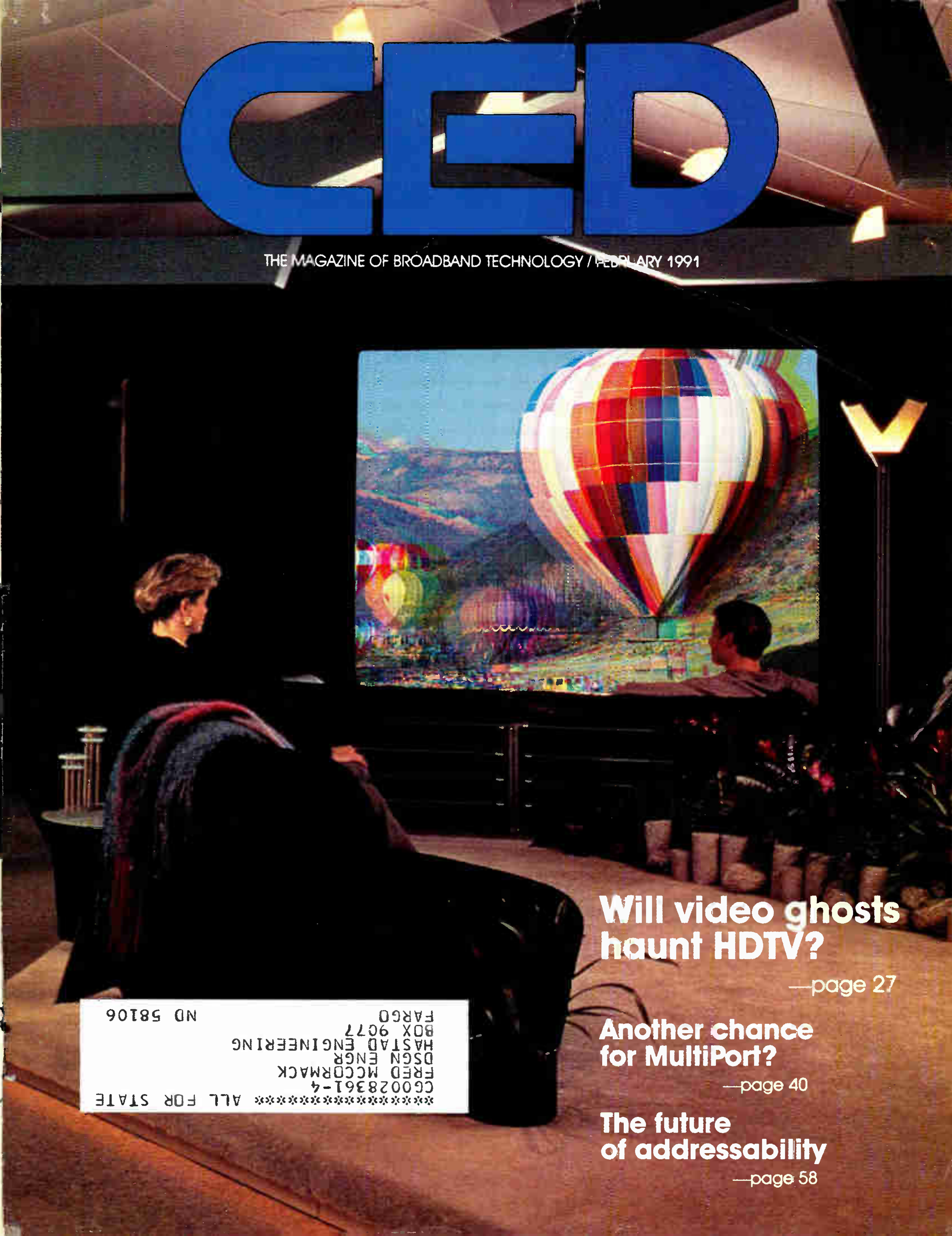

CED
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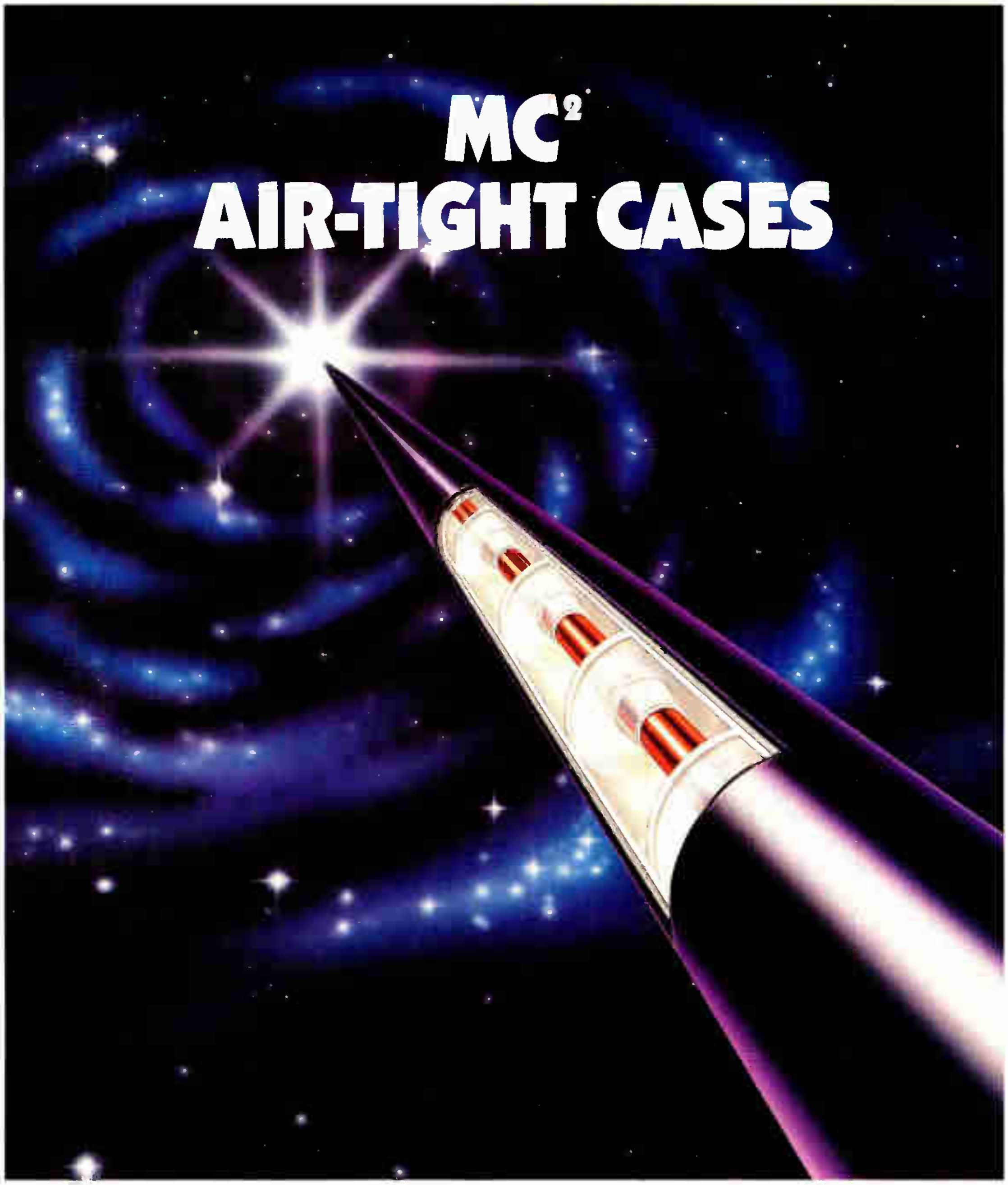

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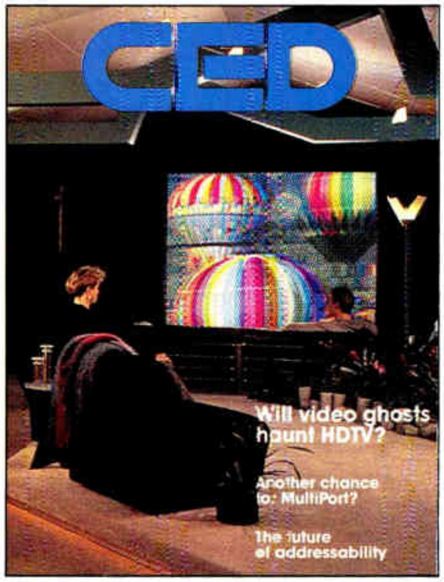

About the Cover:

Will the future of television still contain video ghosts?

DEPARTMENTS

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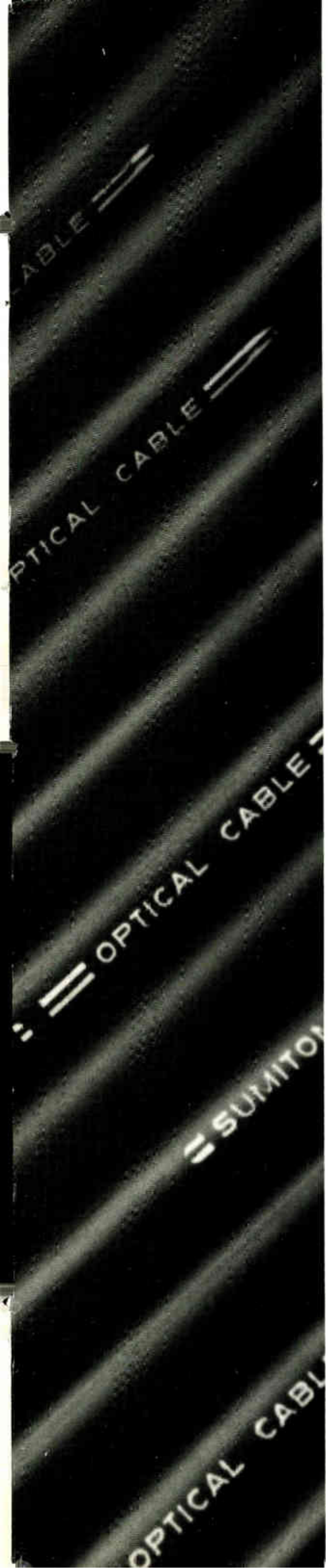

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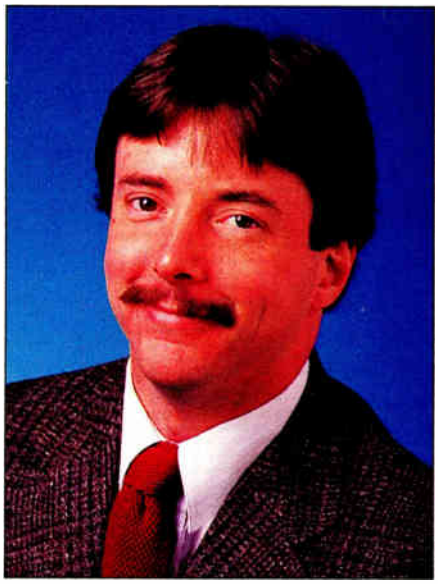
Reader Service Number 4

Take a look at the big picture

Remember the old saying: "Stop the world, I want to get off!" and how it seems so appropriate anytime you're faced with so many decisions and confusing advice? In many respects, cable TV engineers have to feel as though they're about to suffocate under the weight of new information becoming available regarding emerging technology.

Never before in the relatively short history of CATV has the pressure to make an informed, intelligent technology decision been more burdensome. A cable system facing a rebuild or upgrade in the next three to five years (which includes about 50 percent of the franchises granted in the U.S.) has to make sure that the course it chooses to follow doesn't eventually exclude it from important revenue generating options.



Gone are the days when cable systems can realize major growth simply by adding more plant. It's time for every operator to think about what he wants to be when he grows up. Data delivery, voice, teleconferencing, interactive television—they're all important pieces of the broadband communications puzzle that CATV will have to address. Eventually, probably within the next 10 to 15 years it won't even make sense to use "CATV" because the network will involve so much more than television.

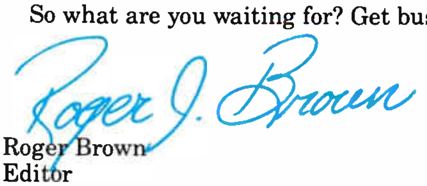
An important first step toward this evolution is fiber optic implementation. Judging from the written presentations and high level of audience interest in fiber optic seminars (the SCTE just concluded its third fiber conference and drew 575 people), it's clear operators are getting the message that optical communication is the way to go.

But the pace of product development is nearly impossible to keep up with. Operators are faced with multitudes of decisions, including: product supplier, architecture and wavelength. Add in the questions about off-premise addressability and consumer interfaces and it's a wonder anyone can rise above it all.

In fact, with all the promising technology poised to come out of the labs, many systems are wondering if it's smarter to wait a year before committing to a fiber rebuild. An informal survey prepared for the SCTE fiber conference showed a high level of operator concern relating to when a commitment should be made. Operators worry if they commit too early they'll miss out on some planned new benefit. It's the classic chicken-and-egg syndrome.

For those who didn't make it to Orlando to hear, the answer for those who fret is: get the fiber in the system. Yes, lasers are slowly getting better, but major new breakthroughs aren't likely. Yes, optical amplifiers are coming, but they simply extend the reach of a fiber system or allow for more splits. And yes, 1550 nm equipment is due soon, but 1310 nm gear is here today and offers its own list of benefits.

So what are you waiting for? Get busy!



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Reader Service Number 5

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VideoCipher plans module upgrade

Cable operators might ask why it's taken so long, but VideoCipher has finally publicly announced a new, mulitifaceted security program designed to deny access to programming by unauthorized viewers.

The General Instrument division last month announced plans for the introduction of "security smart cards" to its VideoCipher II Plus descrambler modules and has commenced discussions with programmers regarding eventual shutdown of first-generation VideoCipher II program transmission.

As reported a year ago in *CED*, the original VideoCipher II descrambling module has been plagued by widespread piracy, resulting in perhaps millions of unauthorized, non-paying subscribers. Industry observers estimate that only one out of four viewers of satellite programming is a legitimate, authorized buyer.

In response, VideoCipher developed and has begun shipping VideoCipher II Plus modules, which were designed to place a new, more sophisticated obstacle in front of the pirates. Many in the cable industry, however, wondered why it took so long.

Now, VideoCipher has designed CipherCard, a security smart card intended for descrambling modules. Approximately the size of a credit card, the card will be inserted into the descrambling module by the consumer. Each CipherCard will be unique and will work only with specific descrambling units. Significantly, the smart cards are renewable security devices that can be authorized and deauthorized by VideoCipher.

CipherCard, essentially a second generation of VC II Plus, will be manufactured in the fourth quarter of this year. Base modules delivered to licensed VideoCipher manufacturers next year will contain a slot for the CipherCard. However, distribution of CipherCards will occur only if the current VC II Plus system is compromised and programmers decide to migrate to a higher security level.

Another part of VideoCipher's program to enhance security is the eventual shutdown of the VC II transmission used today. Discussions with "several large satellite TV programmers" have been held, according to VideoCipher officials. A program calling for free upgrades to VC II Plus technology for current owners of untampered VC II units with active programming subscriptions are at the heart of the discussions.

And finally, VideoCipher announced it has increased its contribution to the Anti Piracy Task Force of the Satellite Broadcasting and Communications Association by 25 percent.

FCC proposal opens TV answer door

Real-time two-way broadcast television was given a shot in the arm by the Federal Communications Commission, which last month issued a notice of proposed rulemaking establishing an interactive video data service in the 218 MHz to 218.5 MHz band.

The action came at the request of TV Answer, a Virginia-based company that plans to market an in-home low-power transmitter/computer that allows viewers to respond to messages, select programming, purchase goods and perform a host of other interactive transactions.

TV Answer has already concluded a two-year test of its system in McLean in which 600 homes were given devices which made it possible to respond to queries made over the air. In addition, an interactive news channel and a jukebox-type channel were tested. TV Answer was an exhibitor at the NCTA Show a couple of years ago.

The FCC proposal calls for the 500 kHz allocation to be split into two 250-kHz segments. The Commission intends to create a service similar to those available to personal computer users and which provide access to information and services.

The Commission is providing 45 days for reply comments. Comments are requested regarding spectrum allocation, interference to nearby channel 13, licensing procedures and construction. The Commission has proposed local licensing control and a lottery to award licenses.

"This (action) opens the door widely" for interactive services, said Sally Olmstead of TV Answer. TV Answer's system uses a controller at the signal source to encode messages over the video and utilizes the in-home transmitter to broadcast to a receiver, which in turn relays the information back to a central office. The Reston, Va.-based company is fine-tuning its newest generation of equipment, said Olmstead. "The phone has been ringing off the hook," she reported.

New amp hybrids operate to 750 MHz

The first pre-production samples of new RF amplifier hybrids capable of operating to 750 MHz (112 NTSC video channels) have been developed by Philips Components, according to Dr. Aleksander Futro, director of technology assessment at Cable Television Laboratories.

The hybrids were the central part of a meeting held in October of last year at CableLabs in which cable operators and hybrid manufacturers discussed specifications for push-pull and power-doubling hybrids.

In mid-December, Philips delivered about 25 hybrid samples to each of its major OEMs. Philips officials claim the samples were constructed without serious difficulties in the manufacturing process.

As of press time, Futro had not yet seen the results of tests performed with a fully-loaded cable system. However, he said he expected little or no problem achieving the desired performance specifications.

According to an article in CableLabs' newsletter, factory production and engineering runs were expected to start at Philips last month.

Larger quantities of 750-MHz amps will be available before the NCTA Show in March, when amplifier vendors are expected to show fully-loaded amps with new 750-MHz hybrids. Volume production is slated to begin this summer. Large volume availability of 750-MHz gear is expected before the end of next year.

The next step is to take hybrids out to 1 GHz or more, a project which is ongoing and will be dictated by market demand, according to the component manufacturers. However, it is expected that those hybrids will be producted in the traditional industry package to maintain backward compatibility.

Canadian lab funds 7 projects

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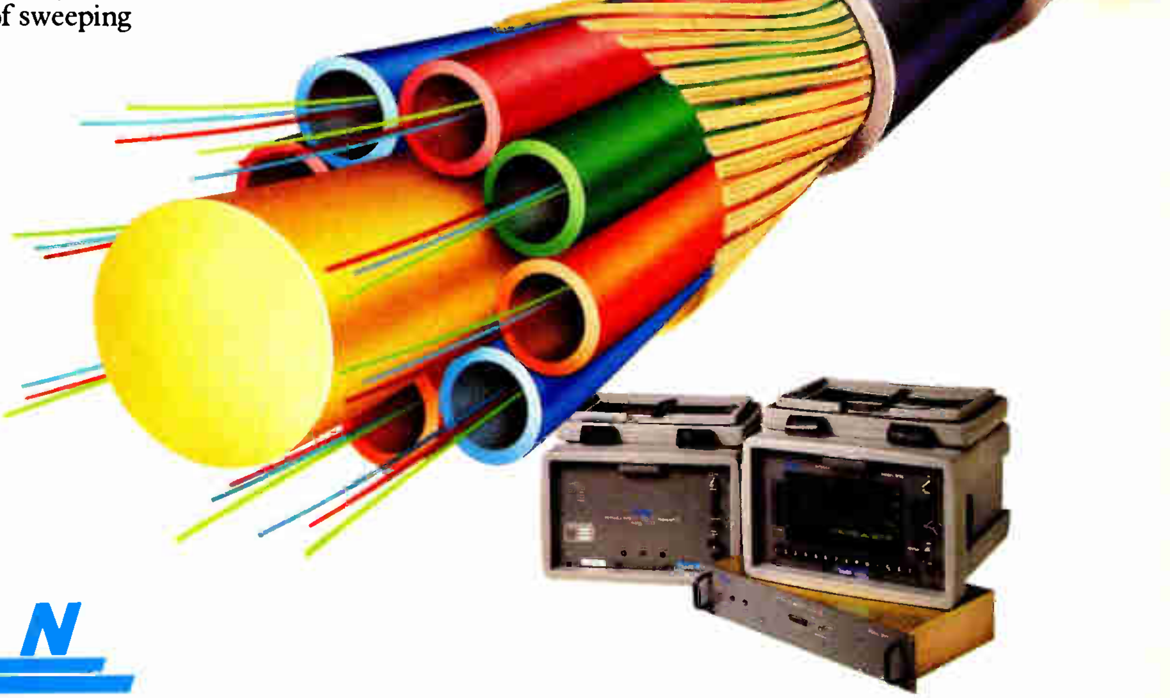

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Reader Service Number 6

tems has established a research and development program called the Canadian Cable Labs Fund.

