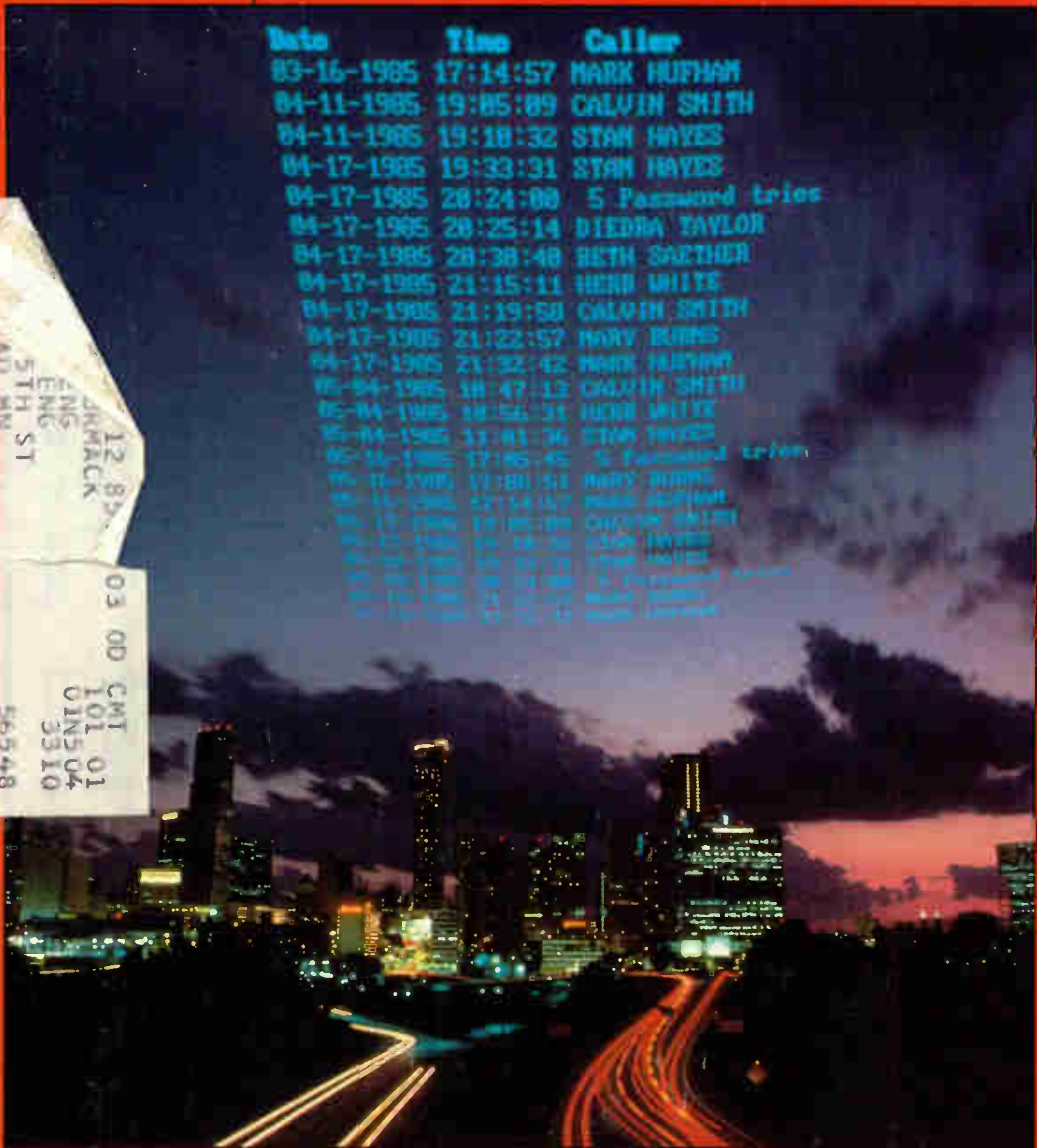
COMMUNICATIONS TECHNOLOGY

Official trade journal of the Society of Cable Television Engineers



Broadband cable: Data's new highway

The right connections

December 1986

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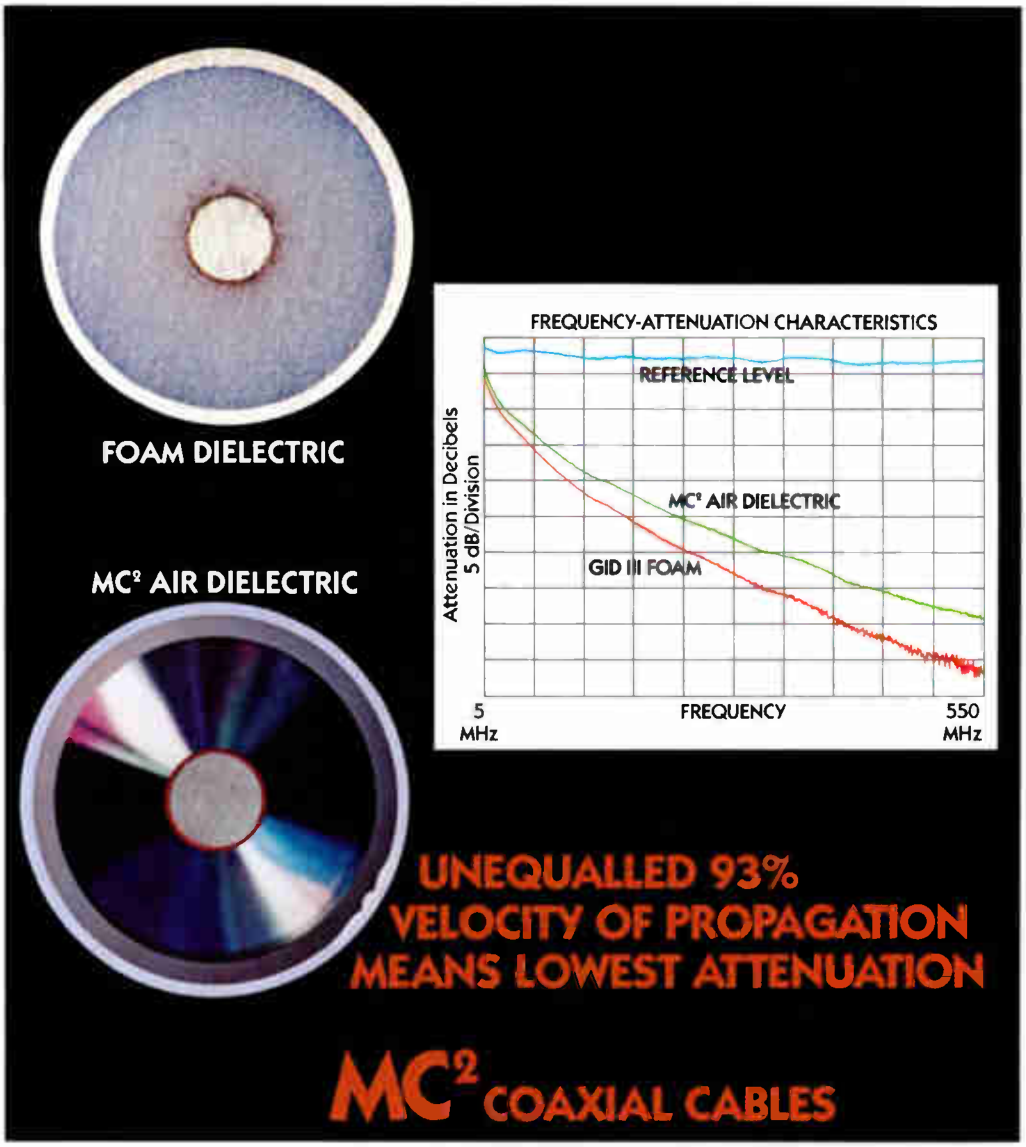

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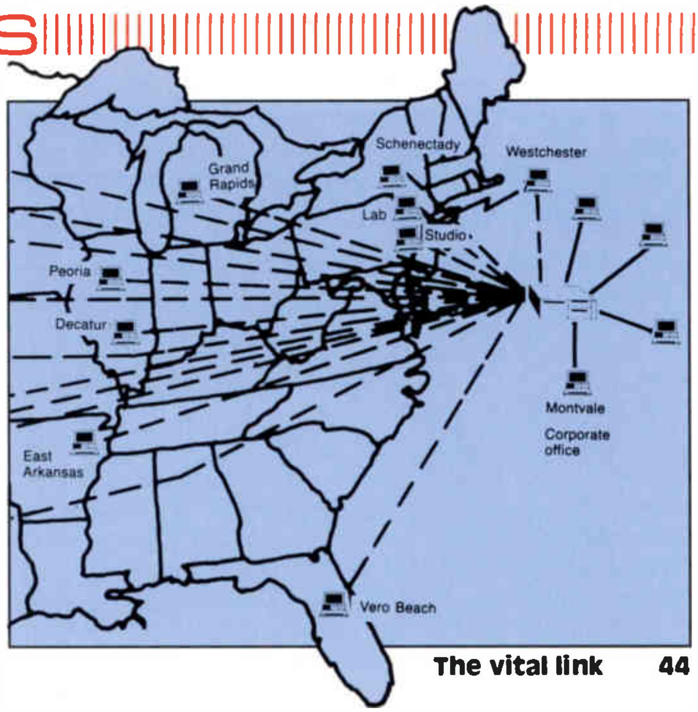

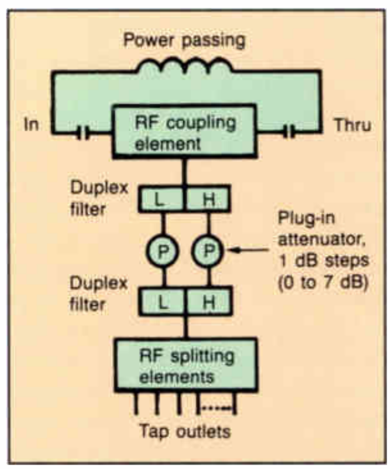

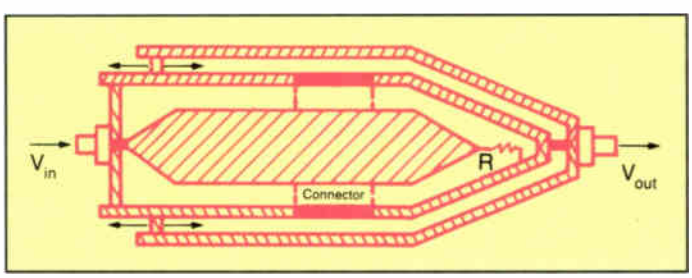

Features

Cover
Data application courtesy Microstuf Inc.

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You know we'll be there.

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Reader Service Number 4.

GENERAL INSTRUMENT

A made-for-cable Western

No. I'm not talking about programming but the 18th annual Western Cable Show in Anaheim this month. With its theme "The Right Connections," the show plans to bring out the cooperative efforts of two major industry organizations, the Society of Cable Television Engineers (SCTE) and the National Cable Television Association (NCTA).

The SCTE has planned a series of seminars ranging from current technical issues facing the industry to advances in test equipment. Wendell Bailey, vice president of science and technology for the NCTA, is planned to speak on the NCTA's latest filings in the technical issues seminar. Also, to link with ATC's Walter Ciciora's discussion of IS-15, the NCTA's engineering committee is setting up a booth demonstrating the latest IS-15 equipment.

Also in store at the show is an afternoon of BCT/E certification testing. This is a topic we've brought up before and is one that can't be overemphasized. Quite recently, the Pennsylvania Cable Television Association endorsed the BCT/E program, the first state association to do so. Let's hope more organizations follow suit.

At the Atlantic Show

While attending the Atlantic Show in October, I had a chance to stop in at several of the excellent technical sessions that were coordinated by John Kurpinski. I watched Gary Selwitz and Jim Stilwell proctoring the SRO crowd at the BCT/E exams; some of the attendees even took tests in several categories that day.

The Atlantic Show is one of the more organized and well-attended regional shows, but when it comes to purely technical *you* have your own event that will take place April 2-5 at the Hyatt in Orlando, Fla. — the Cable-Tec Expo. SCTE Executive Vice President Bill Riker and his staff are planning another fine technical exhibition that has continued to grow each year in attendance, technical expertise and number of exhibitors. If you want more information on what promises to be some of the industry's finest days in 1987, just circle #1 on the enclosed reader service card.

And speaking of the SCTE (they're always on my mind, as you can tell), the *1986/87 SCTE Membership Directory and Yearbook* will be mailed by the first of the year to all SCTE members. It's free to all national members. For more details about it, call Bill Riker at (215) 363-6888.

What else? The SCTE scholarship drive is getting under way. We'll announce the recipients of these awards in the January issue of *CT*.

Finally, the SCTE national headquarters and its Chattahoochee Chapter are sponsoring an engineering and technical management development seminar at the Holiday Inn Airport/South in Atlanta on Jan. 21-22. Notable lecturers and moderators include Bob Luff of Jones Intercable, Cliff Paul of RT/Katek and Wendell Bailey of the NCTA. If you want to know more, call Mike Aloisi, president of the Chattahoochee Chapter, at (404) 633-4326; or Guy Lee, (404) 451-4788.

A sign of the times

We've been noticing in the news lately several interesting developments with some major OEMs. Texscan Corp. has begun its phoenix-like rise from Chapter 11 bankruptcy. It has reached an agreement in principle with its banks and creditors and soon will reorganize stronger than before. Texscan also reported a profit for the first quarter of its 1987 fiscal year.

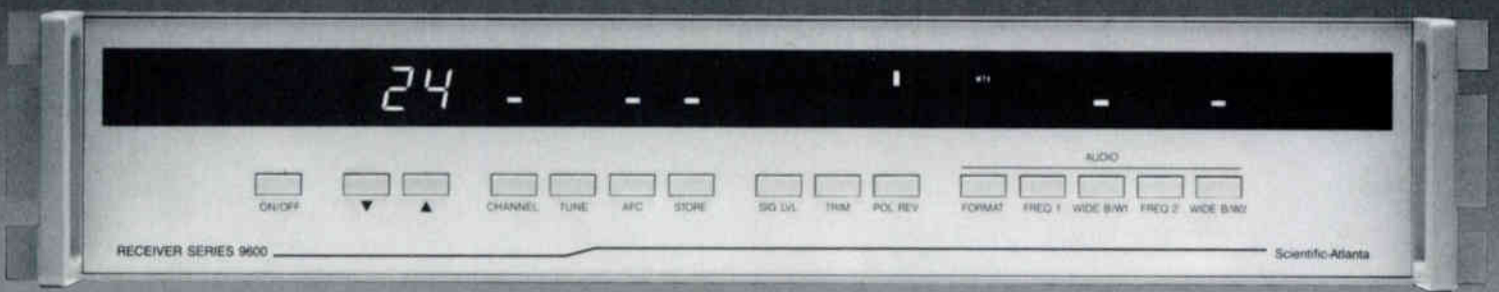
Other companies, such as Oak Communications, also have started off on a better footing for the new fiscal year. And it's good to see companies working together for everyone's benefit. Recently, Scientific-Atlanta and Times Fiber Communications announced the signing of a letter of intent to combine the engineering, marketing and manufacturing capabilities of both companies for the production and sale of coaxial cable products.

These development, I hope, are the sign of the times for our industry. It shows we've come a long way toward a spirit of cooperation. Take a look back to where you were at the beginning of 1986, where the industry was. All things considered, we've made a lot of progress. And in 1987 . . .

Happy holidays from all of us at CT Publications. We sincerely hope your new year brings you success and promise.

Paul R. Levine

LOW PRICED HIGH TECH FOR CATV.



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Scientific-Atlanta's newest satellite receiver—the 9630—combines leading edge technology with modest cost.

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No question about it. The name Scientific-Atlanta *means* unsurpassed quality, advanced electronics and superior design. And now we've packed all of this in a sleek, new package—the compact 9630 receiver. It's the most advanced offering yet for the CATV market.

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Scientific Atlanta

Reader Service Number 6.

COMMUNICATIONS TECHNOLOGY
Official trade journal of the Society of Cable Television Engineers

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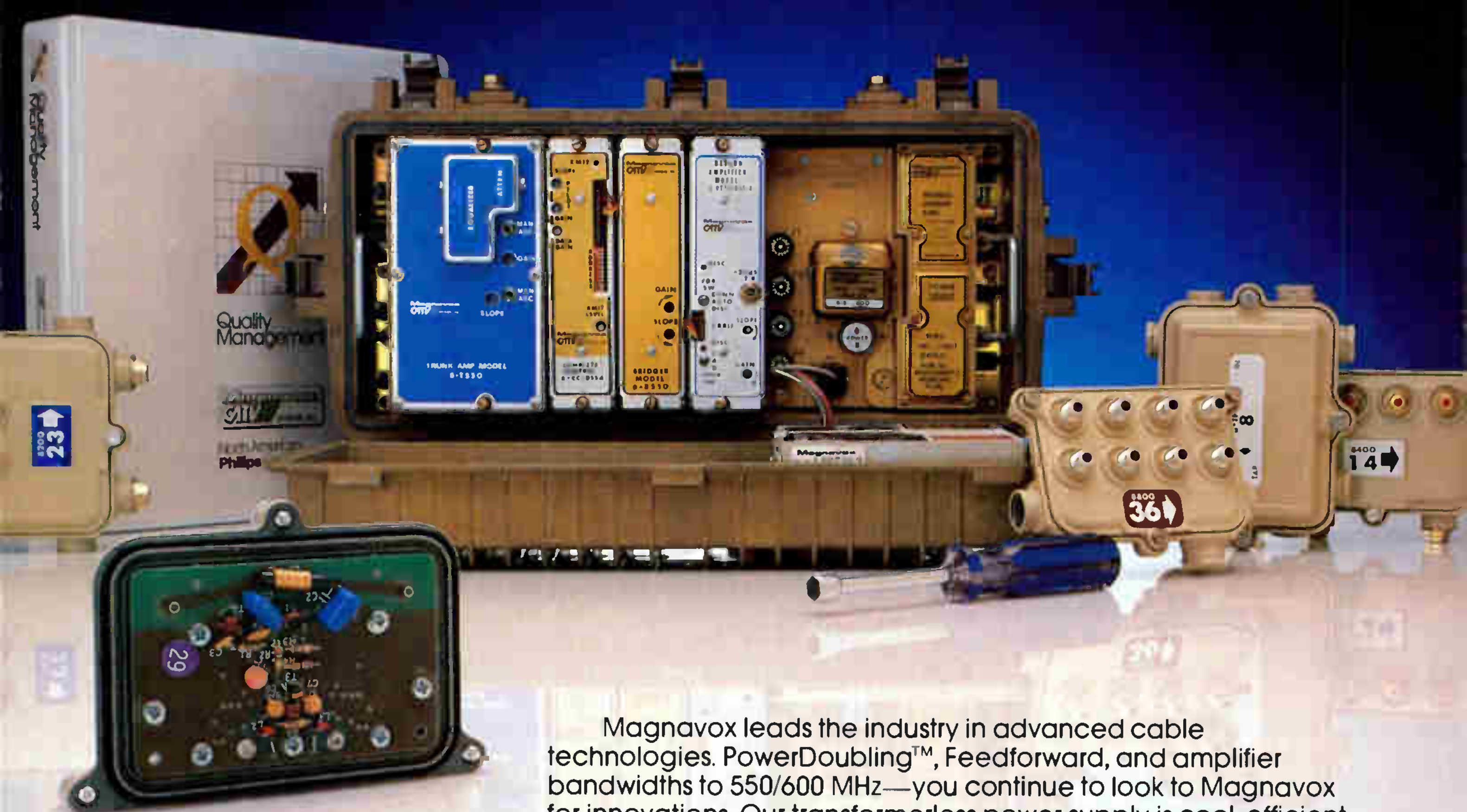
INNOVATION & INFORMATION

Magnavox at its best



Magnavox leads the industry in advanced cable technologies. PowerDoubling™, Feedforward, and amplifier bandwidths to 550/600 MHz—you continue to look to Magnavox for innovations. Our transformerless power supply is cool, efficient, and cost-effective. It's the direction of the future.

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Reader Service Number 8.

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For example, the **Super Ferro** is 93% efficient at normal load factor (see graph at right). Take that news to your power company, and you've got a powerful argument for a 10% saving in your power bill.

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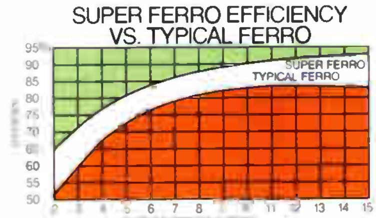
Call **1-800-551-3790** or write today for complete details and test results. Because that 10% would look better on your bottom line than on your power line.



Super Ferro Outperforms The Average Power Supply At Every Load Factor

THE NEW SUPER FERRO BY LECTRO

Reader Service Number 9.

A Burnup & Sims Cable Products Group Company

Tech agenda set for Western Show

ANAHEIM, Calif. — The Anaheim Convention Center will be the site of the 18th annual Western Cable Show on Dec. 3-5, with the theme "The Right Connections." Again this year, in cooperation with the California Cable Television Association, the Society of Cable Television Engineers (SCTE) has coordinated technical seminars for each of the show's three days, as follows:

Wednesday, Dec. 3

- 2:30-4 p.m. — "A technical evaluation of TVROs (dealing with backyard earth stations)."

Thursday, Dec. 4

- 8:30-10 a.m. — "Current technical issues facing the cable industry." *Moderators:* William Riker, SCTE, and Steve Ross, FCC. *Speakers:* Robert Dickinson, Dovetail Systems, "Signal leakage"; Wendell Bailey, NCTA, "NCTA filings"; John Wong, FCC, "FCC update"; Paul Heimbach, HBO, "Ku-band technology"; and Walter Ciciora, ATC, "IS-15."
- 10:30 a.m.-12 noon — "BTSC stereo." *Moderator:* Dave Large, Gill Cable.
- 1-6 p.m. — BCT/E certification testing.

Friday, Dec. 5

- 8:30-10:30 a.m. — "Advances in CATV test equipment: Decoder consumer interface." *Moderator:* Joe Van Loan, Viacom.
- 10:30 a.m.-12 noon — "After the acquisition: A technical evaluation."

Barden selects Magnavox, Trilogy for Detroit build

DETROIT — Barden Cablevision and Magnavox CATV Systems have announced the signing of a purchase agreement for 550 MHz distribution equipment for the Detroit new-build. The $7 million to $8 million pact calls for Magnavox to supply feedforward and power doubling amplifiers to outfit 2,200 miles of plant. Magnavox also will supply taps and passives for the build.

Trilogy Communications Inc. will supply Barden with 2,000 miles of its MC^2 coaxial trunk and feeder cable for the Detroit system. The build began in October and is expected to take approximately five years to complete. The system will have the capacity to serve 433,000 households in the Detroit market.

Cable Exchange forms marketing arm

ENGLEWOOD, Colo. — Cable Exchange has announced the formation of ABC Cable Products for the marketing and sales of its line of wireless remote control units, compatible with converters made by most manufacturers. First to be introduced were the Models J-400, J-450 and J-SRCII, designed to operate with Jerrold converters.

Also, ABC Cable Products announced the sale of its Model ABC-1010/J450 remote to United Cable Television of Colorado; the unit is compatible with the Jerrold DRZ-450 converter utilized by United.

Queens, N.Y., system selects TOCOM equipment

DALLAS — American Cablevision of Queens, N.Y., has selected the TOCOM division of General Instrument Corp. as addressable equipment supplier for its cable system franchise. The value of the contract is estimated at $10 million.

TOCOM will supply TOCOM Plus 5503-VIP baseband addressable converters, a Micro-ACS addressable control system and HVP-III video processors. When completed, the system will serve about 270,000 dwelling units in the area, including Astoria, Glendale, Jackson Heights and Maspeth sections of Queens.

Texscan agrees on reorganization plan

PHOENIX, Ariz. — Texscan Corp. announced it has reached an agreement in principle with its primary lending banks, its official unsecured creditors' committee and its official equity holders' committee on a consensual plan of reorganization in its Chapter 11 bankruptcy proceedings. The plan would be funded by secured borrowings and other financial assistance provided by Southwestern General Corp., a Colorado-based diversified holding company.

Texscan also announced a profit for the first quarter of its 1987 fiscal year, the first quarterly profit the company has made since filing for reorganization in November 1985. In the quarter ending July 31, 1986, Texscan reported net pretax income of $2.21 million and net operating profit of $40,000.

PCTA endorses BCT/E Certification Program

HARRISBURG, Pa. — The Pennsylvania Cable Television Association (PCTA) has endorsed the Broadband Cable Technician/Engineer (BCT/E) Certification Program, which offers professional certification in seven categories relating to the operation of cable systems. The PCTA has agreed to provide its membership with information about the program, developed by the Society of Cable Television Engineers (SCTE), and list dates of SCTE seminars and tests in PCTA publications.

According to William Riker, executive vice president of the SCTE, the PCTA is the first state cable association to endorse the program. "That they are the first is just one addition to the long list of industry firsts the state enjoys, dating back to the birth of the industry itself," said Riker.

● Brad Cable Electronics Inc. has opened another service facility, in Cherokee, N.C. Brad Cherokee currently services all makes and models of standard converters, as well as Jerrold and Oak programmable and addressable converters.

● Intercept Communication Products Inc., a company formed to manufacture and distribute pay TV security and other passive products for cable TV, has acquired the trademark, license and manufacturing assets of Intercept Corp. of Clifton, N.J., effective Sept. 15. The company is headed by former Intercept Corp. executives George Abdelmessieh and Pete Parikh, with Ken Augustine as director of sales and marketing. The new firm is located at 85 Fifth Ave., Building 16, Paterson, N.J. 07524, (800) 526-0623 or (201) 471-2212.

● General Instrument Corp.'s VideoCipher Division has announced that descrambler authorization orders have passed 50,000, helped by recent orders from SelecTV, the 11th programmer to scramble its signals using VideoCipher equipment. Also, GI's Jerrold Division announced a $6 million contract to provide headend, distribution and subscriber cable TV equipment for District Cablevision and Chesapeake and Potomac (C&P) Telephone in Washington, D.C. The system, which is being constructed by C&P, will pass 250,000 homes with approximately 900 miles of cable and is expected to take four years to build.

● Great Lakes Data Systems of Beaver Dam, Wis., has announced that Cable Services Co. Inc. (CSCI) of Williamsport, Pa., will become a distributor for Great Lakes' cable billing systems, said to control many types of addressable converters. CSCI will distribute the equipment to cable operators in northeastern United States.

● Wavetek Corp. announced that its wholly owned subsidiary Wavetek Indiana Inc. has entered into an agreement with Matrix Test Equipment Inc. to acquire certain assets related to Matrix's CATV product line. The key products are the SX-16 multiple carrier and PSX-6 portable carrier generators, the R-12 signal and distortion analyzer, and the R-75 synthesized signal and distortion analyzer.

● Beta Tech Engineering Inc. of Phoenix, Ariz., has announced its purchase of the CATV equipment manufacturing division of Merrill Cable Equipment.

● Anixter Bros. Inc. has signed a contract to stock and sell the full line of Jerrold's Starcom VI addressable converters. The agreement should result in an annual volume of approximately $20 million.

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When you purchase broadband distribution electronics from C-COR, you expect the best value in the industry. But we want you to know you can expect even more. Which is why we give you access to a C-COR Sales Engineer.

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C-COR ELECTRONICS INC WE GIVE YOU MORE.

Reader Service Number 12.

Part II: A day in the life...

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

John was not having lunch today at his favorite New Jersey-style diner. Last month he had been called by a fellow chief engineer and told to reserve this date for the most sensational, edifying and most satisfying affair he would ever experience. "Since when did you become a marketing maven of the Gotham Cable Company?" he had asked Mike Smithers. Mike had ignored the jab and responded jauntily, "I have a new job at double my old salary and I'm sworn to secrecy about my new company and its objectives. It all will be revealed at lunch in the ballroom of the Hotel Maximus and I won't take no for an answer."

As predicted by Mike, John was picked up at his office by a limousine(!) that, after joining a block-long procession of other limousines, finally deposited him at the entrance to the Hotel Maximus. Flanking the entrance was a pair of World War II searchlights scanning the skies, crossing beams and occasionally coming to rest on a giant banner stretched above the entrance proclaiming in shimmering sequined splendor, "Colossal Films." And yes, there was a red carpet starting at the curbside, an obvious invitation to the important affair inside.

The publicity must have been very persuasive, and the expected guests so prominent, that the press and TV coverage was overwhelming. John was only an engineer, so he was naturally ignored while, all around, knots of reporters shouted queries at their respective captive celebrities. It was obvious from the frustrated brows of the reporters that the secret of this occasion had been well-hidden.

Inside the hotel lobby, a well-organized greeting awaited the honored guests with appropriate attention according to their prominence. John was approached by a young lady costumed like all the other hostesses in an obviously expensive designer pants suit discreetly displaying the name Colossal Films. Without hesitation, she called him by name and pinned a large badge to his lapel! How did they do that??? More than a thousand guests so greeted represented a staggering task, but there were more wonders ahead.

The ballroom rivaled a football field in size. At one end, a large screen flickered with images of Colossal personalities and trailers of Colossal films from the past to the present. On one side of the screen a 40-piece orchestra was displaying its virtuosity by playing every conceivable style of music that accompanied what seemed to be an endless parade of musical luminaries from the classical to the latest underground stars. On the other side of the screen was a well-lit dais populated with little clumps of important people shuffling paper and rearranging the seating.

Along the walls were flower-bedecked clusters of intimate tables. Featured were world-famous chefs recruited from all over the world just for this affair: Maxims from Paris; Claridge from London; Canton (no Szechuan!) China; barbeque, Houston style. To appease the possible plebian palates, the open center of the ballroom featured food carts direct from the streets of New York with their delicacies — hot dogs, sausages, pretzels, shiskabob and whatever.

There were no open bars, but white-gloved waiters were continuously circulating with a variety of mixed drinks, and the ever-obliging hostesses were at your elbow to order any drink you desired.

John had arrived early to a hushed hall, but as it filled, the crowd noise eventually drowned out the music. Perhaps alcohol loosened the tongue; anyway, the roar of the crowd was deafening. Mike and John found a table and waited for the inevitable speeches. Finally, the orchestra broke into a fanfare worthy of a Roman emperor, the lights dimmed and television cameras portrayed the dais on the large screen. After a multimedia trumpeting of the achievements of Colossal Films, its chairman, Michael Maestro, was introduced by a world-famous actor as the "finest man alive."

Modest Maestro graciously acknowledged the tribute and plunged into his presentation.

"Show business," he thundered, "has taken it long enough on the chin from the VCR pirates, the greedy distributors and the freeloaders. We are going to regain control of our product as we did in the halcyon days when we owned the movie theaters." The audience sat rapt, at attention. "We are now unveiling the grand strategy agreed to a decade ago, our secrecy unbroken, for which I thank everyone involved. First, we commissioned a foreign TV company to develop the technology. One thousand engineers were at work for all 10 years! We now have a fully secure TV system using two channels of bandwidth capable of delivering superb HDTV and simultaneously a black-and-white NTSC picture for the lowest cost, completely controlled from our Hollywood headquarters. All equipment will be proprietary and leased.

