CED

THE MAGAZINE OF BROADBAND TECHNOLOGY / FEBRUARY 1989

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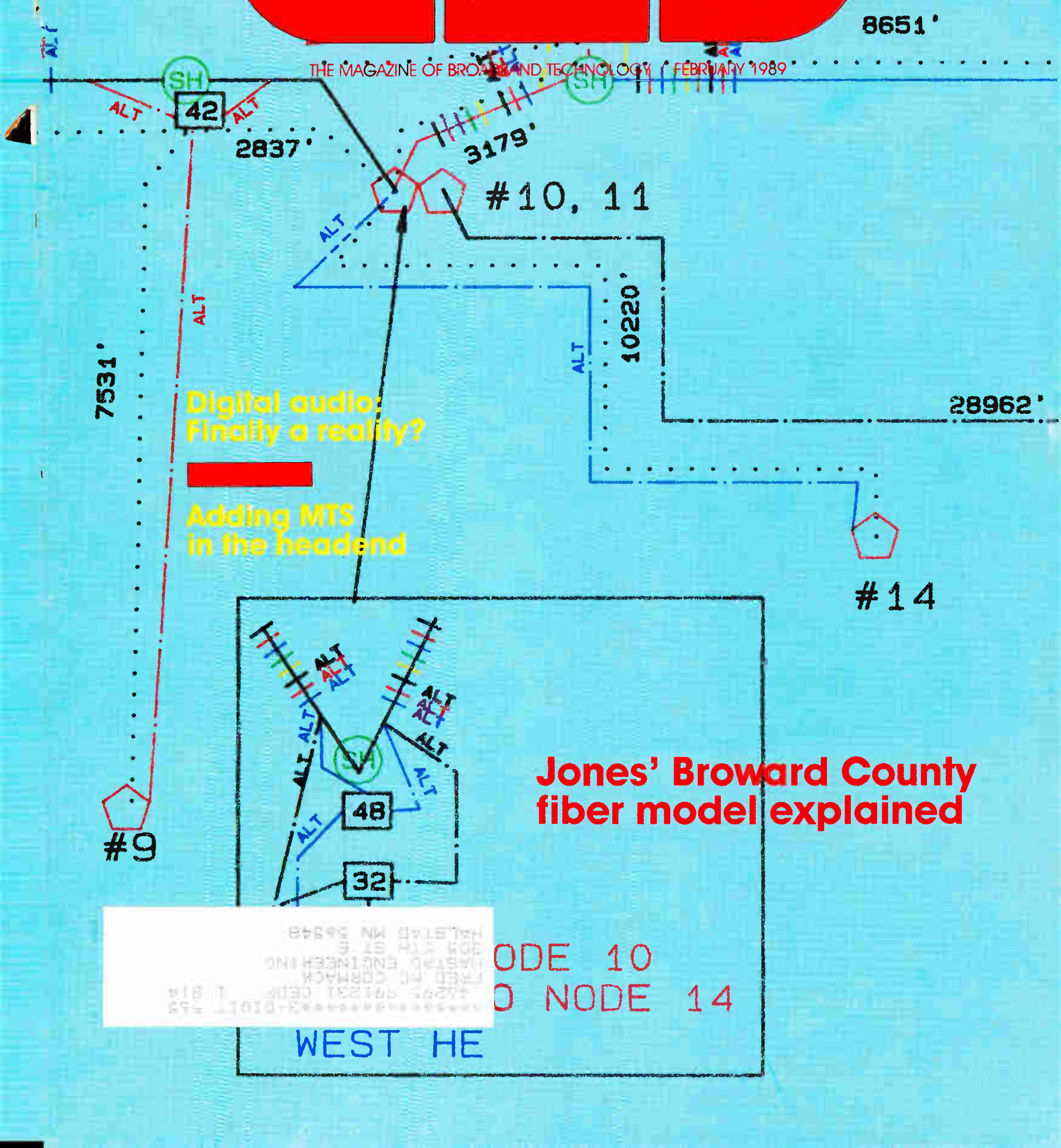
Jones' Broward County fiber model explained



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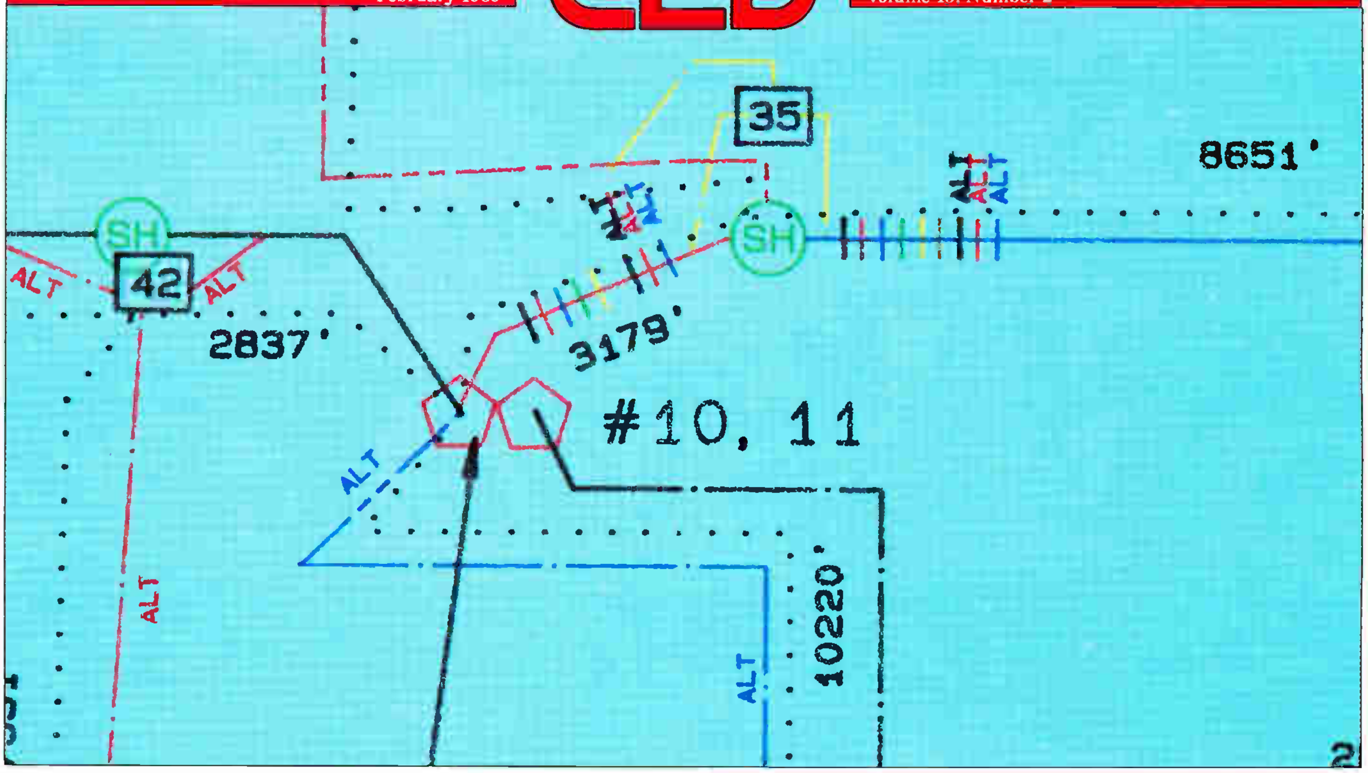
February 1989 CED Volume 15, Number 2



About the Cover:
A CAD (Computer Aided Drafting) drawing of Jones Intercable's Broward County, Fla. system shows how the MSO plans to implement AM fiber optic electronics in the 800-mile system. Courtesy Jones Intercable.

DEPARTMENTS

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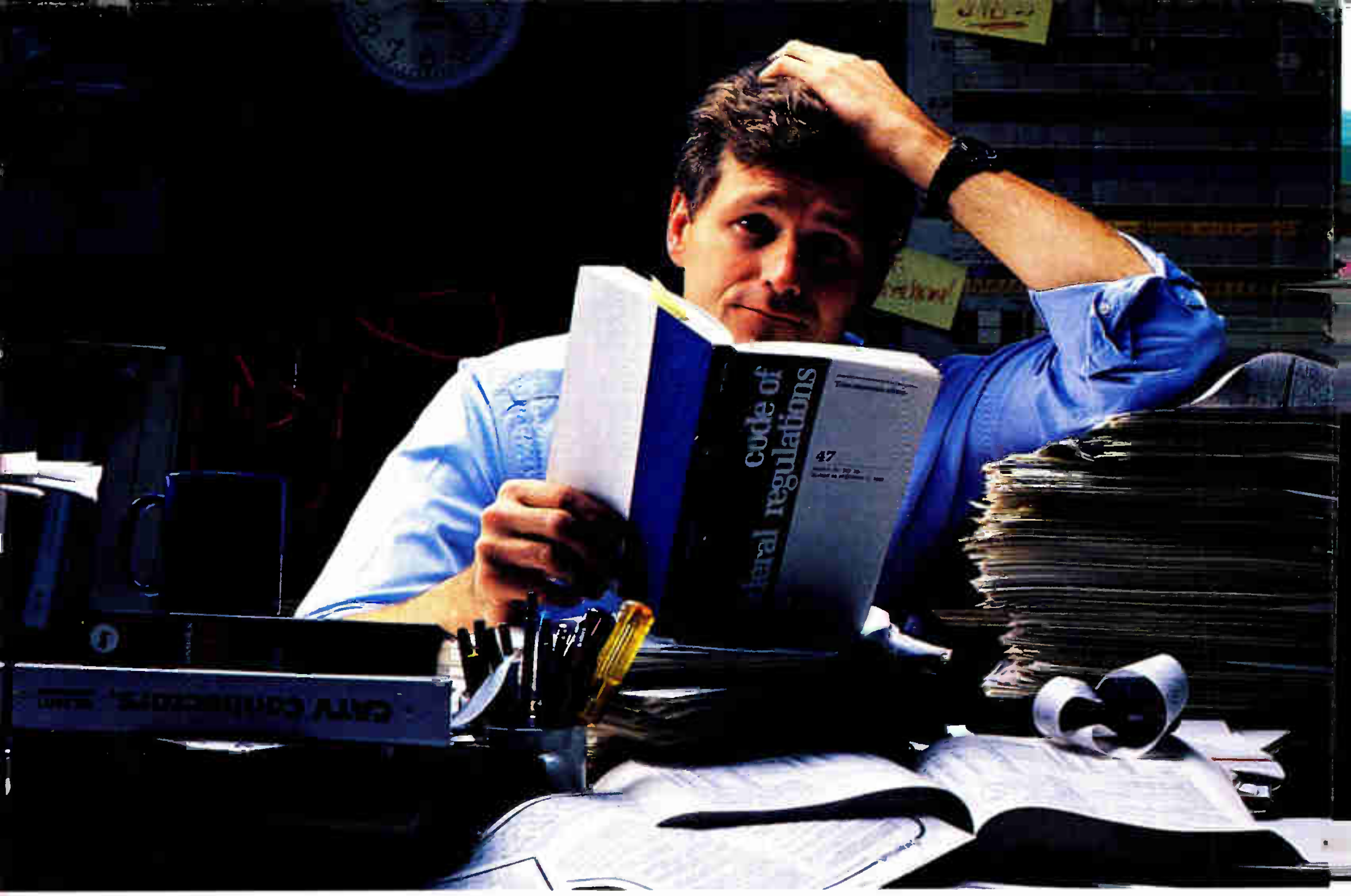

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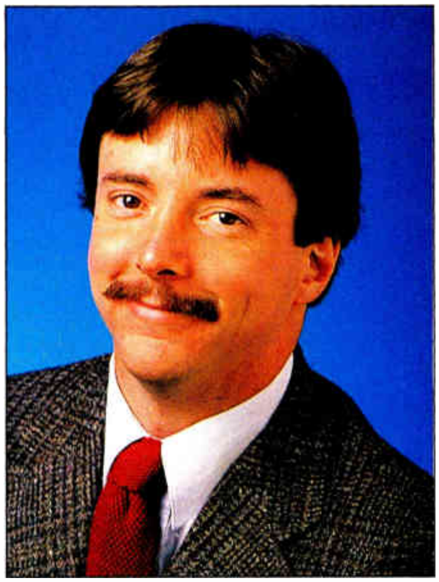
Reader Service Number 4

WAVETEK®

Innovation and cooperation pays off

Our cover story this month concerns Jones Intercable's AM fiber project in south Florida. After reading the story, two things rushed into our minds, including: 1) the industry has finally rounded the theoretical corner and begun to implement lightwave technology and; 2) it pays to think in ways no one else has.

Bob Luff may be right. The Jones Cable Area Network fiber model may be looked back upon as the turning point in the fiber/CATV question. But that remains to be seen. What is obvious, however, is that the industry has indeed embraced the future that fiber optic technology represents.



There are those who believe that CATV has taken to fiber because the baffling regulatory environment may not "protect" the industry from telco involvement much longer. Some say operators were forced to adopt the technology because Wall Street demanded it. Whatever the motivation, the end result will certainly be positive for the industry and its subscribers.

It's been a long 18 months since American Television and Communications' Jim Chiddix and Dave Pangrac went public with their idea about a fiber optic backbone. Numerous theoretical papers about the technology and its benefits have been written and delivered at the major cable conventions. And every time a supplier developed new fiber optic hardware designed for CATV, immediate and intense attention was paid to what the supplier had to say.

But now we can start to look past the theoretical and scan the horizon, where stories about system *implementation* are taking place. At long last the industry will get beyond the hype and hoopla and talk about real-world tests and methods.

And give credit to the Jones engineers who have taken the fiber backbone concept one step further and made it a mini-system of its own. By using a novel approach, the first truly redundant trunking application is taking shape. Engineers have talked about the idea of system backup for years; at last it's here.

We're certain that as other engineers and system designers fully grasp the capabilities fiber can bring we'll all be hearing and reading about unique approaches to common obstacles. We've moved beyond the question of whether or not fiber will work (it will), now the issue is clearly architectures and economic comparisons between fiber and more traditional technology approaches.

We applaud the free exchange of ideas between ATC, Jones and others that led to the use of fiber in Broward County. We think more of that has to occur to keep this industry looking forward to the day when a full range of broadband services can be delivered to the subscriber. The sky's the limit—so let's start flying.

We also want to acknowledge the return of Kathy Berlin to the pages of *CED*. Kathy has taken the role as managing editor and will bring new, insightful input to the magazine. With her keen eye and fresh perspective, we're certain she'll help make this publication better and even more interesting.

Roger J. Brown

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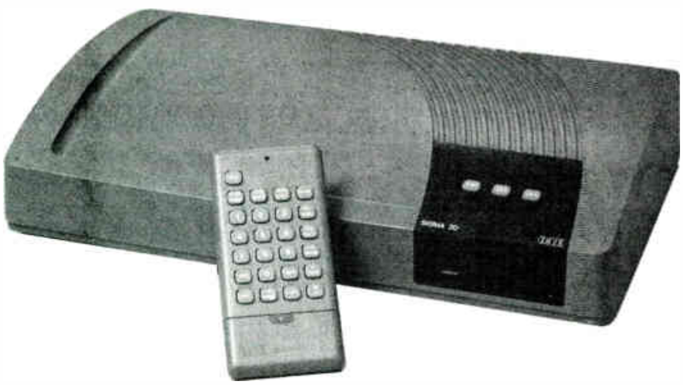

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Reader Service Number 5

Graham Stubbs

Stubbs part of cable's beginning

With thoughts of optical wavelengths as a transmission medium, it's difficult to imagine that technology 20 years ago focused on developing converters and amplifiers. Graham Stubbs, executive vice president for Eidak Corporation, began his cable career when 30 channels were a technological problem and Jerrold was still in the microwave business.

"At that time there was, in some ways. more excitement in the industry," says Stubbs. "The engineer had more freedom. Since there were fewer engineers and fewer companies, it was easier to take risks." And take them he did. From being involved with the basic design of two-way filters and amplifiers, to developing the first addressable converter, Stubbs has been involved with many of the major "firsts" in the cable industry.

Born in England, Stubbs was working for Associated Electrical Industries in Leicester in 1967 when he accepted a position with General Instrument's Jerrold Division as a microwave engineer. Deciding the risk was worth it, Stubbs packed up his wife, two daughters and $300 in savings and moved to the United States. "I never regretted the move to the States and never regretted the move into cable," says Stubbs. "I really enjoy it."

After Jerrold got out of the microwave business, Stubbs transferred over to work on two-way amplifiers. About a year later, Jerrold decided it wanted to get into converter development and appointed Stubbs manager of the engineering department. Stubbs actually did some of the circuit development himself, including design of a double balanced mixer. "At that time," says Stubbs, "it was difficult to get the distortion performance of a converter to be anything like the rest of the cable system. If you put all the signals (which might be 30 at that time) into the converter, you would find the same type of distortion within the converter that was happening within the cable system. Generally speaking, this limited the range of signals you could put into the converter.

"What was novel about the Jerrold converter," he continues, "is that it was so tolerant of the range of signal levels." Stubbs feels he left his mark on the converter business in that the circuit practice developed for the double balanced mixer is pretty much in use even now.

A second beginning

Ten years after starting with Jerrold, Stubbs was approached by Oak Communications to head up the engineering department for both subscription television (STV) and Oak's cable equipment. Stubbs accepted the position of vice president of engineering and was responsible for developing the first addressable converter.

"The way that came about," says Stubbs, "is Oak had developed an addressable system for STV that I was supposed to get up and running. We turned around and applied that kind of technology and experience to an addressable converter." And the reaction of the cable industry? "The reaction was to move very fast toward addressability," says Stubbs. "But what also happened was the entire industry tried to develop those converters and the technology too quickly and, almost without exception, the various manufacturers who entered it had problems, including Oak."

Regardless of the difficulties, Stubbs says Oak's introduction of the addressable converter prompted the relatively rapid deployment of addressability in the cable industry. According to Stubbs, nine years have produced an addressable product that has made significant gains in reliability and flexibility of the addressing system.

While at Oak, Stubbs, the holder of five U.S. patents in addressability and scrambling, helped develop the Sigma concept of encryption. "As with any technology," says Stubbs, "we were looking for better ways to do things. We felt the earlier scrambling systems were possible to defeat." Using the airline concept of "you can watch the movie but can't hear the sound unless you have headsets" Stubbs and others concentrated on putting a hard form of security on the sound channel instead of the video channel. "We came up with digitized encrypted audio for a scrambling system," says Stubbs. "And we embodied that in the Sigma system."

Stubbs worked on perfecting the Sigma product for several years until he felt there were limited opportunities for growth. He then left Oak to become vice president of engineering for Linear Corp. in Carlsbad, Calif. At Linear, Stubbs managed the new product innovation and development for passive infra-red, supervised wireless and digital security systems. While working for Linear, he set up a consulting business in cable. It was during this time that Dick Leghorn, president of Eidak Corp., contacted him and Stubbs began consulting part time for Eidak.

> While at Oak, Stubbs helped develop the Sigma concept of encryption.

New technology

Eidak is a service that provides non-recordability for pay-per-view (PPV) transmission. It consists of modifying the PPV signal before it is transmitted so that it can be watched, but not recorded, by the consumer. After consulting for Eidak 18 months, Stubbs felt there was enough activity with the company to go with Eidak on a full-time basis.

Stubbs says Eidak is positioned to be a key part in cable's future by providing an essential element for PPV viewing[an earlier release date from the movie studios. "The studios tell us that this service is exactly what

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SPOTLIGHT

they've been looking for for a number of years," says Stubbs. "It is not aimed at subscription television such as HBO or Showtime, but rather at bridging the gap between the cable industry and movie studios."

As executive vice president of Eidak, Stubbs is excited about his new role within the company. "My position is focusing on business and team interaction rather than actual technical development—I get a kick out of the people aspect," he says.

Stubbs has always enjoyed working with people in the industry, especially on new product design. "Whether it was Jerrold, Oak or Eidak," he says, "what I really enjoyed was being part of a business and development team that was putting things together. A lot of development work is team effort and I wouldn't take sole credit for any of the products developed. And whenever you look at technology development, you look not only at the engineering team that did it, but in some cases, the business people who had the guts to pay for it."

You've come a long way

Cable technology has come a long way since those early days and so has Stubbs. However, being a part of those early developments has not made him want to sit back and quietly watch. "I think cable is going to mature in terms of growth and I think the industry is on the right track with fiber," he says. "And I think it's long overdue for an entity like Cable Labs to come into place and start to channel the dvelopment of technology and the application of technology." Feeling that engineers will benefit by having a central focus for technology development, Stubbs hopes this will reverse a current trend of spending less on technology.

As for himself, Stubbs is enthusiastic and ready to go with the technology Eidak offers. "One of the things about Eidak is I'm at a place that has a key part in a dynamic business. It's in the home entertainment industry and as HDTV and other forms of television format develop, a company like Eidak will have a part in the control technology," says Stubbs. "I feel good about the direction of cable and the opportunity for me to play a role in it."

Twenty years have made a difference in cable technology but it hasn't changed Stubbs' plans—he was an integral part of cable's beginnings and he intends on being a key part now. ■

—Kathy Berlin

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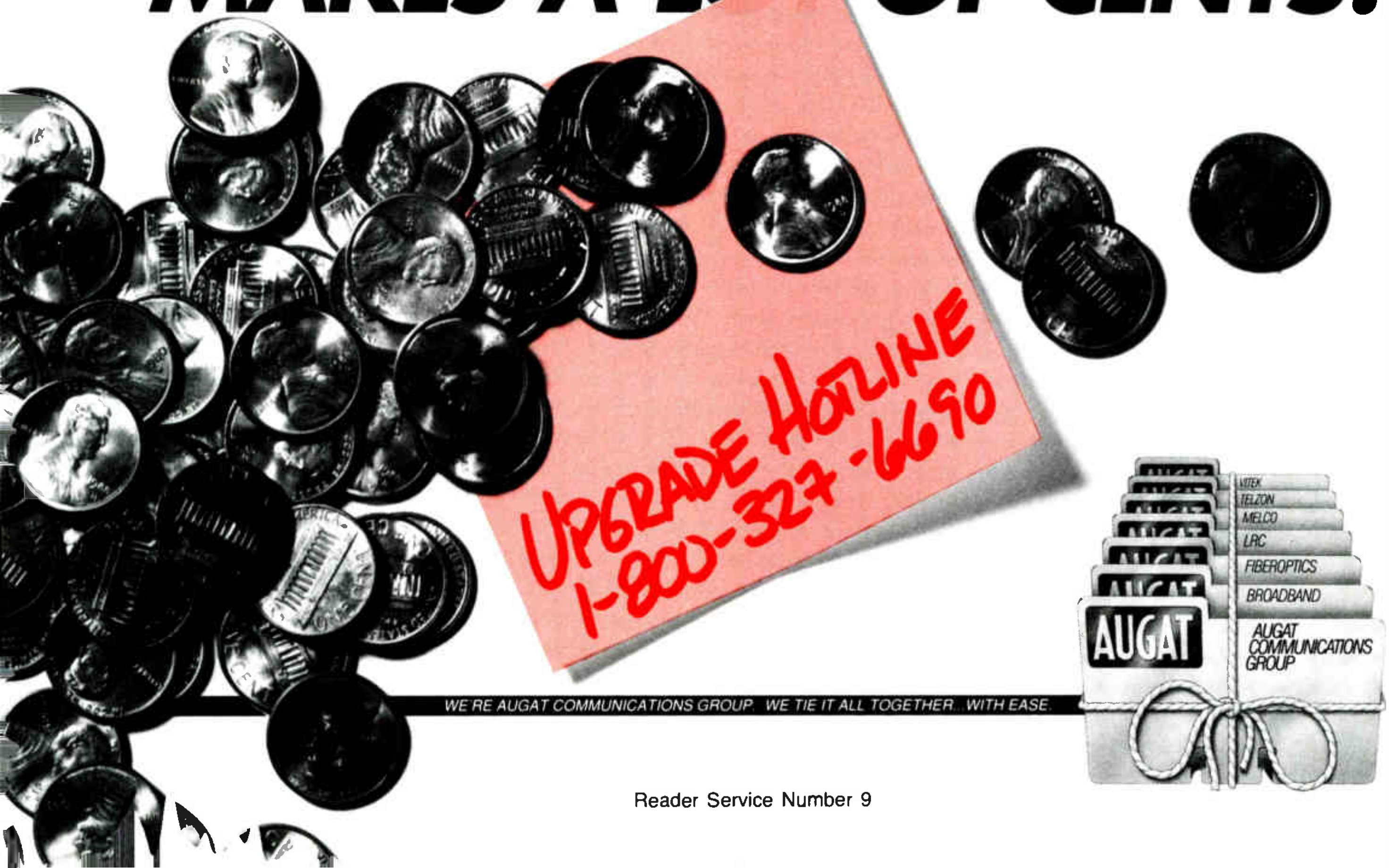

Reader Service Number 9

So where are the cable guys?

There are more committees and meeting groups in the telecommunications industry than any other I know about. At least, that's how I feel about it in my day-to-day work. The truly alarming thing about these committees is that so many of them work on issues or projects that have an impact on the cable TV business.

Sometimes they are well aware of this impact and have at least tried to understand how we as an industry will react. More often, however, these groups are ill-informed or otherwise lacking in information about our world. It's not surprising, therefore to find ourselves so often running around in the panic mode to quickly fix, inform or undo some technical outcome that has been worked on for months or even years.

BTSC a poor example

Examples of this "brinksmanship" are depressingly easy to find. The four-plus-year effort of the broadcast and consumer electronic industries to develop and implement a stereo TV standard is a case in point. The committee structure was well-known in the broadcast world. The BTSC (Broadcast TV Standards) parent committee of the EIA (Electronic Industries Association), working with the NAB (National Association of Broadcasters) and the subcommittee on MTS (Multichannel TV Sound) issued what was to be a final report on the lengthy and thorough deliberations.

By Wendell Bailey, Vice President Science and Technology, NCTA

The only problem was that only one-and-a-half pages covered cable TV systems and equipment out of the entire two-volume set, and these pages contained several factual errors about our technology and its use.

A major effort funded by the NCTA was organized and set in motion. Luckily, a major flap over several other issues developed, and a new set of certain tests was ordered. This allowed the cable industry to be more accurately represented in the final standard.

The real problem

The issue I want to raise, however, is not BTSC itself, but the underlying reasons why we found ourselves exposed to big trouble in this way. The four-plus years of work done by the broadcaster was accomplished with virtually no cable television industry input whatsoever. Even though we had repeatedly been told to attend any and all deliberations on the subject, we, as an industry, reacted in a manner often called "raging apathy."

The battle over the current BTSC standards was waged a couple of years ago. Today, alas, there are a bewildering array of special interest groups representing several industries. These groups work through countless committees and task forces on things that are going to have an impact (either positive or negative) on our industry.

What committees?

Some of these groups are worth knowing about. The FCC, of course, has its advisory committee on advanced TV. This committee works through several subcommittees and working groups which involve almost 500 people. The NAB is working on HDTV proponent testing through the ATTC (Advanced Television Test Center). The NAHB (National Association of Home Builders) is working on its "Smart House," a system of wiring and control that will be of interest to CATV. Not to be outdone in committee-dom, the EIA has its own groups, such as the CEBus (Consumer Electronics Bus), which is also working on an in-home wiring scheme. The EIA also has the R4 committee, which works on issues affecting both TV sets and cable converters.

Let's not forget the SMPTE (Society of Motion Picture and TV Engineers), which does its share of work on HDTV production standards as well as digital studio and other issues. The SCTE (our own Society of Cable TV Engineers) has several curriculum committees for the very important BCT/E certification program. The SBE (Society of Broadcast Engineers) has its own certification program along with its associated committees. There are groups concerned with electro-magnetic radiation from antennas (as in microwave) and the ever popular (and important) NEC (National Electrical Code) and NESC (National Electrical Safety Code) committees.

Cable input needed

All of these groups desperately want and need input from our industry. They are working on issues which have a direct impact on some part of our business. To date, the cable television industry has not been successful in providing the people to produce the necessary time and effort to do the job. We need help! The engineers or managers who attend these meetings do not have to be the decision makers (it's nice if they are) for their company. They just need to understand their own business well enough to know when the discussions are lending to issues which could have an impact on CATV. They must also be able and willing to speak up, when needed, and not let inappropriate activities continue without comment.

In almost all of the committees and groups mentioned above (and others), the "other guys" have out-gunned us with participation. The telcos lead the list of companies who put people to work on the issues. The big three networks (NBC, CBS, ABC) also do a good job and the consumer electronics industry is no slouch where its business is concerned. Cable participation is, frankly, slim and the issues are getting more numerous and more difficult. The potential impact on our business multiplies every day.

I suggest you examine your company's interest in one or more of these groups (and others) and see if you can find a way to help yourself by helping the entire industry. We will all benefit from this type of intelligent investment in our future. ■

FCC looking at telco/cable rule

For almost 20 years, the role of telephone companies in the provision of cable television service has been clearly defined by federal law. While telephone companies are permitted to construct and provide transmission facilities to franchised cable operators, they may not themselves provide video programming, either directly or through an affiliate, to cable subscribers. Now, however, the FCC has tentatively decided to recommend that Congress eliminate the ban and allow telephone companies to operate as programmers and cable operators over their own facilities.

Reasons clear

The reason for the prohibition has always been clear. Telephone companies, as monopoly providers of basic telephone transmission services subject to rate-of-return regulation, have unique incentives and abilities to enter the cable television business in an anticompetitive manner. Specifically, they can use their control of poles and other essential facilities to discriminate against unaffiliated cable operators. And they are likely to cross-subsidize their cable business by shifting costs properly attributable to that business to their regulated rate base for basic telephone service.