The Fund has research teams consisting of 12 principals and more than 20 graduate students based at three universities. Involved in the work is Nexus Engineering, the Communications Research Centre of the federal Department of Communications and CableLabs.

Cable industry veterans will recall the Cable Telecommunications Research Institute, a central R&D facility established in Ottawa a decade ago that eventually failed for lack of support. However, as the pace of product development and operator needs have increased, the need for research was again deemed important.

The Fund's projects are as follows:

- **Linearization of optical transmitters for AM signals**: A $182,000 project examining ways to produce cheaper and better lasers.
- **An expert network analyzer**: This $90,000 project examines how expert systems can be applied to the analysis of faults in trunk and bridger amps to help reduce system downtime.
- **Compressed carrier transmission on CATV systems**: Nearly $100,000 has been allocated to develop a form of compressed carrier transmission. If successful, signal reception quality could be significantly enhanced.
- **Automated cable TV monitoring systems**: $50,000 has been committed toward development of a system to help cable systems recognize potential problems before they occur.
- **Integrated electro-optic modulators and lasers in GaAs**: $44,500 has been allocated toward an attempt to make integrated opto-electronic modulators and lasers on gallium arsenide wafers. This would reduce the amount and size of equipment needed for a fiber video system.
- **Network evolution, modeling and performance analysis for CATV systems and service**: $30,000 pays for an analysis of technical developments as they relate to cable networks. Rogers will be provided with timely choices for future technical development.
- **Expert information management: A customer service interface**: A large group has been given $83,000 to examine the feasibility of applying expert systems, natural linguistics and relational database techniques to the kind of management information systems used by Rogers. The goal is a natural language interface to enhance current data interpretation at the customer service level.

SmartHouse plans Spring debut

It's beginning to look like SmartHouse will be the first out of the gate by offering an automated home. The controversial project, a subsidiary of the National Association of Home Builders, promises to automate several electrical and plumbing functions of the home. A similar but separate, less ambitious project has been undertaken by the Electronic Industries Association.

SmartHouse was officially introduced during the 1991 NAHB convention, held in Atlanta late last month. The exhibit included a behind-the-walls look at the SmartHouse cable and how it's installed, a Smart Theater, a Smart Playroom where visitors could try SmartHouse products and a Smart Product Showcase. A press conference detailing SmartHouse roll-out plans was slated for January 18.

The way in which SmartHouse accommodates cable television has been an issue with high-level CATV engineers. The cables used to run SmartHouse consist of traditional electrical, telephone and coaxial cable all bundled together. Issues related to installation, maintenance, troubleshooting and others have been of concern to the cable industry.

Regardless, SmartHouse officials say the house will be rolled-out to eager homebuilders this spring. SmartHouse is slated to be available in two phases over 21 months: The first phase, Smart Redi, is an entry-level pre-wire/gas, pre-plumb system necessary to enable automation.

The second phase, slated to occur six months later, consists of a complete operating system, including system controller, outlets and electronic components.

To date, 17 manufacturers and more than 40 utility companies and trade groups are part of the project. Recent additions to the project are: Chung-Hsin, who will manufacture the system controller; Molex, which will manufacture core components like cable, connectors and switches; and D2B, which will manufacture a gateway to allow entertainment products to use the D2B protocol to communicate with SmartHouse.

CableLabs board OKs $11 million budget

During a December meeting, Cable Television Laboratories' Board of Directors approved an $11 million budget for 1991, which includes a $4.1 million operating budget, nearly $4.5 million for research projects and a $2.5 million capital budget. The 1991 budget calls for increases over 1990 in all three areas. Last year, $3.5 million was spent on operations, $2 million for research and $750,000 for capital.

Five management goals were approved as well. Those goals include:

- Exploration of an advanced network model that supports current and future communications requirements via analog and digital means.
- Development of a test cable system for new technology deployment.
- Work to ensure CATV can provide optimal quality video and audio to the home at all times.
- Exploration of the integration of PCN and cable systems.
- Development of an advanced, interactive program guide.

The Board also re-elected its officers and reappointed the executive committee for another term.

Task force assembled

In addition, CableLabs established a task force to study system outages and how they can be reduced and/or eliminated. Headed by Warner Cable Senior Vice President for Service Operations Brad Johnston and CableLabs VP of Science and Technology Tom Elliot, the task force will determine the effect of outages on customers, establish an outage performance range and a way to track it, and determine what causes outages and methods to reduce them.

The task force was organized because outages have been determined to be a major cause of subscriber disconnection and directly reflects upon viewers' perception of quality.

Six working groups have been established within the task force. They are: plant powering, headed by consultant Mark Bowers; equipment reliability, John Walsh of ATC; protecting outside plant and headends, Roy Ehman, Jones Intercable; defining outages, tracking, etc., Mike Miller, Viacom; system reliability, Rob Moel, Paragon; prevention through operating practices, Larry Schutz, TeleCable. ■

—Roger Brown

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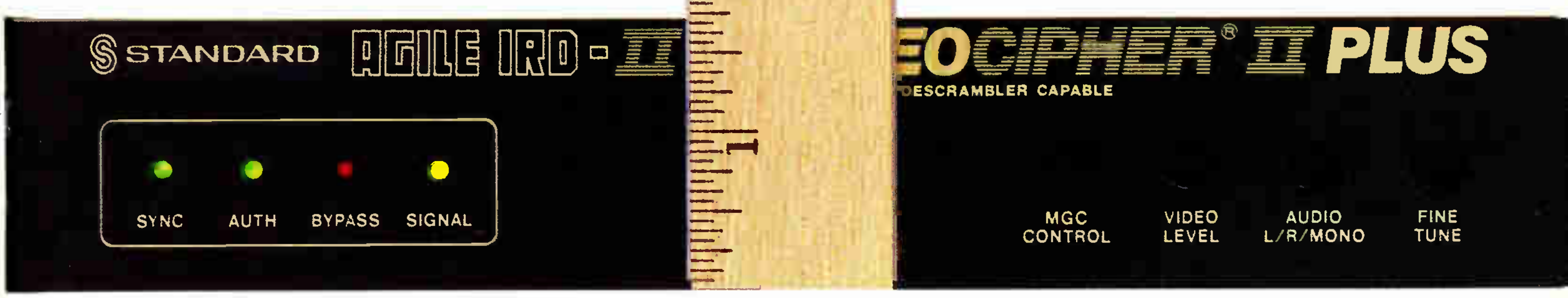

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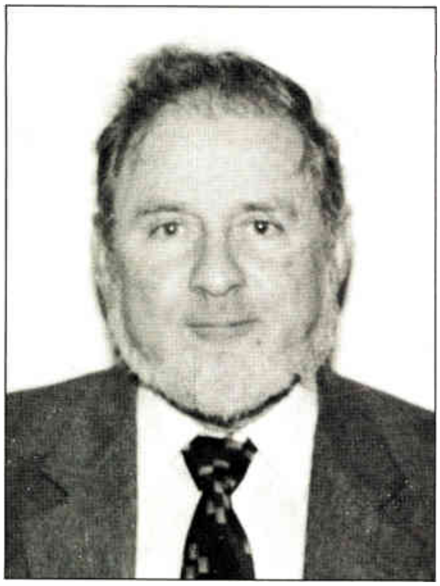

Tom Straus

An engineer's engineer

Have a question about microwave electronics? Dr. Tom Straus is most certainly the guy to see. A 31-year veteran of Hughes Aircraft Company, Straus earned his way to the rank of chief scientist of the company's Microwave Products Division, where he still puts in 10-hour days leading his group in the newest in microwave technologies.

Ask Straus where he's from and you'll get a chuckle. "You tell me," he says. Born in Berlin in 1931, Straus spent his first nine years in Japan, then moved to New York "where I grew up," Straus says. Pursuit of a degree in physics took him temporarily to the state of Michigan, where he picked up his BS degree from the University of Michigan. Straus then moved to Massachusetts, where at Harvard University he attained masters and doctorate degrees in applied physics. In 1959, Straus left the Ivy League and was repotted in California soil—and has remained in the Los Angeles area ever since.

Straus' beginnings with Hughes preceded any involvement with cable television. "I started there working on microwave devices—amplifiers and ground terminals, mostly," Straus recalls. "The last project I worked on before I made the switch to cable television involved optical lasers. Rather an interesting experiment, actually."

First optical laser link

"I believe it was the first optical communication link, back in 1961," Straus continues. "The project involved some experimentation with optical communications through the atmosphere. In the experiment, we took a light beam and modulated it, and transmitted it to a second point, 18 miles away. At the other end, we had a detector that demodulated it. It's the same as fiber optic systems, except there's no piece of optical glass fiber between the points.

"You could actually look into the beam that was coming at you from 18 miles away. So far as I know, that was one of the first communication experiments using lasers."

In 1970, Straus joined forces with engineers from Teleprompter Corporation, then the largest multiple cable system operator. Together, Straus and Teleprompter engineers designed the first microwave transmitter and receiver for cable television.

Manufactured under the auspices of subsidiary company Thetacom, the transmitter/receiver was exhibited for the first time at the National Cable Television Association's 1971 convention. "It was pretty important to the industry," Straus recollects. Straus' efforts on this first transmitter and receiver—or "classical AML," as he refers to it, were rewarded in 1974 when he was chosen as the recipient for the coveted NCTA Engineering Award.

A real head-scratcher

In 1984, Straus hit an engineering roadblock that kept him stumped for almost five years, when a Canadian MSO wanted to blend features of Hughes' original low power AML and its new block up-converter. "The classical AMLs were all channelized, meaning that you fed each channel separately into the input of the transmitter as before you combined it. Then you did the combining passively, at the output of the transmitter.

"At the time, we had just released our first broadband-type block up-converter, which had several benefits—but had an 18 dB (lower) difference in the output level from the channelized version. Well, during our trip to Canada, the engineer took one look at it and said, 'Well, gee, this is nice...now give us something with the same output power capability as your low-power transmitter.' At the time, I thought there was just no way." But in 1989, Hughes introduced a product that not only solved the power output problem, but offered an additional 5 dB of gain. "What a challenge that was," Straus recalls.

When he's not solving microwave puzzles, Straus stays active on the educational front, teaching a smattering of courses in semiconductor physics at UCLA and assisting on occasion at Hughes' AML training seminars. He also enjoys picking up the pen, as evidenced by his record of writing engineering pieces for industry trade publications. Reading is another hobby—which is not at all surprising considering that his bride of 33 years, Annabel, is a librarian. Together they have three children; two daughters and a son. "We have one aspiring actress, a soon-to-be teacher and a plasma physicist," Straus laughs.

How does Straus see the future of cable television? "A lot of things are going on; that's obvious. I don't think, though, that one technology will boil down to be the only technology of importance. I think there are possibilities with fiber, DBS, and digital—but none of these will completely drive out the others. Standard cable and microwave will be around for a while—for quite a while—and will also play an important role," says Straus.

Currently, Straus is continuing work on Hughes' existing line of 13 GHz microwaves "for further improvements," says Straus. Also on the plate are some overseas projects and work in the fiber area. "I'm not certain what we're going to do there."

Straus regularly attends the National Cable Television Association's bi-monthly engineering meetings. At the December meeting, Straus volunteered to lead a committee representing cable television on a broadcast industry national frequency coordination effort. "Translated, it has to do with coordinating microwave frequencies with the broadcasters," says Straus.

Not many employees tend to stick with a company for as many years as has Straus. A self-professed detail person, Straus believes strongly in the importance of precision to produce quality products. His achievements in our industry have helped to make it what it is today—and his unique blend of loyalty, precision and perseverance have given him recognition among his peers as an "engineer's engineer." ■

—Leslie Ellis

CARS band allocation woes

Working in a federally regulated business can certainly create some curious observations, especially if you've been involved for as many years as I have. Indeed, if this was truly Lewis Carroll's vision of the world, someone named Alice would be proclaiming it "curiouser and curiouser."

Many of you know or know about James McKinney, chairman of the Advanced Television Systems Committee (ATSC). As for myself, I am the chairman of the ATSC Budget and Dues Committee and was involved with negotiating the contract to hire Mr. McKinney as the chair. I was given this job for a number of reasons, one of which is that I am the Budget and Dues Committee chairman, but perhaps just as importantly, the group knew that I have had a long time business and personal relationship with Mr. McKinney.

This relationship spans many years. My first meeting with Mr. McKinney came when he was the chief of the Private Radio Bureau at the FCC. Actually, the Private Radio Bureau had no involvement in the cable television industry and my introduction to McKinney was somewhat of a fluke. Very early in the 1980s, I read an article that detailed a speech Jim had given about the wasteful use of radio spectrum for the transmission of television signals. His point was that when one episode of *Dallas* or some other popular program was on, all these television stations were sending the program, and all these satellites were sending the program, and all these cable systems were sending the program across radio links from hubs to headends. Surely, he said, if you add up all these six MHz chunks for terrestrial broadcast and 18, or 22 or 25 MHz chunks for satellite, FM or other transmission modes, a *lot* of frequency space was being consumed for one program. The speech further detailed who the suspected culprits were for these most egregious violations.

Well, after reading this I decided to make an appointment with Mr. McKinney to discuss cable's use of CARS frequencies—primarily because I suspected McKinney had been misinformed about some aspects of that particular technique for transmitting television signals. During our appointment, I explained to McKinney that while his basic point may be valid, he should realize that cable television and its equipment vendors had developed a technique of using AML very precisely, so as to conserve valuable frequency space while sending multiple channels. Further, I explained, until the technique was developed and put into widespread commercial use by cable, everyone consumed much more bandwidth than was necessary for trunking or linking broadcast and any other television facility point-to-point.

Meeting paid off

Well, I don't know that I changed his mind on the matter, but subsequently he went on to become chief of the Mass Media Bureau. It's been my opinion for some time that his interest in our technical activities has done much to foster the goodwill our industry has towards the operating staff of the FCC's cable branch.

Meanwhile, back at the FCC, the issue of CARS band frequencies has somehow bounced around and come back to the attention of federal regulators. Indeed, in October of last year, the FCC adopted a notice of proposed rulemaking that in effect, would allow a new class of user entrants into the CARS frequencies and at the same time prevent cable operators from being licensees in the MDS or MMDS services.

There are a couple of facts that are irrefutable. First, the ballyhoo about MDS and MMDS—the fact is, there is not a large number of these services up and working, and the subscriber base is not large. While this is a viable competitive business to cable television, they are still working their way into this particular world. On the other hand, the CARS are congested and in high use. All of these channels and frequencies together serve a large percentage of the 55-plus million homes that make up the cable subscriber universe.

Ironic outcome

It boils down to this: Regulatory bodies have decided that in a service where there are generally few active systems, they will prevent cable operators from being licensees. And in a service that is chock-full of both cable operators and broadcasters vying for frequencies in this vigorously used spectrum, they are proposing yet *more* entrants—thus placing new demands on that already crowded band.

A few issues arise here. First, cable operators who do have MDS and MMDS licenses in their systems will be grandfathered when the Commission issues its final rules. As for CARS frequencies, we seem to have forgotten that the FCC once before foisted additional users on the lower edge of our spectrum by taking frequencies away from POFS users and giving it our DBS service, which hasn't exactly materialized.

The issues here are interrelated and complex. Surely, the discussion of access to specific frequencies and spectrum is shrouded with passion and flaring tempers. We would do well to bear in mind that the FCC's purpose is to discern the most efficient uses of radio spectrum while conserving spectrum for future use. With recent demands for spectrum to be set aside to accommodate future HDTV and PCN activities, people are beginning to think spectrum fights will dominate the next few years. I think that is most probably true. But I also want to remind you that battles involving potential competing users, the spectrum and the FCC are the normal daily fare for the industry professional.

When it's all said and done, the groups that are granted use and access to these frequencies will be those that prove, by their creativity and activities, that they are serving the public. Those programs which are in the public's best interest will prevail. ■

By Wendell Bailey, Vice President Science & Technology, NCTA

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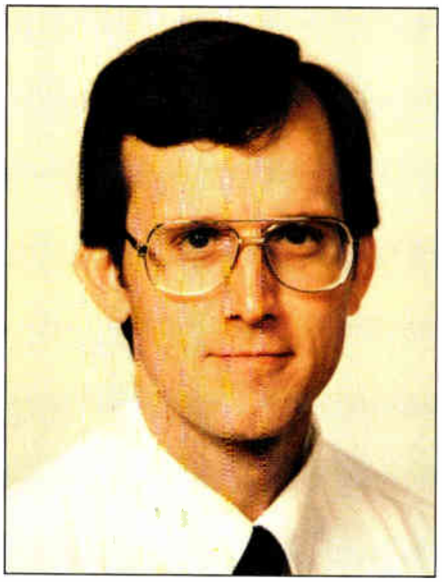


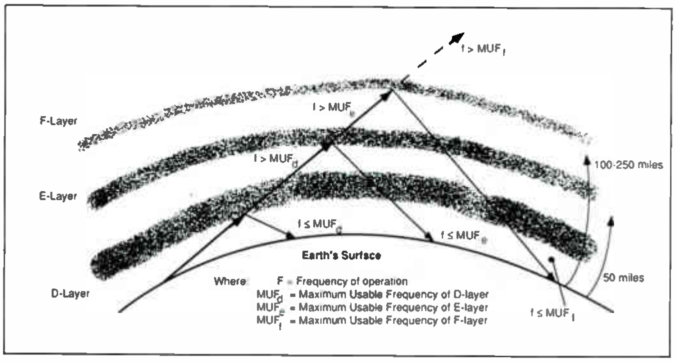
Propagation primer: Part two

Last month, we took a brief look at the makeup of the ionosphere, briefly outlining the existence of ionospheric 'layers' above the surface of the earth which constantly vary in density and altitude from day to night, season to season, and with the varying intensities of the sun's radiation during its 11 year sunspot cycle. These layers, commonly referred to as the D, E, and F (or F1 and F2) layers, are the controlling mechanism for electromagnetic wave propagation as we know it today. This month, we'll take a brief look at how the ionosphere affects wave propagation and how this affect varies with the frequency of the propagating signal.

Figure 1 gives a pictorial representation of the ionosphere as described in Part 1 of this series. Please understand that this is a very simplified representation of a very complex process, but serves to illustrate the concept reasonably well.[1] To review, here we see the D-layer, closest to the surface of the earth, which is the most densely ionized layer and has its most profound affect on propagation during daylight hours. The local D-layer tends to subside at night, as the sun's rays move around the globe, leaving the E and F-layers, which have less diurnal variation, to determine propagation characteristics. But how does propagation occur?

By Chris Bowick, Vice President Engineering for Headend Equipment, Scientific-Atlanta, Inc.

