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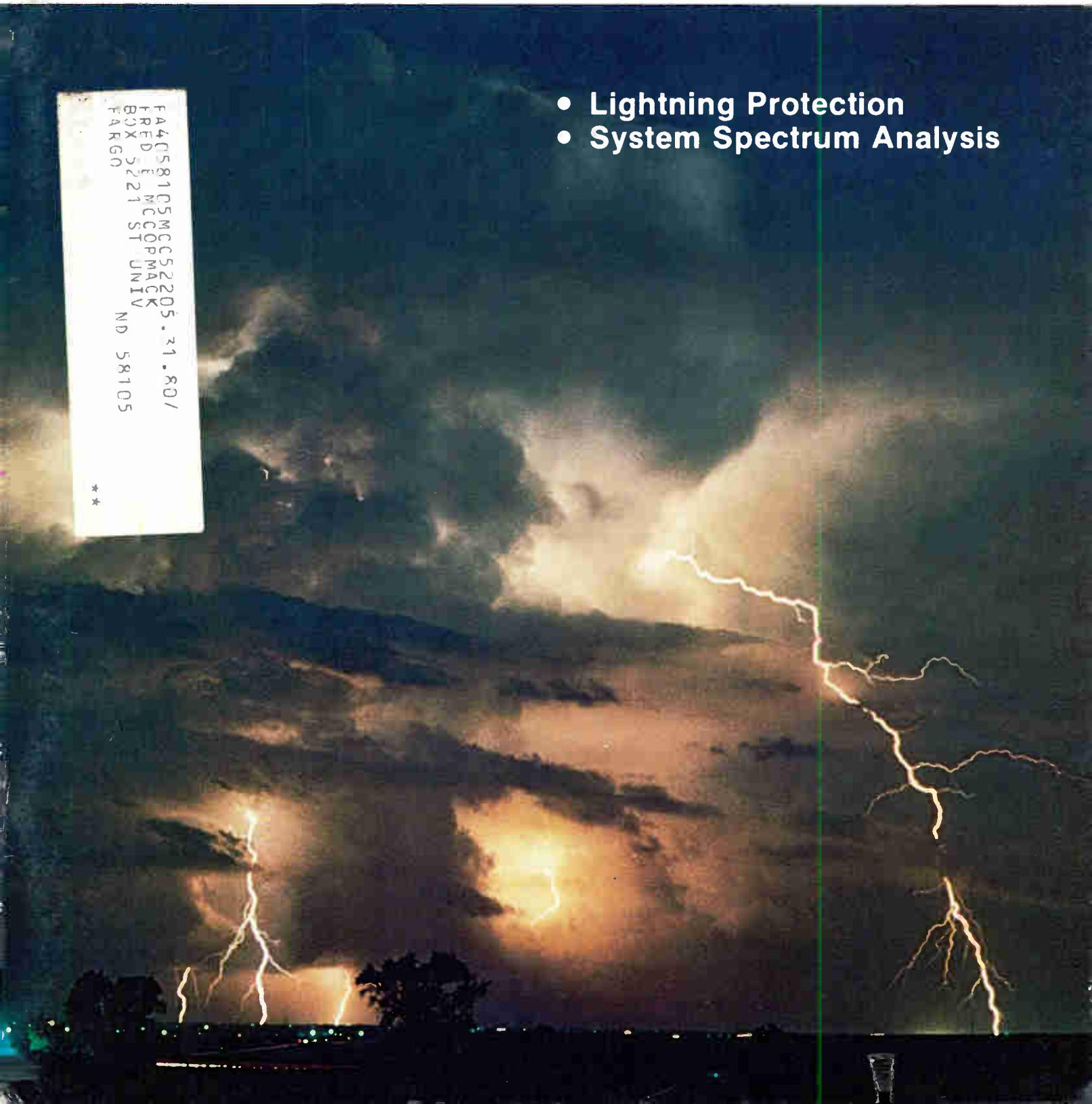
Communications Engineering Digest/The Magazine of Broadband Technology April 1981



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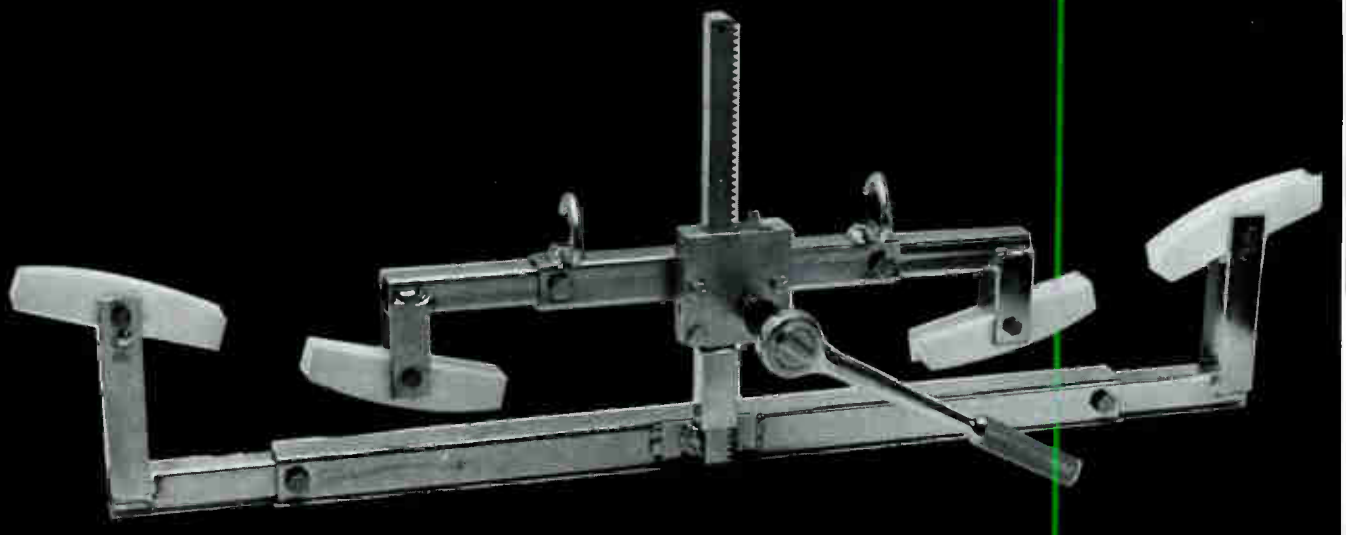

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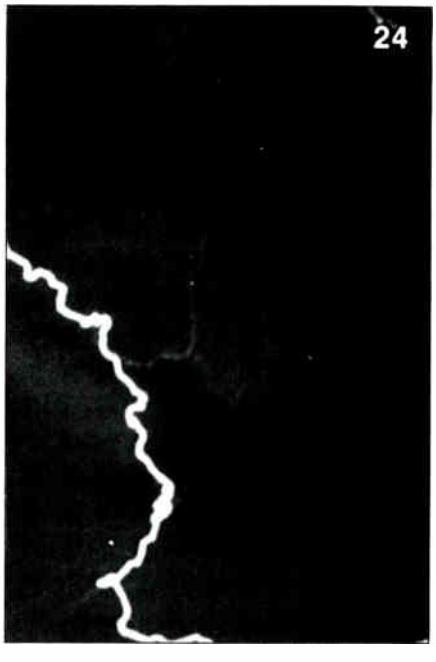
Contents

24



About the Cover
Where is the best place to be when lightning strikes? Far enough away to see it. Unless a cable system is protected against lightning, a direct strike like this one can turn headend equipment into scrap metal.

CED (USPS 300-510) is published monthly on behalf of all parties, including the Society of Cable Television Engineers (SCTE), interested in the advances of broadband technologies, by Titsch Publishing, Inc., 2500 Curtis Street (P.O. Box 5400 TA) Denver, Colorado 80217.

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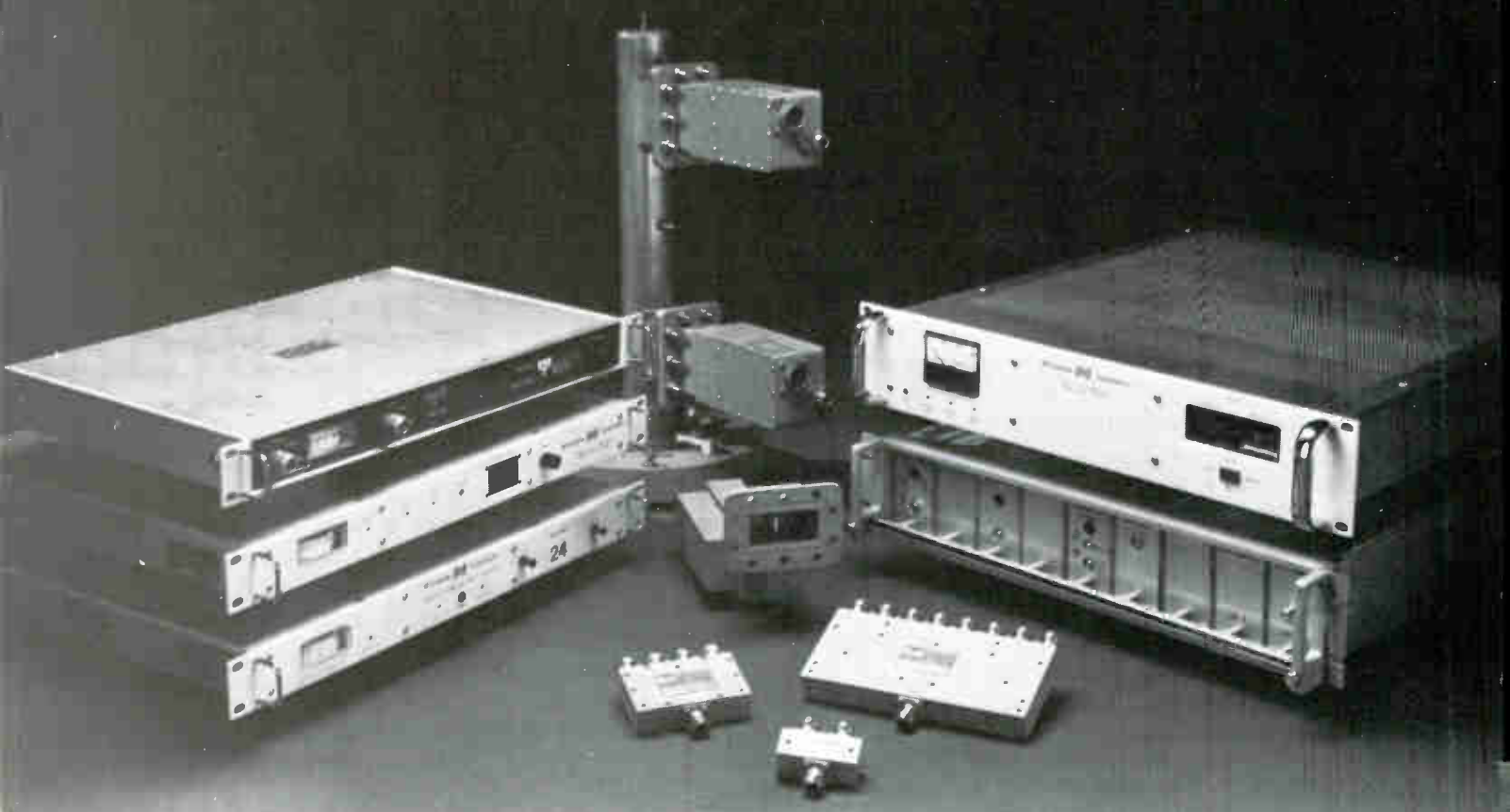

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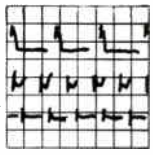

Sigma Scrambler

Oak Communications, Inc., has gained Federal Communications Commission advance approval for its second generation subscription television system. Known as STV-Sigma, Oak's new system becomes the tenth scrambling technique to be authorized by the FCC since 1970. Oak's Model I, which was authorized in 1975, is already in use in several markets nationwide. Other companies which have received FCC authorization are: Zenith, Blonder-Tongue, Teleglobe, System Development Corporation, Pay Television Corporation, Feature Film Services, American Television and Communications and Dynacom International.

Book 'Em, Dano

The **Warner Amex system in Hampton, Virginia**, was directly responsible for collaring a pair of ne'er-do-wells in the last several weeks. Acting on a suggestion from Police Chief Patrick Minetti, Bill Day, system manager, began **airing a police department-produced tape on the Top Ten Criminals in the city**. The seven-minute program featured an introduction by Minetti followed by mug shots of the criminals, their known aliases, a physical description, their last known whereabouts and an explanation of the crime. The Hampton system transmitted the program five times a day, seven days a week, over the public service channel. The results surprised even Minetti who is a firm believer that law enforcement officials are not the only ones responsible for dealing with crime in a city. After the first tape was aired, a cable subscriber phoned in a tip on one of the suspects who was subsequently apprehended and convicted. The second success was even better: one of the criminals was watching the cable channel when he saw his own familiar mug on the screen. He skipped town and was summarily arrested in another city.

Help Still Wanted

The search continues for a new vice president of science and technology for the National Cable Television Association. The association reportedly has been deluged with inquiries from interested candidates, but the field has not been narrowed as yet.

Hello, Do You Read Me?

A major flap is developing over who has the rights to television's vertical interval. The issue surfaced recently when WGN-TV, Chicago, whose signal is transmitted around the country via satellite courtesy of United Video, discovered that information it was attempting to deliver to WGN Electric Systems, Inc.'s cable television system is Albuquerque, as a prelim to extensive teletext tests, was not being received. The reason: United Video was already using the vertical interval for its own experimentation. According to Gary H. Arlen, publisher of *Internationl Videotex Teletext News*, **this confrontation has the seeds for becoming a true landmark case over the rights to the vertical interval**.