"We are demanding, not begging, for Channels D and I on every cable system to be available at a price that is the equivalent of the scale of payment for space on the telephone poles. They will be allowed the same profit margin as the Public Utilities Commission allows to the utilities. To gain their cooperation we have taken two steps: We have purchased on the open market enough shares to put us on the board of the majority of the cable companies, and we are ready to launch our satellite delivery system to supplant or bypass cable as needed. Thus we will shortly achieve our secret goals, control of the TV box office, take the power away from the cable operators and restore the movie industry to its rightful dominance of the entertainment world."

John turned to Mike. "Why did you invite me to listen to an enemy of cable, who might cause me a loss of income or even a job?" "We expected all chief cable engineers to feel that way," said Mike, "here is our proposal. We want D and I to be in tip-top condition for our programs, so every year we will hold a three-week technical seminar on cable technology at the finest resorts all around the world. You and your family will attend tax-free. Even a millionaire couldn't have a better deal!"

Riding back in the luxurious comfort of the limousine, John tried to peek behind the curtain of the future. Is cable doomed to sink into the abyss of the utility format, or can it continue the dual role of a programmer *and* a utility? Will we survive?

The day was over.

Hi-tech deserves Hi-tech.

Watchman®II. Superior stand-by power battery.

Watchman® II is the technological leader in stand-by battery power, designed especially for CATV and other stand-by power applications. Watchman II is made of Duratrex™. This same tough material is used in GNB heavy-duty batteries which virtually eliminates breakage in the field. The bottom line is, it's the top of the line.

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Watchman II's Absolyte® sealed lead acid technology means no maintenance, and no maintenance cost. Watchman II never needs watering, there's no acid spillage or corrosive fumes to damage expensive electronics. And because Watchman II is sealed, you can use it in any position, no matter how remote, even freezing will not damage it.

Premium performance.

Compatible with float service, and unlike most stand-by batteries, Watchman II can be cycled over 250 times. Give your Hi-tech equipment all the power it deserves. Watchman II stand-by power battery.

For more information, contact Jim Trenter, Technical Applications Manager, GNB Incorporated, P.O. Box 64140, St. Paul, MN. 55164. (612) 681-5000.

GNB Incorporated

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Reader Service Number 14.

Narrow band data transmission

The cable industry has in place a highly efficient information delivery system to the home supporting video programming and text. Unknown to many people, the same cable system also delivers one-way data from the cable headend to data receivers in the home disguised as cable TV converters. Many addressable converter systems have been using one-way data over cable for years to address and control the services that are offered by the cable companies. The same technology can be used as a cost-effective information delivery system to data subscribers having personal computers in their home.

By Emory McGinty
Project Manager, Scientific-Atlanta

As long as TVs have been available to the budget-conscious public, people have been looking for ways to deliver printed information along with the video programming. Early attempts included pointing TV cameras at words printed on a large piece of paper. Technology continued to advance and character generators replaced the cameras and printed page for on-screen text. Now, text can be typed directly into a machine and converted directly to a TV signal for broadcast. Computers have found their use in this area by providing large amounts of text storage and by letting the computer decide what text is displayed and when.

Character generators are still used today because they are relatively inexpensive for the cable operator to use. The subscriber only needs a TV to watch both the video programming and text. However, the system has some serious weak points. First, the subscriber must be watching at the time the particular text that he is interested in appears on the screen. Watching video bulletin boards can be very frustrating as page after page of information must be read before information of interest appears. Second, the text uses 6 MHz of bandwidth. On-screen text must compete with video programming in order for the cable operator to see any merit in its use.

Finally, the data is updated very slowly, since the user must read through all the information before he finds what interests him. The more text that is displayed, the slower the text can change. The changing text must accommodate even the slowest reader. Due to the tendency of viewers to lose interest in slowly advancing text, character-generated text has had success only with brief messages.

In order to overcome some of these disadvantages, engineers found ways to hide data in the vertical blanking interval (VBI) of the video programming. The term teletext usually refers to information sent in this manner. An example of data using the VBI is shown in Figure 1. The TV paints a picture on its screen from top to bottom.

Figure 2: Frequency modulation

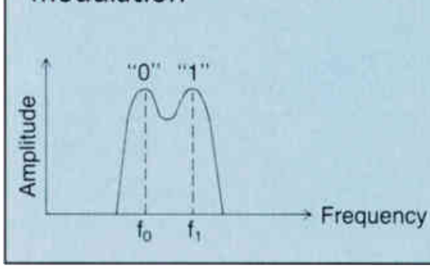


Figure 1: Vertical blanking interval with data

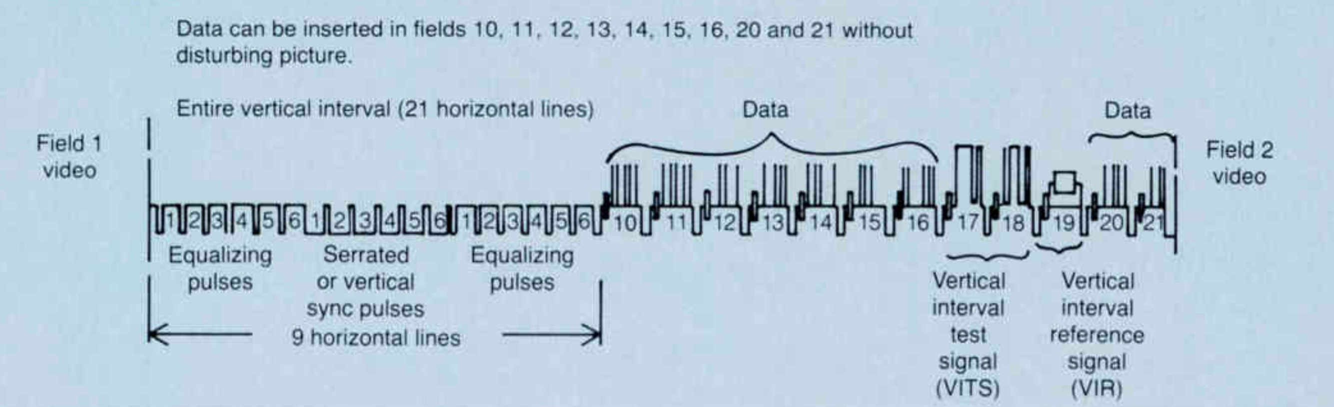
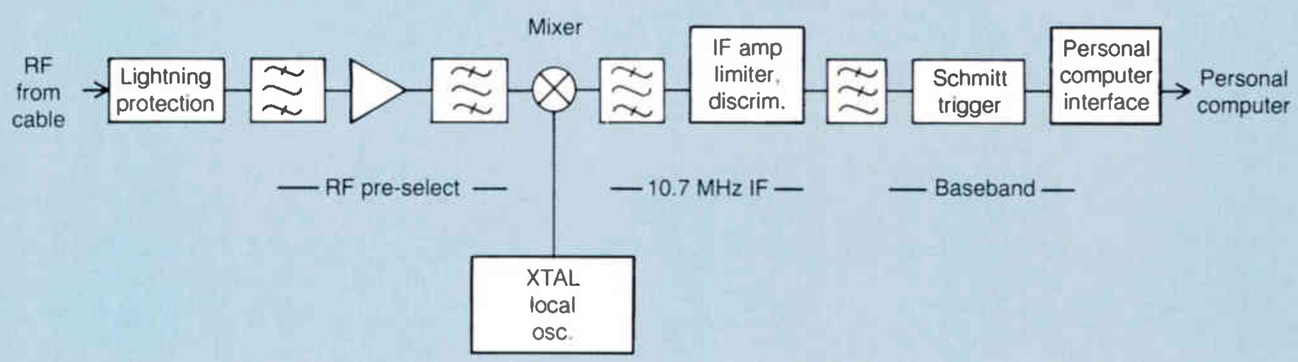


Figure 3: Non-addressable data receiver



When it is finished with one picture it moves the paint brush, or electron beam, to the top of the picture again. The VBI is the time needed for the electron beam to go from the bottom of one picture to the top of the next picture. The VBI has been used for many purposes over the years and no standard has been adopted for its use with data. Using the VBI, thousands of characters of information can be sent in one picture. Unfortunately, the circuitry needed to send and receive information in the VBI is relatively expensive. The data must be separated from the video signal and is coming so fast that it must be stored until it can be seen. And once collected and stored, the subscriber must find some way to display the information.

Modulated data carriers are an alternative to using the VBI. On a modulated carrier, the amount of bandwidth used is a function of how fast the information needs to get to the subscriber. The more the information, the more bandwidth is used. The most popular modulation format for data is Frequency Modulation or FM. In an FM modulated data signal, the data is either a "1" or a "0," represented by one of two frequencies (see Figure 2). The bandwidth is a function of how fast one must switch between the two frequencies and how far apart the two frequencies are set. The circuitry needed to transmit and receive an FM signal is relatively inexpensive.

Computers can talk to one another over telephone lines using this type of modulation. FM modulation also works well on cable TV systems because of its low cost and the small bandwidth it requires. An inexpensive demodulator for receiving 9,600 bits-per-second (BPS) data might use only 200 kHz of bandwidth. Less bandwidth is possible by using more costly filters.

In addition to data speed and bandwidth, transmission reliability also is important. Different data formats have varying degrees of sensitivity to errors during transmission. VBI is most prone to errors, since the information is transmitted as amplitude modulation and is susceptible to many types of noise, such as lightning, ingress or poor connections. FM modulation is relatively insensitive to the types of noise typically found on cable systems since the information is sent as alternating frequencies. Limiters in the receiver strip away any influence noise might have prior to data detection. Only noise that interferes with the transmitted frequencies will affect the receiver's performance. Addressable converters have demonstrated the high reliability of sending data over cable using frequency modulation despite extreme environmental conditions.

Non-addressable delivery system

Figure 3 shows a demodulator that is being used to receive data over cable. The same design can be applied to data rates up to 64 kBPS by adjusting filter bandwidths and carrier frequencies. Cost and performance were the central goals in the demodulator design. The circuitry uses readily available parts and the performance, measured using a bit-error-rate test set, averaged one error in 10^9 bits with a carrier-to-noise ratio of 20 dB. The circuit can be built in an area about the size of a pack of matches.

The same circuit was used over the past 12 months in several cable systems. The data modulators received data from satellite receivers and modulated the data over cable in the FM band. The data receivers connected directly to the cable and had RS232 interfaces, allowing them to be connected to personal computers in the home. Through the cable system, data was distributed to the data subscriber's home and the information was collected and displayed on the subscriber's personal computer.

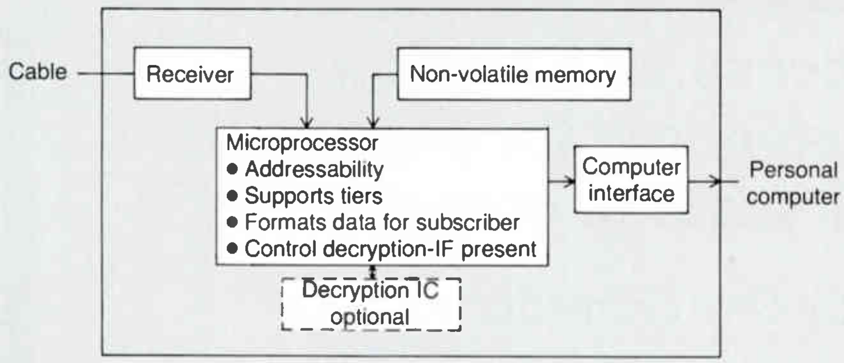
Addressable information delivery

For any service provided by a cable operator, the operator must feel confident that he controls who receives the service. This is particularly true when service to a particular subscriber needs to be discontinued. In an addressable receiver, access to the service can be controlled by the cable operator. Once the receiver is deauthorized, the receiver becomes useless until it is authorized once again. Addressability has two major advantages: the cable operator can easily change services or terminate service, and the cable operator can charge for tiers of service. Unfortunately, this ability does not come for free. First, the cable operator needs the necessary equipment at the headend to control the receivers, to keep track of who has what authorization levels and to implement a more complex billing system. Also, the cable must be capable of supporting the increased bandwidth needed to pass authorization information along with the data to subscribers. The more authorization and control information that must be sent, the less useful data can be sent to the subscriber.

The main difference between an addressable and a non-addressable receiver is the addition of a microprocessor (Figure 4). The microprocessor does not have to be expensive. Its task is to watch the data as it comes by and look for data addressed to that subscriber. Control data addressed to this receiver is used to load the authorization tables in the receiver. All authorized non-control data is passed to the subscriber. The same mechanism is present in addressable cable converters and has been for many years. The technology is tested and proven.

However, the format of the control data is very important. It must be capable of supporting all the cable operator's current and future needs while keeping the

Figure 4: Addressable receiver



amount of control information to a minimum. Control information gives the cable operator control and flexibility, but has no benefit to the subscriber. In fact, it reduces the amount of information he can receive. The amount of control information can be minimized by carefully studying what control is necessary and by using both individually addressed and global commands to the data receiver.

Encryption

Even with the most sophisticated addressable system, as long as the information is available on cable, people will try to steal it. To prevent data theft, encryption can be used so any information that is received in an unauthorized way is of no use.

There are several methods used to secure data over cable. The most popular technique relies on using a data format that is so unique that no one could "figure it out" — or could they? Some manufacturers use unusual modulation formats; others rearrange the bits that are transmitted in a fixed format difficult to figure out.

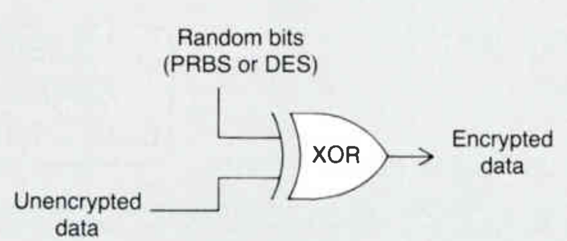
Unfortunately, these techniques do not take into account the "hacker" who delights in these types of challenges. And the worst part is that they publish their findings in user club journals and the secret is no longer a secret.

Another form of security is by "exclusive ORing" random 1s and 0s with the data before transmission. This is called encryption and is shown in Figure 5. The receiver must know how to remove the random data so it can correctly interpret the data it received.

There are two types of encryption algorithms commonly used for data transmission: pseudo-random binary sequences (PRBS) and the data encryption standard (DES). The PRBS method of encryption (Figure 6) can provide an effective method of encryption when the data changes often and its importance does not warrant an unauthorized subscriber using computers to attach the encryption. Data that has great value, such as electronic fund transfer or non-delayed stock quotes, requires more protection than PRBS provides.

The National Bureau of Standards adopted the DES algorithm (Figure 7) for these types of applications. The algorithm can be implemented in either microprocessor software or a single integrated circuit (IC) containing the DES algorithm. This algorithm is gaining popularity for use in data distribution due to its availability in a single IC. Information providers wishing to deliver data over cable want as much protection of their data as is available. Even if the DES algorithm is more se-

Figure 5: Encryption



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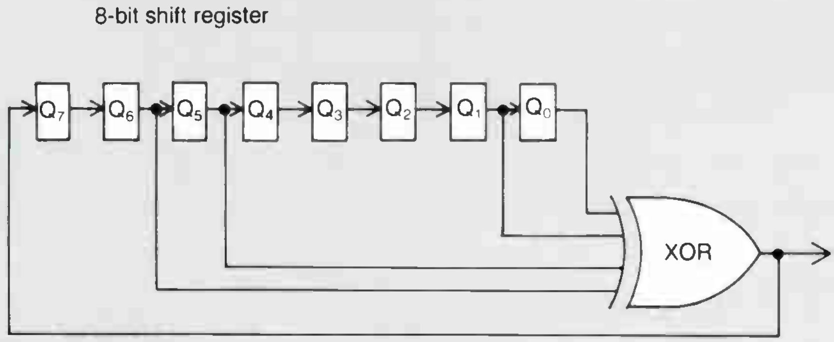
WESTERN SHOW PREVIEW

Reader Service Number 18.

Figure 6: Pseudo-random binary sequence



$X^8 + X^6 + X^5 + X + 1$ has a cycle of 2^8-1 or 255

curity than is warranted, the information provider will often ask for it because they equate the name with security. One information provider might require multiple levels of encryption for many tiers of data to the subscriber.

Readers should be aware that the DES ICs are difficult to use. From a list of available DES IC manufacturers, we selected one based on its speed and flexibility. A bread board has been built using this chip for applications where security of data is of primary concern. The intent was to design a system where encryption can be added economically as it becomes necessary.

No matter which encryption algorithm is chosen, the data is protected only as much as the encryption key used to create the data. Just as a house key provided to a crook bypasses all the locks and window bars, the encryption key unlocks ac-

Figure 7: Data encryption standard

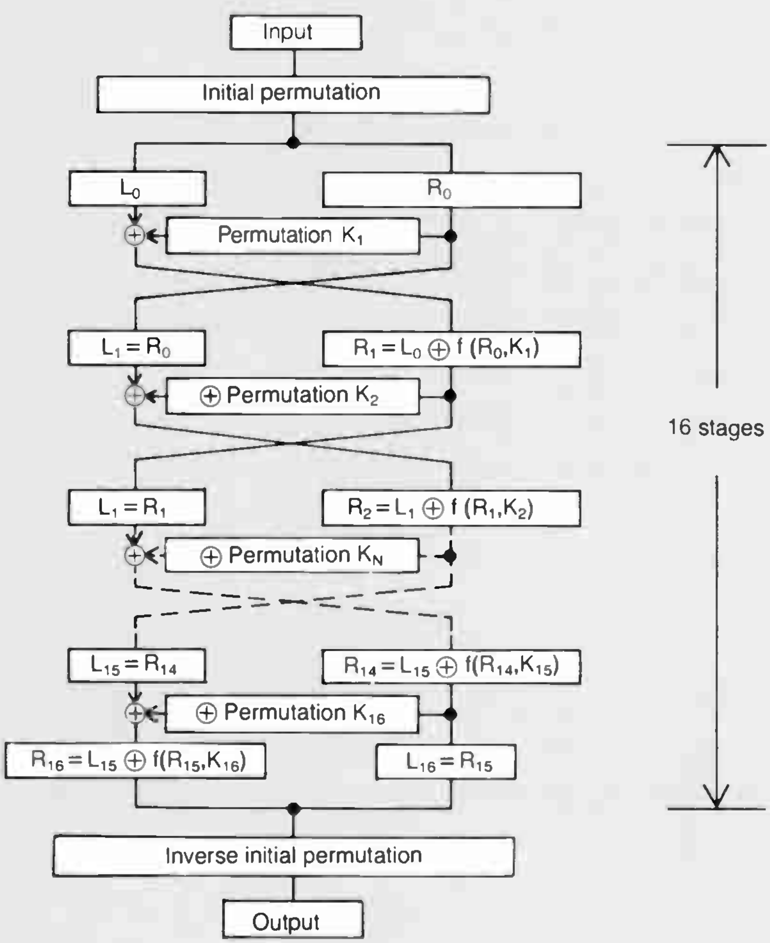
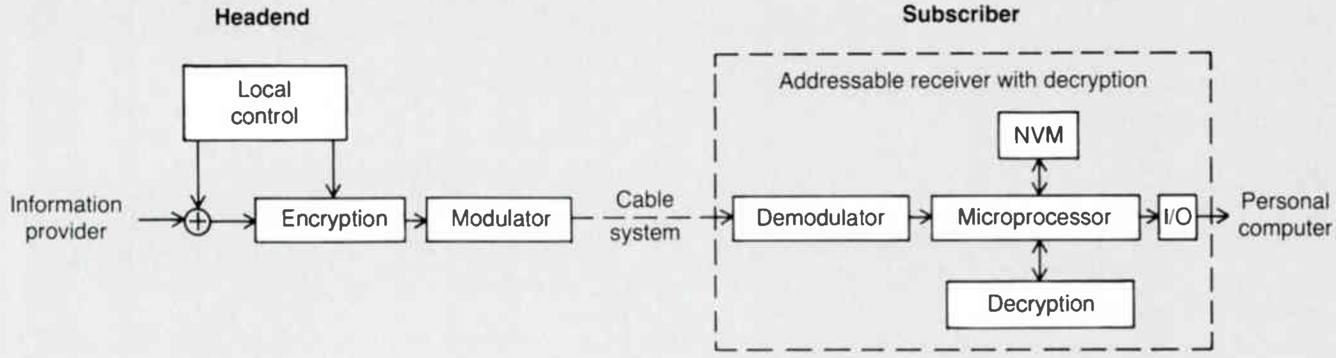


Figure 8: Addressable data delivery system with encryption



cess to the data. Unfortunately, the receiver needs to know the key that was used in the transmitter so it can decrypt the data. So, keys must be sent down the cable to the appropriate receivers. The keys must be encrypted using keys known by both the transmitter and receiver. They should be changed as often as practical.

One method used for sending keys requires future keys to be sent encrypted with current keys. Then at some predetermined time, or as a result of a global command, the future key becomes the current key and the process continues. Both the transmitter and receiver always know which key to use to decrypt data.

An addressable data system with encryption can be added to any cable system, as shown in Figure 8. The receiver (Figure 4) consists of many of the parts that are already in most addressable cable converters. The method of encryption can be any of those already discussed.

The data format, shown in Figure 9, supports both global and individual commands for controlling authorization, tiers and encryption. It is compatible with the high-level data link control (HDLC) data format. The address information is not sent encrypted, so the receiver can identify its data on power up when encryption keys have not been sent. The data field, including the authorization data and future key, is encrypted using the current key. The address information can be extended by setting the most significant bit in the address field or any control field, indicating that the next byte is part of the current field.

DES was chosen for our method of encryption for maximum protection of data during transmission. The system shown can accommodate a modular evolution from non-addressable to addressable to addressable with encryption.

Data opportunities

As cable operators seek additional sources of revenue from their cable system, delivery of digital data to the home can be a benefit to both the cable operator and subscriber. Information providers continue to explore new ways to deliver their information and the technology is available to use cable as the next frontier. Knowledge of digital transmission methods and encryption techniques can help the cable operator take advantage of the opportunities unfolding in this new digital data frontier.

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Figure 9: Addressable format with encryption

HDLC header (1 byte)	Address (1-N bytes)	Control (1-N bytes)	Data field (1-N bytes)	Frame check sequence (2 bytes)	HDLC trailer (1 byte)

Address	Control field	Data field
All "1" = global	Encrypted future key	Future key encrypted with current key
All others = non-global	Encrypted authorization	Authorization list encrypted with current key
	Encrypted deauthorization	None (all authorization tables deleted in receiver)
	Encrypted new user	Current key encrypted with user's serial number followed by authorization list encrypted with current key
	Non-encrypted authorization	Authorization list without encryption

MAP broadband data networks

MAP, an acronym for manufacturing automation protocol, is a means of providing data communications in a factory environment.

By Norman T. Friedrich
C-COR Electronics Inc

The primary recommended media for MAP data transmission is broadband coaxial cable, another name for what has been used for the last 30 years in the cable television industry. Of course, there are some differences between CATV systems and broadband data networks. Some of the most notable are:

1) Data transmission requires two-way communication on the broadband network. Therefore the inbound (reverse) path is just as critical as the outbound (forward) path.

2) Inbound and outbound frequency guardbands are different. CATV systems operate with an inbound passband of 5 to 30 MHz and an outbound passband of 50 to 450 MHz. Broadband data networks require more inbound bandwidth. Typical passbands are 5 to 186 MHz for the inbound and 222 to 450 MHz for the outbound.

3) Level tolerances become critical to the operation of data equipment on a broadband network in both the inbound and outbound directions. A CATV system, in comparison, has fairly wide tolerances in the outbound direction and very little consideration for signal level tolerances in the inbound direction.

4) An outage in a CATV system poses an inconvenience to those watching their favorite television programs. An outage during the Super Bowl will draw the ire of many viewers. In comparison, an outage in a broadband data network can prevent a factory robot from performing its task. This has the potential of shutting down an entire assembly line.

Broadband data glossary

It is appropriate to define several terms that are unique to broadband data communications:

Mid-split: This refers to the band split of a cable system, specifically a system with a 5 to 112 MHz inbound and a 150 to 450 MHz outbound bandwidth. (Various amplifier manufacturers offer slightly different passbands.)

High-split: A high-split system has an inbound bandwidth of 5 to 186 MHz and an outbound bandwidth of 222 to 450 MHz. It also may be referred to as *equal split*. This is the frequency division recommended by the MAP standard (Here too, various manufacturers offer slightly different passbands.)

Video reference levels (VRL): These are the signal levels that a 6 MHz video channel uses in the broadband network. Very often, data channels operate several dB below video reference levels.

Central retransmission facility (CRF): This is simply another term for a headend. It specifically refers to the fact that, for data communications, inbound signals are retransmitted in the outbound direction. For convenience, the CRF often is located in the system computer room.

Translator: This is a device used in the CRF to take signals at a low frequency from the inbound path and upconvert them to a higher frequency for distribution in the outbound direction. Typical translation offsets are 156.25 MHz and 192.25 MHz.

Remodulator: This also is used in the CRF. It demodulates an inbound low-frequency data signal and then remodulates it at a higher frequency for distribution in the outbound direction. A remodulator offers the advantages of excellent adjacent signal rejection and carrier-to-noise performance. Noise from the inbound direction is not translated to the outbound direction.

Inbound and outbound passbands

MAP broadband data networks use both the inbound and outbound passbands for data transmission. Two devices that communicate with each other transmit signals in the inbound low-frequency direction. At the headend these signals are either translated cr remodulated to a higher outbound frequency. In a high-split system the outbound frequency is 192.25 MHz higher than the inbound frequency. The devices receive the transmitted data at the higher frequency. It is apparent that the inbound signals carry equal importance with the outbound signals.

Since data transmission occurs in both the inbound and outbound passbands, additional bandwidth is necessary in the inbound direction. For this reason, 5 to 186 MHz was chosen as the inbound bandwidth, as opposed to 5 to 30 MHz for CATV systems. A 5 to 186 MHz bandwidth provides the equivalent channel capacity of 30 video channels. A 222 to 450 MHz forward bandwidth allows for the equivalent of 38 video channels.

A data channel can occupy anywhere from 50 kHz to 12 MHz of bandwidth, depending on data transmission speed. By utilizing the available bandwidth, the broadband network can provide a multitude of services. The same network can simultaneously carry multiple bidirectional data, video and audio channels.

An acceptable video signal level for a CATV system falls between 0 and 20 dBmV (10 ± 10 dBmV). Most CATV systems operate well within this tolerance; however, televisions and converters withstand such a wide tolerance of signal levels. Conversely, data transmission equipment typically requires narrow system design and balancing tolerance windows.

If a data modem has a ± 10 dB receive window, one must consider the entire loop from transmit to receive when determining the tolerance window. Several factors contribute to receive tolerances:

- Incremental tap values of 3 dB allow for signal deviations of up to 1.5 dB from the design nominal.
- Signal tilts across the bandwidth of 4 dB allow for another 2 dB of deviation.
- Temperature variations in feeder legs where there is no automatic level control compensation can account for additional deviations, depending on the location of the feeder cable and amplifiers.
- Balancing and calibration errors caused by the accuracy and calibration of the test equipment used for system balancing also contribute to the tolerance window consideration.
- Signal level drift caused by aging of the cable and other network components is another contributing factor.
- Because the broadband data network is a two-way system and data communication occurs by receiving signals in the inbound direction and translating them to the outbound path, all of the previous considerations affect the tolerance window twice.

Extreme care in the design and installation of the system becomes very important to maintain tight tolerances in both the inbound and outbound directions.

System reliability

We already mentioned the problem of system outages. Depending on the importance of the data carried on a network, measures must be taken to ensure system reliability. The system operator has to determine a trade-off between the cost of adding components to ensure the reliability of the system and the acceptable level of system downtime.

There are several means of increasing system reliability. Various equipment manufacturers and system designers have advocated different means of achieving this goal; however, there are several practices that are common.

One traditional approach is the use of standby power supplies. With proper battery maintenance, standby power supplies provide an excellent means of preventing signal disruptions resulting from a 110 VAC primary power failure. A variation on the standby power supply is the redundant power supply, which is simply two ferroresonant power supplies in the same enclosure. A switch at the output stage detects the output voltage and switches in case of a loss of output from one or the other ferroresonant transformer. This power supply also allows for connection to two separate primary sources.

Amplifier redundancy is achieved through the use of an active-failsafe or redundant amplifier module. The trunk station is actually two amplifiers in one. If the main amplifier module fails, there is a second module that automatically amplifies the signal to eliminate any outages caused by amplifier failure. The backup amplifier has its own power supply in case the main trunk power fails.

One can take the concept of redundancy one step further by providing redundant cable paths. Intelligent A/B switches strategically placed in the system allow for redundant cable routings.

Although broadband technology is as old as cable television, only recently with the advent of broadband data modems has this technology

been applied to data transmission. Many individuals and organizations with experience in CATV transmission are realizing the opportunities and potential of the broadband data transmission industry. It is important for anyone considering involvement in this industry to consider the many differences between the familiar CATV systems and the new broadband data networks.

MAP specifications

The MAP broadband media specifications encompass many aspects of the broadband data network. Of primary interest are the specifications for design, installation and acceptance of the network. (This is not intended to be a complete listing of these specifications. Refer to the MAP/TOP Broadband Specification for complete information.) First, the design specifications:

Parameter	Specification
Passband:	5 to 450 MHz high-split
Taps:	8-port non-terminating
Amplifier location:	Accessible height above floor level
Trunk cable:	.500 to .750
Distribution cable:	.500 to .750
Drop cable:	100′ RG-6 or 150′ RG-11
System power:	60 volts, 60 Hz
Inbound path loss:	44±3 dB
Outbound path loss:	44±3 dB
Flatness:	N/10 + 1.5 dB or 3 dB (whichever is greater), N = number of amps
Transmit signal level:	54 dBmV (VRL)
Carrier-to-noise ratio:	43 dB
Composite triple beat:	53 dB
Cross modulation:	53 dB
Discrete 2nd-order beat:	60 dB
Discrete 3rd-order beat:	60 dB below three 66 dBmV test signals
Hum modulation:	37 dB
Minimum return loss:	16 dB

Acceptance criteria for many of these parameters may differ:

Parameter	Specification
Cable structural return loss:	26 dB or greater
Inbound path loss:	44 ± 6 dB
Outbound path loss:	44 ± 6 dB
Discrete third order beat:	60 dB below three 66 dBmV test signals
Radiated emissions below 54 MHz:	15 μV/meter at 100′
54 to 216 MHz:	20 μV/meter at 10′
above 216 MHz:	15 μV/meter at 100′
Hum modulation:	Less than 1.5%

Path loss tolerances are wider for acceptance testing than they are for design. Another important difference is the distortion parameters. It is unrealistic to measure composite triple beat and cross modulation distortions in a broadband data network. RF data signals with various bandwidths and modulation schemes do not produce predictable composite triple beat and cross modulation distortions.

It also is impractical to acquire the necessary test equipment to perform these types of tests. The third-order beat test is a practical test easily performed with a minimum of test equipment. It provides a fairly good indication of the overall performance of the network.