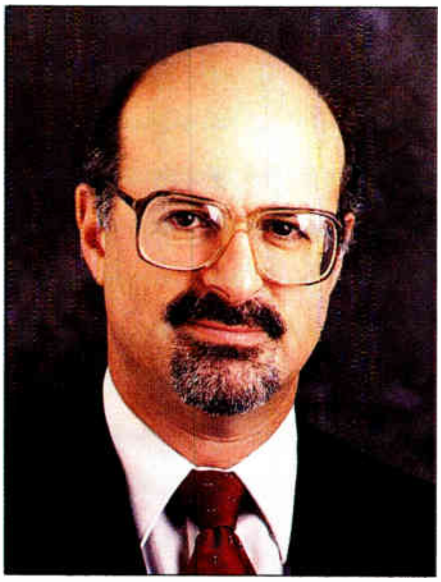
As with light, one of the major factors that will determine whether an RF signal will be reflected primarily in one direction, scattered in all directions, or pass through the media will be the relative smoothness of the reflecting surface compared to the wavelength of the propagating signal. The ionospheric layers that have been described are continuously varying in density and surface 'roughness'. (As an illustrative example, consider the continual variations in density and smoothness of clouds.) If the wavelength of the propagating signal is large (frequency is low), for example, relative to the dimpled surface of the ionospheric layer on which it is impinging, then the surface of the ionospheric layer would seem smooth relative to the wavelength of the signal and would tend to reflect the signal back to earth. Higher frequency signals, on the other hand, having much smaller wavelengths would not see a 'smooth' surface and you would therefore not expect to see as much reflection of these higher frequency signals from the surface of the ionospheric layer. As a rule, lower frequency signals will always tend to be reflected more strongly by a given ionospheric layer than higher frequency signals. In fact, as the frequency of the propagating signal increases (wavelength continues to decrease) we will finally reach a frequency at which the surface of a given ionospheric layer becomes transparent to the propagating signal, and the signal simply penetrates the layer and travels into space. This frequency is known as the Maximum Usable Frequency (MUF) for a given ionospheric layer. Below the MUF, the signal will be reflected; above the MUF, it will not. An approximate MUF based on 'average conditions' (remember it's continuously variable) can be calculated based on measurements of the ionosphere. This information is often published and used by ham radio operators, and government communications experts to determine the optimum frequency of operation for HF and VHF communications over a given distance.



In general terms, a look at the MUF will give you a good idea of why VHF communications, including VHF and UHF Television are considered a form of 'line-of-sight' communications. For the most part, VHF and UHF signals are operating above the MUF for ionospheric propagation and these signals are therefore not reflected back to earth. Instead, the effective antenna-to-antenna horizon (line-of-sight) becomes the signal's maximum transmission distance. Occasionally, however, during times of high solar activity, the ionospheric layers will become dense and smooth enough, thereby increasing the MUF just enough, to allow a form of reflection or scattering of VHF television signals to occur. Sometimes, this phenomena can create a rare or sporadic co-channel interference from a station several hundred miles away. This same phenomena, commonly referred to as sporadic E or sporadic F skip, has been known to allow for rare viewing of very distant television channels on a standard television (prior to CATV of course), using only rabbit ears—a phenomenon I remember experimenting with quite vividly in my childhood as I began my study of propagation for my ham radio licenses.

To summarize our two-part tutorial on propagation, we can say that ionization is most dense and MUF is the highest on hot summer days near the peak of the sunspot cycle. Conversely, ionization is the lowest, and MUF is the lowest on cold winter nights at the minimum of the sunspot cycle. So when might we expect to see the most favorable conditions for long-distance co-channel interference or TV DX (distance) operation? Most likely on cool summer nights (after the D-layer had dissipated) during the peak of a sunspot cycle when the E and F layers are most active. ■

[1]Amateur Radio Advanced and Extra Class License Study Guides, Tab Books, Summit, Pa., 1970.



Interference, coverage areas & the HDTV decision

Now that the leading HDTV proponents have come out with all-digital formats, the FCC decision on an HDTV standard could be largely based on the TV station coverage areas that can be achieved by the different proponents. While TV station coverage areas may not be very important to cable operators, it is critical to broadcasters—a larger coverage area translates into larger viewership and larger ad revenues. An HDTV format with a relatively small coverage area, due perhaps to power limitations and interference, will have a major disadvantage.

But the format that has the biggest coverage area for TV broadcasting may not be best for cable, because with digital systems there can be tradeoffs between picture quality and coverage area.

Interference & separation distances

The FCC's goal is to assign an additional 6-MHz TV channel to every existing TV station, and this 6-MHz channel will be used for HDTV broadcasting. This is a formidable assignment problem, because of interference. In most of the country, it is not possible to drop in another full-power NTSC TV station on any channel, UHF or VHF, because it would cause interference to some existing TV stations.

(Of course, broadcast interference mechanisms are less important to cable. Cable systems do not suffer from broadcasting's co-channel interference problems because cable is a closed medium. The adjacent channel and taboo channel interference problems that plague broadcasting are not a problem because on cable all channels have the same signal strength.)

It is expected that HDTV interference into NTSC receivers will be less of a problem than NTSC into NTSC, because, at least for the all-digital formats, there will not be a synch pulse with a high power level in the signal. The digital signal formats will have a relatively flat energy distribution across the channel. This means that an HDTV station can be located closer to an NTSC station than would be possible for two NTSC stations. As a result, there is a very good chance that every existing TV station will be able to get an additional 6 MHz channel for HDTV.

But until lab tests are done, it is not certain whether this is possible, or whether the HDTV stations will operate with reduced power to avoid interference into existing NTSC stations.

Power levels and coverage areas

It is easy to go into the FCC Rules and find out that UHF TV stations can have a maximum power of 37 dBk (5000 kilowatts), and that co-channel UHF stations must be spaced either 155, 175 or 205 miles apart, depending on where in the country they are located. It is not so easy to translate this into a coverage area, but it can be done if you make assumptions about receiving antennas, receiver noise figures, etc. Let's say, for the sake of this article, that a typical full-power UHF TV station has a 50-mile radius.

In order to determine the power levels and distance separations for the proposed HDTV formats, the FCC Advisory Committee on Advanced Television will make lab measurements of interference and picture quality. First, it will pick the co-channel separation distance that allows the creation of enough new TV stations so that every existing station can have one. Based on studies done by the FCC staff, this distance seems to be around 110 miles. In other words, in any given city, a new HDTV station might be created on any channel that is not being used closer than 110 miles away.

Then, in the Advanced Television Test Center's lab, interference measurements will be made. The HDTV transmitter and NTSC transmitter will be separated by a (simulated) distance of 110 miles, and then the power level of the HDTV transmitter will be cranked up until it starts to cause interference into the NTSC receivers that are tuned to the NTSC signal. This will be the maximum power level for this HDTV format.

Next, holding the HDTV transmitter at this power level, the HDTV receivers will be moved away from the HDTV transmitter to the (simulated) distance where the HDTV signal starts to be too weak to give a good picture. This determines the "noise-limited" coverage area of the HDTV format.

The next step in the testing is to turn on the co-channel NTSC transmitter and see whether it causes interference into the HDTV receivers at the edge of the coverage area. If so, then the HDTV coverage area is reduced, and it becomes an "interference-limited" rather than noise-limited coverage area.

Making the HDTV decision

Let's first assume that all the HDTV formats give pictures that are equally good. They are equally sharp, they render motion equally well, etc. But let's say that they have different interference properties with respect to NTSC. Let's say that one HDTV format can achieve a 50-mile radius of coverage without causing interference to an NTSC station 110 miles away, while the other HDTV formats can only achieve a 30-mile coverage radius without causing interference. Then the 50-mile HDTV format will win.

But what if there are tradeoffs between the picture quality and the coverage area? For a digital signal, this might be achieved by taking away data bits from the picture information and using those bits for forward error correction.

Broadcasters might pick the format that gives the 50-mile coverage area, even though it has a picture quality lower than a format with a 30-mile coverage area. Cable operators, on the other hand, don't need the larger coverage area; they would want the best picture quality, with fewer bits assigned to forward error correction.

If it comes to this, who do you think will win? ■

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

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Alternative Access

Back in the early 1970s, educators appeared before City Councils and County Boards demanding that 25% of all cable TV channel capacity be set aside and reserved for educational/instructional programming. They hoped to repeat their success in the 1950s when they persuaded the FCC to set aside specific frequency assignments for non-commercial educational TV broadcasting stations. They claimed that by the time economic support for educational television could be generated, the limited spectrum, both over the air and on cable, would be captured for commercial purposes. Such fears were certainly not unfounded.

Cable operators, however, bristled at the idea of giving up three channels in a 12 channel system, or 9 of 35 channels. It was especially irritating to recognize that few educators were likely ever to be financially empowered to activate even one of the set-aside channels. In fact, the success of the Public Broadcasting Service (PBS) is due more to its transformation to non-commercial entertainment and information supported by public donations and non-commercial commercials than to appropriated tax funds.

In its application for franchise in the City of Richmond, VA, Continental Cablevision introduced a new and innovative concept designed not only to deal with the educational demand without sacrificing revenue producing program channel capacity, but also to provide a special telecommunications network capable of providing private commercial voice and data services for the business community.

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

Continental's institutional network

Called an Institutional Network (I-Net) this concept as proposed by Continental in Richmond was to be a totally separate and independent mid-split network lashed to the same strand as the subscriber network, but limited to those areas that could provide access for schools and the principal commercial institutions.

Budgeting for education is a zero-sum game. Rarely has the potential for improving the quality of education by means of television been considered important enough to justify funding without offsets, usually taken out of the teaching payroll. Consequently, educational channels tend to be used for such low budget incidental purposes as alpha-numeric notices and student training in the studio. Moreover, business applications of the I-Net have repeatedly been frustrated by state public utility commissions, preserving the historic monopoly of telephone common carriers over voice and data transmissions.

> Cable TV seems poised on the brink of a significant entry into the voice and data side of telecommunications.

Thus, the I-Nets that were so widely proposed (required in many cases by the RFP), but not so widely implemented, have largely been abandoned or converted to more limited special purpose applications. Yet, during the heyday of the I-Net, the demand for T-1 high speed data channels, (1.544 Mbs) for business data transmission far outstripped the capacity of the telephone networks. In many cities the cable TV I-Nets could have supplied the capacity needed to meet the demand, had they not been inhibited by regulatory rulings. But telephone company expansion effectively closed this window of opportunity before the cable TV industry was ready to enter the regulatory fray.

Now, the window is beginning to open again. Although the FCC has attempted to preempt interstate regulation, the issues are sufficiently clouded that some states continue to require that all voice and data transmission must be on certificated carriers. Such states tend to issue certificates only to the established intrastate telephone carriers. On the other hand, some of the state commissions are not standing in the way of independent firms who propose to offer alternative private carrier access (actually *bypass*) for voice and data transmissions between businesses and teleports, long distance carriers, or other businesses in the same community.

Activity in these states is beginning to intensify. A number of relatively small entrepreneurs (including some cable TV operators) have been testing the waters, lining up rights-of-way with utilities, railroads, and even cable TV networks for optical fiber transmission lines, consulting with PUCs and city officials, and surveying the market potential. Most are financially able to handle only a part of the potential in the larger cities. Thus, there are likely to be many such private carriers, until the inevitable consolidation takes place.

Cable ahead

Cable TV networks may already be a step or two ahead of the pack to the extent they actually control parts of their right-of-way. It may even be that cable TV trunk lines are already easily adapted to alternative access service, especially if fiber backbone or fiber-to-feeder architecture has been installed.

The window may be open for several more years as the effect of federal preemption becomes more widespread. But the time may come when the market will be saturated with private carriers. Perhaps ultimately the established telephone companies may retrieve these upstart bypass ventures, as they have done with many of the licensed non-wireline cellular telephone operators. Selling out at fair market value after a few years of entrepreneurial development is not exactly an unattractive outcome.

Cable TV seems poised on the brink of a significant entry into the voice and data side of telecommunications. ■

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Engineering meeting serves up full plate

The bi-monthly meeting of the NCTA Engineering Committee was held in Englewood, Colorado at the Raddison Hotel Denver South on December 13, 1990. Chairman Tom Jokerst called the meeting to order at 9:00 a.m.

Tom Gillett of CableLabs kicked off the meeting by introducing Stu Liposs from A.D. Little, who highlighted the results of a six month study on the opportunities that personal communications networks might hold for cable that the Labs had commissioned. The goal of low-cost universal instruments working in all modes was pictured as possible, especially if the cable industry supplied the PCN backbone. Market research has shown that latent demand is very high. Other presentations included Chuck Pagano covering ESPN's plan for rolling out a new system for switching and blackouts in August, and Bruce Babcock presenting NBC's preliminary plans for delivering PPV Olympics.

Washington update

Wendell Bailey, NCTA VP of Science and Technology and Brenda Fox, NCTA General Counsel and VP, Special Policy Projects detailed the proposed further NPRM on effective competition that was being addressed simultaneously at the FCC. Congress' attempt to reregulate cable spurred the FCC's FNPRM that outlines three tests to discern whether or not a cable system should be subject to local rate regulation. First reply comments for this important proceeding were due January 31, 1991.

Tom Jokerst addressed other FCC notices having to do with CARS band antennas. An October, 1991 deadline to upgrade transmit antennas may catch some systems unaware. Additionally, congested areas will be redefined, which also affects what antenna types are needed by cable systems. Although the Department of Commerce has county lists of congested areas, the FCC Mass Media Bureau will amend that list to create their own.

Jokerst also sought a volunteer to represent cable on a broadcast industry national frequency coordinating committee. Tom Straus of Hughes Aircraft Company volunteered.

Subcommittee reports

HDTV—Brian James for Nick Hamilton-Piercy. The most significant news in the HDTV areas was that more proponents have formally announced their intentions to provide digital ATV systems for testing at the Advanced Television test center in 1991. James asked for volunteer expert viewers to take part in system test cycles for the cable portion of the ATTC tests. Hamilton-Piercy also thanked subcommittee members who had served as expert viewers as the NTSC impairments perceptibility test bed was put into operation. Faroudja's Super NTSC was to be tested over cable systems in the Northeast in January.

Satellite practices—Norm Weinhouse. With VideoCipher problems a closed chapter, Weinhouse and Sound Subcommittee chairman Ned Mountain moved on to a joint effort to achieve full uniformity along the path from uplinked signal to subscriber homes. As noted at the October meeting, movements of satellites in 1991 will mean a good deal of ground segment shifting and realigning.

Standards—Dick Shimp. This group is acquiring data and getting involved in an IEEE subgroup related to fiber optic standards and measurement techniques.

Signal Leakage—Wendell Bailey for Ted Hartson. The FCC will consider input from the cable industry to stagger required submission dates for the Form 320. Members were encouraged to contact John Wong or relay their preferences to NCTA's Science and Technology department.

In-home wiring—Dana Eggert. Eggert reported on the progress of the subcommittee's four working groups—education and training. This group is brainstorming on the creation of ad-slicks that systems could distribute to subscribers illuminating common, avoidable service problems.

EIA/NCTA Joint Committee—Vito Brugliera for Walt Ciciora. Program guide information work continues in this group. There is also continued discussion regarding receivers and direct pick-up (DPU). CableLabs is considering hiring a contractor to rate television sets according to DPU. Other suggestions related to consumers unions conducting tests on TVs and VCRs while the industry groups maintained open and cooperative relations. Claude Baggett also reported that the "line for line" report on vertical blanking interval information was due by the end of 1990.

SCTE—Les Read for Bill Riker. Registration for the annual Cable-Tec Expo (Reno, Nev. on June 13-16) is going strong. All NCTA subcommittee chairmen were invited to hold meetings in conjunction with the Expo.

NEC—Jim Stilwell. Stilwell covered revisions for the 1992 code. Some problem areas for cable included mandatory cable marking and a possible second section's application for interdiction systems.

ATSC—Bernard Lechner. One of the technical groups (T4) created a specialist group on digital compression. They are preparing documents for the next CCIR cycle. One related to worldwide studio production/program exchange. Another specialist group is addressing spectrum reallocation issues for WARC, notably to not freeze out HDTV transmission by locking in DAB or other technologies. Other specialist group issues include interoperability and consumer product interface, and how scrambling and conditional access are affected by each proponent system. The need for strong cable representation was reiterated.

CEBus—Jud Hofmann. The AV bus group is looking into a bundle of shielded cable that would move broadband signals around without modulation. They are working on minimum bus configuration requirements, which affects cable interests because of PPV or wider bandwidth ATV from cable systems which could be shipped around on this bus. Another major problem is connector identification and usage. The coaxial bus is not moving along. The IR bus standard was approved by the committee, and the twisted pair standard is out for circulation and approval.

CableLabs—Tom Elliott and Claude Baggett. A PCN conference is scheduled for January 15-16 and has had a large response. As reported in the last meeting, the Lab is working with the joint EIA/NCTA committee to devise an automated program guide. A beta test guide is the next goal. Finally, a contractor was chosen for the study on customer satisfaction.

The next full committee meeting will take place on February 20-21 in Washington, D.C. Tentative dates for further 1991 meetings were named, and are as follows: April 10-11, June 5-6, August 14-15, October 9-10 and December 12-13. ■

By Katherine Rutkowski, Director, Technical Services, NCTA

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Ghosts may no longer haunt TV's future

It's Sunday evening and you've settled in front of the tube to watch this week's edition of *60 Minutes*. But what's that? To the right of Mike Wallace is a faint, duplicated image of his head.

Don't rub your eyes or bother to adjust your set. It's just a ghost; the ubiquitous time-delayed, distorted version of an intended off-air signal that has been a part of television since broadcasts began. But soon, this bane of signal purity, which most people simply live with, may slowly fade away.

By definition, a ghost is created when a television signal bounces off a building, mountain or other object and arrives at the television set twice—once directly, and once via a different path that takes longer to traverse. Long a menace to broadcast television, the ghosting problem is quickly soaring in importance as video technology advances toward high definition television.

No fewer than five industry groups (see sidebar) representing cable, broadcast and the engineering community at large, meet regularly to ponder the ghosting dilemma. Ghost cancelling technologies are slated to be tested by such groups as Rogers Cablesystems (in conjunction with CableLabs), the National Association of Broadcasters, the Federal Communications Commission, the Advanced Television Systems Committee and the Electronic Industries Association.

Advanced television a trigger

Why such a flurry of activity around what historically has been a tolerable (but annoying) bit of video mischief? "Ghost cancelling technologies will become a necessity with advanced television," explains Bob Keeler, distinguished member of technical staff for AT&T Bell Laboratories. "The original NTSC system is fairly robust, in that people can still see a picture and hear the sound, even in the presence of a ghost. But it's not clear what will happen with the advanced television systems—they pack much more information into that system."

Dr. Walter Ciciora, VP of technology for American Television and Communications and a patent-holding expert on ghosting, explains the technical complications posed to advanced television by video ghosts. "High definition television has double the scan lines—the beam goes across the tube twice as fast. That means that the ghost will be twice as bothersome, because for a given ghost displacement you'll get twice the displacement on the screen.

"Add in the fact that HDTV signals are multiplexed analog components, and you've got an even bigger problem," Ciciora continues. "The chrominance and luminance signals are compressed and transmitted at two different points in time. In the receiver, then, they're stretched out, which further lengthens the displacement of the ghost. In fact, to make things really obnoxious, the color ghost and the luminance ghost are stretched two different amounts, so they're converted into two ghosts. It's going to be one heck of a challenge to get HDTV to work in the broadcast environment because of that."