Growing Their Own

As part of the city's "total approach" to telecommunications as well as with its eye on the future, the Mayor's Office of Manpower Resources for the City of **Baltimore is asking for help in obtaining** the following information: **curriculums for training manpower in construction and installation of a CATV system**, including skills that need to be mastered and approximate time required to learn the skills; appropriate prerequisites in selecting participants for construction and installation training programs, such as physical requirements and educational levels; and average starting salaries for construction workers and installers. If readers wish to provide input, please contact Ruth Savanuck, Mayor's Office of Manpower Resources, 701 St. Paul Street, Suite 500, Baltimore, Maryland 21202.

Once More with Feeling

AT&T is trying to be as specific as it can be in telling members of Congress these days that it intends to provide directory listings, call-guide information and yellow page information with display advertising as part of a total information package, one which should be considered interactive because of the customer's ability to use the telephone as a response mechanism. The telephone company argues that the visual display of such information should be no more restricted than the audible messages it provides for time, weather, etc. However, it still maintains it is not interested in creating or controlling TV programming or in engaging in the traditional CATV business, which it describes as the one-way transmission of programs.

The Envelope, Please

Telidon, the Canadian videotex system, has been **presented** the **New Perspective Award** by Touche Ross International, an accounting and management consulting firm with affiliates in 82 countries. The international award was given to Communications Minister Francis Fox who accepted on behalf of the Canadian Department of Communications which developed the system. According to Russell Palmer, chief executive officer of the United States branch of Touche Ross, the awards are presented annually to "firms, individuals and institutions who have demonstrated innovative thinking, boldness and courage in confronting the problems facing mankind." Telidon won in the category of design excellence and technical superiority. The award itself is an original sculpture "symbolizing man's creative quest," designed by American sculptor Judith Brown.

Happy Birthday, Ralph

After all these years of vigorous debating on behalf of consumer advocacy, one would think Ralph Nader was accustomed to being interrupted. But perhaps he didn't expect it in his own backyard. Nader was giving the closing address at the National Conference on the Consumer and Cable Television (co-sponsored by Nader's National Citizens Committee for Broadcasting) when a rotund gentleman in top hat and tails gave a spirited blast from a kazoo and raced down the aisle to join Nader on the stage. He attempted to place a paper party hat (complete with elastic chin-strap) on the advocate's head—an offer that Nader, obviously annoyed, declined. Next, the interloper burst into song, wishing Nader a belated happy birthday from a friend, possibly a former friend. It turned out that the singer was a messenger from Eastern Onion, the singing telegram people. Nader eventually warmed to his performance and even quipped, "They should have this on cable."

Seminars

APRIL

6-10: The **Community Antenna Television Association** will present a cable television technical training seminar at the Holiday Inn of Garland in Dallas, Texas. Contact the CATA at (305) 562-7847.

8: The **New England Cable Television Association** will hold its spring meeting at the Sheraton-Tara Hotel in Nashua, New Hampshire. Contact the association at (603) 224-3373.

12-15: The **National Association of Broadcasters'** 59th annual convention will be held at the Las Vegas Convention Center. Contact the NAB at (202) 293-3570.

13-14: The **Society of Cable Television Engineers** will sponsor a "Digital Electronics and Cable TV" seminar at Stouffer's Inn at the Denver Airport, Denver, Colorado. Contact SCTE at (202) 293-7841.

13-15: The **Illinois Institute of Technology**, Chicago, is holding its 16th annual seminar on soldering technology. Contact the Office of Special Programs, (312) 567-3300.

13-15: The **International Association of Satellite Users** is holding its 1981 conference and trade show at the Washington Hilton Hotel, Washington, D.C. Contact the organization at (703) 893-2217.

15: Cable Trends and Cable Atlanta will host a dinner meeting of the **Atlanta Cable Club** at the Atlanta Stadium Club, Atlanta, Georgia. Contact Marian McConnell, (404) 898-8500.

15-16: The **Maryland/Delaware Cable Television Association**'s spring meeting will be held at the International Hotel. Contact Charles Ross or Stanley Janor at (301) 332-4088.

17-19: Satellite Television Technology is holding a seminar on satellite television at the Washington Shoreham Hotel in Washington, D.C. Contact the firm at (405) 396-2574.

17-19: The **Society for Private and Commercial Earth Stations** will hold its "Spring '81 Satellite Private Terminal Seminar" at the Shoreham Hotel, Washington, D.C. Contact the society at (202) 387-1856.

21-23: A **Jerrold** technical seminar will be held in Calgary, Alberta. Contact Len Ecker, (215) 674-4800.

23: CTAM is holding the next workshop in its Management Development Series at the Colony Square Hotel in Atlanta, Georgia. The topic is "Managing Your Time." Contact Rita Chambers, (202) 296-4219.

26-28: The **Virginia Cable Television Association** will hold its annual convention in Wintergreen, Virginia. Contact Lorraine Whitmore, (804) 320-2180.

MAY

4-8: The **Community Antenna Television Association** will present a cable television technical training seminar at the Paramount Heathman Hotel in Portland, Oregon. Contact the CATA at (305) 562-7847.

5-7: A **Jerrold** technical seminar will be held in Portland, Oregon. Contact Len Ecker, (215) 674-4800.

11-12: The **Society of Cable Television Engineers** will sponsor "System Test Requirements" and "System Preventive Maintenance" seminars at the Hilton Airport Inn, Kansas City, Missouri. Contact SCTE at (202) 293-7841.

13-15: Integrated Computer Systems, Inc., is holding a workshop on "Fiber Optics Communications Systems" in Washington, D.C. Contact Ruth Dordick, (800) 421-8166; (213) 450-2060.

20-22: Infomart and **Online** are sponsoring "Videotex '81," a seminar on videotex communications at the Royal York Hotel in Toronto, Ontario. Contact the firm at (416) 598-1981.

26-28: Information Gatekeepers, Inc., is sponsoring "Electronic-Office '81" at the Commonwealth Pier Exhibition Hall, Boston, Massachusetts. Contact Michael A. O'Bryant, (617) 739-2022.

29-June 1: The **National Cable Television Association** is holding its annual convention at the Los Angeles Convention Center, Los Angeles, California. Contact Dan Dobsin, (202) 463-7905.

JUNE

1-5: The **Community Antenna Television Association** is holding a cable television technical training seminar at the George Washington Motor Lodge-East in Philadelphia, Pennsylvania. Contact the CATA at (305) 562-7847.

9-11: A **Jerrold** technical seminar will be held in San Francisco, California. Contact Len Ecker, (215) 674-4800.

9-11: The International Marketing Center of the U.S. Department of Commerce, Paris, France, is sponsoring an exhibition and seminar on U.S. fiber optics, **"Fiber Optique-'81."** Contact Ellen M. Bond, (617) 739-2022.

14-16: Montana Cable Television Association will hold its annual meeting at the Sheraton Hotel in Billings, Montana. Contact Bob Briney, (406) 586-1837.

14-17: The **Institute of Electrical and Electronic Engineers** is holding its 1981 International Conference on Communications at the Hilton Hotel in Denver, Colorado. Contact Bob Skelton, (303) 779-0600.

16: Showtime and Wometco Cable TV will host a dinner meeting of the **Atlanta Cable Club** at the Atlanta Stadium Club, Atlanta, Georgia. Contact Marian McConnell, (404) 898-8500.

16-18: Nepcon East '81 will focus on the East Coast electronics manufacturing industry and take place at the New York Coliseum, New York, New York. Contact Industrial & Scientific Conference Management, Inc., (312) 263-4866.

23-25: A **Jerrold** technical seminar will be held at the Best Western Arena Motor Inn in South Williamsport, Pennsylvania. Contact Len Ecker, (215) 674-4800.

25-26: The **New York State Commission on Cable Television** will hold its "Seventh Annual Northeast Cable Television Technical Seminar" at the Empire State Plaza Convention Center in Albany, New York. Contact Robert L. Levy, (518) 474-1324.

JULY

7-9: A **Jerrold** technical seminar will be held in Madison, Wisconsin. Contact Len Ecker, (215) 674-4800.

10-12: The **National Federation of Local Cable Programmers** is holding its fourth annual convention at the Atlanta Biltmore Hotel in Atlanta, Georgia. Contact Cindy Kuper, (404) 523-1333.

21-25: A **Jerrold** technical seminar will be held in Phil .delphia, Pennsylvania. Contact Len Ecker, (215) 674-4800.

27-28: The **Society of Cable Television Engineers** will sponsor a "System Preventive Maintenance" seminar at the Dutch Inn in Orlando, Florida. Contact the SCTE at (202) 293-7841.

AUGUST

4-6: A **Jerrold** technical seminar will be held in Denver, Colorado. Contact Len Ecker, (215) 674-4800.

20-22: The **Southern Cable Television Association** convention and trade show, the "Southern Show," will be held at the Georgia World Congress Center, Atlanta, Georgia. Contact the group at (404) 237-8228

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Volume 7, No. 4

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Editorial

Marketers and Engineers: A Dangerous Gap

Last month was a busy one for cable people making the rounds to industry meetings in all parts of the country. There are no signs of it letting up. Whether it's state association meetings focusing on bills proposed in their local legislatures, or technical conferences and seminars sponsored by SCTE, CATA, or industry manufacturers and suppliers, or even NCTA's Executive Seminar on Enhanced Services, there's at least one common thread: everyone is focusing on the future while going about the daily business of building and rebuilding their systems, marketing and maintaining them and, of course, trying to meet the bottom line.

However, when the pressures mount for meeting those daily and weekly schedules, as we had pointed out before, it is sometimes difficult to embrace the notion that tomorrow's challenges need to be addressed today. The resultant frustation appears to be creating a level of anxiety among many segments of the industry. And, at widely dispersed meetings last month (NCTA's Executive Seminar on Enhanced Services in Phoenix and SCTE's Spring Conference in Nashville), the frustration was expressed in exactly the same way. A few years ago it might have been blue sky. Now, phrased differently, those who are, for whatever reasons, reluctant to take the plunge into something new, say they are being coerced by the futurists and some suppliers into areas in which as yet there is no demonstrable demand. All this technology is just out there waiting for a market to happen is what's so often stated. Apparently, what is happening is this: the explosive rate at which I.E. technology, for example, is developing is placing a strain on the more traditional "need/fulfillment" function of marketers and their relationships to those who must apply the technology to that function.

NCTA's and SCTE's meetings present the best examples of this. On the one hand, a group of corporate industry executives met to explore together what markets in the broad field of enhanced services—security, data transmission, energy load management, videotex—represent opportunities for the cable industry. The meeting was off the record, but we can tell you this: the CEOs spent most of their time asking what the technology is really capable of doing and how much will it cost? What are the capabilities of coax versus optical fiber or twisted pair for passing data?

At the same time, at SCTE's conference, the engineers, with a pretty good idea of what works and what doesn't, spent much of their time asking each other what it was that their corporate leaders were going to ask them to deliver.

Franchising requirements aside (and that's a big aside), the net is that, with a few exceptions, you have chief executives hesitant about which markets to explore because of uncertainty about the industry's technical capability. And then there are the engineers uncertain about what capability to design into the system because they don't know what it is going to be used for. Now if there is anything to be learned from the innovation curve of pay cable, it is that nothing came to pass until the appropriate technology of satellites was wed with the software of films. Then the industry realized its phenomenal lift. It has been suggested that the same curve will be followed by implementation of enhanced services. Because, just as there was in pay, there are going to be fits and starts. So let's hope that those with the market start talking to those with the technology, and both can go talk to those who have the money.

By the way, congratulations to SCTE's new officers:

President, Tom Polis
Western Vice President, Dick Covell
Eastern Vice President, Bob Tenton
Treasurer, Tom Bird
Secretary, Jay Levergood

Pat Gushman

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The Cable Connection

In order to assist you with your National Cable Television Show plans, we are alerting you now to our series of convention issues and advertising opportunities. Please keep this information close at hand. We are certain you will find it invaluable.

Our convention cycle for *CableVision* and *Communications Engineering Digest* is as follows:

		Pre-NCTA	Convention Issue	Convention News Wrap-Up	Convention Photo Wrap-Up	Tech Review Show Wrap-Up
CableVision	Issue Date	May 18	June 1	June 8	June 22	
	Space Reservations	Apr. 13	Apr. 27	May 4	May 20	
	Ad Copy Due In House	Apr. 15	Apr. 29	May 6	May 22	
Communications Engineering Digest	Issue Date	May	June			July
	Space Reservations	Mar. 23	April 20			May 22
	Ad Copy Due In House	Mar. 26	April 22			May 25
CableVision's NCTA Survival Guide	Issue Date		May 29			
	Space Reservations		Apr. 27			
	Ad Copy Due In House		Apr. 29			

Pre-convention issues offer an opportunity to cultivate your customers and prospects, stimulating them to think about products or services *prior* to the show. These editions start them on the way to your booth at the show.

CableVision's and *CED*'s convention issues help to instruct these customers and clients as to your location and the unique benefits of your service or product. We recommend an identifying booth number whenever and wherever possible.

Finally the Photo Wrap-up edition and technical review offer you two opportunities. First to remind those who attended the show to make that buying decision and second to let those who did not attend, know what they missed.

- This year we have made several improvements in the design of our publications. Our popular Survival Guide will once again be distributed throughout the convention area. In addition to the booth guide, important telephone numbers, hotels, etc., we will include a new section, a review of the news just prior to the conference. Only full-page advertisements are accepted in the Survival Guide.

- The June 8th issue of *CableVision* will be distributed at the NCTA Show on Monday so that the participants will receive total coverage of the convention prior to leaving Los Angeles. This offers you an additional opportunity to reach your business contacts with your advertising message.

By the way, don't forget that *CED*'s July Tech Review will also include the industry standard, *CED*'s frequency chart, the indispensable tool for the engineering community in CATV.

All of these advertising opportunities offer many premium positions. Your Account Executive will be calling soon to assist you in your planning. Special catalogues, literature and guides can be inserted into special issues. Should you have any further questions please give us a call at these locations.