Revenue opportunities

With the continued increase of MAP-compatible broadband data networks there are many ways to profit by providing various services. The CATV industry has the expertise for broadband cable installations. People with CATV experience are now in demand for all phases of the broadband data transmission market.

System designers familiar with two-way designs are able to work with end-users to plan and design a network. Of course, the designer should be aware of techniques that provide system redundancy, close tolerances and status monitoring. The designer also will have to provide an immense amount of documentation, including distortion calculations, and inbound and outbound signal levels at every network node.

Construction companies familiar with cable splicing and installation practices can use the same skills for installing MAP-compatible networks. In some cases, the data networks may allow for simpler installation because the majority are located indoors with amplifiers mounted within easy access of the floor.

Local CATV companies have the opportunity to provide alignment and certification services. Most have access to the necessary test equipment for balancing broadband networks. Their services can be offered to local factories installing these networks.

Ongoing maintenance contracts that provide periodic system inspections and emergency repair services can provide a steady source of income. Many facilities with broadband data networks do not have in-house expertise with broadband systems. A local cable company has the opportunity to provide this type of service.

Jumping on the bandwagon

The next few years will show a dramatic increase in the implementation of MAP-compatible broadband data networks with many people jumping on the bandwagon. This sudden interest will generate many opportunities for revenue, as well as promote further research into potential applications for broadband networks in the data and CATV industries.

Source
MAP/TOP Broadband Specification — Draft C, MAP/TOP Media Committee, Oct. 9, 1986.

Broadband LAN test considerations

The third part of this series deals with intermodulation distortion.

By Steve Windle
Applications Engineer, Wavetek Indiana Inc.

Real-world amplifiers do not have perfectly linear RF transfer characteristics. As a result, intermodulation distortion occurs. The products of this distortion interfere with data transmission if they are present within the data carrier modulation frequency spectrum. With a system/spectrum analyzer, a precision preselector (bandpass filter) and a multiple carrier generator, tests can be performed to measure intermodulation distortion and determine its source when out of design specification.

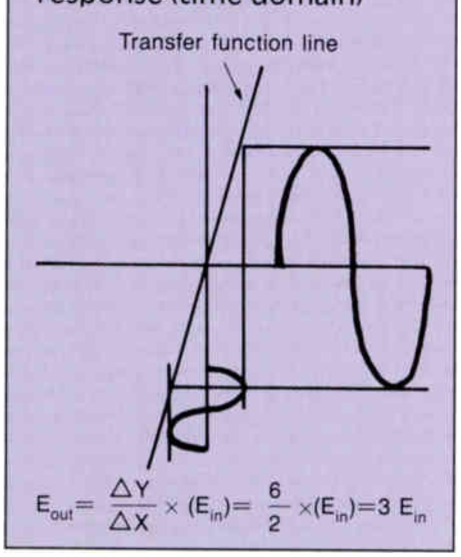
Nearly all serious distortions associated with transmission on broadband coaxial systems are caused by the active equipment in the transmission medium. These distortions may be divided into two major categories: 1) non-linear (i.e., harmonic, intermodulation, cross modulation) and 2) linear (i.e., amplitude vs. frequency and phase vs. frequency). Linear distortion is caused by inductive and capacitive qualities and typically is measured by sweep frequency analysis and relative group delay testing, respectively. Non-linear distortions, the more complex functions of the transfer characteristics of amplification equipment, are the primary topic of this article.

Ideal vs. real-world amplifier

To better understand this concept, a basic review of amplification is in order. The ideal amplifier would have a predictable input-to-output relationship, using the linear function $y = mx + b$, where:

y = output level
x = input level
m = AC gain
b = DC offset or output level

Figure 1: Linear amplifier response (time domain)



The DC variable normally is not considered in frequency amplification devices and should be considered as zero. This would leave the simplified expression $y = mx$ or $E_{out} = AE_{in}$. In Figure 1, the output level is predicted by the slope of the transfer function line multiplied by the input level. This indicates input signal amplification with no distortion.

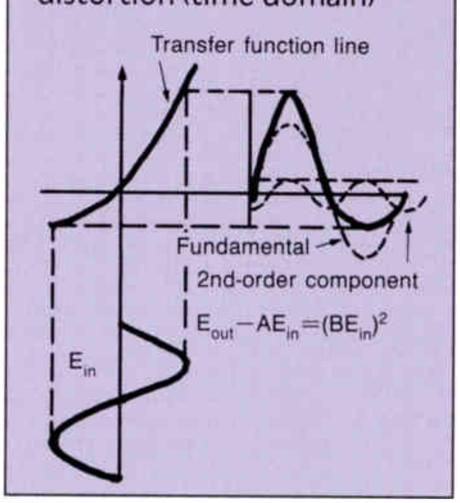
Real-world amplifiers have more complex transfer function lines than the linear response represented in Figure 1. A graphic expression of both second- and third-order distortion may facilitate the understanding of this phenomenon. Second-order distortion occurs when amplification equipment is operated with a quiescent point closer to cutoff or saturation. When this condition exists, amplification occurs with a transfer characteristic similiar to the square law function of diodes (Figure 2). The output frequency content now may be predicted by the expression $E_{out} - AE_{in} = (BE_{in})^2$.

Fourier analysis is one mathematical technique used to account for this change in the output with respect to the input signal. This mathematical expression provides a description of a periodic signal, in terms of its fundamental frequency component and related frequency components at integer multiples of the input signal. In simpler terms, the output of the amplifier will contain the amplified original signal *and* a component at twice the input frequency. The graphic representation in the frequency domain is in Figure 3.

This transfer function also will allow the mixing of two fundamental carriers to produce new components at the sum and difference of the original frequencies (Figure 4). Applying this theory to multi-frequency transmission systems, second-order distortion products may appear on or about the operating frequency of a modulated carrier, causing distortion during demodulation (Figure 5).

Second-order distortion became a problem in cable television when single-ended line amplifiers were required to operate over a

Figure 2: Second-order distortion (time domain)



'The primary concern of intermodulation testing is...the relative effect the (beat) component has on a transmission carrier'

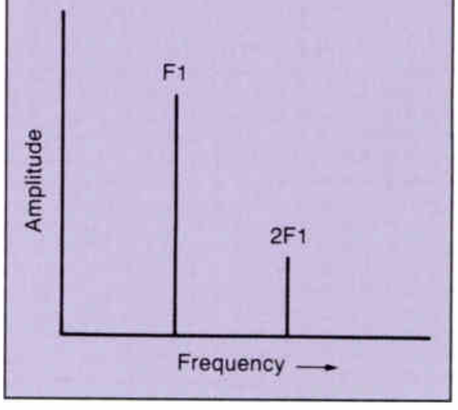
broader frequency range. The adopted solution was to use a push-pull circuit configuration that effectively moved the quiescent point to the symmetrical intersection of two transistor transfer curves. With this technique, each transistor only was responsible for amplification of 180° of the stimulus signal and would phase cancel the even harmonic components.

For third order, the remaining transfer function became $E_{out} = AE_{in} + (BE_{in})^3$. In this expression, the phase relationship is not periodic at 180° intervals, producing no cancellation of the distortion waveform (Figures 6 and 7).

The third-order mixing of three fundamental carriers also will pass through this transfer function producing new frequencies predicted by the expression $F_1 \pm F_2 \pm F_3$ (Figure 8). The relative distortion product known for limiting amplifier cascades in heavily loaded CATV systems is either the discrete (single frequency) component of these carriers, or the composite beat (summation of multiple trios of frequencies).

Advances have been made in controlling third-order distortion over the past few years. Feedforward is a good plan for obtaining better transfer characteristics (Figure 9). In this approach, the incoming signal is divided into two routes, the signal route and the distortion

Figure 3: Second-order harmonic distortion (frequency domain)



route. The signal route amplifies the signal and produces distortion, A(S + D). This amplifier output is tapped and supplied to a phase inverter to invert (S + D), producing relative phase delay. This signal then is mixed with the original incoming signal and amplified. The original signal is phase cancelled and the resultant output equals inverted 20D. The distortion amplification path now is combined with the signal amplification path, the resultant being 20S + (20D − 20D) = 20S, or gain to the original signal with distortion cancellation.

Testing concept

The primary concern in intermodulation testing is not the amplitude nor power of the beat components, but rather the relative effect the component has on a transmission carrier. The CATV industry typically has evenly spaced carriers with consistent modulation techniques supplying information to a standard receiver. It became apparent that to interpret a limitation value of "perceived" distortion to a single style of receiver, it would be best to consider the worst case, or the effect with a fully loaded system. This brought about composite beat testing.

The local area network industry may or may not operate with evenly spaced carriers. Their modulation techniques vary with transmission speed and format, and the receive characteristics are dependent upon these modulation schemes.

Yet another dimension that adds to the testing

Figure 4: Second-order intermodulation (frequency domain)

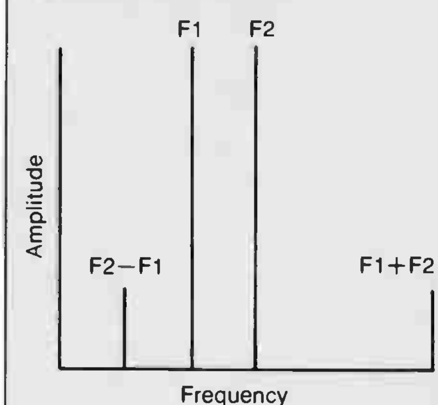
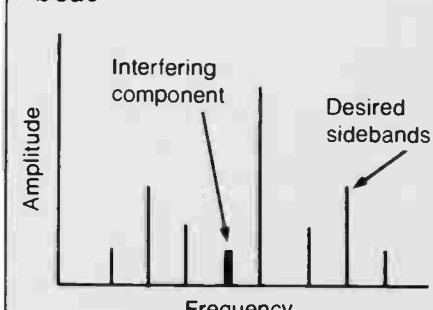


Figure 5: Interfering beat



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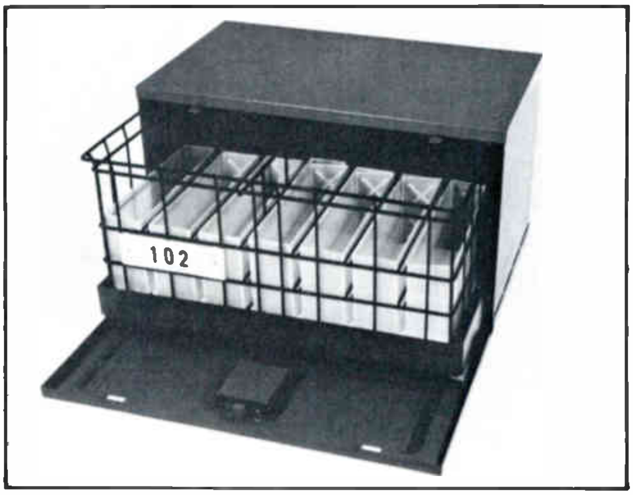

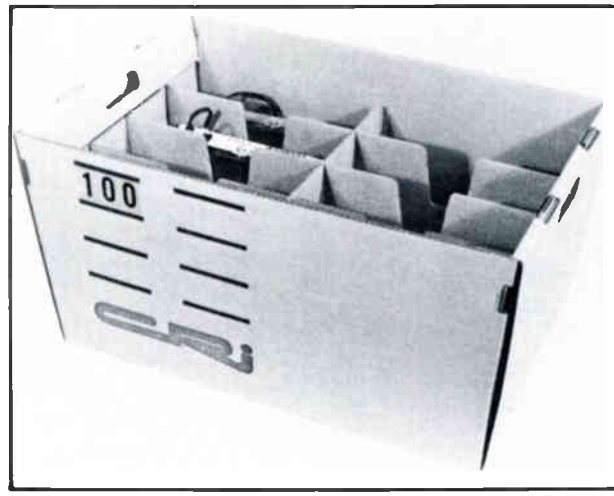

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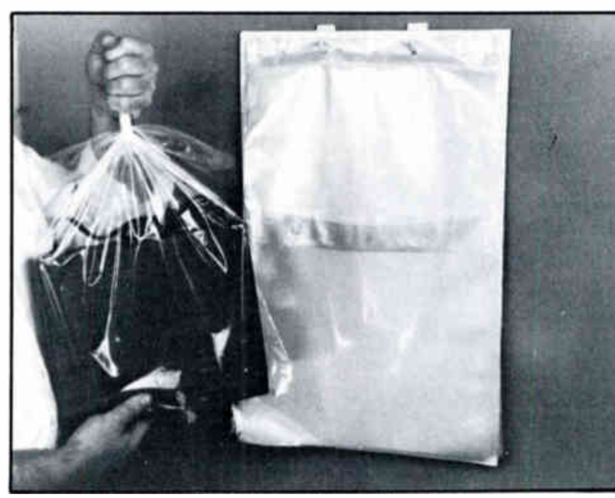

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dilemma is the fact that carrier amplitudes vary with loading, modulation format, speed and spectrum allotment. Second- and third-order tests are relative tests, relating the beat peak or effective amplitude to a specific carrier amplitude. This would lead one to conclude that a measurement relative to one transmission carrier may not apply to another (Figure 10).

In this example, the second-order beat product of $F_{11}-F_{10}$ appears in the spectrum around F_1. The mixing of $F_{12}-F_{10}$ results in a beat product of the same amplitude at the operating frequency of F_2. In this example the absolute value of the beat components is the same, but the relative measurements are different. The resultant effect of these beats most likely will be different, and is entirely dependent upon the individual receiver's distortion threshold.

Figure 6: Third-order distortion (time domain)

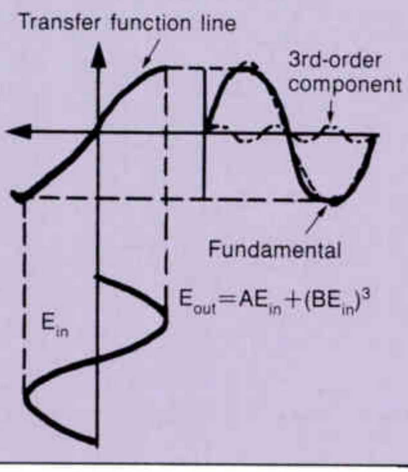


Figure 7: Third-order harmonic distortion (frequency domain)

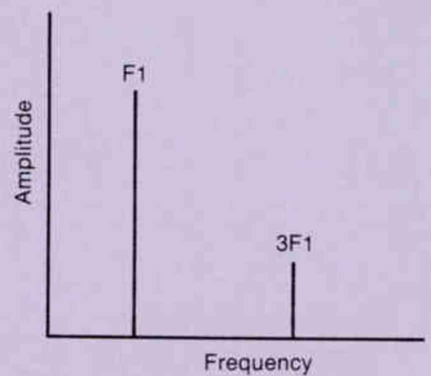


Figure 8: Discrete triple beat

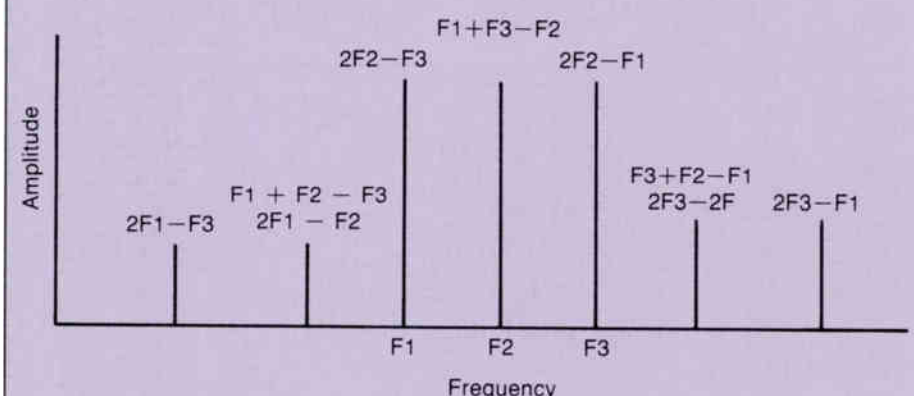
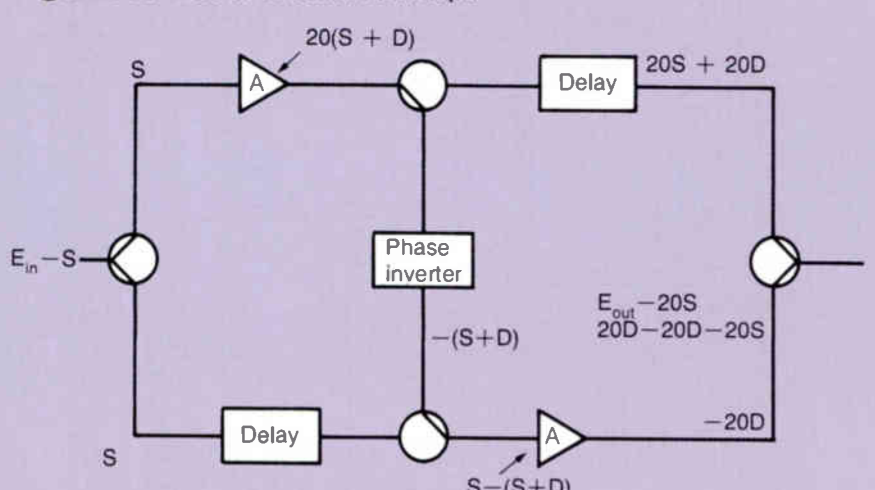


Figure 9: Feedforward concept



One conclusion that could be drawn is that the best performance test would be the "exact" simulation of the spectrum loading with continuous wave carriers and examine all possibilities. This would yield the greatest understanding in a worst-case condition, but would not predict conditions if expansion was desired at a later date. The generator to simulate this spectrum test also would be extremely expensive, as frequency agility and spectral purity are difficult design tasks in instrumentation. The test scenario also would probably prove impractical, as sheer size and lack of portability would limit its usage.

As an alternative, discrete intermodulation testing can be used as opposed to composite or other techniques. In this approach, two or three carriers are used to produce the desired beat, dependent upon the order of the distortion, with a third or fourth carrier injected as a reference, if needed. The figure derived from this procedure should be used as an operational "figure of merit," relating the environment of the transmission medium to the desired peripheral.

There are many practical advantages to discrete testing, including:

1) The amplifiers are tested in an elevated output level condition. This will exercise the equipment in an equivalent power handling capacity. The elevated levels produce beats that also are elevated in amplitude. This improves the carrier-to-noise relationship of the distortion component, enhancing the measurement accuracy and repeatability.

2) Because of the improved repeatability of the measurement, the correlation between design team predictions and actual tests results will be much closer. This will allow closer inspection of vendor components for compliance.

3) Field troubleshooting using the half and double cascade technique will help uncover single station distortion to shorten downtime. Recorded data from acceptance testing could be available at each amplifier for comparison.

4) Carriers used to create distortion, when operated at system levels, could be used for other system tests, such as hum or carrier-to-noise. Reference carriers would be readily available for spot amplifier inspection or tap level tests.

Test equipment and procedure

Discrete intermodulation measurements can be made using a spectrum analyzer, a preselector and a multicarrier test generator.

To perform the second-order intermodulation test, inject the test carriers at the point of origin desired. This typically would be the headend for outbound testing and at the furthest amplifier input for return testing. Set the output level of the test generator such that the amplifiers are overdriven but still in the linear relative change area of operation.

(Continued on page 104)

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LAN system design using split-band tap units

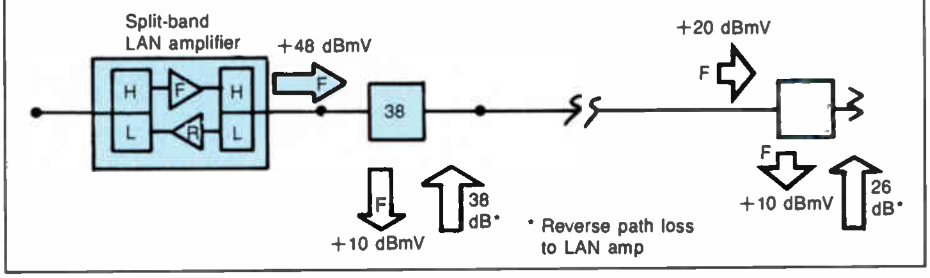
New developments in local area network technology may, in many cases, find application in the CATV environment. This article focuses on one such development, a new tap unit for split-band single-cable two-way systems. The new tap is designed to solve a problem that has been a nemesis for CATV two-way system design in the past: the return path. The problems resulting from the use of standard CATV tap units in two-way plant design and a number of existing "solutions" are discussed. As well, systems designed with standard CATV taps and split-band taps are compared. The improvements resulting from the use of the new tap unit are quantified, where possible, and the more subtle operational implications are analyzed.

By Joseph P. Preschutti
President, Broadband Networks Inc.

The first commercially successful large scale use of two-way CATV technology is the local area network (LAN) industry application of broadband in high-performance data communications systems. Although CATV system equipment has been "capable" of two-way operation, the lack of any major profitable operations has limited the deployment of functional two-way broadband systems in the CATV industry. LAN industry activity has reignited the development of new equipment for two-way systems. These new developments include efficient high-speed data transmission devices such as modems, system status monitoring and fault detection equipment, and others that affect the implementation of the basic distribution system itself.

The broadband system designer will find a wealth of new ideas and improvements in the state of the art by keeping abreast of new developments in the LAN marketplace. To a large extent, these developments are being driven by a market that is inherently unfamiliar and uncomfortable with current broadband technology, yet requires the capability of broadband to deliver high-performance systems. Because of this need for "user-friendliness" standardization, simplicity and reliability of operation of the broadband plant are high priorities.

Figure 1: Feeder design using standard CATV taps



Control of reverse path loss

CATV systems are designed using standard CATV tap units, which are selected to provide adequate control of the RF signal power delivered to the subscriber. LAN systems require tight control of the return system as well as the forward system. The LAN system designer is handcuffed by the standard CATV

Table 1: Performance benefits, split-band vs. CATV tap

	CATV tap system	Split-band tap system	Improvement
Return system path loss variation, P(var), dB	12	3	9
Ingress susceptibility, dB	28	31	3
Modem transmit power, minimum, dB	38	34	4
Carrier-to-noise ratio, dB	ref	+4	4
Adjacent channel interference, dB	ref	9	9

tap unit when attempts are made to control the reverse system.

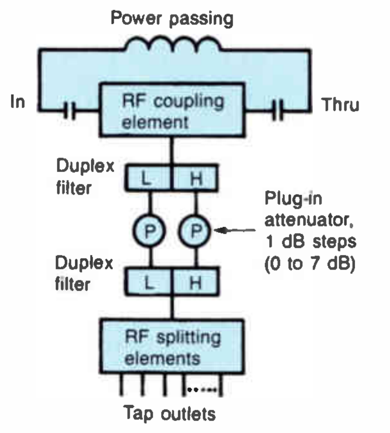
Refer to Figure 1 for an illustration of this problem. Assume a system requiring +10 dBmV out of the tap using amplifiers with +48 dBmV forward output signal level. The designer selects a 38 dB tap for the first tap off the amp output. Now, a transmitter placed at this tap unit is required to overcome this 38 dB of tap loss. On the same feeder leg the end-of-line taps, having values of 10 or 7 dB, present cumulative return path losses back to the amplifier of less than 26 dB. This discrepancy arises due to the nature of the coaxial cable frequency-dependent attenuation characteristics. Since the loss of the cable is significantly less at the lower frequencies, the reverse system path loss is much lower at these end-of-line locations. The net result is a very wide variation in the return path loss of the system.

A brute force solution to the problem is to specify the modem transmit output level differently for each tap location in the system. Procedures requiring manual modem adjustment for each tap die a quick death in practice because of the technical difficulties required to operate systems in this manner. The wide margin for error in modem adjustment, 12 dB, results in the possibility of having modems that are not adjusted properly (either overloading the vulnerable return system or being injected at too low a level for proper performance).

More elaborate schemes with automatic modem output level adjustment via protocols involving remote sensing and command of modem transmit levels have been attempted to solve the problem of reverse path loss variations. These solutions result in added cost and complexity of both the terminal equipment and the headend equipment. The possibility of these systems being vulnerable to reacting to faults in the distribution system plant adds further complexity to the utilization and operation of systems in this manner.

Prudent system design should not specify a 12 dB variation in a major parameter. Thus, specifications on return path loss variation in LANs require system design techniques for single-cable two-way plant that differ from those generally used in CATV system design. Since the designer must control the variation of the return path loss, the only means available using standard CATV taps is to limit the reach of the feeder. This limited reach is the result of the actions required to limit the path loss variations, namely, reducing the amp outputs and limiting the use of cable between actives and end-of-lines.

Figure 2: Split-band tap unit functional block diagram



Lower amplifier output levels require lower value taps, thus reducing the maximum reverse path loss. In addition, the end of feeder is limited. The amount of coaxial cable used between amplifiers or from an amp to an end-of-line tap is specified so that the minimum path loss is increased. Both of these actions result in higher installation cost, increased use of costly actives and a marginal improvement in the performance of the system vis-a-vis return path loss variations.

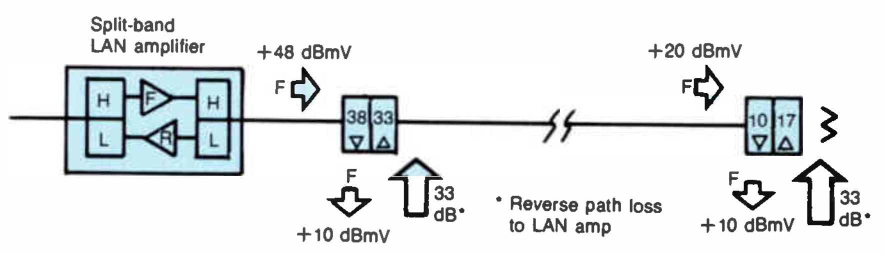
The simplest solution to this problem would be the use of a split-band tap unit that allows the designer to freely select the forward system tap value independent of the return system, and vice versa. A number of advantages become evident when such a device is used.

First, and foremost, the tap outlet can have a standardized and controlled specification for injection of transmitted RF power, similar to the control now exercised over the forward system output. This means that the two-way broadband system equipment specifications for transmit power could be designated within 3 dB, just as they are for receive power. Furthermore, the maintenance procedures used could be improved to the point similar to those used by the phone company. That is, you don't need a meter to plug in a phone and good sense dictates that a reasonable approach to coaxial installation is an attempt to emulate this simplicity.

Another benefit is that the LAN system can utilize the more powerful amplifier technologies available in the CATV marketplace such as power doubling, power quadrupling, feedforward and others. These technologies make good economic sense in the LAN environment but previously could not be taken advantage of because of the need to artificially limit the amp output because of reverse path loss specifications using standard CATV taps. As well, the system can be allowed to extend to the reach naturally available to the forward system, again not being constrained by the limitations involved in meeting return path loss specifications.

Finally, more subtle benefits accrue when using this system design technique. These benefits are uncovered when system designs using the split-band tap unit are compared to LANs using standard CATV taps. They include an improvement in the immunity of the system to ingress, a reduction in the modem transmit power required, improved adjacent channel interference performance and possible improvements in basic parameters such as

Figure 3: Feeder design using split-band tap units



carrier-to-noise and carrier-to-intermodulation performance.

Inside a split-band tap system

The "dual-value" split-band tap is shown in Figure 2. The addition of circuitry that allows the individual adjustment of tap attenuation value between the RF coupling element and the signal splitting circuits provides a simple and effective means of designing split-band systems with both downstream and upstream path losses being controlled.

With the split-band tap unit, the situation illustrated in Figure 1 involving the amplifier with +48 dBmV could have as the first tap unit one with a base value of 33 dB instead of a standard 38 dB tap unit. This 33 dB tap then would have an additional 5 dB pad plugged in to the forward path to provide the proper level of +10 dBmV out of the tap while the return path loss would be only 33 dB. (Figure 3 illustrates this concept.) Furthermore, the end-of-line tap could be a base tap of 10 dB with an additional plug-in 7 dB attenuator in the return path instead of a standard CATV 10 dB tap. This would increase the tap value from 10 to 17 dB for the return path and result in the path loss being 33 dB from this end-of-line tap unit. Thus, the return system has been designed with a fixed value of 33 dB for return system path loss instead of having the 12 dB variation inherent with the use of standard CATV tap units.

In order to analyze the effect of the dual-value split-band tap (SBT) on the performance of a system it is necessary to define certain parameters. For the following analysis it will be assumed that: 1) The "basic tap value" of the SBT is a 3 dB step tap assortment with the highest value being 33 dB; 2) 1 dB step attenuators can be used as plug-in devices in the "pad" areas shown in Figure 4; and 3) the pad value attenuation is limited to a maximum of 7 dB.

Computations of path loss values were made for a split-band system with the spectrum from 5 to 175 MHz used for upstream transmission and from 230 to 450 MHz for downstream transmission. The downstream value of the tap outlet signal level was specified as a minimum of +10 dBmV at the highest channel in the forward spectrum. The system was tapped at regular intervals of 80 feet with the appropriate value eight-port tap being used. In-line feeder equalizers were specified to limit in-band tilt to a maximum amount of 3 dB. This resulted in placement of in-line equalizers at spacings of 320 feet using attenuation values for 0.500 inches gas injected dielectric solid aluminum coaxial cable.

Two different amplifier output levels were analyzed: +45 dBmV and +48 dBmV. Several different feeder designs were calculated including: 1) a feeder with no splitters, in which only coaxial cable, tap and in-line equalizers were used; 2) a feeder as in the first case except with a splitter at the amplifier output; and 3) a feeder as in the first case except with a high-loss leg of an 8 dB directional coupler driving the line.

The following parameters were calculated: 1) tap outlet signal level at 450 MHz; 2) tap outlet signal level at 230 MHz; 3) path loss to amp input at 175 MHz for a signal injected at the tap outlet; and 4) path loss to amp as in the third case except at 5 MHz.

Three main system configurations were investigated: 1) standard CATV taps using standard in-line equalizers; 2) standard CATV taps using special in-line equalizers with the capability of installing flat attenuation as well as equalization; and 3) split-band tap units with standard in-line equalizers.

The effects of these system configurations on the reverse path loss variations are presented in Figures 4 through 9. Figures 4, 5 and 6 illustrate the case of a +48 dBmV amplifier output, while Figures 7, 8 and 9 show the case of a +45 dBmV amplifier output. Figures 10 and 11 show the effect on the forward system tap output window for standard and split-band taps.

Results and improvements

Figures 4 and 7 represent current state-of-the-art system design procedures. The effect of lowering the amplifier output level was to reduce the reverse path loss variation from 10 to 8.5 dB. The cost of lowering amplifier output levels 3 dB is quite substantial compared to the 1.5 dB improvement achieved by this method.