Nobody disagrees that the telephone companies still have the means and incentives to engage in anticompetitive conduct. But the FCC believes that it can now develop non-structural "safeguards" that can effectively detect and prevent discrimination and cross-subsidization—something that has never been done before. The FCC also suggests that if it can effectively prevent anticompetitive conduct, there will be great benefits from allowing the telephone companies to provide cable service.

Widespread opposition

The FCC has put its proposal out for public comment, and it has drawn widespread opposition. Virtually nobody (except the telephone companies) believes that the FCC's accounting rules can prevent cross-subsidization, nor do many share the FCC's faith that it can adapt its still evolving and untested "Open Network Architecture" rules to prevent telephone companies from discriminating against unaffiliated programmers and packagers seeking access to integrated broadband networks.

It's not only cable operators who recognize the dangers of eliminating the prohibition. Other competitors in the video marketplace—broadcasters, in particular—understand that repeal of the law would allow the telephone companies to dominate all aspects of the television marketplace. Moreover, the broadcasters are concerned that the FCC's safeguards might themselves radically affect broadcasting and the video marketplace.

Newspaper publishers oppose elimination of the prohibition because they want to preserve the cable operator as an alternative to the phone company for the delivery of data and teletext. Public interest groups, such as the Consumer Federation of America, oppose repeal not only because of the anticompetitive effects in the video marketplace but also because telephone ratepayers would end up footing the bill for the construction and operation of broadband facilities for cable service. And a number of state regulators oppose repeal because they have had experience trying to regulate phone companies and understand that the FCC's safeguards are wholly inadequate.

Where are the benefits?

The FCC has grossly overstated the potential benefits of cross-ownership, too. First, the FCC suggests that telephone companies might provide head-to-head competition for cable operators where no such competition now exists. Even where there's only one cable operator, that operator generally faces competition from broadcasters, video stores, TVRO retailers, MMDS services and other competitors in the video and entertainment businesses.

But besides that, the reason that there's generally only one cable operator in a community has nothing to do with whether or not telephone companies are allowed to be cable operators. There's no scarcity of potential non-telco cable operators in a community. If cities allowed—or if economic conditions permitted—additional franchises, there would be additional head-to-head competition with or without the phone company. And, as an economic analysis commissioned by NCTA shows, there's no apparent reason to expect any unique efficiencies on the part of phone companies.

No economic sense

The FCC also maintains that allowing telephone companies to provide video programming will somehow increase their incentives to construct common carrier facilities for broadband communications and will hasten provision of all sorts of unspecified new non-video services.

But that makes no economic sense unless the Commission's proposed safeguards turn out not to work, so that telephone companies are able to deny other video programmers comparable access to their facilities and to subsidize the premature construction of broadband facilities with ratepayer revenues.

At bottom, what seems to be motivating the FCC is an ideological belief that all restrictions on entry by potential competitors are bad. That belief has caused the Commission to conclude, in its Further Notice of Inquiry, that there is no downside to eliminating the telco/cable cross-ownership prohibition when, in fact, the risks of anticompetitive behavior and of adverse effects on the video marketplace are enormous. ■

By Michael Schooler, Deputy General Counsel, NCTA


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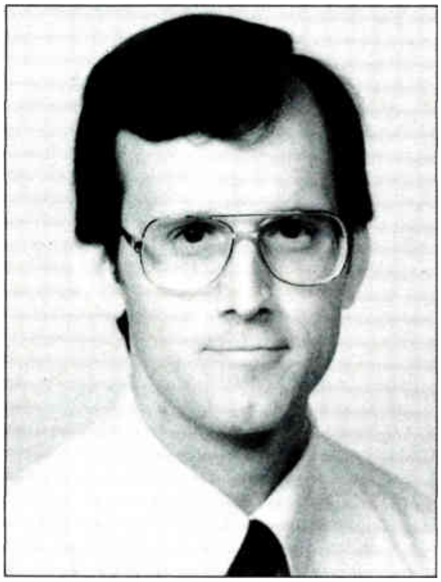


Degradation accumulation methods

Last month's column (January 1989) presented a summary of industry recommended practices on video performance. Unfortunately, because of an editorial error at CED, all of the greater-than (>) and less-than (<) signs in the column were reversed. Nonetheless, by mentally reversing the signs, in a single chart we were able to compare the recommended performance parameters of RS-250B, NTC-7, HBO, and the NCTA.

Harder than it looks

At first glance, some of the performance requirements might seem quite easy to meet. And in fact, for a single piece of equipment, such requirements are somewhat trivial. The difficulty increases significantly, however, as you begin to daisy-chain equipment. In our CATV environment, it isn't at all unusual to have as many as seven pieces of equipment in the system which may cause an accumulation of classical video distortions.

Appendix 1 of EIA Standard RS-250B addresses the issue of "Accumulation of Performance Degradations." This section is meant as a tool to help predict the aggregate performance of an overall system, based upon the performance of each individual component in the system.

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

Looking at a CATV system

Consider a typical CATV application, for example. Such a system might consist of an exciter, as well as an encoder for scrambling at the uplink. At the headend, we might have a satellite receiver, scrambling decoder, modulator, and a sync-suppression scrambler. And, finally, in the home, we might have a baseband set-top terminal where demodulation and remodulation of the signal must again occur. Each of these devices may individually contribute to certain video distortions. The overall, or end-to-end performance is therefore a function of each device in the system.

The performance of each device contributes directly (though typically not in a linear fashion) to the video performance that we provide to our customers. Of course, there are many other devices in the system which might affect overall video performance, especially S/N performance, but I have mentioned those to which are typically attributed specifications for video distortions on their data sheets. Therefore, the distribution plant, while contributing significantly to overall S/N performance of the system, is not listed as a major contributor to the classical video distortions, and is therefore not included in the chart.

A graphic illustration

The attached Table, developed on Lotus, outlines quite graphically what can happen to video performance through a system consisting of the seven individual boxes described above. Note that the performance specifications listed for each component are representative of those that might be found from a cross-section of various manufacturers and cannot be attributed to any particular manufacturer. The Table therefore simply gives a rule-of-thumb prediction of an arbitrary system's end-to-end video performance. One can certainly choose higher performing devices than those shown in the Table. But the numbers listed for each component are certainly not out of line, based on a review of industry data sheets.

Calculations simplified

Based on the predictions given in the Table, it's a wonder that the picture is even watchable (of course in some cases, we might argue that it isn't watchable). The point being that good end-to-end performance is what we are all shooting for, but we must realize that the aggregate end-to-end performance is a function of each component in the system.

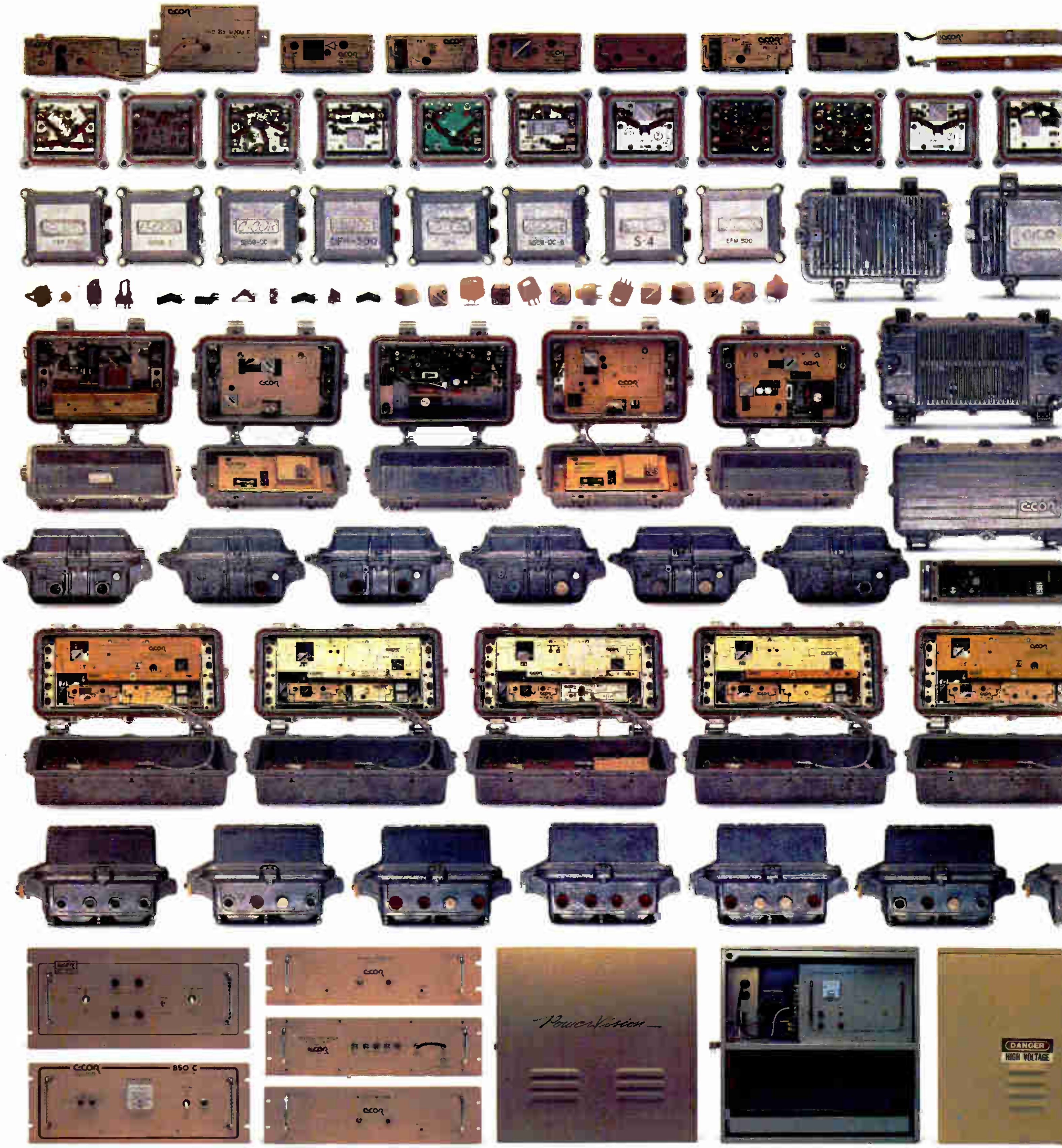
Video Performance Accumulation Spreadsheet

RS-250B Rule-of-Thumb
(Not including Distribution Plant)

Parameter	Device #1	#2	#3	#4	#5	#6	#7	Total	Method
Diff Gain (%)	2	2	5	3	3	3	5	12.4	3/2 Power
Diff Phase (Deg.)	1	1	5	3	3	3	5	11.7	3/2 Power
C/L Delay (ns)	25	25	100	50	50	25	75	150.0	RSS
C/L Gain (IRE)	1	1	5	1	3	1	5	7.9	RSS
Line Time (IRE)	1	1	1	1	1	1	2	3.2	RSS
Field Time (IRE)	1	1	3	2	1	1	3	12.0	Linear
Short Time (IRE)	4	1	3	2	2	2	4	7.3	RSS
C/L Intermod (IRE)	1	1	1	1	1	1	1	3.7	3/2 Power
Weighted S/N (dB)	65	65	60	65	60	65	53	50.8	RSS

Note: Field Time Distortions might be correctable via downstream clamping. See January 1989 column for definition of accumulation methods.

In order to make the calculations simple, the equations were developed on a Lotus spreadsheet. That way, any parameter in the spreadsheet can easily be changed, and the calculations are performed automatically, creating an excellent system planning tool. I highly recommend the spreadsheet approach, especially for playing "what-if" games. Note, however, the predictions of RS-250B are meant only as an estimate and don't necessarily provide results that match reality exactly. ■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Flawed premise

I cannot comment on the final conclusion of Gary Moore's article (One Final Thought, *CED* December 1988, p.136). However, there are significant errors and omissions in the presentation which would need consideration in an objective analysis.

In his second paragraph, Gary has forgotten or is not aware of how CATV systems are actually constructed. Most CATV systems are constructed on a trunk and distribution basis. To a first approximation, the signal-to-noise performance is determined by the trunk and the distortion performance by the distribution. It is assumed that the cascade limitation of four applies to the trunk. This leads to the configuration of Figure 1 where each of the four trunk amplifiers can feed up to four distribution cascades.

Examination of Figure 1 shows each trunk cascade could service approximately eight miles of distribution; or at 60 subscribers per mile, 480 subscribers. This configuration could be legitimately criticized on the basis of being too efficient in distribution. This criticism could be countered by the probability that more than one trunk cascade would emanate from the hub. At any rate, the number of subscribers that could be served from a hub is significantly more than Gary's "generous" estimate of 100.

I agree with Gary that the ultimate conduit to the subscriber for all communications and information services will be a single fiber connected to a switched network. The switched network eliminates the need for much subscriber terminal equipment and allows authorizations and changes to be made under cover at the hub without a truck roll. However, much of the equipment required is not in commercial production. For example, there are no optical "central office" switches although I am sure they are under development at several locations.

The signal delivered to the subscriber is light. Presently, all television sets and most communications equipment require electrical radio frequency input. This situation will exist for the foreseeable future. Consequently, each subscriber will require an optical to electrical converter, offsetting to some unknown degree the advantage of the switched system in reduced subscriber terminal equipment.

Present practice of providing fiber from the master "headend" to the hubs is certainly salutary and could be compared to the present telco practice of using fiber interexchange. It appears that it is much too early to make meaningful technical and economic comparisons and the experimentation should be continued.

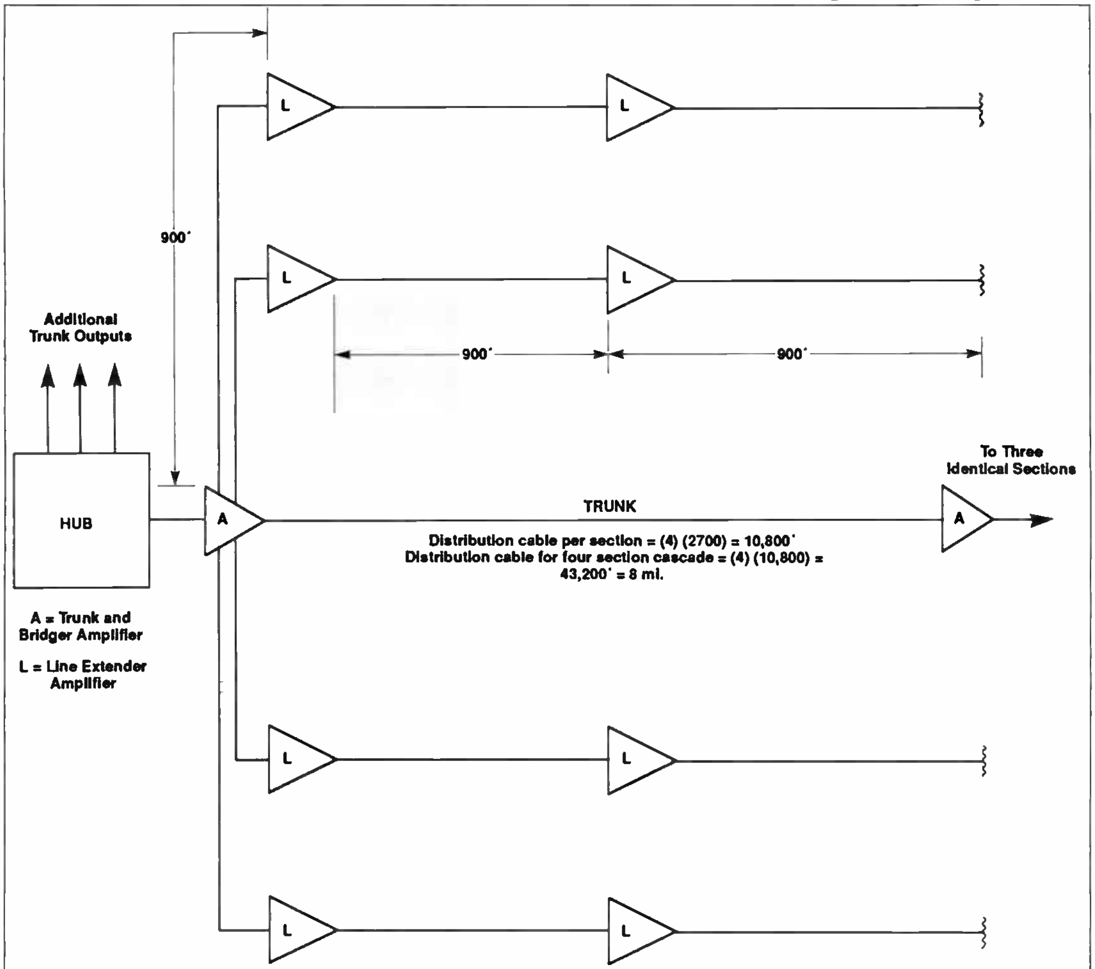


Figure 1. Idealized CATV Distribution System

The switched fiber system appears to be the ultimate vision. When and in what detailed form it will come are difficult to predict. Telcos may force it sooner rather than later.

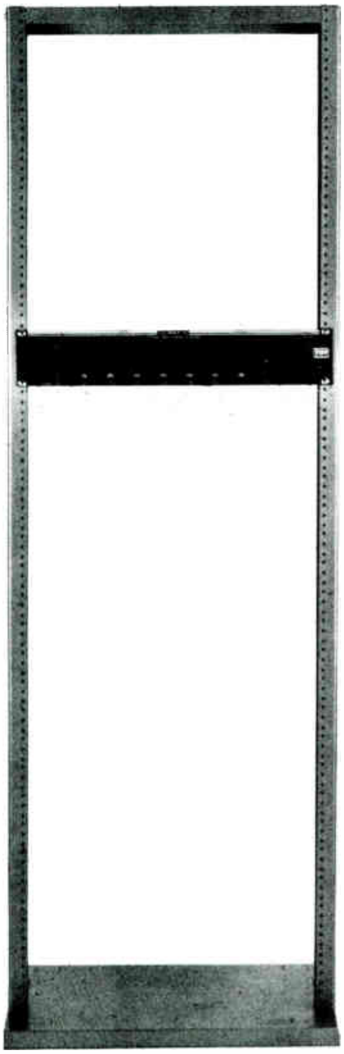
F.J. Bias
Baldwinsville, NY

Bits of bytes

With respect to some of the nomenclature used in Daniel Carnicom's "Broadband MAP" article in the December issue (p.84), in the second paragraph, he refers to a "10-mb (megabyte)" network. In fact, "mb" would be the abbreviation for millibit (i.e., 1/1000th of a bit!); megabyte would be abbreviated as "MB." In any case, an IEEE 802.4 network can operate at 10 megabits per second (Mbps). Similarly, the other networks should indicate a speed in terms of Mbps.

Gary C. Kessler
Gary Kessler Associates

The blame for that error properly lies with CED's *editorial staff. —Ed.*



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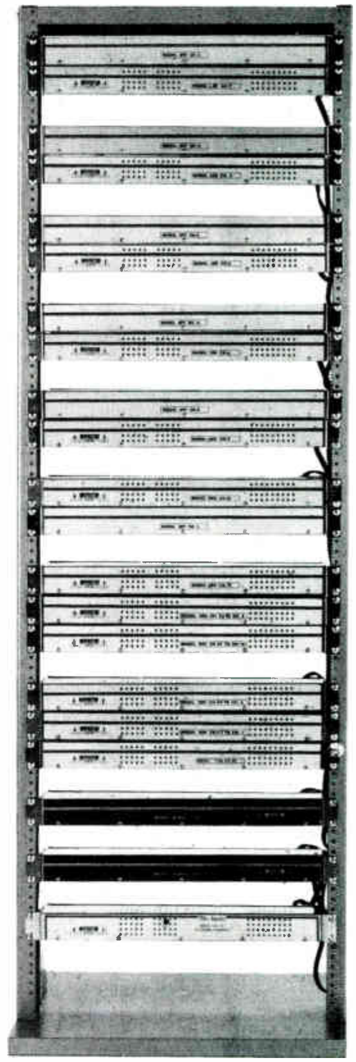

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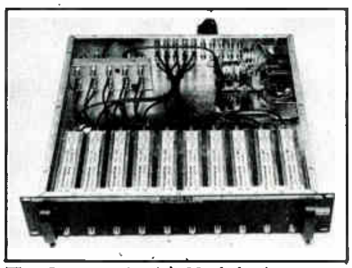

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The Broward Cable Area Network fiber model

Jones Intercable's 800-mile Broward County, Florida fiber upgrade will perhaps be recorded in the history books as the turning point in the cable industry's inevitable embracement of fiber optic technology. Why?

The unique system—coined Cable Area Network (CAN) by Glenn R. Jones—uses a new hybrid fiber/coax architecture which represents a profound step forward for the cable industry. Broward County, Florida, now stands as the country's largest deployment of AM fiber optic technology in the cable industry today, with more than 1,700 fiber miles, 82 transmit AM lasers, and 50 strand-mounted optical receivers. The new hybrid multi-fiber/coax design provides the first-ever route diversity and signal path redundancy features in the majority of the distribution plant. This CAN fiber/coax design reduces traditional amplifier cascades such that the average subscriber is served by no more than five! This greatly improves the coax plant noise, distortion, picture quality and outage performance beyond that ever achieved in any large coax-only cable system to date.

> The model can be overlaid on nearly any cable system at time of rebuild or upgrade, providing tremendous increases in channel capacity, picture quality and reliability.

The model can be overlaid on nearly any cable system at time of rebuild or upgrade, providing tremendous increases in channel capacity, picture quality and reliability at a cost comparable to traditional coax/microwave rebuilds or upgrades.

The intent of this article is to discuss in some detail the motivation, assumptions and difficult decisions that led to the development of this Cable Area Network model.

Political, competitive consequences

As a preface to the Jones CAN fiber/coax model, it has been disturbing that as an industry with so much promise, we have at present an expansion limitation of 550 MHz. There is no practical equipment on the market today that would allow a full system design beyond 550 MHz. Many systems, due to initial design spacings or other considerations, are already expansion limited to considerably less than 550 MHz. In fact, a great number have already reached their practical limit with nowhere to go but a complete and difficult-to-finance rebuild. Where is our future?

A goal of the Jones CAN fiber model was to insure that our design would position our fiber systems to grow far beyond 550 MHz when necessary without triggering a complete rebuild. Encouraged by ATC's theoretical paper of a fiber hub concept that could perhaps reduce the remaining coax amplifier cascades to as low as only three amplifiers, we saw for the first time the potential to break the 550 MHz or less limitations on our systems at a fraction of the price of a complete rebuild.

A full analysis of the 550 MHz issue comes down to **cascade length**. There is nothing inherently wrong with drop cable. It can easily pass 750 MHz or 1 GHz, given the typical short distances of normal drops. There is nothing wrong with trunk or feeder hardline cable. Both can easily pass 750 MHz or 1 GHz. Passive devices can be upgraded to 750 MHz by simple and inexpensive substitution of higher technology tap plates; 1 GHz performance can be accomplished by slightly more expensive tap changeout when new generation 1 GHz taps become available in the future.

The problem is trying to cascade 30 or 40 trunk amplifiers. The small amount of distortion and noise introduced by each amplifier becomes quickly unmanageable with 750-MHz or 1-GHz amplifier designs after a handful of amplifiers. Cascading only one, two, three or maybe as many as five 750-MHz or 1-GHz amplifiers is realistic.

Therefore, if a practical fiber/coax design could be found today that made economic sense on its own, and in addition, would pave the way for the system to expand beyond its existing "natural band-width limitations"—perhaps 750 MHz, 1 GHz or beyond, this surely would be a fiber/coax design worth pursuing.

The CAN concept would also better position the industry going forward regarding new opportunities that may require considerable additional bandwidth (upstream and downstream).

Such a development would not only save the industry billions of dollars in "brick wall" limited expansions but would have a monumental impact on cable's ability to compete with telcos, DBS, MMDS, VCR rentals, etc. and embrace new or expanded services such as HDTV, data, etc. Cable could have within its sights a reliable and inexpensive 1 GHz retrofit of existing plant at a fraction of the cost of anyone starting from scratch.

FM vs digital vs AM

A year ago there were only a handful of cable engineers seriously exploring the use of fiber technology in the cable industry. Only one, or perhaps two manufacturers had equipment. During 1988 many theoretical papers were written on the future of cable and fiber and other than a few short point-to-point FM links between air conditioned rooms, a few limited AM fiber links were built, mostly in labs.

Perhaps the most important conclusion was that nearly every cable engineer agreed that while FM fiber tech-

By Robert A. Luff, Group VP Technology, Jones Intercable

nology was available, and resulted in high-quality performance, it is clumsy and expensive because it requires channel-by-channel baseband video to FM electronics at the transmit site. And worse, channel-by-channel FM-back-to-AM electronics is required at each receive site. Such receive sites require several 19-inch racks of equipment, a moderately large building with air-conditioning, back-up generators, fuel tanks, parking lots, security, etc. As a result, aggressive rollout of FM based fiber technology into residential neighborhoods is obviously impractical now or in the near future.

Digital technology may develop within the decade, but it suffers the same bulk and expensive modulation conversions at both the transmit and receive ends as FM.

> Jones has decided to focus its attention on the Fabry-Perot laser because we feel its performance is suitable today for our multi-fiber model.

Accordingly, the cumbersomeness of FM and digital fiber technologies correctly caused a focus on AM fiber technology, which although not fully fine-tuned can without question handle the most efficient media conversion from traditional coax (RF) to fiber (light) and back again. While more improvements are forthcoming, efficient CATV fiber systems can be designed *and built today* using AM fiber technology.

The laser and channel capacity

Even though nearly all agree that AM fiber technology is the "safe money," AM fiber technology has trouble at present carrying more than 30 to 40 channels the distances necessary to traverse cable franchise distances. The problem is the laser itself, not the optical fiber or receiver, which are both operating at or near theoretical limits today and are economically priced. The tough and only issue is the laser performance.

There are two basic lasers suitable for AM applications—the Fabry-Perot (FP) and the Distributed Feedback (DFB). While the DFB lasers have a slight linearity advantage, they are also several times more expensive than the FP lasers. Actually, as an average, the FP lasers out-perform the DFB lasers. This is because perhaps only 50 percent of DFB laser production is useable at all for AM performance requirements. When the rejects are removed from the equation, the remaining "hand-picked" DFB lasers compared to the near 100 percent FP production yield results in FP lasers appearing to average slightly improved overall performance. Also, by handpicking FP lasers, the actual one-on-one performance difference is difficult to measure, in our experience.

Advances slow in coming?

For the better part of the year, manufacturers of both laser designs have been engaged in making their laser designs perform better in AM applications by a concentrated effort to improve laser linearity. But linearity is certainly not a new design property. Since both the lasers were first developed, physicists around the world have been working on making each laser more linear. So it is with no surprise that just because the cable industry "suddenly in 1988" desires a more linear and higher output light power device, improvements this past year have been "slow in coming."

While breakthroughs can occur at any time, a more likely scenario, in our opinion, is that there will be only small incremental improvements to both Fabry-Perot and DFB laser designs over a longer period of time. And, in our judgment, neither laser type will necessarily improve any faster than the other.

Thus, Jones has decided to focus its attention on the Fabry-Perot laser because we feel its performance is suitable today for our multi-fiber model and because its cost is already lower than DFB lasers by nearly one-third. As a result, many more FB lasers can be designed into a given system for the same budget as DFB laser technology. Further, the lower cost FP laser will allow the cable industry to bring the very real benefits of fiber much closer and sooner to the end subscriber, which we believe is very important in our competitive era and with HDTV just around the corner.

The Broward System

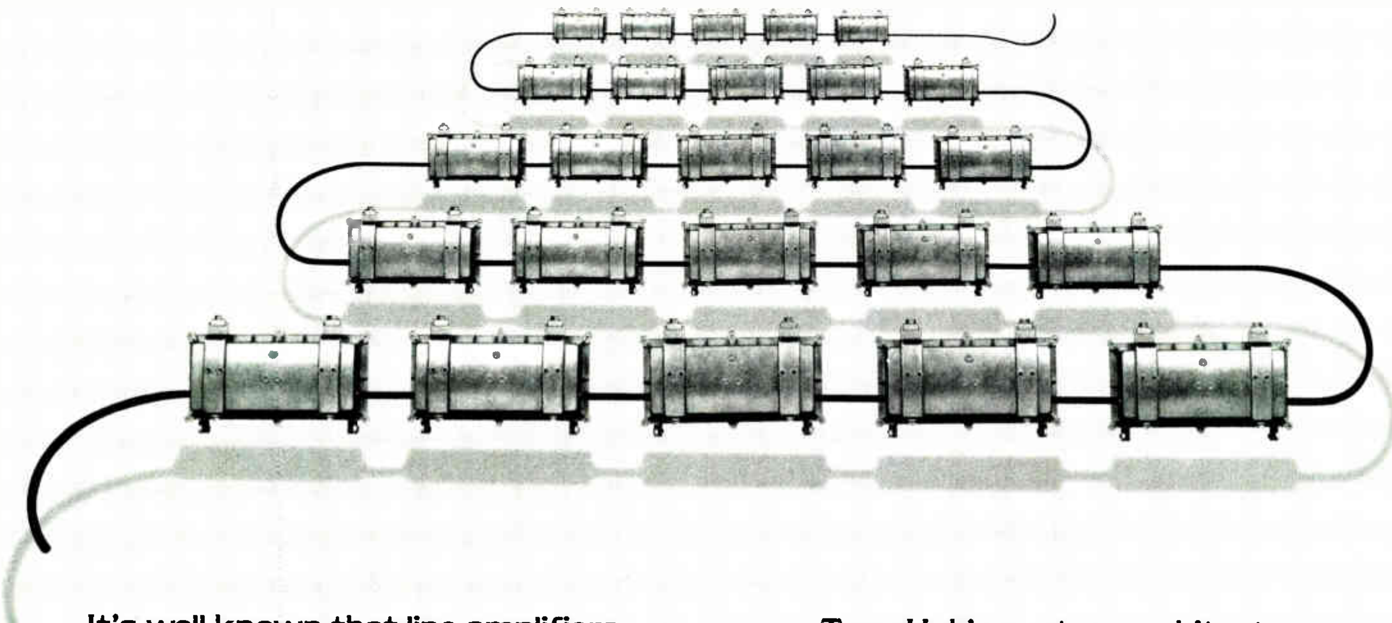
With this in mind, the Jones Engineering Department set out to explore different cable/fiber configurations that, while using the basic Fabry-Perot laser technology, might nonetheless stumble upon a design technique or application that would result in superior performance—something like HRC or feedforward where basic performance limitations were solved—not by hoping for some breakthrough by physicists in improving the basic design of transistors, but by clever application or circuit configurations of those very same limited transistors.