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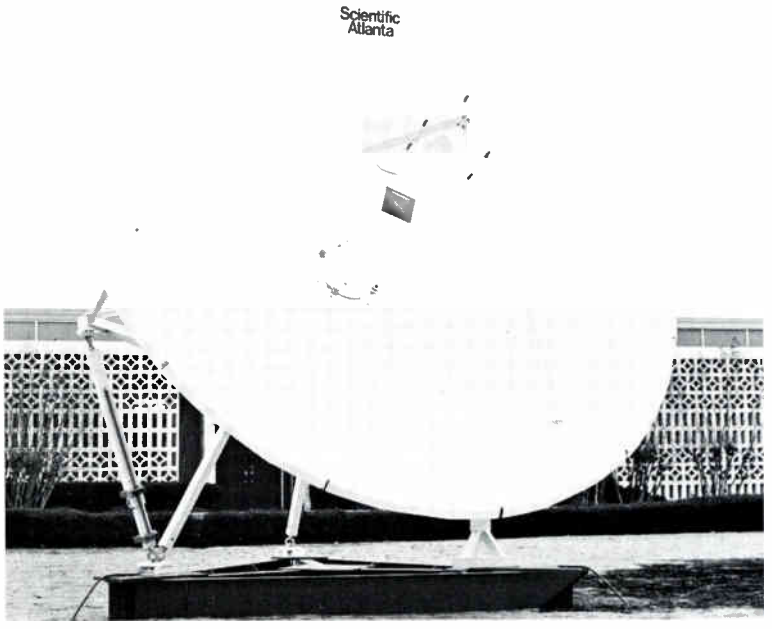

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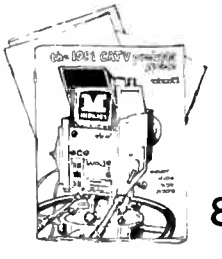

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Lee: FCC Backlog Will Grow After Reagan Budget Cut

WASHINGTON, D.C.—The eight percent budget cut directed by the Reagan administration could have a far-reaching impact on the operations of the Federal Communications Commission. Acting Chairman Robert Lee testified to that effect during a budget hearing before a House Appropriations subcommittee.

Lee stated that the budget slash would force the closing of several field offices, create considerable delays in the licensing process as well as authorizations to market new equipment, and cancel "pending economic and ownership studies" in cable television.

For fiscal year 1981, the budget will remain at $76,926,000, Lee said. That figure is the same as the estimate appropriated by the Carter administration for 1981. However, in order to meet the demand, the number of approved permanent positions was reduced from 2,110 to 2,004.

The real crunch will come in fiscal 1982. The commission's original budget called for an appropriation of $82,167,000, funding 2,110 permanent positions.

"The revised budget estimates for fiscal year 1982 being submitted today total $77,351,000 and 1,941 permanent positions or a reduction of $4,816,000 and 169 permanent positions from the January levels," Lee explained.

This reduction will have several ramifications regarding the cable industry. According to Lee, there has been "a major increase" in the number of cable systems that are requesting to use aeronautical radio frequencies. The bands in question are the 108-136 MHz and 225-400 MHz slots Recently, the FCC has amended its rules from requiring that a cable operator give the commission at least 60 days notice before operating on those frequencies. The new regulations force a cable operator to notify the commission of his intent to use the potentially interfering frequencies and then wait until authorization is granted. The new rules set no limit on the amount of time the agency can take before responding. Last month, a check with the enforcement branch of the FCC revealed that 140 cable systems are waiting for such authorization due to a backlog of requests.

If the budget reduction is upheld, the problem will get worse, not better.

"We are making a major effort to ensure that radio frequency 'leakage' from these systems does not interfere with aircraft use of these same frequencies," Lee said. "To deal with this problem we have been forced to reallocate the majority of our staff in this area away from processing cable microwave system requests to the new requests. As a result of the budget reductions and the leakage problem, a threefold increase in pending cable microwave system license requests is estimated for fiscal year 1982."

When asked why he had volunteered budget cuts for the FCC, which would in effect increase the commission's backlog, Acting Chairman Robert E. Lee said it was "A hint from the Reagan administration."

At the same time, Lee estimated that all licensing authorizations would be further delayed by the budget cut. This protraction would particularly apply to the new low-power television program.

"In the auxiliary service program, where our new program to establish low-power TV is located, we expect to have 5,500 requests for new licenses pending at the beginning of fiscal year 1982," Lee noted. "We expect to receive 3,500 new applications, dispose of 1,780, leaving 7,278 applications pending. We would expect that operating at our fiscal year 1982 funding levels, it would take four years to dispose of this total."

Hardest hit by the cutback will be the field operations activities. Based on the new budget, the following offices would be closed: Beaumont, Texas; Savannah, Georgia; Cincinnati, Ohio; Pittsburgh, Pennsylvania; Washington, D.C.; and the monitoring station in Anchorage, Alaska.

In addition, the FCC had planned to phase out five special enforcement teams and reallocate the resources to establish ten field offices across the country. Two of these offices have already been opened, one in Little Rock, Arkansas, and the other in St. Louis, Missouri. Now, Lee said, the offices already established will be shut down as well as the proposed offices for Phoenix, Arizona; Des Moines, Iowa; Salt Lake City, Utah; Tulsa, Oklahoma; Nashville, Tennessee; Greensboro, North Carolina; Spokane, Washington; and Albuquerque, New Mexico.

In concluding his testimony, Lee addressed the issue of moving the FCC to Rosslyn, Virginia, across the Potomac River from Washington. The commission has five leases on office space in the District of Columbia, but the leases for the majority of the space expire within the next two years. The proposed move to Rosslyn, according to Lee, "will save a substantial amount of money—$29 million—over the next 11 years."

When Lee finished, Representative Neal Smith (D-IO), who chaired the subcommittee, asked the acting commission chairman if the licensing delays would continue to escalate in coming years. Lee replied that they "probably would increase."

"Then all we're doing is delaying a workload to a future year," Smith said. "In that case, why did you volunteer this budget cut?" he asked.

"A hint from the Reagan administration," Lee answered.

Copyright Chairman Suggests Congress Eliminate CRT

WASHINGTON, D.C.—Copyright Royalty Tribunal Chairman Clarence James has strongly suggested to Congress that the CRT be eliminated "so the marketplace can set the true value of secondary transmission."

James made his remarks during an oversight hearing of the CRT conducted by the House Subcommittee on Courts, Civil Liberties and the Administration of Justice. After issuing the caveat that his presentation was based on his own opinion, James proceeded with a step-by-step analysis of the shortcomings of the Tribunal. His strongest comments were directed toward the handling of copyright payments from the cable industry.

"The legislative history is clear that there is absolutely no economic justification for the statutory schedule initially adopted by Congress for the cable industry," James said. "The rates for cable were not adopted on the basis of any objective standards."

Based on this premise, James asked the subcommittee members present to

eliminate the compulsory license and for Congress to establish "the true value in the marketplace" of cable services.

Throughout his presentation, James referred to the inequities of the current system of royalty payment. He even submitted a proposal made by the copyright owners that would compute the royalties due on a system-by-system basis. That same proposal was offered by the copyright owners during the royalty adjustment proceedings last fall. However, in the final decision handed down by the CRT, the proposal was rejected. James' plan for eliminating the CRT included marked similarities to the copyright owners' proposed payment scheme. In fact, James suggested that the copyright owners were the logical source for a new rate system.

"I would imagine that if the copyright owners were put to the ultimate test, they could develop a system or formula which the Congress could enact that would eliminate the necessity and need for a distribution proceeding and continuous government involvement," he said.

James stated that one of the prime motivations for his stance was the inefficient distribution procedure for cable royalties.

"There are cable funds on deposit in the Treasury of the United States which respectively represent 1978, 1979 and part of 1980 in the amount of more than $41,657,000," James said. "Because of this clearly unworkable procedure of royalty distribution established by Congress, copyright owners are effectively denied and will continue to be denied their just rewards—the proceeds form the royalty funds, timely paid."

In concluding, the CRT chairman said that now is the appropriate time to reevaluate the issue of cable copyright payments.

When he had finished, the subcommittee members congratulated him for his effort.

"You seem to have succeeded in lancing a very large boil," said Representative George Danielson (D-CA).

"You may have lanced the boil," added his colleague, Representative M. Caldwell Butler (R-VA), "but I'm not sure what you've done to the infection."

If the elimination of the CRT is actually approved by Congress, cable operators would probably negotiate directly with the copyright owners for the rights to syndicated programming.

Fowler Steps Closer To FCC Chairmanship

WASHINGTON, D.C.—Two months of speculation ended last month with the official announcement that Mark S. Fowler has been named to the Federal Communications Commission. Although President Reagan intends to appoint Fowler as commission chairman, that move will not be made until after April 10, when the resignation of outgoing Chairman Charles Ferris becomes effective.

Mark S. Fowler, a former radio broadcaster and television station director, has been named to the Federal Communications Commission.

Fowler, 39, is a senior partner in the Washington law firm of Fowler and Meyers. He served as communications counsel to Reagan in both his 1976 and 1980 campaigns for president.

Fowler comes from a broadcast background, having worked in radio as an announcer, sales representative and program director for several stations during the 1960s. He graduated from the University of Florida in 1966 and that institution's law school in 1969.

During an interview with **CED**, Fowler stated that one of his guiding precepts at the commission would be the tenet: "Make haste slowly."

"This means that we will act quickly to allow the new technologies to develop," Fowler said. "But at the same time we must carefully study their effect on established technologies."

Fowler said that although he hails from a broadcast background, this does not mean he will ignore the needs of the cable industry. "When there are two diametrically opposed industries," Fowler said, "often the best solution is a synthesis."

Scientific-Atlanta Markets Energy Management System

ATLANTA, GEORGIA—Scientific-Atlanta has begun a major marketing push for a new energy load management system that utilizes coaxial cable as the communications medium. The system is a modification of a S-A energy load management system that used radio signals as the delivery mechanism.

NCTA: Advising Against Marketing "Cable-Ready" TVs

Most cable television engineers believe that the design of cable compatible television receivers is unrealistic at the present time ("Cable-Ready Televisions Create Industry Problems," **CED**, March 1981, p. 15). Accordingly, the National Cable Television Association has contacted the manufacturers of "cable ready" sets in an effort to open a dialogue that will lead to a solution to this problem. Below is a text of the letter sent to manufacturers by NCTA President Tom Wheeler:

Dear:

Your company is marketing a so-called "cable-ready" television receiver. The technology utilized in this receiver, as well as its marketing, has raised many serious problems for cable television operators. The purpose of this letter is to identify some of these difficulties.

Many consumers have interpreted the marketing claims of the "cable ready" receiver to mean that with its purchase, they could circumvent the need to purchase cable service from their local cable television system. This, of course, is not the case.

A far more serious problem arises from the incompatibility of the "cable ready" sets with existing cable television technology. Since the idea of incorporating decoders into television sets was conceived in the early 1970s, cable technology has advanced to incorporate developments such as scrambling, addressability and program tiering. These cannot be handled by a single built-in decoder. If a consumer subscribes to a system with multiple tiers of premium service, he/she must use an external converter/decoder to receive and unscramble the signals.

The marketing of "cable ready" receivers has caused increasing consumer complaints. Cable operators are in the unfortunate position of having to tell consumers that their new set, which was purchased at least in part because it was "cable ready," is not compatible with current cable technology and that the "extra" they purchased is of no value.

The cable television industry is willing to advise and whenever possible supply necessary information to help set manufacturers overcome these problems. Please let us know how we can best alleviate the difficulties now being experienced.

There are four elements to the load management system: a central controller, a headend modulator, transponders and power line carrier receiver controls. When residential energy control is needed, the central controller (located at the utility station) sends a signal to the cable headend over telephone lines. The signal is then modulated to a very narrow bandwidth signal—about 15KHz—which can be sandwiched between video channels without interfering with the programming.

Transponders located at each transformer on the utility poles receive the signal from the coaxial cable and convert them to power line current that is sent into each residence. In the home, the power line carrier control receives the signal and disconnects certain appliances to reduce the energy consumption level necessary during peak demand. According to S-A, the control is designed for a "fail-safe operation" that allows it to remain disconnected for no longer than seven and one-half minutes unless it receives another disconnect signal. Frank Hyde, marketing manager, said that only specific appliances are generally shut down by the system.

"Water heaters are a prime target," he said. "Also air conditioners are high on the list."

S-A has been supplying load management systems to utility companies for over four years. Hyde said many cable companies are now ready to add energy management to their list of services.

"In certain situations, say, for instance, a rural environment, CATV really isn't there yet," Hyde said. "But in a municipal environment it seems to be a natural.

"The system can be set up in one of two ways," he continued. "The utility can buy the equipment and make an agreement with the cable company to supply them a certain spectrum for operating the load management system. That could take the form of mutual consideration for pole rentals or something like that. The second option is where the cable operator buys the equipment and leases it to the utility. Both options are viable; it's just a matter of circumstances."

GI, SED Systems Ink Earth Station Deal

NEW YORK, NEW YORK—SED Systems, Inc., of Canada has licensed General Instrument Corporation to manufacture and market television receive-only and direct broadcast satellite-to-home earth stations using patents and technology developed by SED Systems.

In announcing General Instrument's entry into the rapidly emerging market for earth station equipment, Frank G. Hickey, chairman and chief executive officer of General Instrument, said, "Adding satellite television earth station equipment to our broadband communications systems technology is a natural extension of our capabilities.... The addition of these satellite products will enable the company to expand its participation in the CATV, MATV, industrial and consumer markets.

"Our agreement with SED Systems enables General Instrument to capitalize on their expertise in the satellite communications field and on Jerrold's position in pay television, our production and marketing expertise, and our worldwide reputation as a leader in broadband communications."

Initially, General Instrument will utilize engineering and manufacturing operations in Toronto and Delhi, Ontario, Canada, which currently supply cable television electronic and antenna products. The company plans to modify the Canadian facilities to gear up for an expected high-volume production of DBS receivers to meet projected Canadian requirements and to supply TVRO earth stations to CATV, MATV, industrial and electronic distributor customers. The new products would be marketed worldwide

as the market matures.