If an in-line equalizer device that allows control of reverse path flat loss as well as frequency compensation circuits was used, as in Figures 5 and 8, the reverse path loss variations would

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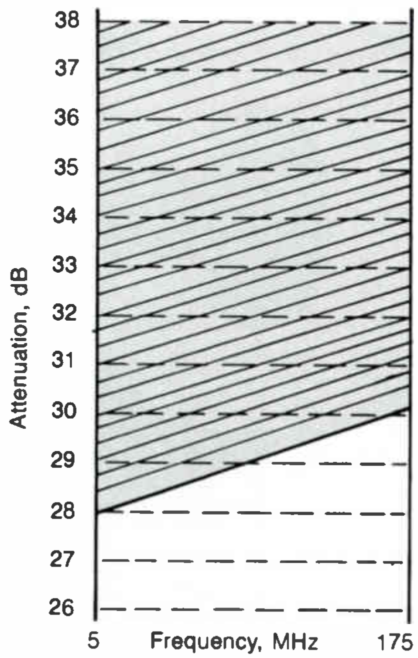
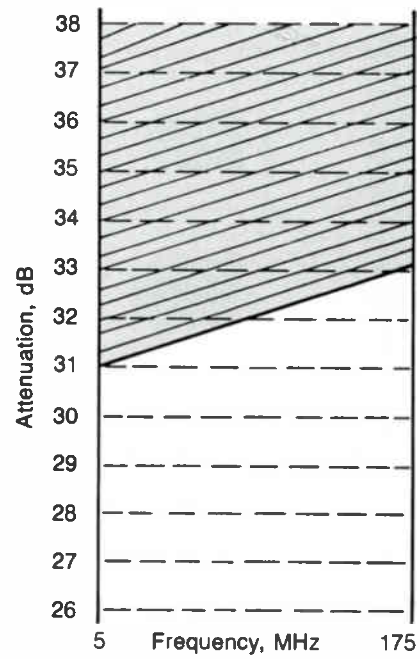
Figure 4: Reverse path loss window*



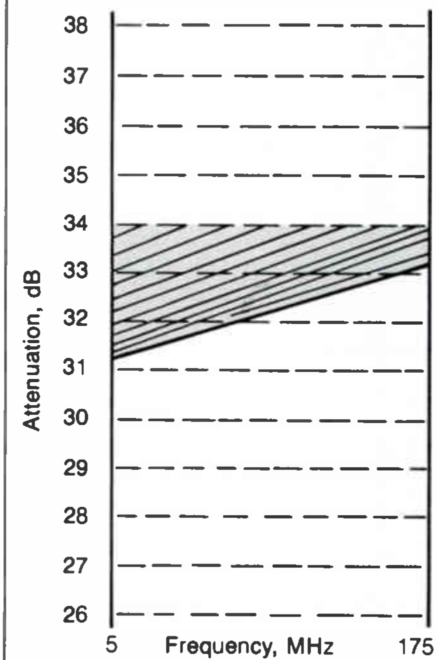
* Using standard CATV taps, +48 dBmV amplifier output, standard in-line equalizer.

Figure 5: Reverse path loss window*



* Using standard CATV taps, +48 dBmV amplifier output, padded in-line equalizer.

Figure 6: Reverse path loss window*



* Using split-band taps, +48 dBmV amplifier output, standard in-line equalizer.

be 7 and 5 dB, respectively, for the cases of +48 and +45 dBmV amplifier output levels. This represents an improvement of 3 and 3.5 dB, respectively.

When split-band taps are used the results shown in Figures 6 and 9 are achieved. The design window for reverse path loss can be controlled to within 1 dB at 175 MHz with a 3 dB variation at 5 MHz being contributed by the in-line equalizer. This represents an improvement over both of the preceding configurations, with the reverse path loss variations decreasing by 7 dB when compared to the standard configuration and 4 dB better than a system utilizing a special in-line equalizer device, for systems using +48 dBmV amplifier output levels.

The forward system design window, which is shown in Figures 10 and 11, also is improved somewhat using the split-band tap. The window at 450 MHz is 1 dB for the split-band tap unit, while it is 3 dB for the standard CATV tap unit. Variations at 230 MHz are decreased from 4 to 3 dB.

A comparison of the performance improvements of the return system is summarized in Table 1 and explained in the following paragraphs.

Return path loss variations — This is the primary variable controlled by the split-band tap unit. The variations in the return path loss are effectively reduced from the 12 and 7 dB values with standard CATV taps to a maximum of 3 dB at 5 MHz with the SBT. Thus, the total boundary for variations including in-band equalization and available dB values of the tap improved by 9 and 4 dB, respectively.

Minimum modem RF transmit output — The minimum output signal power required of the RF modem transmitter can be 4 dB lower than with the standard CATV tap, as shown in the example. With the standard CATV tap, 38 dB path loss was encountered, while with the SBT, 34 dB was the maximum path loss encountered.

Susceptibility to ingress — Using standard CATV tap technology the lower boundary on path loss for signals injected at the tap outlet was 28 dB. With the split-band tap unit, the designer has the flexibility to choose the specification of the dB value of the reverse injection. In the example shown, the system is designed around a 33.5 dB ± 0.5 dB window at 175 MHz. Compared to standard techniques, the system as designed has a 3 dB higher minimum path loss. With the SBT the designer has the flexibility to trade off the modem transmit power required for more ingress susceptibility. For instance, if the return path loss specification was chosen to be 36 dB, we would have a 6 dB improvement in the susceptibility to ingress.

Adjacent channel interference — This will improve, assuming fixed modem transmit power, by the same amount as the return path loss variation. In this case, 7 and 4 dB respectively, compared to the two techniques that can be employed using standard CATV taps. However, if modem transmit levels are adjusted, this parameter would be roughly equivalent with both systems. The susceptibility to error in the ongoing operation of the system is much less with the SBT.

Carrier-to-noise ratio — Worst case carrier-to-noise ratio will improve by the dB difference between the maximum path loss incurred by a signal injected into either system. In this case the improvement will be 4 dB. Needless to say, a 4 dB improvement in CNR is not insubstantial.

Carrier-to-intermodulation ratio — Worst case carrier-to-intermodulation ratio will improve by at least twice the dB value for adjacent channel performance improvement for second order intermodulation products and three times the dB value for third order terms. This is dependent upon whether modem RF output levels are fixed or adjusted independently for each outlet. If the fixed specification is used, the improvements will accrue.

Design, installation and cost

When designing with the split-band tap unit the designer must select pad values for both forward and reverse paths, as well as select the basic tap value. In addition, the documentation of the system design must include this information for the system installer.

Installation of the split-band tap will require the proper installation of the pads, as well as the basic tap value. The added time for this operation is about three minutes, if done prior to or concurrent with tap installation.

The cost of the split-band tap is substantially higher than the CATV tap due to the added complexity of the device and the relatively lower volume of production of this specialized product. Fortunately, however, there are several

The new 'SOLUTION ONE'

For simplified 2-button master control over all TV/VCR/pay T.V. switching. It's the answer you've been waiting for.

Forget those older big box units with their truck-dashboard styling. Forget the number of knobs, dials and switches it takes to operate them. Discover instead the new breed of TV/VCR Switcher from SEAM Electronics that does a great deal more, for a good deal less!

With our revolutionary 'SOLUTION ONE' Switcher in command, quick convenient changeover is accomplished by simply depressing or releasing two pushbuttons. You lose nothing – and simplify everything. All possible combinations of regular TV viewing, pay television, cable input, taped VCR content, rental movies, monitoring and even recording or recording-while-viewing are accommodated. The converter continues its regular function under its guidance. Stereo, cable-ready and remote control convenience, lost due to pay T.V. decoder limitation, is restored. What you achieve in total is faster, no nonsense, error-free central control over selection!

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- Installation is a straightforward, once only operation using standard CATV coaxial cable connections; maintenance is virtually non-existent.
- Innovative passive R.F. switch design supplies a minimum isolation of 70 DB up to 100 MHZ and 60 DB up to 450 MHZ thus assuring long life, interference free operation (full specifications on request).
- Compact slimline styling (6.8" x 3.5" x 1.5") with a furniture-quality simulated walnut finish and gold tone accent trim.
- Comes fully packaged with Owner's Manual and one year limited warranty.
- And the cost? A mere fraction of the price tag of those larger 'active units.
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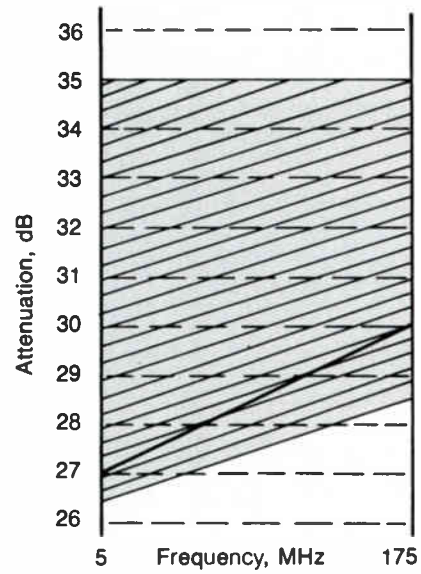
Dealer Enquiries Welcome

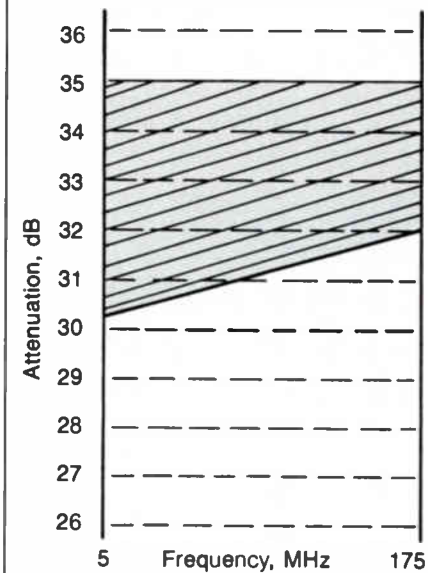
Reader Service Number 34.

Figure 7: Reverse path loss window*



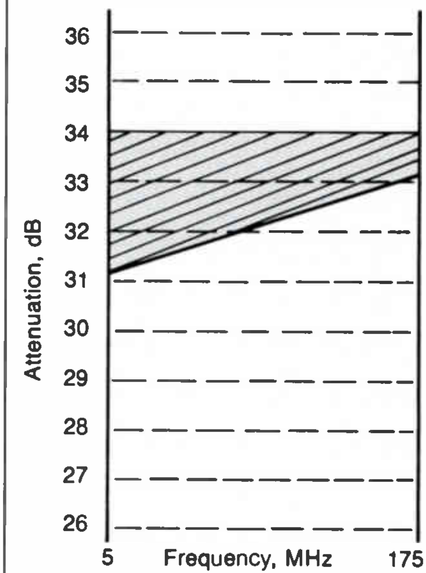
* Using standard CATV taps, +45 dBmV amplifier output, standard in-line equalizer.

Figure 8: Reverse path loss window*



* Using standard CATV taps, +45 dBmV amplifier output, padded in-line equalizer.

Figure 9: Reverse path loss window*



* Using split-band taps, +45 dBmV amplifier output, standard in-line equalizer.

counterbalancing cost savings parameters. The reduced cost due to a reduction in the number of amplifiers is a considerable savings. The reduction in the ease of meeting system compliance tests with a system that easily fits a set of specifications rather than one in which high-performance specifications are only marginally met also must be considered.

The cost of utilizing an in-line equalizer with the ability to add flat loss as required to optimize the system path loss performance improves the variation somewhat when designing with standard CATV taps at a lower cost than the split-band tap, but with lower performance. Further, the ongoing maintenance and use costs for the network can be profoundly different. The ability to fix RF modem transmit levels and the reduction in the number of actives will yield measurably higher reliability systems.

The purpose of this analysis was to detail the performance improvements that are realizable with the use of split-band tap units. Another approach to an analysis of this is to fix the specification of a system and compare the costs. One such analysis reported to me involved a system using four-port taps spaced at 40 feet and designed for a 6 dB path loss variation contribution by the tapped portion of the system. The designer was able to reduce the cost of the system by improving the tap-to-amplifier ratio from 10 taps per amp using standard CATV technology to 18 taps per amplifier using the split-band tap unit. The cost reduction was due to the reduction in the number of amplifiers in the system.

Finally, the cost of upgrading the tap unit from the standard CATV version to the split-band version, when compared to the overall cost of installing a broadband distribution system, is less than 2 percent.

Figure 10: Forward tap window, standard taps

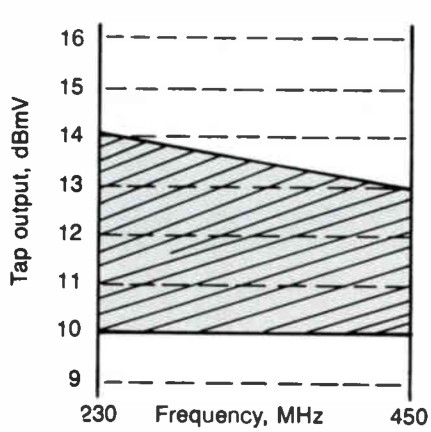
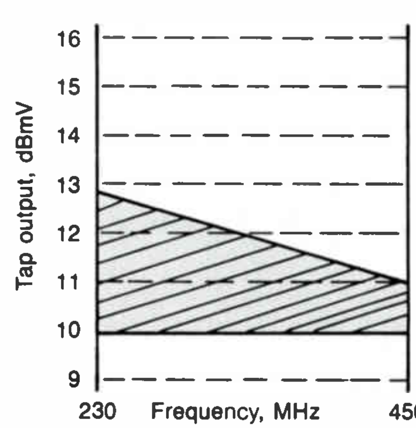


Figure 11: Forward tap window, split-band taps



Summary and conclusions

The use of broadband systems for data communications LANs such as the IEEE 802.4 and MAP applications require performance specifications that are not optimized using standard CATV tap units in single-cable split-band system designs. Optimum configuration of these systems requires the use of a dual-value tap unit, which allows the designer to control reverse system path loss to the same degree that control is exercised in the forward system design.

Use of the dual-value tap unit will result in substantial performance improvements over the current state of the art in most critical performance parameters.

Author's note: I wish to acknowledge the assistance of several individuals who contributed ideas, analysis input and criticism. These are: Steve Davidson from the Jerrold Division of General Instrument; Colin Horton from C-COR Electronics; Jay Staiger of Magnavox; and from the Industrial Computer Group of Allen-Bradley, Jim Fischer and Dick Foster.

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Reader Service Number 35.

Modems: The vital link for CATV

Modems are nothing new in the cable industry. In fact, they have been in use for many years in headends, providing news and weather information, stock market reports, community services and advertisements for cable viewers. They have become a crucial part in the addressable systems of today, and their importance has spread outside the headend, playing a key role in the advent of computerized billing services, customer sales and pay-per-view ordering for large MSOs. They have opened the door to new profit opportunities for operators by allowing data communications on broadband systems, producing alternatives to conventional methods such as telephone lines.

By Todd Lomaro
Chief Digital Network Engineer
United Artists Cablesystems Corp.

Data communications is the movement of information from one point to another by means of electrical transmission. The binary information stored in one computer can be transferred to another through several mediums, the most common being the telephone system. A modem (the acronym for *modulator/demodulator*) provides the interface between the computer and the telephone circuit by converting or modulating the binary data into a form that is acceptable for telephone (voice frequency) transmission. A modem on the receiving end of the transmission demodulates the signals back into binary data.

Centralized data can be accessed from remote terminals and systems hundreds of miles away via telephone circuits and modems. Modems permit remote sites to transmit mail, transfer sales reports and orders, edit documents, and a host of other functions. Inventory control, personnel records, customer data and even billing can be accessed anytime, any place, providing updated information.

Speed becomes a factor especially when on-line interactive processing with a remote system is required. Communication circuits are rated by the speed in which data can be transmitted. Voice grade telephone circuits can provide transmission rates ranging from 300 to 9,600 bits per second (BPS) or baud rate. The rate of transmission will, in fact, depend on how fast the modem can modulate the information (transmission only will be as fast as the slowest modem in the link). Most commercially available modems modulate at speeds between 300 and 2,400 BPS. The more sophisticated modems can transmit at speeds of 9,600 BPS and up.

With increases in technology, particularly in high-grade data lines and broadband cable, speeds in excess of several megabits per second can be achieved. The higher speed modems are generally in use with large mainframe systems that facilitate a good deal of remote on-line activity. The faster modems require special data-only lines. These circuits usually are leased from the telephone company on a per-month basis and are needed for their increased bandwidth capabilities and immunity to interference that could cause errors and loss of data.

Modems in the headend

Modems first appeared in the cable system headend about 10 years ago, providing news and weather information from the United Press International (UPI) for broadcast on cable TV. The information was transmitted via telephone lines into the headend where a modem would demodulate the signal and feed the data to a character generator. The news and weather information then was broadcast on a barker channel continuously through the cable.

'Modems rapidly are becoming the key to effective and efficient PPV services'

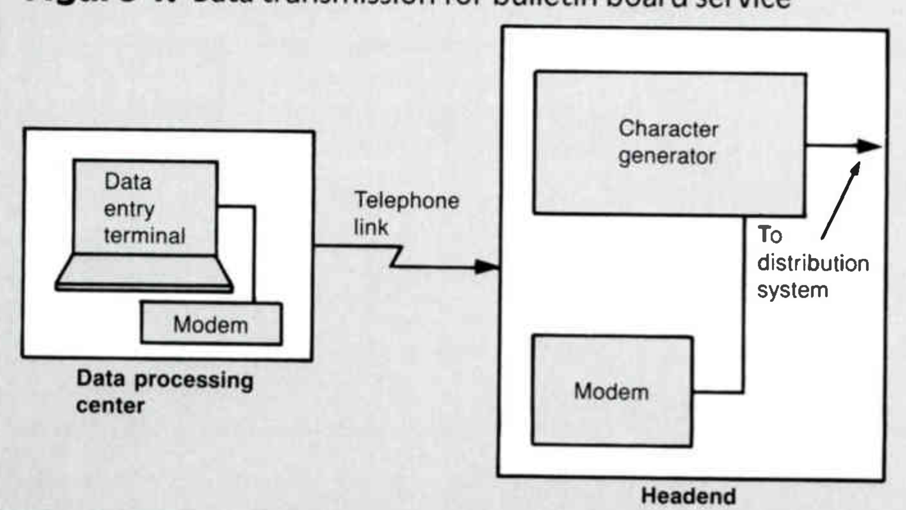
The ability to transmit data up to the headend for processing and eventual broadcast gave rise to other cable services such as community bulletin boards and classified ad stations (Figure 1). Customer information could be entered on a computer terminal at a central location and the data forwarded by phone line to the originating headend. The data then would be received by modem and eventually processed by a character generator.

Addressability and how to achieve it have become increasing concerns for system operators. There are several approaches to the idea. Systems that are one-way addressable require an addressing computer and an address controller, or an FSK (frequency shift keying) generator in the headend. The FSK generator is in essence an RF modem in which FSK is a modulation technique. Converter address information is stored on the computer and downloaded to the controller or modem. The data then is RF-modulated and combined with video/audio signals, which in turn are distributed in the system. The address information then is demodulated by the set-top converter (internal modem) that has stored in memory the proper address codes. The address code received by the converter is checked against the code in its memory for authorization.

A graphic example of this process is shown by a block diagram of the General Electric Comband System in Figure 2. There are three components for the addressing system: 1) Comband addressing computer, 2) computer interface and 3) FSK generator. (A host or billing computer can be interfaced onto the front-end.) These items provide the one-way addressability of the system, allowing operator control over viewing channels and PPV events for customers. But the use of a modem in the headend does not stop just with services for customers.

A relatively new application for modems within the headend is that of remote headend telemetry. Test equipment in the headend can be accessed and operated remotely by field personnel. A computer can be instructed to perform several measurements, such as taking video and audio levels, and the data fed to a

Figure 1: Data transmission for bulletin board service



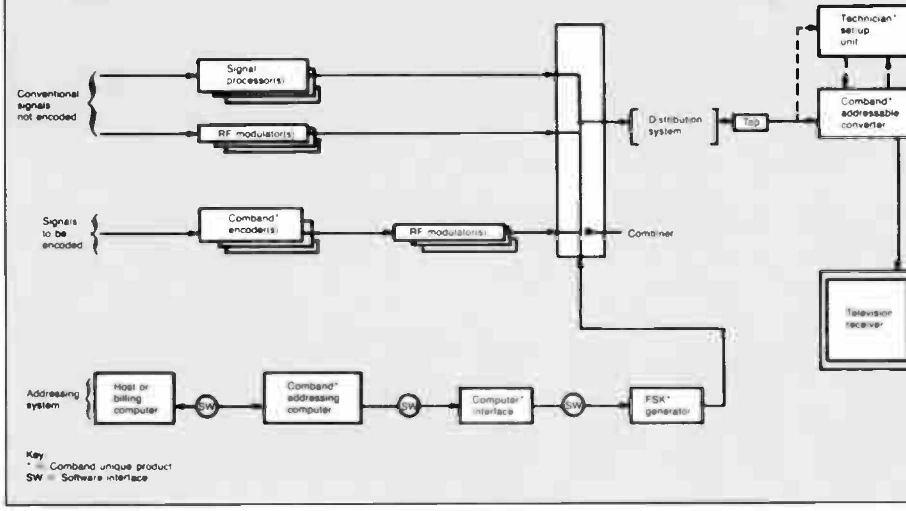
modem for transmission back to the field for analysis. The information can be transmitted by telephone, or an RF modem can interface directly with the existing cable. The signals at the output of the modem are combined with the headend signals. The receiving system extrapolates and converts the information and transfers it to a printer for immediate analysis or to a computer for storage.

Billing systems and PPV ordering

Most billing systems utilize modems in all aspects of their services. CableData, for example, provides a complete computer system that enables billing services, order entry, service scheduling, inventory control (converters) and customer information tracking for the cable industry. Utilizing a Tandem TXP computer and several modems, these important, everyday functions can be provided for entire systems and divisions regardless of locations. Four Eastern division systems of United Artists Cablesystems (Oakland, N.J.; Westchester, N.Y.; Brookhaven, N.Y.; and Massachusetts) all are on-line, with modems and terminals, to the division's main data processing center in New Jersey. A Paradyne 9,600 baud modem allows the on-line interactive processing of data to take place between the remote terminal and the Tandem system.

Modems rapidly are becoming the key to effective and efficient PPV services for customers as well. There are several methods to the PPV ordering process. Perhaps the most predominant method is manual call-in where customers tell an operator what program they want to buy. The information is entered into a billing computer (for instance, the CableData system), which processes and off-loads the proper addressing codes to the system controller in the headend. If the billing system is located outside the headend, then the communication link is provided by modems.

Figure 2: General Electric's Comband System

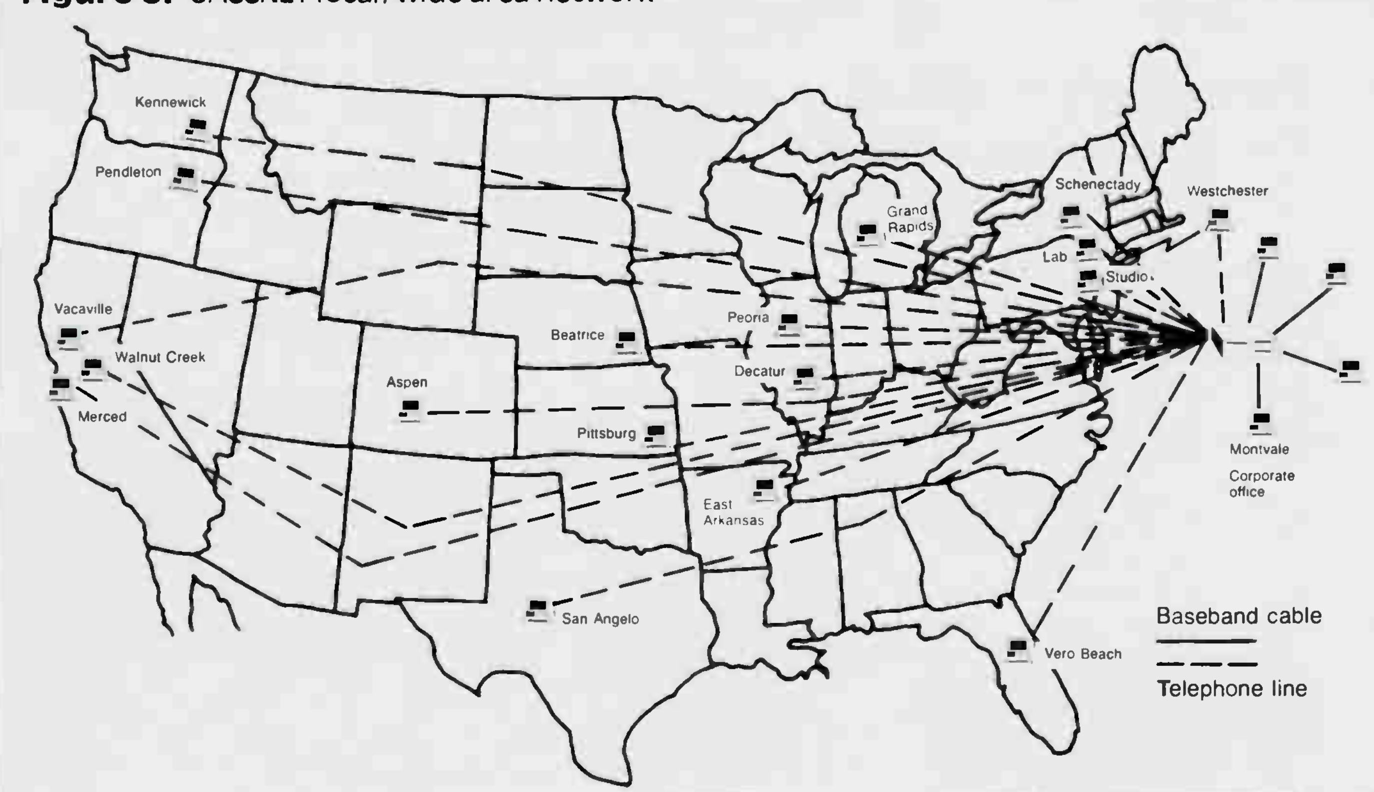


Another method of PPV ordering offered by CableData is an automatic order-taking device or phone entry processor (PEP). PEP is an ordering system that allows the customer to order PPV events by pressing a sequence of digits on a touch-tone phone. It eliminates the need for manual processing of orders and no additional hardware is required in the home. The PEP utilizes a modem to convert the touch-tone pulse into a binary data base, which then can be accessed for billing and converter address code information. The pertinent information (in order to ensure a "hit" on the converter) is uplinked to the headend addressing system through a modem.

LANs and broadband systems

Although still relatively new to the cable industry — and yet another utilization of modems — are communication networks. A local area network (LAN) permits terminals to share resources such as processing, storage and printers through a private communication system. It is a baseband system, in that information travels over a single channel that comprises the entire bandwidth of the medium (coaxial cable). Baseband LANs, however, are restricted in a certain

Figure 3: UACCNET local/wide area network



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For your subscribers who want to get the most out of their video components, offer them the Panasonic® VCS-1 switcher.

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To get the VCS-1 message to your subscribers, Panasonic provides extensive marketing support. Like cooperative advertising funds, statement stuffers, point-of-purchase displays, create kits containing complete print ads—even a TV spot to run on your local avails.

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Our Non-Addressable Remote Converter, the TZ-PC120, features

68-channel capability. Each channel is precisely controlled by phase-locked synthesized tuning, switchable between HRC and Standard/IRC offsets.

We didn't forget the favorite-channel memory. In fact, the TZ-PC120 can store up to 68 channels. It also features direct-access tuning, two-speed all-channel scan and last-channel recall. All this without an "Enter" button.

When it comes to our optional

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parental control, the TZ-PC120 lets your subscribers lock out the sensitive channels they don't want their children to see, without affecting the remaining channels. And thanks to our innovative *Stored Charge Non-Volatile Memory,* parental control channels and other memory functions will not be affected by a power outage. There's also an 18-button infrared remote control. It's compact, controls every function and comes complete with Panasonic batteries.

For your subscribers who want even more, there's the TZ-PC150. It has all the features of the TZ-PC120 plus *volume control* and *mute*. Parental control and base-band audio and video outputs are optional.

The new addressable PC-200 converter.

When it comes to your headend, the new PC-200 addressable converter

can help give you a head start. Downloadable features include channel map, channel authorization, clear parental control, initial activation and emergency alert.

The PC-200 also features 68 channels, a full-function infrared remote control, electronic parental control, favorite-channel recall and two-speed scan.

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Reader Service Number 37.

capacity since baseband signaling cannot be propagated over long distances without degradation.

The limitations of baseband LANs can be overcome through the use of modems to tie in remote terminals into a network. These terminals can share network resources, as if they were a local node. Although a minimal additional cost (of modem and phone lines) must be incurred, increased data communication and, hence, increased productivity can be achieved. United Artists' UACCNET (Figure 3) is a local/wide area PC network that couples all company IBM (or equivalent) PCs, providing shared programs and data resources for local PCs as well as remote systems. All remote PCs have the ability to network, and send and receive information by means of electronic mail.

But the most promising method of data communication, especially for cable operators, is broadband networks. Unlike baseband systems, broadband communications can carry a number of channels simultaneously on the same medium. Since signals are RF-modulated, propagation characteristics far exceed those of baseband networks. A variety of applications for broadband systems are possible.

There are two advantages to broadband networks: cost and reliability. RF modems that attach to the cable replace voice-frequency modems needed for telephone lines. They are generally cheaper, faster and more reliable than voice-frequency modems. The bit error rate (BER) for cable is much less than for telephone lines, which adds to the integrity and confidence for broadband networks. Another cost advantage is savings from the leasing of phone lines, which, depending on the type, can be the biggest expense for remote communications. These advantages, along with the ability not only to carry voice and data but also quality video, give rise to opportunities for the CATV industry outside that of entertainment TV.

Opening the door

The modem probably is the most overlooked piece of hardware in the cable arena. But its service and, most of all, its flexibility have proven invaluable for operators and engineers. Now considered standard equipment for system headends, the modem has extended beyond its initial use in cable TV. It can open the door to new and exciting technologies for the entire industry.