First we needed a real system—not a theoretical one—to develop our model. Most importantly, we needed a real design with a real bill-of-materials with real quotes from vendors to compare against traditional coax/microwave system upgrade costs. (All engineers have at one time or another awakened from a dream remembering a perfect solution but when we attempted to apply it in the first real situation it suddenly fell apart!) And secondly, we needed a budget to actually build the result of our efforts so that this would not just be another theoretical paper.

The Broward County cable system was perfect on both counts. Jones had just purchased the 800-mile, 35-channel system and, after careful review, had established a budget based on traditional coax and microwave solutions to bring it up to a modern 54-channel addressable system.

Broward County is located north of Miami and immediately west of Ft. Lauderdale. The franchise stretches all the way west to the Florida Everglades. Broward County is one of the fastest growing counties in the country. The system, while very well maintained by the previous owners, was limited to 300 MHz and already had excessively long cascades. Any upgrade, even with feedforward/power-doubling technology would have required AML microwave to reduce cascades to a manageable limit. However, such a design direction would have, in our opinion, caused poor subscriber service, considering the heavy rain and power failures caused by daily violent storms common to this area of the country during most of the year.

NO SIGNAL SHOULD HAVE TO GO THROUGH ALL OF THIS



It's well known that line amplifiers directly diminish CATV signal quality. Yet today's cable distribution systems rely upon an architecture in which signals must pass through as many as 60 amplifiers before they reach a subscriber.

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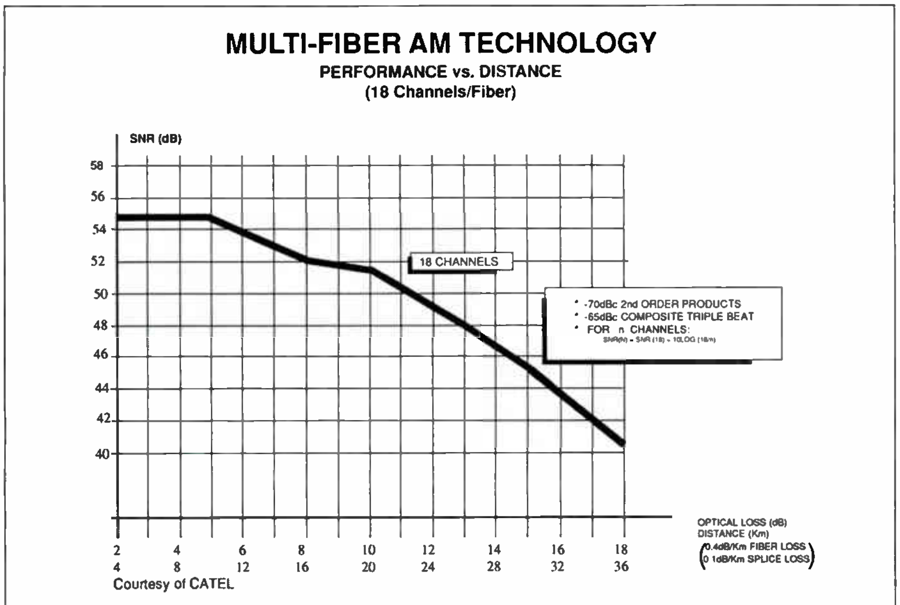

Graph 1

An analysis of fiber

A quick analysis indicated that the $1.5 million for high powered AML and the $500,000 difference between conventional upgrade modules and feedforward modules, plus repowering costs and the subscriber outages caused by repowering might be best spent on a possible fiber solution.

A fiber project budget—not to exceed these identified "savings"—was established at $2.1 million ($1.5 million + $500,000 + repowering).

And, finally, the upgrade had to be completed by summer 1989, which meant that if the system was to be built with fiber, it had to be built with equipment ready or nearly ready today, not with specification sheets for equipment actually scheduled for first delivery in six months.

With desire, system, budget, and time frame in place we were ready to actively develop our fiber model.

A CAD (Computer Aided Drafting) system was purchased, the system was walked out and digital base maps created. The CAD system allows different design concepts to be efficiently tested and compared. In fact, to date, 32 different fiber/coax design models have been totally or partially tested and compared against the traditional coax/microwave only upgrade alternative.

This powerful tool has allowed the Jones engineer, through trial and error at first, and as patterns evolved, to refine the system to a profound fiber/coax model. This model will serve as a guide for others in rebuilding limited capacity outage-prone systems. Fiber is the missing link in establishing a highly efficient, cost effective hybrid fiber/coax plant blend.

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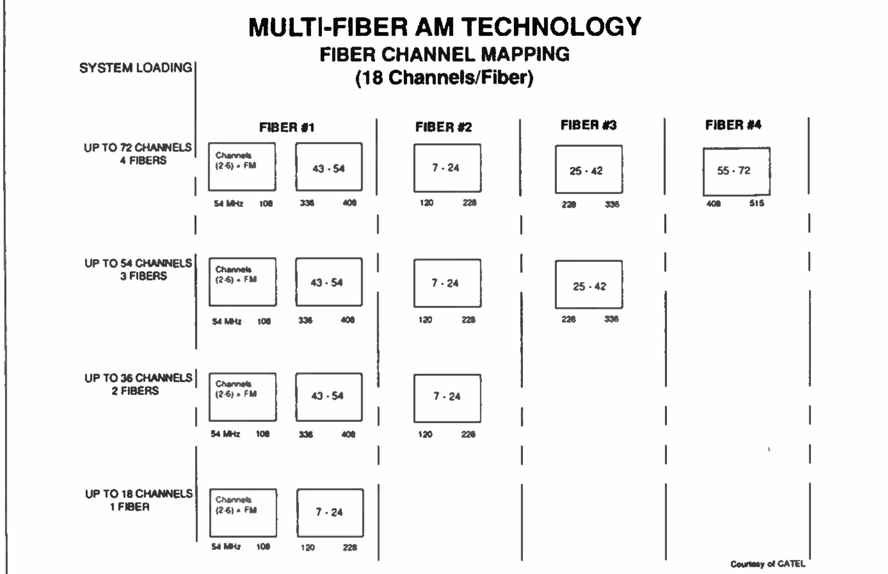

Figure 1

The Jones model

The heart of the Jones Cable Area Network model is based upon the understanding that AM laser technology is the correct technology but that a breakthrough that would allow 80 or more channels per fiber with distances necessary to traverse a total franchise may be a long time coming. Thus, a multi-fiber solution, with fewer channels per fiber (laser) is being pursued and optimized now for the long haul while relying on existing customer-friendly coax for the last part of the link to the subscriber.

It was found that by reducing the number of channels per fiber, performance improved to very usable levels (see Graph 1). While such a technique caused the need for multiple fibers and lasers, the savings resulting from this technique by being able to use the less expensive Fabry-Perot laser more than offset the additional fiber and lasers link cost.

While this may be hard to grasp at first, the reduction of channels per laser also increases maximum usable path distance. Such "windfall" path distance is converted into path splits; that is, each inexpensive Fabry-Perot laser may serve up to four separate receive sites. In the end, the always-limited budget dollars in a complete fiber upgrade result in many more fiber benefits realized by the systems' subscribers by using the multi-fiber and less expensive Fabry-Perot laser approach.

Channel per fiber mix

Various channels per fiber designs were tried in the Broward model. A number between 12 to 18 channels/

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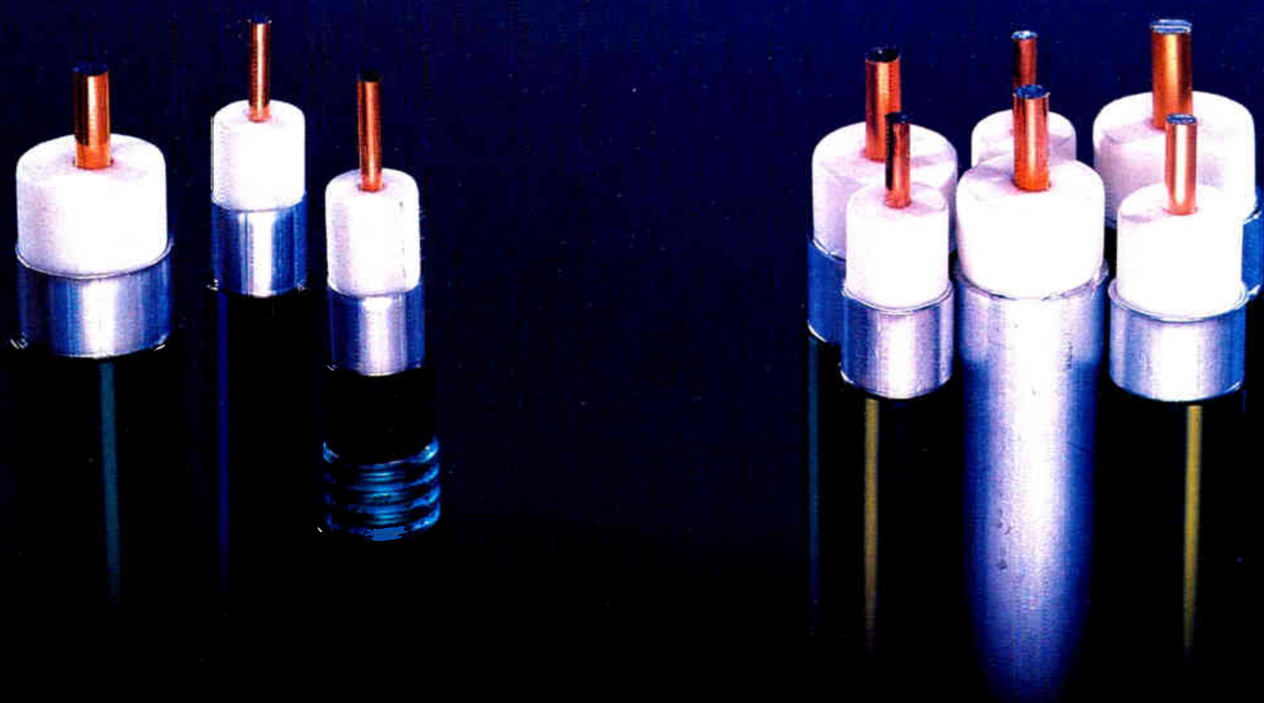

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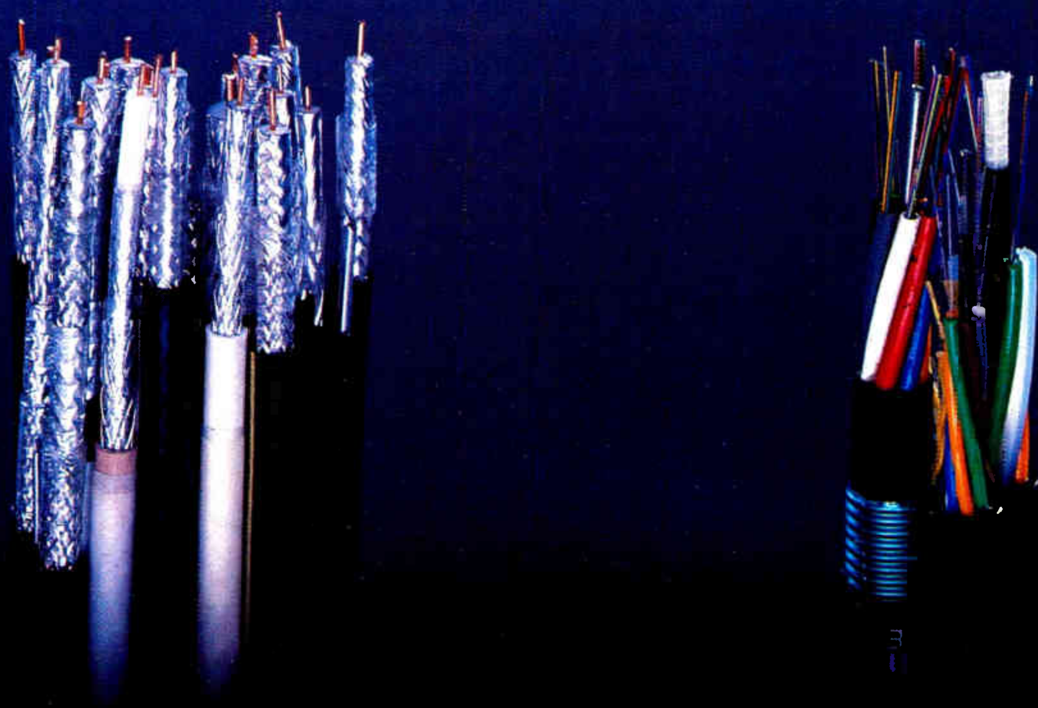

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Total Cable C/N	-50.55 dB.		
Cable System CSO (2nd.)	-65.00 dB.		
Cable System CTB	-55.00 dB.		
Fiber C/N	-52.00 dB.		
Fiber CSO	-65.00 dB.		
Fiber CTB	-65.00 dB.		
Subscriber C/N	-49.22 dB.		
Subscriber CSO	-61.99 dB.		
Subscriber CTB	-52.61 dB.		

Figure 2

fiber proved optimum. Average laser performance (getting better) and cost per laser (getting lower) suggest the optimum number of channels/fiber may increase in the future. This model would gracefully embrace such a development by simply requiring one or more fewer fibers in future designs.

It was fortunate that Catel Telecommunications Inc., a long-time leader in FM fiber technology, had for somewhat different reasons already begun development of a multi-fiber AM technology solution. In a very short period of time, Catel engineers were able to demonstrate a working laboratory prototype of the then nearly-perfected Broward hybrid fiber/coax design.

Catel made a significant improvement over the initial Jones concept by keeping the channels per laser within an octave. The Fabry-Perot laser's second order performance is slightly poorer than the DFB laser and can be a limiting design factor. By keeping channels on a single FP laser within an octave, the second order beats can be easily filtered out by a simple RF passive filter placed at each receiver right after conversion from light to RF, but before combining with the other fiber signals. These bandpass filters also reduce the noise bandwidth such that after combining, noise is nearly equivalent to a single laser path, not four.

Not only was the manufacturer's technology input invaluable, but its ability to accurately attach a price to the hardware allowed both technology and cost optimization as well. Accordingly, a final channel/laser plan was proposed by the manufacturer (See Figure 1).

Critical to the design were the overall system design specifications listed in Figure 2. While we desire better performance in some areas, we are aware that since we began this project, laser performance has improved somewhat and costs have reduced. We are confident that by the time the project concludes, better performing lasers will be available routinely or alternately premium lasers will be available at more reasonable prices. Only a few links are actually designed to the limit of these worse-case figures, which in reality are better than the measured actual coax performance, given the present extraordinarily long amplifier cascades present in the system.

Path diversity and redundancy

The Jones Cable Area Network model provides for the first-ever route diversity and signal redundancy through the long-haul portion of the CATV distribution network.

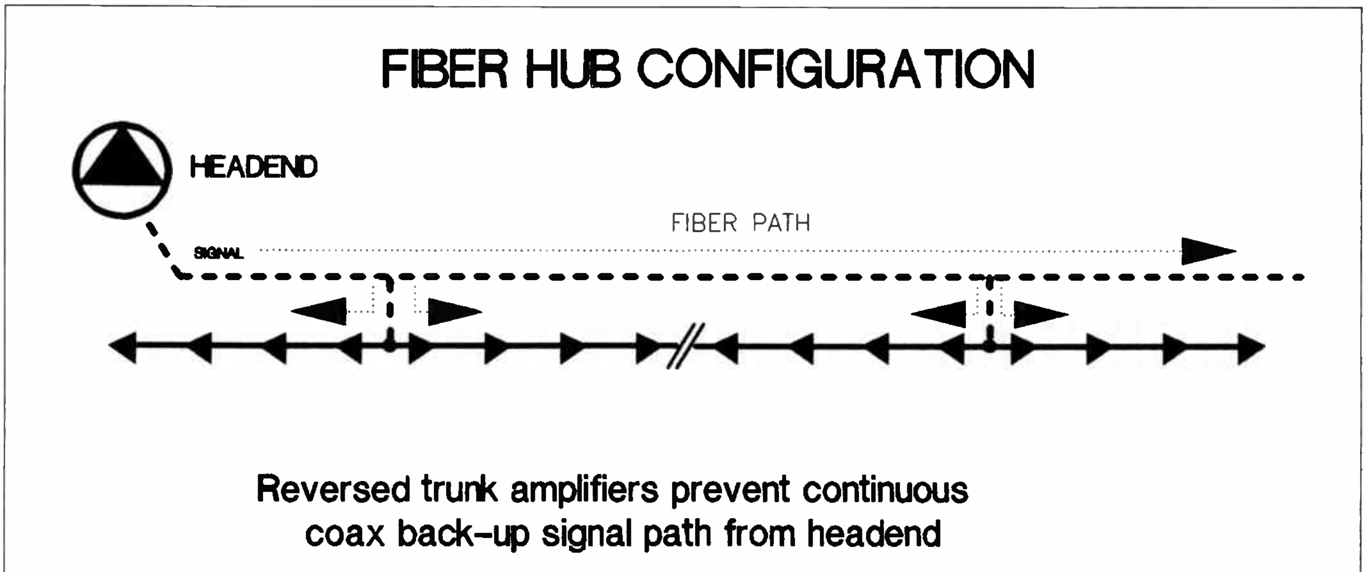


Figure 3

Other fiber/coax models tend to run the fiber actually overlashed to the trunk it is enhancing and 50 percent of the trunk amplifiers are turned around to save fiber receiver costs. Two issues are created in this scenario: should the path meet some unforeseen catastrophe, such as the pole being knocked down, then both fiber and coax plants are broken and the plant is down. Also, a natural existing redundant signal path from the headend to the end of the system (original coax trunk run) is spoiled by turning amplifiers around and backfeeding from receiver nodes (see Figure 3).

The Jones design defines a parallel fiber path several blocks removed, creating the significant benefits of path diversity at a very small increase in cost. Perhaps the greatest difference

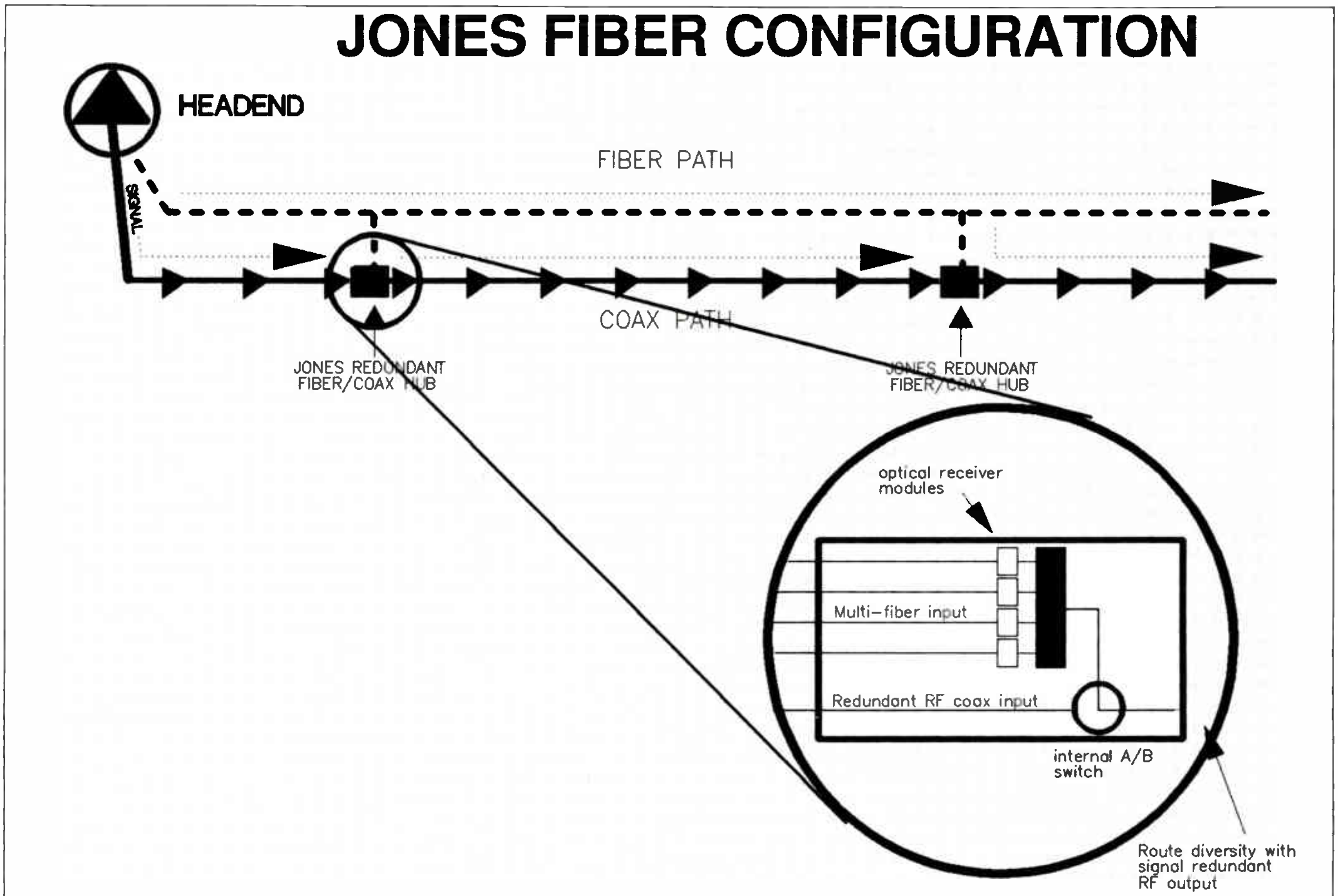


Figure 5

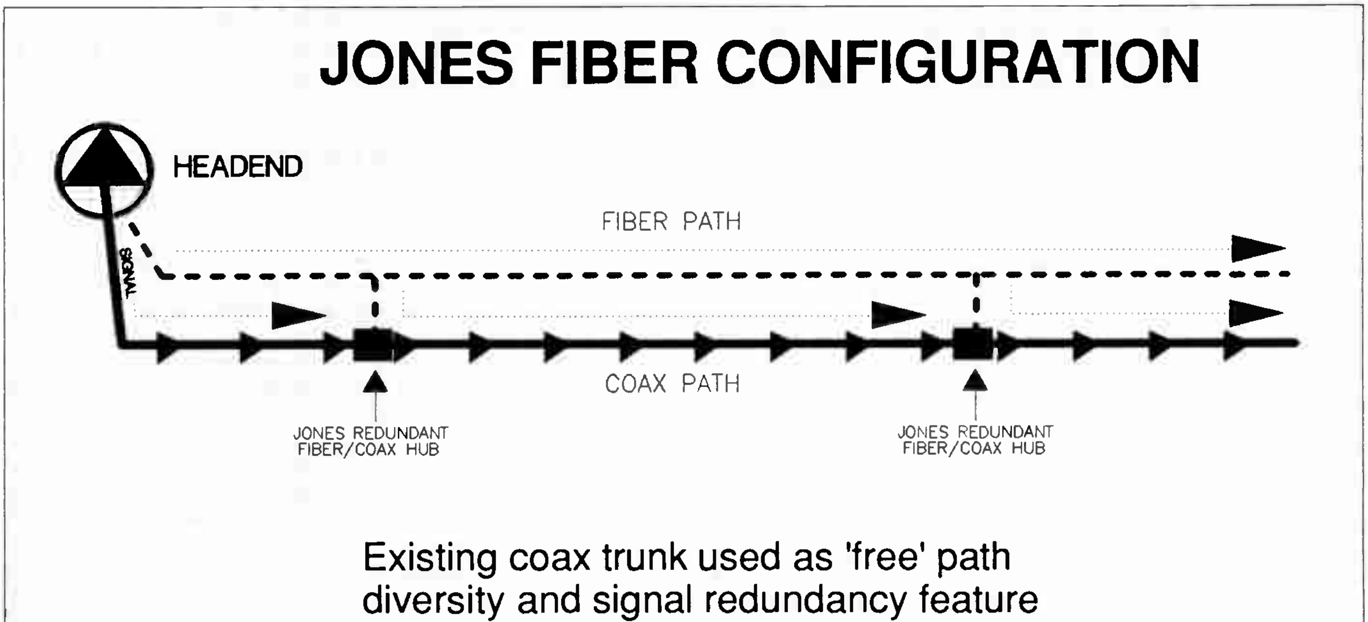


Figure 4

from previous models is that the coax trunk amps are never turned around in the Jones model (see Figure 4). This maintains the present headend-to-end-of-system coax path which is used as a "free" redundant signal path "protecting" the primary fiber path.

At approximately each fifth amplifier, four fibers are pulled from the fiber trunk (parallel path but several blocks away) and run over to the existing trunk amplifier location. The four fibers terminate in a strand-mounted fiber receiver housing (approximately the same size as a coax trunk housing) which actually contains four optical receiver modules—one for each fiber (see Figure 5). The converted light to RF outputs of each fiber is filtered for second order as explained earlier and combined into a simple four-input passive combiner. Its single output is a sum composite of the four individual fiber channels. This signal is amplified by a standard hybrid and the resulting output level is identical to the output of the traditional amplifier it now replaces.

The unique signal redundancy capability comes from using the available RF signal from the last previous amplifier of the cascade that previously was connected to the replaced trunk amplifier input. This connector is simply disconnected from the old amp input housing connector and reconnected to the alternative "B" input of the optical receiver housing. Each optical receiver has a simple circuit to determine lack of recovered RF signal. Should any event take place (receiver failure, cut fiber, laser malfunction) that would cause lack of recovered RF signal in any or all optical receivers, the A/B switch internal to the optical receive housing would be triggered and the input switched from the primary fiber path to the coax input from the previous amplifier.

Status monitoring

The worst result that could happen with a fiber element malfunction in the long haul portion of the system is reverting back to a coax feed from the adjacent CAN. Since this would not be noticed by subscribers, it was necessary to develop a status-monitoring system that would signal that the station was in the backup condition.

As it turned out, more time was spent on this design consideration than practically any other issue because the most direct return path is fiber. However, status monitoring on fiber return, while not actually difficult, has not been done before in the CATV industry. The result was employment of an inexpensive digital laser in each receiver that simply signals a digital address and the switch condition. We were very reluctant to make the process and circuitry any more complex than this because in our experience the most dependable working amplifier or receiver can be made less so by a complex status-monitoring system. Accommodations have been made for "advancements" in this area over time, should the need and proven design be demonstrated in the future.

Status monitoring on fiber return, while not actually difficult, has not been done before in the CATV industry.

Outage control

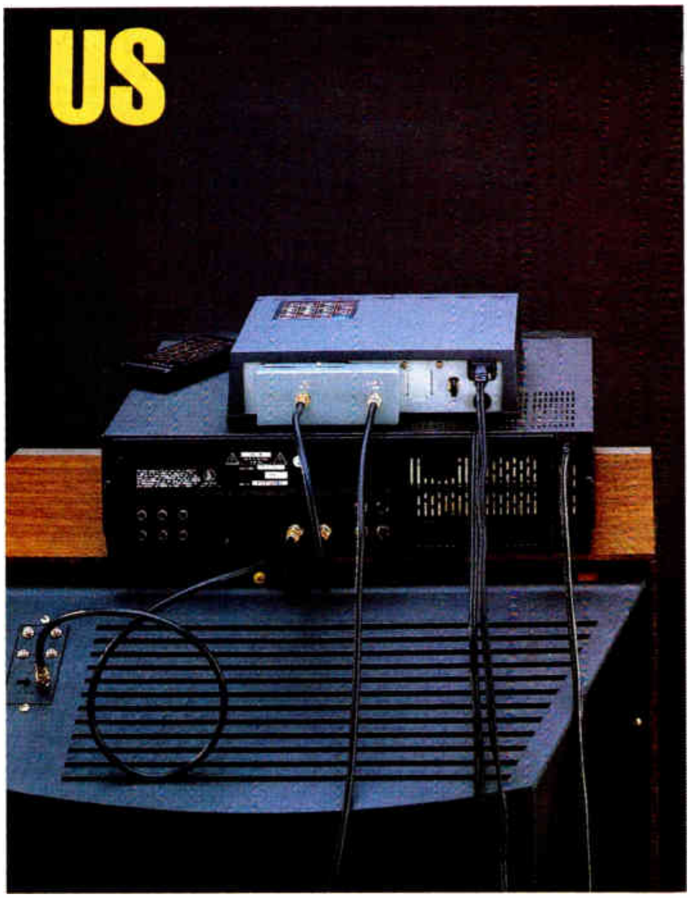
The long haul path redundancy to the approximate five-amplifier Cable Area Network cell will have a profound positive impact on not only better controlling future system outages but to ensure that any outage is limited to CAN cell boundaries. Such limited outages may make switchboard overload a thing of the past.