Two step process

Most engineers involved in the plethora of ghost cancelling committees agree that the new technology is best described in two stages. In the first stage, a training pulse generated at a broadcast site is sent over the air simultaneously with the intended signal. In stage two, the training pulse is compared to the intended signal, and any transmission errors are corrected at the receive site (the cable headend or the television set itself). "There's a handoff there. Broadcasters have to standardize on a specialized training pulse, and receiver manufacturers have to agree on the processing of that training signal," says Lynn Claudy, director of advanced engineering and technology for the National Association of Broadcasters (NAB).

Presently, the training signal is under the closest scrutiny. Two versions are under construction—the Broadcast Technology Association (BTA) of Japan's sin x/x waveform, and AT&T Bell Laboratories' pseudorandom sequence. "There are some arguments over which method is better," says Wendell Bailey, VP of science and technology at the National Cable Television Association. "The deciding factors are speed of interpretation (of the training pulse), how the information is conveyed, convergence time, and—naturally—cost."

BTA vs. pseudorandom

The BTA's sin x/x training pulse involves a single pulse transmitted in one line of the vertical blanking interval. Special shaping on the leading edge of the pulse gives it a wide, flat bandwidth. "One advantage of the BTA signal is that it is tested and available," Keeler says. "Also, if the ghost is constant, as in a building where the ghost is always reflected to the same place, then the receiver can learn the ghost pattern and put it into memory." Claude Baggett, director of consumer electronics systems for CableLabs adds, "In Japan, the technology is much more oriented toward rooftop antennas, so ghost patterns do remain somewhat constant."

While the BTA training pulse sends one pulse per field in the VBI, AT&T's pseudorandom sequence (also called pseudonoise sequence) sends 255 pulses with random widths. "The pseudorandom approach is more like radar in that it is a pseudorandom code," explains Ciciora. "Autocorrelation techniques are utilized to take the long code and compress it into a narrow pulse. In principle, you get a very significant energy multiplication."

Both techniques have unique advantages. The Japanese version, for example, can essentially lock on to a particular ghost and commit it to memory. Although slower to converge (around 20 seconds, industry experts estimate), the BTA version remembers the ghost—assuming its characteristics do not change. The pseudorandom sequence, conversely, offers a much quicker convergence time but not the capability to memorize the ghosted channel characteristics.

"Because (the AT&T) version has more edges, there's more energy. So naturally, the receiver can take advantage of that accumulated information more quickly. Also, the pseudorandom approach performs better in the presence of noise," Keeler explains.

Where do these technologies fit into current consumer electronics manufacturing strategies? "It's my suspicion that if you're building analog hardware, you'll prefer the sin x/x approach. And if you're going to be building primarily digital hardware, you'll probably favor pseudorandom," Ciciora surmises.

AT&T Bell Laboratories is not the only group investigating the pseudorandom sequence approach, according to Tony Uyttendaele, director of engineering development and advanced systems for Capital Cities/ABC and the chairman of the Advanced Television Systems Committee on ghost cancelling. "Both Philips Labs and Sarnoff are looking at their own methods of utilizing the pseudorandom sequence. Our hope is that this technology proves to be more cost-effective than the BTA version, which can cost upwards of several hundreds of dollars. It's my assessment that it will cost less."

Zenith Electronics is yet another participant in the ghost cancelling conundrum. Although the company's relationship with AT&T Bell Laboratories has been announced for over a

year, recent developments in digital technologies have pushed ghost cancelling onto the plate as well. In a recent announcement, Zenith and AT&T announced joint development of an all digital HDTV system that, not surprisingly, includes ghost cancelling circuitry.

Cost

The cost of ghost cancelling technologies is a tricky issue, depending on which group—the consumer electronics builders (and ultimately, television set owners) or cable operators—"eats" the cost of the equipment needed at the receive site. Pricing on the BTA receiver ranges from $600 to $1,200. AT&T costs are not yet available, but industry experts point toward a much more affordable price. "On a high-end television set, the cost of the pseudorandom approach will be incremental," comments Uyttendaele. "On a $69 set, however, the cost of the ghost cancelling may double the cost of the set."

Cable's argument is to move the receive portion of the cancelling technology into the headend—"where the (cost) denominator is much larger, depending on the number of subscribers," Bailey says. "It makes more sense to get cooperation from the broadcast community and share the cost than to put the financial onus on individual television set consumers."

Testing timetables

Activity surrounding the development of a training signal standard is already underway. The NAB, one of the groups currently striving for a training pulse standardization, recently requested proposals for a standardized training signal. The proposals were due October 31, 1990. "From the submissions we received (the Broadcast Technology Association of Japan, Samsung Electronics, Philips Laboratories, Thompson Electronics and AT&T Bell Laboratories), we came up with the date of June of 1991 to start a field test program," says Claudy. At press time, the NAB had agreed to dovetail its proposed testing with the activities of the Advanced Television Systems Committee's (ATSC) ghost cancelling subcommittee headed by Uyttendaele.

The ATSC is the group charged with the testing of the training signal "which will not be an easy thing to do, because we're only looking at one component within the system," explains Uyttendaele. "We must determine a test procedure that illuminates the optimum signal, independent of the operation of the receiver." The ATSC will be testing versions by the BTA, AT&T Bell Laboratories, Sarnoff/Thomson and Philips. Details about the test procedure were to be discussed at the next meeting, slated for late January. The testing is scheduled to begin in June.

Also keeping a close eye on the ghosting situation is the Federal Communications Commission. Under the auspices of the Systems Subcommittee on Advanced Television, a working party has been established (working party two) to dig farther into the effects of the bothersome video specters on high definition television—where ghosts will surely be more of a real problem than a mere bother. Headed by Mark Richter of the Public Broadcasting Service, the group meets regularly to examine the ghosting dilemma and to develop test procedures for the training signal.

While the majority of the industry groups are engrossed with the development of a training signal standard, Rogers Cablesystems, in cooperation with CableLabs, has already begun testing of a variety of ghost cancelling technologies. Systems under test include such manufacturers as Toshiba, NEC, Sony and JVC.

"We started the project in January of 1990," says Gary Chan, staff engineer for Rogers, who is directly involved in the ghost cancelling project. "We're currently evaluating four ghost cancelling systems—all BTA versions—at Saltspring Island (an island between Vancouver and Vancouver Island). There is a tremendous amount of ghosting problems there because of the proximity of the Seattle stations (KOMO, KING and KIRO)."

"We're not really testing for a specification—we're testing primarily for performance of the whole system," Chan continues. "It's kind of a selfish point of view, in that we're simply trying to improve the cable signal that is delivered to the subscriber." Recent discussions with CableLabs produced funds for additional testing "deeper into the system," says Chan.

"First, we tried it at the main headend. Now we want to move it down to a hub site—through several microwave hubs and then to a distribution hub. This is to see if moving the ghost canceller down the chain has any adverse affect." Chan hopes the testing will be complete by April of this year.

GHOST CANCELLING INDUSTRY TESTING GROUPS

Working Party Two, Systems Subcommittee for the FCC Advisory Committee/Advanced Television. Chairman: Mark Richter, Public Broadcasting Service, Alexandria, VA.

Advanced Television Systems Committee, Technical Group 3, Specialist Group 5 (ATSC-T3-S5) Chairman: Tony Uyttendaele, Capital Cities/ABC. Testing of the ghost cancelling training signal slated to begin at the Advanced Television Test Center mid-1991. Current proponents: BTA, Sarnoff Labs, Philips.

Electronic Industries Association, R-4 Working Group. Developed to monitor developments in ghost cancelling and assure compatability with consumer electronics manufacturers.

National Association of Broadcasters (NAB), Washington, D.C. Announced desire for a voluntary broadcast standard for ghost cancelling in November 1990. Respondents include: BTA, Samsung Electronics/Ready & Deane; Philips Laboratories; Thomson Electronics on behalf of David Sarnoff Research Center, and AT&T.

Rogers Cablesystems/CableLabs: Testing in progress of complete ghost cancelling systems including Toshiba, NEC, JVC and Sony.

Two heads are better

Such a large collective mind working on the ghosting problem will surely produce significant results, and the end of 1991 should mark the availability of both signal and system standards to address the ghosting situation. "The important thing is that something is being done," says Ciciora. "Bell Labs did a story a long time ago that indicated that the objectionability of a ghost is exponentially related to its displacement. So when you start talking about HDTV, you start to realize just how bad ghosting will be. I imagine all the industry groups will ultimately start to share results—it would be absurd not to. We're all in it for the same final reason: To get rid of the ghosting problem." ■

—Leslie Ellis

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Reader Service Number 15

Fixed value pads in CATV amplifiers

The modern cable television amplifier serves in systems with varying gain requirements, upper end frequency and output. Manufacturers, therefore, attempt to make one product applicable to as many conditions as practical.

One feature that helps the amplifier adapt to many conditions is the plug-in pad. Sockets to install these small fixed value attenuators may exist in several places within an amplifier. Proper use of each of these facilities is important because improper use can degrade picture quality and render a good system marginal in performance. This article will discuss the proper use of each of these pad facilities.

Figure 1 is a block diagram of a typical trunk amplifier. Components within the solid line represent the trunk module, while other building blocks are part of the complete station.

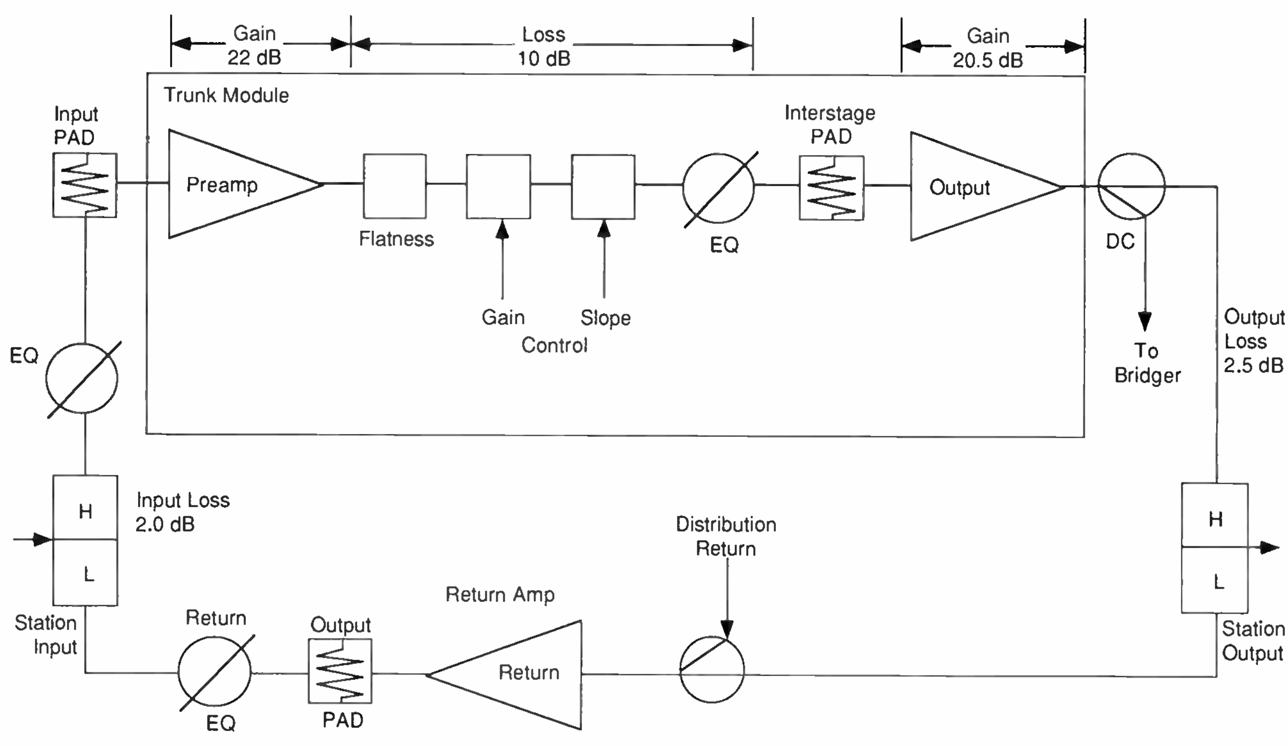
By Helmut Hess, Applications Engineer, General Instrument Corp.

> Amplifier manufacturers attempt to make one product applicable to as many conditions as practical.

Our "typical" amplifier includes two dB of loss between the station input and the module input. Also included in this path is our first pad facility, usually referred to as the input pad. It controls the input of the trunk module.

Within the trunk module there are commonly two amplifier hybrids, the preamplifier and the output amplifier. Between these two gain stages are a variety of circuits. Gain and slope are controlled by feedback loops. The flatness control board allows adjustment of the overall frequency response. The equalizer is necessary to achieve tilted output from the amplifier. We also find another pad facility, the interstage pad of the trunk module. The sum of all losses between the two gain stages is 10 dB. The interstage pad is a relatively new feature in trunk amplifiers. If improperly selected, it frequently causes degraded performance.

The output of the trunk module appears at the station output through additional loss, as shown. Signals in the return bandpass, that are applied to the forward output connector, are separated by the high/low filter and are directed to the input of the return amplifier. The output of the return amplifier encounters another pad facility. It would be unusual to pad the output of an amplifier in a cascade, except in this case where it is actually attenuating the input of the next



Block Diagram of Typical CATV Trunk Amplifier

Figure 1

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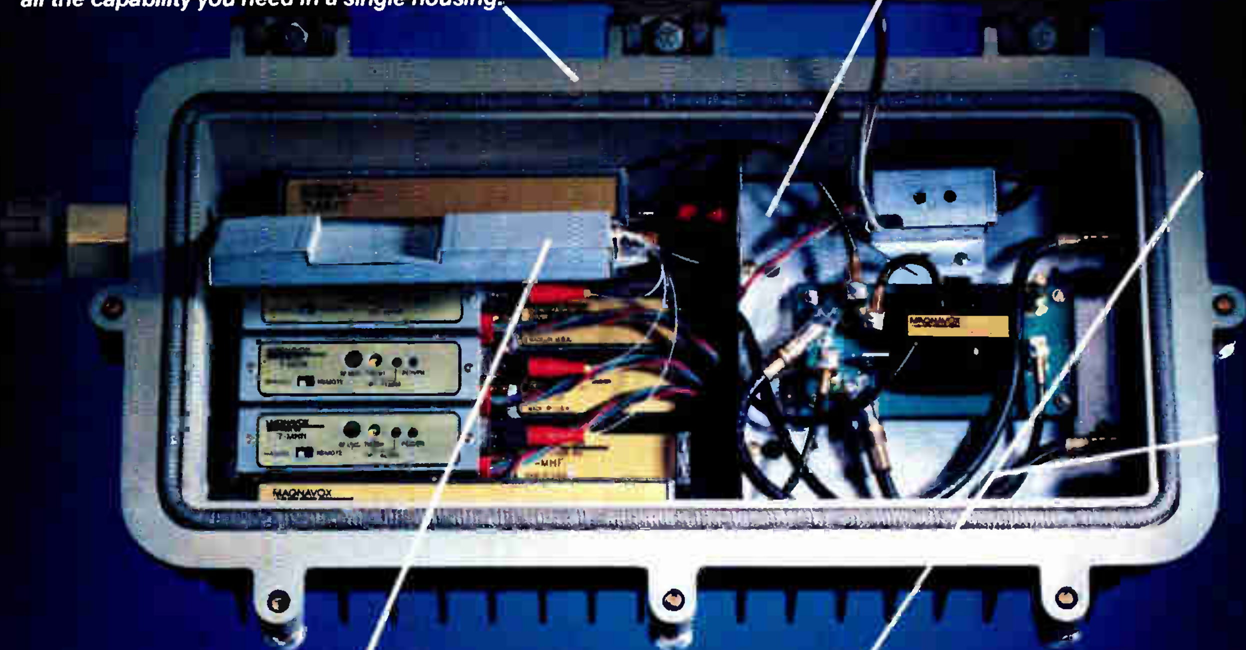

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Reader Service Number 16

amplifier. This pad and the associated return equalizer permits balancing multiple trunk lines to the input of the next station.

The interstage pad

Since the interstage pad commonly causes the greatest confusion it is mentioned first. Refer to Graph 1, which traces noise figure, carrier-to-noise ratio and distortion as the interstage pad is incremented in value from

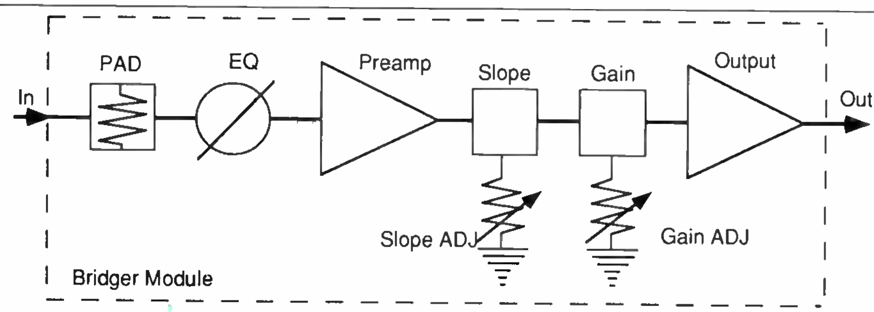
> The distortion of the amplifier increases significantly as the interstage pad value increases.

zero dB through 6 dB. Note that the Y-axis is shown in terms of better (+) or worse (−) than original specifications for the unit in question.

It is assumed that the amplifier output is held constant and therefore the input must increase with an increase in pad value. It may be noted that the noise figure of the module degrades somewhat as the pad value increases, but the input signal level increases more rapidly than the noise figure.

For this reason the carrier-to-noise ratio improves by nearly 6 dB when the 6 dB pad is installed. This improved noise performance is quite attractive, but not without penalty. The distortion of the amplifier increases significantly as the interstage pad value increases, due to the higher distortion contribution of the preamplifier at the higher output level it must provide. In this case, the distortion increases by approximately 3.5 dB when the 6 dB pad is installed.

While Graph 1 looks at the effects of the interstage pad when the output is held constant, Graph 2 investigates changes in performance if the input level is held constant. The interstage pad is again cycled from zero dB through 6 dB. The output level will change 1 dB for each dB of additional pad. Although the carrier-to-noise ratio suffers a small amount, there is a



Block Diagram of Typical Bridger Amplifier
Figure 2

major improvement in distortion. This improvement is caused by the lower output level of the output amplifier.

The input pad

The input pad shown in our typical amplifier has been available in cable television amplifiers since the time of Moses. It is as useful today as it has been since it was invented. The intended use is to attenuate excessive input signal. Technicians at times avoid using this facility because it is thought to cause degraded carrier-to-noise ratio, which in fact it does not do. For equal output signal level, the padded amplifier will provide the same C/N as the unpadded amplifier with correspondingly lower input signal level. The only difference between the two examples will be the greater gain of the unpadded unit, because, of course, the padded amplifier requires a higher input level to provide the same output. Therefore, the C/N remains the same and the gain is reduced.

> Choose pads with care and they will help to operate the system at peak performance.

Graph 3 is an exercise to investigate the effect on noise and distortion when the station gain is held constant. Gain, and therefore output, remains constant by changing the input pad simultaneously with the interstage pad.