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We stand solidly behind every piece of cable equipment we sell.
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Head-end through drop materials, it performs the way we say, or we'll correct it — immediately.
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We'll also compete with any distributor on price, selection, delivery, and service.
Aerial
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Underground
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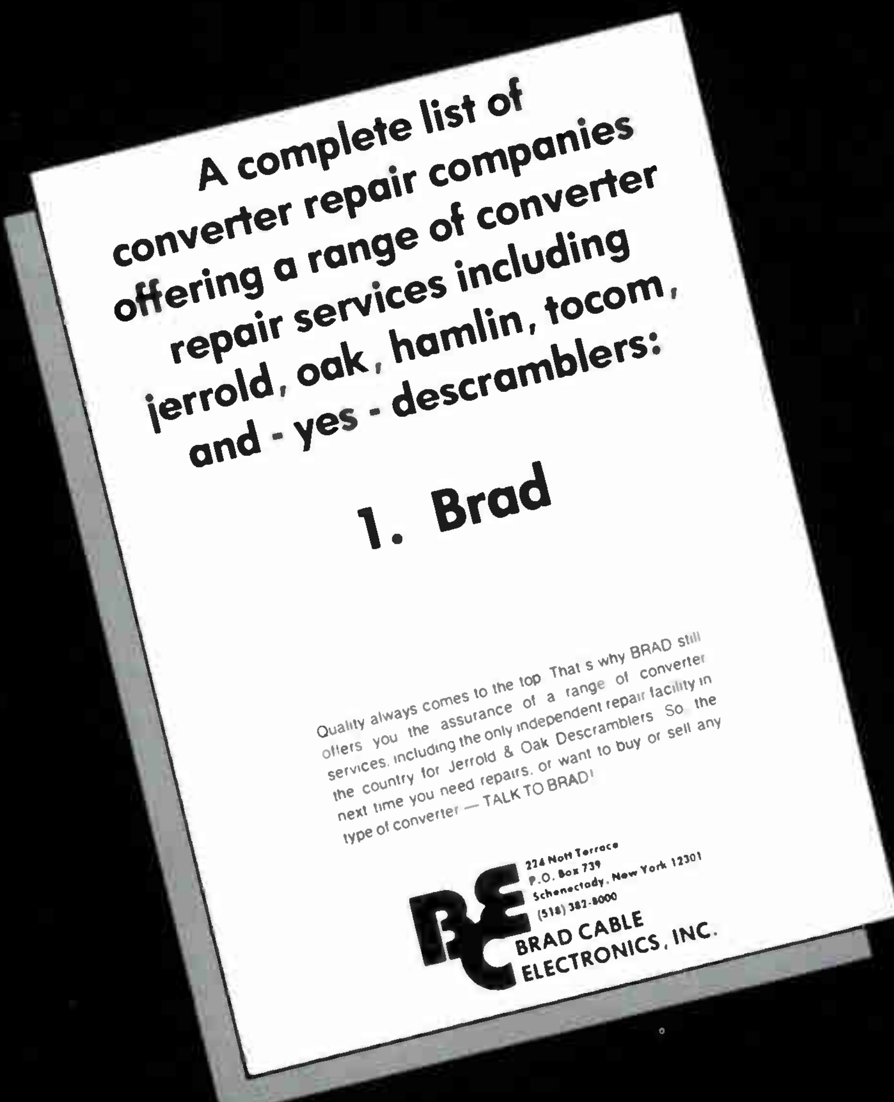
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Baseband digital modems

By P. Randall Bays
Fairchild Data Corp.

Terrestrial microwave users should think twice about replacing their analog systems with digital microwave equipment. Instead, an investigation into effective ways to provide the efficiency of digital while maintaining the flexibility of analog is in order.

One solution is the use of baseband digital modems (BDMs). BDMs only recently have found their place as a viable alternative to costly digital microwave. Their roots go back about 15 years when the Canadian sector of RCA Ltd. made a few BDMs for a common carrier (called CNCP) for the transmittal of data above voice.

The advent of digital data service (DDS) at 1.544 MBPS and 58 kBPS by common carriers gave reason to private microwave users for placing these services on their own systems. Not only would private capabilities enable direct interface with DDS on the short haul, but it was much more cost-effective to place these high data rates on their own long-haul systems than pay thousands of dollars per year to lease these digital data services. BDMs are equipped with either a DS1 interface of V.35 interface to provide the interconnect to DDS.

Subcarriers above voice/video

Baseband digital modems generate their own subcarrier directly above the voice or video carrier in the range of 1 to 20 MHz. Figure 1

Figure 1: Three T1 carriers above video

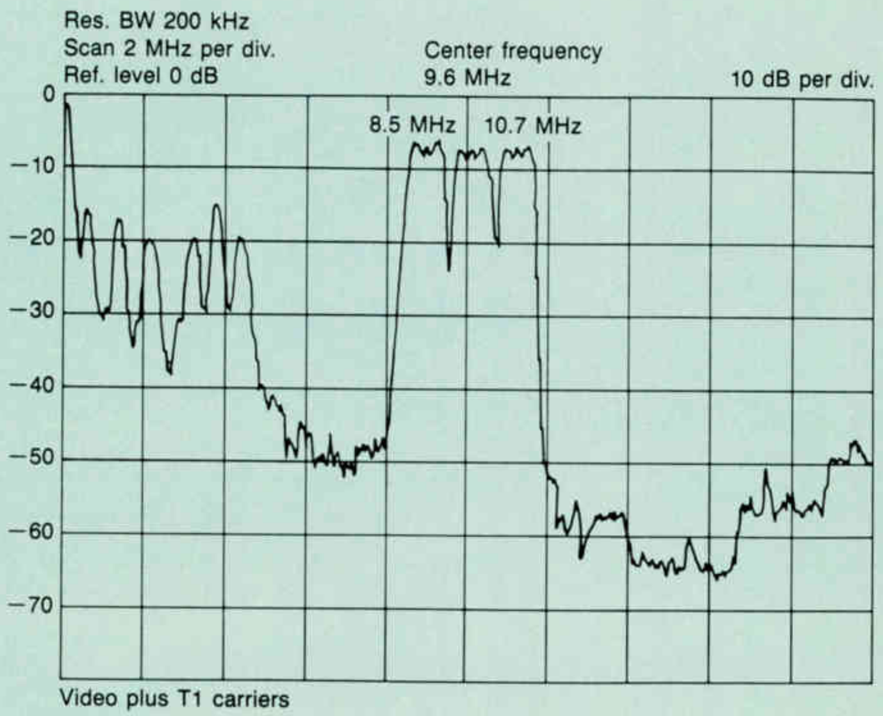
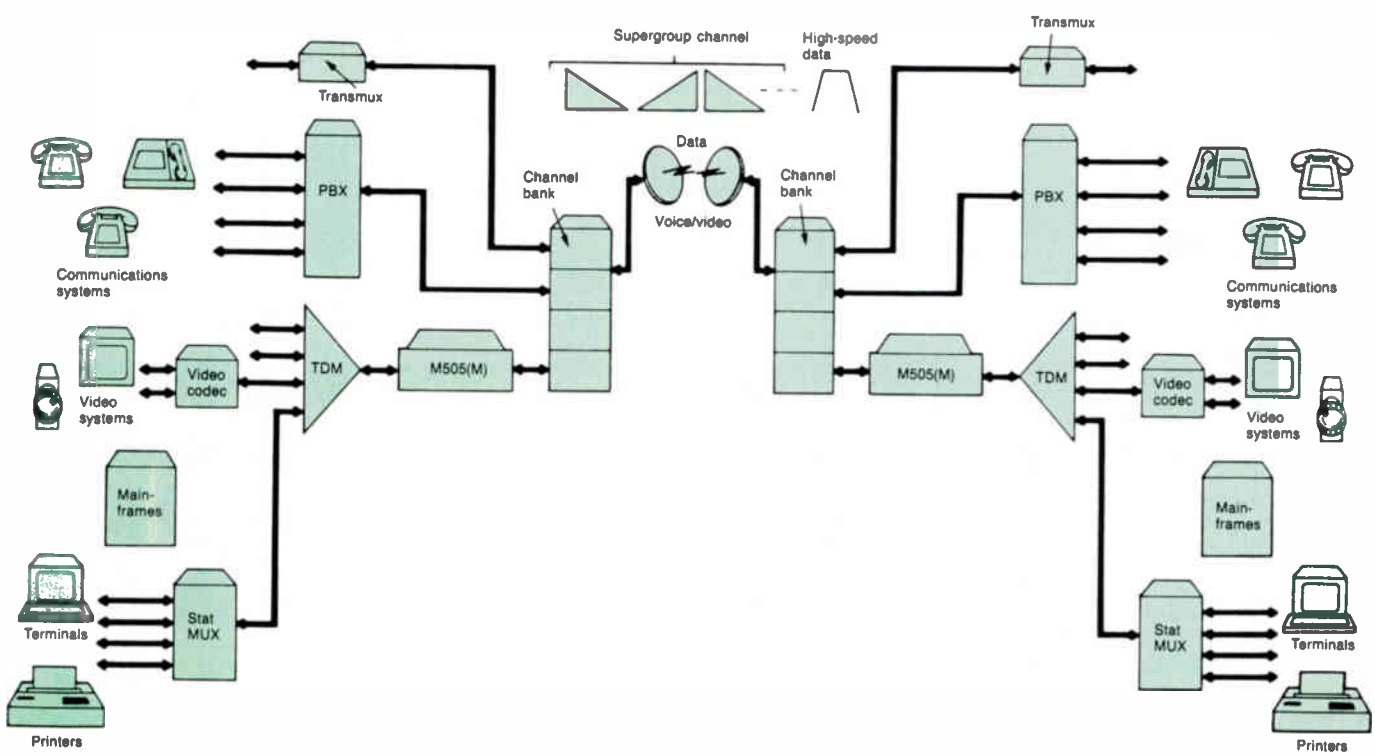


Figure 2: Typical microwave system application



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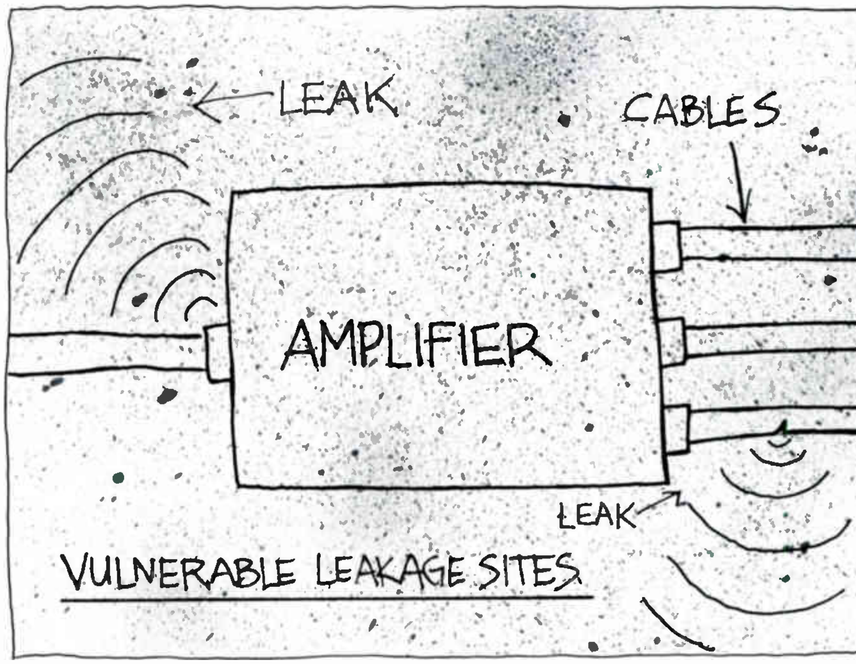

No matter how well it's maintained, every Local Area Network is susceptible to leakage. Yours included.

It's a subtle problem. Often unnoticed. Or unnoticeable. Perhaps even overlooked.

But leakage is serious, nonetheless. With equally serious consequences.

Ingress, in. Egress, out.
The causes are simple. The diagnosis, however, isn't.

Leakage occurs because of a breakdown at any of the vulnerable points. A loose cable. A corroded fitting. A nick in the cable. Usually, something minor enough that won't take the system down.

Which is precisely why leakage goes undetected.

LAN leakage comes in two forms.

Ingress, where data seeps into your system from outside. Or *egress,* where your system is, in effect, broadcasting data that may interfere with airborne or other frequencies.

Big Brother is watching.
Egress leakage has the potential to be the more severe because it often affects off-air, shared frequency services.

Your data leaking out threatens airline communications. It threatens military communications. It threatens emergency communications.

The problem is real. Leakage is a very sensitive issue. One that is attracting more than casual attention from the likes of the FCC and FAA.

Already, the FCC has formulated rules to address CATV leakage. Can LAN be far behind?

If LAN operators don't police themselves now, they'll face potentially severe government regulations and fines. Both very costly.

The threat is real, too.

Good in, garbage out.
Ingress leakage, while not as potentially dangerous as egress, can be costly in its own right.

It threatens the integrity of the system you were hired to maintain. RF energy from outside sources, such as CB radios or other high level sources, seeps into your spectrum. It doesn't belong. It's unwanted. It messes things up.

Transmission error rate increases. System reliability decreases.

User complaints soar.

All of a sudden you've got a problem for which, because of its subtlety, you can't quickly get to the source and correct.

The cure: routine testing.
The best way to prevent leakage is to adopt a program of routine leakage testing.

Wavetek can help.

We can determine the scope of your current leakage problem. Recommend solutions. Help establish maintenance programs.

And we can supply you with the proper leakage testing instruments for the particular make-up of your LAN.

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Reader Service Number 42.

'BDMs only recently have found their place as a viable alternative to costly digital microwave'

shows an analog radio with three T1 carriers above video. These carriers are distinct and independent from each other and the video. Digital internal filtering produces sharp roll-off characteristics that minimize the need for external filtering.

The usefulness of having analog voice or video and multiple digital subcarriers is evident. While voice/video requirements are being satisfied, the same microwave radio can be equipped with multiple BDMs for independent applications like PBX interconnection, video teleconferencing, computer and local area network (LAN) interconnections, and meeting the user's requirement for virtually any digital communication application.

Companies like McDonnell Douglas and New Mexico Public Services are using BDMs for digital video teleconferencing. Boeing Computer Services implemented BDMs to transmit high-speed computer-aided designs to its mainframe. Universities and school systems use them to interlink PBXs and LANs, and hospitals link computerized diagnostic equipment. Figure 2 shows a typical example of mixing voice and data applications over a common analog microwave radio. The M505(M) depicts a BDM receiving multiplexed data and modulating that information into the baseband of the radio.

Placing the digital subcarrier directly into the baseband of the radio affects the deviation by no more than −2 dB. This leaves plenty of capacity for additional subchannel loading of the radio.

A concern with placing digital data on microwave radio is its greater sensitivity over analog to environmental factors associated with analog microwave radios. Technological breakthroughs in modulation schemes such as quadrature phase shift key (QPSK) and digital filtering have laid these concerns to rest. BDMs typically have a threshold of better than −6 dB from the radio threshold with the BDM measuring a bit error rate (BER) of 10^{-9} with 20 dB carrier-to-noise. This is important for radios susceptible to fade and jitter environments or that have an abundance of noise being modulated with the carrier.

The best of both worlds

Even though the analog system is dated or may not meet its original design standards, that does not make it unusable in meeting digital requirements. BDMs recently have influenced management decisions for maintaining an existing analog microwave radio. They offer microwave operators the best of both worlds: the drop/insert and loading capabilities of analog *and* the efficiencies of digital data.

Agile Omni, the industry's most advanced receiver designed by the most relied upon name in the business . . . Standard.

With the new Agile Omni, you need no other receiver.

Standard designed it for cable TV operators, broadcasters, CATV, SMATV, and business and special teleconferencing networks—now and in the future.

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Reader Service Number 44.

RF shielding measurements of passives

The following article will try to invalidate measurement techniques by presenting conflicting data. It is intended to stimulate thought and action rather than discredit others' attempts to find a clear solution.

By Michael Holland
President, Pico Macom Inc

In the interests of meeting FCC RF leakage requirements, cable systems have been increasingly faced with the dilemma of trying to set standards for individual passive components in order to meet overall system leakage levels. The FCC, which will specify only maximum system leakage, does not set the individual requirements for components, even though their connections and location significantly affect the ultimate leakage level. The main problems we face in this area are:

1) How to determine the minimum shielding requirement of a passive device while it is out of a system in order to know with certainty that it will not exceed maximum leakage levels when in the system; and

2) How to measure the individual component in a test fixture in order to determine proper selections and acceptance standards.

At the risk of a system fine or channel shutdown by the FCC, requirements usually are set conservatively by a cable system, making the product cost substantially higher than needed. This prime requirement of shielding often creates a situation in which other quality factors of a passive device, such as return loss and isolation, are overlooked. Increasing quality while reducing cost can be achieved only by taking the guesswork out of the methods presently used.

Specifications

The shielding requirements of passives presently are selected by guesswork, figuring typical signal levels in and a conservative level out, which, when hooked to a system, *should* limit leakage to the required maximum. Unfortunately, the physical size, shape and cables connected to the passive are as much a factor as the piece itself. Calculating resonances and reflections are only trial and error at best. In reality, the industry standard has grown with what was available from manufacturers. Three years ago −80 dB shielding was acceptable, two years ago −100 dB was the standard, and now −120 dB is minimally acceptable (specifically with splitters).

Due to the non-symmetry of most passives, test procedures, readings and equipment cannot come close in determining an actual leakage value such as −100 dB. They can show a subjective difference between two devices in similar cases only if the cases are in a linear size range to the chamber used for their testing.

Manufacturers and large MSOs have been forced to make major product decisions and selections using test equipment consisting of poorly designed chambers, which sometimes are made from garbage cans in the hopes of showing they are doing their best. If a system had leakage problems, we all want to say we did the best possible job of prevention using state-of-the-art testing. This has caused many good engineers and scientists in our industry to avoid questioning conflicting data and nonsensical results. Without this pressure to have a "shielding number" in order to pass or fail, our engineers could be using proper scientific procedures in ruling out results when substantial questions and variances occur, rather than closing their eyes to the conflicting data.

The pressure to determine acceptable requirements limits the possibility for our growth and understanding, holding us back from developing a better, lower cost product. This subject should become a priority for engineers to unite in developing future goals and mutually agreed-upon standards. The fact that so many drop components, such as taps, couplers and splitters, are needed for a system — with the potential for an additive leakage — makes this a critical subject.

Let me relate some of the testing methods and findings we have made over the last five years and to point out some of the obvious technical problems found. In all methods we have heard of, examined or tried, it appears that no one, including us, has found an answer that is scien-

Figure 1: CATV shielding test method

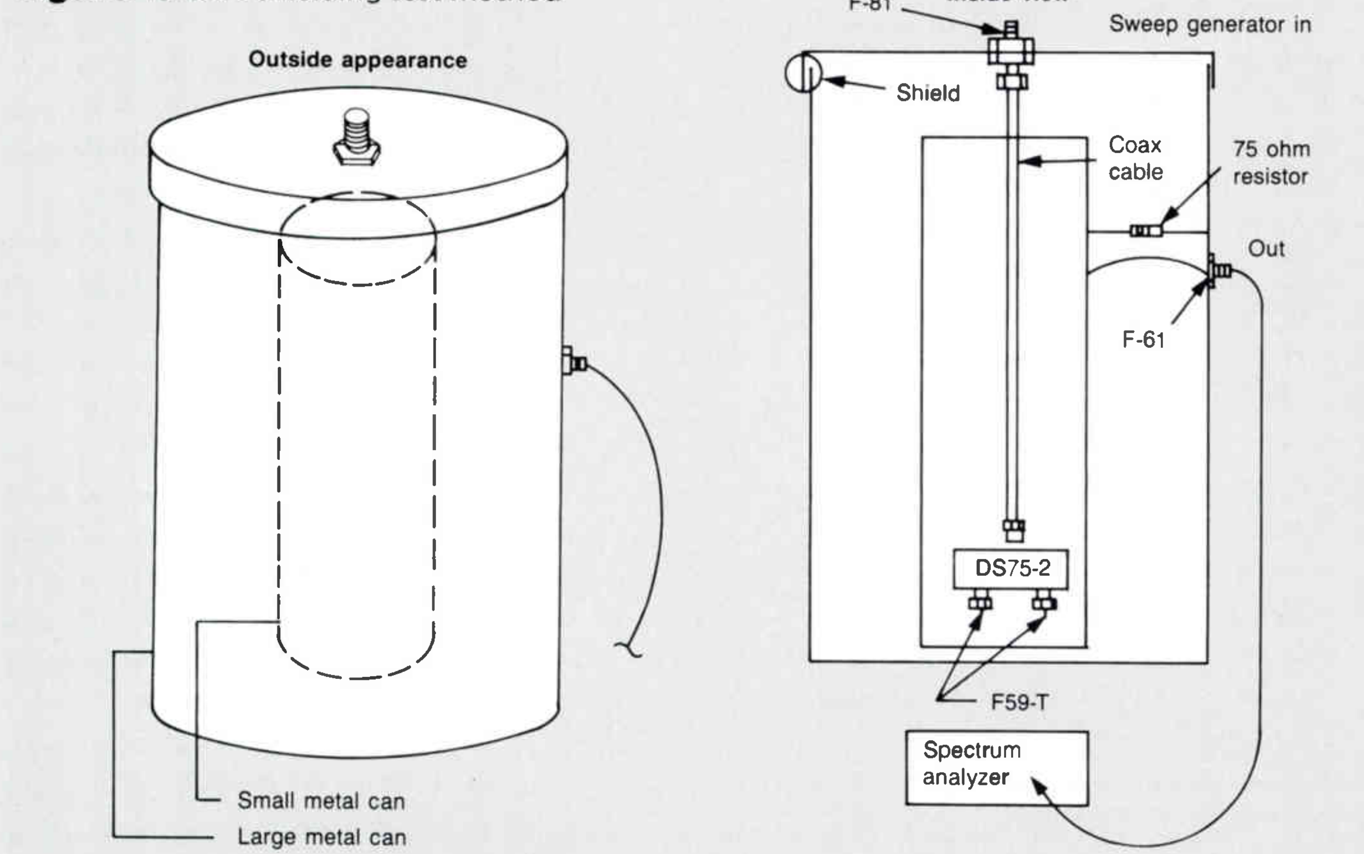
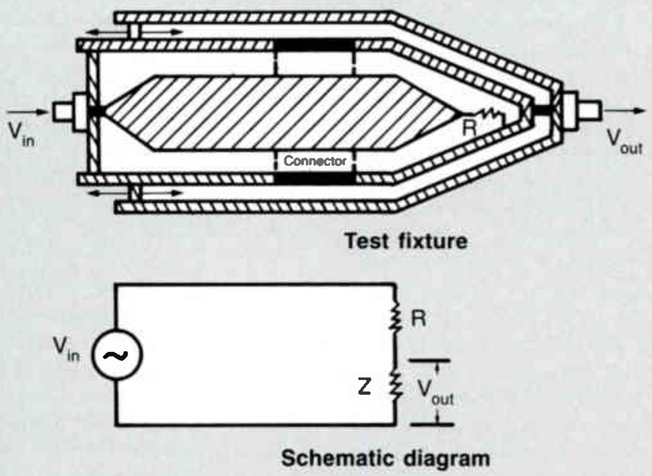


Figure 2: Concentric chamber shielding method

Shielding effective (SE)
Applicable document: MIL-C-38999H

Definition: $SE = 20\log_{10}\left(\frac{V_{out}}{V_{in}}\right)$



tifically acceptable. The comments made here are intended to stimulate thought and call attention to the problem. Any positive testing is better than none if the results are kept in the same perspective as the validity of the procedures used.

EMI testing

Organizations like the IEEE are resources for vast information on the subject of electromagnetic interference (EMI) and shielding. Advanced EMI testing and shielding is commonplace in many other industries with similar problems to ours. This has caused the evolution of many test labs with chambers and equipment that cost over a million dollars. These are used constantly by experts and consultants on the leading edge of this technology.

Why, then, do none of our CATV engineers, who use chambers made for under $1,000, ever consult or use data from these sources to support their methods? Wouldn't it be reasonable to compare to what we have found in our testing with that of a state-of-the-art test system that generates mathematical design and calibration standards? We all know this has not been done, because it would invalidate any results we presently have.

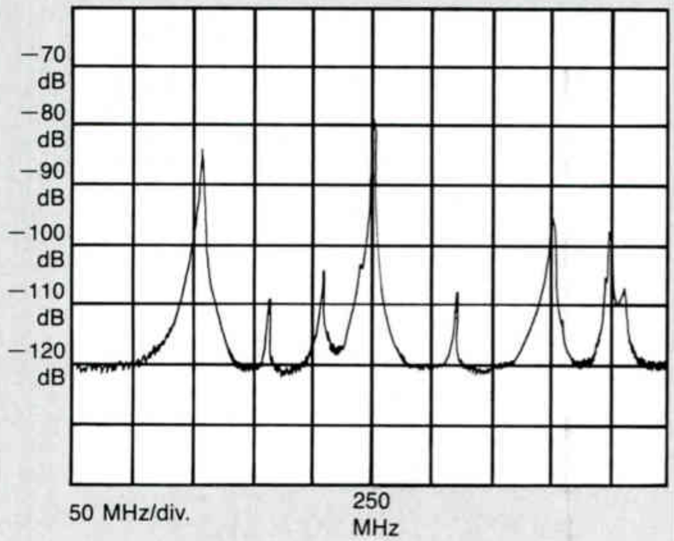
Perhaps those concerned with overall system leakage might focus more attention on the basics of the components themselves. Trying to solve the problem before a device is installed (by proper selection) rather than after would be a benefit and a more effective means of prevention.

The most common test method now used in the CATV industry consists of a sealed cylindrical chamber with a (supposedly) matched pick-up cylinder (see Figure 1). This technique is based upon the assumption that we are injecting a signal into the device under test and absorbing all the signal that escapes from it into the chamber inner tube. As a result, it is an easy task to measure what the difference between the signal you put in and what you get out in the chamber, as leakage.

This appears straightforward until you test the theory by removing your sample expecting to get all the signal you put into the chamber out. When this is done, the results are disappointing.

What if you get −50 dB out when you put 50 dB in with only a wire antenna inside fully radiating? Then you get −100 dB with a passive under test. What is your result? Is it −100 dB, the difference, the change in noise floor? If your method was correct, you would get out what you put in. This is not presently the case. As I will discuss later, these contradictions appear to invalidate the process, although comparative measurements between two devices of similar size can be made with

Figure 3: Typical two-way splitter test results



some degree of accuracy. These minor successes, without any degree of quantitative validity, have stunted our progress.

Other testing methods

Two other methods used in this type of EMI product testing are the attuned concentric chamber, which can be used only on cylindrical devices with symmetry such as a cable or connector, and the traditional shielded room with broadband antenna.

The concentric chamber (Figure 2) relies on perfect impedance matching between the chamber and the shield, measuring the change in impedance of this shield. The shielding or leakage then is mathematically computed. There is a whole series of military specification test procedures that use this technique (such as MIL-C-35999H).

In general, this method revolves around the idea of a radiated signal being determined by the level of mismatch of the outer case of the connector, cable, etc., to its load. The voltage developed in this slight mismatch has nowhere to go but outwards as radiation. Therefore, you are never trying to receive or capture this signal, which is in most cases too minute to measure effectively. This is similar to measurements using light interferometers in other sciences.

The shielding effectiveness is defined as

$$20\log_{10}\left(\frac{V_{out}}{V_{in}}\right)$$

where V_{in} is the injected signal into the test fixture applied across R, and V_{out} is the voltage developed across the test sample (in this case a connector) of unknown impedance. The ideal situation exists with maximum shielding when $V_{out} = 0$.

Specific calibration typically is set to MIL-C-38999H, where the VSWR (voltage standing wave ratio) is better (i.e., less) than 1.5. This method uses a directional coupler set up as a return loss bridge with the proper formulas for VSWR from reflected and forward voltages. The chamber matching or 1.5 VSWR is accomplished by tuning slugs that are moved for optimization.

In summary, this method relies upon symmetrical devices in order to determine case matching. Splitters and other passives do not fall physically into this category, although the technique might aid in solving our problem.

The shielded room with anechoic material is used primarily for active devices that generate signals, but it also has been used with suitable corrections on passive materials. The problems with shielded room measurements are the ruling out of standing waves or reflections occurring from the shape of the test sample, the room size, the room shape, and the reflective constant of the wall lining at the frequency used. There are even experts using state-of-the-art equipment who disagree on these findings. They say, "It's an art," not yet a science.

The problems of reflections and standing waves usually require shielded rooms of 20 by 30 feet in order to measure correctly a small device.

Changes in resonance

Our chambers are acceptable to us because we are able to tell slight leakage differences between devices of the same size and shape. Could the apparent differences be changes in the test device's resonance caused by leakage rather than the RF leakage itself? The fact that we can make some slight comparative measurements has made us think we actually are reading dBs of pure leakage, such as −80 dB, −90 dB or −120 dB, and that a 20 dB difference between two devices actually is 20 dB leakage.

For example, the following is a typical CATV measurement setup and typical test results (Figure 3). Consider:

1) Each chamber has distinctive peaks — do you measure top or noise floor for shielding?

2) These peaks are inherent in the chamber as a resonance. An open wire signal feed will have the same frequency points.

3) If you can vary the amplitude and the width of the resonant peaks (but vary the frequency only minimally) by using different passive devices, are you shifting the standing waves or actually radiating pure signal?

4) If you placed an open wire antenna in the chamber and put in 50 dB of signal, you should read 50 dB out. If not, will a device under test be accurate? In actuality, you can read many frequencies at −80 dB. Does this invalidate your test when using a passive sample?

5) *Placement:* Strong RFI in the location can skew findings. Do you place the whole test fixture in a shielded room?

6) *Cable placement:* Cable placement and location of spectrum analyzer and generator are critical when looking for −120 dB.

7) *Direction of sample in chamber:* If you turn the sample and your findings change, is it a factor?

8) *Terminators on unused ports:* Have you matched them? Change them and you will see some leakage from the threads.

9) *Size:* How about different size samples? You'll notice this changes the entire result. How do you explain the positive results achieved in two-way splitter comparisons? All are sealed slightly different, causing different resonant results. That is why the width and the peaks of the results vary, not just the noise floor. Put some different size holes in your device and notice the non-linear changes.

Right now this is our only method, but it cannot be accepted as a quantitative method claiming that this device is −120 dB shielded and this one −117 dB. There is a significant change in some devices of the same shape from −60 dB (spike tips) to −100 dB when better sealing techniques are used. This actually could be only 5 dB or 10 dB, indicating that the chamber method produces a possible logarithmic rather than a linear result.

We compared a few levels of devices that tested −70 dB and −110 dB in our own and a cable company's chamber, with ones tested in a commercial test room. Initial testing showed both reading in the −40 dB range in the sophisticated system.

In perspective

Putting our present results in perspective is important due to the daily use of passive materials in systems. Because the electrical test results can at best give only general comparative advantages, we should look closer at the mechanical sealing methods used. Some passive devices use serrations to cut into the cover material, some bend over the case, and some newer designs use multiple interlocking grooves to achieve high shielding levels.

