for cable training. The three-day seminars combine instruction in theory and practical hands-on training, using gear and test equipment common throughout the industry. The fee is $300.

June 19-21 *Magnavox Mobile Training* will be held in Orlando, Fla. Call Amy Costello Haube, (800) 448-5171 (in NY state, (800) 522-7464) to register, or for additional info.

Sept. 12-14 *Magnavox Mobile Training* will be held in Columbus, Ohio. Call Amy Costello Haube, (800) 522-7464 to register, or for additional info.

C-COR ELECTRONICS INC

C-COR Electronics "state of the art" seminars are three-day events designed to instruct relatively new technicians in basic theory, installation and maintenance of cable TV systems. Attendance is limited to a maximum of three persons from one system. The fee is $195.

June 20-22 *C-COR Electronics Seminar* will be held in Pittsburgh, Pa. Call Teresa Harshbarger, (800) 233-2267, ext. 326 to register or for details.

Sept. 19-21 *C-COR Electronics Seminar* will be held in Dallas, Texas. Call Teresa Harshbarger, (800) 233-2267, ext. 326 to register or for additional info.

Et cetera

June 12-16 *The Seventh Annual Fiber Optic Exposition* will be held at the RAI Congrescentrum in Amsterdam, The Netherlands. A three-part event, the conference program contains over 120 papers on: fiber optic technology, Local Area Networks, optical communication, military fiber optics and fiber optic sensors. An educational and exhibit program will also be hosted. For details call EFOC/LAN '89 Secretariat, IGI Europe; c/o AKM Congress, 41-61 691 51 11, Basel, Switzerland.

June 13-16 *Ditel Inc.* will host a training course on "Fiber Optic System Design, Installation and Maintenance." Also included will be LAN and CATV classes. This is a monthly course held at Ditel corporate headquarters, Hickory, N.C. Call Marsha Alexander, (704) 328-5640 for details.

June 26-28 *Northeast Cable Television* will hold a trade show and technical seminars on "Rebuild and Upgrade" at the Roaring Brook Ranch, Lake George, N.Y. BCT/E exams will be also be adminstered. Call Bob Levy, (518) 474-1324 for info.

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Palmer CableVision has an immediate opening for a Draftperson. This position will be responsible for updating existing system maps showing area developments and electronics.

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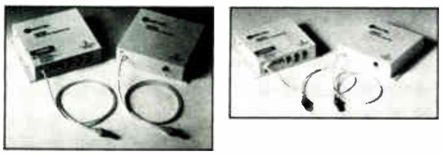


Ortel's 5515 A/B fiber optic analog link and 5610A broadband link

Ortel Corporation has introduced two new fiber optic links, Model 5515A (10 GHz) and Model 5515B (12 GHz). The links can transmit microwave signals over single mode fiber for distances of 20 km and beyond. The link consists of a 3515A/B laser transmitter and a 4515A/B photodiode receiver. Specifications include flat response, wide dynamic range, -40- to +70-degree operations, and 50 ohm coaxial SMA input/output.

Also available from Ortel is the 5601A Broadband Link™. The VSB format, multi-channel link can transmit up to 20 AM video channels through a single optical fiber over distances in excess of 10 km. The link uses Ortel's Fabry-Perot laser and receiver. Specifications of the multi-channel link include a frequency range of 50 MHz to 550 MHz, CNR values of 49 dB for 20 channels at 10 km and a typical link loss of 22 dB. The input signal per channel is 42 dBmV. For more info call (818) 990-1235.

Available from **Siecor** is the FC-PC single mode connector. The field-installable connector features the glass-in-ceramic ferrule design, which allows a UV adhesive to replace epoxies normally used to connect fiber optic cables. The glass ferrule reportedly reduces polishing time to 45 seconds or less. The FC-PC connector has a typical insertion loss of 0.5 dB and return loss less than -35 dB. It is compatible with all FC type connectors adhering to the NTT standard. Call (704) 327-500 for details.