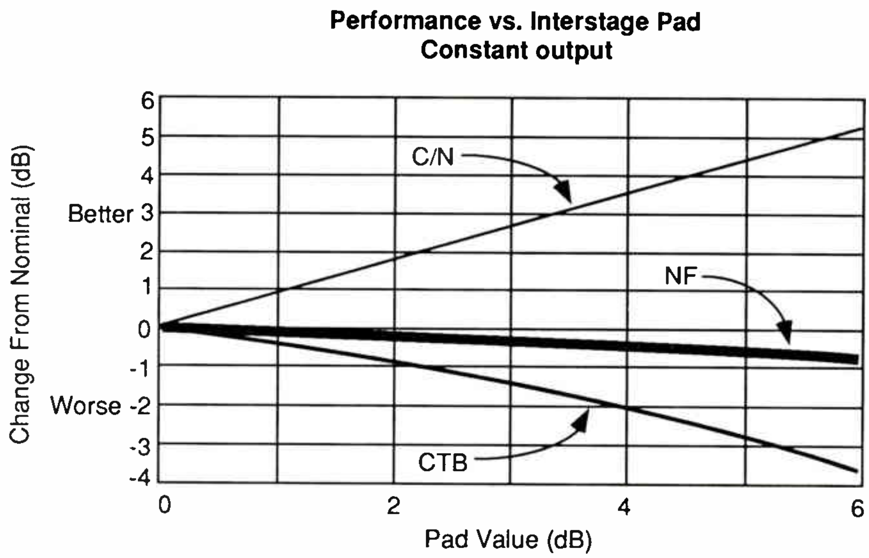
Additional margin sharing

As the interstage pad increases, the input pad decreases by the same amount. The sum of the two pads is always 6 dB. Although this may seem like a frivolous exercise, there may be reason for padding in both places at the same time. This practice may be desirable when the additional margin is to be shared between distortion and noise. The graph emphasizes the effects of the two pad facilities within the amplifier.

As the input pad is decreased in value from 6 dB to zero, and the interstage pad goes through corresponding increases, the CTB degrades by almost 4 dB while the C/N improves by more than 5 dB. A 3 dB pad in each location would result in a C/N improvement of 2.7 dB and with a 1.5 degradation of CTB. One should consider that by lowering the output of the amplifier at this point, the degraded CTB performance can be shared nicely with the carrier-to-noise ratio. This lower output level may be of assistance in the future when the system is expanded to include additional channels. Graph 3 appears identical to Graph 1 because raising the input to maintain constant output has the same results as decreasing the input pad, as in Graph 1.

The output pad

The output pad shown in the return path in Figure 1 is viewed as not having any effect on the local ampli-



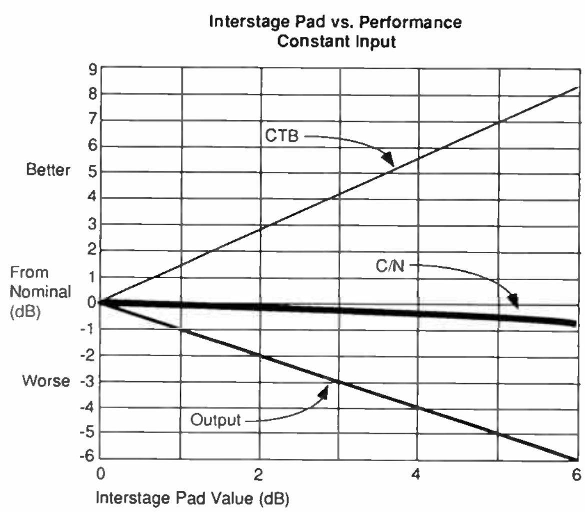
The effect of the interstage pad on the performance of our sample amplifier. The output is held constant.

Graph 1

fier, but affecting the signal level of the next amplifier. For this reason it is viewed to be a remotely located input pad and Graph 2 applies. This pad is quite useful in balancing the return path of a two-way system. It, along with a cable equalizer, allows balancing multiple return paths into a common return amplifier.

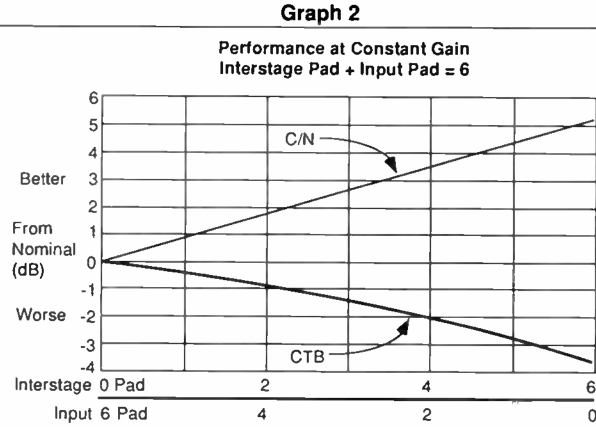
Observations

The above information can be used in a number of ways beyond choosing the proper pad in the proper location. For instance, cable attenuation changes with temperature. Automatic amplifiers compensate for this phenomenon by adjusting their gain and slope. Our example amplifier operates at 28 dB of gain. If this 28 dB of loss between amplifiers consists of pure cable, it would change 2.8 dB in loss over a range of 100 degrees Fahrenheit. The necessary change in gain is obtained through the variable interstage loss controlled by AGC and ASC.



Effect of the interstage pad while holding the input level constant.

Graph 2



Performance of sample amplifier at constant gain. Input pad and interstage pad are changed at the same time.

Graph 3

Referring to Graph 1 we can determine that CTB of our sample amplifier will change approximately 1.5 dB from hot to cold, while noise will change about 2.7 dB over the same range of temperature. This may be a somewhat simplistic conclusion, but certainly not without merit.

We can also analyze the proper use of controls and other facilities in a typical bridger module. The block diagram of a typical bridger module is given in Figure 2. This module is required to provide the highest possible output level for greatest efficiency of the distribution system. Its input level depends on the operational level of the trunk module. This output level may vary from 30 dBmV to possibly 40 dBmV. The bridger must have sufficient gain to provide the proper output level over this relatively wide range of input levels. If we use the gain control as shown in Figure 2 to compensate for this range of input level, the CTB ratio will suffer greatly. This range of signal level is off the scale (Interstage Attenuation) in Graph 1 and indicates that CTB may change by more than 4 dB by simply turning down the gain. For this reason, the gain control of the bridger should near its upper limit of travel. Use the pad facility to keep gain control within one dB or two dB of this point.

Summary

Our graphs were generated using performance criteria for the gain stages, as well as making assumptions of various losses which can be encountered in a trunk station. The graphs can be used to indicate a trend, but they will not apply directly to all amplifiers. For this reason, the information should be used with caution.

Fixed pad facilities within amplifiers help to operate the station at optimum performance. Proper selection of the pad and installing it in the proper position within the amplifier is essential. Use the interstage pad to favor carrier-to-noise ratio and use the input pad to favor distortion. Keep in mind that adjustments in operational signal levels, input or output, will complement the pad and may make upgrades easy. Choose the pads with care and they will help to operate the system at peak performance. ■

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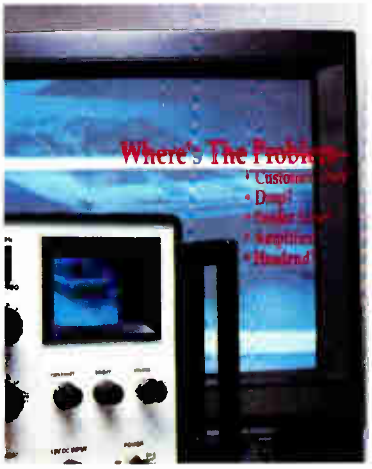

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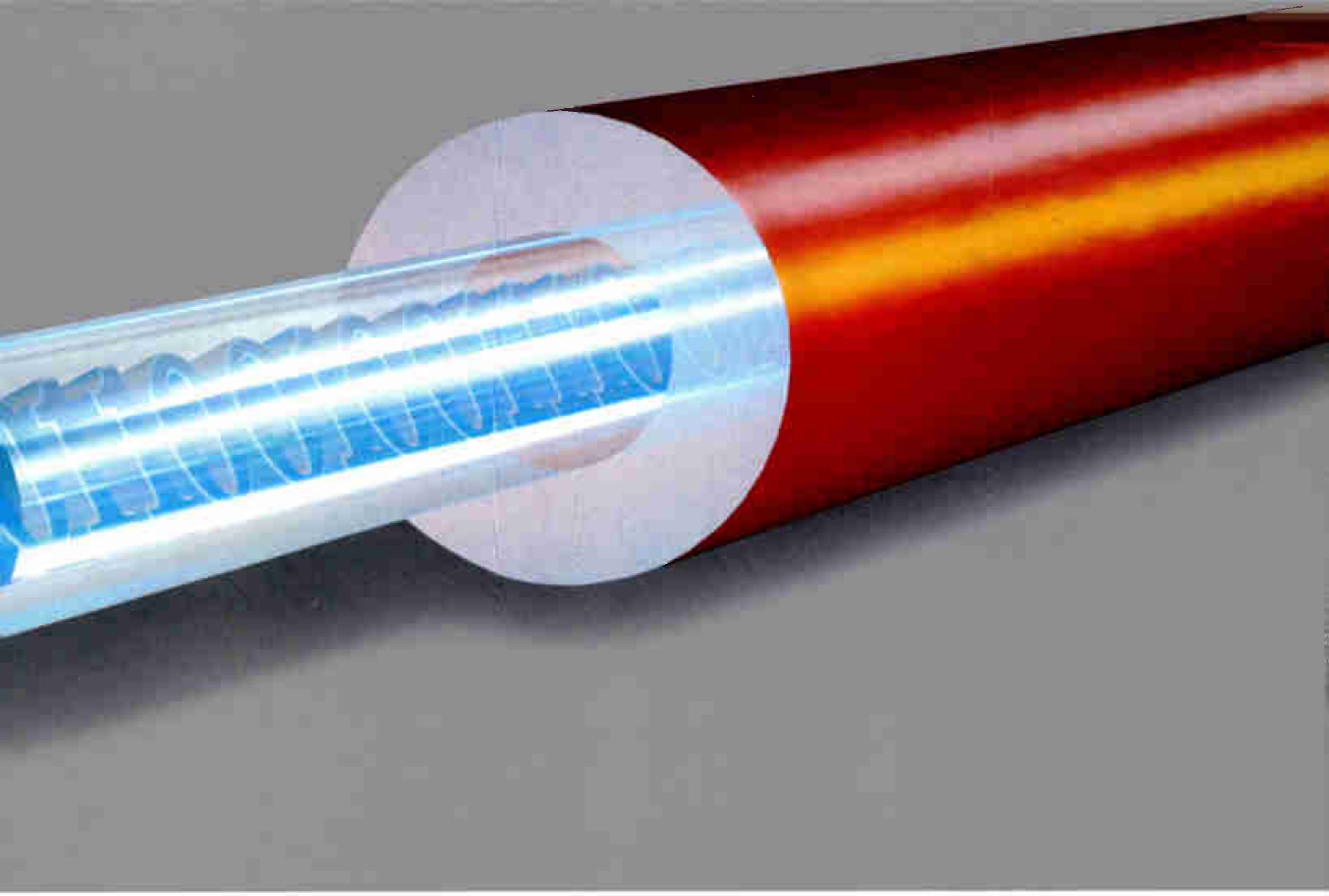

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SUMINET 5700

Specifications for 2.4Gbps PCM video transmission equipment

Specifications		NTSC 24 Channel	NTSC BTSC-Composite 20 Channel
Bit rate		2488. 32Mbps	2488. 32Mbps
Loss Budget		20dB	20dB
Max. transmission distance		50km (on 0.4dB/km loss SMF)	50km (on 0.4dB/km loss SMF)
Optical device		1310nm LD/1550nm LD InGaAs PIN PD	1310nm LD/1550nm LD InGaAS PIN PD
Video signal	Number of channels	24 ch / 48 using WDM	20 ch / 40 using WDM
	Coding	10.368MHz 8 bits	12.4416MHz 8 bits
	Amp. freq. response	20Hz-4.2MHz±0.5dB	20Hz-4.2MHz±0.5dB 4.2MHz-4.8MHz +0.5/−1.0dB
	DG/DP	<3% / 1.3°	<3% / 1.3°
	S/N (unweighted)		
	(weighted)	>60dB (*1)	>60dB (*1)
	Chrome/Lume Delay	<33ns (3.58MHz)	<33ns (3.58MHz)
	Line/Field tilt	<1%	<1%
	Luminance Non-Linearity	<4%	<4%
Audio signal	Number of channels	48ch / 96 using WDM	20ch (4.5MHz subcarrier BTSC) / 40 using WDM
	Coding	16 bits linear	
	Amp. Freq. response	20Hz-18kMz±0.5dB 18kHz-20kHz±1.0dB	
	S/N (unweighted)	>60dB	
	Distortion	<0.1% (1.04kHz, 0dBm)	
Size (inches)	Video	19×14×13⅜ (W×H×D)	19×14×13⅜ (W×H×D)
	Audio	19×7×13⅜ (W×H×D) × 2	
Power supply		90-130VAC or 180-260VAC	90-130VAC or 180-260VAC
Power consumption		to be estimated	to be estimated
Temperature range		0 to 40 degree Celsius	0 to 40 degree Celsius
Humidity		<85%RH	<85%RH

*1 target value (not yet evaluated experimentally)

Connectors:

Optical connectors	FC/PC type
Video connectors	1Vpp (Max. 1.2V) 75 ohms unbalanced BNC connectors
Audio connectors	+10 dBm Max. 600 ohms unbalanced (Option) Cannon connector ref: HA16PA-35 (TX) ref: HA16JA-3P (RX)

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MultiPort: Another missed opportunity?

Captioning law an open door, but is option too late?

On November 21, 1989, legislation was introduced in the Senate that would require closed captioning circuitry to be built into all television sets 13 inches and larger. It was subsequently introduced in the House as a separate bill, with the same wording, in March 1990. The bill passed the House and the Senate in May of 1990. The rest, as they say, is history. On October 16, 1990, President Bush signed into law the Television Decoder Circuitry Act, which requires television sets, 13 inches and larger, to contain caption decoding circuitry by July 1993.

The speed with which the bill flew through the legislative process delighted the subcommittees sponsoring the bill, as well as the National Center for Law and the Deaf, who did much of the footwork concerning the legislation. But to many in the cable industry, that same speed left a stunned silence and a regrouping of efforts to determine the law's impact on cable TV.

Out of this regrouping came a proposal to use MultiPort—a 21-pin plug used to interconnect external electronic devices to television receivers and VCRs—as a means of providing a captioning decoder for each television set. Because the MultiPort plug contains all the required input and output signals, a captioning decoder unit could be simply plugged into the MultiPort device.

Mixed views

This very option is causing a difference of opinion in captioning circles, television set manufacturers and the cable technical community. One question that comes to mind is, is the cable industry too late in trying to propose an option after the law has been passed? Another question concerns MultiPort's ability to meet the law's requirement—does the circuitry have to be built-in? And a final question rests squarely on the consumer—what is the best option, both technically and economically, for the consumer who eventually will pay for the end product?

Many of the answers to these questions rest with the Federal Communication Commission's (FCC) interpretation of the law. "If you read the law passed," says Wendell Bailey, vice president of science and technology for the NCTA, "it says the commission shall investigate putting this in. It doesn't say the commission will promulgate rules demanding that this (circuitry) has to be put in—but that's the way everybody is interpreting what has happened."

Walt Ciciora, vice president of technology for ATC, agrees. "I think what is required is the *capability* be there in all these TV sets. And I think the FCC is responsible for interpreting what that means and ensuring that it in fact happens. And of course, one way to do it is to just build the chip in and that makes the TV set capable of displaying captions. The question is, what can you do short of that, that still fulfills the requirements but at the same time is a little bit less onerous?"

> The speed with which the bill flew through the legislative process left many in the cable industry stunned.

Why MultiPort?

It is this question that possibly prompted the use of MultiPort as an option. It has been estimated that captioning will add $40 to $60 to the cost of a television set or VCR. (Zenith's Consumer Products Group Marketing Vice President Bruce Huber has been quoted as saying that estimates of $20 to $30 [premium] at retail are way too high.) This is a cost that will directly affect all consumers, regardless of whether they need, or want, the captioning capability.

Consumers pay the price

"The cost to the economy will be in the several hundred million dollar per year range," says Ciciora, "whereas up until now, no more than five million dollars have been spent for the people who need this thing." Ciciora's thoughts are that the proposed MultiPort approach would allow manufacturers to meet the requirements by having MultiPort installed and giving a low-cost (or perhaps no-cost) captioning plug-in module to those who identify themselves as hearing impaired.

"It would also fulfill the promise of MultiPort from a signal descrambling standpoint as well," says Tom Jokerst, assistant vice president and director of engineering for midwestern region of Continental Cablevision. "But it also means that if the manufacturer were to put on a MultiPort interface which should cost less than the captioning decoder circuitry, a number of things could happen that would have importance over time, much more than initially. One is that as captioning technology might improve, you would be able to upgrade your captioning decoder by merely unplugging or plugging it into the TV set.

"Another thing," continues Jokerst, "is if you have a failure, you don't take the whole set in for repair, you merely change the captioning decoder section. And most importantly, if a future technology that we might utilize in some respect happens to create a conflict with the captioning system, then you've got a way around it, you can change the captioning decoders."

Another, more immediate, advantage to using MultiPort is the availability of such devices. There are currently in excess of 500,000 television receivers with MultiPort circuitry installed. On the other hand, set-top captioning decoders only number ap-

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major effect on the captioning industry. "We anticipate that in July 1993, when the audience grows from today, which is perhaps as much as one million people, to in the first year, 20 million and then 40 million, and 60 million, yes, we anticipate this to have a major effect."

"It's great not only for deaf and hard of hearing people in this country," says Thieme, "but in years to come it will be found to be one of the best things to ever happen for anybody concerned about the literacy problem in this country—immigrants learning English as a second language, adult illiterates, children learning to read—all these population groups can benefit from being exposed to captioned television."

But the question of captioning is not being opposed by the cable industry. Instead, the concerns over compatibility, future technical requirements and economic costs have all led to the proposed MultiPort solution. "And of course on top of all this," says Ciciora, "is the fact that the same MultiPort plug on the back of the TV could be used by the rest of us for our cable descrambler or for interconnecting to other devices such as Nintendo games, home computers, DBS receivers and so forth."

Captioning without MultiPort

The remaining question rests with the FCC's Notice of Proposed Rulemaking. Now that the Rulemaking has been issued, and once the 45 day response period is over, there is then time for a reply comment. Once these two stages are complete, the FCC will work to put out its final report and order.

LARRY GOLDBERG

'All it really means is that the cable operators will have to be sure they're not stripping the captions.'

And if the final outcome is to have built-in captioning circuitry, what does that mean for the cable industry? "There's really nothing they have to do," says Goldberg. "All it really means is that cable providers will have to be sure they're not stripping the captions—maybe the program providers will feel greater pressure to caption more of their materials."

"Captioning obviously will help some people," says Bailey. "The fact is, it means all TV sets are going to be costing more, yet it is indisputable that the majority of people who buy them, don't need them. So that is a cost the government has foisted on every citizen in order to help a few.... There will be more people out there watching captioning so the selling of captioning services will be easier and that means more programs will be captioned. So in that regard, programmers will feel somewhat more pressure to caption."