My purpose has been to generate discussion in order to move us forward, rather than to discredit advances we, other manufacturers and cable systems have made. Putting our present understanding in perspective is critical to associations like the NCTA and the SCTE, and in gaining the reinforcement and pressure that will bring the shielding issue to an active position. Hopefully, we can inspire people in our industry to share data leading towards the establishment of realistic testing methods and product requirements that will benefit us all. ■

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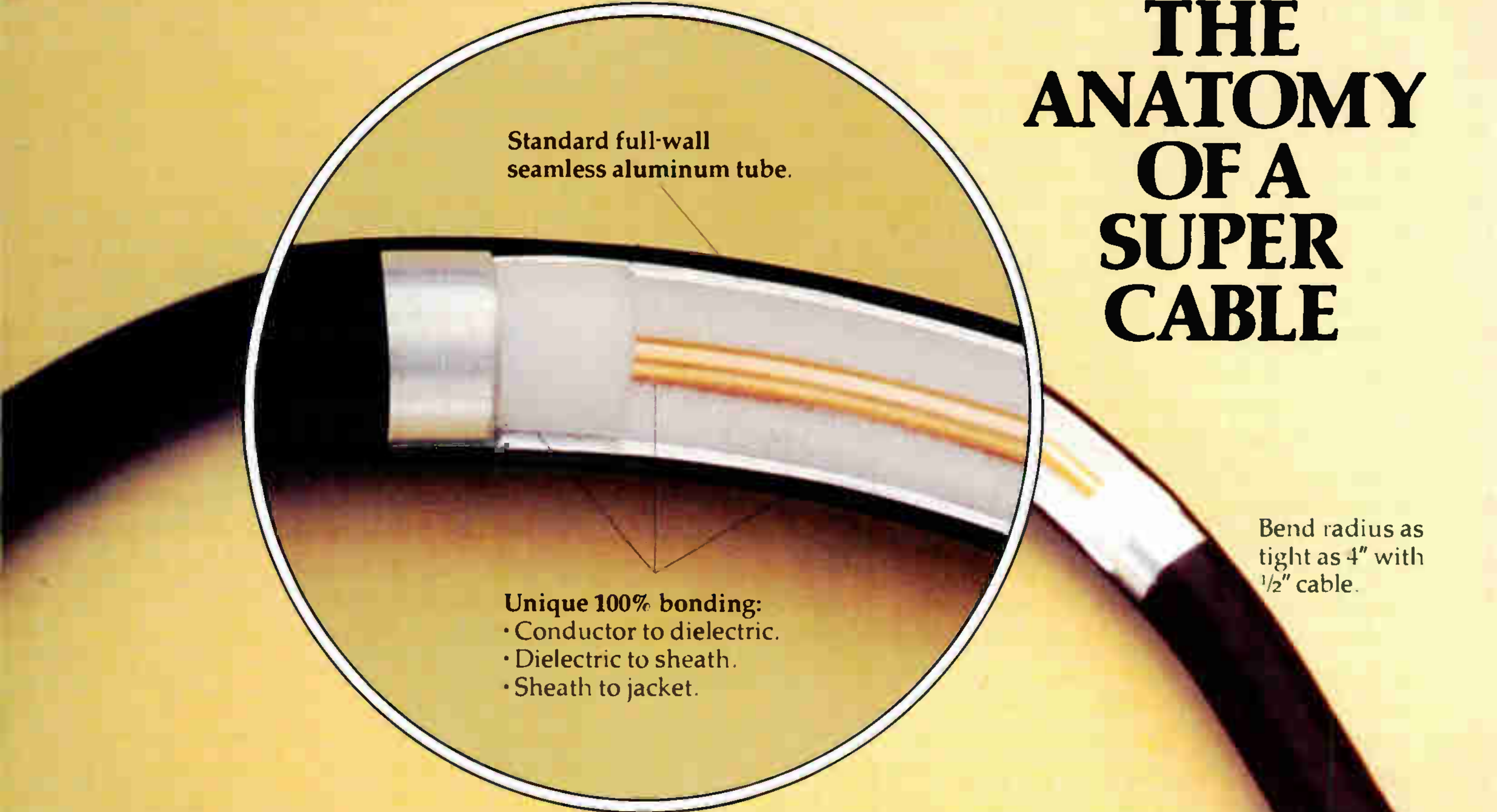

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Reader Service Number 46.

Grade B contours and rate deregulation

By Martin J. Walker
Vice President, Engineering, Simmons Communications Inc

The federal Cable Communications Policy Act of 1984 has been hailed by many in the industry as cable television's "Emancipation Proclamation." No longer will we have to beg, hat in hand, for the city's permission to raise rates. No longer will we have to be content with the 5 percent cap on increases during the two-year interim period between Dec. 29, 1984, when the act became law, and the date of deregulation, Dec. 29, 1986. Or will we?

The act stipulated that the FCC would be the arbiter of exactly what "effective competition" means, the standard by which cable systems would be eligible for rate deregulation. After hearing comments from all concerned parties, the FCC added Section 76.33 to its rules, defining *effective competition* as the presence of three or more Grade B contours over the community, three or more significantly viewed signals in the community as defined in Section 76.54, three or more translators licensed to the community, or any combination of these, as long as there were at least three different signals among them. (For example, two Grade B contours plus a translator carrying the programming of one of these two signals would not qualify for deregulation. See sidebar.) These rules effectively deregulated the vast majority of cable systems in the United States.

Wrongful declaration

The FCC left an "out," however, for communities who wished to pursue it. If a community feels that it has been wrongfully declared deregulated by the cable operator, that community can demonstrate to the FCC by an appeals procedure that the required signals are not present, that effective competition does not exist and that the community still should be subject to rate regulation and an annual 5 percent cap.

Should the community win the appeal, any tier of service containing broadcast stations (be they picked up off-air, by microwave, satellite or any other means) will be subject to regulation. On top of that, the operator possibly may be forced to refund any monies over and above the 5 percent cap collected to that point.

It won't ever happen, you say? Too much trouble for a community to pursue it? Wrong! Several cases already have been filed with the FCC, and deregulation has not yet been implemented.

To complicate matters ever further, it is possible — since the FCC works on a community-by-community basis — that there may be parts of your system that are regulated and parts that are not. It's also possible that one community in your system could win an appeal and by market pressure force you to lower rates in other communities to be on a par with the successful appellant.

Although the burden of proof will be on the community and not the operator, it still would be nice to know if you can feel comfortable about being deregulated in any given community.

Figure 1: Predicted contour map for broadcast station

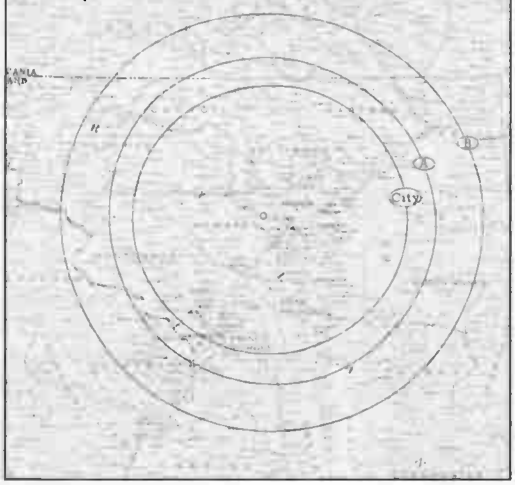
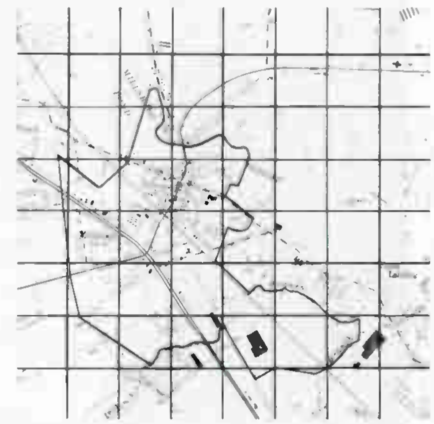


Figure 2: B contour measurement points



Significantly viewed signals

The first thing to do is to examine the list of significantly viewed signals for the community of interest. A list of these stations may be found in numerous places, such as in the *Cable and Station Coverage Atlas*. These signals were found to be "significantly viewed" by the FCC during surveys conducted among non-cable households in 1972 and have not been changed since that date. As a result, call letters might have changed, new stations might have begun operation, or old stations might have ceased operation — and none of these changes will appear in the list.

As an example, the significantly viewed signals for the state of Delaware are given in Table 1. They are listed on a countywide basis, since this is the way the FCC defines them. Therefore, if your community is at the far end of a county for which five significantly viewed signals are listed by the FCC, it is possible that on an appeal your community could demonstrate these signals are not significantly viewed in that community. (For more details and how to demonstrate if a signal is significantly viewed, see Section 76.54 of the FCC rules.)

Next, it would be helpful to get an idea which signals might cast a

Table 1: Significantly viewed stations

		Kent County
KYW	3	Philadelphia, NBC
WPVI	6	Philadelphia, ABC
WCAU	10	Philadelphia, CBS
WPHL	17	Philadelphia, Independent
WMAR	2	Baltimore, NBC
WBAL	11	Baltimore, CBS
		New Castle County
KYW	3	Philadelphia, NBC
WPVI	6	Philadelphia, ABC
WCAU	10	Philadelphia, CBS
WPHL	17	Philadelphia, Independent
WTAF	29	Philadelphia, Independent
WKAS	48	Philadelphia (not operating)
		Sussex County
WBOC	16	Salisbury, CBS
WMAR	2	Baltimore, NBC
WBAL	11	Baltimore, CBS
WJZ	13	Baltimore, ABC
WTTG	5	Washington, Independent

you will need to calculate the half wave dipole length in inches using:

$$L = \frac{5905K}{F_{MHz}}$$

Where K is the dipole correction factor. To determine K, first calculate the freespace half wavelength in inches using:

$$L = \frac{5905}{F_{MHz}}$$

Then determine the ratio of the freespace half wavelength to the dipole antenna element diameter (Figure 3). Once this ratio is calculated, the K factor can be found using Figure 4.

Recording unusual factors

Your recorded data should include date, time and weather conditions. Any unusual factors, such as a large building nearby that causes a reflection, also should be noted. If your readings are close to the Grade B point, it would be wise to repeat them at a different time of day, to make sure of your result.

If you cannot get your antenna to a 30-foot height, TASO (Television Allocations Study Organization) has recommended the correction factors in Table 2 for measurements made at a 10-foot height. Merely add the appropriate factor to your 10-foot high measurement to obtain an approximate 30-foot measurement.

References

NAB Engineering Handbook, Seventh Edition, 1985, Section 2.7
Code of Federal Regulations, 47, Parts 73.683, 73.684, 73.686, 76.33, 76.54.
Cable and Station Coverage Atlas, 1986 Edition, Television Digest
Television and Cable Factbook, 1986 Edition, Stations Volume, Television Digest.
The Radio Amateur's Handbook, 1984 Edition, American Radio Relay League.

FCC Section 76.33: Rate regulation

The text of the FCC rule regarding rate regulation reads:

76.33 Standards for rate regulation

(a) A franchising authority may regulate the rates of a cable system granted a franchise after Dec. 29, 1984, and any cable system after Dec. 29, 1986, subject to the following conditions:

(1) Only basic cable service as defined in 76.5 (pp) may be regulated;

(2) Only cable systems that are not subject to effective competition may be rate regulated. A cable system will be determined to have effective competition whenever at least three unduplicated signals serve the cable community. Signals shall be counted if they place a Grade B contour (as defined in Section 73.683 of our rules) over any portion of the cable community, are significantly viewed within the cable community (as defined by Section 76.54 of our rules) or are translator stations licensed to serve the cable community, provided that the translators are not used to retransmit stations already providing Grade B contour or significantly viewed signals within the cable community. The commission may grant exceptions to this standard where the franchising authority demonstrates with engineering studies in accordance with Section 73.686 of the commission's rules and other showings that such signals are not in fact available within the community.

(3) A cable system once determined to be subject to effective competition shall not be subject to regulation for one year after any change in market conditions which could cause it to be determined not to be subject to effective competition.

(4) A cable system may automatically pass through to the basic service rate without franchising authority approval cost increases that are readily identifiable and entirely attributable to the provision of basic service. Rate increases of this type may be taken in addition to the automatic 5 percent annual rate increase to which the cable system may be entitled under the Title VI of the Communications Act.

(b) For franchises granted on or before Dec. 29, 1984, a franchising authority may, until Dec. 29, 1986, to the extent provided in the franchise agreement:

(1) Regulate the rates for the provision of basic cable service;

(2) Require the provision of any tier of service without charge (disregarding any installation or rental charge for equipment necessary for receipt of such tier); and

(3) Regulate the rates for the initial installation or the rental of one set of the minimum equipment necessary to receive basic cable service.

(c) Any state or local law in existence on Dec. 29, 1984, which limits or preempts regulation of rates for cable service by any franchising authority shall remain in effect until Dec. 29, 1986, to the extent that it provides for such limitation or preemption.

(d) In establishing any rate for the provision of basic cable service by cable systems subject to paragraph (a) of this section, the franchising authority shall: (1) give formal notice to the public; (2) provide an opportunity for interested parties to make their views known, at least through written submissions; and (3) make a formal statement (including summary explanation) when a decision on a rate matter is made.

(e) Any party may petition the commission for relief of the provisions in this section in accordance with the provisions and procedures set forth in Section 76.7 for petitions for special relief.

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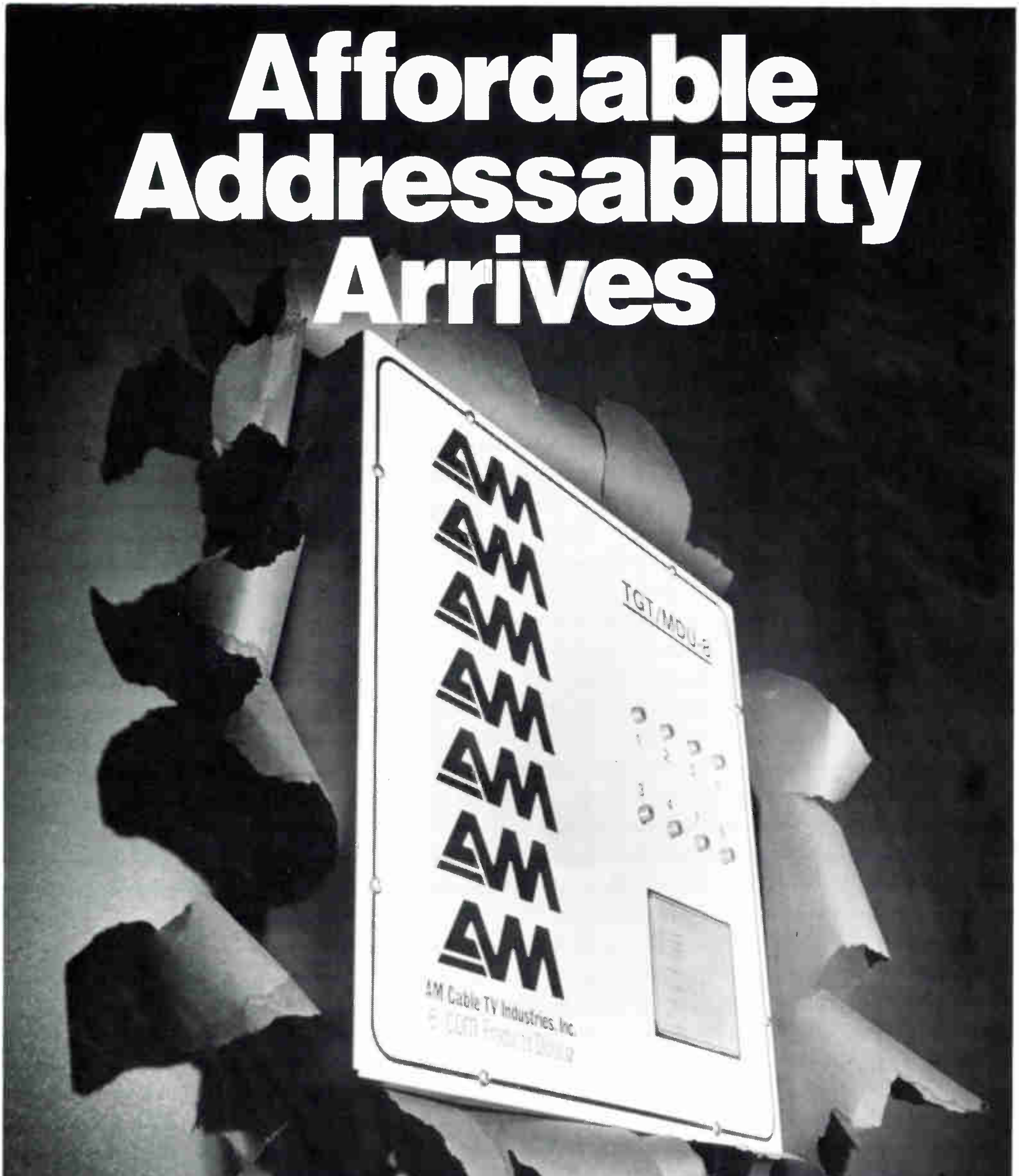
Reader Service Number 50.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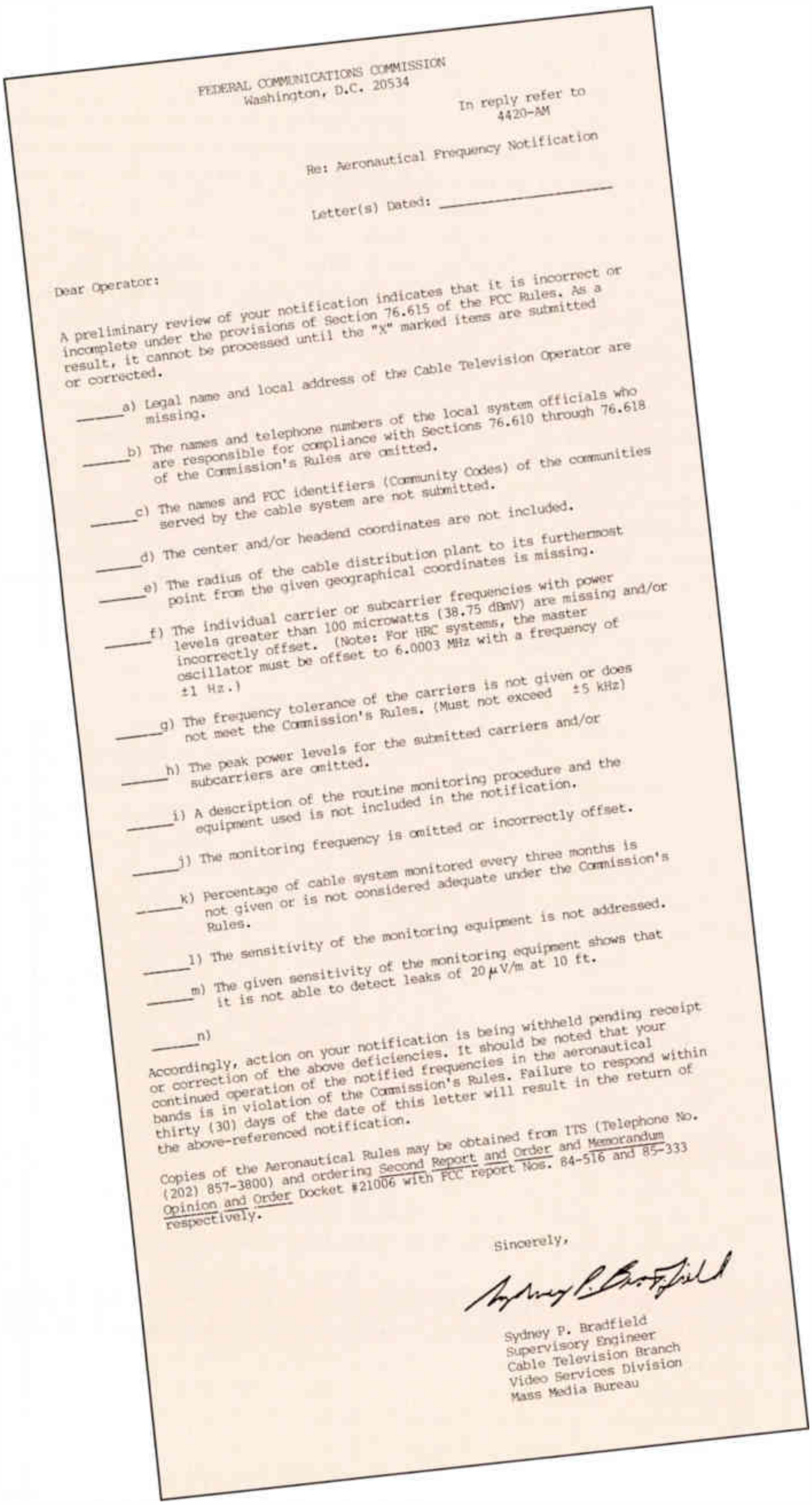
Englewood, CO 80155

Now that the smoke has cleared

By Cliff Paul
Consulting Engineer, RT/Katek Communications Group

It has been over a year since the Memorandum Opinion and Order terminating the proceedings on Docket 21006 was released on July 1, 1985. For those of you who are not familiar with 21006, it amended Part 76 of the commission's rules to add frequency offset and notification requirements and to require quarterly monitoring for signal leakage from cable television systems (i.e., aeronautical frequency clearances and cable signal leakage).



FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20534

In reply refer to
4420-AM

Re: Aeronautical Frequency Notification

Letter(s) Dated: ________

Dear Operator:

A preliminary review of your notification indicates that it is incorrect or incomplete under the provisions of Section 76.615 of the FCC Rules. As a result, it cannot be processed until the "X" marked items are submitted or corrected.

____a) Legal name and local address of the Cable Television Operator are missing.

____b) The names and telephone numbers of the local system officials who are responsible for compliance with Sections 76.610 through 76.618 of the Commission's Rules are omitted.

____c) The names and FCC identifiers (Community Codes) of the communities served by the cable system are not submitted.

____d) The center and/or headend coordinates are not included.

____e) The radius of the cable distribution plant to its furthermost point from the given geographical coordinates is missing.

____f) The individual carrier or subcarrier frequencies with power levels greater than 100 microwatts (38.75 dBmV) are missing and/or incorrectly offset. (Note: For HRC systems, the master oscillator must be offset to 6.0003 MHz with a frequency of ±1 Hz.)

____g) The frequency tolerance of the carriers is not given or does not meet the Commission's Rules. (Must not exceed ±5 kHz)

____h) The peak power levels for the submitted carriers and/or subcarriers are omitted.

____i) A description of the routine monitoring procedure and the equipment used is not included in the notification.

____j) The monitoring frequency is omitted or incorrectly offset.

____k) Percentage of cable system monitored every three months is not given or is not considered adequate under the Commission's Rules.

____l) The sensitivity of the monitoring equipment is not addressed.

____m) The given sensitivity of the monitoring equipment shows that it is not able to detect leaks of 20 µV/m at 10 ft.

____n)

Accordingly, action on your notification is being withheld pending receipt or correction of the above deficiencies. It should be noted that your continued operation of the notified frequencies in the aeronautical bands is in violation of the Commission's Rules. Failure to respond within thirty (30) days of the date of this letter will result in the return of the above-referenced notification.

Copies of the Aeronautical Rules may be obtained from ITS (Telephone No. (202) 857-3800) and ordering Second Report and Order and Memorandum Opinion and Order Docket #21006 with FCC report Nos. 84-516 and 85-333 respectively.

Sincerely,

Sydney P. Bradfield
Supervisory Engineer
Cable Television Branch
Video Services Division
Mass Media Bureau

'Start now in testing for the cumulative leakage index'

It now appears that all the worry by the FCC and the industry on the effects of this ruling was not all that necessary. In general terms, the FCC retained:

- Frequency offset notification,
- Monitoring requirements and
- Cumulative leakage index (CLI) effective July 1990.

The industry obtained:

- Relaxation in the cable signal threshold power level from 10^{-5} watts peak power to 10^{-4} watts *average* power;
- Aeronautical frequencies used by cable systems on or before Nov. 30, 1984, that were cleared by the FCC are grandfathered with certain reservations;
- Cable systems using the new offset frequencies do not require prior clearance. However, they are required to notify the FCC in writing before they may use the new frequencies; and
- Testing for CLI was postponed until July 1990.

Since I retired from the FCC, I have traveled many miles around this country and have found a much greater interest in meeting these new rules than in the past. This, I believe, is due mainly to the efforts of the NCTA, SCTE, the systems themselves and the FCC. There has been, of course, as in any rulemaking, some problems.

One of these is the question of the use of FM-modulated carriers, as might be used in supertrunking. The problem in this case is that under the new rules — it was true in some cases under the old rules — the power levels of the signal may come in conflict with an aeronautical radio because of the frequency deviation. The FCC is solving this problem on an individual basis. A showing indicating the *average* power level is below 10^{-4} watts (38.75 dBmV) will resolve any question the FCC may have.

Another situation of a different nature is that a great number of systems do not include in their notification for the use of aeronautical frequencies all the information required by the FCC under Section 76.615 of the rules. Some people who received the accompanying notice got "shook up" until they realized it really is a deficiency letter, not a citation. It is strongly suggested that this letter be used to recheck your notifications before submitting them to the FCC.

Remember that July 1, 1990, is not that far away. Start now in testing for the cumulative leakage index to determine how well your system performs. You may be surprised.

One year later: The 'how-to' of CLI

By R.J. Davidson
Division Engineer, United Artists Cablesystems

To refresh your memory: "The situation: We have 900 miles of CATV plant, built between 1969 and 1972, which currently serves 50,000 subscribers." (Please refer to *Communications Technology*, November 1985, pg. 36.) CLI (cumulative leakage index) was averaging 75 throughout the system, with the worst leak reported to be 1,850 μV/m.

Initially, we attempted to find and repair 100 percent of the leaks, first using a subcontractor and then an in-house RFI specialist. Our experiences from both of these efforts were similar — low productivity and high cost per mile. This caused us to develop a third method: Fix only the big leaks, described in detail in this publication in November 1985.

Now, one year later, here are the actual field results of our efforts, as compared with our previous experiences and planned goals (see Table 1). The experiences of fixing 100 percent of the leaks found are listed under the heading "Experience." The goals of our plan, to fix only the big leaks first, are listed under "Planned," and under "Results" are the first year's actual field results.

Result review

System CLI has dropped significantly, but not to the desired level of <64. Worst leak and average leak levels also have shown dramatic improvement.

Leaks per mile <83 μV/m are being found and repaired three times more frequently than expected. This has adversely impacted all of the other elements in Table 1 by almost the same factor of three.

Poles repaired per workday results of 8.6 is slightly higher than planned, indicating that the level of the system's effort to clear radio frequency interference (RF) actually has been greater than planned.

Estimated completion date refers to the month and year in which we will have completed the initial repair work in the entire 900 miles of plant. It is suspected that the procedure

Table 1: Comparison of CLI field results

	Experience	Planned	Results
System CLI	75	64	67
Worst leak	1850 μV/m	83 μV/m	104 μV/m
Average leak level	65 μV/m	36 μV/m	42 μV/m
Leaks per mile	10	1	3
Poles cleared/workday	58	340	131
Poles repaired/workday	14	8.5	8.6
% of poles requiring work	24%	2.5%	6.6%
Average cost per mile	$218	$24	$62
Miles completed/day worked	1.4	8.5	3.3
Miles completed/calendar day	.6	4.9	1.7
Estimated completion date	March 89	October 86	March 87

> 'System CLI has dropped significantly, but not to the desired level'

of fixing the big leaks first actually is eliminating a percentage of the phantom leaks, which took a lot of our time and effort attempting to locate when we were trying to repair 100 percent of the leaks detected.

We currently are budgeted to add a second technician to the RF leakage problem in an effort to increase the miles completed per calendar day. However, on second thought, there may be another solution. If we increase the attenuation in the Sniffer antenna circuit (B position) from 12 dB to 15 dB, we would be seeking and repairing only those leaks >117 μV/m. The net effect might be that the quantity of leaks needing repair per mile would decrease and the miles completed per day would increase. This, of course, assumes that the CLI will continue its desired trend downward toward a level <64. We will be trying this for the next three to six months, before we hire and equip a second technician.

Leakage causes

According to Table 2, F-connector replacement accounted for 57.4 percent of the RFI problems and included replacement of non-integral crimp ring connectors, shield drain wires not folded back over the outside jacket, and reduced shield-to-connector conductivity caused by corrosion.

Unterminated tap ports and loose F-connectors seem to be the result of the employees' reduced attention to the details of the installation task. Leakage from pay service traps and damaged tap ports appears to be a combination of the low shielding characteristics of cable-type traps and the cross-threading and extended leverage hazards of the canister trap.

Table 2: Causes of leakage

F-connector replaced	57.4%
Unterminated tap ports	16.2%
Pay service traps	11.5%
Damaged tap ports	5.5%
Loose F-connectors	4.6%
Ground block	2.1%
Trunk/feeder connection	.8%
Drop, pole to house	.5%
Damaged trunk/feeder cable	.4%
Drop, splitter	.2%
Line extender	.2%
Drop, house to set	.1%
Poor ground	.1%
Trunk amp	.1%
Directional coupler	.1%
Subscriber tampering	.08%
Subscriber equipment	.01%

Since the first five causes produced 95.2 percent of all of the leaks found, there must be immediate resolution of these causes. Otherwise, we will be constantly creating just as much, if not more, leakage than we are repairing. All of these causes are well within the job responsibility of the average installer and service technician; therefore, we have undertaken refresher training for these employees with obvious emphasis.

The last two causes in Table 2, subscriber tampering and subscriber equipment, have occurred a lot less frequently than expected. It has long been the concerned opinion of the marketing group that subscriber tampering was rampant in our systems, as it may well be. However, at this point in time, their opinion is not well-supported by these findings. When we reduce the attenuation in the Sniffer (B position) to 0 dB, we may discover that these causes will increase in frequency. It will be worth continued monitoring.

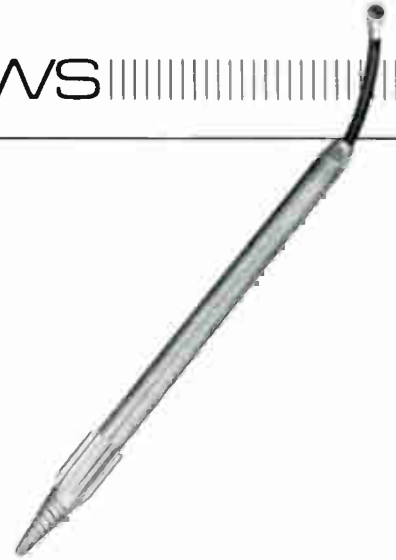
Cost-effective path

We are satisfied that our current program, fixing the big leaks first, is providing reasonable progress toward the objectives of FCC Docket 21006 along a logical and cost-effective path. With continued monitoring and procedural refinement, our goals will be reached during the grandfathering period.

Piercing tool

Pierce Airrow has introduced a new spline-head 2-inch diameter pneumatic underground piercing tool, useful in laying telecommunications cable. The product has a row of precision machine fins circling the front of the tool's body. Underground, the fins are said to cut grooves in the soil, reducing body friction and increasing speed, especially in hard, compacted soil.

For more details, contact Pierce Airrow International Inc., P.O. Box 300, Menomonee Falls, Wis. 53051, (414) 781-9093; or circle #91 on the reader service card.



Reference generator

SatSync from Kode, a division of Odetics Inc., is a line of time and frequency generators or receivers that use the time information available from GPS (global positioning system) satellite signals to provide a continuous time and frequency reference. (GPS is a satellite-based timing, navigation and positioning system under development by the U.S. Department of Defense.)

One product, SatSync III, is a receiver, comparator, oscillator and time-code generator. By determining time and frequency while the GPS satellites are in view, the product is said to provide a 24-hour timing accuracy of five microseconds or better. SatSync III may be expanded with a second chassis to feature input/output ports providing time codes such as IRIG A and IRIG B for instrumentation applications with multiple simultaneous outputs.

For more information, contact Kode Division of Odetics Inc., 1515 S. Manchester Ave., Anaheim, Calif. 92802-2907, (714) 774-5000; or circle #98 on the reader service card.