No financial details of the agreement, which is subject to the execution of a definitive agreement and the approval of the boards of directors of both companies, were disclosed.

SED Systems currently has 200 DBS receivers in operation using the Canadian Telesat Anik B satellite. The system, used for educational and television pilot programming, is being tested by the Canadian government.

SED Systems' particular expertise is in microwave technology, producing GAASFET low-noise amplifiers and associated RF systems. The company is a major supplier of earth station equipment in Canada, having developed such equipment working with Telesat Canada and the Canadian government on the Anik A and Anik B satellite systems, and the advanced technology CTS/HERMES joint satellite project of NASA and the Canadian government, which was the first satellite to operate in the 12-14 GHz band and the first to prove DBS technology.

Commenting on the capability of present and planned world satellite systems and the market requirement for industrial and consumer ground receiving equipment during the 1980s, Michael Hodson, president of SED, stated that the agreement between SED and General Instrument brings together state-of-the-art technology with the ideal production and marketing resources to match the demands of this decade.

In addition to the television entertainment markets, growth in the market for satellite television receivers over the next decade is expected to occur in business and institutional communications systems. Hotels and motels will incorporate them into systems used for business teleconferences. Business communications networks will tie-together far-flung operations via cable and satellite. Broadband technology is expected to find increasing application in businesses, hospitals and universities for educational and training purposes.

Satellites

In the Works at CBS: High-Definition TV for DBS

WASHINGTON, D.C.—CBS has unveiled its tentative plans to enter the realm of direct broadcast satellite (DBS) services using the new technology of high-definition television (HDTV) as the vehicle. Although no business decisions can be made until the 12 GHz spectrum is allocated at the 1983 Regional Administrative Radio Conference, CBS is devoting its research skills to developing several facets of the technology.

"We think high-definition television is coming faster than most people thought," said William Lilley, vice president of CBS. "Our goal is to make it feasible as a broadcast business."

High-definition television is differentiated from standard sets by four technical elements: an increase in the number of scanning lines from 525 to 1,125, thus improving the resolution; improved color fidelity; an increase in the aspect ratio that shifts the dimensions of a television set from the present 4:3 (horizontal:vertical) layout to a 5:3 ratio; and stereo sound capabilities.

CBS recently introduced a handful of invited guests to view the brave new world of television. During the demonstration, a high-quality standard television set was juxtaposed with a prototype of the HDTV set. Several scenes were transmitted simultaneously over both sets for comparison. The differences were striking: the high-definition set reproduced the subtleties of color and contrast that are obvious in daily observations but impossible to translate into pictures on a standard set.

"This will not merely be an improvement, it will be a whole new dimension," said Joseph Flaherty, vice president of engineering and develop-

ment for CBS. Flaherty credited the application of digital technology to television transmissions as the step that enabled the development of HDTV. According to Flaherty, the present analog technology is akin to pouring water from one glass to the next down a line of glasses. Since some water sticks to each glass, there is a gradual loss of water. In terms of television, there is a degree of degradation of the picture with each generation of transmission.

On the other hand, Flaherty said, digital technology is analagous to pouring a glass of marbles from one glass to the next. At each step, there is no loss of marbles.

Although substantial progress has been made, several barriers remain before the technology is feasible. Standard equipment is unusable for HDTV, therefore new cameras, monitors and recording devices are required as well as the delivery system.

The innovation that moved the concept of HDTV one step closer to the studios was the development of the three-tube color camera by the Japan Broadcasting Corporation (NHK). NHK has devoted ten years of research to the three-tube camera. Ongoing research is being conducted with provisional specifications as follows: 1,125 scanning lines per frame; an aspect ratio of 5:3; a field frequency of 60 Hz; and a video signal bandwidth of 30 MHz.

The key to the development of the camera was a new one-inch pickup tube called a diode impregnated cathode saticon (DIS), another recent innovation at NHK, according to Junji Kumada, research engineer. The DIS allows the taping of moving objects with high resolution and low lag characteristics. With the DIS, the three-tube camera allows high definition pictures while also possessing all the functional aspects of a conventional camera. It also features a digital system with a memory device for transposing a scene into an electronic configuration.

Other Japanese companies working with CBS in developing HDTV equipment include Sony and Ikagami. According to CBS projections, the technological problems could be ironed out within a few years.

The most crucial barrier to CBS' plans is the delivery system. The Federal Communications Commission is considering imposing interim guidelines on the use of the DBS spectrum until final allocation of the spectrum is parceled out at the 1983 RARC. In December 1980, Satellite Television Corporation, a subsidiary of Comsat, filed for authorization of two satellites that would transmit premium programming from DBS satellites. CBS has opposed the STC filing.

"We're not opposed to Comsat," Lilley said. "But if the FCC grants their request, that would give them 30 to 40 percent of the available frequencies. This is an extremely valuable public resource and we want the FCC to ration out the frequencies in a cost-effective manner."

CBS is interested in acquiring as much of that spectrum space as possible, but no frequencies can be authorized until the orbital slots are allocated at the 1983 RARC.

According to Lilley, CBS is the only network broadcaster that is working on HDTV. At least, he said, "I don't know of any work being done by the others."

If the spectrum is granted and the technological barriers surpassed, Lilley said HDTV could be available to the general consumers by 1990. As for CBS' role in developing programming for the new service, Lilley indicated those decisions are yet to be made.

Business Notes

★ **GTE Communications Network Systems, Inc.**, has changed its name to GTE Telenet, Inc. Formed in late 1979, the company is one of four major operating units of GTE. It is responsible for voice, data and information systems and services marketed to business and government customers. The company has incorporated in its name that of its best-known subsidiary, GTE Telenet Communications Corporation. In addition to changing the name of GTE Communications Network Systems, its subsidiaries will include GTE Telenet in their names: GTE Telenet Systems, Inc.; GTE Telenet Field Engineering; and GTE Telenet Information Services, Inc.

★ **M/A-COM, Inc.**, N.V. Philips Gloeilampenfabrieken of the Netherlands and Phillips Optical Communications Corporation, a subsidiary of the United States Philips Trust, have completed the formation of a joint venture in fiber optics. The venture will develop, manufacture and market optical fibers, optical fiber cable, associated hardware and related systems. James R. Kanely, president and chief operating officer of Valtec, a M/A-COM company, will serve as president of the new venture, which will begin operations in the 67,000 square foot Valtec Fiberoptics Communications Division in West Boylston, Massachusetts. Another M/A-COM company, LINKABIT Corporation, has received a contract in excess of $20 million from Satellite Business Systems to design, develop and produce digital signal processing equipment to be used in the SBS satellite business communications system.

★ **Comsearch, Inc.**, of Falls Church, Virginia, has been awarded a contract by Satellite Business Systems of McLean, Virginia, to perform computer prediction analysis and required electromagnetic radiation surveys on its Ku Band earth satellite stations as a routine study for all proposed site installations to be installed throughout the United States. These stations are a new generation of earth stations that represent a technical challenge as the installations will be in metropolitan areas, usually on the rooftops of downtown office buildings. The objective of the predictions and measurements is to characterize the existing electromagnetic environment over a wide frequency range.

★ **United Video, Inc.**, is constructing a satellite uplink-signal transmission facility in the Chicago suburb of Frankfort, Illinois. The $700,000 installation is scheduled to begin operations July 4. It will be equipped with a ten-meter Andrews antenna and transmission facilities designed by UVI's engineering staff and Satellite Transmission Systems of Hauppauge, New York. Currently, UVI is leasing uplink facilities at RCA's satellite earth station in Lake Geneva, Wisconsin. UVI recently filed with the FCC for its own facility to gain more flexibility during experimentation with new services while technically improving current ones.

★ **Scan-Data Corporation** (OTC) has acquired Document Systems, Inc., for 321,000 shares of common stock. It will operate the company as a wholly owned subsidiary to be renamed Scan-Data Financial Systems, Inc. The subsidiary will have a twofold business purpose—to develop products for the banking and financial services markets worldwide, and to sell Scan-Data products in these markets in the United States.

★ **United Information Systems** is entering the data communications market by going public with its once-private Uninet enhanced communications network. The move immediately establishes Uninet as the nation's third largest commercial digital communications network. For ten years Uninet has been the private nationwide network for the computer group of United Telecommuncations, Inc.

★ **Midwest Video Productions** of Tulsa, Oklahoma, has expanded its teleproduction capabilities with the addition of RCA videotape recording and editing systems valued at approximately $500,000.

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GENERAL INSTRUMENT

Cover Story

Saving Headends and Earth Stations From Lightning Destruction

By Roy B. Carpenter, president, Lightning Elimination Associates.

The progress in electronic systems design has brought with it an increased sensitivity to the operating environment and to the interface connections. These interfaces bring with them both the desirable and the undesirable. The interface of concern of this article is power lines.

The power lines bring in the motivating power for the cable system. They also bring destructive and disruptive electrical transients, herein termed anomalous events.

Destructive anomalies are electrical events superimposed on the normal line voltage that cause it to be elevated above the safe level or operating range of the equipment it feeds, regardless of the character. This is normally taken at 120 percent of the normal peak voltage. As an example, it would be 200 volts for a 120 volt RMS line.

Disruptive anomalies are electrical events superimposed on the normal line voltage that create a situation within the unit fed that causes it to momentarily malfunction. This momentary malfunction causes erroneous commands, creates faulty data or "locks up" a system. This can be an annoyance and sometimes costly in lost time, but does not cause damage.

This article is an attempt to eliminate some confusion on lightning protection by defining known hazards and comparing the performance of contemporary protectors with the hazards, thus providing a reliable decision tool. The data used to define the hazards has been taken from a wide variety of publications on the subject.

Lightning Terms

One of the problems related to lightning protection is the jargon used and the way it is used. To eliminate misunderstanding, it is necessary to define basic terms encountered in discussing lightning.

- An **over voltage** occurs when line voltage is elevated to well above the normal RMS voltage and sustained above that level for a period in excess of one cycle (over plus 15 percent).
- An **under voltage** occurs when the RMS line voltage drops to what is termed the "brownout" level and remains at that level for a period in excess of one cycle (over minus 15 percent).
- An **energy surge** is a rapid increase in the flow of total energy (joules or Watt-seconds) to the service entrance that is sustained for periods of less than one-half cycle.
- **Single phasing** occurs when one phase is dropped prior to the service entrance.
- **Transients** are usually considered as random voltage pulses of relatively high magnitude, but short duration, usually less than about 100 microseconds.
- **EMP, electromagnetic pulse,** is a single pulse of energy created by a collapsing magnetic field such as that created by lightning or a nuclear burst. The magnitude can vary from insignificant to devastating.
- **Switching transients** are created by the public utility during load switching or power source switching actions. They are also the result of other nearby customers, usually on the same feeder, switching on and off high current devices.
- A **joule** is a measure of energy, the product of volts, amperes and time. It is the only true measure of protector performance. A Watt is the product of volts and amperes only.

Destructive voltage anomalies that permanently damage connected components may be categorized as naturally-caused or man-made. Table 1 lists potentially destructive anomalies by cause.

Natural Hazards

Most naturally-caused line voltage anomalies are related to atmospheric activity of one form or another. Lightning related anomalies can be the result of either cloud-to-cloud or cloud-to-earth events. These, in turn, are related to such factors as the geographical location of the site, the isokeraunic number related to that location and the time of year.

Figure 1 is an isokeraunic map of the United States. The number defines the potential number of lightning days that can be expected in a year at a given location. That number can be used to estimate the probability of lightning for a given day (if seasons are disregarded) and the number of strikes that may be expected to terminate in any given area for that year. In applying these data, two factors must be considered: it is an estimator only and can vary considerably from year to year, and it only takes one strike to cause irreparable damage.

Lightning in general can cause three specific forms of hazards: direct strikes producing power surges, induced transients from nearby strikes, and the EMP from the strike's magnetic field.

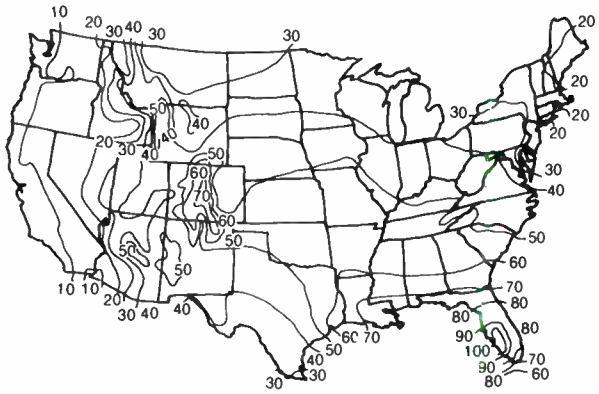
Power surges result from a direct strike to any or all phase conductors near or at some distance from the facility. The character of these surges is, therefore, directly related to the character of the lightning stroke, the line it strikes and the distance to the point of concern. To define their specific character, an engineer must look at specific cases or parameterize the rise time, stroke-peak current, distance between strokes and facility or the resulting line impedance, and the grounding resistances at significant points in-between.

One significant factor is shown by Figure 2 where the surge voltage is estimated for an average lightning strike for various distances from the station of concern. These numbers must be greatly increased for higher energy strokes. Other measurements indicate that these voltages could achieve levels in excess of 100 Kv if the wire insulation would support that potential without arcing and if the measurement point were near the stroke. The higher voltages seem to be the norm, rather than the exception, for FM and TV transmitter sites.

Table 2 presents a summary of the range of pertinent parameters. The shape of typical lightning stroke current flow is such that it rises rapidly to its peak and then tapers off relatively slowly, following a log-normal shaped curve. There are two

Figure 1

Number of Lightning Days per Year



The probability of lightning for each day is: Iso number ÷ 365
The maximum for the USA is 0.27 or a probability of lightning on one day out of four.