How the law is interpreted, and technical specifications written, remains to be seen. "If (the law) is really strict and forces something to be built-in so that every TV you buy has captioning on it," says Ciciora, "then we might be too late—and we might have missed a really significant opportunity." ■

—Kathy Berlin

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Reader Service Number 25

Specifying directional couplers for CATV distribution systems

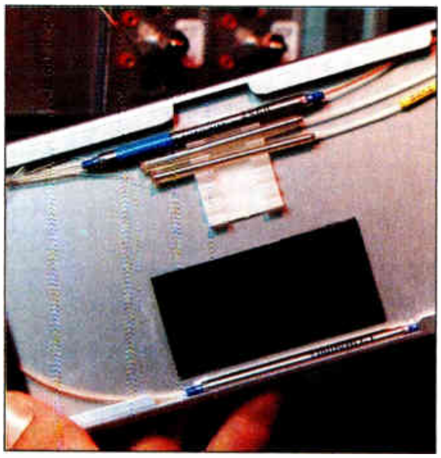

Figure 1

Coupler intensive cable television network architectures are providing a cost-efficient transition from bandwidth-limited coax systems to the considerable technical and operational benefits of fiber. The optical systems present designers and operators with some new engineering challenges, however, in terms of optical power distribution, performance and reliability.

New cable TV systems extensively use directional couplers and splitters to extend fiber transmission deep into the distribution network. Proper component selection is critical to achieving consistent and balanced optical power throughout a system.

Essential for optical resource sharing, high-performance couplers passively split or combine laser power. Because they introduce very little loss, couplers distribute single source transmissions to two or more receivers without exceeding tight power budgets.

Splitters (or tree couplers) equally split optical power between two or more output channels. Directional couplers (or taps) can be made to divide a signal unequally (60/40 or 80/20, for example) according to the specific requirement of the system. This makes them exceedingly useful in the power-sensitive cable television distribution systems. With selected tap ratios, these devices can be used to compensate for variations in signal loss along diverse fiber routes, providing overall optical power balancing and consistent performance throughout a system (see Figure 1).

By Curt Weinstein, Sales Engineer, Components, Corning Inc.

FTF architecture

By reducing the number of expensive lasers needed to build fiber-optic systems, couplers are helping fiber to penetrate cable networks deeper than ever before. New network designs, utilizing advanced component technology, are enabling fiber's passive migration into local feeder systems.

Figure 3

Notably, the new coupler-intensive fiber trunk and feeder (FTF) architecture delivers headend optical transmission directly to local distribution loops without an intervening coaxial trunk network. Fiber/coax hubs in the distribution nodes detect the optical transmission and convert the signal to RF for neighborhood distribution via subscriber-friendly coax drops (see Figure 2).

Roughly analogous to fiber-to-the-curb telecommunications architectures, FTF uses 1x2 directional couplers in the headend and in optical distribution nodes to achieve extensive laser signal branching. In certain situations, 1x4 splitters also might be used. In this way, couplers make FTF network designs economically feasible.

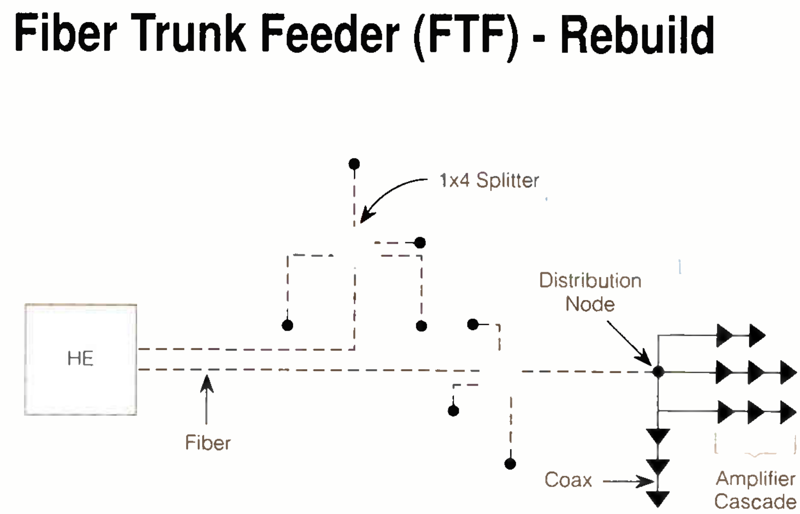

Figure 2

A typical FTF system employs on average 2.5 couplers per laser, in turn reaching 3.5 receiver nodes. Each node feeds an average of 400 drops, allowing a single laser to service approximately 1,400 subscribers. So, couplers more than triple the average number of subscribers served by each laser—accounting for a two-thirds reduction in opto-electronic cost.

Coupler performance requirements

System design, including component specifications, ultimately is determined by all the performance factors that contribute to the desired customer service quality.

Maintaining picture quality in FTF cable systems demands an unimpeded carrier signal with negligible distor-

Working Example

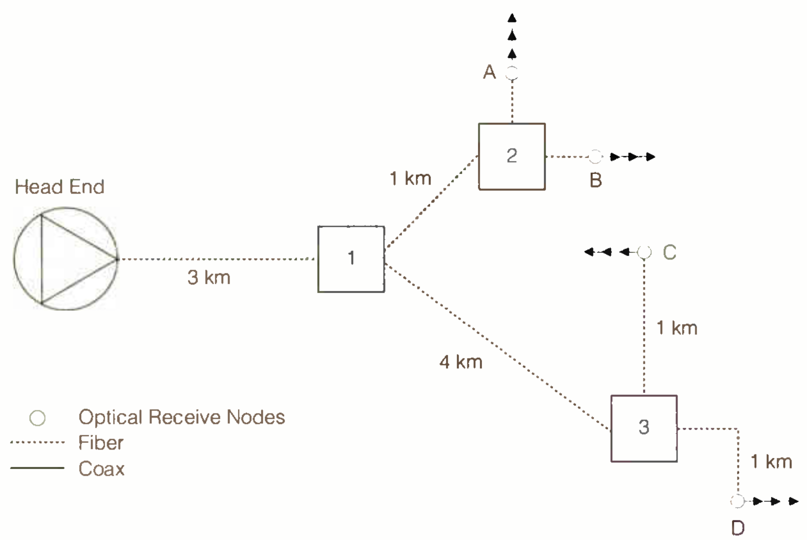

Figure 4

tion products. A carrier-to-noise ratio (CNR) of better than 50 dB is required for acceptable video levels. Limiting composite second order (CSO) and composite triple beat (CTB) to less than 60 dB to 65 dB is usually required to prevent non-linear distortion effects from degrading system performance. These values are typical for loss-sensitive AM video transmission systems.

In order to achieve the desired performance in an FTF system with AM transmission, typical optical link budgets usually total between 10 dB to 12 dB per link.

A 1x2 tree coupler, by virtue of splitting the optical power evenly (50/50) between the two output channels, introduces a theoretical optical loss of 3 dB on each channel. A 1x4 splitter introduces a 6 dB theoretical loss on each output leg. However, the insertion loss represents the total optical loss actually introduced by the coupler. This includes the theoretical loss as well as the added contributions of the device from excess loss, wavelength dependence and non-uniformities in splitting.

For example, subtracting 7 dB per channel for a 1x4 signal splitting in the distribution node of an FTF system would result in an optical budget on the order of 3 dB to 5 dB. Assuming, conservatively, 0.4 dB/km to 0.5 dB/km for fiber cable loss, one could extend the system between six to 10 km, or about 3.5 to six miles from the splitting point.

Obviously, lower losses would permit longer trunks or improved CNR, CSO and CTB. So, the selection of highly efficient couplers with lower insertion losses becomes essential (see Figure 3). And more important, the possibility of counterbalancing uneven lengths becomes a critical requirement on the directional couplers.

Designing with directional couplers

Determining the ideal power ratio is an iterative process that usually begins by examining the network area layout. Factoring in the concentrations of subscribers and the desire to keep line extenders to a maximum of three from a node site yields a layout of the fiber distribution routing plan.

Starting at a headend and a known distance to an optical receive site, it is possible to work backwards from these detector locations. Depending on the specific performance requirements of the system, it is possible to assume that a laser will provide a given optical margin. Total anticipated link-loss budgets then can be calculated by adding estimated cable attenuation for fiber routes (based on distance) to insertion losses attributed to all splices. As in coaxial networks, when power loss or gain is expressed in terms of decibels, the units can be added linearly, so the combined effect is the sum of individual contributions and losses.

The resulting budget is used to "weigh" the total losses in each fiber link against the available power range differential between the source output and receiver sensitivity. If sufficient power exists, it is possible to calculate what tap ratios should be specified for directional couplers used in signal splitting.

Legs "A" & "B" Loss Budget

4 km cable at 0.4 dB/km (3 + 1 km)	1.6 dB
1 1x2 splitter at optical splitting location #2	3.5 dB
10 splices at 0.1 dB maximum loss includes: cable, couplers, maintenance splices, TX/RX terminations	1.0 dB
Safety margin	0.5 dB
Total link loss:	**6.6 dB**

Legs "C" & "D" Loss Budget

8 km cable at 0.4 dB/km (3 + 4 + 1 km)	3.2 dB
1 1x2 splitter at optical splitting location #3	3.5 dB
20 splices at 0.1 dB may loss/splice includes: cable, couplers, maintenance splices, TX/RX terminations	2.0 dB
Safety margin	0.5 dB
Total link loss:	**9.2 dB**

Table 1

Designing With Couplers

Corning Directional Couplers
Passband 1285 - 1330 nm

Tap Leg Max Insertion Loss (dB)

Thru Leg Max Insertion Loss (dB)	11.3	7.9	6.0	4.7	3.5
0.9	90/10				
1.4		80/20			
2.0			70/30		
2.8				60/40	
3.5					50/50

Coupler Splitting Ratios (%)

Table 2

In FTF architectures, optical resource sharing is accomplished by in-line placement of 1x2 directional couplers. Their individual tap ratios will allow—after all losses are debited—both affected fiber links to maintain sufficient optical power margins.

To demonstrate how to calculate tap ratios for directional couplers, consider the cable television system represented by Figure 4. It shows the optical paths from the headend to points A, B, C and D. The objective is to identify the optimum directional coupler for location number 1.

The initial step of this process is to add all losses along each of the legs and to the distribution node, and then compare the total losses on each leg with the available laser power. In order to simplify the sample, the distances of each optical distribution node are equal. Link-loss budgets apply to fiber links to each of the four nodes in the system as seen in Table 1.

If both links are served by the same laser with an optical margin of, say, 12.5 dB, the optical budget for the directional coupler in legs "A" and "B" is 12.5 dB minus 6.6 dB, or 5.9 dB, and likewise 3.3 dB in legs "C" and "D" (12.5 dB minus 9.2 dB).

Once these optical budgets are known, the most effective tap ratio is easily determined. The longest leg from the headend is the most loss sensitive of the two optical paths, and the optical margins calculated for the two couplers represent the maximum losses the devices may introduce.

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3	12	21	30	39	48	57	66	75	84	93	102	111	120
4	13	22	31	40	49	58	67	76	85	94	103	112	121
5	14	23	32	41	50	59	68	77	86	95	104	113	122
6	15	24	33	42	51	60	69	78	87	96	105	114	123
7	16	25	34	43	52	61	70	79	88	97	106	115	124
8	17	26	35	44	53	62	71	80	89	98	107	116	125
9	18	27	36	45	54	63	72	81	90	99	108	117	126

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Table 2 shows the insertion losses introduced on the through leg and the tap leg of directional couplers for tap ratios at 10 percent intervals from 90/10 through 50/50.

It indicates that with an optical margin of 3.3 dB, a 60/40 coupler would be most appropriate. It would not exceed the loss limitations of either path.

Other coupler requirements

Another critical specification criteria is backscatter. Optical reflections back into a laser cavity from couplers, splices and fiber impede the laser's performance, resulting in noise, reduced margin or even failure. Couplers with low reflection, or backscatter (less than 50 dB) as well as high directivity (less than 55 dB) will maintain CNR performance and minimize CTB and CSO effects.

Outside the headend, couplers may be exposed to harsh operating conditions, with temperature and humidity extremes. Rugged, environmentally durable components, tested to endure -40 degrees Celsius to +85 degrees Celsius with humidity to saturation, usually are recommended.

90/10 Tap Achromatic Coupler

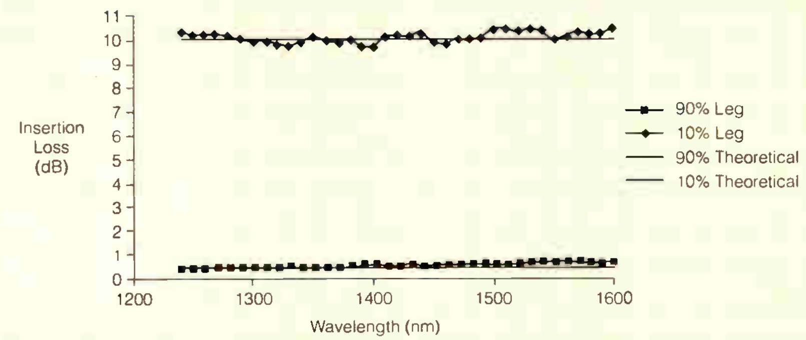

Figure 5

Future system upgrades that add subscribers, increase services and enlarge feeder areas may require products that offer simultaneous achromatic optical performance in multiple wavelength operating regions (see Figure 5). One of the most compelling motivations for expanding into the 1550 nm window will be the availability of emerging optical amplifiers. This technology—which offers nearly unlimited extension of optical networks without adding lasers—operates only in the 1550 nm wavelength region in current designs.

New cable television architectures extend optical fiber into local feeder networks. The fiber-optic couplers inherent in the new FTF network design, for example, optimize the sharing of costly lasers. Directional couplers are essential to this approach in that they can divide source power using to specific tap ratios that result in optimal optical performance. ■

Addressable technology: Expanding cable's roles

It is virtually impossible to pick up a recent trade publication without reading at least one article on addressable technology. Whether it be enhanced converters, digital audio, off-premise technology or digital compression, addressability is clearly here to stay.

As the 1990s unfold, the vast level of services made available through addressability—and in particular, interactivity—will inevitably expand the role of the cable operator in home information and entertainment. Thus, when evaluating addressability, it is important to consider not only its present role, but the more global picture of its role in cable for the future.

Benefits of addressability

Addressable converter technology was introduced in large scale in 1980 principally to benefit the cable operator. These benefits were largely categorized as either generating additional operator revenue or reducing operating costs. Figure 1 diagrams a basic one-way addressable cable system.

By Dan Moloney, Director, Product Management, Jerrold Comm., Subscriber Systems Division

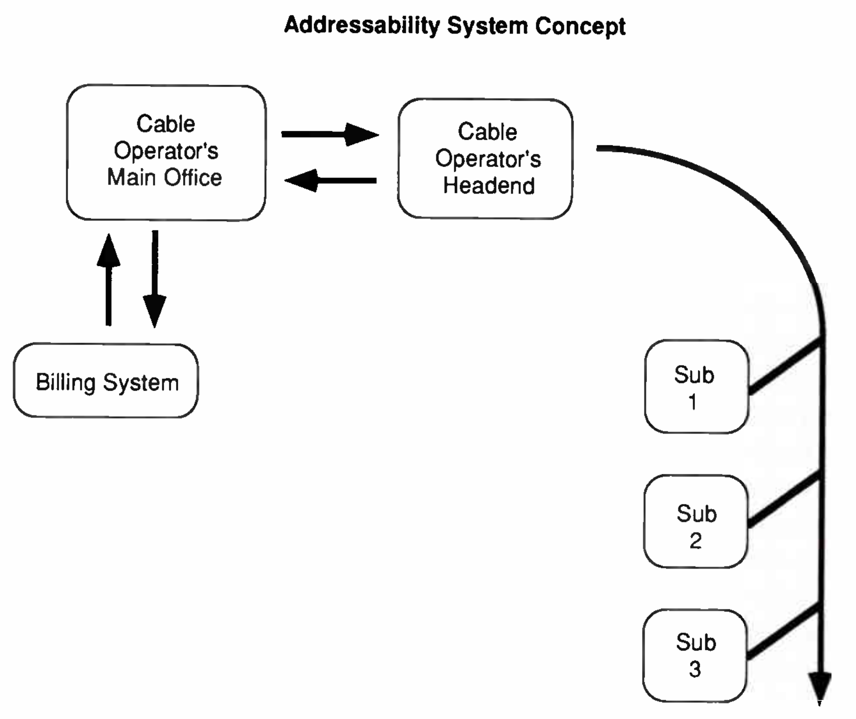

Figure 1

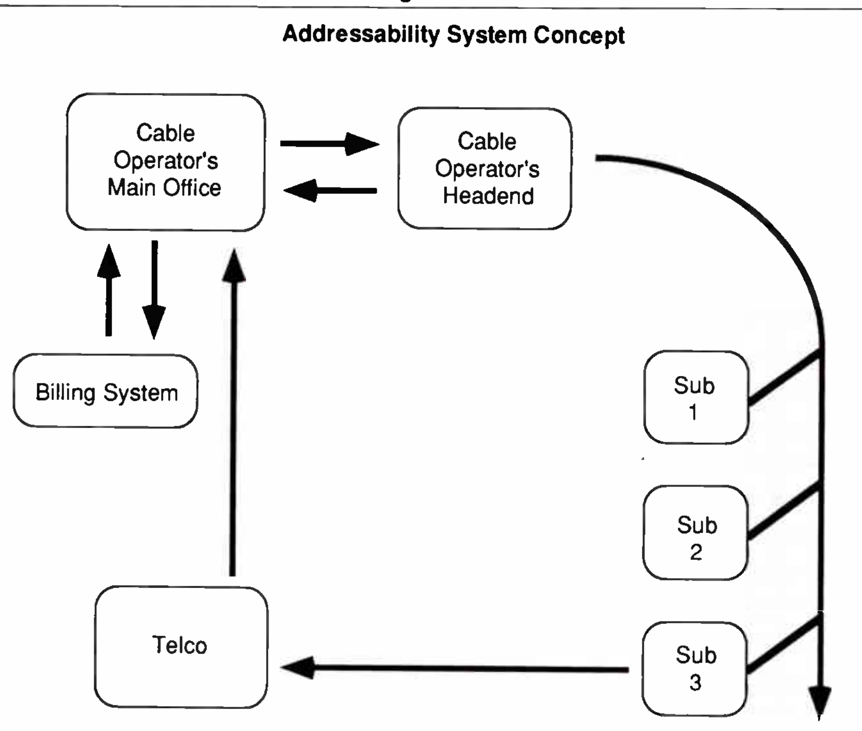

Figure 2

Enhanced revenue opportunities resulted from the ease with which pay-per-view (PPV) and multipay services could be provided to a large portion of the subscriber base. By using the enhanced promotional capabilities of barker channels, operators could effectively advertise these new services and thus increase the subscription level with traditional non-pay subscribers.

Along with the expanded revenue options, addressability also offered a way to reduce operating costs. When compared with conventional descrambling converters, addressability was a way to reduce the costs of installation and churn. It also could readily ease changes in channel line-ups resulting from the addition of new services. While support at the cable operator's main office required some added costs, the overall impact remained a net operating cost reduction.