Broadband modem

EFData has introduced a new broadband cable and microwave modem, Model BCM-64, a frequency-agile, synthesized modem for operations within the mid-range data rates of 56 and 64 kBPS. The product features 100 kHz channel spacing that provides for access to all 4,000 channels within the 5 to 400 MHz broadband range.

According to the company, channel spacing eliminates the need for different models to operate at different frequency ranges and enhances the system's flexibility while minimiz-

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Optional Features Include:

▪ Internal rechargeable 5 APH battery for portable operation ▪ Tracking generator with 10 dB step attenuator ▪ Tracking generator with 1 dB step attenuator ▪ FM/AM/SSB receiver ▪ IEEE-488 interface bus ▪ RS-232 interface bus ▪ 75Ω adaptor ▪ Quasi-peak detector

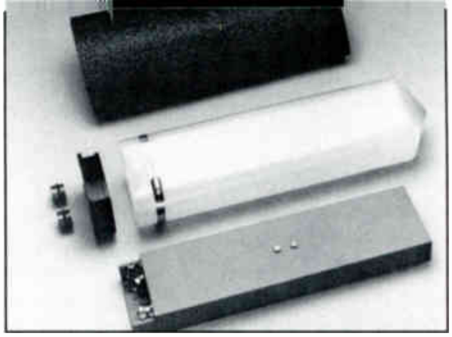
Contact your authorized IFR distributor for a demonstration.

IFR SYSTEMS, INC.
10200 West York Street / Wichita, Kansas 67215 U.S.A.
316/522-4981 / TWX 910-741-6952

Reader Service Number 56.

ing requirements for spares. It also allows the product to operate in high- and mid-split translated systems and non-translated systems.

For more details, contact EFData Corp., 1030 N. Stadem Dr., Tempe, Ariz. 85281, (602) 968-0447; or circle #95 on the reader service card.



Buried splice system

The Brand-Rex division of BRIntec Corp. has introduced a buried splice system, designed for outside plant use where fiber-optic splices must be encapsulated. Its inner closure design prevents water migration between cable jackets into the splice organizer. The organizer and closure can accept three cables at one end to allow easy branch splicing, according to the company.

The system includes the organizer, an organizer protection boot, boot grommet, foam sleeve and two outboard cable grommets.

For more information, contact Brand-Rex Fiberoptic Equipment & Services, P.O. Box 8010, Worcester, Mass. 01614, (617) 795-1780; or circle #89 on the reader service card.

Addressable controller

Jerrold has introduced its Model AH-4E addressable controller in an effort to facilitate implementation of impulse pay-per-view (IPPV). According to the company, it has the capability to adapt to one- or two-way IPPV ordering via the company's Starfone and Starvue sidecar systems.

The basic model is capable of handling 96,000 converters, while the upgraded model can handle 128,000. All models are capable of authorizing parameters of Jerrold's downloadable Starcom VI converter.

For more information, contact Jerrold Division of General Instrument Corp., 2200 Byberry Rd., Hatboro, Pa. 19040, (215) 674-4800; or circle #97 on the reader service card.

Coaxial multiplexers

OPT Industries has introduced its Co-Mux

Micro-Beam™ The Cable Expansion Problem Solver

Channel Master® MICRO-BEAM™ is a flexible, cost-effective CARS-band microwave relay system designed to solve the cable expansion problem facing today's cable operators.

That's why some of the top MSO's like, United Cable, Newhouse Broadcasting, Centel Cable, Cable Entertainment, Sonic Communications and Telescripts, use MICRO-BEAM™ as an alternative to the more expensive systems on the market today.

Eliminates Additional Headends

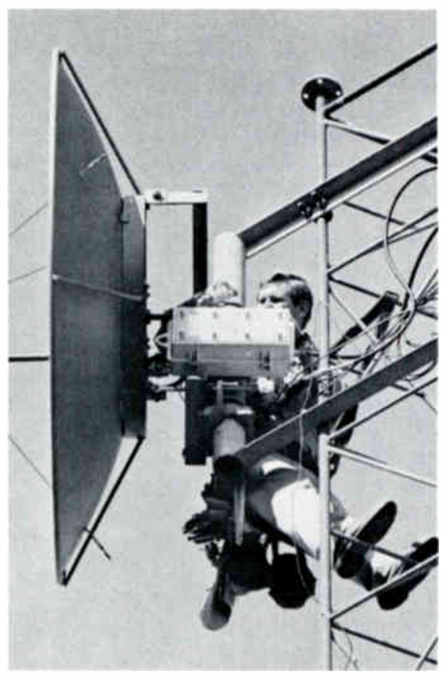
MICRO-BEAM™ reaches isolated subscriber pockets and spans natural barriers without additional remote headends, adapting to your entire service including audio, video, data and addressability signals and commercial insertion capabilities. MICRO-BEAM™ also saves you that $500 per-channel descrambling cost by allowing you to descramble each channel at the main headend. In fact, MICRO-BEAM™ is so compact, it allows you to transmit from a weatherproof unit that mounts behind the antenna. It can even be mounted on water towers, and can be placed anywhere in your system, not just at the headend.

Two Affordable Systems

MICRO-BEAM™ is available in two affordable systems that can be configured in many ways to meet your systems needs. A 36-channel 300 MHz system available in 1 and 5 watts, allows many more receive sites and offers cost savings in smaller systems for as low as $46,965! The 1-watt system can transmit your signal fully loaded over 9 miles in each of four directions or 15 miles in each direction with the 5-watt system.

The 60-channel 450 MHz system also comes in 1 and 5 watts and provides the range and channel capacity larger systems demand.

For example, the 1-watt system can cover a path distance fully loaded up to 7 miles in four directions or 14 miles in one direction. The 5-watt system can carry 60-channels up to 20 miles and allows up to 4 separate receivers fully loaded up to 12 miles in each direction.



In addition to extra power, the 5-watt system utilizes GaAs FET amplification, highly stable microwave oscillator and redundancy of key components to insure reliable operation and reduce maintenance. A Status Monitor Panel, included with the 5-watt transmitter, allows remote monitoring of all system functions by bringing all test points to the headend or tower base.

The rugged transmitter unit is housed in a heavy-duty weatherproof housing designed for pressurization. The transmitter is cable powered, and operates in temperatures ranging from -50°C to +60°C, with humidities up to 100%.

Cost-Effective Expansion

With MICRO-BEAM™ you can expand your system cost-effectively because there are no "hidden costs" for optional equipment and services, so you get more for your money!

Standard Equipment & Services

- **450 MHz Transmitter**
- **Microwave Receiver**
- **LNA/Image Rejection Filter/AGC**
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- **Feasibility Study**
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- **F.C.C. Application Assistance**
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- **24-Hour, 7-Days A Week, Technical and Warranty Service**
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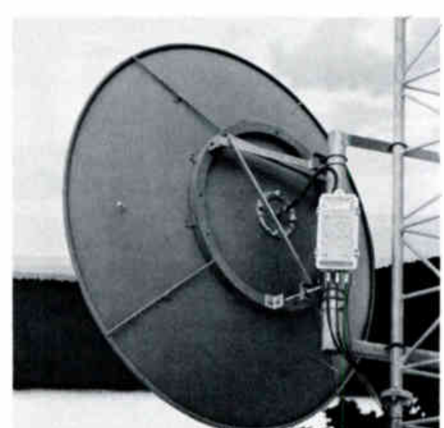
Because MICRO-BEAM™ is basically option free, the system you order is in stock, giving you the fastest lead time of any microwave product on the market.

See us at the Western Cable Show Booth No. 1122 or:

CONTACT: Channel Master
Division of Avnet, Inc.
P.O. Box 1416
Smithfield, NC 27577
(919) 934-9711



Channel Master®
Division of Avnet, Inc.
Industrial Park Drive, Smithfield, N.C. 27577

Reader Service Number 58.

and Bal-Mux passive coaxial multiplexers, designed to add flexibility and capability to data communications systems. They are said to allow connection of additional 3270 devices on existing coaxial or twisted pair cable.

Co-Mux coax-to-coax models include units for two-to-one connection, four-to-two connection and a double multiplexed ABC switch. Bal-Mux coax-to-twisted pair models are four-to-one units available in RJ11 connector and IBM Cabling System modular connector versions.

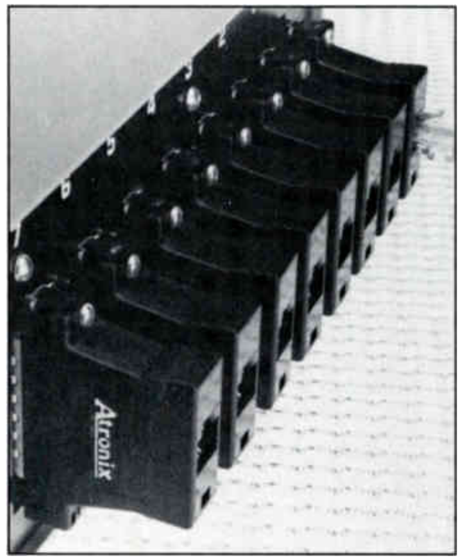
For further details, contact OPT Industries Inc., 300 Red School Lane, Phillipsburg, N.J. 08865, (201) 454-2600; or circle #96 on the reader service card.

Heat shrink sleeves

Magnashrink heat recoverable sleeves from 3M are said to provide fast, effective and long-lasting service in a broad range of cable applications. The product is a one-piece repair sleeve with its own self-sealing adhesive closure. When heated, the sleeve shrinks to conform around and bond with the cable sheath to form a water-tight and pressure-tight bond that is said not to loosen, crack or corrode.

According to 3M, the sleeves are designed for repair of pressurized and nonpressurized lead and polyethylene sheath cable in aerial and buried applications. They are available in 60-inch lengths and in six different cable diameter sizes.

For more information, contact 3M, P.O. Box 2963, Austin, Texas 78769-2963, (512) 834-6563; or circle #87 on the reader service card.



Data adapters

Atronix Inc. has introduced a line of modular data adapters that can fit side-by-side in a backplane for asynchronous applications. Each product features RJ45 universal eight-wire telephone jacks and integral male hardware with a low profile design and measures less than 5/8-inch wide.

According to Atronix, the adapters are easy to assemble without tools and permit the use of modular telephone wiring. They are available with either male or female RS232 connectors.

For more details, contact Atronix Inc., 207R Cambridge St., Burlington, Mass. 01803, (617) 273-5595; or circle #99 on the reader service card.

FO attenuator

Lamdek Fiber Optics, a division of Eastman Kodak, has announced an adjustable attenuator for use with its single-mode connector. The attenuator is said to provide continuous adjustment for attenuation levels from 0 to −80 dB. According to the company, it can be used with 1,300 or 1,550 nanometer signal wavelengths.

The product consists of a stainless-steel attenuator tube with an adjustment screw and an attenuator adapter; the tube and adapter are keyed for easy assembly. The parts fit between a Lamdek connector plug and connector adapter.

For more details, contact Lamdek Fiber Optics, 901 Elmgrove Rd., Rochester, N.Y. 14650, (716) 726-0100; or circle #88 on the reader service card.

Control system

The Video Communications Division of Panasonic Industrial Co. introduced its addressable control system at the 1986 Atlantic Show. According to Panasonic, the product features the company's own scrambling modes — 15 preset patterns generated by random numbers — that are not compatible with pirate boxes and, hence, significantly increase signal security.

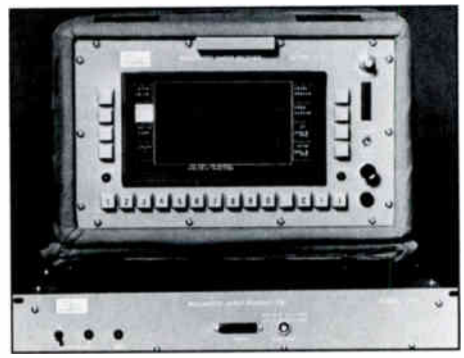
Also in the product is a channel modulator and rack-mounted scrambler modules that are said to accommodate up to three scramblers in a 4.5-inch unit. The modules are used to scramble the video signals for specific channels. The frequency shift key data modulator converts computer data for transmission down the video line. Completing the system is a scrambler controller that adjusts the timing for the scramblers and generates standby data signals in case of an outage.

For more information, contact Panasonic Industrial Co., 1 Panasonic Way, Secaucus, N.J. 07094, (201) 348-7183; or circle #100 on the reader service card.

Sweep system

Calan Inc. has introduced its Model 1776/1777 integrated sweep system/spectrum analyzer, combining a high-resolution, non-interfering sweep with a dual microprocessor-controlled spectrum analyzer. According to the company, the product uses surface mount RF design, weatherproof Hall-effect switches and a solid-state electro-luminescent display, for use in 5-600 MHz CATV systems.

The product is said to automatically scan the CATV system, verify the location of all carriers,



then set up specific guard bands around the carriers to protect them from any sweep interference. The receiver reads both the sweep and carrier levels, integrating them to create a high-resolution (better than 0.25 dB) sweep response.

For further information, contact Calan Inc., R.R. 1, Box 86T, Route 739, Dingman Plaza, Dingman's Ferry, Pa. 18328, (717) 828-2356; or circle #94 on the reader service card.

Rain/snow sensors

Environmental Technology's Model CIT-5 and CIT-6 sensors for C- and Ku-band earth stations are said to convert both snow and ambient temperature information into logic signals for snow melting and rain deviator control systems. The products provide logic outputs for precipitation and the operating and lock-out temperature

thermostats. High sensitivity permits the detection of frost and dew under most conditions; the lock-out signal optionally inhibits system operation at temperatures too low for snow melting.

According to the company, Model CIT-5 has operating and lock-out temperatures preset at 38°F and 17°F, respectively. The CIT-6 provides calibrated adjustments, with ranges of 34°F to 44°F for operating and 0°F to 25°F for lock-out.

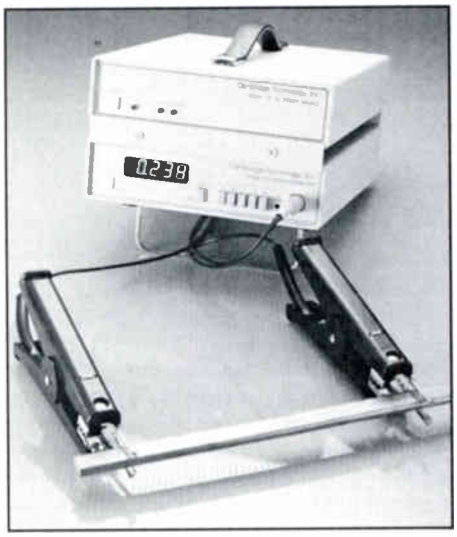
For more details, contact Environmental Technology Inc., 1302 High St., South Bend, Ind. 46618, (219) 233-1202; or circle #86 on the reader service card.

Data power supply

LorTec Power Systems has introduced its Model 103CRH, a 10 kVA three-phase uninterruptible power system, designed to provide continuous power for computer-based equipment and other critical electronic systems. It is said to handle both three-phase and single-phase loads simultaneously.

The product consists of a solid-state inverter, battery charger/rectifier and a solid-state automatic static switch. In normal operation, the battery charger is powered by the commercial AC line and supplies regulated DC power to the inverter while float-charging the battery. Should the commercial AC line fail, the batteries automatically provide the necessary DC power to the inverter to maintain AC power to the load.

For more details, contact LorTec Power Systems Inc., 145 Keep Ct., Elyria, Ohio 44035, (216) 327-5050; or circle #93 on the reader service card.



AC power source

Cambridge Technology is offering its Model 511 AC power source, permitting true 1 microohm resolution measurements to be made when used with the company's Model 510 digital microohmmeter. According to the company, the power source will operate the meter from an internal battery for more than an hour continuously in a worst-case situation, and for many hours when used in normal operation.

The unit's 20-watt, 120 VAC, 60 Hz output is said to make almost any other small instrument or tool into a portable device. A built-in battery charger is provided, as are LEDs to indicate low battery and charging.

For more details, contact Cambridge Technology Inc., 2464 Massachusetts Ave., Cambridge, Mass. 02140, (617) 876-0891; or circle #90 on the reader service card.

Line transformers

James Electronics has introduced its Series 37 transformers, designed to meet the need for low-silhouette, high-performance line coupling transformers for telecommunications and data transmission. The Model 15940 has a nickel-iron core that will accommodate the 90 milliamp DC current of telephone lines. Minimal insertion loss also qualifies these transformers for both audio and data transmission circuits.

For more information, contact James Electronics Inc., 4050 N. Rockwell St., Chicago, Ill. 60618, (312) 463-6500; or circle #92 on the reader service card.

Figure 1: Wiring for store-and-forward

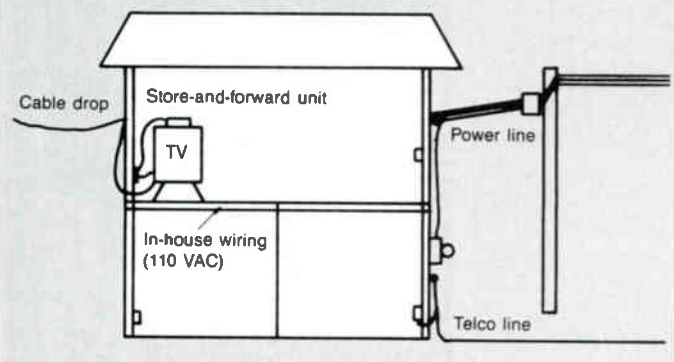
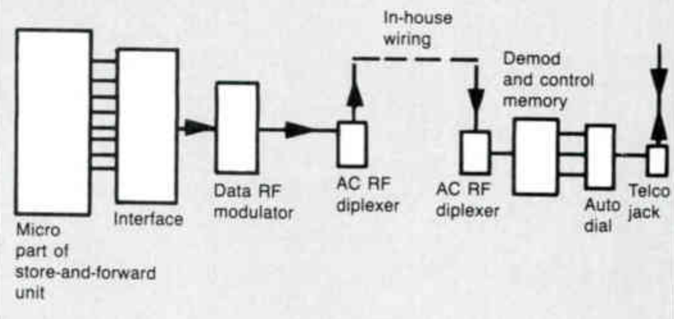


Figure 2: Low-frequency data control for PPV system



A solution to the telco interface problem

By Russell A. Skinner
Director, Special Project Engineering
American Television and Communications Inc.

The delivery of pay-per-view (PPV) programming is quickly becoming the new wave for the cable industry. In order to deliver this service to our subscribers, numerous techological solutions have been approached. The critical mass objective that must be obtained is the ability for the subscriber to make an impulse decision to purchase programming and have that programming immediately displayed. From the operator's perspective, it is imperative that the PPV transaction be recorded and recovered by the operator and that the appropriate royalty and copyright fees can be paid based on the actual viewership of the programming provided.

One of the technologies offering a solution to both of these concerns while providing a cost-efficient approach to the impulse PPV business is store-and-forward. This technology best can be described as an electronic control unit that acts like a credit bank. Credit information is downloaded through the forward cable system to an individual store-and-forward unit, authorizing a credit limit prearranged by the subscriber. Information is returned to the operator by means of an interface to the existing subscriber's telco system.

On computer command and during least significant hours, an individual store-and-forward unit accesses the telco line, dials a predetermined number to interface with the cable operator's computer and downloads information regarding the transactions made. The use of telco circuits provides a cost-effective mechanism to transport the necessary data from the subscriber back to the operator without the added operational and capital expenses of maintaining two-way cable television plant only for this purpose.

Interfacing the store-and-forward technology with the telco line creates several major obstacles that have to be overcome. A telco jack has to be installed at or near the store-and-forward module. For safety reasons, this jack should be within six to 12 feet of the module and not cross any hallways or doorway openings. Another problem is that not all subscribers have (or want) access to the phone company's touch-tone switching services. Therefore, the module must have the compatibility to use touch-tone *or* rotary pulse dialing. Telco jacks and interfaces in locations where they are not readily available can add a significant burden to the installation cost of store-and-forward.

> 'Not all subscribers have (or want) access to the phone company's touch-tone switching services'

An installation solution

Borrowing on some existing technology, it is possible to minimize the amount of additional wiring necessary to install a telco circuit while maintaining the required telco interface. This interface solution employs very straightforward technology used by power companies for a number of years to communicate data in parallel with the subscriber's in-house wiring. By modulating data from the store-and-forward unit onto the power wiring in the dwelling, and by installing the receive-data unit at an existing telco jack or at a point of entry to the building where the telco circuits are easily accessible, the store-and-forward unit will be able to communicate with a system auto dialer.

This type of information can be slow-speed in nature, can be addressed by unit so that multiple store-and-forward units can be used within the same dwelling, and also can be coded so as to not interfere with any adjacent units in nearby dwellings. Since this technology operates at a very low frequency, existing equipment can be used to provide the communications link for the cost of approximately \$5-\$7 incremental to the store-and-forward unit.

By using low-frequency data modulation on the power line, it should be possible to reduce safety and installation considerations to a minimum, overcoming some of the major criticisms of using store-and-forward technology and telco circuits.

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December

Dec. 9-11: Center for Personal Development seminar on fiber-optic communications, Arizona State University, Tempe, Ariz. Contact (602) 965-1740.

Dec. 10: SCTE Delaware Valley Chapter meeting on engineering management, professionalism and ethics with BCT/E exam on transportation systems. William-son Restaurant, Horsham, Pa. Contact Bev Zane, (215) 674-4800.

Dec. 10: SCTE Greater Chicago Meeting Group review of BCT/E Category VII — Engineering Management and Professionalism, plus test on Category IV — Distribution Systems, Arlington Park Hilton, Arlington Park, Ill. Contact William Gutknecht, (312) 577-1818.

Dec. 10-12: Institute for Advanced Technology seminar on local area networks, IAT Training Center, Washington, D.C. Contact (800) 638-6590.

Dec. 12: Wavetek system sweeping seminar, the Wavetek factory, Beech Grove, Ind. Contact Steve Windle, (317) 788-5980.

Dec. 17: SCTE Miss/Lou Meeting Group seminar on AML microwave, plus a tour of Trilogy Communications facilities, Ramada Inn, Jackson, Miss. Contact Rick Jubeck, (601) 932-4461.

Dec. 17: SCTE New England Chapter, BCT/E review course for Category IV — Distribution Systems and test on Category VII — Engineering Management and Professionalism, Sheraton Hotel, Foxboro, Mass. Contact Bill Riley, (617) 472-1231.

January

Jan. 5-6: University of Central Florida course on low-noise electronic circuits for electro-optics systems, Americana Dutch Hotel, Walt Disney Village, Lake Buena Vista, Fla. Contact Vince Amico, (305) 275-2123.

Jan. 7-9: Magnavox CATV training seminar, Torrance, Calif. Contact Amy Costello, (800) 448-5171.

Jan. 7-9: University of Central Florida fiber-optics workshop, Americana Dutch Resort Hotel, Walt Disney Village, Lake Buena Vista, Fla. Contact Vince Amico, (305) 275-2123.

Jan. 12-14: Magnavox CATV training seminar, Torrance, Calif. Contact Amy Costello, (800) 448-5171.

Jan. 14: SCTE Shenandoah Valley Meeting Group seminar on fiberoptics, Blue Ridge Community College, Verona, Va. Contact David Lisco, (703) 248-3400.

Jan. 13-15: Jerrold technical seminar, Clarion Hotel/Airport, San Francisco. Contact Seminar Administrator, (215) 674-4800.

Jan. 20-22: Magnavox CATV training seminar, San Jose, Calif. Contact Amy Costello, (800) 448-5171.

Jan. 21-22: SCTE National Headquarters and **Chattahoochee Chapter** engineering and technical management development seminar, Holiday Inn Airport/South, Atlanta. Contact Mike Aloisi, (404) 633-4326; or Guy Lee, (404) 451-4788.

Jan. 26-30: George Washington University course on optical fiber communications, Seapoint Hotel, San Diego. Contact (202) 676-6106 or (800) 424-9773.

Jan. 27-29: Magnavox CATV training seminar, Portland, Ore. Contact Amy Costello, (800) 448-5171.

Jan. 28-30: Institute for Advanced Technology seminar on local area networks, Loews Summit, New York. Contact (212) 752-7000.

Planning ahead

Feb. 18-20: Texas Show, Convention Center, San Antonio, Texas.

April 2-5: Cable-Tec Expo '87, Hyatt Hotel, Orlando, Fla.

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Aug. 30-Sept. 1: Eastern Show, Merchandise Mart, Atlanta.

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Reader Service Number 67.

The status of status monitoring for LANs

By Lawrence W. Lockwood
East Coast Correspondent

Status monitoring has not been overwhelmingly accepted by the majority of CATV operators. Many have been known to voice the opinion that "the maintenance of the status monitoring system is greater than the maintenance saved by the system." This indeed may have been the case with some of the first systems, but continued improvements in capabilities and reliability have made that observation debatable. However, the desirability of a status monitor for the operation of a local area network (LAN) is not debatable — it is a necessity, especially if the data net is much more than a very few point-to-point nodes. (A node, as used in networking, is defined by the Institute of Electrical and Electronics Engineers, IEEE, as "a terminal of any branch of a network or a terminal common to two or more branches of a network" — in LANs, usually a data transmission or reception point.) This necessity has been properly noted and status monitor requirements incorporated into the latest draft of the IEEE 802.7 standards committee.

The IEEE 802 committee is the body that is responsible for LAN engineering standards. The latest draft of 802.7 ("Broadband Local Area Systems Recommended Practices") is Draft D and is being balloted by the committee prior to its issuance as an IEEE standard, then an American National Standards Institute (ANSI) standard and finally an International Consultative Committee for Telephone and Telegraph (CCITT) standard. The excerpted sections pertaining to status monitors follow.

IEEE 802.7 (Draft D) local area systems standards: Broadband local area systems recommended practices

3.6 System diagnostics

Several hardware manufacturers have developed remote system diagnostic aids, commonly referred to as "status monitoring" and "reverse switching" devices. The primary goals have been to provide a mechanism for monitoring the performance of devices and disconnecting selected portions of the inbound path by means of control equipment located at the headend. Devices are fitted with transponders which are given a unique address and which can be polled by the headend controller. Devices that can be monitored by transponders are: amplifiers with redundancy features, power supplies with battery backup, redundant power supplies, redundancy (or A/B) switches, and network interface units (NIUs). Transponders can also "stand alone" to monitor the media performance at any point the user desires (e.g., in feeders, at NIUs, end of line, etc.). Circuitry in each transponder is devoted to obtaining the status of various performance parameters associated with the monitored devices and for control purposes such as feeder and/or trunk switches of inbound signal paths, feeder and/or trunk attenuators associated with inbound signal paths, and to exercise backup (redundancy) capabilities.

3.6.1 Benefit of status monitoring

The key benefit is improved system reliability. Status monitoring is not intended to indicate a failure has occurred but to warn of system degradations and potential failures so maintenance staff can be dispatched to repair or adjust the system before failure occurs. The minimum parameters given in Table 3.6 provide information so that timely service can be performed to avoid failure and therefore maximize reliability. Because status monitoring indicates the general location of faults or failures, maintenance staff can be sent directly to the problem site (saving trial and error troubleshooting time), significantly reducing the mean time to repair (MTTR).

For status monitoring to provide benefits, the user must recognize it as a tool. It does not perform the job of the maintenance staff. It may increase the work load of the maintenance but in doing so improves the system reliability. If the user ignores or does not understand the information provided, the benefits may not be realized. Training in status monitoring operation and interpretation is critical.

A recommended minimum set of parameters that should be measured and reported by, as well as controllable, at each transponder in the status monitoring system is listed in Table 3.6.

Table 3.6: Minimum set of parameters measured, reported and controlled by status monitoring systems

1) One RF measurement in each direction (inbound and outbound).
2) One power supply measurement.
3) The ability to set major and minor alarm levels on each measurement in 1 and 2.
4) The ability to individually enable/disable each alarm.
5) If the transponder is used with trunk amplifiers, it also should report status and provide alarms for:
   a) Lid closure
   b) Backup AC power supply status
   c) Inbound path switch status (if an inbound switching capability is provided)
   d) Redundant amplifier status (if a redundant amplifier capability is provided).

   It also should provide a control facility to:
   a) Control inbound feeder path switch (if an inbound feeder path switching capability is provided).
6) If the transponder is used with backup power supplies, it also should report status and provide alarms for:
   a) Backup supply status.

   It also should provide a control facility to:
   a) Enable/disable backup mode.
7) If the transponder is used with redundancy switches, it also should report status and provide alarms for:
   a) Switch status.

   It also should provide control facility to:
   a) Set redundancy switch position.

3.6.2 Use of inbound switching

The main usage of inbound switching for LANs is to aid diagnosis in maintenance by significantly reducing the time to locate and isolate interference from unauthorized transmissions, ingress or impulse noise induced into the inbound system. The technical maintenance staff can systematically use switching to reduce the area of manual troubleshooting before going out into the system. If the noise interference is disrupting the services throughout the entire system, it can be isolated from the system, thus permitting the majority of the system to operate normally. The repair personnel then go to a specific location to pinpoint and repair the source of the problem. The result is a significant improvement in system reliability because it takes less time to locate, isolate and repair. It is impossible to isolate the interfering area without inbound switching.

The ingress localization function can be improved by the use of a remotely switchable attenuator. When using only on-off switching to localize ingress, services on the cable are disrupted. Using attenuators, the same localization can be accomplished without significant service interference. Once the interference has been located using attenuators, the on-off switch is used to isolate the sources from the rest of the system.

3.6.3 Recommended frequencies for status monitoring channels

If the status monitoring and/or inbound switching functions are required as part of a broadband LAN installation, the (Table 3.6.3) frequency allocations for transponder signalling are recommended.