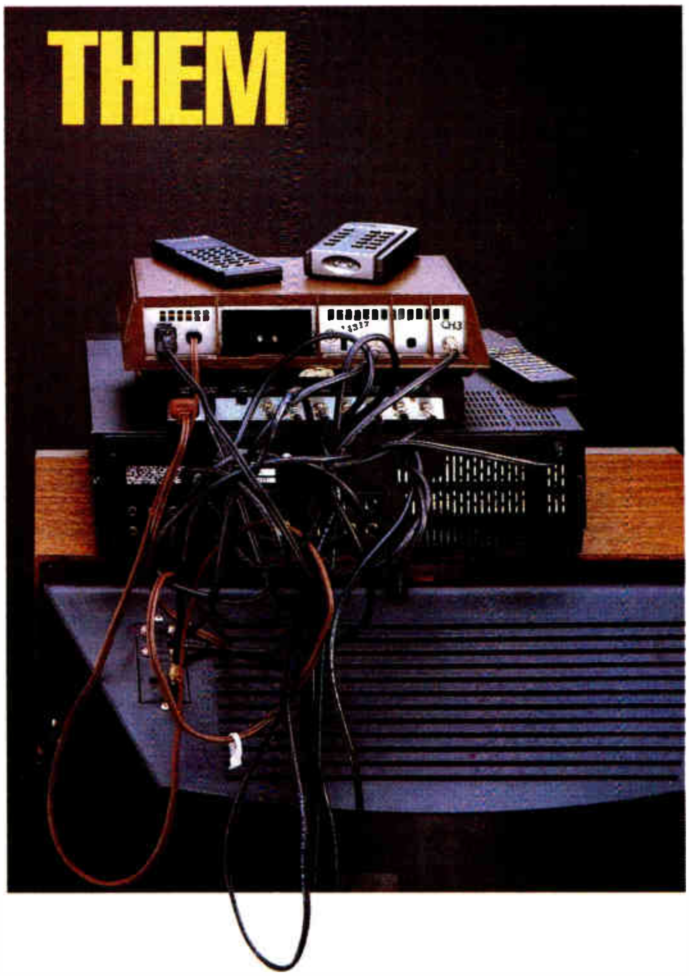
This unique architecture has another important benefit during initial construction. After module upgrade replacement has been completed in the CAN cell, further nuisance outages, common during a rebuild, can be eliminated. If the fiber backbone is constructed all the way to the last optical receiver in a particular trunk run and the cutover from coax to fiber started at the end CAN cell and progressively continued back toward the headend, then a subscriber will see a one-time brief (30-second) interruption during the entire system upgrade.

The sequence will go like this: The optical receiver will be installed and connected to its four fibers and checked out. If all is well, the output connector from the coax amplifier will be unscrewed from the coax amplifier and immediately screwed into the fiber receiver output. Subscribers on this last five-amplifier cascade will be interrupted only during this brief connector changeover. Once connected to the optical receiver output, these subscribers would now be, worse case, only five amplifiers from the headend and would immediately receive the positive benefits of fiber while the rest of the system is being similarly converted without further interruption to them for the rest of the system changeover.

The next step would be to disconnect the input from the coax amplifier and reconnect it to the "B" or coax redundant input on the fiber receiver. Now the last five-amplifier cascade is fully protected by the former coax signal. Each five-amplifier chain from the end

Consumer Interface





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back to the headend is done similarly.

The multi-fiber solution

Colleagues and manufacturers who have only heard bits and pieces of the Jones Cable Area Network fiber/coax model generally focus on the "inefficiency" of multiple fibers. They say (and are generally correct) that fewer is better and one would be best! As engineers, we have all been conditioned to using the fewest parts necessary for the objective. The question is—what is the objective?

If the objective is simply to deliver cable television signals to the home, then yes, maybe a single fiber solution is what we should tirelessly work toward. However, we believe very strongly that cable TV signal transportation will be but one usage of the massive capacities we will generate with fiber technology. Whether or not we ultimately carry all cable-TV entertainment signals on a single fiber, I see the day when multi-fiber bundles enter a single strand-mounted CATV optical receiver housing. In these housings will be various color-coded optical receiver modules: Green for CATV; white for local government; blue for data services; orange for telephone.

In other words, regardless of how many CATV channels we can engineer per fiber, the future of CATV is new broadband services. Diversification or differentiation of services on different fibers is a prudent way to proceed to insure minimal cross-service regulatory issues and separation of costs while allowing for different optimum technologies (AM, FM, digital) for different services. Maintenance requirements would also be enhanced by keeping future services on separate fibers. Multi-fibers and lasers are a concept that clearly makes sense and is independent of the CATV channels/laser developments.

Regardless of how many CATV channels we can engineer per fiber, the future of CATV is new broadband services.

Acknowledgements

We are pleased to openly discuss our experience and findings as we proceed with our CAN concept and wish to gratefully thank ATC for its earlier work in this area and Catel for its dedication and expert development and product manufacturing—without all of which our efforts would not be possible. The author wishes to also acknowledge Hugh Bramble, Jones corporate principal engineer, and John Linebarger, Jones fund engineering manager, for their untiring pursuit and refinement of the Jones fiber model. Finally, thanks also go to Glenn R. Jones, chairman and CEO, who named our exciting concept—CAN. ■

Copy protection: what's in store for PPV

The issue of non-recordability is a critical strategic factor for the future of the pay-per-view (PPV) business. If PPV is to flourish, the cable industry must have the option of delivering certain movies and events in a way which protects against unauthorized VCR copying. This protection is the key to regaining the first home release of hit movies and specials—a position which the cable industry lost when cassette stores decisively displaced pay cable in the post-theatrical release sequence. Without at least simultaneous release with home video, the PPV movie business could well disappear.

Closing the window?

Today, movies typically appear on PPV four to six weeks after home video. Moreover, absent non-recordability and as further protection for the home video market, several studios have indicated they are considering slipping the PPV window an additional 30 or more days; the Video Software Dealer's Association (VSDA) is on record as advocating a 120-day delay. The implications of such a slippage are significant. The value of the PPV product is diminished as it becomes "stale," thus negatively impacting buy rates. Also, delayed PPV windows begin to encroach on subscription TV windows, causing both consumer confusion and dissatisfaction.

The way for cable to reverse the current PPV window slippage is to deploy a reliable, secure copyguard system to be used for selected early release program material. Only with such a system in place will the studios consider moving up the window—a move critical to the growth, indeed the survival, of PPV.

The task of creating a televison signal which can be viewed using standard television receivers but which nevertheless is effectively immune to video cassette-recording is a difficult one. It is not intuitively obvious that it is even possible; the idea faces the objections, on the surface, that if a television receiver can display a picture, then recordable signals must exist somewhere within the set—or if a picture is displayed on the television screen, then surely a camcorder ought to be capable of recording it.

By Graham Stubbs, Executive Vice President, Eidak Corporation

TABLE 1
Functional Objectives

- Non-recordability of PPV signals
  - Movies
  - Live events
- Secure at all points in the system
- No new hardware in the home
- Ease of installation; no local system maintenance or operation
- Cable system transparency including addressable descramblers
- Compatibility with large population of TV receivers of differing makes and models

Under scrutiny

The Eidak® copy protection system does indeed work, and as will be seen, also deals effectively with those objections. It has been subjected to the scrutiny of NCTA's engineering committee, and is in field test operation in Viacom's Milwaukee Cablevision system.

TABLE 2
Security

Goal: to avoid copying of PPV movies and events in the home

1. Make the cost of piracy as high as possible
   - No simple modifications to subscriber equipment
   - No inexpensive "stabilizing" device
2. Leave no unprotected gaps in the system
   - No unprotected signals at the headend
3. Make attempted piracy traceable
   - Add fingerprinting at critical system locations
4. Control the system hardware
   - All operational headend hardware under centralized control
5. Put no hardware in the subscriber's home
   - The cable signal is already Eidakized[SM]

Copy protection for cable PPV has some unique requirements—especially as compared with the techniques applied to some videocassette recordings to deter videocassette duplication. A majority of homes equipped to receive PPV programming are also equipped (i.e., have a VCR) to copy it. By comparison, relatively few homes are equipped (i.e., have two VCRs) to duplicate rental video tapes. Thus, the potential for copying PPV movies is far greater than that for copying of tapes.

If copy protection is to be useful in cable, it has to be effective—i.e., it must not be easy to circumvent. The security considerations to prevent unauthorized copying are comparable to those of scrambling techniques used to prevent unauthorized viewing.

An ideal copy protection for cable PPV must have the following characteristics (see Table 1). The Eidak® copy protection was designed from the beginning to meet these cable PPV requirements.

Security

As compared with cable (or satellite) scrambling systems, this system for copy protection has the singular advantage that no unique device is distributed for home use—and thus there is no device which can be modified or be tampered with. The signal alteration is by its nature, very difficult (and expensive) to restore to a recordable form. The security objectives for the Eidak® system are listed in Table 2.

The non-recordable characteristics of the Eidakized[SM] signal are maintained all the way through the television receiver circuitry, and in the displayed image. Beyond the satellite uplink, at no point in the signal distribution system is there a usable recordable signal. For a movie, designated at the satellite uplink to be distributed in a non-recordable form, the only way that it can pass through a cable headend for viewable distribution requires it automatically to be copy protected at the headend.

How it works

The Eidak® system produces an

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altered television signal which all known videocassette recorders will fail to properly record but which is displayed normally on television receivers.

The technique involves changing the synchronizing signals being received by the television receiver or the videocassette recorder. The alteration entails changing the video rate by adding or deleting lines from fields. It is achieved in such a way that the all-electronic scanning system of a television receiver or video monitor can track the signal, but the mechanical scanning head of a VCR cannot.

The standard NTSC signal as used in the United States (and approximately 60 percent of all television transmissions throughout the world), involves 525 horizontal sweeps of the signal for each pair of vertical sweeps of the signal (i.e., during each frame). During each pair of the vertical sweeps, vertical synchronizing signals are transmitted which control the vertical positioning of a spot on a television receiver.

In the case of the videocassette recorder, these vertical synchronizing signals also control the rotation of a scanning drum in such a fashion that the scanning heads follow precise paths diagonally across the tape during recording and playback. A proper pattern of varying the timing of vertical synchronizing signals can be made to severely perturb videocassette recorders while, at the same time, it will present acceptable signals on television receivers.

Techniques to achieve non-recordability, based on a similar principle of frame rate disturbance, have been described before[1]. What is new in the Eidak® system is careful timing of these frame rate variations in order to:

TABLE 3
Method of Operation
Video Signal Modification

- Change instantaneous vertical time-base approximately ± 3 percent
- Add/delete lines from fields maintaining interlace
- Number of lines per field varies with time in a pattern designed to optimize disruption of VCR recording and playback
- Average number of lines per frame is maintained at 525
- Standard individual line timing chroma phase, etc.
- Active picture lines location adjusted within the field to maintain the picture location on television display

The EIDAK System

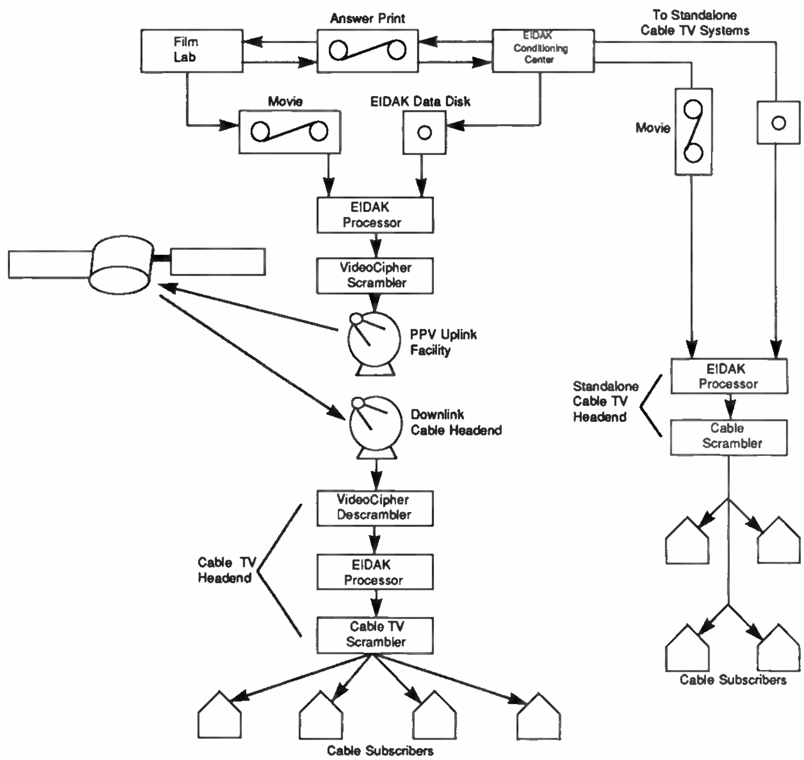

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Figure 1

- Be effective with a wide range of VCRs
- Avoid visible TV receiver display artifacts
- Achieve compatibility with addressable scramblers/descramblers.

Frame rate varied

The vertical time base (i.e., frame rate) is varied up to ±3 percent by adding or deleting up to 10 lines per frame in a time-varying pattern designed to disrupt effective recording. Care is taken to add or delete lines in pairs in order to maintain interlace during the changing patterns of lines. The location of active picture lines is adjusted dynamically within the field in order to keep the displayed picture centered in the vertical axis on the television screen. This centering compensation is generally accurate to within about ±1 line.

In order to mask even this slight artifact, the time varying pattern is normally applied only at discrete times, quite often at scene changes; analysis and identification of the exact timing of these patterns is normally handled by analysis of a movie prior to transmission, and creation of a data time track. For the live events, this process can also be performed in real time.

The Eidak® copy protection process is normally applied at the cable headend, and controlled through the satellite feed. The video signal received from the satellite decoder is first processed to extract control information which includes timing profiles referenced to time code. The composite video signal is sampled (at 4X color subcarrier) and stored in digital field memory—up to eight frames of memory are used. The stored fields are read out of memory at a rate corresponding to the required modified field rate, and are re-associated with appropriately modified synchronizing signals.

What about addressable converters?

An important part of this process is the creation of a vertical-reset timing signal for the addressable scrambler. Cable scramblers in general (Jerrold, Oak, Scientific-Atlanta, Zenith, etc.) provide signaling at vertical field rate, and scrambler circuits are typically implemented using line counting to determine field location. The scramblers undergo a minor modification in order to receive and utilize a vertical

field reset signal from the Eidak® processor. (In the case of remote operation, this is achieved using an Eidak®-provided device which develops this trigger from incoming Eidakized[SM] video.) In every case, once the addressable scrambler is properly synchronized with the Eidakized[SM] signal, the subscriber descramblers work properly with the scrambled signal, and require no modification.

The modified video frame rate characteristic of the Eidakized[SM] signal is preserved all the way through the system, including within the television receiver itself. Signals used for deflection and applied to the CRT control guns are still non-recordable. Furthermore, although the eye of the viewer perceives no flicker, the CRT phosphor is illuminiated in the same time varying manner; when an attempt is made to make a recording from the TV screen with optical conversion using a camera, an annoying artifact in the form of a horizontal bar, with vertical movement, disrupts the recording.

Tests have been made with a wide variety of video tape recorders, from professional one-inch models to 8mm camcorders. The servo characteristics vary from recorder to recorder; the Eidak® method permits an appropriately wide variation of time varying patterns.

TABLE 4
Effect on VCR

- Receiving head drum is normally servoed to vertical sync to mask head switching
- Because of its rotational inertia the spinning drum cannot slew fast enough to follow changes in vertical sync rate
- Servo loses lock and miswrites video on tape
- Net result is intermittent break-up of picture on playback/head switching artifacts

System configuration

Analysis of a movie to determine optimum profile timing typically occurs prior to transmission. A data file is created which associates this information with the movie videotape's time code track. When PPV movies are distributed by satellite to cable headends, this data is transmitted over the satellite link simultaneously with the video transmission, and is used in the cable headend's Eidak® processor to create the actual time profiles and profile generation. For live events, the timing analysis is automated in real time. A scrambling overlay is also applied at the satellite uplink; which can only be removed by Eidak® cable headend processors. The scrambling overlay assures automatic copy protection by cable affiliates and eliminates the possibility of unauthorized taping at downlinks.

In the case of standalone PPV cable systems, the data control fucntions are integral with the Eidak® processor.

Typical Eidak Time Profile

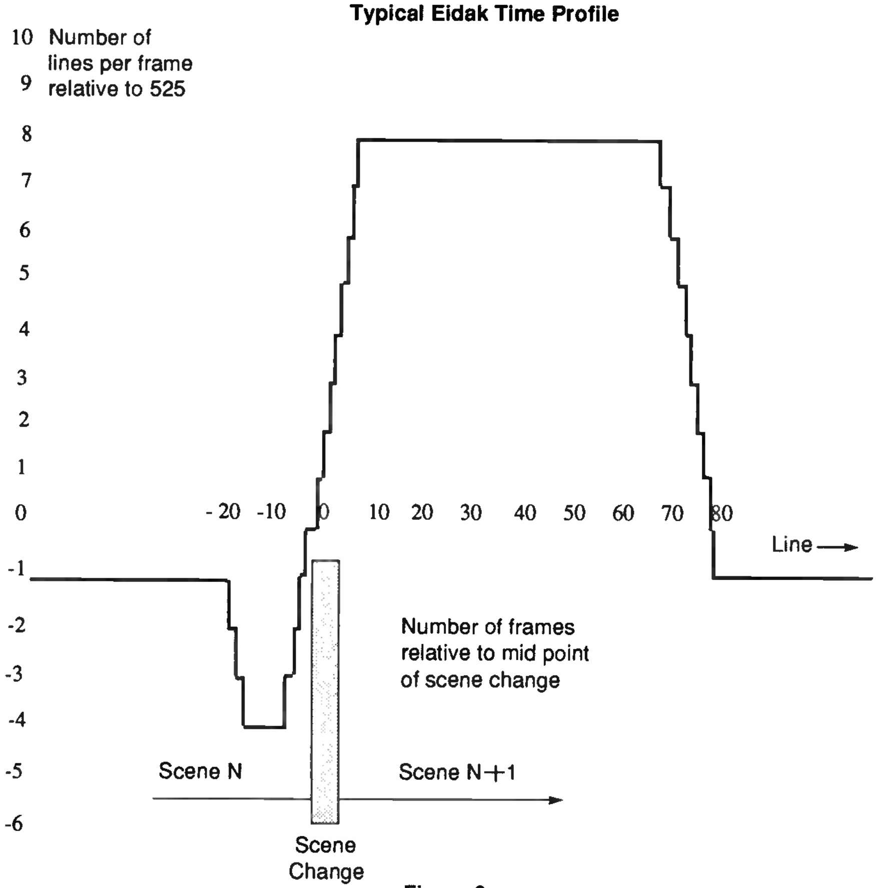


Figure 2

Testing

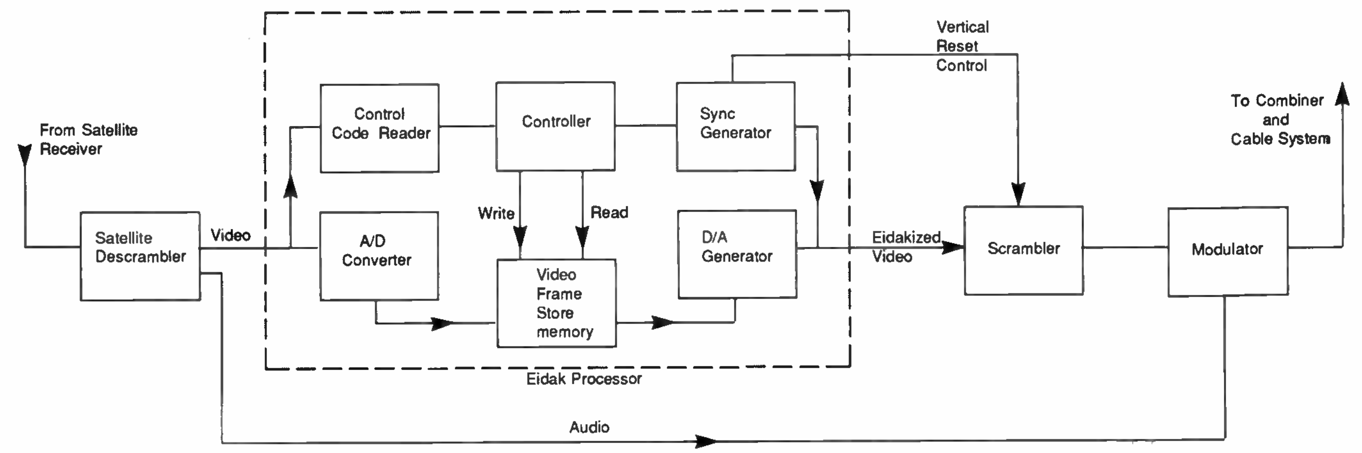
Absent thorough testing and verification, the introduction of copy-protected signals into cable PPV systems would introduce an element of technical uncertainty because of the differences, however slight, between the Eidakized[SM] signal and NTSC video. A thorough test program has been designed to assess the tolerance of systems (and TV receivers) to the modified signals. It includes work carried on in design, simulation, and consumer research facilities, in consumer electronics distribution outlets, and field tests conducted at operating cable systems.

The test objectives were:

- **Laboratory:** signal quality (including system-unique artifacts; operation with each of the addressable scrambler/descrambler systems used in cable; a selection of new and old TV receivers representing a wide range of signal processing technologies and VCRs; simulated cable distortions.
- **Consumer electronics stores:** operation with a large number of television receivers, including state-of-the-art models and projection sets; attempted recordings with a variety of VCRs.
- **Consumer research laboratory:** consumer reaction to TV receiver displays both of Eidakized[SM] signals and attempted recordings of copy protected signals.
- **Cable system field tests:** operation with headend equipment; operation throughout cable plant; evaluation with a large number of subscriber-owned receivers; subscriber reaction to Eidakized[SM] program material; hub distribution including FM microwave and AML.

As expected, these tests resulted in some new knowledge and helped optimize the system.

Eidak Processor Block Diagram



Conclusion

The Eidak® system addresses the need for cable-compatible copy-protection technology with the degree of security necessary to assure early access to PPV movies and events. It has been shown to work with the wide range of equipment and operational constraints found in cable systems.

> Tests have been made with a wide variety of video tape recorders.

Copy protection fills the one remaining technological gap in the cable industry's PPV infrastructure—it is a key strategic factor in the future development of PPV. ■

Reference

[1]A. Lippman and T. Hoque (MIT). Unrecordable Video, IEEE Trans. Broadcasting September 1987.

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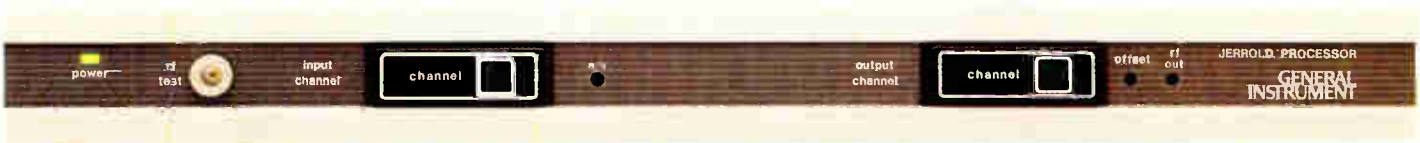

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Audio over cable: the hype begins (again)

Amid all the hype and furor surrounding the advent of high definition and improved definition television, a quiet revolution is taking place. Just as consumers are seemingly anxiously awaiting the dawning of improved video, so too are they anticipating improved audio.

Just as improved video is perceived as a possible strong source of additional revenue for cable-TV operators, so are audio-only services. The idea isn't at all new (witness the failed Studioline project of a few years back), but many believe its time has finally come.

The contenders

At least three companies are counting on the explosive growth and popularity of digital programming from compact discs to drive the audio-over-cable market, including International Cablecasting Technologies (ICT), Digital Radio Labs (DRL) and industry heavyweight Jerrold, with its Digital Cable Radio service. Meanwhile, several other already existing services believe the analog tape format, properly programmed and delivered, is just as good and doesn't require additional hardware in the home.

It could be that both are correct.

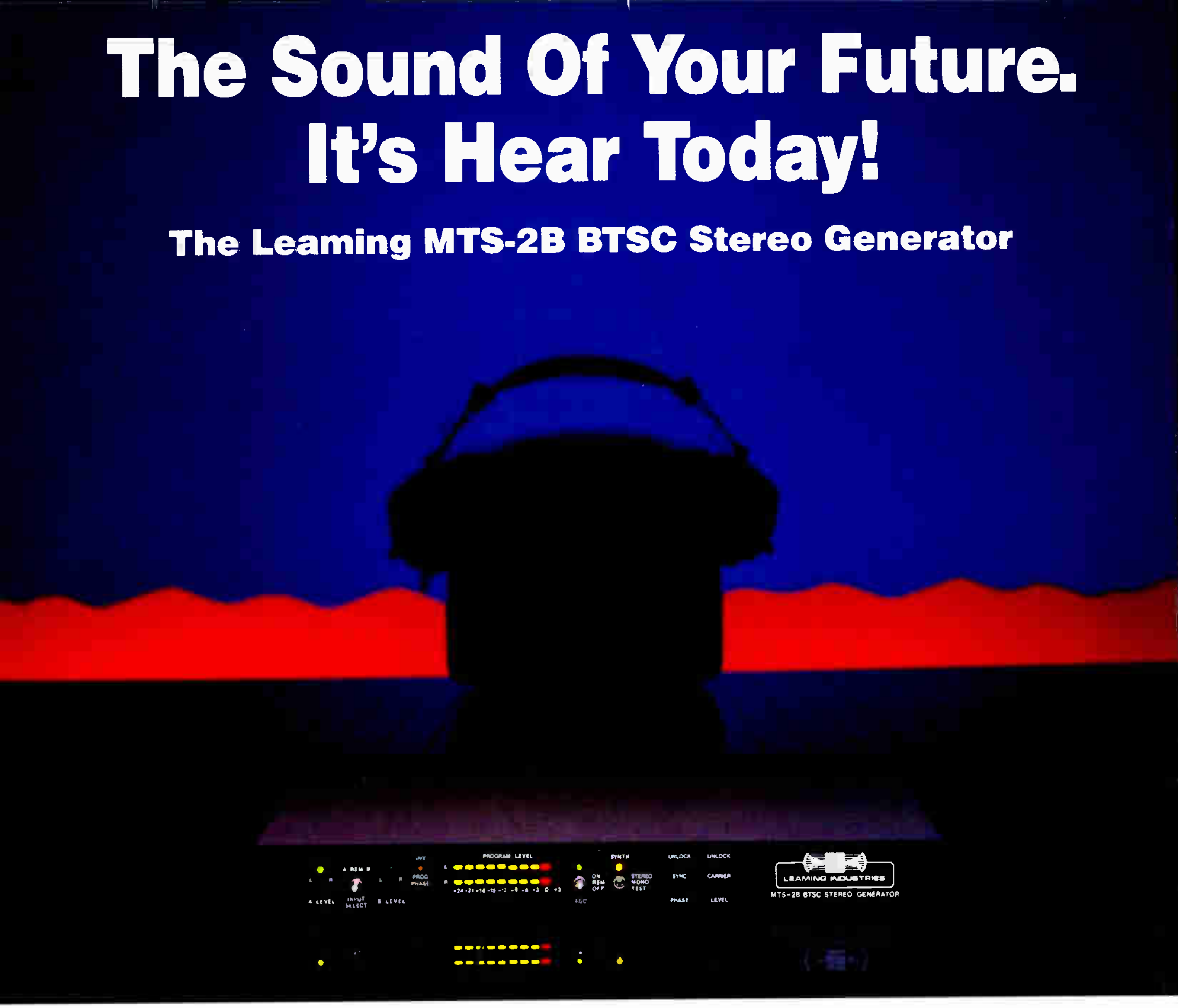
Jerrold and ICT are the most boisterous and well-known firms with a digital format. Both companies have exhaustively researched the marketplace and believe digital audio "radio" is something subscribers want and will pay money to receive.

In fact, Jerrold has been market testing its Digital Cable Radio service since July in Willow Grove, Pa. (a Comcast system), Deland, Fla. (Cablevision Industries) and Sacramento (Scripps-Howard). In each system, 150 subscribers were given prototype tuners to place with their stereo equipment. According to Dave Del Beccaro, Jerrold's vice president of new business development, those subscribers have praised the system's performance. "The satisfaction level seems quite high," says Del Beccaro. Ninety-seven percent of the listeners say the sound has met or exceeded their expectations; 88 percent say the overall service did the same and 68 percent say the DCR tuner is their "most used" stereo component. More importantly, Del Baccaro says DCR didn't cannibalize pay-TV subscribers, so the revenue gained by offering DCR is fully incremental.