Combination monitor/vectorscope

Leader Instruments Corp. has announced the availability of the Model 5872, a new combination waveform monitor/vectorscope that includes all the features and capabilities of the Model 5870 except SCH phase measurement and full line selection. The Model 5872 includes simultaneous vector and waveform display for observation of two video sources on the same screen. Features include sweep rates of 1H, 2H, 1V, 2V and 1H MAG, 2H MAG, 1V MAG and 2V MAG, a 5-times vertical gain magnifier and a switching mode power supply which automatically adapts the unit to a wide range of AC (90 Vac to 250 Vac, 48 Hz to 440 Hz) and DC (11 Vdc to 20 Vdc) voltages.

Leader's Model 5872

Leader's Model 1041

Leader has also announced the introduction of a new 40 MHz dual trace, dual time base oscilloscope, the Model 1041. The unit is designed to meet applications in design, testing and service of both analog and digital circuits and equipment. The oscilloscope has an 8-by-10 cm PDA CRT. Triggering controls include variable holdoff, TV sync separators, high and low frequency rejection and delayed sweep triggered functions. A channel one output is available on the rear panel to drive other instruments such as a frequency counter. For info on either product call (516) 231-6900 in N.Y., or (800) 645-5104.

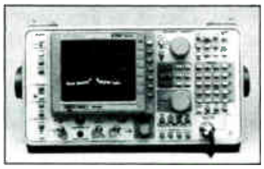
Introduced by **Texscan MSI** is a new ComSerter full random access commercial insertion controller. The CSR-194 will handle a single network with up to four videotape machines. Offered with the CSR-194 is a new capability, the Dynamic Deck Change (DDC). This feature allows the cable advertising operator to place one, two or three of the videotape decks into a backup queue. In the event of an on-line deck or tape failure, the backup deck(s) can be used to insert spots until the failed deck can be restored.

Other features of the CSR-194 include full stereo audio switching and commercial playback, built-in black burst generator for filing commercial transitions, auxiliary video and stereo audio input, full internal audio and video AGC and broadcast standard vertical interval switching. The unit will be available in June 1989. For more details call (801) 359-0077, ext. 121.

Available from **Sencore** is the FC71 portable 1 GHz frequency counter. The counter gives 9.5 hours of continuous operation on a single charge with 0.5 PPM accuracy from zero degrees Centigrade to 40 degrees Centigrade, and useable from -25 degrees Centigrade to 50 degrees Centigrade. Features of the counter include 5 mV sensitivity average, 0.01 Hz resolution in one second and automatic readings with IEEE 488 computer interface (IEEE 488 Bus Compatible). For additional info call (800) 843-8866.

Avcom's Model PTR-25

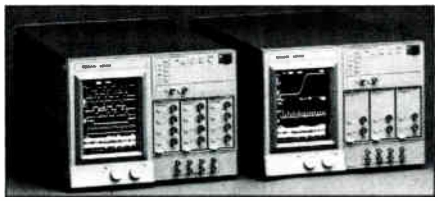
Avcom has introduced a new portable test receiver, the PTR-25. The PTR-25 receiving circuitry is derived from Avcom's COM-2 and COM-3R satellite receivers. A full range of outputs are available from the PTR-25 to provide signals for large TV monitors, video recorders and audio amplifiers. An IF sampled output is available for observing the 70 MHz IF signal including terrestrial interference. For details on the PTR-25 call (804) 794-2500.



Tektronix's 2782

The 2782 Microwave Spectrum Analyzer from **Tektronix** will be available for ordering on June 15, 1989. The 2782 offers a coaxial frequency range of 100 Hz to 33 GHz with fundamental mixing to 28 GHz, full-range sweep from 100 Hz to 33 GHz, resolution bandwidths from 3 Hz to 10 MHz and 100 dB display dynamic range. Other capabilities of the 2782 analyzer are digital and analog waveform displays, a color display system using a liquid-crystal, color-shutter display and front panel simplicity. The Tektronix Microwave Spectrum Analyzer is priced at $65,000.