7.4 Broadband coaxial system maintenance and monitoring

7.4.1 Automated system monitoring

Advances in medium monitoring systems (frequently called status monitoring systems) offer a means to remotely monitor the RF integrity of the system. Typical systems include a transponder module installed within the amplifier or power supply housing which communicate to a master headend modem connected

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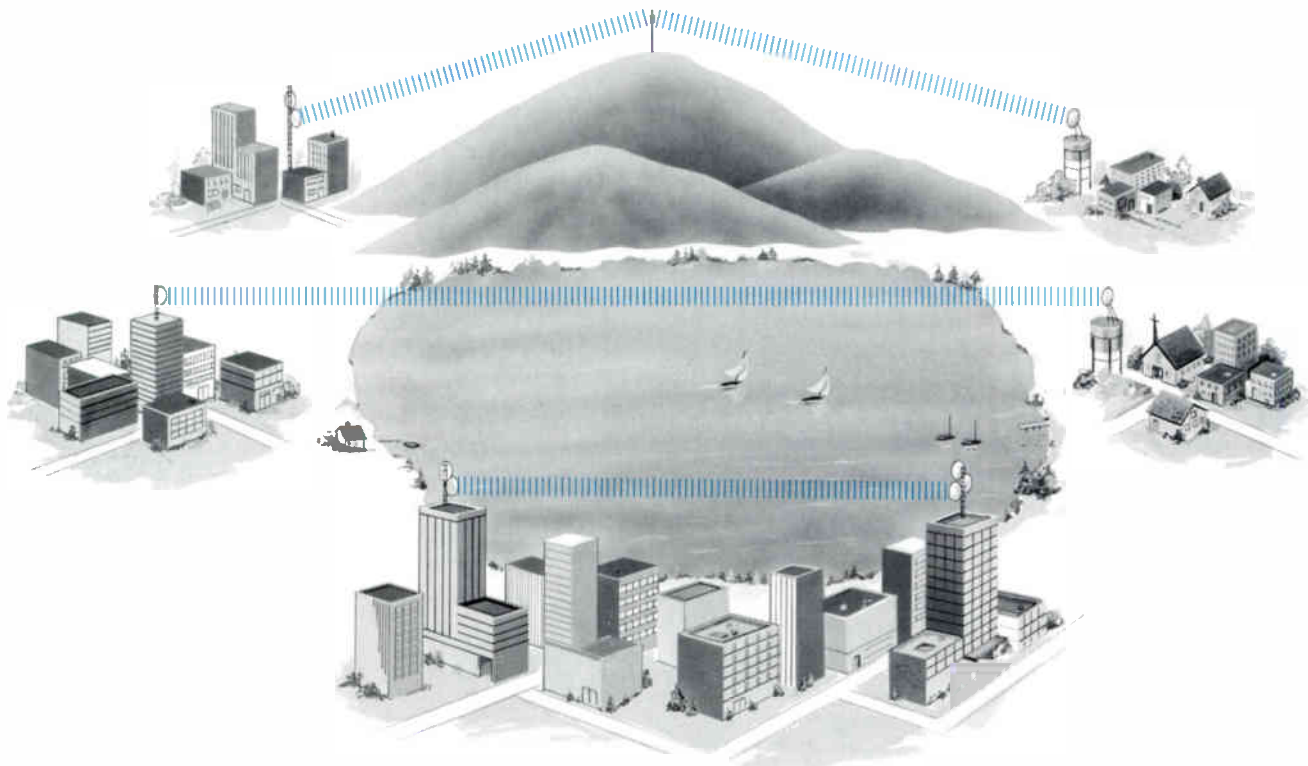

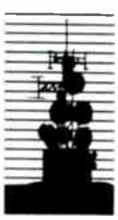

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to a small computer system. The headend computer polls each transponder in the system which in turn responds with information about the status of the transponder and optional attached monitored devices. This information is then stored and compared when additional polls are made. Changes in these parameters are logged and reported to the system manager for diagnosis and corrective action. Additionally, the status monitor can detect and log major/minor faults and measured parameters that exceed user-defined thresholds.

Status monitoring systems provide the user with the ability to analyze system parameters and correct problems in the system prior to complete system failure, significantly decreasing the mean time to repair and increasing the overall system reliability.

The status monitoring system can provide the user with several reports that can be used to satisfy the system documentation and maintenance requirements. Some systems provide a complete description of the network topology that can be used to satisfy system documentation requirements of Section 4. Additional reports on automatic system tests may satisfy preventative maintenance testing requirements. An alarm audit log also is provided in most systems that allows the user a way to recreate the conditions and actions that resulted in a system or component failure.

Status monitoring systems and the data service (LAN) station management systems also may transfer information that will enable the user to locate and detect system problems. In particular, the physical layer receive level measurements provided by 802.3 and 802.4 station management systems can be very useful in determining the location of a signal level loss in the network. Standards are currently being developed in the 802.7 working group that will provide an exposed interface and protocol for transferring information between status monitoring systems and the 802 station management system.

7.4.2 Minimal requirements for measurement and control parameters

A recommended minimum set of parameters that should be measured, controlled and reported by each transponder in the status monitoring system is:

1) One RF level measurement in the inbound and outbound path. This measurement provides the user with the capability to monitor each path, to analyze, and trace signal level (of either transponder communication carriers or pilots) to detect degrading levels and provide corrective actions.
2) One power supply measurement — This measurement allows the user to monitor power supply voltages and detect failures or degradations that enable the user to take corrective action at the problem location.
3) The ability to set major and minor alarm levels on each measurement in 1 and 2. This feature provides an automatic alarm that informs repair personnel that a condition exists that requires immediate attention. Audio and visual alarms should be provided.
4) The ability to individually enable/disable each alarm. This feature allows the user to disable the alarm on a unit that is being removed for service or testing.
5) If the transponder is used with trunk amplifiers, it also should report status and provide alarms for:
   a) Lid closure — This status allows the user to detect an open housing (a possible

Table 3.6.3: Recommended transponder communication carrier frequencies

	Midsplit	Highsplit	
Single cable			
Inbound:			
	<11.75	<11.75	(MHz)
	102-108	>150	(MHz)
or:			
Outbound			
	<186	<240	(MHz)
or	>300	300-306	(MHz)
or		>378	(MHz)
Dual cable			
Inbound and outbound			
	<17.75 or 95.75-101.75		(MHz)
or	>300		(MHz)

Note: The status monitoring command channels and the pilot frequencies must coexist with each other and with any data or video services present on the cable. Close cooperation and planning between all suppliers is required.

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source of ingress) and correct the condition before the system operation is degraded.

b) Inbound path switch status (if an inbound switching capability is provided) — The status of the feeder switches is used to insure that the switch position is in the desired state.

c) Redundant amplifier status (if a redundant amplifier capability is provided). Notifies the user that the backup amplifier is in use so that corrective maintenance can be scheduled.

It also should provide a control facility to:

a) Control inbound feeder path switch (if an inbound feeder path switching capability is provided). Used at the central monitoring point to perform fault diagnosis and ingress source determination.

6) If the transponder is used with backup power supplies, it also should report status and provide alarms for:

a) Backup supply status — Notifies the user that the backup supply is in use so that corrective maintenance can be scheduled on the primary.

It also should provide a control facility to:

a) Enable/disable backup mode.

7) If the transponder is used with redundancy switches, it also should report status and provide alarms for:

a) Switch status — Notifies user that the redundant component(s) are in use so that corrective maintenance can be scheduled on the primary.

It also should provide a control facility to:

a) Set redundancy switch position.

7.4.3 Optional parameters to measure in the system

Most status monitoring systems offer a mix of the following capabilities (refer to section 7.4.2 for a minimal set of operations needed to determine whether the media will continue to operate with acceptable performance). The additional (optional) parameters presented in Table 7.1 provide other diagnostic information for the network that is very useful but may not be available on all status monitoring equipment.

The parameters defined in Table 7.1 are used by the system manager as follows:

Additional RF levels — Additional RF levels in the inbound and outbound paths may be used to determined the slope deviations of the network.

Transponder status — Provide an indication

Table 7.1: Optional status monitoring parameters

Measurement and status parameters

The following parameters are measurement and status parameters that enable the user to draw conclusions about the condition of the system and to control the system:

- Additional RF levels in inbound and outbound paths
- Transponder status
- Humidity
- Temperature
- Voltages
- Device current
- System diagnostic test status
- Auxiliary inputs status
- Transponder communications statistics

Control parameters

The following are control parameters that allow the user to perform tests, isolate faulty equipment and adjust operating levels of the system:

- Transponder transmit level
- Perform system diagnostic test
- Enable/disable an individual alarm
- Set the measurement frequency for measurement
- Set auxiliary outputs

Management information parameters

The following are parameters that allow the user to control access, maintain and document the system:

- Disable local functions
- Serial number/address
- Version number
- Configuration
- Transponder type
- Location
- New station status
- Station recovered
- User privilege
- Upload/download capabilities
- Cable topology

Threshold parameters

The following parameters set threshold or states at which previously defined measurements cause alarms at the central monitoring point:

- RF level thresholds
- Voltage thresholds
- Current thresholds
- Temperature thresholds
- Auxiliary input mask

Events (alarms)

An alarm may be provided at the central monitoring point for the following parameters and device states:

- RF level threshold exceeded
- Voltage threshold exceeded
- Current threshold exceeded
- Temperature inside closure exceeds threshold
- Redundant switch status
- No communications
- New Transponder has been detected
- Cover open
- Auxiliary input matches input alarm mask
- Power reset of transponder detected
- Monitoring process halted
- Transponder failure

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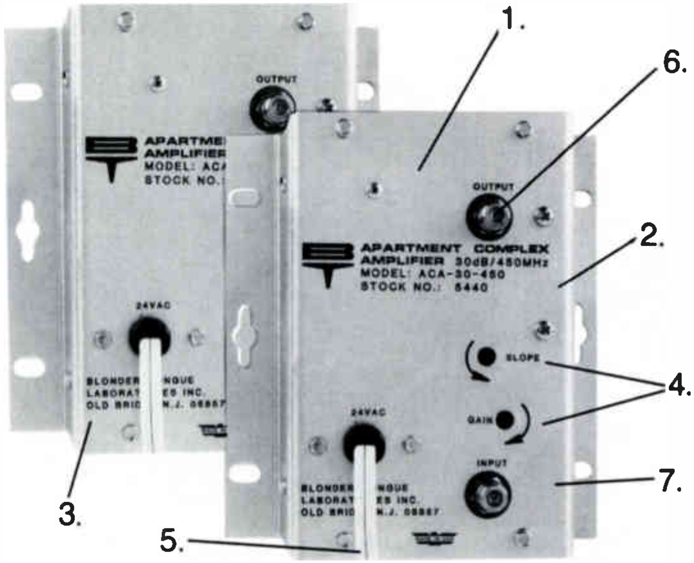

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at the central monitoring point of the status and health of the transponder.

Humidity — Indicates the humidity at the transponder location. It can be used by the system manager to detect degrading operating conditions and provide corrective action before the system fails.

Voltage — Measurement at the transponder of AC and DC supply or control voltages of the monitored device. It can be used by the system manager to detect degrading operating conditions and provide corrective action before the system fails (e.g., low power supply voltage or changing AGC/ASC/equalizer control voltages).

Device current — Indicates the current drawn by the monitored device at the transponder location. It can be used by the system manager to detect degrading operating conditions and provide corrective action before the system fails.

System diagnostic test — A test that can be initiated at the central monitoring point to indicate system performance of a device and/or the system (e.g., feedforward test, ingress test, etc.).

Status of auxiliary inputs — A capability that allows the user to optionally read the status of an external device. This provides the user the capability of monitoring external equipment that does not have a remote status monitoring capability.

Transponder communications statistics — Statistics gathered on the transponder communications (i.e., bit errors, CRC, etc.). This provides the user with the assurance that the transponder is communicating properly.

Transponder transmit level — This control enables the user to adjust transponder output levels to compensate for path loss variations as a diagnostic tool.

Enable/disable individual alarms — This provides the user the capability to ignore certain alarms.

Set measurement frequency for level measurement — Allows the user to specify the frequencies to make level measurements.

Set amplifier operating level — This control can be used to adjust certain portions of the system to compensate for path variations or as a diagnostic tool.

Set auxiliary outputs — This enables the user to control an external device that does not have a status monitoring capability (example, some A/B switches).

Some of the suggested changes that will be proposed during the balloting of Draft D will undoubtedly be incorporated into the standard as accepted. However, it is unlikely that there will be any meaningful engineering modifications. Therefore the status monitor standards can be accepted as shown in these excerpts.

There is an important point to note in these standards for LAN status monitoring: there are two levels of measurement capabilities — the minimal requirements and optional parameters (Sections 7.4.2 and 7.4.3). The minimal requirements section corresponds very closely to the capabilities of status monitor systems used in CATV. The optional parameters section details added capabilities that would be necessary for the increased reliability mandated for data LAN service.

There are a number of status monitoring systems currently available (e.g., from Jerrold, Texscan, Network Technologies/AM Cable and Scientific-Atlanta). All of these systems will provide the minimal requirements listed. Of these, the only system currently available that also will provide the additional optional parameter measurements is the Network Technologies/AM Cable system.

The reliability requirements for data networking is much higher than is commonly accepted for CATV operation. Downtime in data service can amount to large amounts of money for even a very short period and this added reliability is the reason for the optional parameters. These parameters are of increasing importance to the system reliability as the number of nodes increases.

Conclusions

Status monitoring is a required function for the operation of a LAN. The parameters to be measured for a LAN are, at a minimum those that are provided in a typical CATV status monitor system, however, the increased reliability requirements of a data LAN dictate additional parameters to be measured — especially as the LAN gets larger.

Figure 10: Relative tests

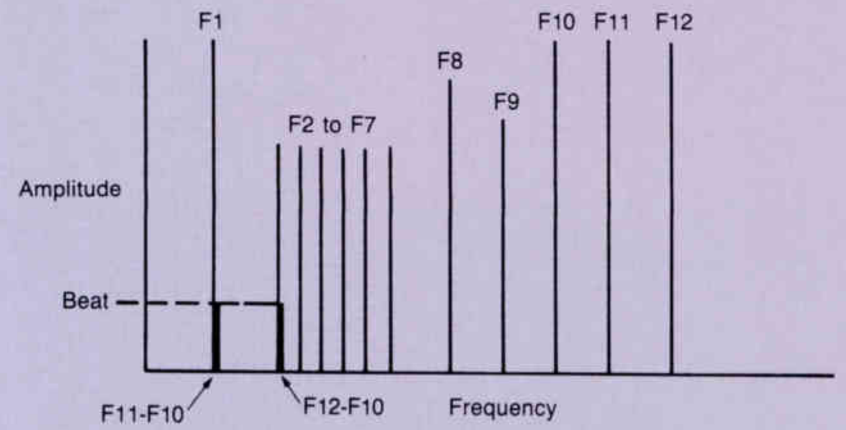


Figure 11: Second-order relationship

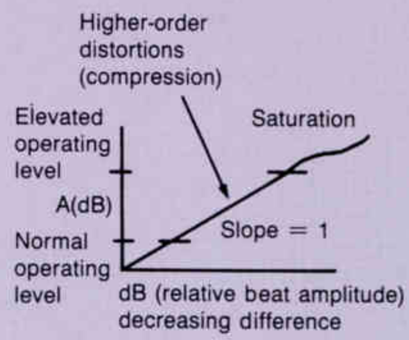
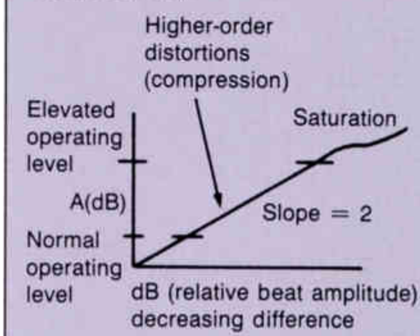


Figure 12: Third-order relationship



(Continued from page 32)

The curve in Figure 11 suggests that the amplifier may be operated at elevated levels (typically 20 dB for these carriers) and still produce a one-for-one linear change relation. In other words, a 1 dB change in output level will bring the beat 1 dB closer in relative amplitude. This elevated level should be available from the vendor or by inspection. To calculate the level, use the formula:

$$\text{Test level increase (dB)} = 10\log\left(\frac{\text{maximum number of system video carriers}}{\text{3 carriers}}\right)$$

To make the measurement, read and record the amplitude of the reference carrier with a properly preselected spectrum analyzer. Remove the test carrier and remove attenuation on the analyzer until the beat is stable on the display. Record the peak amplitude of the beat. Subtract the beat amplitude from the reference carrier amplitude to obtain the relative difference. Next, add the amount of test level increase to the relative difference. The result is the second-order beat measurement at system operating levels. Measurement formula:

dB (second order) = (test output level − beat level) + change in levels

The third-order test is performed in the same manner. The main difference is that three test carriers are used instead of two and the relative change difference is two-to-one instead of one-to-one (Figure 12). Measurement formula:

dB (third order) = (test output level − beat level) + 2 (change in levels)

Although real-world amplifiers do not have perfectly linear RF transfer characteristics, proper use of their linear range can permit accurate measurement of intermodulation distortion. By keeping tabs on this distortion, the system operator can be aware of marginal operation and take the proper precautions to eliminate potential system problems.

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AD INDEX

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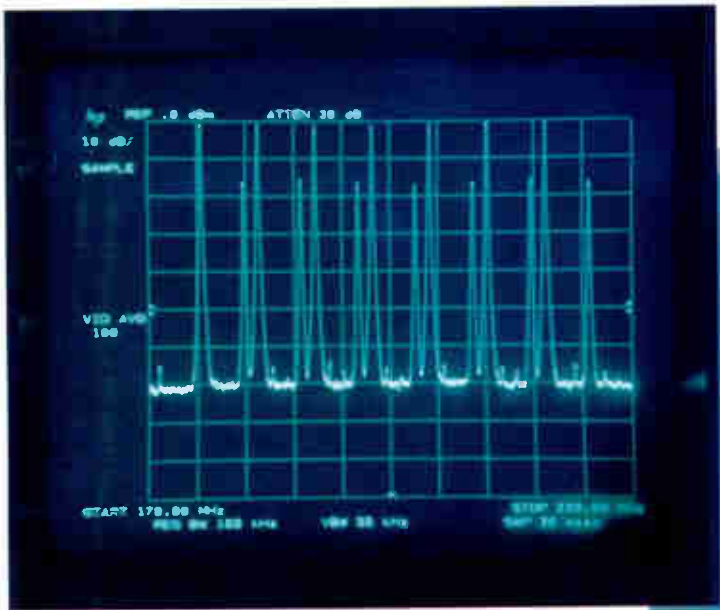

. . . and look like this.

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Composite triple beat:
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Cross Modulation:
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Output Level:
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S-1879

Noise figure and noise temperature

By Ron Hranac and Bruce Catter
Jones Intercable Inc.

Noise figure and noise temperature are related quantities used to characterize the noise performance of devices. Noise figure, expressed in decibels (dB), is generally used for terrestrial applications, because the equivalent noise temperature has numerically large values. Noise temperature, expressed in degrees Kelvin (°K), is common in satellite communications and space applications, since the equivalent noise figure is relatively small. Table 1 provides noise temperature conversions from 5°K to 500°K in 5° steps. Table 2 provides noise figure conversions from 0.5 dB to 25 dB in 0.5 dB increments. The formulas from which these tables were created, along with examples of their use, are on the next page.

Table 1: Noise temperature to noise figure

Noise temp. (°K)	Noise figure (dB)	Noise temp. (°K)	Noise figure (dB)	Noise temp. (°K)	Noise figure (dB)	Noise temp. (°K)	Noise figure (dB)
5	0.0742	130	1.6085	255	2.7400	380	3.6368
10	0.1472	135	1.6599	260	2.7796	385	3.6691
15	0.2190	140	1.7107	265	2.8189	390	3.7011
20	0.2896	145	1.7609	270	2.8579	395	3.7329
25	0.3591	150	1.8105	275	2.8965	400	3.7645
30	0.4275	155	1.8596	280	2.9348	405	3.7959
35	0.4949	160	1.9081	285	2.9727	410	3.8270
40	0.5612	165	1.9561	290	3.0103	415	3.8579
45	0.6265	170	2.0036	295	3.0476	420	3.8886
50	0.6908	175	2.0505	300	3.0845	425	3.9191
55	0.7542	180	2.0970	305	3.1212	430	3.9493
60	0.8167	185	2.1430	310	3.1575	435	3.9794
65	0.8783	190	2.1884	315	3.1936	440	4.0092
70	0.9390	195	2.2334	320	3.2293	445	4.0389
75	0.9989	200	2.2780	325	3.2648	450	4.0683
80	1.0580	205	2.3221	330	3.2999	455	4.0976
85	1.1163	210	2.3657	335	3.3348	460	4.1266
90	1.1739	215	2.4089	340	3.3694	465	4.1555
95	1.2306	220	2.4517	345	3.4038	470	4.1842
100	1.2867	225	2.4941	350	3.4378	475	4.2126
105	1.3420	230	2.5361	355	3.4716	480	4.2409
110	1.3966	235	2.5776	360	3.5052	485	4.2690
115	1.4506	240	2.6188	365	3.5384	490	4.2970
120	1.5039	245	2.6596	370	3.5715	495	4.3247
125	1.5565	250	2.7000	375	3.6042	500	4.3523

Table 2: Noise figure to noise temperature

Noise figure (dB)	Noise temp. (°K)	Noise figure (dB)	Noise temp. (°K)	Noise figure (dB)	Noise temp. (°K)	Noise figure (dB)	Noise temp. (°K)	Noise figure (dB)	Noise temp. (°K)
0.5	35.3854	5.5	738.9588	10.5	2,963.854	15.5	9,999.588	20.5	32,248.54
1.0	75.0884	6.0	864.5108	11.0	3,360.884	16.0	11,255.108	21.0	36,218.84
1.5	119.6359	6.5	1,005.3824	11.5	3,806.359	16.5	12,663.824	21.5	40,673.59
2.0	169.6190	7.0	1,163.4430	12.0	4,306.190	17.0	14,244.430	22.0	45,671.90
2.5	225.7010	7.5	1,340.7898	12.5	4,867.010	17.5	16,017.898	22.5	51,280.10
3.0	288.6261	8.0	1,539.7763	13.0	5,496.261	18.0	18,007.763	23.0	57,572.61
3.5	359.2291	8.5	1,763.0428	13.5	6,202.291	18.5	20,240.428	23.5	64,632.91
4.0	438.4471	9.0	2,013.5519	14.0	6,994.471	19.0	22,745.519	24.0	72,554.71
4.5	527.3311	9.5	2,294.6277	14.5	7,883.311	19.5	25,556.277	24.5	81,443.11
5.0	627.0605	10.0	2,610.0000	15.0	8,880.605	20.0	28,710.000	25.0	91,416.05

To convert noise temperature (T_E) to noise figure (F), use the formula

$$F(dB) = 10\log_{10}\left(\frac{T_E}{290} + 1\right)$$

To convert noise figure to noise temperature, use the formula

$$T_E\ (°K) = 290\left(10^{\frac{F}{10}} - 1\right)$$

Problem:
You are using a 100°K low-noise amp (LNA) on your satellite antenna. What is the LNA's noise figure in decibels?

Solution:
Use the formula:

$$\begin{aligned} F(dB) &= 10\log_{10}\left(\frac{T_E}{290} + 1\right) \\ &= 10\log_{10}\left(\frac{100}{290} + 1\right) \\ &= 10\log_{10}(0.3448 + 1) \\ &= 10\log_{10}(1.3448) \\ &= 10\ (0.1287) \end{aligned}$$

Noise figure = 1.2867 dB

Problem:
The trunk amplifiers in your system have a 9.5 dB noise figure. What is their equivalent noise temperature in degrees Kelvin?

Solution:
Use the formula:

$$\begin{aligned} T_E\ (°K) &= 290\left(10^{\frac{F}{10}} - 1\right) \\ &= 290\left(10^{\frac{9.5}{10}} - 1\right) \\ &= 290(10^{0.95} - 1) \\ &= 290(8.9125 - 1) \\ &= 290(7.9125) \end{aligned}$$

Noise temp. = 2,294.6°K

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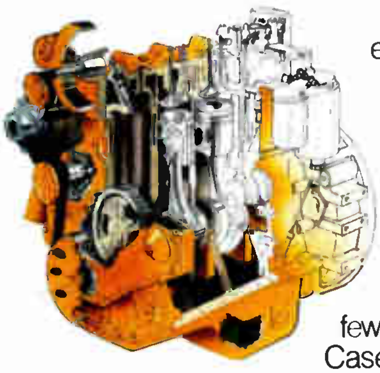

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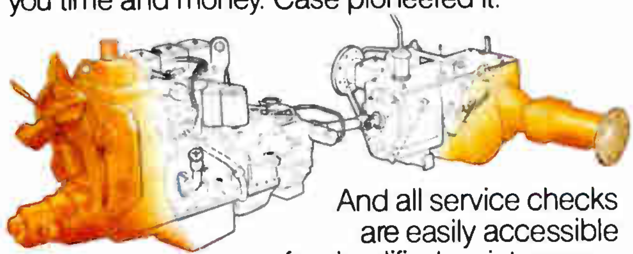

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KEEPING TRACK

Robert Luff has been appointed vice president of technology for Jones Intercable Inc. Prior to this, he was senior vice president of engineering at United Artists Cablesystems Corp. of Montvale, N.J. He also is currently president of the Society of Cable Television Engineers.

Contact: 9697 E. Mineral Ave., Englewood, Colo. 80112, (303) 792-3111.

Luff

Geoffrey Roman has been promoted to vice president of marketing for the **Jerrold Distribution Systems Division** of General Instrument Corp. He most recently served as vice president of sales and marketing for local area networking and consumer and commercial satellite TV. In his new position, Roman will manage Jerrold's headend and distribution equipment. Contact: 2200 Byberry Rd., Hatboro, Pa. 19040, (215) 674-4800.

Roman

EFData Corp. announced **Alan Potter** as its national sales manager. He will direct corporate sales of all products through a network of sales agents. Prior to joining EFData, Potter was a marketing specialist with Fairchild Data Corp. Contact: 1030 N. Stadem Dr., Tempe, Ariz. 85281, (602) 968-0447.

Potter

Brad Cable Electronics Inc. announced **Scott Wheeler** as customer service representative. He has worked in customer relations in airlines and the ski industry. Wheeler will be responsible for the Northern part of the United States. Contact: P.O. Box 739, Schenectady, N.Y. 12301, (518) 382-8000.

Wheeler

Compression Labs Inc. announced the promotion of **Kathryn Reavis** to vice president of marketing. Formerly director of marketing, she will be responsible for the development and implementation of the company's market strategies and plans. Before joining CLI as director of business development, Reavis was strategic planning consultant for the Boston Consulting Group. Contact: 2305 Bering Dr., San Jose, Calif. 95131, (408) 946-3060.

Reavis

Glenn O'Connell has been promoted to sales manager for **OEM Sales**, a division of Pico Macom Inc. Prior to this, he served as account supervisor for OEM. O'Connell will oversee the division's sales efforts as well as its cable TV product development.

Contact: 12500 Foothill Blvd., Lakeview Terrace, Calif. 91342, (818) 897-1120.

James Chiddix has been named vice president of engineering and technology for **American Television and Communications Corp.** (ATC). He was previously senior vice president of ATC's Hawaii division. In his new position, Chiddix will be responsible for directing ATC's technical resources against current and future priorities and opportunities.

Also announced at ATC, **Stephen McMahon** was named president of the Jackson, Miss./Monroe, La., division. Previously vice president for legislative and regulatory affairs in the company's Florida division, he joined ATC in 1979 as general manager of its Orange/Seminole Cablevision system. Before joining ATC, McMahon was dean of administrative affairs and then president of North Florida Junior College.

Finally, **Jerome Ramsey**, formerly vice president, secretary and general counsel of Mile Hi Cablevision, has joined the law department of ATC. Prior to Mile Hi, he was an associate in the firm of Gassman and Holt, an assistant U.S. attorney for Colorado and an associate with the Denver law firm of Holland and Hart. Contact: 160 Inverness Dr. West, Englewood, Colo. 80112, (303) 799-1200.

First Data Resources Inc. appointed **Scott Anderson** to regional sales manager for the Cable System Services Division. He will be responsible for the sales of the company's cable control system and its PC-based Micro Delivery Option (MDO). Contact: 7301 Pacific St., Omaha, Neb. 68114-5497, (402) 399-7000.

NaCom Construction Corp., a subsidiary of AmeriLink Corp., announced **David Miller**'s appointment to the newly created position of director of operations. Previously he was with Comcast Corp. where most recently he managed design and construction.

Contact: 1900 E. Dublin-Granville Rd., Columbus, Ohio 43229, (614) 895-7307.

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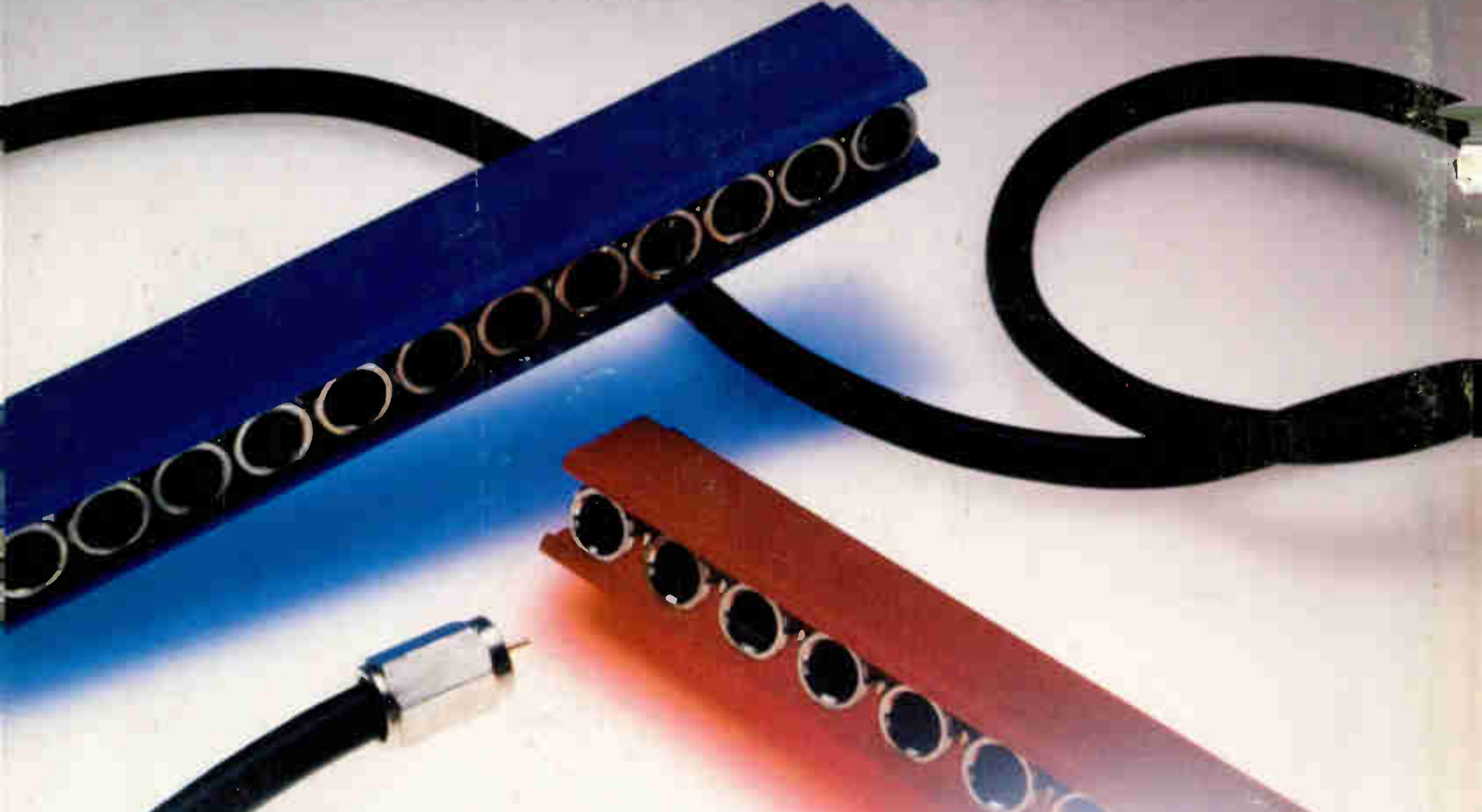

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- No crimp tools are required.

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