Figure 2

Sample Surge Voltage as a Function of Distance from Stroke to Line

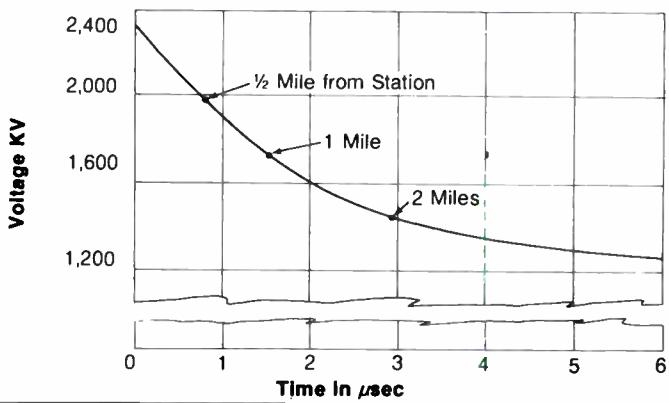


Table 1

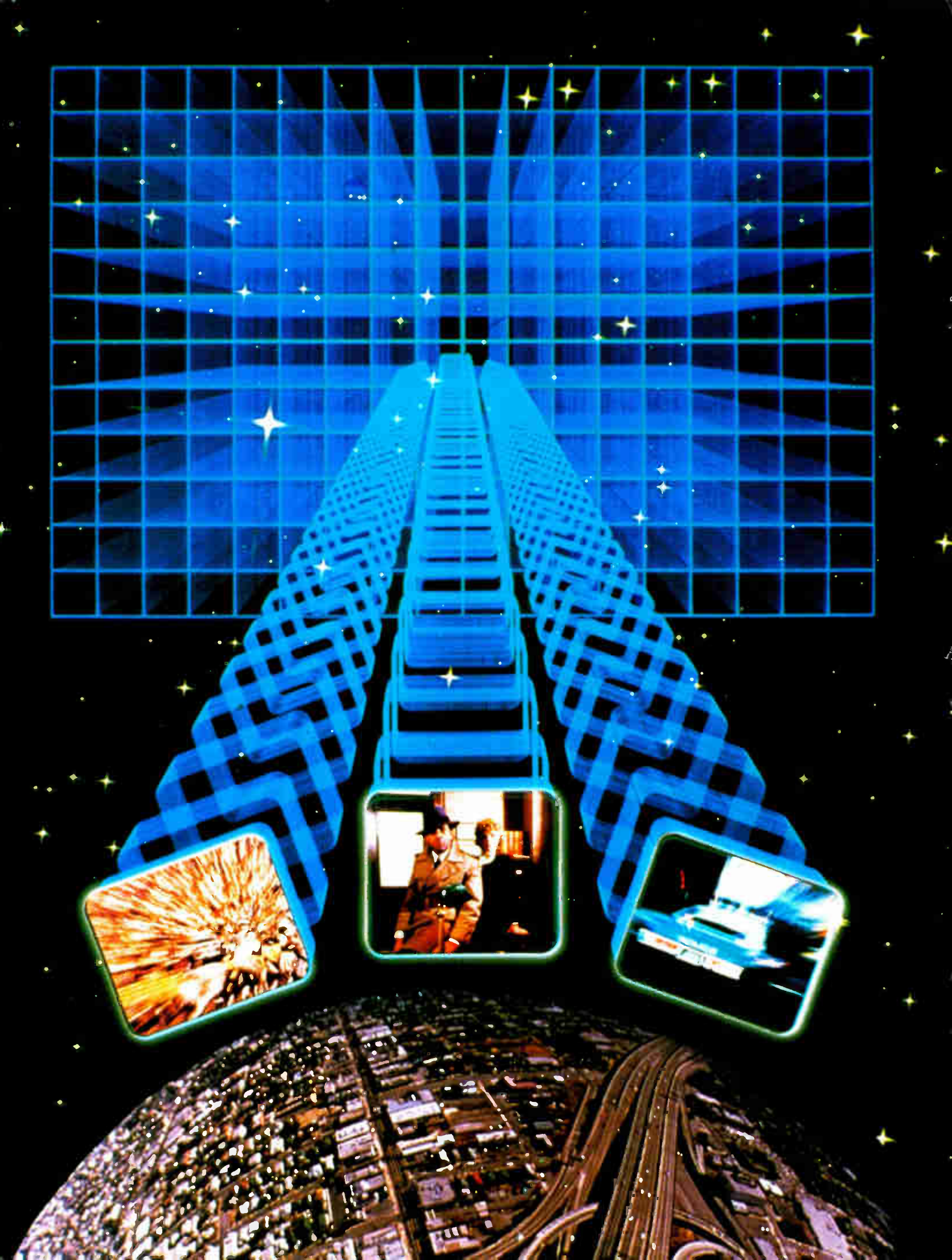
Potentially Destructive Power Mains Anomalies

	Natural Causes			Man-Made Causes			
Potential Anomaly	Cloud-to-Ground Lightning	Cloud-to-Cloud Lightning	Tornados	Public Utility	Other Customers	Own Plant	Accidents and Explosions
Overvoltages				X			X
Undervoltages				X			X
Surges	X				X		X
Transients	X	X	X		X	X	X
EMP	X	X					X
Single Phasing	X			X			X

Table 2

Significant Lightning Stroke Characteristics

Charge Range	2 to 200 Coulombs
Peak Currents	2,000 to 400,000 Amperes
Rise Time to 90 Percent	300 Nanoseconds to 10 Microseconds
Deviation to 50 Percent	100 Microseconds to 10 Milliseconds
Potential Energy at 99 Percent	5,000 Joules



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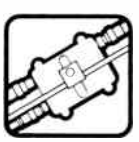

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classes of lightning strokes: the impulsive stroke and the non-impulsive or hot stroke. This characteristic determines the damage caused.

The impulsive stroke causes most of the damage to electronic systems. Since they embody a large percentage of high frequency energy, the rate of rise exceeds 10,000 amperes per microsecond and can achieve rates of over 100,000 amperes per microsecond. They last for no more than 100 microseconds.

The non-impulsive or hot stroke rises much slower than the impulsive stroke, as low as 500 amperes per microsecond. However, it usually lasts much longer, extending out to as long as ten milliseconds to the 50 percentile. These strokes are responsible for many fires and explosions.

Induced transients are the second order effects of lightning activity in or near the area of concern. Their character is related to the lightning discharge and the system character into which the transient is induced. In general, they are high voltage, low energy disturbances. Estimates of the potential for this disturbance phenomenon range up to 100 Kv. This value is more dependent on the system circuit parameters than lightning itself; installation breakdown levels usually limit the peak voltages to much lower levels, except on primary feeders. Public utilities have found that this phenomenon accounts for most of the lightning faults on lines with a potential of 20 Kv and lower. Lines as short as 50 feet can pick up a significant transient, depending on their proximity to the stroke. These transients tend to take a shape related to the differential of the stroke itself: short, negative and positive pulses of less than ten joules.

Induced transients are created by one of three related phenomena. They are the result of the invisible but highly potent electrostatic field found between the charged clouds and the earth. This field moves and varies in strength with the charged cloud activity. Cloud-to-earth strikes create the situation shown in Figure 3; cloud-to-cloud strikes create the situation illustrated by Figure 4.

Atmospherically induced transients are created by sudden variations in the electrostatic potential of the atmosphere. Where the clear air field may be 150 volts per meter elevation above earth, during an electrical storm this field can achieve levels of up to 30,000 volts per meter of elevation. Nearby cloud-to-cloud and cloud-to-earth discharges can cause significant field variations continuously throughout the storm period, on a random basis, in both the time and magnitude domains.

In Figure 5, both the suspended power lines and the inter-plant data lines experience induced transients when a charged cloud in the area of concern

Figure 3

Vertical Lightning, Cloud-to-Ground

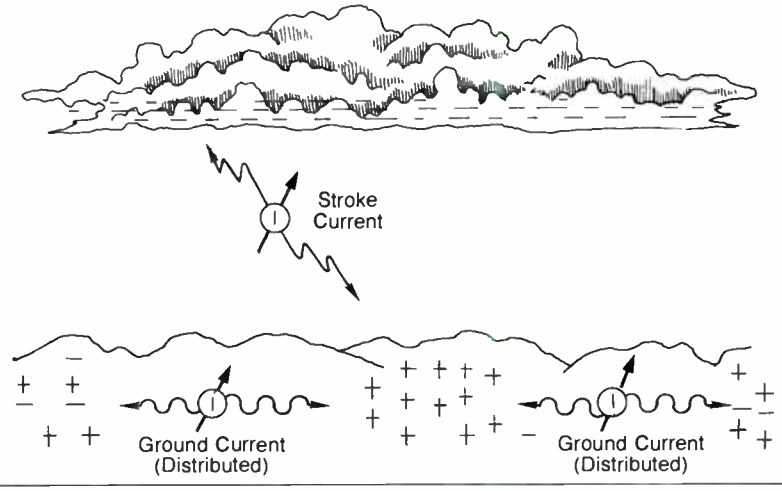


Figure 4

Horizontal Lightning, Cloud-to-Cloud

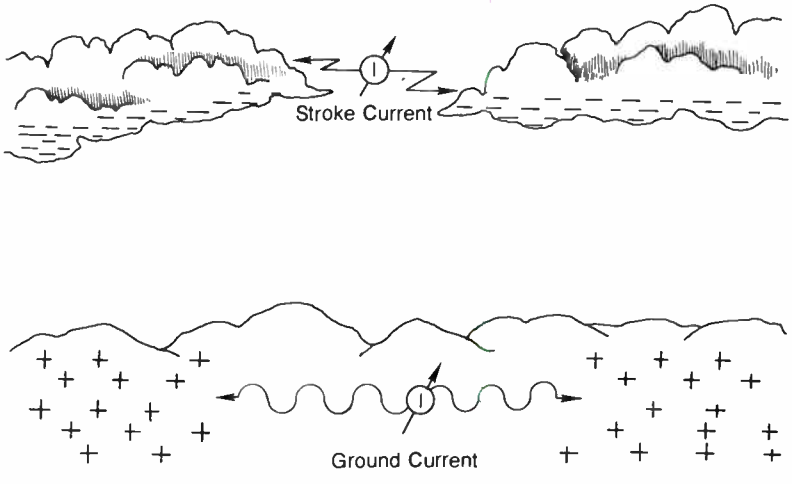
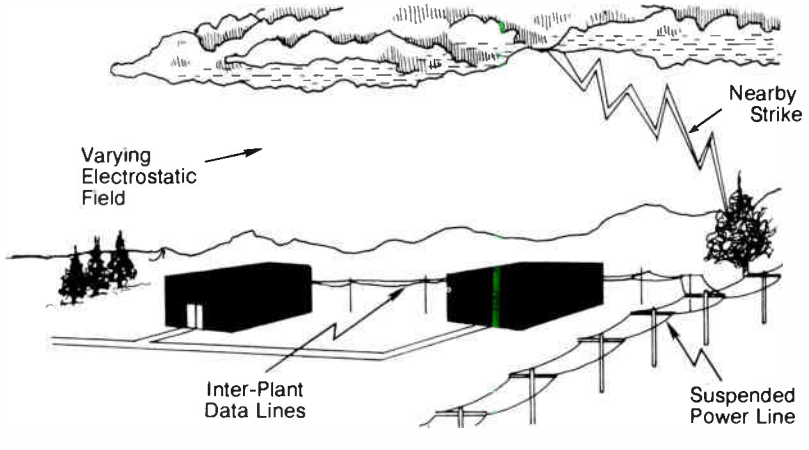
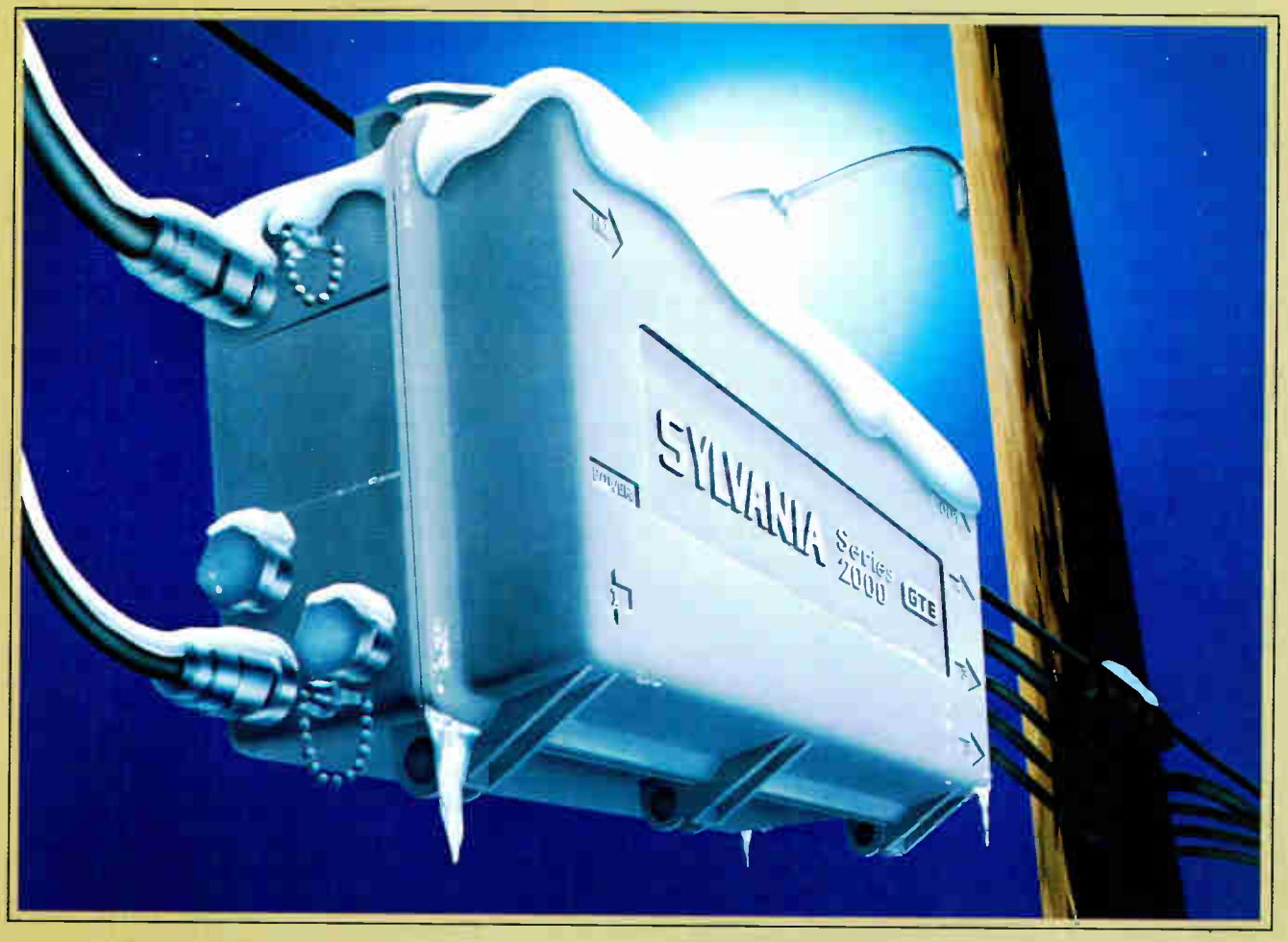


Figure 5

Atmospheric Transient Causations



The Sylvania 400 MHz line. The signal must go through.