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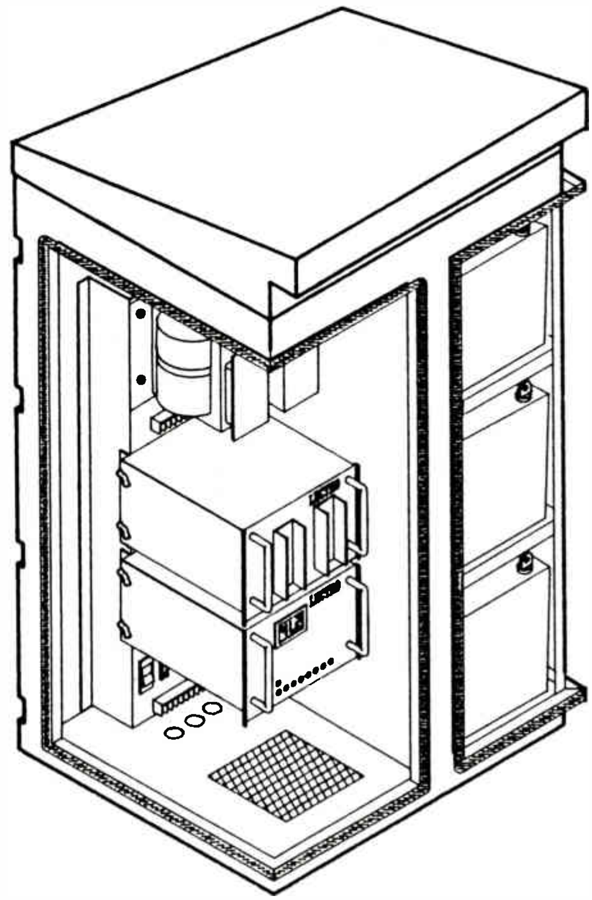

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Reader Service Number 31

ers have also begun to realize some advantages. First, they can see the flexibility addressability provides for near instantaneous response to changes in service authorizations, whether subscription services or PPV events. In addition, subscribers got their first glimpse of cable's transactional nature through two-way addressable technology, either on a real-time basis or via store-and-forward technology. Figure 2 diagrams the expanded two-way system concept.

For addressability to continue as cable's leading edge technology, though, its role in the cable system must continue to expand. While the form of addressable consumer product has been the subject of much recent debate, it is clear that a presence within the subscriber's home must be maintained to provide the full extent of these potential services.

Addressable terminal of the future

In discussing the in-home terminal of the future, the concept of today's converter comes most readily to mind. While many of the capabilities of today's product will certainly remain, the actual converting (i.e. timing) function will play a much smaller role in tomorrow's overall product concept. Instead, the human interface will dominate.

The physical shape and aesthetics of the terminal must still be defined, but it will undoubtedly be remotely located and controlled. While most communication today occurs using an IR scheme, a migration toward a bi-directional RF scheme seems more likely in order to eliminate the need for unobstructed point-to-point directional communication and to facilitate interactivity. (This also blends nicely with providing other telephony-type services in the home, as I will discuss later.) The remote itself will be much simpler than today's typical unit, as sophisticated on-screen graphics and icon-accessed menus eliminate the need for full functionality.

The subscriber terminal will provide access to a wide variety of programming services, as digital compression facilitates the delivery of many more channels. Both video and audio services will be available through the tuner, both in standard NTSC video/BTSC audio formats and in enhanced quality formats (for example, high definition video/CD quality audio.)

An added benefit of the digital technology will be to ensure subscriber access to the unit is adequately controlled. By using high level encryption schemes for security, programmers will also make available more first-run movies in a near video-on-demand arrangement. This will give subscribers more control of their entertainment selection.

Enhanced services

With a much simpler human interface and the availability of expanded programming, subscribers will finally reap the full benefits of cable interactivity. High speed information downloading will enable consumers to interact with an electronic programming guide. This guide will not only contain information relating to program content like today's printed program guide, but will also contain the data services

What is vitally important when considering addressability now is the expanded world of addressability in the future.

of interest to the subscriber. For example, stock information and sports scores, customized to the subscriber are two potential areas that can be readily accessed, truly on demand.

Also through this same interface, the push of a button will permit automatic programming of the VCR, either through the VCR's IR receiver or a telephone interface that is beginning to be included in VCRs. If the subscriber wants to save the data, the button push will dump the information to a computer for storage on disk or even directly to a printer or a fax machine for hardcopy printout.

Electronic home integration

Electronic home integration (EHI) will also become another enhanced service to subscribers through this addressable terminal interface. Teleph-

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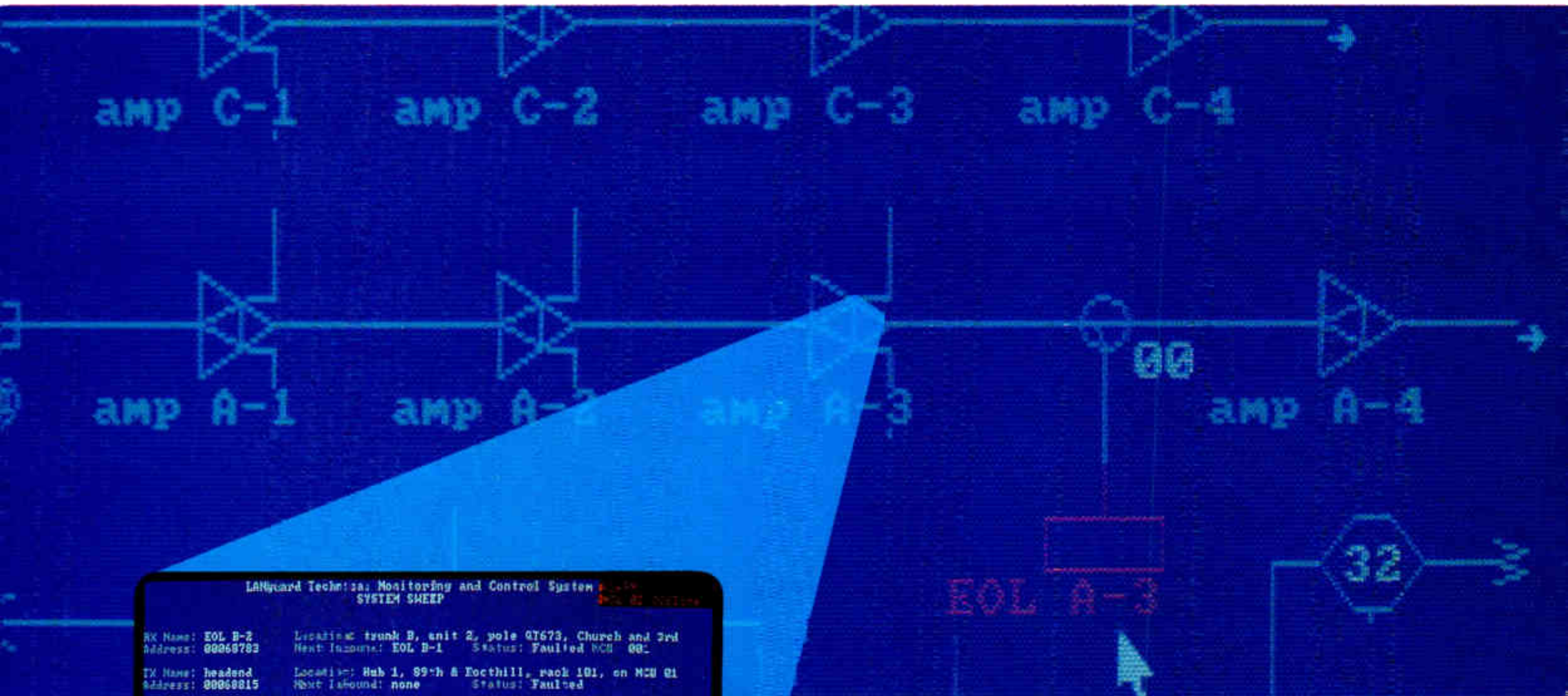

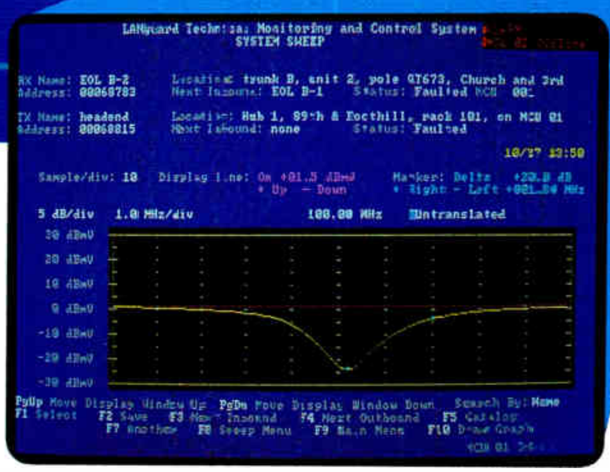

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Reader Service Number 34

Integrated Home Block Diagram

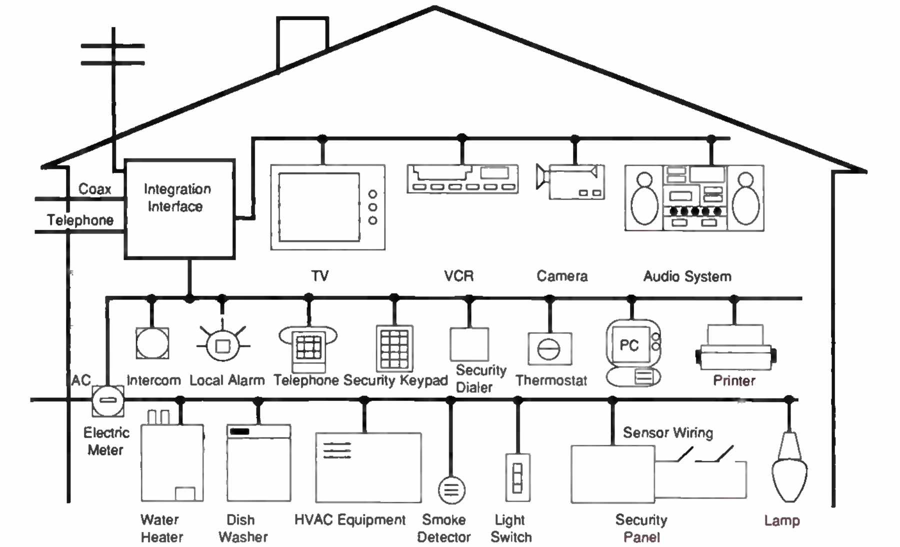

Figure 3

ony-type services can be accessed through a remote control which doubles as a cordless telephone, communicating with the terminal via two-way RF. The switched-star telephone network can continue to be used for the telephone services, or replaced by a two-way cable fiber network. Beyond telephony, electronic home appliance control will enable subscribers to use this same interface to interact with any delivery within the home. Thus, the terminal will become the nerve center for all electronic operation within the home. Figure 3 demonstrates several of the devices that could be controlled over various in-home networks.

Futuristic capabilities

Beyond these enhanced services, tomorrow's addressable terminal will ultimately expand even further in simplicity and functionality. User-independent voice recognition technology will enable subscribers to eliminate the handheld portion of the remote control altogether. Voice commands will supplant buttons, giving subscribers total freedom from the physical attachment to the remote. In addition, this will permit voice response units to be located in various rooms within the home, communicating with the central home terminal either via RF or over the home bus network.

Coupled with voice response, voice synthesis will allow the terminal to talk back to the subscriber. Thus, as a supplement to the on-screen graphics, voice response will allow the subscriber to be completely removed form direct visual contact with the display device. Two-way interactivity between the subscriber and the terminal will then be truly on-demand, available at any time or place within the home, and customized for the individual user.

With the cost of memory devices continuing to decline, and as submicron chip technology becomes more commonplace, the ability to store large quantities of data (or digital video) will become economical. Thus, subscribers will be able to issue a voice command to their unit to retrieve the latest hit movie from the video library maintained by the operator and within minutes, the program will be dumped to a storage device within the home. The terminal may then confirm the data's retrieval and ask the subscriber whether he wants to view the program now, in ten minutes or permanently store it for later viewing.

Not far off

While many of these capabilities might seem far-fetched, they are very likely to occur in the 1990s. Most of the technology is available today on a small scale and for high costs. It will not be more than three to five years, however, before the costs drop to the level necessary for most to become realistic.

What is vitally important when considering addressability now, therefore, is not simply the product of today, but more appropriately the expanded world of addressable technology in the future. ■

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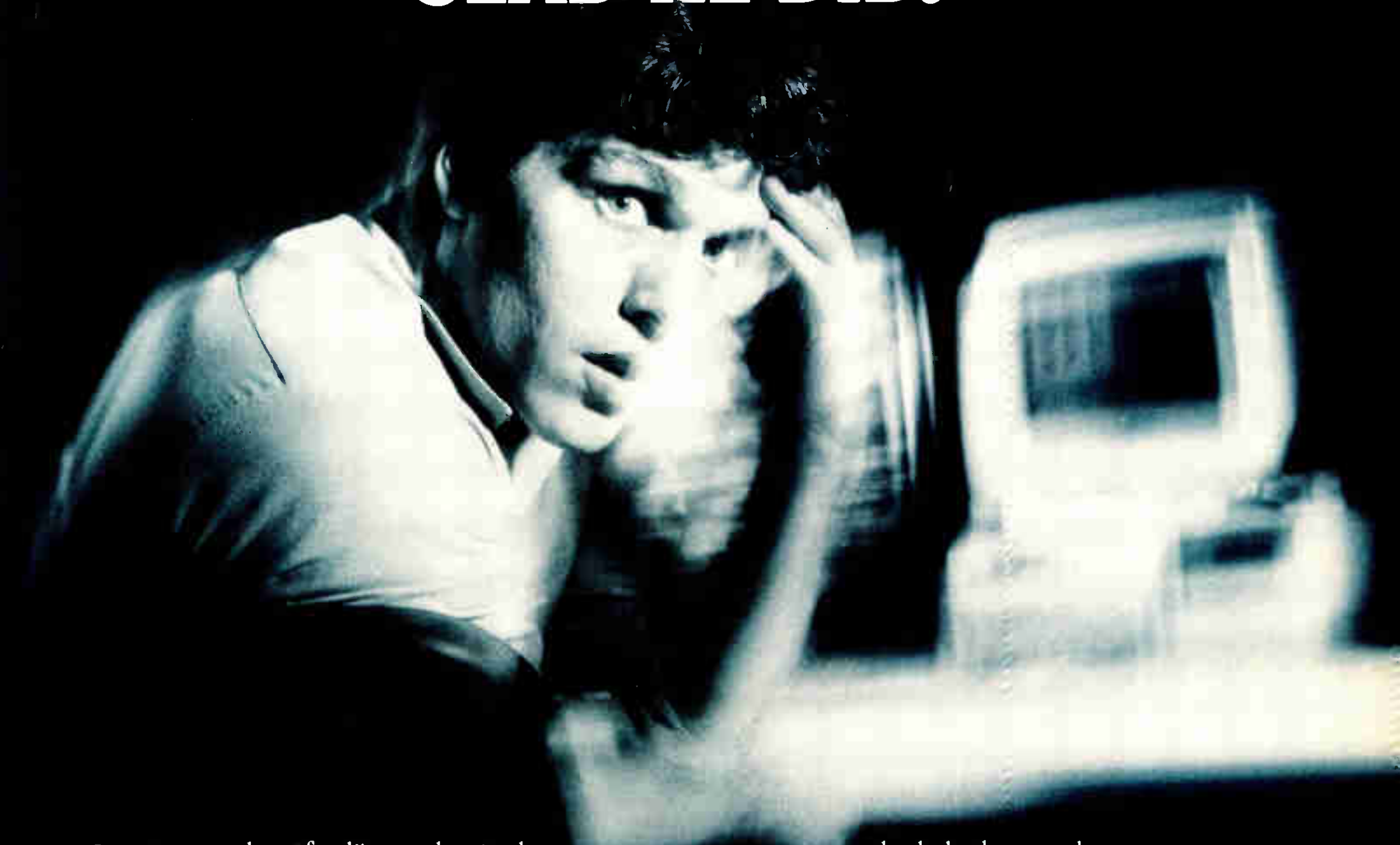

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Reader Service Number 35

Fundamentals of optical fiber communication systems

This article (second part of two) highlights the basics of optical fiber communications and its application in the CATV environment. Several key topics in fiber optic communications are covered, including a discussion of optical transmitters and receivers and modulation techniques.

The fiber optic transmitter module has the task of converting electrical signals into optical signals. Two types of devices can be employed within the transmitter—light emitting diodes (LEDs) and semiconductor laser diodes. Both of these are no larger than a grain of salt and are made of the same types of same semiconducting materials. LEDs are relatively inexpensive and have gained widespread use in short-haul data links such as local area networks, bar code readers, calculators, electronic status indicators, etc. Laser diodes are predominantly used in CATV transmission systems and long-haul telecommunication networks.

Theory of operation (LED): An LED is basically a crystal in which impurities are added (doped) to create two dissimilar materials. A pure crystal will theoretically have all its outer electrons engaged in the bonds that hold the atom together. When the electron is part of the bond it is in the valence band. When an electron is free and available as carrier it is in the conduction band with more energy than one in the valence band. Adding dopants creates an area of N-material which have extra electrons not needed for the bonds and an area of P-material which do not have enough electrons to fill all bonding sites. These vacancies in the bonding sites are called holes and act like particles with a positive charge. Thus the P-material contains positively charged holes and the N-material contains negatively charged free electrons. The two dissimilar materials meet at the PN junction which is void of free electrons and holes. This area is known as the depletion region.

Although the free electrons and holes are attracted to one another, they do not possess enough energy to cross the depletion region. When a bias current is passed in the proper direction through the crystal, the depletion region breaks down. This allows the free electrons and holes to move toward the junction and across it. As an electron and hole meet, they recombine and the electron moves from the conduction band to the valence band. In doing this, the electron gives up energy in the form of a photon of light. Since the electrons give up different amounts of energy, the light emitted will be composed of a number of different wavelengths (Figure 11).

LEDs generally cannot achieve the level of performance required in long-

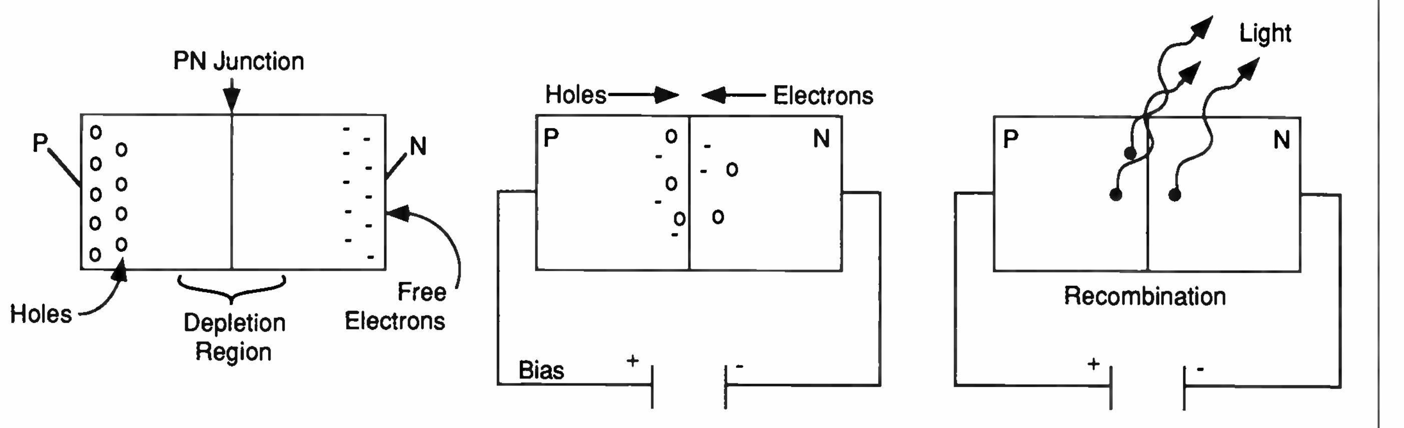

Figure 11

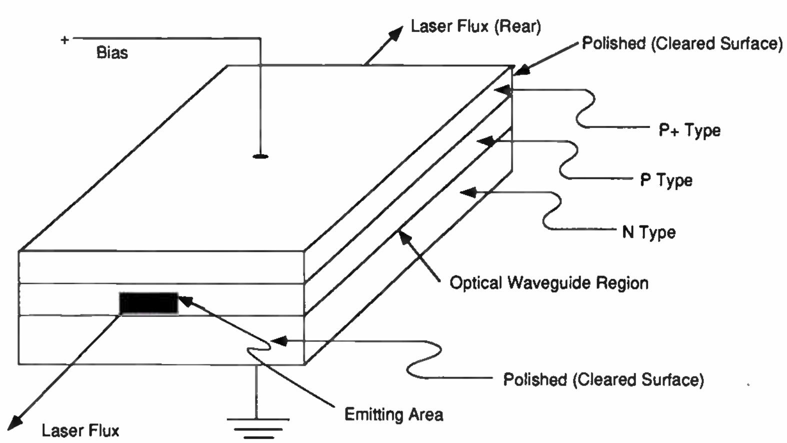

Figure 12

By Robert Harris, Fiber Optic Staff Engineer, C-COR Electronics, Inc.