Tektronix is also introducing a new class of instruments called Digitizing



Tektronic's DSA 600 Series

Signal Analyzers (DSA), for acquiring, measuring and analyzing either ultra-fast transient or repetitive signals instantly. The new class includes Tektronix's DSA 601 and the DSA 602, a 2 GS/s instrument with 1 GHz bandwidth, 8-bit vertical resolution, 32K record length, 12 acquisition channels and a color display. Both the DSA 601 and DSA 602 achieve vertical accuracy of ±1 percent and time base accuracy to within 0.005 percent. The DSA 600 Series executes waveform processing functions up to 180 times per second. Signal processing functions include FFT (fast Fourier transform), point-by-point pass/fail testing, averaging, smoothing, interpolation, integer and floating point math, signal dejitter and envelope acquisition. For more info on Tektronix' Spectrum Anlyzer or DSA 600 Series call (800) TEK-WIDE.

Alpha Technologies has announced the completed development and field testing of the PSM-1 Power Supply and RF Modem. The PSM-1 is designed to transmit power supply data in the 50 kHz to 150 kHz band back to the headend via the trunk line and active device power path. An active beta test site is in operation in Bellingham, Wash. Cox Cable of Macon, Ga. has recently purchased a PSM-1 system for evaluation. For further details call (206) 647-2360.

Relief for rotary dial subscribers

Telecorp Systems Inc. has introduced a voice recognition module for

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"It seemed like a good idea at the time"

...America's sale of scrap metals to Japan prior to December, 1941, for example. There are inevitably decisions made, with the best of intentions, which turn out to be detrimental to at least one of the parties involved. Fortunately, many such scenarios can be avoided by exercising the proper precautions.

Why, in business for example, would anyone want to provide someone with the very materials necessary to ensure that that person became a competitor? Yet this is exactly what many of today's MSO's are doing by selling their system scrap to companies or individuals whose main intent is to build their own systems.

Partial reels of aerial and underground cable as well as outdated but functional electronics are finding their way back into service in increasing numbers in rural systems throughout the country. More often than not, they are being bought for little or nothing from cable systems who are completely unaware of the competition they are creating.

Unfortunately too, there are still those that equate the highest bid on salvageable materials with the highest prices paid. It's bad enough that the guy who got your "scrap" built his system with your materials. What really is the slap in the face is knowing that you never got paid for what it was really worth...something about increased labor and hauling costs, an inability to do anything with the reels, etc., as if any of that was your problem!

The bottom line is this...why continue to worry about the service you'll get, the price you'll be paid, or where your scrap materials will eventually "reappear"?! We have a proven track record of dependable service equalled by no one else in the cable industry. Possibly our most important asset, however, is that we know our place...you build the systems and we buy the scrap for the recovery of the plastics and the metals.

Give us a call if we can be of service during your new or rebuild construction. It will be at least one decision that won't "come back" to haunt you...!

RRS

RESOURCE RECOVERY SYSTEMS
8610 BROADWAY,SUITE 220
SAN ANTONIO, TX 78217
(512)828-7777
FAX (512)828-2944

the System 6000. The module will allow cable subscribers with rotary telephones to use the same benefits of ARU technology as touch-tone® callers. The module will be available in the fall, 1989.

Telecorp Systems has also announced the addition of three separate System 6000 models which feature up to 20, 32 and 60 ports respectively. Large-capacity System 6000 units allow cable systems with a large number of telephone lines to use just one ARU for all telephone traffic.

The Telecorp System 6000 ARU also introduced software release 3.0 to the cable industry. The software release adds automatic outage reporting and notification, and voice messaging capabilities. For more details on Telecorp System's new products call (404) 449-6991.