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charges everything on the surface of the earth beneath it, to an equal but opposite potential by induction. The resulting field between the cloud and earth can achieve levels in excess of 30,000 volts per meter of elevation above earth. A wire elevated above the earth by ten meters in this field would be charged to a potential equal to its surroundings, which could theoretically equal as much as 300,000 volts with respect to earth. A sudden lightning discharge to earth or another cloud will cause this field to collapse leaving the elevated wire with a bound charge, which seeks ground through any available path, even jumping large insulators in the way. This creates a voltage pulse that can exceed 100,000 volts at times. Transients resulting from electrostatic field changes can be propagated over long distances, depending on the circuit parameters.

As an example, a nearby cloud-to-cloud discharge or a strike one mile away will induce as much as 70 volts per meter of exposed wire into a thus connected system.

Earth-current induced transients are created by lightning strikes to earth, to or near the facility of concern. With the termination of a stroke to earth all the charge induced into the earth by that cloud must move from the point where it was induced to the point of impact of the stroke (see Figure 6), and thereby neutralize the charge. As a result of this motion of the induced charge, earth currents are set up within the earth's crust on or near the surface. Any good conductors buried in the earth within the charged area will provide a preferred path for these earth currents and thus be the recipient of these severe earth currents. The results are transients within the conductor, either directly or indirectly related to the earth current character. Current along the sheath of wires will induce transients into the inner conductors through mutual induction, or these currents will be superimposed on the conductors without sheaths. Figure 7 illustrates two other forms of earth-current transient effects.

Electromagnetic-field induced transients are also created by lightning discharges. For this phenomenon the lightning flash channel acts as a vertical radiator or antenna. The large flow of current in a short time down the ionized lightning flash channel sets up a rapidly changing electromagnetic field propagating out from the stroke channel in much the same fashion as a broadcasting station using a single tower/antenna. These waves propagate for many miles and are the cause of static in a radio receiver, reflected waves in the transmitters and transients in nearby conductors, as illustrated by Figure 8. Generally, cloud-to-cloud strokes produce predominately horizontally polarized waves, while the cloud-to-earth

Figure 6

Earth Current Transient Causations

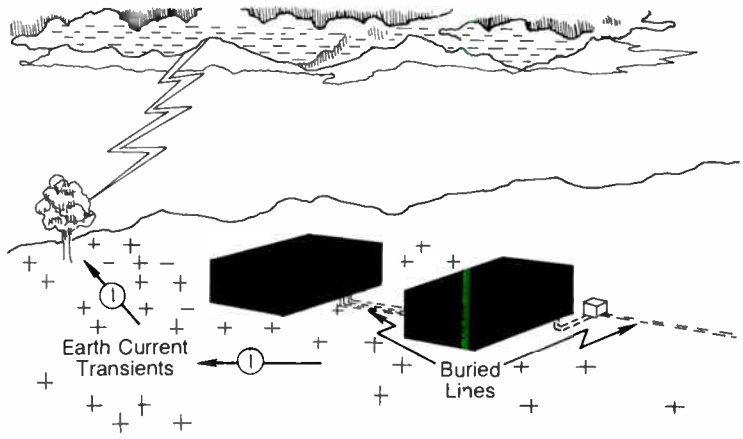


Figure 7

Other Earth Current Transient Causes

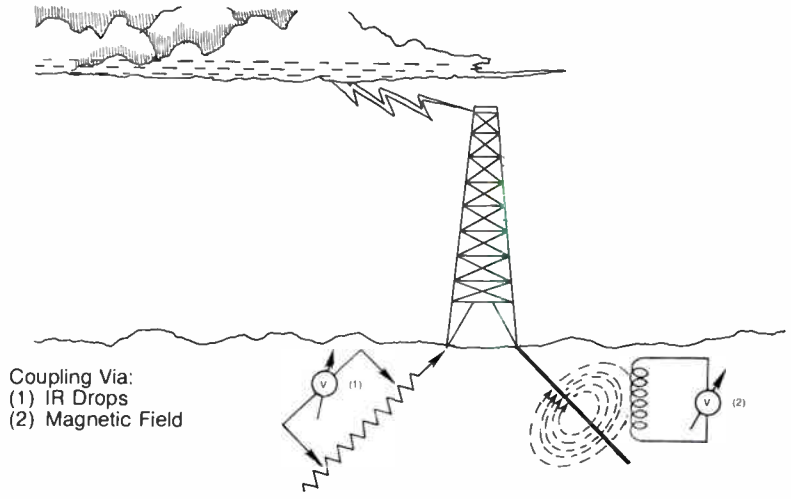
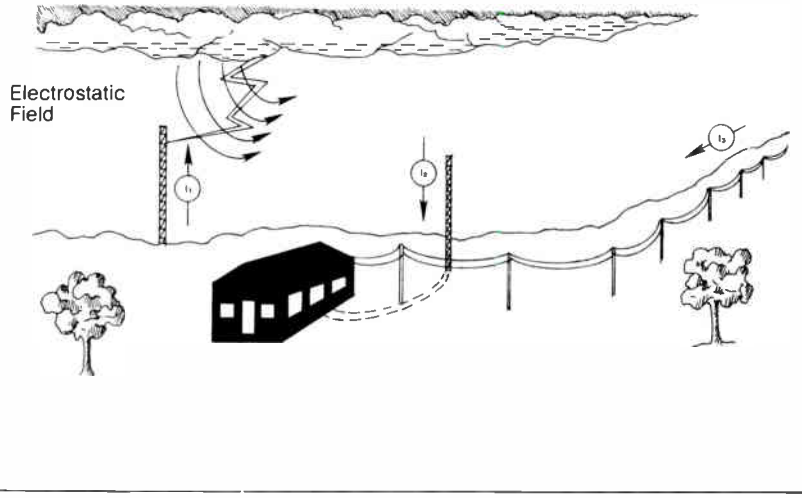
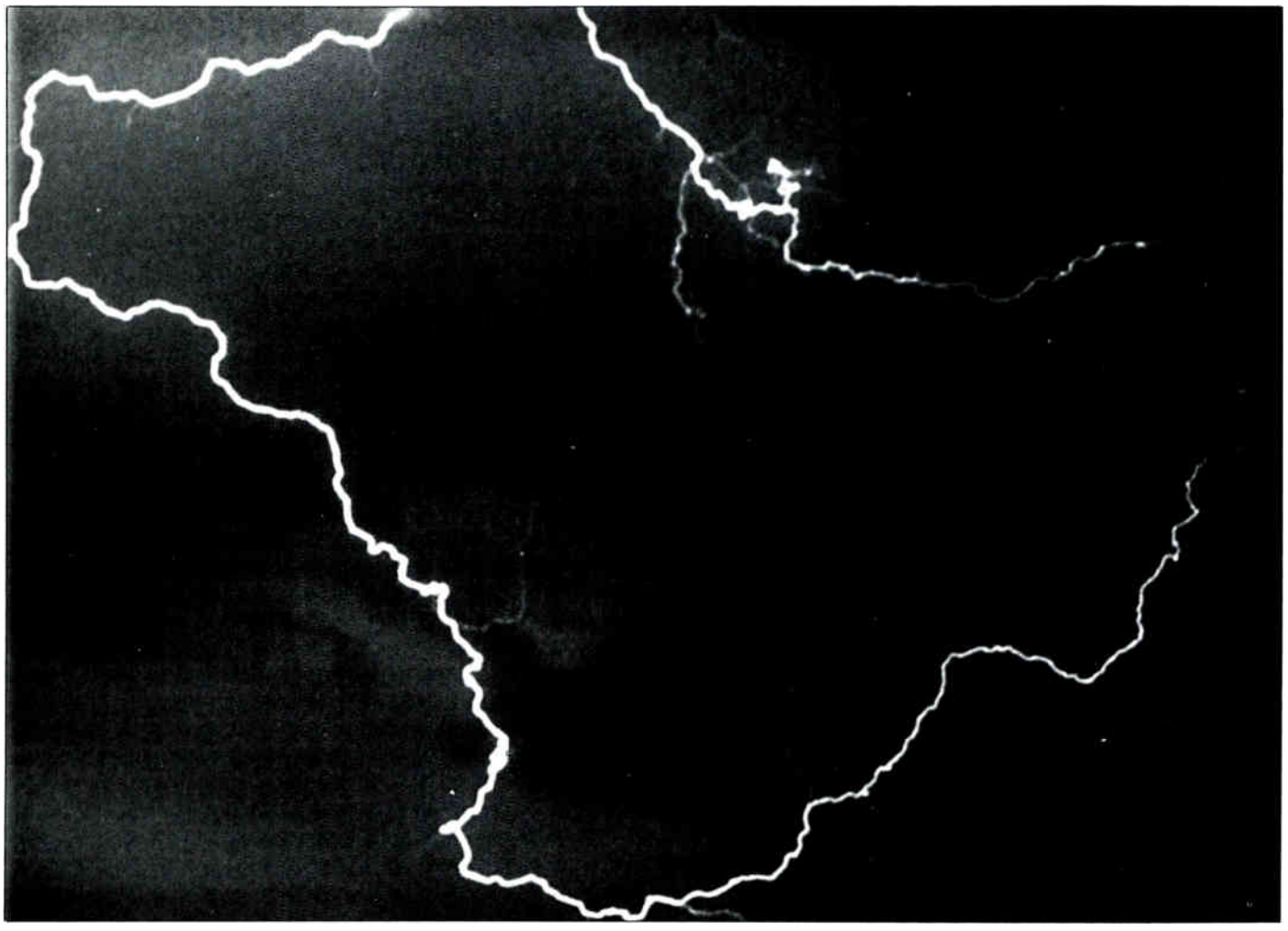


Figure 8

EMP Induced Transients





strokes produce vertically polarized waves. The di/dt's can exceed 100,000 amperes per millisecond.

Tornadoes create a cyclic phenomenon of a shape similar to a poor sawtooth generator. This phenomenon is the result of a charge separation within the eye of the twister and its rotary motion. As the twister does its thing, the induced voltage rises and falls with and at the frequency of rotation of the twister. The induced potentials can be damaging if the twister passes near an area of concern.

To protect against all of these induced transients, the protective systems must be designed to satisfy the worst case situation. The requirements would be the following:

Transient Energy	500 Joules
Transient Peak Current	20,000 Amps
Transient Peak Voltage	4,500 Volts
Transient Rise-Time	50 Nanoseconds

Man-Made Hazards

Man-made disturbances come from the electrical systems environment man has created. These disturbances can be the result of a directly-injected phenomenon or an externally-induced phenomenon. It is futile to attempt to define all the potential causes, but the following identifies and deals with some of the more significant. Man-made disturbances may be sub-divided into those caused by electromagnetic or electrostatic fields and those caused by some form of accident.

Man-made **electromagnetic field transients** usually are created by poor installation practices or inflexibility in the plant layout. For example, the power lines for large motors and power lines for sensitive electronics are layed side-by-side in the same cable tray.

During the planning stages for a plant, it should be understood that power lines carrying any large loads that are switched will create transients on the lines. Electric motors with poor commutators will radiate transients into nearby lines and cause malfunctions in any electronic equipment sharing it as a common source of power.

The possibilities of **directly-injected hazards** are as diverse as the industry itself. Some common examples are: high voltage wires dropping onto the data/control lines or arcing over them; or failure of insulation or isolation devices which inject a high voltage onto the data lines. This happened three times in one year at three similar facilities separated by thousands of miles. In all three cases the related computer was destroyed.

The **electromagnetic pulse (EMP)** resulting from a large atmospheric explosion, usually nuclear, will also create this phenomenon. The characteristic of the EMP is usually considered similar to lightning, but with much faster rise times (nanoseconds) and much shorter duration (only a few microseconds). The energy content can be very high near the center of the explosion.

Protection Requirement

The protection requirement, if limited to destructive anomalies, must be derived from a composite of all the potentially destructive causes. Table 3 presents a summary of these factors listed by the previously identified causes. The values listed are for what is considered approximately the 99 percentile. That is, out of 100 incidents of that class, at least 99 would not exceed the listed value.

A summary of the resulting design requirements by key design parameters follows:

Peak Voltages	45,000 Volts
Peak-Surge Current	160,000 Amperes
Rise-Time Response	50 Nanoseconds
Peak-Surge Energy	5,000 Joules
Loss of Phase	10 Cycles or Less
Overvoltage	Line ±30 percent
Undervoltage	Line -30 percent

It should be understood that it is possible to encounter situations well beyond these parameters. As an example, LEA has found that FM radio and television stations, because of their location in remote or elevated areas, are subjected to the higher energy level, fast rise-time surges.