Subtle differences

The differences between Jerrold's Digital Cable Radio, ICT's CD/8 service and Digital Radio Labs' system are subtle, but important. All three vary slightly in number of formats they plan to offer and headend delivery methods. Jerrold anticipates delivering eight to 10 "basic" formats and perhaps an additional eight or 10 "niche" formats that may carry an additional monthly charge. ICT says its research shows 12 to 16 formats would be best. DRL plans to deliver 16 channels of sound, plus graphics for the television.

Jerrold plans to transmit its "channels" of music discretely in 600 kHz "bites" that operators can pick off and send down their systems. ICT and DRL, conversely, have planned to send their signals disguised as a 6 MHz-wide



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15339 Barranca Parkway, Irvine, CA 92718 video channel. The obvious drawback to that approach is that cable operators would have to give up a video channel to offer the service. (However, ICT has announced its plans to develop a narrowband transmission scheme that would work like Jerrold's.)

Another bone of contention between the three nascent services is quality. ICT claims to deliver "CD quality audio" all the way to the subscriber. So do DRL and Jerrold. ICT says it will use 16-bit sampling that delivers 2 Hz to 20 kHz frequency response, 96 dB dynamic range and 96 dB signal-to-noise. DRL quotes the same numbers. Jerrold, though, uses an 18-bit decoding/encoding process developed by Dolby Labs.

More hardware

Each of the services requires an additional "tuner" box placed in the subscriber's home. Both Jerrold and ICT have designated "target" prices for the units in the $50 to $75 range. DRL will offer two models, according to President Norm Hogarth. The basic model will be offered to cable operators while the full-featured model will be offered for sale directly to consumers.

Executives from all three services agree that commercial-free music entertainment, with as few interruptions as possible, will make the services popular with listeners. With so many similarities between the services, it may turn out that the "winner" is determined by marketing prowess.

> With so many similarities between the services, it may turn out that the 'winner' is determined by marketing prowess.

ICT's principal officials hail from successful marketing backgrounds. President and COO Tom Oliver came from HBO, where he was senior vice president; Vice President of Marketing and Consumer Technology Thomas Shemo came from The Boston Consulting Group; and Vice President of Communications Molly Seagrave also came to ICT from HBO.

Digital Radio Laboratories Inc's Model DF1000

Along with the personnel came the same marketing approach HBO used when it entered the cable industry, says Oliver. Unlike Jerrold, which hopes to stay out of the programming side of the business and provide hardware instead, ICT plans to count on others to provide the hardware and technology and concentrate instead on pooling the technology and programming and delivering it over cable.

Forging alliances

Along that line, ICT has announced agreements with Marantz and AT&T for hardware and marketing support. The Marantz pact will result in integration of ICT's patented data compression and transmission technology (called DM, for Digital Modulation) into Marantz tuners. Although detailed time schedules have yet to be determined, Oliver expects the units to be available in about one year. The agreement with AT&T's American Transtech Division calls for Transtech to develop a program to identify likely subscribers of the audio service.

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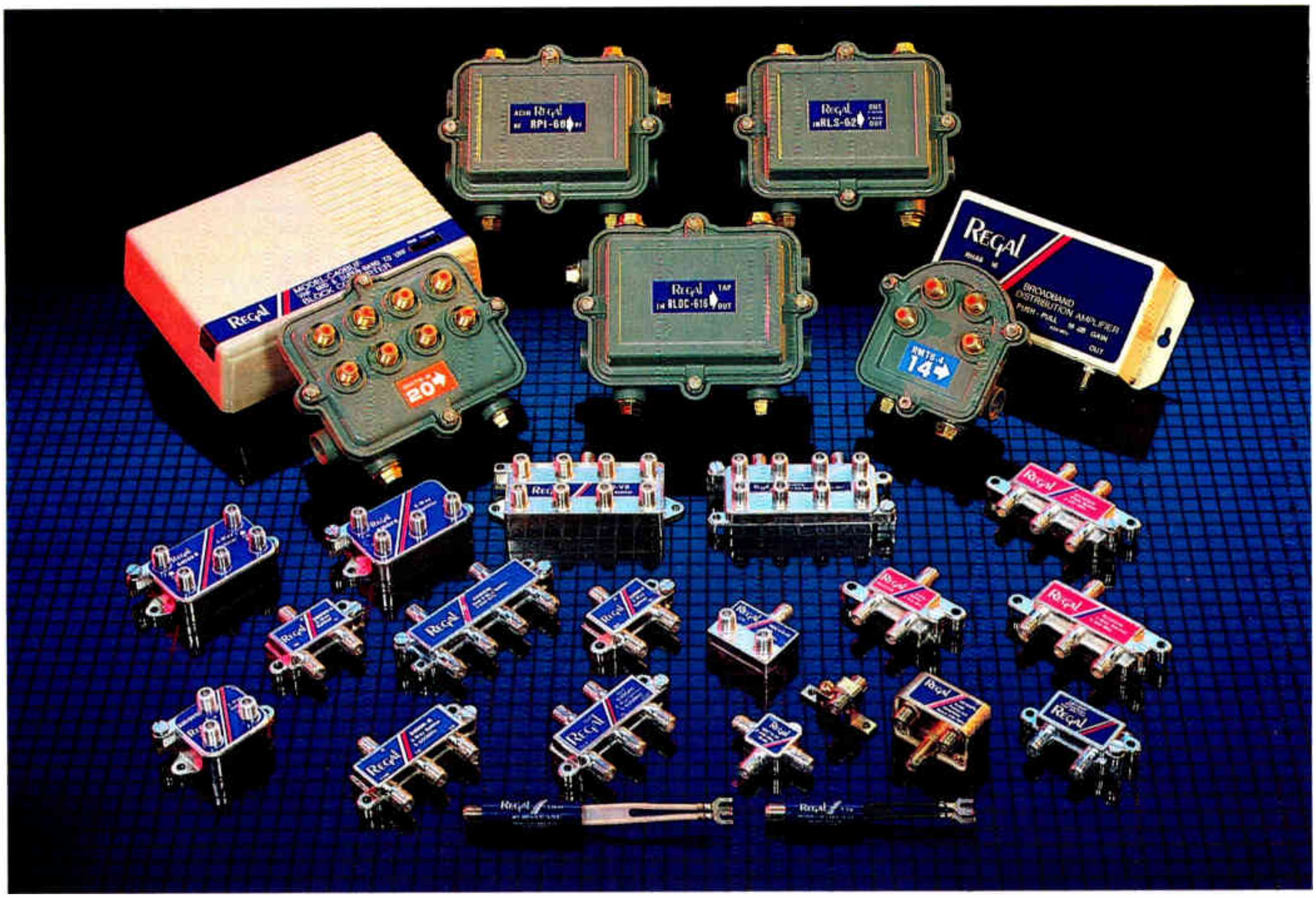

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Reader Service Number 37

Transtech will design a proprietary system as part of its Customer Development Identification (CD/ID) program. It will use a multivariate computer model to locate and identify prospective music-oriented customers who are heavy purchasers of audio equipment and pre-recorded music.

Locating subscribers

The program is being designed to locate, by specific name and address, the music-oriented subset of each cable system's subscriber base, which could average out to be as high as 50 percent of all cable subscribers, according to Shemo. The computer sort will match the characteristics of prospective audio service subscribers against household demographic, psychographic and purchase behavior indices acquired from such sources as audio/stereo magazine subscriptions and stereo component warranty card information.

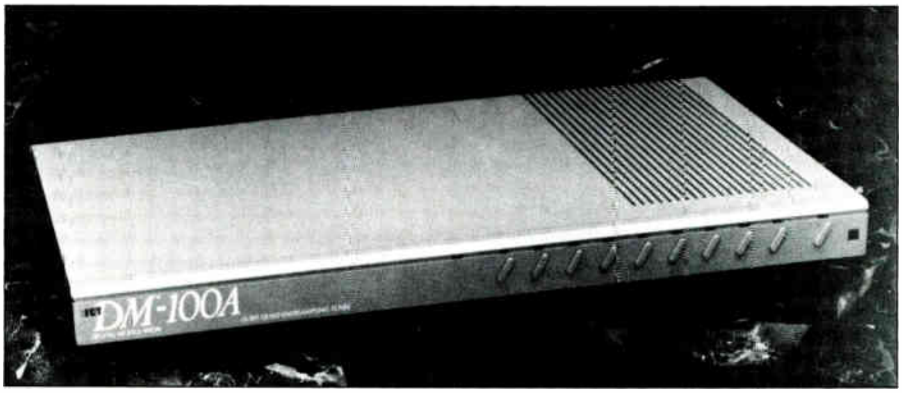
After these prospective customers have been targeted, ICT will work with cable operators to develop and implement marketing campaigns aimed at these specific customers, said Shemo.

Shemo has said, in a news release issued about the agreement, that although "two-thirds of all cable susribers are interested in CD music despite the cost, in the CD/ID target group, the interest is fully 90 percent".

Despite the fact that ICT's service isn't up and running yet (a basic, six-channel service is set for launch this spring; CD/8 will be up in the summer), the company's market research seems to show a bright future. Fully one-third of all cable subscribers in any given market have expressed interest in such a service (that number doubles in homes where CD players already exist), according to Shemo, and they say they're willing to pay about $7.50 per month in addition to paying upwards of $100 for a tuner.

In addition, the lift potential is extremely high, says Oliver. Seven percent of all cable non-subscribing homes approached about the service say that if such an audio service was available on cable, they'd reconsider their decision not to subscribe. That number is twice the lift generated by HBO, Oliver says.

Jerrold's research shows similar results. In fact, in the system test-beds, the service is getting between 5 percent and 9 percent penetration at $6.95 per month. So, with these services offering to equally split the revenues with cable operators, a system with 10,000 subscribers taking the audio service could generate an additional $35,000 cash per month. Jerrold is so convinced of market acceptance, it is now telling operators that all capital costs can be recouped within 18 months, says Del Baccaro.



ICT's DM-100A tuner

What will it cost?

What costs are necessary? In the headend, a single rack-mounted piece of equipment and a personal computer will be needed. In Jerrold's case, the rack unit will consist of a series of cards that may cost about $500 each (you'll need a card for each audio channel), according to Del Baccaro. Jerrold's system will work with any addressable controller, while ICT's technology is proprietary.

DRL hopes to launch its service in the Los Angeles area initially sometime in the third quarter of '89. says Hogarth. Although no announcements have been made yet, Hogarth says he's talking to numerous cable operators in the L.A. area.

But is all the additional hardware necessary? Jeff Hansen, general manager of Galactic Radio, Jones International's audio service that utilizes traditional analog tape technology, doesn't think so.

Galactic Radio offers 10 audio channels and reportedly will have 1.35 million subscribers in nearly 80 cable systems by March, says Hansen. Among the offerings are six different formats of music, three radio "superstations," and a non-music reading service channel for the visually impaired. Operators are charged 2 cents per subscriber per month for the service, but can sell two minutes of commercial time per hour. (Galactic Radio offers 56 minutes of music per hour; the other two minutes are for national ad spots.)

Proven technology

Galactic Radio was started in 1987, and at that time, digital methods of delivery were considered but ruled out because the technology wasn't proven, says Hansen. "The last thing we wanted to do was go on a satellite with an unproven technology and ask the operators to act as an R&D site," he says.

But Hansen isn't blind, either. "We're very much aware of the movement toward CD's," he says. Which is why large portions of Galactic Radio's source material comes from compact discs.

But, importantly, Hansen says his research shows that consumers are more concerned about how a service is programmed, not about the technology used to deliver it.

Galactic Radio organized four listener focus groups and, after playing identical musical selections from tape and from CD, asked the participants to identify which selection was the "highest quality." Almost exactly half the respondents selected the CD selection as best, while the other half selected the analog tape or couldn't tell. "I think that says a lot," says Hansen. "It tells me that high-quality analog (methods of transmission) is just as good as digital."

Additionally, the focus group members said they had little or no interest in investing in additional stereo hardware. "We found that the subscribers were not interested in another tuner and didn't want to pay for it," says Hansen.

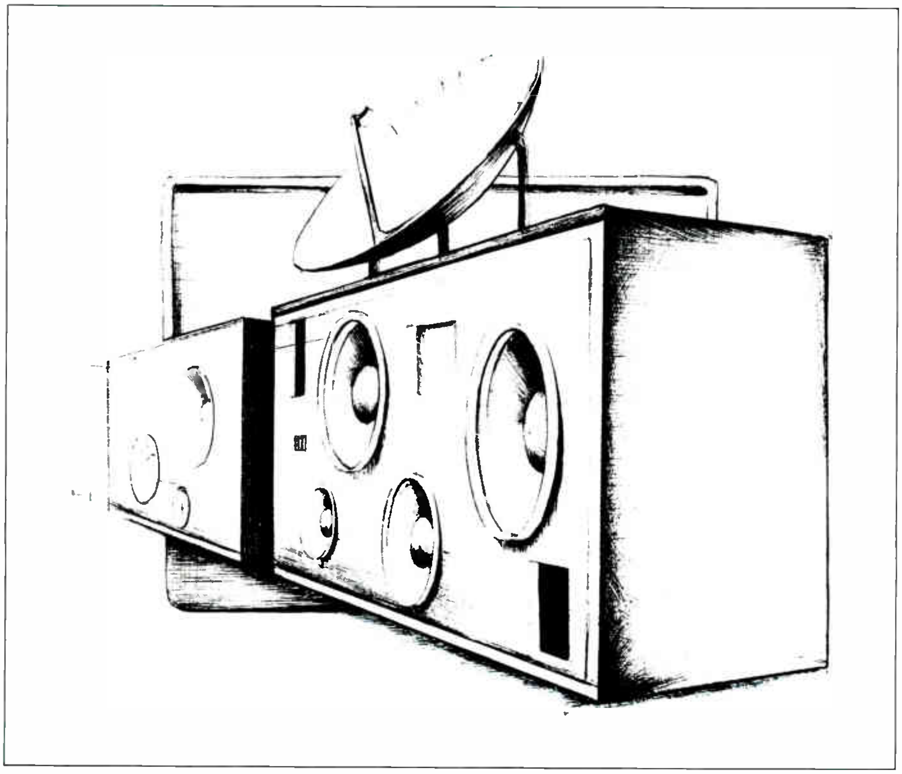
In fact, cable operators should assess whether they would want to inventory another tuner and be responsible for its maintenance and repair, Hansen says.

Regardless of the approach, one thing seems clear: Cable subscribers are becoming more knowledgeable and demanding about audio and cable operators apparently won't be left out when it comes to new revenue possibilities. ■

—Roger Brown

Upgrading your CATV system for MTS stereo

The popularity of stereo-TV has grown steadily since the *de facto* standard for MTS broadcasting was established in 1984. The penetration of stereo TVs into America's homes has actually been growing at a faster pace than the much heralded VCR did (see Figure 1). This new development in home entertainment will greatly impact the CATV world, much like the VCR did not too long ago. In fact, it will probably impact the CATV industry even more than the broadcast industry, since cable has a greater amount of late release movie, special-event and concert programming with higher quality audio tracks.



Headends being upgraded

Recognizing the growing market demand for stereo TV, cable operators across the country have begun to upgrade their headends for MTS stereo carriage of satellite TV channels. The growing population of VideoCipher II descramblers in CATV headends makes the reception of stereo TV signals fairly straightforward for system operators since a stereo output capability was included in the VC II design.

However, the system operator will have to purchase and install an encoder for each satellite service he or she wants to provide MTS audio on before their subscribers can enjoy the enhanced programming. Since there are currently more than 25 satellite services transmitting at least some of their programming in stereo, a cable system operator will need to carefully plan for both the capital outlay and the mounting space required to upgrade to stereo.

By Joe Vittorio, Applications Engineering Group, Jerrold Division of General Instrument

When adding a stereo encoder to a channel, an operator faces several considerations which might effect the installation—such as whether or not the channel will be scrambled or if commercial insertion will be required. This article will briefly review the various considerations that typically affect the installation of a stereo encoder and will describe the most common wiring configurations.

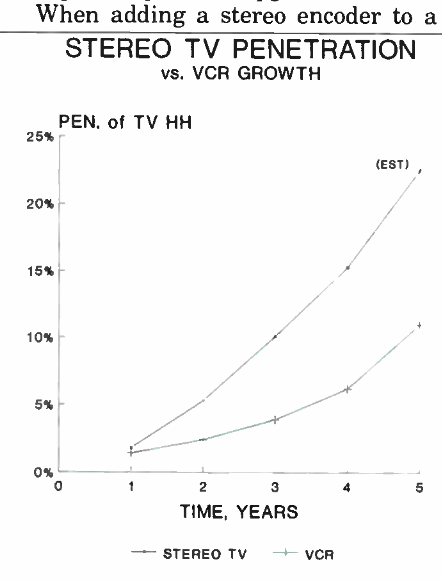


Figure 1

What's required

Inputs. A stereo-TV encoder basically converts the baseband left and right audio signals provided by the programmer into a multiplexed signal, which is fed to a modulator for broadcast on the desired channel. On VideoCipher II descrambled channels, the audio inputs for the stereo encoder can be obtained at the rear panel of the VC II as left and right baseband audio outputs. For a non-VC II channel the left and right audio signals will generally be obtained through a subcarrier system specific to that service.

Further, some programmers have recently begun to transmit additional audio information to take advantage of the Second Audio Program (SAP) capability which is part of the MTS format. This audio signal can be obtained through a separate subcarrier system and then multiplexed by the encoder for reception simultaneously with the MTS stereo signal. This SAP channel is primarily being used for bilingual applications. And finally, video from the VC II (or satellite receiver if the service is not scrambled) will have to be looped through the stereo encoder so that the MTS signal can be synchronized to the horizontal

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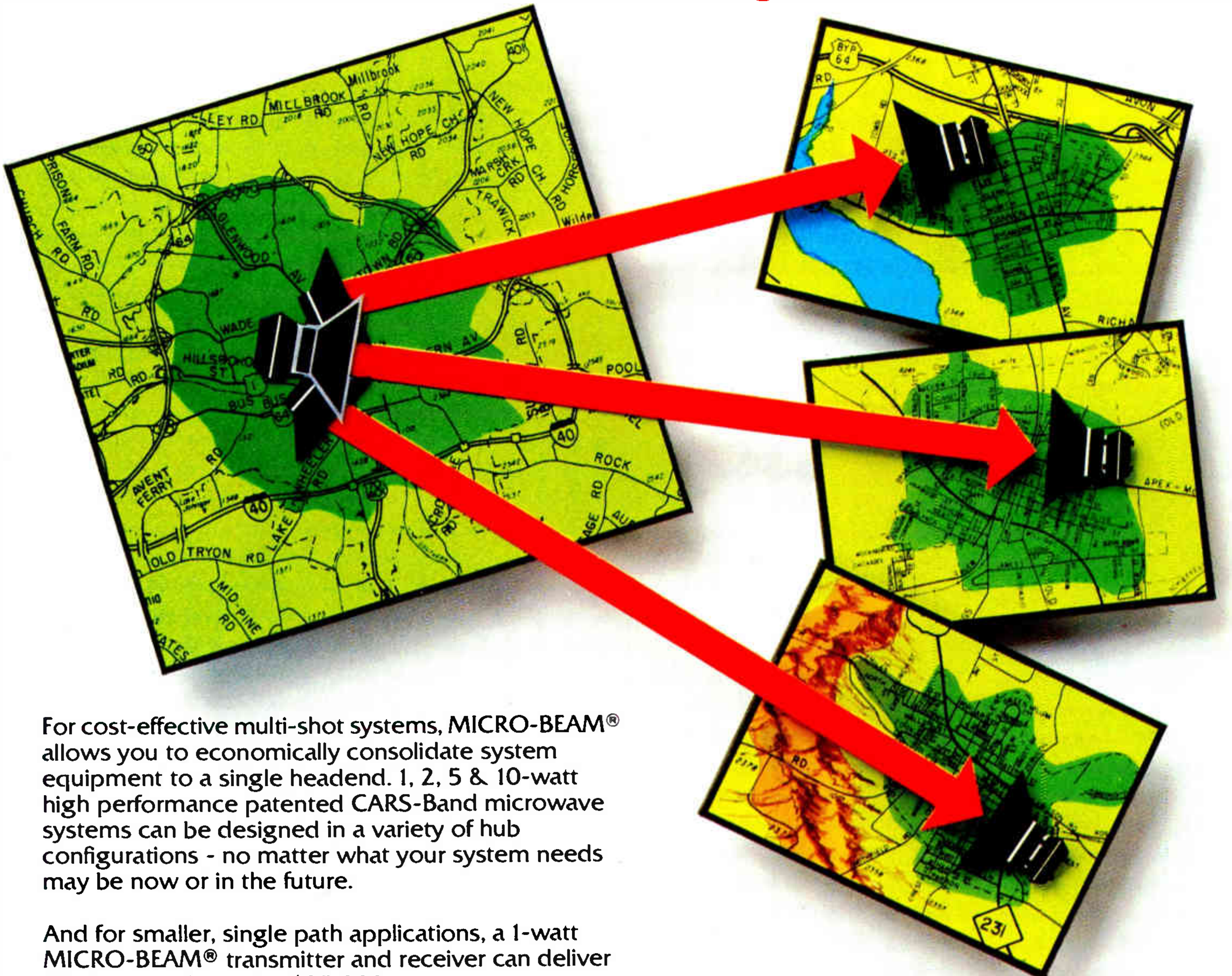

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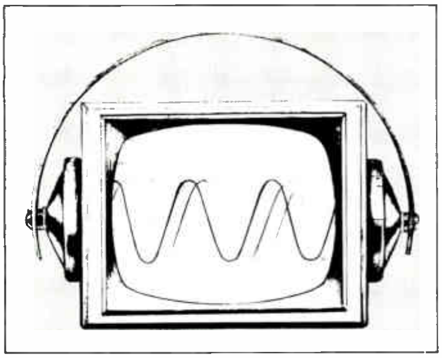
Outputs. Most stereo encoders today include both a composite baseband and a 4.5 MHz output signal to allow for interfacing with many different models of modulators. Some manufacturers have also included a 41.25 MHz IF output signal to provide even greater flexibility for those cases where a 4.5 MHz interface isn't available in the modulator. The selection of which output signal to use depends on various factors, including whether or not the channel will be scrambled (on the cable system) and what model of modulator



the encoder will be interfaced to.

Other factors include downstream signal processing applications such as FM supertrunk or microwave transmission. Generally, the manufacturer should be consulted if you run into an application that is not covered in the encoder installation manual.

When considering a stereo upgrade, one of the most common questions asked concerns the compatibility of the modulator with MTS encoded signals. Since the MTS signal is much broader in bandwidth than a standard audio signal, there is concern as to the pass-through capability of the modulator. Interfacing to the modulator at 4.5 MHz or 41.25 MHz usually eliminates this concern, but isn't always possible. If the composite baseband output has to be used, the major modulator manufacturers have stereo compatible (wideband) audio modules available for field upgrade.

Bringing it all together

A basic installation might entail wiring the stereo inputs to the encoder, connecting the 4.5 MHz encoder output signal to the modulator and then connecting the scrambler and the modulator together (see Figure 2). Adding commercial insertion raises a few more issues to consider. Generally, the video will be switched ahead of the encoder and the commercial audio brought to the "B" or auxiliary input on the stereo encoder. The "on-air" output would switch an A/B contact and, if required, a stereo/mono contact on the encoder for automatic switching control at the time of insertion.

Further, if the channel is time shared between two program services (one during the day and another at night, for instance) with the alternate service audio wired to the auxiliary input, than the insertion video and audio switching will have to be done upstream of the encoder. Wiring diagrams for each of the above situations can usually be acquired from the encoder manufacturer upon request.

SAP audio

With the advent of bilingual broadcasting by several programmers (notably HBO and Cinemax), additional consideration will have to be given to the reception and retransmission of SAP program audio. The SAP audio is received via a QPSK digital audio sub-carrier receiver which provides a baseband signal for the encoder SAP input (see Figure 2). The major encoder manufacturers offer a SAP option kit for field upgrade if you are upgrading existing units.

Upgrading to MTS stereo should not be a painful task. Detailed wiring diagrams, such as that shown in Figure 3, can be obtained from Jerrold and some of the other encoder manufacturers upon description of your requirements. Careful advance planning of the interfaces required for each channel being upgraded will make the task easier to carry out.

Testing

After completing the wiring connections to the encoder and the associated interface products, a functional test should be carried out to assure that the entire audio path is functioning properly. Test the encoder according to the instructions provided by the manufacturer, using, as a minimum, the following equipment:

- a low distortion audio oscillator,
- 25 MHz or better dual channel oscilloscope,
- MTS compatible converter,
- good quality MTS decoder, and
- reasonable quality stereo headphones.

Be sure to test for video related buzz. Note that video related buzz does not indicate a defective stereo encoder (if the encoder was designed correctly) nor is it a function of MTS encoding. This buzz is primarily due to either or both of the following conditions:

- overmodulation of the video signal, or
- improper balance of the video chopper modulator.

Contact the manufacturer for assistance if you are not sure how to adjust the balance of the video chopper circuit. Also, if the channel is being scrambled, check that the scrambler timing is set correctly as this might also cause some buzz.

If you are using a baseband or volume control converter for your testing, be sure to adjust the volume control for optimum stereo pass through or separation (i.e. unity gain). The latest volume control converters have a quick method for finding the unity gain point (touch "F," then "Mute" keys on the Jerrold Impulse 7000 for example) when required. ■

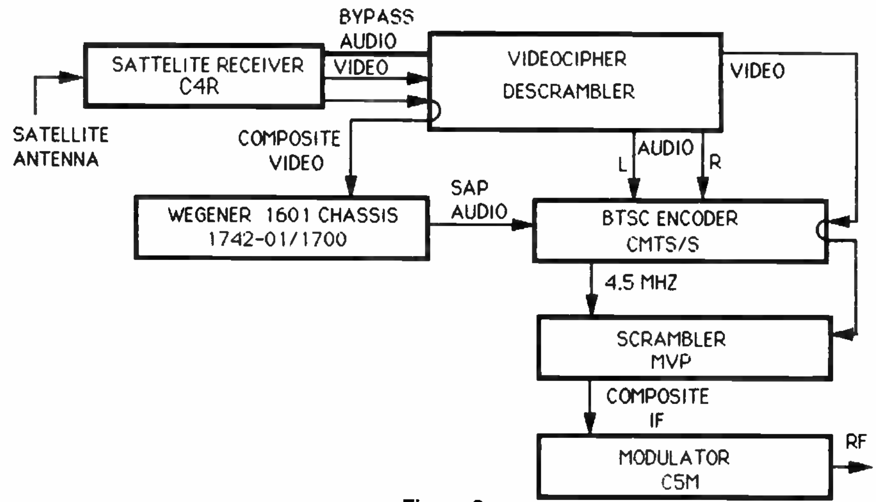


Figure 2

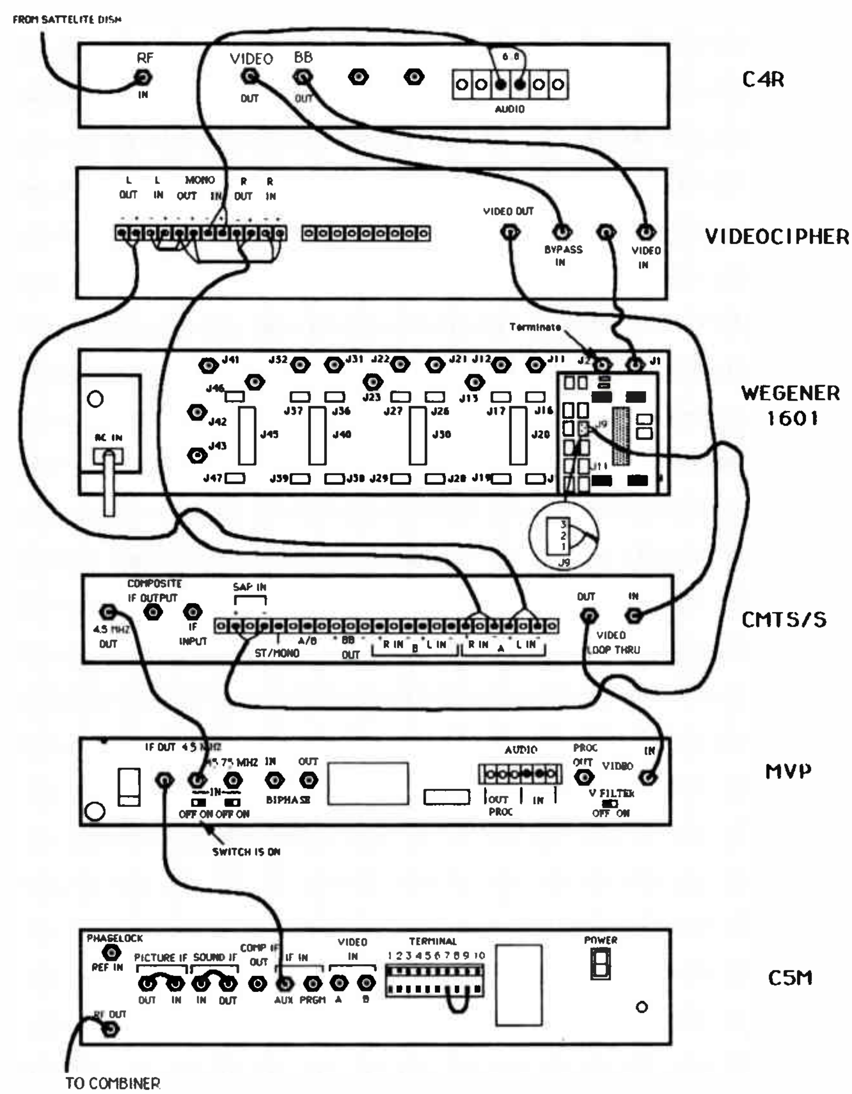


Figure 3

Allen-Bradley introduces broadband ISObridge

Allen-Bradley, a subsidiary of Rockwell International, recently announced it has developed the ISObridge for interconnecting various Ethernet and IEEE 802.3 subnetworks over a MAP/IEEE 802.4 broadband network.