An integrated design and drafting package for broadband applications has been introduced by **ADS Inc.** The Lynx CADD (Computer Aided Design and Drafting) software, a PC-based system, allows the designer to put design on the map. The Lynx automatically calculates the optimum design. A detailed bill of materials is produced, and up to eight user-specified frequencies are tracked simultaneously. Monitoring of the signal from a subscriber's house back to the headend is also possible. For base mapping, the Lynx CADD has a road command with intersection cleaning and a MAP/CUT command which automatically divides a topo, utility or tax map into individual maps. For more info call (404) 448-0977.

Illinois Bell has announced the availability of Ameritech® CATV Order Entry Service, a product that enables cable subscribers to order cable programs by dialing a telephone number. Either touch-tone or rotary dial can be used. The telephone number is associated with a specific program on a pay-per-view channel and only requires 10 seconds for the transaction.

Viewsonics has introduced a full line of passive devices that will function from 5 MHz for CATV/SMATV/MMDS/Data, etc. Two-, three-, four-, six-, eight- and 12-way splitters are available with 100 dB RFI integrity, 75 ohm impedance at all ports and 12 dB return loss from 5 MHz to 10 MHz. Coupler/taps are also available in one-, two-, four- and eight-outputs with 100 dB RFI integrity. All indoor/outdoor splitters and coupler/taps are hermetically sealed, machine threaded and have a sealed die cast housing. Models are priced starting at $1.05.

Also introduced by Viewsonics is a new coaxial cable stripper, the VSCST-1, designed to strip jacket, shield and braid in one step. The stripper has a cable size adjuster pre-set for RG59, RG6 and RG58 cables. The VSCST-1 also features a blade replacement cartridge. An allen wrench is supplied for blade adjustments. The strippers are priced at $14.95. For details on Viewsonics passive devices or strippers call (800) 645-7600; in N.Y. call (516) 921-7080.

Preventing lightning strikes

Lightning Eliminators and Consultants Inc. has developed the SBI-Spline Ball Ionizer. The SBI is a sphere of up to two feet in diameter, with metal wires radiating out from the sphere. It is designed for the maximum charge dissipation that can be expected from a small ionizer. The performance of the system is based upon the size of the sphere, and the length and spacing of the extended wires. For a technical data sheet or more info call (303) 447-2828.

Charles Machine Work's Model 3500

Charles Machine Works Inc. has introduced the Model 3500, an all-hydraulic 35-HP-class trencher. A hydraulic drive radial piston motor is the heart of the 3500's digging attachment. A Deutz F3L1011, three-cylinder, air-cooled diesel engine is also used. The 3500 has a large-capacity hydraulic oil cooler, supplemented by a shuttle valve. The Model 3500 can be equipped with a new, optional Ditch Witch® A222 front-mounted backhoe and is available for purchase through Ditch Witch dealerships. For details call (800) 654-6481.

Available from **Underground Equipment and Supply Co.** is the Prairie Dog Model 700TWA horizontal earth boring machine. Designed for utility work, the model 700TWA drills holes from two inches to 14 inches in diameter and has a range or 600 feet or more. The 700TWA uses an air motor to drive drill rods with a forward and reverse reducing transmission and clutch and uses special quick coupling drill rods. These stems are supplied in 4-foot sections in either 1 7/16 inches or 1¾ inches diameter. For more info call (713) 448-8444.

R.L. Drake's Model ESR 1224

The R.L. Drake Company has introduced a mid-priced integrated receiver decoder (IRD), the ESR1224. As the second unit in the Series 2 line of IRDs from Drake, the ESR1224 features UHF remote control. The ESR1224 also features threshold extension circuitry, uses a 950 MHz to 1450 MHz block input frequency and input switching to eliminate the need for external relays. The unit can accommodate one C-band and one Ku-band LNB and is compatible with all Drake LNBs and its BDC24 block downconverter. The unit is priced at $1,247 without the APS1024 and $1,356 with the APS1024. For details call (513) 866-2421.