The designer must, therefore, select the risk considered acceptable to his client and design the protective system to satisfy or exceed those parameters. LEA recommends that the foregoing list be the basis for the design. All systems must exceed that capability by a safe margin and then fail-safe.

Protection Concepts

Line protectors fall into three classifications: filters, surge or transient protectors, and voltage regulators or isolation transformers. The conventional line filters are primarily limited to the removal of radio frequency interference (RFI). Power surges and other disturbances are attenuated very little. Line transformers are available in one or a combination of two types: regulators or isolation transformers. Regulators usually maintain a given output voltage over a range of input voltage variations of up to ±30 percent. The isolation or super isolation transformer is a low-pass filter with up to 120 db of attenuation across a limited RFI band. They do not protect against lightning related power surges of significant magnitude.

Devices sold as "surge protectors" often have similar and, thus, confusing claims. They are seldom related to a well defined hazard. Each of them must be evaluated against the total spectrum of performance requirements as previously defined.

First, however, the applications concept should be considered. As illustrated by Figure 9, there are two ways of implementing surge protection into the system to be protected. The protector may be installed in parallel with the device to be protected or it may be installed in series, prior to the unit to be protected.

All of the conventional protectors, except the LC filters, are designed to be wired in parallel with the load they protect. As seen in Part A of Figure 9, the parallel protector's effectiveness is compromised by two factors:

- Because it forms a parallel circuit with the load to be protected, the load must share the disturbance it is to be protected against. As a result, the protector reaction time is very significant, as is the clamping ratio (ratio of peak line voltage to voltage at the peak-surge current). In actual cases, measurements have proven to be very high, in excess of ten times the normal line voltage at the peak of the surge.
- The wiring that connects the parallel protector into the circuit becomes a series impedance to the rapidly clamping, high surge current, thereby adding the voltage developed across these series impedances to the high clamp voltage.

By way of contrast, a series hybrid protector is in series with the power feeding the protected unit, thereby acting as an interceptor to any incoming disturbances. The negative effects of connecting leads, reaction time and even clamping ratio are overcome through use of series elements and by separating the paths for the surge current from the clamping control elements. An examination of the foregoing factors alone is sufficient to demonstrate that the series hybrid protector concept is the only concept that can be made one hundred percent effective.

Surge Eliminators

The surge eliminator (SE) designs are all based on the same concept, with the same objectives. In addition to the previously defined requirements, the SEs must:

- React within 5 nanoseconds.
- Eliminate at least 99 percent of the possible disturbances for the particular application without loss of the protector or protected function.
- Fail-safe above the 99 percentile by opening the circuit of the protected function.
- Eliminate even the high frequency, high voltage impulse spike.

To illustrate surge eliminator performance, consider the situation depicted in Figure 10. Part A presents a badly distorted sine wave for a 120 volt RMS hot-to-neutral situation where

Table 3

Total Environmental Hazard Character

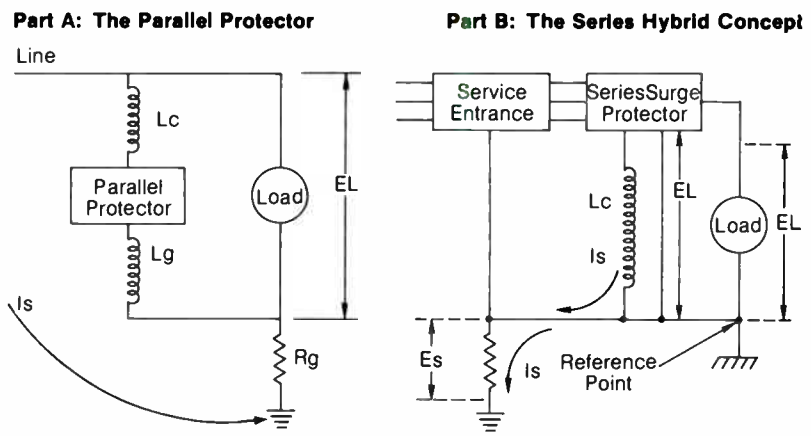
For at least 99 Out of Each 100 Events

Hazard	Peak Voltage*	Rise Time	Energy Impact	Peak Currents	Frequency Spectrum
Overvoltage	+ 20%	Slow	Massive	Massive	Line
Undervoltage	- 20%	Slow	Reduced Power	None	Line
Energy Surge	± 32 KV**	50 NS.	+5 K Joules	160 K Amps	1 KC to 1 MHz
Single Phasing	Load Dependent	N/A	Complete Loss of Phase Power	Massive Two Phase Currents	3 to 10 Cycles Duration
Transients	± 5 KV	50 NS.	+ 100 Joules	2 K Amps	1 KC to 10 MHz
Noise	± 400 V	1 US	Negligible	Negligible	1 KC to 10 MHz
EMP	± Massive	50 NS.	+ 10 Joules	Massive	1 KC to 10 MHz

* With respect to the sinewave.
** Impractical for computer locations.

Figure 9

Protector Implementation Concepts



Is = Surge Current
Lc = Inductance of Connections to Line.
Lg = Inductance of Ground Connection.

several forms of voltage anomalies are illustrated. The equipment destruct level is assumed to be above about ±200 volts peak. The surge protector must, therefore, prevent the voltage from rising significantly above that level.

To accomplish this, the SE functions as follows (refer to the functional diagram in Figure 11). First, the voltage controller assembly constantly monitors the output voltage. When it rises above the clamp voltage, which is usually set at 1.2 times the normal peak voltage, it acts as a constant voltage device holding the voltage at the selected clamp level. If the anomaly is more than a small transient it turns on the high energy dissipation assembly. Some of the energy is dissipated within the unit to compensate for the influence of the grounding system surge impedance. The remainder is dissipated in the grounding system and its connections.

During the SE operation the voltage to the protected system is maintained within the operating limits of the system, neither being crowbarred to or near ground potential, nor allowed to rise significantly above the clamp level. As soon as the surge or transient has passed, the SE returns to its passive mode.

The surge eliminator series elements contain a low-pass filter to accomplish the energy conservation control functions and minimize noise and impulse transients. Negative going spikes on the positive half-cycles and positive going spikes on the negative half-cycles are attenuated to some degree: about 10 db.

LEA surge eliminators are designed to provide complete protection. SEs will handle at least 99 percent of the potential surges or transients they would experience in a particular application. Beyond that, all SEs are designed with a special surge fuse that will open if the capability of the SE is exceeded. Figure 12 illustrates this principle. Note that the fuse-blow characteristic is a decaying exponential that asymptotically approaches the circuit operating current. The LEA SE will dissipate any energy below the curve and above the operating current level and the fuse will protect against any unusual event that would introduce energy in excess of the SE capability. The probability for this event is less than one chance in ten years for the average location within the continental United States.

Figure 10

Surge Eliminator Protective Action

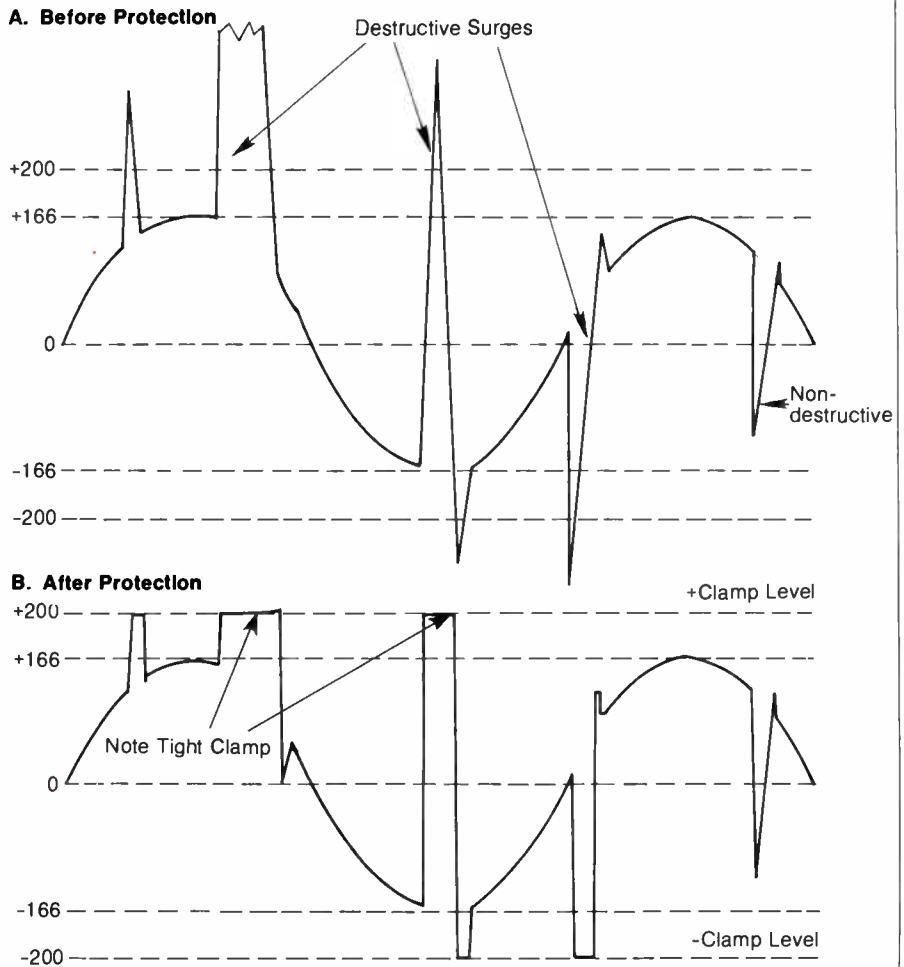


Figure 11

Surge Eliminator Block Diagram

Each Phase Is Similar in Multi-phase Units

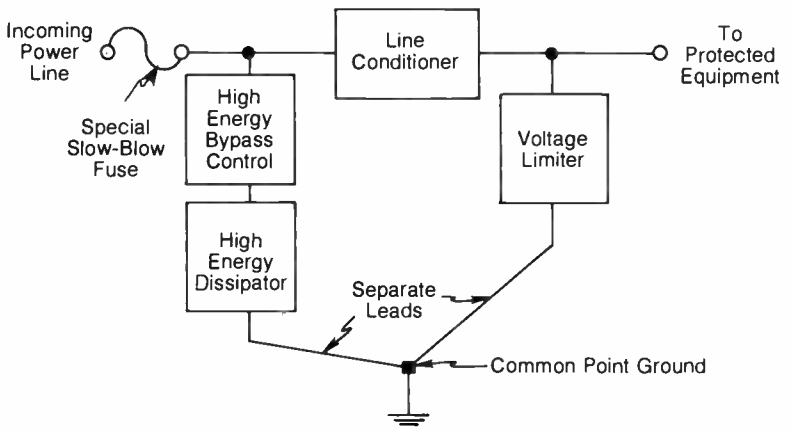
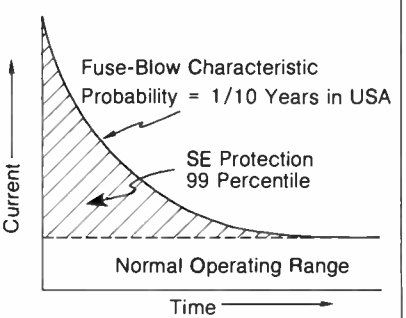


Figure 12

Surge Eliminator Operational Concept



The rating of LEA surge eliminators in terms of power handling capabilities is not a simple matter. Although SEs can dissipate energies in excess of 5,500 joules per phase and handle surge current flows in excess of 160,000 amperes, this does not completely describe the protection provided. The LEA SE design is such that it makes use of the grounding resistance and power system surge impedance to increase the overall protection capability significantly. This principle is illustrated by Figure 13 in which a worst case lightning strike of 200,000 amperes is assumed to have terminated at a hilltop utility pole. The pole is assumed to be within 35 meters of the users' terminal wherein a LEA SE is used for surge protection. The parameters selected are typical for a mountain top facility, or perhaps a bit on the optimistic side. Referring now to the related equipment schematic diagram, it may be seen that both the surge impedance of the connecting wiring and the grounding resistance are used to dissipate a major portion of the stroke released energy, most of which is in the grounding resistance. That is, the excess energy heats up the earth around the grounding components. From these data it is evident that the LEA SEs could provide protection against lightning induced energy levels in excess of a total of 40,000 joules.

The clamping ratio (CR) is also a factor of importance in considering a surge protector. The CR is defined as the ratio of line voltage under the worst case lightning surge current vs the initial clamping level. For all surge protectors the terminal voltage permitted at the protected equipment rises with a rise in surge current. Obviously, the lower the CR value the safer the protected unit is for any given set of conditions. Figure 14 presents a comparison of typical CR values for various forms of protectors on the market, as a function of surge current. Note that as the surge current increases above 10,000 amperes, the CR values for all but the LEA SE range from at least three to ten. By the time the surge current reaches 100,000 amperes, the 99th percentile, the CR would be well over ten, if the device survived. In contrast, the LEA SE maintains a CR value of less than two, which is possible because the voltage controller function is referenced to the system's common point ground rather than a single SE ground.

Roy B. Carpenter earned a degree in electrical engineering at Northeastern University and worked in aerospace systems engineering for 25 years. Ten years ago, he founded Lightning Elimination Associates. The firm holds several patents in lightning and surge protection.

Figure 13

The LEA Surge Eliminator Operation in a Worst Case Environment.