Key features include: the capability to "learn" the location of devices on a network or be forwarded to another network; extension of the distance and bandwidth usage found in an isolated IEEE 802.3 network (distance and bandwidth utilization is extended up to 12 miles); and hardware and software transparency. Because the ISObridge operates at the data link layer, it is both hardware and software transparent, enabling users to interconnect Ethernet networks from various vendors.

The product provides up to three 10 megabits-per-second (Mbps) data channels in the three 12-MHz MAP/IEEE 802.4 channels on the broadband cable. Because 802.3 and Ethernet subnetworks can be interconnected to the MAP broadband channel, the ISObridge can interconnect multiple applications. For example, TOP stations on an 802.3 subnetwork could communicate with MAP nodes on the 802.4 broadband channel. For more information, contact Allen-Bradley, (800) 223-5354.

Zenith ships PC bus card

Zenith has announced it has begun to ship its new PC bus adaptor card. Called the Z-LAN 4000C, the card is designed around the same architecture as the company's Z-LAN 500 broadband PC network, but it operates at a speed of 4 Mbps.

The device features an on-board co-processor which results in performance improvements. It conforms to the OSI reference model and supports NETBIOS, which also resides on the card. This reduces the PC memory requirements, enabling the card to perform a remote program load for diskless PCs.

The 4000C is being marketed directly to large end-users and through VARs, system integrators and OEMs. The list price of $895 includes software and a frequency-agile modem. Delivery takes 60 days. Call Zenith for more information, (312) 391-8000.

Alantec of Fremont, Calif. recently introduced a high-speed Multi LAN switch (MLS), nicknamed a "backbone in a box." The MLS is capable of interconnecting as many as 16 LANs while providing filtering and network management features.

The product is based on the company's SmartBus architecture that enables fast packet switching among LANs in a single building or between LANs connected via fiber optic links at distances up to 10 Km (6.2 miles). The unit allows transfers between LAN segments to travel at 160 Mbps.

> NaCom announced another in a string of successful major LAN cabling installations.

The MLS, which operates on the MAC layer, offers some features not generally found on bridging products operating on that layer. These include: the ability to alter the routing among LAN segments from a central management station and to set access control features that filter packets based on protocol type, source or destination address, packet length, broadcast identifiers, or even TCP/IP connect requests on a per segment basis. It also provides the central management station with real-time statistics and a complete audit trail of archived activity.

Prices for the MLS start at $9,800 and comes standard with Ethernet AUI connectors. The product is available in three configurations with four, eight or 12 ports. For more information, call Alantec, (415) 770-1050.

NaCom's on a roll

NaCom announced another in a string of successful major LAN cabling installations. This one was for TRW's Defense Systems Group in Redondo Beach, Calif. The $700,000-plus contract involved installation of dual cable broadband LAN cabling systems in seven U.S. Air Force Logistics Command military buildings at Tinker Air Force Base (Oklahoma City) and Kelly Air Force Base (San Antonio).

The work was part of the Air Logistics Center Local Area Network (ALC LAN) project sponsored by the Air Force Systems Command. Among other large projects that helped NaCom register a three-fold increase in sales over the last 12 months were two multi-building broadband LANs located at military institutions, and campus-wide LANs at medical, chemical and commercial/industrial facilities (over 25 projects in 15 states). For more information call NaCom, (800) 848-3998.

The **Wollongong Group** of Palo Alto and **Advanced Computer Communications** of Santa Barbara recently announced their intention to merge the two companies.

Wollongong has long been considered a leader in TCP/IP and OSI networking software products, especially in the area of network management. ACC has established itself as a provider of network connectivity products and mainframe interfacing.

Although final details were not available, it is expected that Roland F. Bryan (current President of ACC) will become chairman and chief technical officer of the new operation. Herbert J. Martin (president and CEO of Wollongong) will maintain that title in the new company.

New standby power unit

Perma Power Electronics of Chicago announced a 1200 VA version of its existing standby power system. The new product, the SPS-1200, protects against data loss and equipment damage resulting from blackouts, sags and brownouts as well as high line voltages, spikes, surges and RFI/EMI noise.

The unit provides eight minutes of battery back-up at 1200 VA, 40 minutes at 200 VA. A chirping buzzer provides an audible indication when the system is on back-up, is overloaded or that the surge suppressor is inoperative. The chirping changes into a rapid beeping sound during the last two minutes of back-up. For more information call (312) 647-9414.

—Greg Packer

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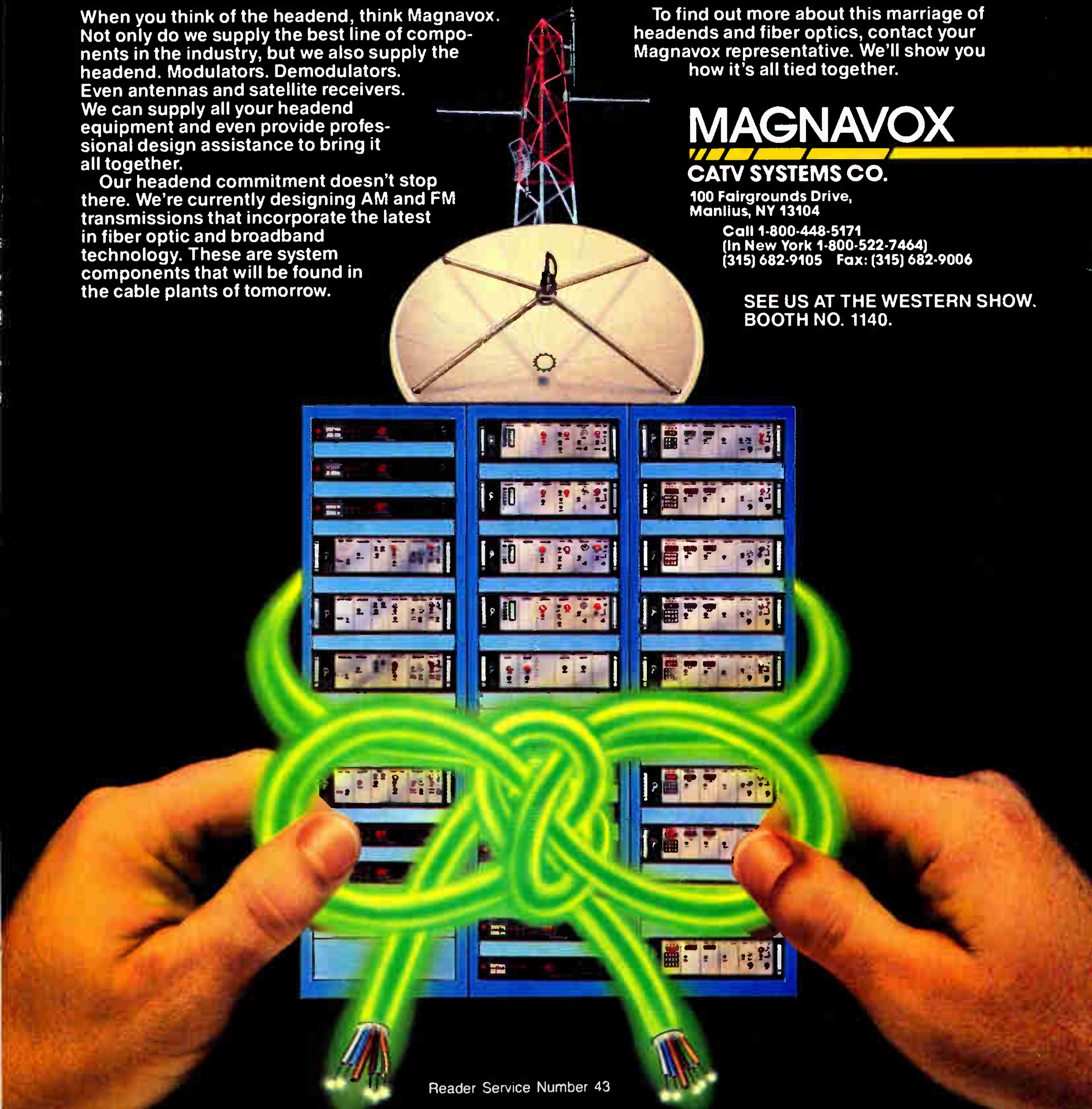

Reader Service Number 43

Complexities in cable system design

The complexity of minimal cost cable system design has exploded in the last two years, and shows little sign of easing off. The most obvious and visible example is the introduction of fiber optic links, especially AM fiber. But as more of us take up the cry, "fiber is just another tool in your design toolkit," I thought it appropriate to examine that toolkit and see what's inside.

Coaxial tools have become more flexible, and at the same time more complicated, with push-pull and parallel hybrid (power doubling) being augmented with the introduction of variations on parallel hybrid, including power quadrupling, and feedforward.

By David M. Fellows, Scientific-Atlanta

Fiber

I will save an in-depth study of the design options available with the fiber tools in the toolkit for a later date, but the current broad options include FM fiber and AM fiber. In both options, all products are not created equal! The challenges presented to an FM product designer are several: How to deal with sync-suppressed scrambled signals in order to reclamp the AM signal eventually desired at the hub end of the link; how to deliver a quality AM signal at the hub if shortcuts are taken in the AM modulators; and how to cost reduce the various signal conversions that take place. Each of the FM products on the market have taken a different approach to each of these challenges.

Output Level at Equal Distortion

PP	PHd	AT	PHd²	EE
ref	+2.5dB	+4dB	+5dB	+9dB

Figure 1

In the AM world, the most basic difference in the current products available involves the decision to use an optical isolator or not. The designer who chooses to save the cost of an isolator, and the operator who uses his product, are betting that the fiber cable plant will not generate enough reflections and optical feedback into the

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REGIONAL OFFICES: Fred Kimmer, 509 Burgess Street, Philadelphia, PA 19116, (215) 934-5654; Robert Freedlund, 3404 Allendale Drive, Bloomington, IN 47401, (812) 334-2661; Dan Trayler, 7275 S. W. Alpine, Beaverton, OR 97005, (503) 626-2727; Michael Crotts, 4967 Thornwood Trace, Acworth, GA 30101, (404) 928-6922; Jim Rushing, 555 Republic Drive, 200, Plano, TX 75074, (214) 578-0071.
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AMPLIFIER CALLBOOK

transmitting laser to degrade the signal level below design goals. To help ensure this, the number of channels carried per fiber is limited. Over time, as more products are introduced, more subtle differences will emerge.

Coaxial amplifiers

The main body of this article will deal with the coaxial tools in the system designer's toolkit. The basic technology options will be discussed; within each technology there are frequency options and gain selections to be made. Push-pull hybrids (PP) are the first high gain amplifier stage to have been made linear enough for widespread cable application. As operators desired more gain with less distortion for system upgrades, the parallel hybrid (PHd) was developed. This basically puts two push-pull amplifiers in parallel for approximately twice the output power. These gain blocks can, in turn, be put in parallel for more output (quadrupled, or PHd^2).

A different approach is taken with feedforward amplifiers (FF). In this amplifier, an error signal is developed in the hybrid chip, and subtracted from the output signal for low distortion.

Distortion at Equal Output Level

PP	PHd	AT	PHd^2	EE
ref	+5dB	+8dB	+10dB	+18dB

Figure 2

The challenge is to have stability over a wide temperature range.

A comparison of the output power and distortion characteristics of these technologies is shown in Figures 1 and 2. Power and distortion trade off against each other at a 2-to-1 rate. There are typically two gain stages in an amplifier, these comparisons assume that the first stage is push pull. In Figure 1, distortion is held constant and the power capability of each technology is shown. The column labelled AT is a proprietary parallel hybrid technology which allows higher output powers to be achieved.

> A system operator is usually making a choice of technology when the system is adding channels.

Figure 2 shows what happens when the output power is held constant, and the distortion is measured. Another parameter of interest is the power consumption of each technology, shown in Figure 3. This is the DC power consumed, with varying power supply efficiencies removed.

Rebuilds and upgrades

Since most of the major new builds in this country have been completed, a system operator is usually making a choice of technology when the system is adding channels. If a rebuild is being considered, a comparison between push-pull and parallel hybrid is appropriate. Parallel hybrid's higher output power allows greater spacing, hence fewer amplifiers and less cost, but each amplifier costs more. When the comparison is done on station price alone, push-pull wins out, but when the installation and setup cost of each station is included in the analysis, this

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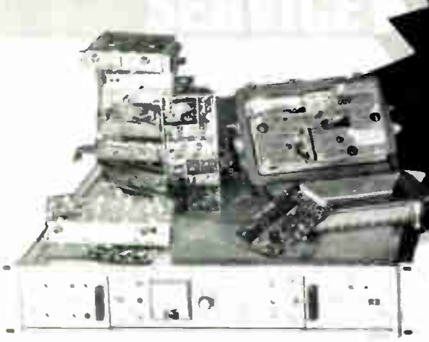

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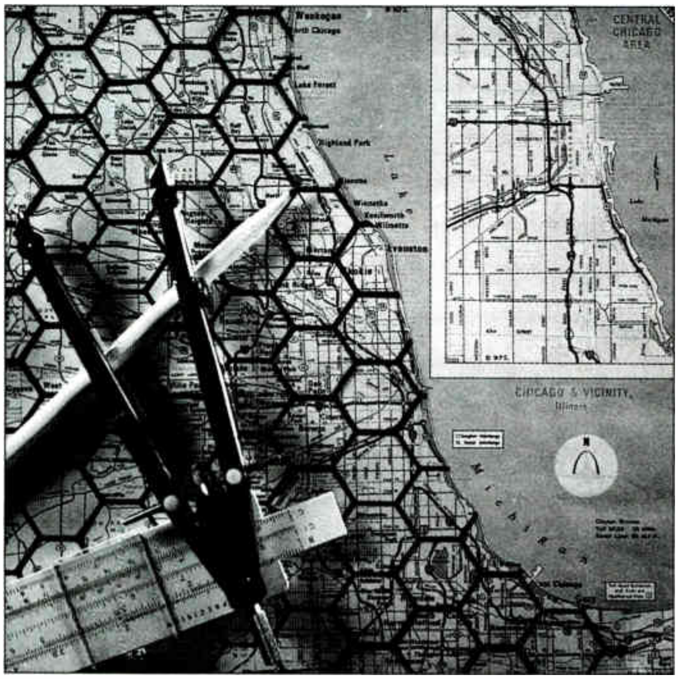

usually tilts the balance in favor of parallel hybrid, even in new builds.

As an illustration, with parallel hybrid amplifiers an operator may need 20 percent fewer, but each one costs 30 percent more. This means push-pull is the choice. However, when the fixed cost of installing and sweeping an amplifier is added to both technologies, parallel hybrid may only cost 10 percent more and should be the choice.

If the cable plant is at all salvageable, the design effort centers around engineering a drop-in upgrade. Here, the starting frequency, the desired frequency, and existing technology all come into piay. If "steps" in frequency are defined as 300 MHz (35 channels), 330 MHz (40 channels), 400 MHz (54 channels), 450 MHz (62 channels), and 550 MHz (78 channels), then Table 1 shows the technology of choice when the existing system is push-pull, fully spaced.

Upgrade Technology

1-Step:	PHd Trunk, PHd Bridger, PP LE's
2-Step:	FF Trunk, PHd Bridger, PHd LE's
3-Step:	Hi-Gain FF Trunk, PHd^2 Bridger, PHd^2 LE's
or:	Hi-Gain FF Trunk, FF Bridger, PHd LE's
4-Step:	Probable No-Go, without respacing

Table 1

Note that in a three-step upgrade, the designer faces a choice of technologies. The feedforward bridger option, from Figure 3, consumes less power and probably costs less up front.

Drop-in feeder upgrades are being looked at closer in combination with

D.C. Current

PP	PHd	AT	PHd^2	EE
ref	+37%	+37%	+124%	+84%

Figure 3


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AM fiber backbones. Here the reach of each technology is of interest, and is shown in Table 2. This depicts the distance each technology can go, assuming a typical 450 MHz system, 20 amplifier trunk cascade, with the feeder contributing two-thirds of the total distortion. In this case, the relative distances a bridger and two-line extender service area can reach is shown.

> The addition of fiber will add to the choices available.

Technology Range Comparison

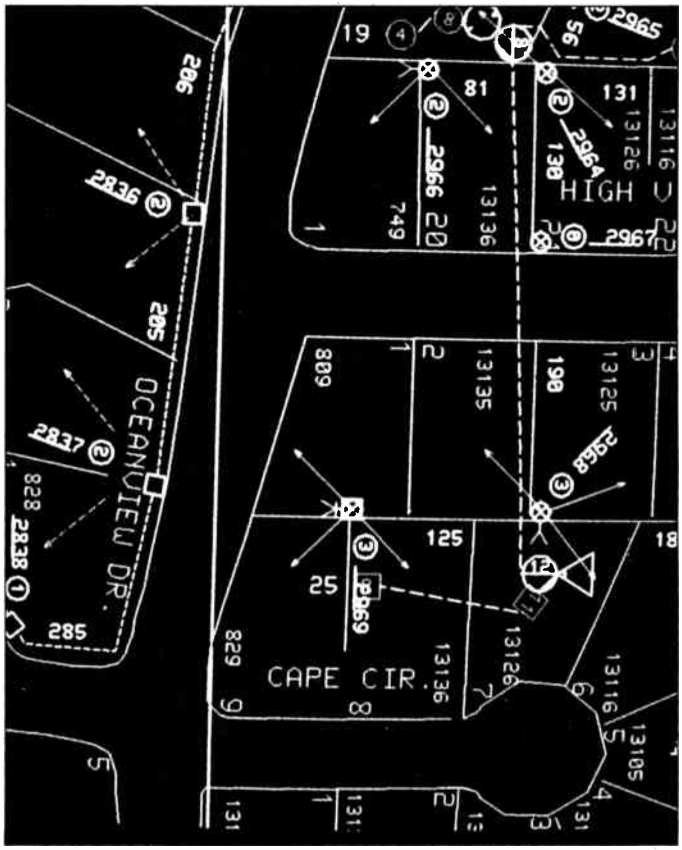
FF Bridger, FF LE's:	X
PHd² Bridger, PHd² LE's:	.92 X
FF Bridger, PHd LE's:	.91 X
PHd² Bridger, PHd LE's:	.88 X
PHd Bridger, PHd LE's:	.83 X
PHd Bridger, PP LE's:	.79 X
PP Bridger, PP LE's:	.75 X

Table 2

Conclusion

This article has given a brief overview of the technologies and tools in a system designer's toolkit, and discussed some of the tradeoffs between them. Some of the value of a full-line supplier of CATV equipment is in the help he can provide in guiding a system operator through the myriad of choices available.

The addition of fiber will add to the choices available, but the remaining coaxial plant will continue to present a challenge in the search for a least cost solution to a rebuild or upgrade situation. ■



Signal leakage control via computer software

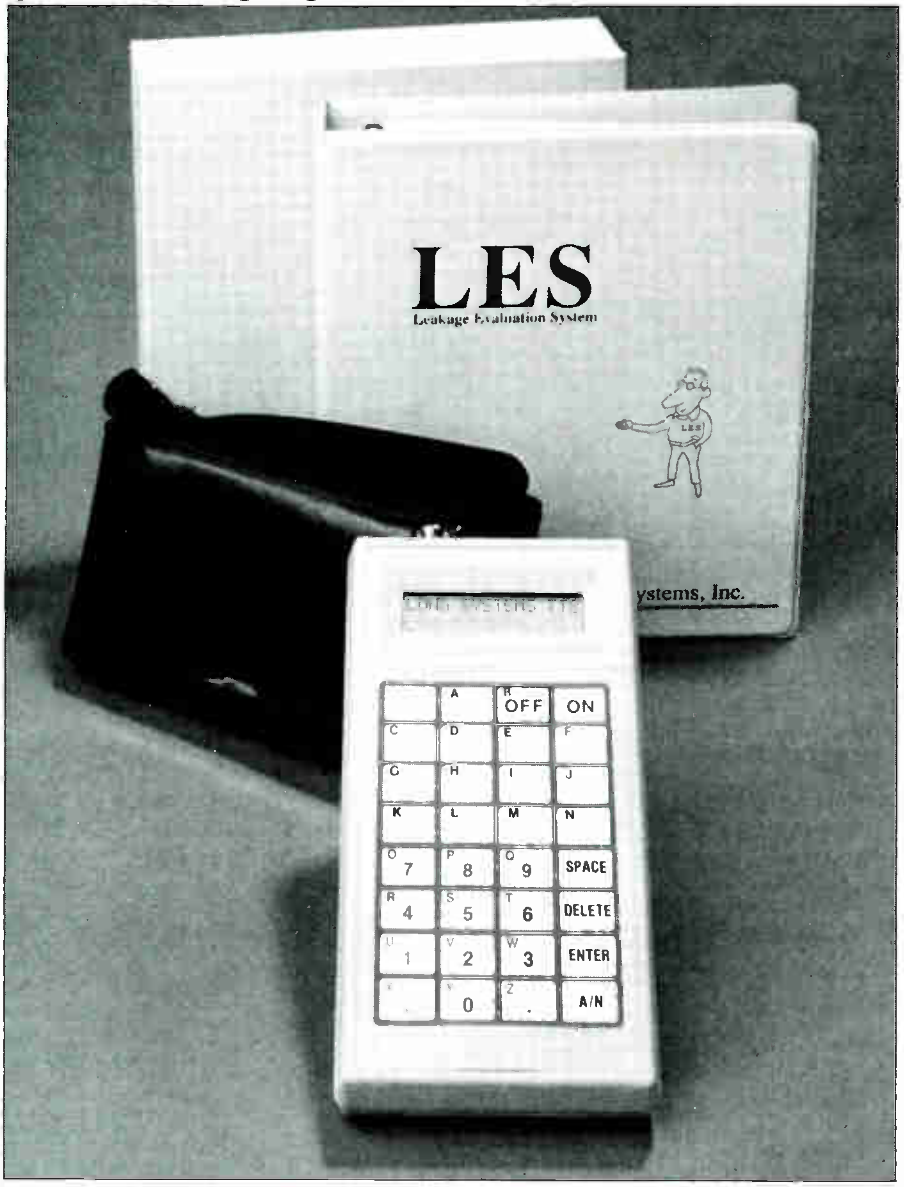
If cable operators fail to be prepared for compliance with the FCC's leakage regulations (Title 47, Part 76) by July 1990 there will be more than just RF signals leaking from their cable systems—they could be hemorrhaging money in the form of fines and other penalties. Management needs to realize this is a deadline for being *in compliance*, not the date a cable system should begin measuring its leakage.

The cable engineering community understands this, thanks to the efforts of the SCTE, the NCTA Engineering Committee, John Wong of the FCC and others who have been beating the drums of warning. But it is not clear whether management yet understands the seriousness of signal leakage and compliance with the FCC requirements.

Drum roll, please

One drum major for many years has been Robert Dickinson. His company, Dovetail Systems, recently entered into a joint venture with Alpha Technologies, called Cable-Trac, which will provide planes and pilots across the country for airborne signal leakage testing and data collection. Dickinson chaired a panel on signal leakage at the recent Western Show but was disappointed with the publicity it generated. "Fiber optics and HDTV had the limelight and here we are back where we started from," Dickinson laments. "Nobody cares about leakage."

Dickinson adds, "The deadline is getting closer and I'm afraid there are going to be numerous systems caught short."



Long Systems' TT8 remote data terminal

Does management, those who hold the purse strings, realize that funds must be allocated to purchase the tools their engineers need to detect leakage and determine Cumulative Leakage Index (CLI) levels over the next year? One important tool is commercially available computer software designed for CLI test data entry and reporting.

The seriousness of this issue dictates that management avoid being "penny wise but dollar foolish." Some will wait until the last minute and then scramble to find a good program. Others will assign a technician whose hobby is playing with computers to make up a program, only to find out too late that it is inadequate to complete the task. Still a few others will try to ignore the problem and hope it goes away only to end up in real trouble with the Feds.

Side benefits

One of the best methods of getting prepared is to purchase a full-featured signal leakage control and CLI database management software program. System managers need to realize that a good leakage control program will offer much more than that. While such software does cost money (one estimate is it costs about $14 per system mile), it can cut customer service calls in half and actually improve the quality of the signal delivered to the home television set.

According to Tom Russell of Tele-

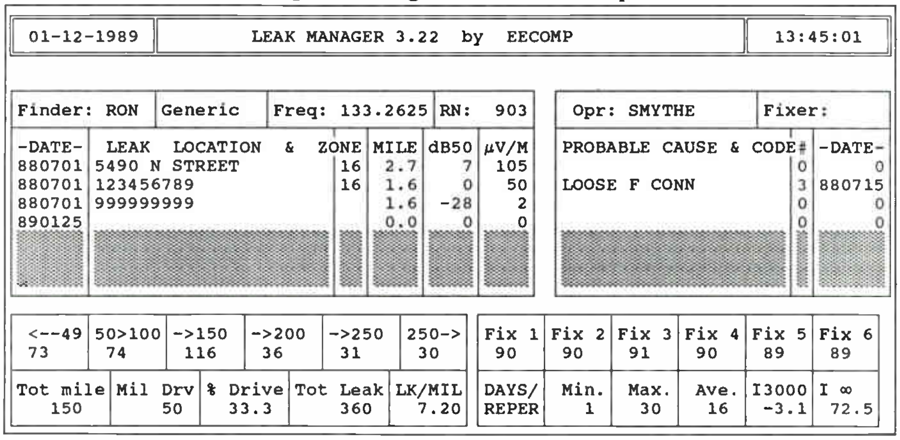
communication Products Corp., developers of the CLIDE (Cumulative Leakage Index Data Easily) program, "It (leakage detection) is the most effective preventive maintenence that you can do in a cable system."

An added benefit of the detailed data that signal leakage control software produces can be identifying signal theft. Russell adds, "People have found that CLI testing helps locate illegal activity because of the faulty hook-up or wiring done by non-cable system personnel. The illegal typically doesn't hook up in a manner that will give you a non-leaky signal so you pick them up when you go driving out."

While all of these are true side benefits, the real task of CLI management software is the organized input and manipulation of RF signal leakage information and the calculation, analysis and generation of that data in an efficient and useful form, including the required annual FCC Cumulative Leakage Index and the quarterly monitoring and maintenance performance reports.

According to Russell, "In order to properly manage CLI, they (cable system managers) have to have some kind of software. The data very quickly buries you. To be able to produce the report as well as create the forms for doing the drive-out, to keep track of all of this data, it just requires it."

The best software for signal leakage is one that massages the data to produce a multitude of ways of analyzing it as well as generating reports and work orders. Says Dickenson, "This is not a difficult computational job. It's just a nuisance. The guy who wins the best program is the one who can do it most conveniently and effectively, and can gain the most out of it such as outputting summaries and work orders and the whole nine yards. I think that's where the expertise is rather than in any particularly smart algorithms because the computations themselves are fairly rudimentary."



EECOMP's data entry screen showing real-time management information

Leak-Manager

Roy O. Ehman, director of engineering for Jones Intercable, developed a signal leakage program called "Leak-Manager," which is sold by his company, EECOMP of Littleton, Colo. Leak-Manager can run on floppy disks but because of the inherent sluggishness of floppies it is recommended that a hard disk be used. Leak-Manager offers six real-time on-screen displays which are updated as each entry is made. These displays are for leaks per mile, CLI infinity, CLI 3000 (if distances are being entered), six leak level categories, six leak "fix" categories, and a repair screen.

The software also provides for multiple unit entry modes for data obtained from several testing devices such as signal level meters or Sniffers. Leak-Manager will generate six reports: a valid FCC log; repair work sheets sorted from highest leak levels; repairs by management "zones" on separate pages; a current summary; a program activity log showing dates, times, operator, etc.; and a total file dump with individual record status and operator ID. Several thousand leaks can be handled within 384K of free memory with Leak-Manager. According to Ehman, 25 systems are currently running Leak-Manager.

'LES' is more

Another commercially available program is Leakage Evaluation System

What Is The Best Selling CLI Software?

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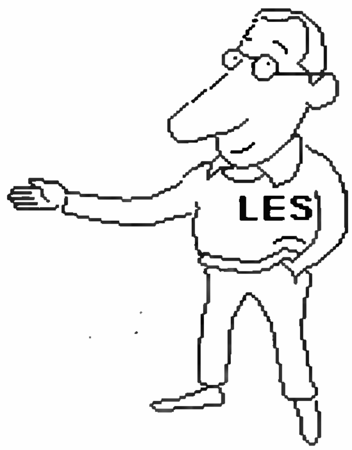

Now, what is the other guy using for CLI software? Right, once more! The emerging industry standard, The LES - Leakage Evaluation System. Call us today for a free demo disk and information. Long Systems is moving up in the world. Please note our new address and phone.

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(LES) developed by Long Systems Inc. According to Harry Long, president, "Ours was the first full-featured software package offered to the industry. We're now rapidly becoming the industry standard because almost 50 percent of the top 50 MSOs have systems using our software. We are a very major player," Long claims.

A user-friendly menu-driven program, LES will do all that CLI software should do and more. It will automatically convert any input mode to µV/m. In addition, LES provides a "break-even analysis" telling you specifically which leaks to repair to bring your system to a break-even point with compliance thresholds. LES also has a pop-up calculator for on-screen conversions and a pop-up frequency chart. Security of data is provided by password protection. LES is available in IBM or Apple Macintosh versions.