Team System's Astro VG-814

Team Systems has introduced the Astro VG-814 programmable video generator to simulate any Japanese, European or American HDTV standard. The VG-814 produces RGB output using virtually any resolution, aspect ratio, frame rate or bandwidth. Scan can be interlaced or non-interlaced with sync/video or separate sync(s) and video. Programmed from the front panel, the VG-814 stores and recalls up to 40 programs or patterns, including 15 factory-installed, user defined fixed patterns. Pixel by pixel control over the entire 2048-by-1280 graphics plane enables creation of any special test pattern.

Horizontal scanning is programmable from 10 kHz to 130 kHz in 2 dot or 30 ns steps; pixel frequency is independently programmable from 5 MHz to 75 MHz. Vertical scan range can be set from 100 lines to 2048 lines per frame, sync pulse of 1 line to 99 lines, and active display time from 1 line to 2000 lines. The Astro VG-814 video generator is priced at $5,650. For info call (800) 338-1981; in Calif. call (408) 720-8877.

And the Vanguard Award goes to...

David Pangrac

The Vanguard Award for Science and Technology has been presented to **David Pangrac**, director of engineering and technology for ATC, in honor of his development of the "fiber backbone" concept for AM broadband transmission. Pangrac pioneered the development of a hybrid optical fiber/coaxial cable CATV system architecture. Pangrac joined ATC in 1982 as vice president and chief engineer of its Kansas City system. He joined the ATC corporate staff in 1987 in his present position. Pangrac is a member of the SCTE and is past president of SCTE's Heart of America Chapter.

Texscan Corp. has announced the appointment of **William Dawson** as vice president and general manager of Texscan MSI, located in Salt Lake City. Dawson was recently vice president of quality for the corporation and previously vice president and general manager at Texscan Instruments in Indianapolis.

Michael Holland has resigned as president of Pico Macom Inc. and will be starting a new company called **Holland Electronics Corp.** Holland Electronics will provide CATV and SMATV headend equipment and accessories.

John Burke has been appointed to the position of product manager within **Jerrold's Subscriber Systems Division Marketing Department**. Burke will be responsible for portions of the subscriber product line, including international converters, on-off premise products and other terminal products.

Also within the subscriber division, **Ron Ebert** has been appointed the national service director. Ebert has been with Jerrold since 1958 and was most recently national service manager. As service director, Ebert is responsible for administering the division's product-warranty agreements.

In other announcements by Jerrold, **Dan Sutorius** has been named project manager, Fiber Optic Distribution, in Jerrold's Cableoptics business unit. Sutorius will be responsible for the day-to-day business/marketing aspects of Jerrold's fiber optics research and development programs. An immediate project Sutorius will be responsible for is the transfer of AM fiber optics technology into product for cable TV backbone trunking applications.

Internationally, Jerrold has named **Horatio Egnoto** as vice president of European Operations. Egnotto will report to Jerrold President Hal Krisbergh and will manage Jerrold's Slough operation in the United Kingdom. Egnoto will be responsible for developing marketing opportunities throughout Europe.

Chris Chambers has been named CAD product manager for **Cable Link Inc.** Chambers started with Cable Link in general refurbishing work and shipping. He then worked as systems analyst in the MIS department. With the move to product manager, Chambers will be responsible for management of strand mapping and system design operations.

Midwest CATV, a division of Midwest Corp., has named **Rex Porter** as vice president of its western region. Porter was formerly with Pyramid Industries. Porter's immediate goal is to "be up and running within 90 days...to supply a full distributor product line on a regional basis." In another appointment, **Kenneth Gray** was named operations manager of Midwest's southern region. Gray was formerly affiliated with the Generac Corp. as regional sales manager and Anixter Cable TV as district sales manager.