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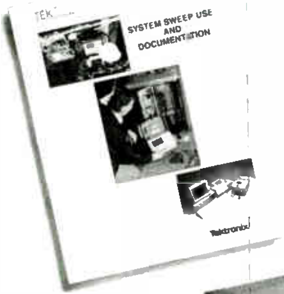

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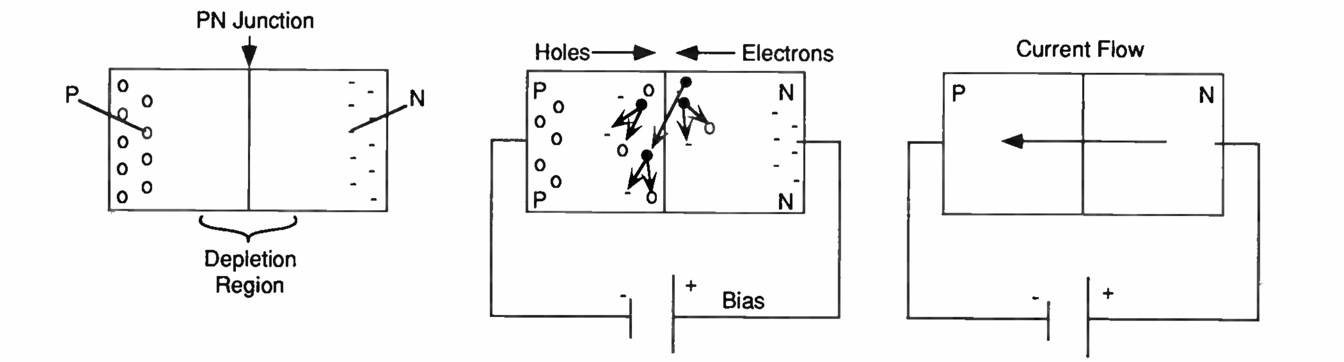

Figure 13

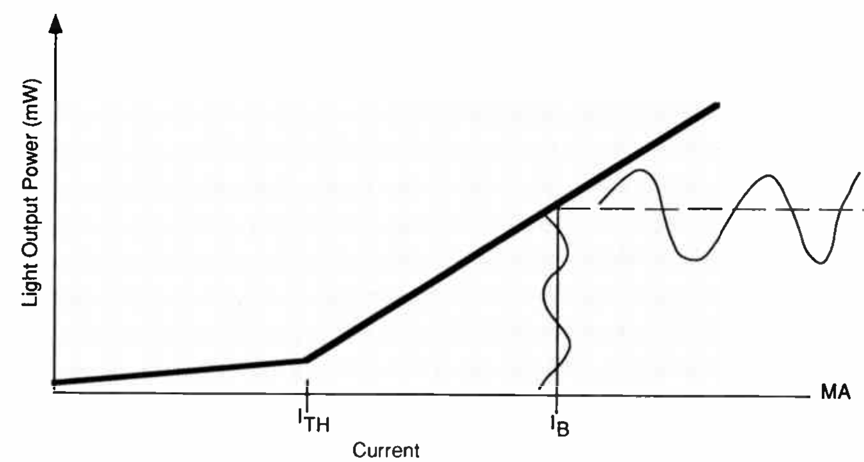

Figure 14

the intermodulation distortions. Further, a larger optical loss corresponds to a lower carrier-to-noise ratio, thus limiting the distance of a fiber link. Actual link distance depends on channel loading, laser output power, received optical power and pre-amplifier circuitry.

Frequency modulation: Subcarrier FM has been used quite effectively in multichannel CATV systems. At the headend, baseband video signals are frequency modulated onto an RF carrier then combined and transmitted over the fiber. The FM based system requires more bandwidth per channel (18 to 40 MHz) than an AM system which results in a reduced channel loading capacity—typically 16 channels per fiber. However, there is a significant improvement in the overall signal-to-noise ratio as well as an increase in the distance over which the signals can be transmitted—about 24 dB of optical loss. A typical CATV application is long haul point-to-point or point-to-multipoint signal delivery. However, at the receive site, the FM signals must be demodulated then remodulated using VSB-AM on the correct RF channel in order to transmit the signal on coax to the home. The equipment needed for this must be housed in an environmentally protected building. Additionally, there are limitations to the number of times the FM signal can be repeated due to penalties in the carrier-to-noise ratio.

Digital modulation. By far the greatest advantage to uncompressed digital transmission of video is its ability to transmit signals over very long distances (28 dB of optical loss) with little degradation of signal quality. Digital systems provide a means for transparent signal regeneration and repeating. The signal quality is, therefore, independent of distance. At the headend, up to 16 baseband video channels are routed to an analog to digital (A/D) converter that changes the information into a digital form (ones and zeroes). The digital channels are then time division multiplexed (TDM) and sent to a laser transmitter. The laser transmitter then converts the electrical ones and zeroes into light pulses by turning the laser on for a one and off for a zero.

Transmission rate is approximately 1.5 gigabits per second (GB/s). At the receiving end, the light pulses are converted back to electrical pulses, demultiplexed (TDD) and sent to a digital to analog (D/A) converter where the information is converted back into a baseband video signal. The recovered baseband signal is then applied to the appropriate RF modulator, combined and distributed over the coax portion of the system. As with FM, the receiving equipment must be in an environmentally protected building. Although uncompressed digital systems are highly bandwidth inefficient, this will matter less as future fiber systems evolve to greater bandwidths. ■

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Reader Service Number 40

SCTE fiber seminar attracts 575 persons to Orlando

Despite the well-publicized downturn in the CATV economy, nearly 600 technical personnel from cable systems and equipment manufacturers turned out in Orlando, Florida for Fiber Optics '91, a two-day seminar sponsored by the Society of Cable Television Engineers.

The event clearly mirrored fiber optic activity ongoing within the industry. A common theme expressed throughout the papers—as well as the private conversations—was that fiber technology has matured to the point that it has some level of application in every CATV system. According to Jim Chiddix, senior vice president of engineering and technology at American Television and Communications and a conference moderator, said the conference demonstrated that fiber trunking has become a "given" in system upgrades and rebuilds.

Many presenters indeed focused on the concept of fiber to the feeder, with some noting that ATC's Fiber Trunk and Feeder architecture literally stopped rebuilds in their tracks and sent engineers back to their drawing boards. For example, Paragon's rebuild of St. Petersburg, Fla. was radically altered. "Construction of conventional plant stopped in July of 1990!" wrote Eugene White, Paragon's vice president of engineering. "Fiber to the feeder offered advantages over conventional architecture."

Other operators, however, noted that designing an FTF system isn't always as easy as it's been made to seem. "The simplicity of FTF architecture was deceiving," wrote Thomas Staniec, a chief engineer for Newchannels. "However, our interest in FTF and its impact on the future of CATV kept us focused on it," he added.

The SCTE seminar—which appears to be headed for annual status—included something for everyone. Construction practices and guidelines were intended for those on the brink of a fiber install. Managers were given a feel for fiber's present and future economic benefits via detailed cost analyses versus conventional materials. Fiber's performance was sized up for engineers and some new product developments—including use of the 1550 nm window, voice and data delivery, and digital equipment—were explored.

In fact, a few eyebrows were raised when Al Johnson, director of technical operations for Cablevision Systems, predicted that optical amplifiers would be available for cable-television use within the next 6 to 8 months. Meanwhile, the discussions surrounding use of 1550 nm equipment vs. the popular 1310 nm gear were raised a few notches by contributions from ATC, AT&T and Synchronous Communications. While most manufacturers acknowledged improvements in lasers designed for 1550 use, they concluded that the benefit of increased signal range was largely offset by problems with dispersion.

CableLabs announcements

Two new staff positions were approved, including a senior electronics technician and an engineer for advanced network development. Additionally, all current board officers, executive committee members, officers and technical advisory committee members were reappointed through 1991. New board members James Kingsdale, president, Paradigm Communications and James O'Brien, president, Jones Intercable were elected and seated.

In other CableLabs news, Dr. Richard Green, president and CEO of the Labs, was appointed chairman of task group 11/1 of the International Radio Consultative Committee (CCIR). The task group, organized and coordinated through the U.S. Department of State Bureau of International Communications and Information Policy, is working to establish international studio and program exchange standards for high definition television (HDTV). Greene's expertise in this area has spanned more than ten years, having been directly involved in his pre-CableLabs days with the Public Broadcasting Service days and, before that, with the CBS Advanced Television Technology Laboratory.

Product news

Alcoa Fujikura Ltd. has announced its new PREP Connector Cleaner, a hand-held ferrule cleaner for optical fiber connectors that enables dirt-free, lint-free field connections for positive optical signal transmission. The palm-sized device can be carried in a pocket or toolbox and contains a dry woven polyester firm belt for removal of dust, dirt, oil and gels from fiber and ferrule end-face without the use of alcohol or solvents. It can clean up to 1,000 ferrules before disposal. A thumb-activated, spring-loaded door mechanism advances the film belt and exposes a fresh film section through two rounded holes and two elongated slots in the top of the housing. To use, the operator inserts and rotates the ferrule tip in the first hole, wipes in the first slot, and then rotates and wipes in the second hole and second slot, respectively. For more information, call (800) 866-3953.

Alcoa Fujikura's hand-held ferrule cleaner

Ortel Corporation has introduced the 10005A TVRO fiber optic link, used to transmit the LNB output from a satellite earth station antenna to a remote receiver or headend over distances up to 15 miles with a single fiber cable. "With our new system, you can place your antenna far from terrestrial interference and still have your main earth station facility or headend close to the community it serves," says Larry Stark, Ortel director of marketing.

Because the link is fiber optic, it offers features such as 15 mile transmission without a repeater, immunity to microwave interference, and insensitivity to weather conditions such as rain and lightning. The system is capable of transmitting all 12 channels from a single polarization. Radio frequency parameters of the 10005A is a passband range of 950 MHz to 1450 MHz. The baseband signal to noise ratio at 15 miles is 60 dB. Further specifications include an input/output impedence of 75 ohms. For more infor-

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THE CONNECTOR

Amphenol's® new design features three separate seals to protect against signal and environmental leakage — more than any other connector on the market. Its unique round crimp eliminates the six "water channels" found in traditional hex crimp connectors. An O-ring helps prevent corrosion and an inner gasket effectively seals the interface to dramatically decrease drop-related service calls. The connector's innovative one-piece design is easy to install — no lost pieces or cumbersome boots and grease. All three seals in one easy piece!

Amphenol® 6 Series
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THE CABLE

Times Fiber® has recently introduced T-10 drop cable, the perfect complement to Amphenol's triple-sealed connector. T-10 drop cable features 1GHz capacity and comes with Times Fiber's own lifeTime™, the original corrosion-inhibiting, nonflowing, aerial flooding agent.

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1991 Winter Consumer Electronics Show

I had intended to continue discussion of video compression this month. However, I just returned from the 1991 Winter Consumer Electronics show and realized that a report on the show might be timely.

Judging from the crowds at the 1991 Electronic Industries Association (EIA), Winter Consumer Electronics Show (WCES), you'd never know there was an economic slowdown. This of course does not translate into sales, profits, or prosperity—or even continued employment!

Explore Technology Inc.

Explore Technology Inc. demonstrated a technique for transmitting video in a time-compressed mode. A *Wall Street Journal* article from the previous week talked about downloading two hours of movies in a few seconds. It spoke of Video on Demand, VOD, and even of using telephone lines. In fact, the demonstration consisted of 12 minutes of video downloaded in about six seconds.

There was no magic. While time was compressed, bandwidth was proportionally expanded. The technique is covered by a newly issued U.S. patent. Since many patents which are challenged in the courts are held to be invalid, the strength of this new issue is as yet untested. Anyone's video compression may be applied.

By Walter Ciciora, Vice President of Technology, American Television and Communications

SkyPix

SkyPix demonstrated its compression technology over an actual satellite dish. Eight separate video signals were transmitted over a single transponder. The pictures were sharp. Most who viewed them with me saw no imperfections. However, there were artifacts visible to the trained eye. It is important for an engineer not to reject a commercially viable approach just because it is not perfect.

While artifacts are clearly visible, it is hard to judge how objectionable they are since they are different than anything else seen in video or film. In fact, I found myself getting so involved in the action of the movie "Red October" that I tended to overlook the artifacts.

Kodak CD Photos

Kodak introduced a system which digitized 35 mm photographs with 2,000 line resolution and recorded them on compact disks. The images could be played back over a television set via a specialized disk player, that also accommodates conventional audio CDs.

Kodak's intention is that the processing will be done at the local Kodak film processor. The images could also be printed on a thermal printer, which yields excellent pictures very close to consumer grade color photographic prints. The printer can be driven by a computer, which would allow modification of the shots during processing—pictures could be "cropped", for example, a change in size or deletion of unwanted parts. Multiple pictures could be combined on a single sheet. Titles and special icons could be added. It was claimed that later versions would allow color modification.

This significance of this for the cable industry is that the recordable CD will soon be available at affordable prices. They will make possible the ability to download music, text or compressed video via cable onto a recordable disk on a "pay-per-record" basis.

Color LCD Displays

Color liquid crystal display monitors and TVs also were shown. Sharp's 8.6 inch LCD color monitor had an excellent picture, significantly better than the smaller screens of just a few years ago. The 5.6 inch and 4 inch screens were also very good. Sharp showed an excellent prototype of an HDTV LCD projector. While the pictures were excellent, they were very dim, and had to be viewed in a darkened area.

The importance of these developments can best be judged when prices are set and delivery dates are committed. If these are reasonable, it speaks well of the day when the on-the-wall screens could be purchased. When these screens become large, HDTV will have an excellent vehicle with which to penetrate the market.

Universal remote controls

Universal remote controls appeared in more new varieties. While some had more features, could control more devices, and were pre-programmed for more models, none seemed to be the breakthrough device which might really be easy to use.

The "VCR +" device attracted alot of attention. Numbers printed next to television guide listings are entered into the hand unit. Using the number and data, such as the cable systems' channel line up, allows the unit to turn the VCR on and off and to change channels.

HDTV

HDTV was not a big issue. Most interesting was a Toshiba display of an HDTV receiver with an NTSC "up converter." The NTSC signal is line doubled and comb filtered, then put on the screen in a variety of ways. Cropping and variable zooming are offered along with a simple picture with black bands on the sides.

The next Consumer Electronics Show is this summer in Chicago, June 1-4. Registration is free if done in advance, and about $30 at the door. But the big problem is hotel accommodations. If you plan to go, register soon. The CES is immediately followed with one day of overlap by the Institute of Electrical and Electronic Engineers (IEEE) International Conference on Consumer Electronics (ICCE), June 4-7. The CES displays what is available in the next year or so while the ICCE gives a more technical look three to five years down the road. In both cases, the topic is relevant since it tells us what our subscribers are going to want to connect to their cable service. ■

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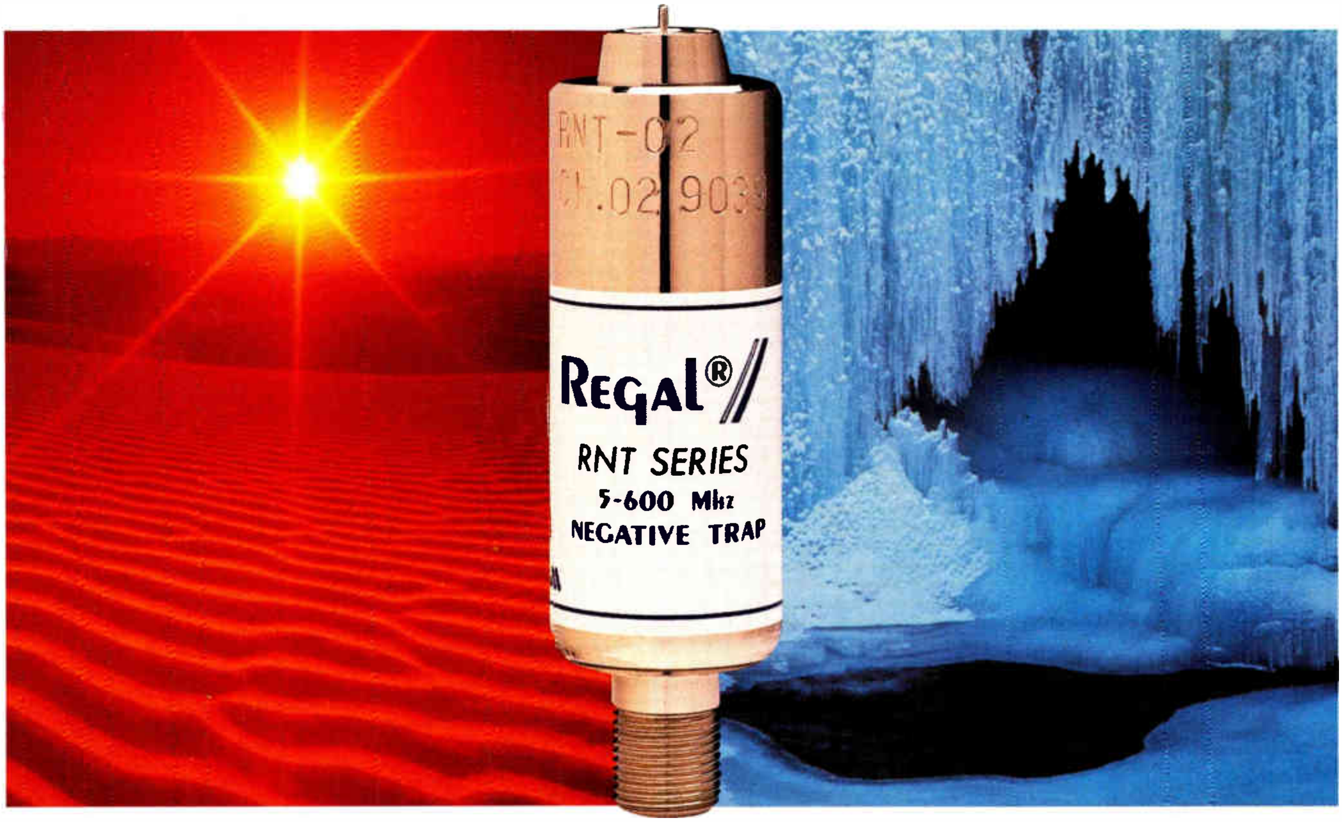

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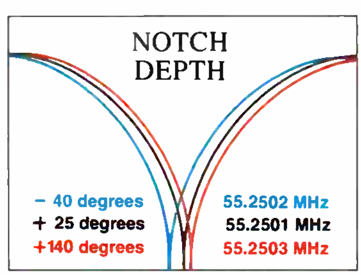

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