Also, Long Systems now provides a remote data terminal, the TT8, which allows technicians to enter the leaks in the field using a handheld computer and then download the data directly into the host computer when they return from the drive-out. This can eliminate the time consuming and error-prone step of manually entering the data that was collected in the field and recorded on forms.

According to Long, the $800 approximate cost is made up by the savings in time required to manually enter the data. Also, the new data is available on a same-day basis instead of whenever the data entry personnel get around to it. Long Systems has begun showing the TT8 Remote Data Terminal at recent NCTA CLI seminars.

Ask CLIDE

The Telecommunication Products' CLI software "CLIDE" is a menu-driven tool for managing signal leakage data. Its screens guide the user through all data gathering and entry processes while the program is capable of converting, calculating and analyzing the database to produce all the necessary forms and reports. Its operation appears smooth and effortless.

The CLIDE program requires an IBM PC/XT/AT computer (or one that is fully compatible) with 640K RAM, MS-DOS, version 2.0 or higher, a hard disk drive with a single floppy diskette, and an 80 column printer.

Given the importance and value of signal leakage data, cable systems need to consider ways of protecting themselves from the loss of data because of power surges or failures. One method is stream-tape systems that provide continuous back-up files on magnetic tape. These systems can be costly, up to $10,000, but are failsafe.

But, short of being totally failsafe, data should be backed-up periodically and regularly. Russell of Telecommunication Products advises backing-up data at least daily. The company, which also markets computer-controlled ad insertion products, developed a simple technique for creating back-up data files that require as little as a half-hour's time per day. Called Back-Pack, the technique is not a program but, rather, a concept or set of instructions for quickly accomplishing the task. According to Russell, the company will entertain inquiries about Back-Pack from systems concerned about signal leakage data storage and protection. ■

—*George Sell*

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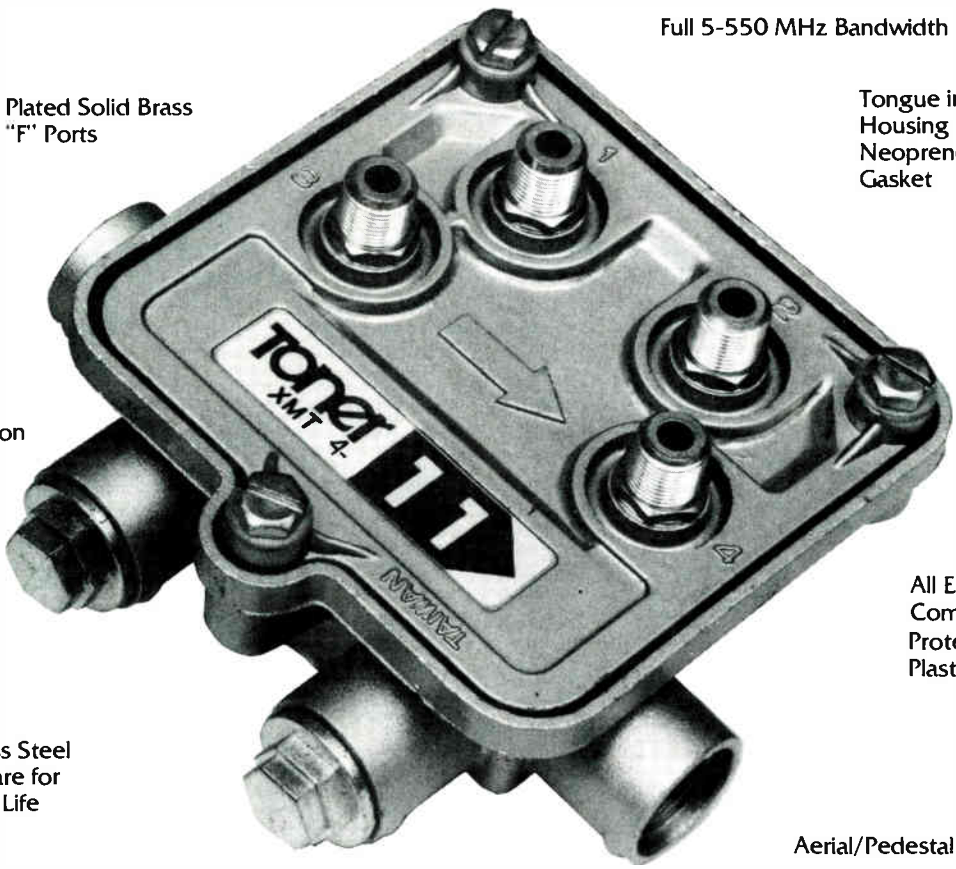

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Advances in CLI flyover measurements: the helicopter

Figure 1

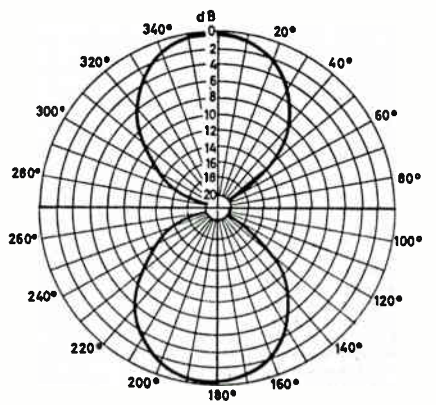
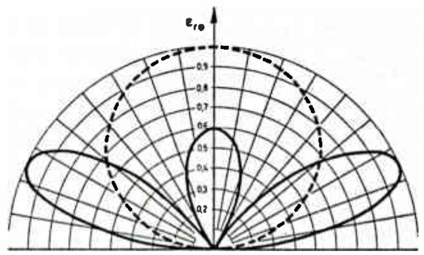


Figure 2



During 1988 many CATV systems were leakage tested, using ground survey as well as fixed wing aircraft flyover testing methods. Engineers and field technicians, however, experienced difficulties when trying to correlate the flyover test data with the ground survey results because of problems associated with distorted antenna radiation patterns, the high cruising speed of the aircraft and limited vertical visibility.

Rotary wing aircraft (helicopters) can significantly improve CLI flyover test results.

Following is a description of the advantages of the helicopter survey, such as the application of antennas with good front/back ratios and high directivity, better control of the antenna's radiation pattern, leakage identification by the triangulation method and advantages of the perfect vertical visibility from the helicopter cockpit.

By Steven I. Biro, Biro Engineering

Test antennas and radiation patterns

Aircraft have large reflective surfaces which can significantly affect the radiation pattern of the test antenna, as explained below. Figure 1 is the radiation pattern of the half-wavelength dipole taken at the test range under "open space" conditions.

When the same half wavelength dipole is mounted approximately 0.35 wavelength from a large reflective surface, the radiation pattern breaks up into a multi-lobe configuration (see Figure 2.) The amplitude and angle of the side lobes are a function of the spacing between the dipole and the reflective surface as well as the shape of the metal body.

Figure 3 shows the CLI flyover test dipole mounted on the bottom of the fixed wing airplane, less than 0.25 wavelength from the fuselage. The net result is a diffuse, multi-lobe pattern configuration similar to that of Figure 2.

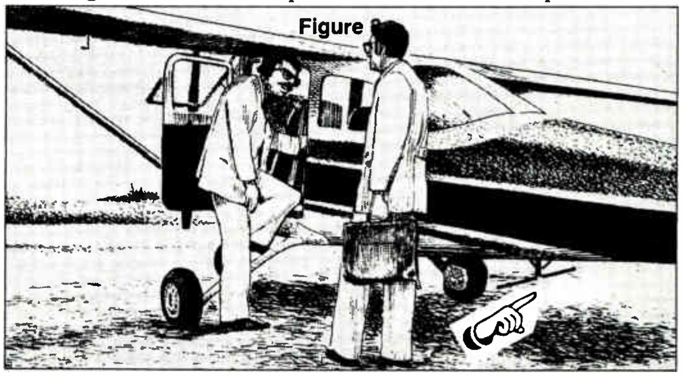
No standard procedure

There is no standard procedure to eliminate interaction between the test antenna and the aircraft fuselage. However, it is obvious that a multi-element antenna, mast-mounted in front of the helicopter, (Figure 4) is considerably removed from the airframe. Consequently, the radiation pattern of the high directivity antenna remains practically intact.

The application of a multi-element, high front/back ratio antenna, such as the log-periodic antenna of Figure 5 can further reduce, although not completely eliminate, the mutual coupling between the antenna and the airframe behind it. The good directivity of the multi-element log-periodic aerial, the single main lobe, and the reduced side lobes make the antenna the perfect tool for pinpointing the leakage source with the triangulation method.

Figure 6a displays the radiation pattern of the log-periodic antenna in open space. The helicopter mounted antenna's radiation pattern (Figure 6b) is skewed and wider, but still superb compared to the radiation pattern of a

Figure 3



Test dipole mounted on the bottom of the airplane

Figure 4

Multi-element antenna mast-mounted to helicopter

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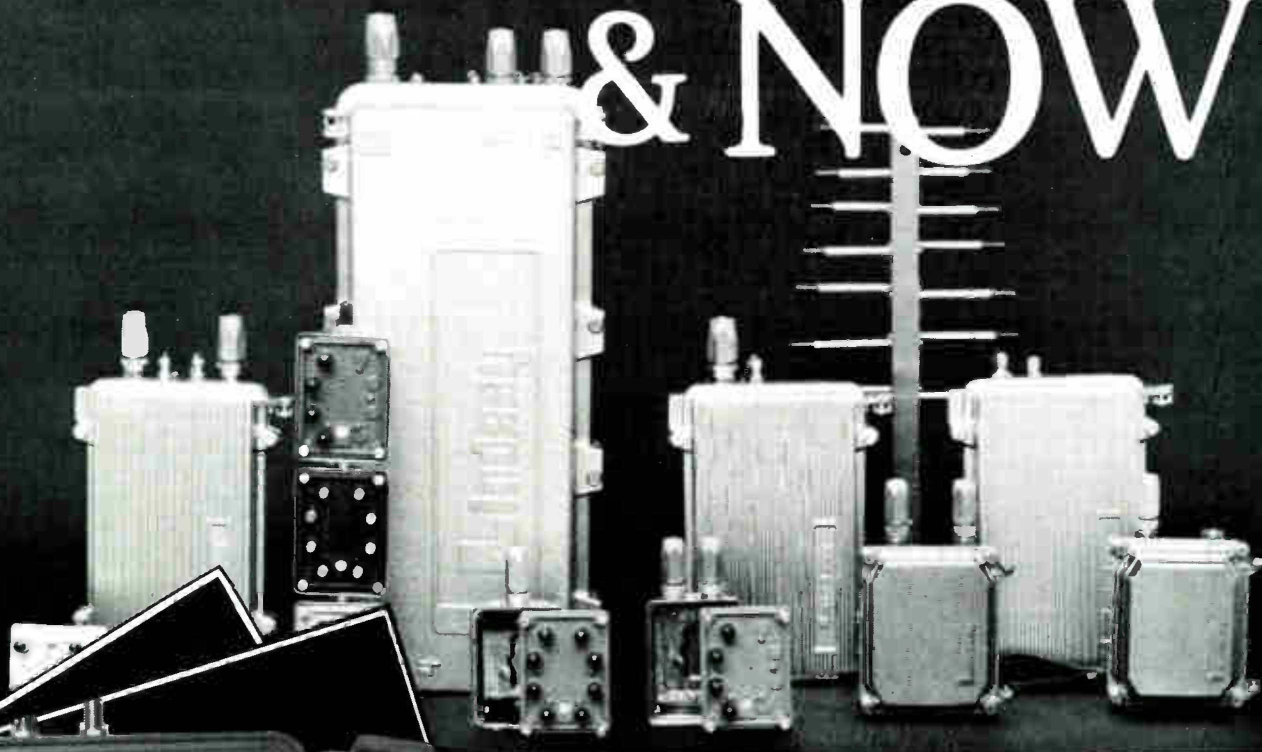

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Figure 5

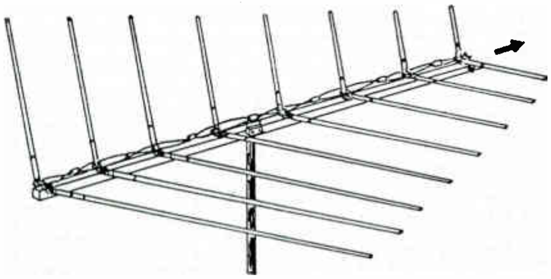
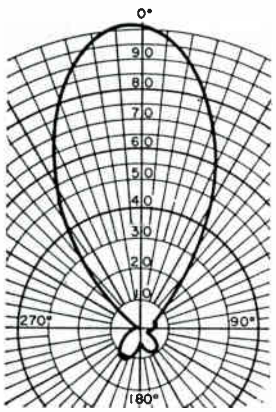
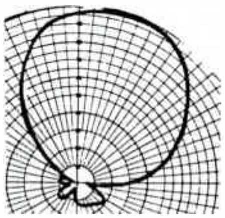


Figure 6



(a) **(b)**



single dipole hung on the bottom of the fixed wing aircraft, as shown in Figure 2.

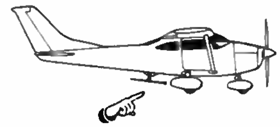
While the multi-element test antenna is always coaxially mounted on the helicopter, the dipole on the bottom of the fixed winged airplane can be either cross-mounted (Figure 3), or coaxially attached as shown in Figure 7. Considering the high cruising speed of the fixed wing airplane, pilots prefer a coaxial dipole installation. That however, further reduces the efficiency of the flyover CLI testing as explained below.

Figure 8 is a reproduction of the dipole's radiation characteristics. Signals from the front, the direction of travel, will not be received since the radiation pattern has a deep null in that direction. The signal pick-up is limited to the sides. Unfortunately, the symmetrical radiation pattern cannot provide a definite answer as to which side.

Vertical visibility and cruising speed

From the fixed-wing airplane's cockpit the view is limited to the side and front of the aircraft. Neither the pilot

Figure 7



nor the CATV engineer is in a position to observe the terrain below. To circumvent the problems associated with the missing vertical visibility, the fixed-wing airplane CLI flyover adapted the LORAN controlled signal recording technique. Yet, this enthusiastic reliance on chart recorders has been disappointing. The recorder cannot differentiate between desired and spurious signals. For the recorder, every re-

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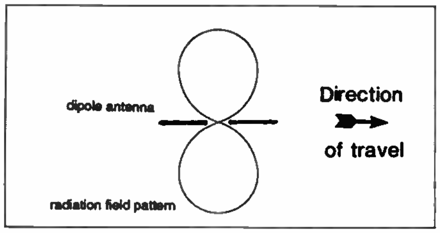
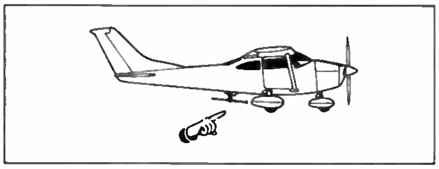
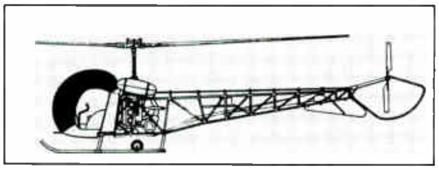


A dipole's radiation characteristics



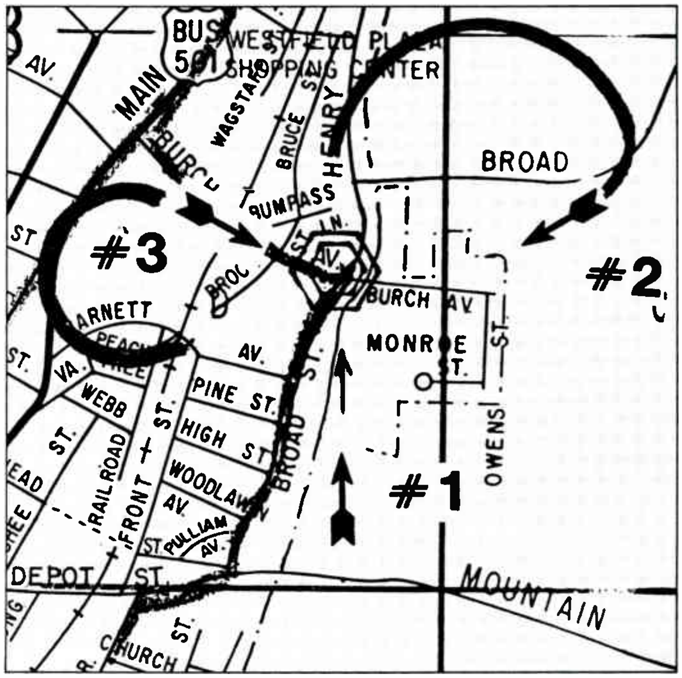
Airplane with limited visibility



Helicopter with high visibility

ceived aeronautical transmission on the test frequency, every harmonic of high power two-way radios and CB transmitters, any AC interference from high voltage transmission lines, or even static is a potential leakage signal. This is the same problem experienced in the early days of ground type leakage surveys, when the test carrier was unmodulated or the volume control on the signal level meter had been turned down.

During the helicopter flyover the pilot and the test engineer enjoy perfect vertical visibility. Cruising at a modest speed of 30 to 35 miles per hour, they can visually follow highways and avenues, or locate apartment complexes and high rise buildings. Last but not least, the engineer can conveniently and reliably read the instrument, watch for the presence of the 1000 Hz tone-modulated test signal, record only the real leakage occurrences, and eliminate the spurious beat observations. A receiving antenna at an elevation of 3,000 feet above ground can pick up an enormous quantity of aeronautical transmissions, which, if unchecked, can skew the test results.



Leakage detected by triangulation, or two sharp turns over the source.

Finding leakage by triangulation

After confirming the existence of the leakage during the CLI flyover, wouldn't it be nice to identify and pinpoint the source of leakage? The high cruising speed and limited turn-around capability of the fixed-wing airplane, compounded with the diffuse radiation pattern of the half-wavelength dipole make the identification impossible.

The helicopter approach, on the other hand, is eminently qualified for that assignment. The helicopter can turn quickly in a small circle, and drop to a much lower altitude in seconds. The highly directive, mass mounted antenna is ideal for leakage source direction finding purposes.

Figure 11 shows the triangulation directions during the flyover. Readings taken from the widely separated areas and directions may be considered time consuming, but the results are definitely beneficial.

In another case, the same triangulation technique was used, except that the helicopter was flying at 500 feet above ground due to relatively weak signal leakage. ■

RF leakage testing using a simple test chamber

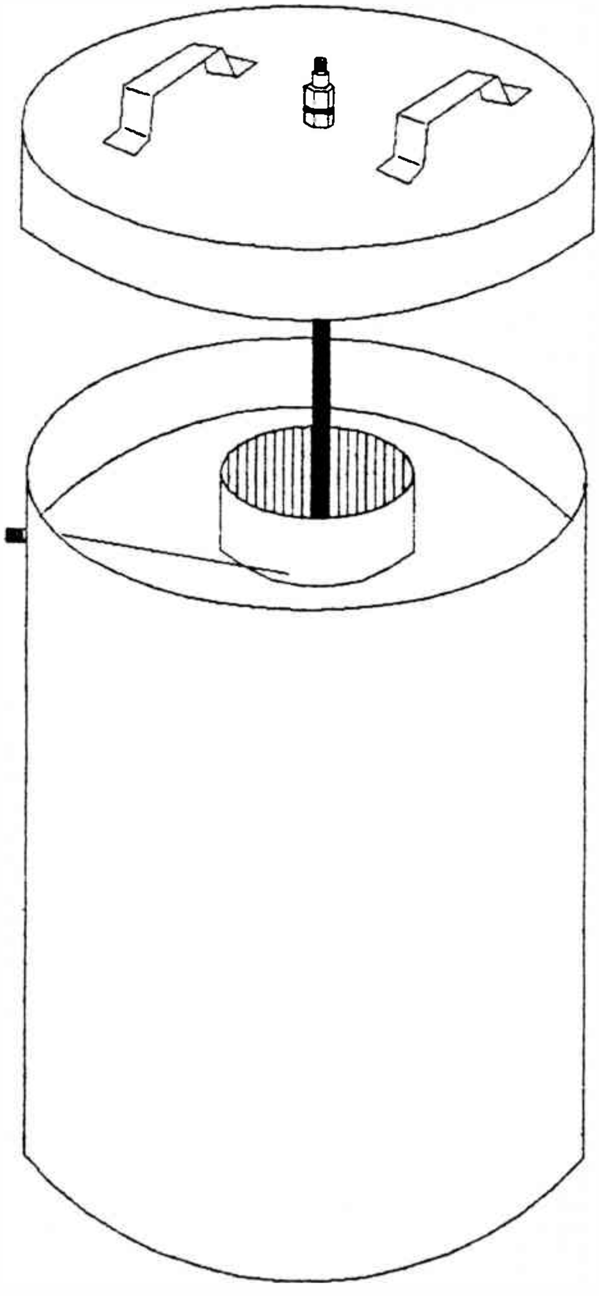
In an era of new system upgrades and re-franchising just around the corner, system engineers should be aware of the new FCC provisions of Sec. 76.611 which becomes effective July 1, 1990. In part, the provision will require that no system is to operate in the frequencies of 108 MHz to 137 MHz and 225 MHz to 400 MHz unless such system is in compliance with signal leakage performance criteria established by Cumulative Leakage Index (CLI). The criterion is based on two types of tests, in which either one test satisfies the other.

Measurement methods

The first is ground measurements, which we are more familiar with, and the second is a 1,500-foot flyover above average terrain. For an average sized system, flyovers can be done within a few hours. Its downsides are the inability to accurately locate the origin of a leak, lack of immediate repair, and the cost of specialized equipment including a plane, a pilot and a daring CATV engineer. In addition, maintaining average flyover altitudes over sharp changes in terrain levels, skyscraper MDUs, and restricted flight areas can abate the CLI accuracy.

Furthermore, ground surveillance will still be required in the problem areas to correct RF leaks. Ground surveillance, on the other hand, can pinpoint egress and be rectified with immediate remedial action. However, ground surveillance is not without its downsides either—it takes much more time to cover 75 percent of the system, which could take days, weeks, or even months. In general, the flyover might be seen as an instantaneous measure of CLI at any given period. If flyovers can be coordinated with the regular ground leakage surveillance team, CLI measurements can be as routine as a sweep maintenance program.

By John Gutierrez, ComNet Engineering Co.



RF test chamber

RF leakage is an inherent characteristic of any CATV system, and this includes Local Area Networks (LANs). Broadband LANs are not specifically named in the provisions of Sec. 76.605(a)(12) probably because RF LANs weren't around at the time of the writing of the regulation. The first of the interactive broadband LANs were designed as mid-splits, which are not active within the FAA communication frequencies of 108 MHz to 137 MHz region, the prime intent of the FCC Part 76 for CATV mid-band use.

Nevertheless, RF LAN owners have complied with the provision by *de facto* adoption. Today's modern RF LAN systems are designed as a dual cable or high-split architecture and have use of the active FAA frequency designations. By design, it would also appear that LANs may also be embraced by the Sec. 76 provision including any other type of RF cable communications system using the same aforesaid frequencies. While issues and consequences of CLI are better left to another treatise, our focus will be how to test broadband components for RF leakage as an initial step to assure CLI compliance.

The SEED chamber

During the 1970s there was a lot of hoopla about building sophisticated broadband CATV networks having "megachannels," pay-per-view, remote meter reading, institutional networks (I-Nets), etc. While MSOs marketed and vied for large franchises, engineers were coming to grips with the technical problem of return path signal corruption due to RF ingress, let alone return amplifier noise and distortion accumulations. In this instance, a major MSO, UA-Columbia (at the time), realized that CATV components would have to be evaluated for their shielding effectiveness prior to a purchase decision.

By selecting RF components with high shielding characteristics, system RF ingress and leakage could be minimized by design. Many hardware vendors often claimed high shielding effectiveness, but the RF chamber quickly weeded out unacceptable components. CATV hardware components tested were drop cables, connectors, traps, miniature splitters, taps, line passives and limited headend equipment.

RF testing was done by using a custom built RF test chamber patterned after the Belden SEED™ (Shielding Effectiveness Evaluation Device). The Belden SEED was specifically designed to test the shielding effectiveness of braided coaxial cables. Although the Belden SEED is a 50-ohm device, 75-ohm CATV drop cable could be tested using special adaptors. The major downside of the Belden SEED was that it was physically impossible to test DCs, taps, connectors, pay traps, and other large physical signal passing components. What was needed was an RF test chamber to test RF components in a SEED-like chamber.

It was the late George Fishman, when at UA-Columbia, who engineered and built a version of the Belden SEED, transforming its appearance from a small ominous missile into an oversized "garbage can" often jeered at as a Smoky Mountain distillery. Having an opportunity to work with George and seeing his unusual RF test chamber really work, you may wish to build this device to test CATV components for shielding effectiveness.

Constructing the chamber

The test chamber construction and dimensions are shown in Figure 1. The chamber stands 46 inches high and 28 inches in diameter. In reality, the chamber is nothing more than an oversized 75-ohm air dielectric coaxial cable. The outer chamber wall is constructed of 26 gauge sheet metal. The rolled ends and bottom are sealed by solder. The removeable top lid is designed to fit snugly enough to eliminate outside RF fields from being picked up by the center conductor.

The entry connector on the removable lid should be an 'F' female to .500-inch aluminum cable of about 20 inches in length. The other end of the aluminum cable will be the device under test (DUT). You will also need assorted .500-inch connector adaptors. The center conductor of the test chamber is made from an eight-inch diameter duct sheet 40 inches in length and is held suspended by two ¾-inch plywood disks. The center conductor should be suspended three inches away from either end of the chamber. The center conductor collects RF radiation from the DUT and is attached to an F-81 barrel mounted in the outer shell.

RF Test Chamber Diagram

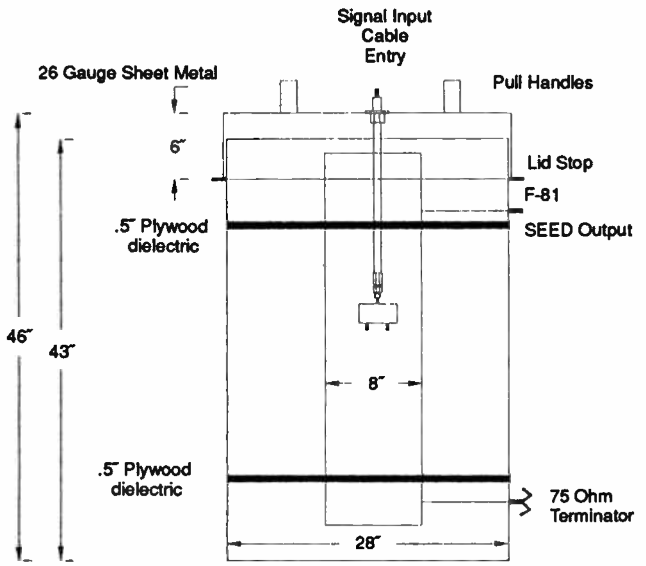


Figure 1

This is the RF output of the test chamber. Chamber termination is provided by a lead attached to the bottom of the center conductor into an F-81 barrel which is also mounted to the outer shell and terminated by a 75-ohm terminator. Both leads to the center conductor are soldered.

> It was the late George Fishman who engineered and built a version of the Belden SEED.

Set-up and testing

When properly constructed, the chamber should isolate outside RF fields by better than 120 dB. The chamber provides highly repeatable analysis of shielding effectiveness within ±3 dB over a 1 MHz to 600 MHz range. Physical location of the chamber is not critical. Testing is pretty straightforward and no calculations are required other than adding the gain of the post amplifier to the measured levels.

Figure 2 shows the test set-up. The test equipment required will be a spectrum analyzer with either CRT beam storage or with a peak hold write function. An RF tracking generator with an RF output level of 0 dBm (+48.75 dBmV). Non-storage spectrum analyzers are not recommended because of the slower than usual horizontal time base speed used. Most tracking generators have a 50-ohm output impedance and will require a 50 ohm-to-75 ohm converter.

The RF tracking generator produces an exact corresponding output frequency as the spectrum analyzer sweeps across its bandwidth. An alternative to a tracking generator is to use a leveled CW/sweep generator, such as a Wavetek 1801C or equivalent. Since most CATV systems use the 1801 in the bench repair facility, the following test description will apply to the 1801.

A well shielded and low noise 40 dB gain amplifier (noise figure less than 6) is used as chamber post amplifier. A recommended post amplifier is a Wide Band Engineering A52/40 or equivalent. The purpose of the post amplifier is to increase the input sensitivity of the spectrum analyzer while minimizing the effects of internal noise contributed by the spectrum analyzer which can mask the leakage measurements. Depending on your spectrum analyzer options, an X-Y recorder can plot the test results. Some spectrum analyzers may have a printer port for recording the output. You can use a Polaroid type camera to record your tests.

Use quality materials

It is very important that the RG-6 test cables be of high grade and properly attached F-connectors be used. In personal experiences quad-shield cable was not always the best. It is recommended that Belden 9058 be used.

Before testing any components, you must first verify the RF integrity of your chamber construction. Terminate the RF signal input of the chamber. Set the spectrum analyzer reference to +60 dBmV at the top graticle. With the 40 dB gain amplifier connected between the chamber and the spectrum analyzer, the spectrum analyzer new reference level will now be +20 dB. That is, +20 dBmV at the post amplifier input would yield the 60 dBmV reference at the amplifier output. (If you use a spectrum analyzer with dBm's, setting it initially for a 0 dBm reference would now change to a -40 dBm reference.)