Also, Midwest CATV has added two sales representatives. **Al Starr** will be headquartered in Clarksburg, Va., and cover outside sales in western Pa. and western N.Y. for Midwest's eastern region. Starr has 15 years experience in system layout and engineering design. **Tom Thorpe** will cover the New England states and operate out of Pottstown, Pa. Thorpe was recently a sales engineer for NCS Industries.

William Fitzgerald has been appointed president and CEO of **Pico Macom Inc.** Fitzgerald's background includes experience in management, manufacturing, and sales and distribution both in the United States and the Far East. Fitzgerald will be responsible for expanding the company's product line and increasing customer services.

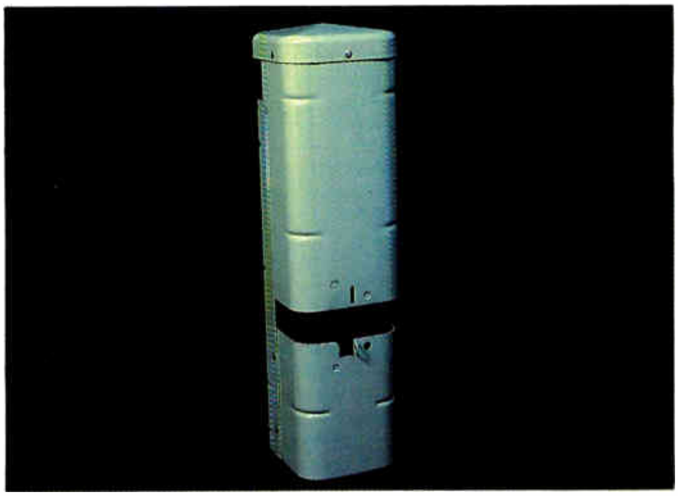
Augat Communications Group—LRC Electronics has announced the addition of **Larry Massaglia** as national accounts manager. Massaglia, formerly with Gilbert Engineering of Scottsdale, Ariz., will be primarily responsible for the major MSOs headquartered in Denver, Colo. as well as their regional offices.

Dawn Simpson has been named district sales manager for **Comm/Scope, Inc.** Simpson will cover the Midwest, including Illinois, Kansas and Missouri.

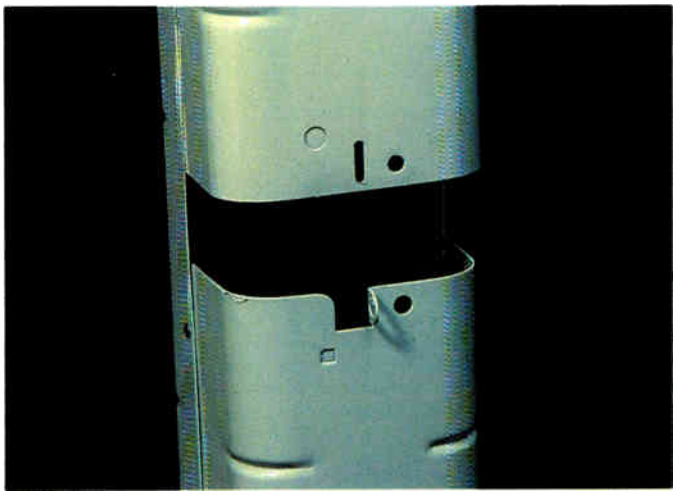
C-COR Electronics Inc. has named **Thomas Harbourne** as regional account executive. Based out of La Jolla, Calif., Harbourne has been with C-COR since 1986 as national sales manager for the power products division. Prior to C-COR, Harbourne was market manager at Elgar Electronics.

—Kathy Berlin

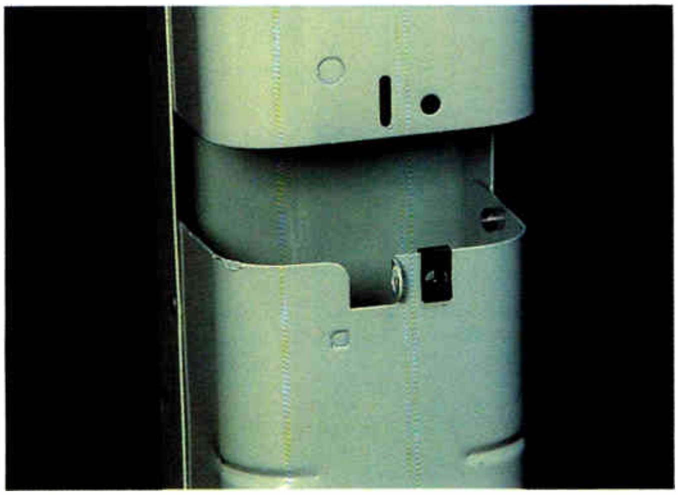
FAST FIELD SECURITY FOR YOUR CABLE TV PEDESTAL



Pedestal cover with knock out in place.



Knock out is easily removed with hammer and ordinary screwdriver.



Locking clip fits over pedestal in seconds.

Star Lock is tightened and removed only with special screwdriver type key for maximum security.

Only Reliable pedestals come with factory-provided knock outs for installing **Diversified Control Systems** Star Locks.

A small but important feature... because it provides maximum security for cable TV pedestals or apartment boxes fast and easy right in the field.

Hasp broken or missing? No problem. Diversified's Star Locks are designed to deliver a secure closure without using the hasp.

It's a great combination: Star Locks and Reliable Electric, the best-selling pedestals in the industry. And you can get them both from one trusted source: Anixter Cable TV.

RELIABLE

RELIANCE COMM/TEC

+

ANIXTER® CABLE TV

WEST-ANAHEIM: (714) 779-0500, (800) 854-0443; **DENVER:** (303) 373-9200, (800) 841-1531; **SEATTLE:** (206) 251-6760, (800) 426-7665; **MIDWEST-CHICAGO:** (312) 364-7000, (800) 544-5368; **CLEVELAND:** (216) 526-0919, (800) 321-8068; **DALLAS:** (214) 446-7337, (800) 231-5006; **IRON MOUNTAIN, MI:** (906) 774-4111, (800) 624-8358; **SKOKIE, IL HDQTRS:** (312) 677-2600; **EAST-ATLANTA:** (404) 995-5110, (800) 241-5790; **LONG ISLAND, NY:** (516) 293-7788, (800) 645-9510; **NEW JERSEY:** (201) 328-0980, (800) 631-9603; **TAMPA:** (813) 626-7115, (800) 282-9164; **CANADA-CALGARY:** (403) 250-9646; **MONTREAL:** (514) 636-3636; **TORONTO:** (416) 625-5110; **VANCOUVER:** (604) 321-5885

In an emergency, weekends and holidays or after 5 P.M. call toll free 1 (800) 323-8166,

CORPORATE OFFICES, ANIXTER CABLE TV, INC., 4711 Golf Road, Skokie, IL 60076, (312) 677-2600

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The Future Is Here!

The ANIXTER Fiber Optic Laser Link AM CATV System

AT&T and Anixter Cable-TV have joined forces to bring you — *today* — the most exciting technological advancement in the cable-TV industry. And, we're proud to say it's the *only* system that is truly *"Made in U.S.A."*

It's Anixter's Fiber Optic Laser Link AM CATV System — a major breakthrough for cable TV in the transmission of multiple AM analog television channels over long distances. Following extensive, highly successful field tests, initial installations of the Laser Link System will be made *this year* by many MSO's. Major features and benefits include:

- Easy installation and maintenance
- Compatible with existing CATV networks
- Low start-up costs
- Reduced maintenance costs
- Easy network upgrades
- Improved signal quality and reliability

Call our Fiber Optic Information Center at: 1-800-FIBER-ME. (1-800-342-3763)

See us at the Cable Tec Expo, Booth #434.

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