Set the spectrum analyzer start-stop frequencies from 1 MHz to 500 MHz (50 MHz/Div), i-f bandwidth of 10 kHz, video filter on, and sweep set to about 1 Div/5 or 10 seconds.

Assuming that you are set at 10 dB/Div and have 10 vertical divisions on your graticle, the bottom line would represent -70 dB below the reference level. Reducing the spectrum analyzer input attenuator by five notches (typically 10 dB/step) results in the bottom line on the graticle to now represent a -120 dB below the reference level. A well constructed chamber should offer greater than 115 dB of isolation.

If you experience difficulty achieving this expected isolation, focus your attention on the lid not making a good seal. The main cable entry or the F-81 barrels can also cause the problem. All nearby FM and TV stations should be unmeasurable when the RF chamber is well sealed. Use aluminum foil duct tape to seal around the chamber entry locations.

Verify system tightness

The next step is to verify that the .500-inch cable connections do *not* leak. Terminate the DUT end of the .500-inch cable and close the chamber. Connect the RF generator directly to the spectrum analyzer input. Set spectrum analyzer reference for +60 dBmV at the top graticle line, then set the output level of the generator at +60 dBmV. Some fine tuning of the generator's attenuator may be required to set the level at the top line. Set the 1801 for line sweep and adjust the sweep width to fill the desired bandwidth edges. Remove the generator output lead from the spectrum analyzer and connect the lead to the chamber signal input. Connect the spectrum analyzer to the chamber's post amplifier, and reduce the input attenuator of the spectrum analyzer by 50 dB. Be sure to use the scope's storage mode. If all is well, you should see the same response seen in the pre-test above. If not, check your connectors— *they must be wrench tight!*

To test components in the chamber, let's assume you will test a two-way house type splitter. Attach the splitter to the .500-inch cable using appropriate fitting adaptor(s). Make sure the output legs are properly terminated and wrenched down snugly.

Using the same equipment settings described in the paragraphs above, you should see the effects of component radiation. As a general rule, any new component having a measured shielding effectiveness of greater than 90 dB should be considered acceptable. Any component with less than 60 dB of RF isolation should be absolutely ruled out. It was interesting to observe the test results of distribution taps that do not use the RF mesh gasket and house splitters that don't use conductive epoxy.

Why test for shielding effectiveness?

By using the test chamber, you will be in a better position to choose your RF components wisely and to obviate future RF leakage problems. In addition, you will be able to offer your vendor welcomed technical improvements. If you are planning to upgrade your present system, you can use the RF chamber to test presently used components for possible continued use. You'll get a first hand observation of the importance of good cable installation practices for a signal tight system. Feeder distribution and subscriber drops account for about 80 percent of total radiation discrepancies found. With the new FCC provisions regarding CLI just around the corner, it seems to make good sense to begin a QC evaluation program as an integral part of your CLI reporting. ■

RF Test Chamber Set-Up

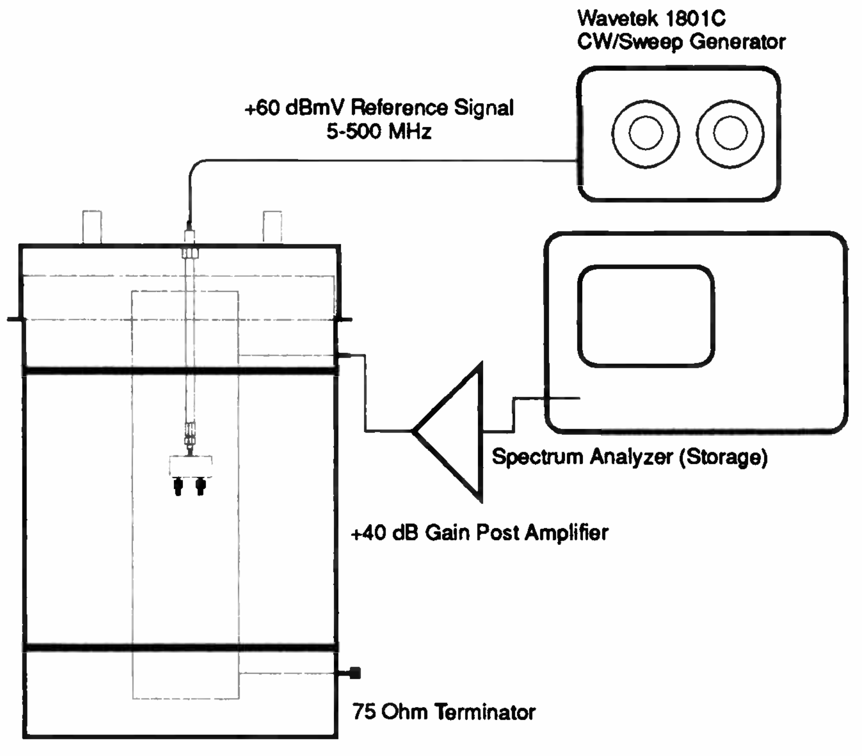


Figure 2

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WHAT'S AHEAD

SCTE

February 15 *The Florida Chapter, South Florida Group* will present a technical seminar on "System Design and Powering." The chapter will also review BCT/E Category II. Call Dick Kirn, (813) 924-8541, for details and location.

February 15 *The Delaware Valley Chapter* will meet at the Williamson Restaurant, Route 611 and Blair Mill Road in Horsham, Pa. The meeting discussion will focus on "Developing in-house training programs." Call Diana Riley, (717) 764-1436 for info.

February 22 *The Great Lakes Chapter* will host a technical seminar. Call Daniel Leith, (313) 549-8288, for info on place and subject matter.

February 22-24 *Texas Cable Show*, San Antonio, Texas. The SCTE will sponsor technical sessions and administer BCT/E examinations. Call the Texas Cable Television Association, (512) 474-2082, for info.

February 25 *The Rocky Mountain Chapter* will host a technical seminar at the ATC National Training Center, 2180 S. Hudson St., Denver, Colo. The topic will be "Installation Troubleshooting" and will include both lecture and hands-on demonstration. Call Rikki Lee, Media Director, (303) 792-0023.

February 28 *Satellite Tele-Seminar Program* will be a review course for BCT/E Certification Category VI (terminal devices) featuring William Cohn and Mike Long of Zenith Electronics Corp. The program will air from noon to 1 p.m. Eastern time on Satcom F3R transponder 7.

March 12-14 *Razorback Chapter* will sponsor a technical seminar at the L'ARK Show, Convention Center, Hot Springs, Ark. Topics include: "Sweep Systems" with Terry Bush of Wavetek, "Terminal Devices" with Jim Farmer of Scientific-Atlanta, "Signal Leakage and CLI" with Tom Polis of Communications Construction, and "Satellite Signals" with Paul Beeman of Viacom Networks. BCT/E examinations will be administered in all categories. Call Jim Dickerson, (501) 777-4684, for info.

C-COR ELECTRONICS INC

February 21-23 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.

February 21-23 *C-COR Electronics Technical Seminar* will be held in Charlottesville, Va. Call Teresa Harshbarger, (800) 233-2267 Ext. 326, for details or to register.

March 21-23 *C-COR Electronics Technical Seminar* will be held in Orlando, Fla. Call Teresa Harshbarger, (800) 233-2267 Ext. 326, for details.

ncta

February 14-15 *The NCTA CLI seminar* will be held at the Atlanta Airport Hilton. The seminar focuses on signal leakage and compliance with the FCC's cumulative leakage index (CLI) regulations. Call the NCTA Science and Technology Department, (202) 775-3637, for pre-registration.

TRADE SHOWS

February 13-14 *The Georgia Cable Television Association* will hold its annual convention at the Omni International Hotel, Atlanta, Ga. Call the GCTA, (404) 252-4371, for info.

February 22-24 *The Texas Cable TV Association* will hold its 29th annual convention and trade show in San Antonio, Texas. Call (512) 474-2082 for details.

ASU

February 27-March 1 *Arizona State University* will hold a seminar in Tempe, Ariz., on Fiber Optic Communications. The seminar is designed for technical personnel who require an understanding of optical waveguide communications. Demonstrations and lab sessions are included to allow for hands-on experience. The course fee is $795. Call the Center for Professional Development, (602) 965-1740, for info on program content or enrollment procedure.

ComNet

March 8-9 *ComNet Engineering* is sponsoring a seminar at the Marriott Airport Hotel, Austin, Texas, which focuses on the technical aspects of broadband theory pursuant to 802.7, MAP/TOP, and NCTA standards. The seminar is intended for technicians and engineers involved with the design, analysis, or maintenance of broadband systems. The fee is $795. Call John Gutierrez, (512) 892-2085, to register or for additional info.

CED

Please send your schedule of events to:

CED Event, 600 S. Cherry Street, Suite 400, Denver, CO 80222, (303) 393-7449.

C-COR demonstrates its fiber-to-coax amplifier

C-COR Electronics has announced a conceptual model of a fiber-to-coax amplifier. C-COR's objective for exhibiting the product at the Western Show in December was to determine industry requirements in a fiber-to-coax amplifier and to evaluate the response to its product. The optical bridger station, which will probably be an AM modulated product, will convert light to RF. Current plans are to integrate status monitoring into the product along with a low frequency return path to eliminate the need for a reverse amp. C-COR has not quoted a delivery date.

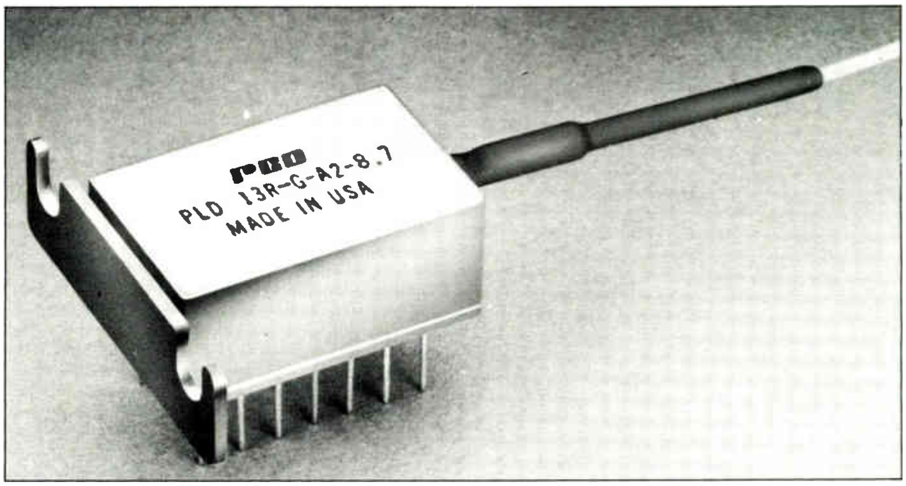
Keeping future needs in mind, C-COR is also looking at the possibility of incorporating a transmitter and receiver into the product to allow for light-to-light as well as light-to-RF capabilities. This would enable the amplifier to have a truly redundant optical path with intelligent switching. Development work is continuing on both FM and AM modulation. For more details call (814) 238-2461.

In other fiber-related news, **Norland Products Inc.** has introduced the Norland Fiber Acceptance Test Kit for testing optical fibers. The test kit uses

Norland Products fiber test kit

a one-meter pigtail connector and Norland UVC optical splices to attach bare fibers to test equipment. This enables a fiber acceptance reading to be made within seconds with any OTDR or test meter.

Applications such as cable acceptance testing and fiber continuity testing can be done using Norland's test kit. For more details call (201) 545-7828.



PLD-1300R RWG (ridge wavelength) laser diode module from PCO

PCO Inc., a subsidiary of Corning Glass Works, announced a ridge waveguide (RWG), single-mode laser module, the PLD-1300R. The module features RWG construction and consists of a InGaAsP laser diode and a rear facet InGaAs PIN diode to monitor the laser's output. The laser diode is coupled to a single-mode fiber by means of a special PCO-designed lensing system. Nominal output power into single-mode fiber is 300 microwatts. This coupling system maintains stable operation over a temperature range of 0 to 60 degrees centigrade without need for thermo-electric cooling. Delivery of volume quantity is scheduled for the first quarter of 1989. Call (818) 700-1233 for more info.

Philips demos HDTV

The first demonstration of high definition television (HDTV) hardware for U.S. satellite transmission has been shown by **Philips Laboratories**. Demonstrated in New York to the technical press, the Philips HDTV system, known as HDS-NA (High Definition System for North America), is compatible with existing television in the U.S. The system is characterized by wide screen capability (16:9 ratio), delivery of 1,050 lines of television information per frame time, transmission of video signals without introduction of motion artifacts and compact disc digital audio sound.

The Philips HDS-NA system is designed to accommodate all modes of television transmission including broadcast, cable and satellite. It uses no frame store for signal processing, requires only a single conventional FSS or DBS transponder, and uses simplified hardware. Philips will begin field testing the HDTV satellite feeder signal in 1989 as part of a joint effort with Hughes Communications, a subsidiary of Hughes Aricraft Company. For details call (615) 521-4499.

Qintar AVM-7060 agile modulator

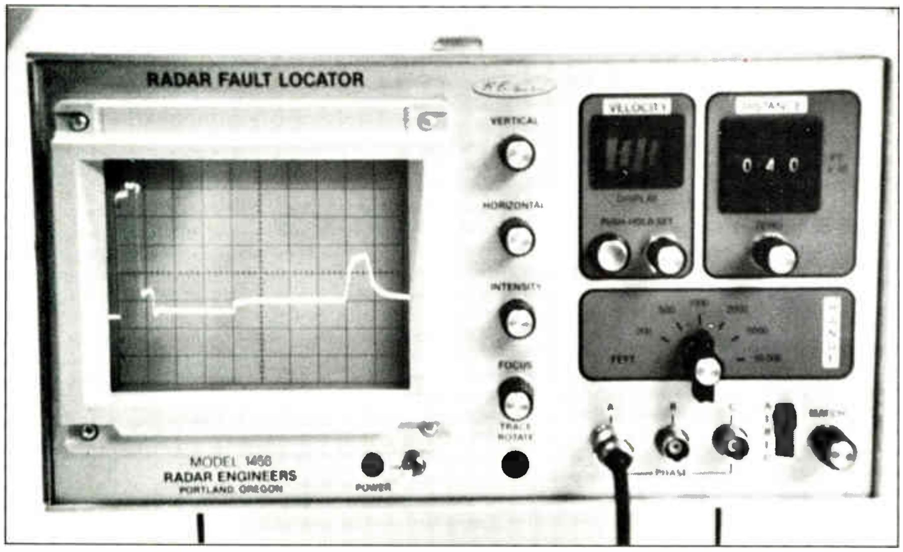
Closer to home

On more familiar thoughts, **Qintar Inc.** has introduced the model AVM-7060 frequency agile audio/video modulator with adjacent channel compatibil-

R.L. Drake Co.'s 40-degree LNB

ity. Fully agile, the AVM-7060 offers output channel selection of VHF 2 through 13, midband A through I, superband J through W, A-1 through A-6, and hyperband AA through WW. Also offered is a front panel FCC offset switch for FCC required 12.5 kHz or 25 kHz offsets and a rear panel switch for standard, HRC and IRC offsets. The AVM-7060 delivers a full +60 dBmV output. For additional information call (800) 252-7889 or (805) 523-1400.

The **R.L. Drake Company** offers a new 40-degree low noise block converter (LNB) which uses high electron mobility transitor (HEMT) technology to capture weak signals. The C-band LNB receives incoming satellite signals with frequencies of 3.7 GHz to 4.2 GHz and converts them to the intermediate frequency range of 950 MHz to 1450 MHz that's accepted by the block satellite TV receiver. With the new unit, priced at $229, Drake now offers a complete line of LNBs, including 60-, 50-, and 40-degree models. Call (212) 686-2666 for more details.



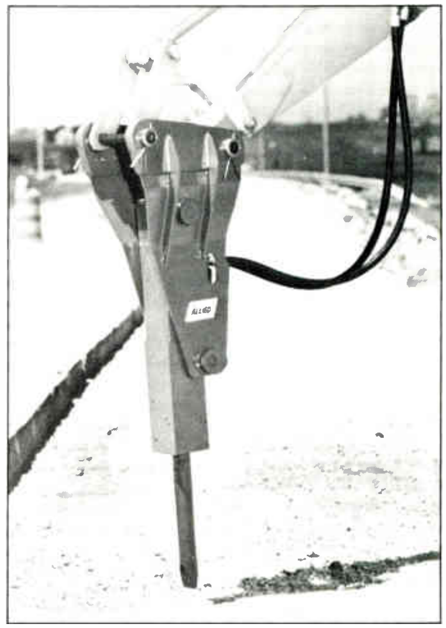
Radar Engineers' Model 1456

Designed to locate faults in buried primary cable, **Radar Engineers** has introduced the Model 1456 Radar Fault Locator. A 3¼ X 4-inch CRT permits viewing in the field of the cable trace, and the propagation velocity factor is shown on a liquid crystal display. A range switch allows selection from 200 to 10,000 feet of cable length, with pulse width automatically optimized with each range. The Model 1456 operates on AC power with an optional DC power supply. For more info call (503) 256-3417.

Viewsonics has introduced the Drop Expander Amplifier as a way to solve long drop, new drop or increased TV set loading without breaking into house outlets. The power adapter uses the 30V or 60V power available at one of the unused two line ports at the tap and the signal from the "F" tap port. Eight models are available with 10 dB and 20 dB gains and some with self-contained four-way splitters. Prices start at $29.50 each. Call (800) 645-7600 for details.

Allied has added to its range of light duty hammers with the Model 715 and 725 Hy-Rams. The hammers mount on skid steers, mini-excavators and rubber tire backhoes for various breaking applications. Both hammers feature Allied's hydraulic design and a nitrogen gas charge, allowing the hammers to operate using a minimum of oil fed by the carrier pump. The model 715 is rated in the 550 ft. lbs. impact energy class, while the 725 Hy-Ram is rated at 750 ft. lbs. For more info call (216) 248-2600.

For convenient message-taking, **Interface Technology Inc.** has introduced NotePad to its interactive voice response system, Cable-IT. Subscribers and technicians dictate messages to NotePad when all available customer service representatives (CSRs) are busy or the office is closed. Using a recording method, Cable-IT digitizes and stores messages for later transcription and action. NotePad provides 24-hour service to all callers. For details call (314) 434-0046.

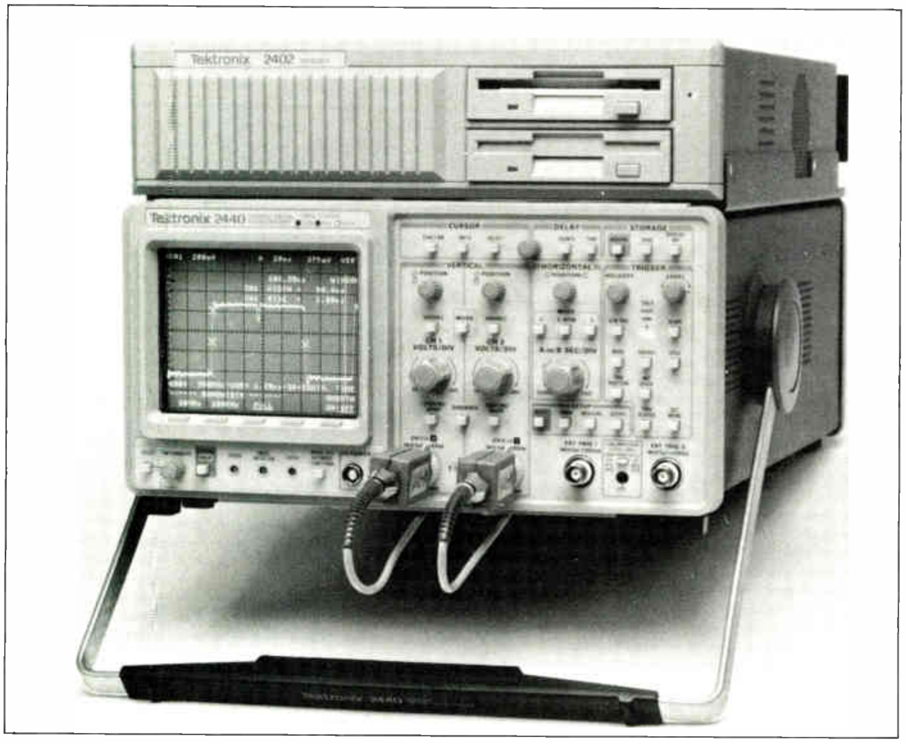


Allied's Hy-Ram® Model 715

Testing, testing

Not to be forgotten, many of the test equipment manufacturers are introducing new and improved methods to check system reliability. **Tektronix Inc.** has announced the 2402 TekMate, a software and hardware product that offers waveform processing, storage, and communication capabilities. When linked with any Tektronix 2400 Series digital oscilloscopes, the 2402 lets users perform waveform analyses and store over 500 waveforms, logging date and time information with the waveform data. The 2402 TekMate is compatible with all 2400 Series digital oscilloscopes, including the 300 MHz, 500 MS/s 2440. Users can make immediate waveform comparisons, establish pass/fail waveshape tests or view derived functions, such as FFT, on the scope screen. For details call (800) 426-2200.

A new spectrum analyzer with built-in digital-radio test functions has been developed by **Hewlett Packard**. The HP 8592A Option H52 covers 50 kHz to 22 GHz frequency ranges, with the option to extend the frequency to 25 GHz. The analyzer has four built-in agency masks (limit lines for measurement results) available in 4 GHz and 6 GHz for the U.S. and 13 GHz for the



Tektronix Model 2402 Tek Mate

United Kingdom and West Germany. HP 8592A Option H52 also is capable of storing up to 12 additional custom, user-created masks.

The digital-radio analyzer offers a transient-analysis monitor mode that records any significant (>35 kHz) frequency shifts in the transmitted digital-radio signal; a frequency-response measurement that allows a signal to be established as a reference on the display; the ability to create custom masks at one frequency for use in another; and the capability to send measurement results directly to a printer.

Also available from Hewlett Packard is an accessory module that adds 128 kbytes of internal memory to the HP 8561A and HP 8562A/B portable spectrum analyzers. The HP 85620A mass-memory module provides capabilities such as unattended operation and automated measurements without a computer. The module plugs into the rear panel of the analyzer and allows for storage and execution of downloadable programs.


H-P's mass-memory module

To help use test and measurement equipment in remote locations, Hewlett Packard has designed a portable, self-contained, AC power supply. The HP85901A power source operates using an internal battery, an external battery or a 12-V DC supply. It produces AC power at either 115-V or 230-V output, and provides up to 200-W continuous and 230-W maximum power. Operating time typically exceeds one hour at 100-W continuous load. Call (800) 752-0900 for more info.

Offered by **Performance Cable TV Products** is the Model 1200 Performance Universal 12V Battery Tester. The battery tester determines the condition of deep cycle, high capacity storage batteries used in standby, uninterruptable and back-up power supplies. The hand-held tester shows the condition of a battery while it is subjected to an 80 ampere load for 10 seconds. The LED readout reveals the battery's internal impedance, determining its ability to hold a charge.

Regular testing of batteries is facilitated by two added features: pin jacks to accommodate an auxilliary voltmeter and an automatic timer which provides a reference for the tests. For details call (404) 443-2788.


H-P's portable power source

B&K-Precision, a division of Maxtec International Corp., has introduced an oscilloscope in the 60 MHz category. The portable Model 2160 offers 1 mV per division vertical sensitivity, V-mode for viewing two signals unrelated in frequency, dual time base and a unique curve-trace style component tester for out-of-circuit tests on a variety of components. The user can select from 22 calibrated sweep time ranges on the main time base and 19 cali-

Performance Cable TV Products' hand held battery tester

brated ranges on the delayed-sweep time base. Each sweep time range is fully adjustable between calibrated ranges. Call (312) 889-1448 for info.

People news

Alan B. Anixter retired at the end of 1988 as the first and only Chairman of the Board of **Anixter Bros. Inc.** Anixter Bros. was founded in 1957 by Alan and William Anixter. Itel Corp. acquired the company in 1986. Anixter Bros. surpassed $1 billion in sales for 1988 which was the final goal Mr. Anixter wished to see accomplished before retiring.

Scientific-Atlanta announced the creation of two business units within its broadband communications business division. **David Fellows** has been named vice president and general manager, distribution, headend and earth station systems. **Steve Nussrallah** is the new vice president and general manager, subscriber systems. Both are responsible for the marketing, research and development and field service for their individual units.

Chuck Merk

Bob Price of **BradPTS** has been elected to serve on the national board of the Society of Cable Television Engineers. Price, senior VP of BradPTS, will work out of Area 12.

Chuck Merk has joined the **Jerrold** subscriber systems division of General Instrument Corp. as vice president of engineering. Merk, who succeeds Anthony Aukstikalnis in the engineering position, joined the division in mid-November. Merk's background includes technical management positions with AT&T Bell Telephone Research Laboratories, Motorola, ITT Telecom, Star-Tel and Harris. Also within Jerrold, **Dave Wachob** has been named director of advanced technologies. Wachob will direct market research, strategic planning and business development for Jerrold's advanced technologies.

Zenith Cable Products, a division of Zenith Electronics Corp., has named **Robert G. Cunningham** as vice president of sales. Cunningham has been Zenith Cable Products' national accounts manager since 1987 and succeeds Charles "Chick" Eissler who is retiring at the end of the year.

Robert G. Cunningham

Two individuals have joined **Midwest CATV**, a division of Midwest Corp., in sales positions. **James Kazda** comes to Midwest from Magnavox CATV Systems. **Michael Cooke** also joins Midwest in their southern region. ■

—*Kathy Berlin*

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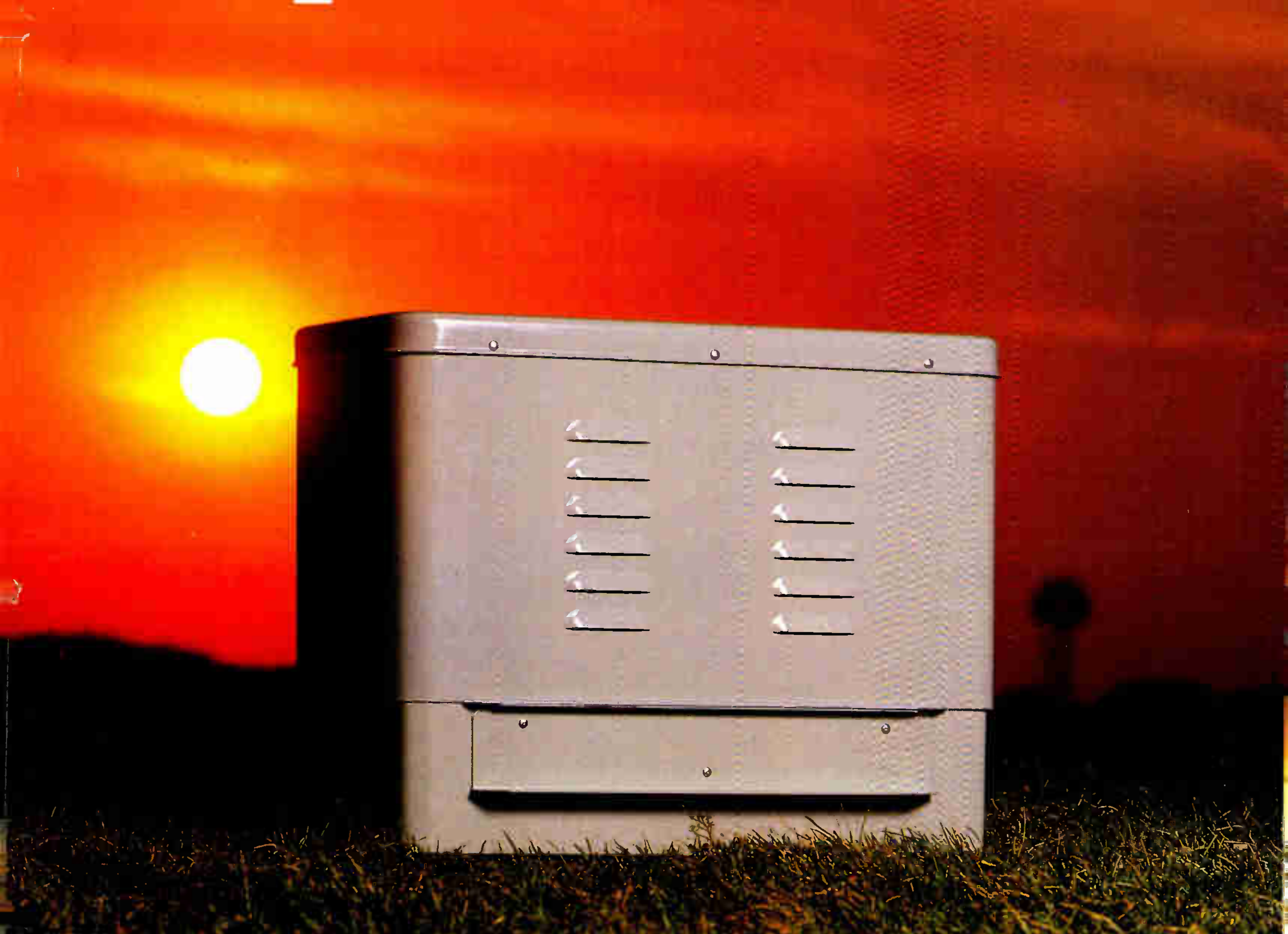

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The ANIXTER Fiber Optic Laser Link AM CATV System

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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

For more information, call the Anixter office in your area.

ANIXTER® CABLE TV

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