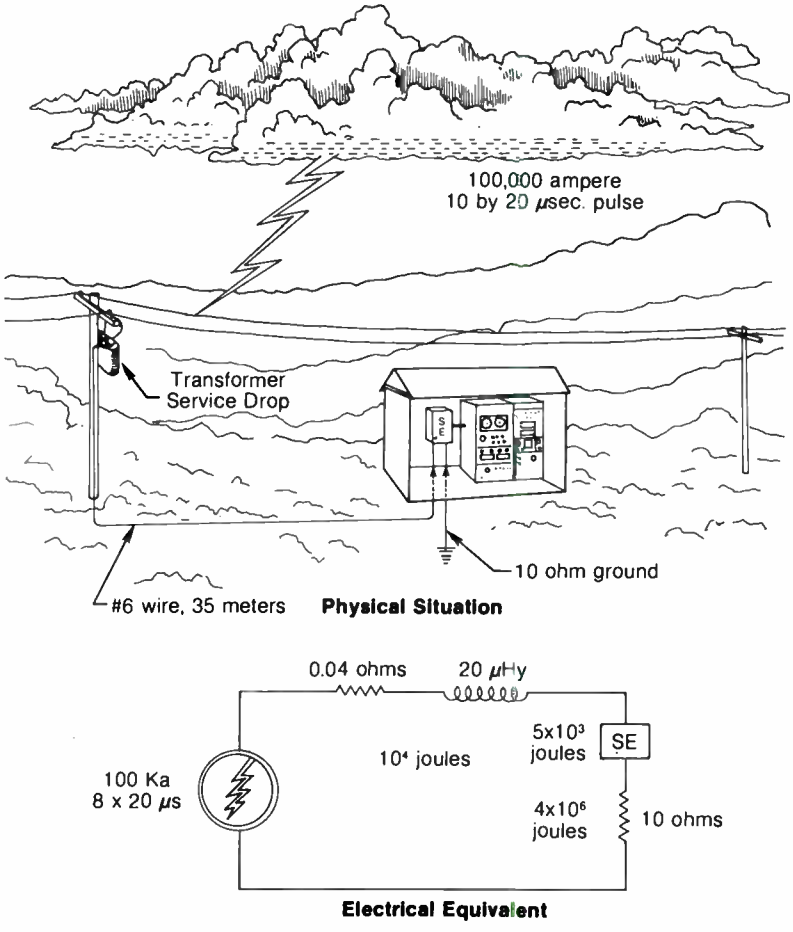
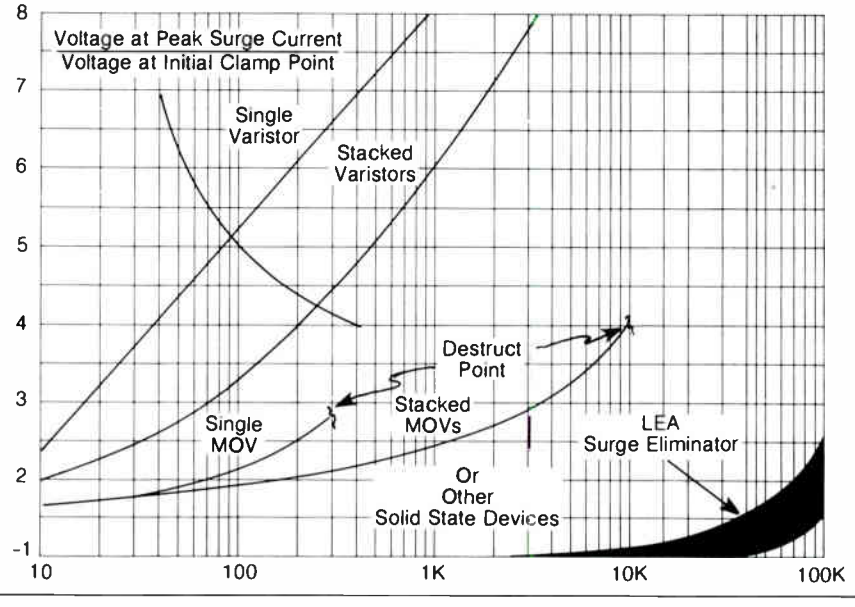


Figure 14

Clamping Ratio Characteristics



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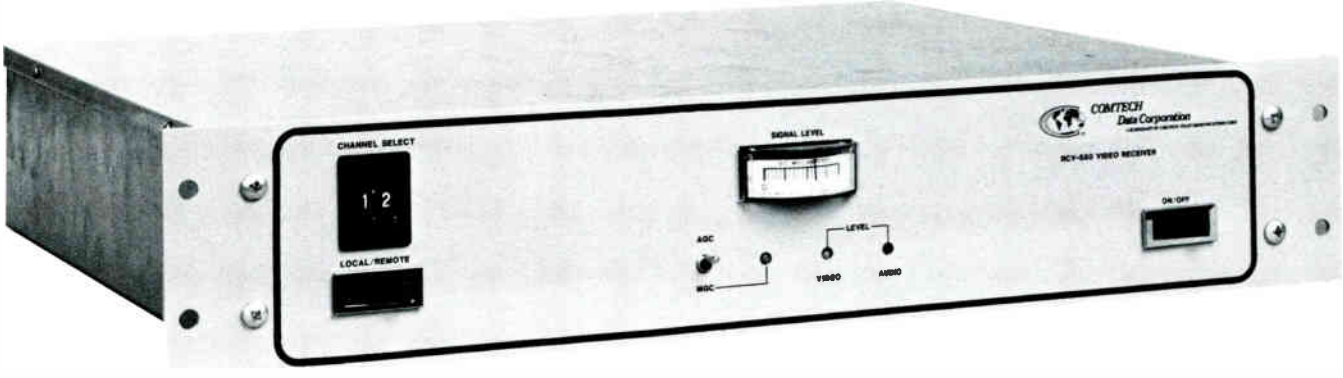

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The Principles Of Spectrum Analysis

In this issue, Raleigh B. Stelle III, national and international sales manager for Texscan Corporation, continues his series of articles on the fine points of operating test equipment. Next month, Stelle's series will conclude with a look at coaxial cable calculations.

The spectrum analyzer is fast becoming an indispensable tool in many cable television systems. Large numbers of channels and the distortion products created by many signals make an analyzer a much needed piece of test equipment. However, many people are still not familiar with how these machines function and what all the screen presentations really mean. This article takes a look at some analyzer theory of operation.

Almost everyone is familiar with a standard broadcast receiver and its operation. As we move the tuning dial, different programs are heard. Each station has an RF carrier wave of some frequency associated with it. If we were to plot a graph of the RF carrier, it should resemble the one shown in Figure 1.

Figure 1 shows one unmodulated signal at frequency=1/T. Several carriers may exist at any one given time, so let's plot just two. See Figure 2.

The plot of these two unmodulated carriers shows that C2 is twice the frequency, or twice as fast, as carrier C1. Or, the frequency of C2 is twice as high as the frequency of C1. Both carriers were plotted in an A (amplitude) versus T (time) plane. This type plot is called the time domain. Now, imagine a third dimension to this plot. A third dimension would extend into and out of this page. An isometric view of such a plot is shown in Figure 3.

Figure 4 shows two signals on an isometric plot.

Now, in your imagination, include a "window" which moves up the F line and gives us an "end view" of the two signals. All you could see through the window as you passed across C1 and C2 would be a line. Now, let's plot them as shown in Figure 5 on page 38.

Figure 5 is a plot of unmodulated signals in the frequency domain. The term "unmodulated" should be stressed because some interesting things happen when the carriers are modulated, or the width of the window is changed. We will get to those shortly.

Consider the broadcast receiver again. If we rock the tuning dial very slowly back and forth from stop to stop, we would hear each station for a short time as we come to and pass it. Now rock the dial very rapidly—all you hear is gibberish. We have tuned the receiver too fast to derive any auditory information and hear only a series of unrelated pops.

Connect an oscilloscope to the broadcast receiver so that the horizontal scale tracks the tuning knob and the oscilloscope is calibrated in terms of frequency in the horizontal direction.

Connect the speaker terminals (detector/amplifier) to the vertical input of the oscilloscope. Rapidly rock the tuning dial and two things happen on the scope. The horizontal scale moves back and forth and the dot will deflect upward as we pass a station and the detector "sees" the signal.

If this "rocking" is done rapidly (a few times per second) and repetitively we will form a "picture" which we can interpret visually, as shown in Figure 6 on page 38.

Now do the tuning electronically (with varactors) and we have a basic spectrum analyzer.

Now, let's take a look at how this magic box does its job (see Figure 7, page 38). Each block has a specific function to perform and has a particular output for different conditions. Let's examine what happens in our analyzer when we see a CW signal at 100 MHz.

What happens in the first mixer?

We all know how the superhet (stand-

Figure 1

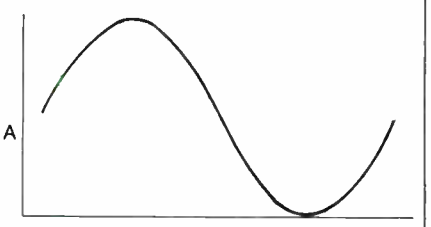


Figure 2

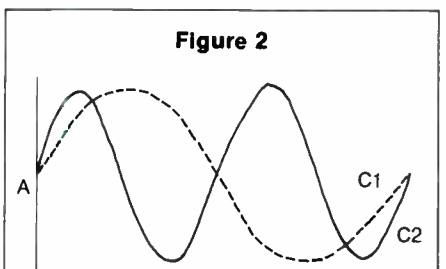


Figure 3

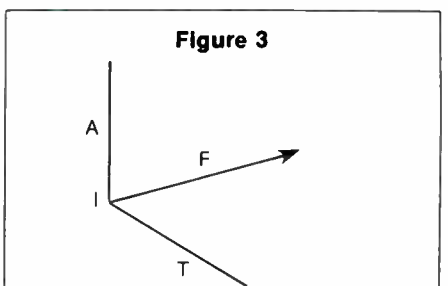
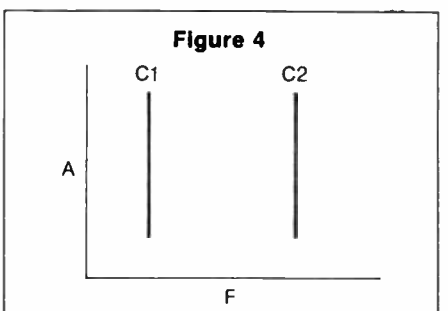


Figure 4



ard broadcast) radio works. Two signals mix together and produce a third signal which is different in frequency from the two original signals.

Let:

Signal 1=A=LO Frequency

Signal 2=B- Input Frequency

Mixing theory tells us that:

A+/-B=C= Intermediate Frequency or IF.

It would be just great if only that happened, but in the output of the mixer, we may find several undesired responses, such as:

2A+/-B=C or, A itself;

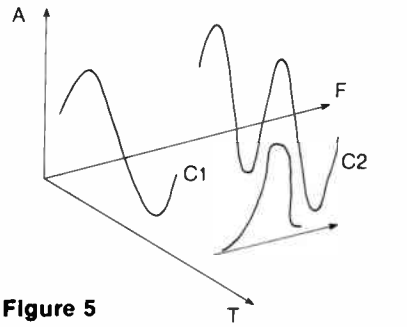


Figure 5

3A+/-B=C or, B itself;

A+/-2B=C

This problem is obviously multiplied dramatically with multiple signals present at the input: for example, 12 channels plus FM. These are called spurious responses, and we definitely don't want them in our analyzer. So we put in a filter (FL-1 in the block diagram).

A bandpass filter is used to attenuate most of these spurious signals. It has its center at the IF frequency and will be the first selectivity in the unit.

Consider for a moment the choice of the IF frequency. Since the input will pass all frequencies, it is possible to get into image problems if we choose the IF frequency too low.

For example: an IF at 10 MHz would mean (1) we couldn't analyze any signals at 10 MHz—the analyzer's gain at that frequency would see small amounts of signal leakage and cause erroneous readings.

(2) Since we originally stated a single 100 MHz CW signal, let's do the mixing routine.

A=100 MHz, B=?, and C=10 MHz

Since A+/-B=C, A could be either 90 or 110 MHz. Let's choose B=110 MHz. All is just fine if only 100 MHz is present, but—if a 120 MHz signal is also present, now:

A=120 MHz, B=110 MHz and A-B=110 MHz.

We see the image response at 120 MHz superimposed on the desired signal at 100 MHz.

(3) Since an LC oscillator with only one variable (L or C) can only tune an octave (an octave is a doubling of frequency. Example: 1 KHz-2 KHz, 100 MHz-200 MHz, etc.), and the range of our analyzer should be as broad as possible, we need to find an IF that will let us cover the desired frequency range and still have the local oscillator (LO) tune less than an octave.

Let's add it up: (1) The IF must be outside the pass band of the analyzer.

(2) The IF must be chosen such that the local oscillator tunes at least a 300 MHz range (our desired coverage), but less than one octave (300-600 MHz is the minimum range which will satisfy this requirement). For good linearity the tuning range should be much less than an octave. Also, consider these factors.

(3) The higher the IF frequency, the greater the image separation.

(4) The higher in frequency the IF, the more difficult it is to achieve gain and selectivity.

(5) Considering all of these more difficult factors, arbitrarily choose some convenient frequency.

In our example: 700 MHz.

The local oscillator is now required to tune 700-1,000 MHz, the IF is 700 MHz and the unit will respond to desired signals in the 0-300 MHz range and the images from 1,400-1,700 MHz. How much 1.4-1.7 GHz energy is there floating around your cable system? So, we'll just ignore that part. The local oscillator should deliver about +60 dBmV +/-3 dB across its range to operate the mixer correctly.

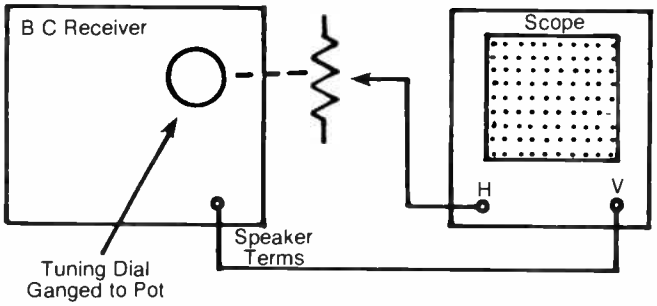


Figure 6

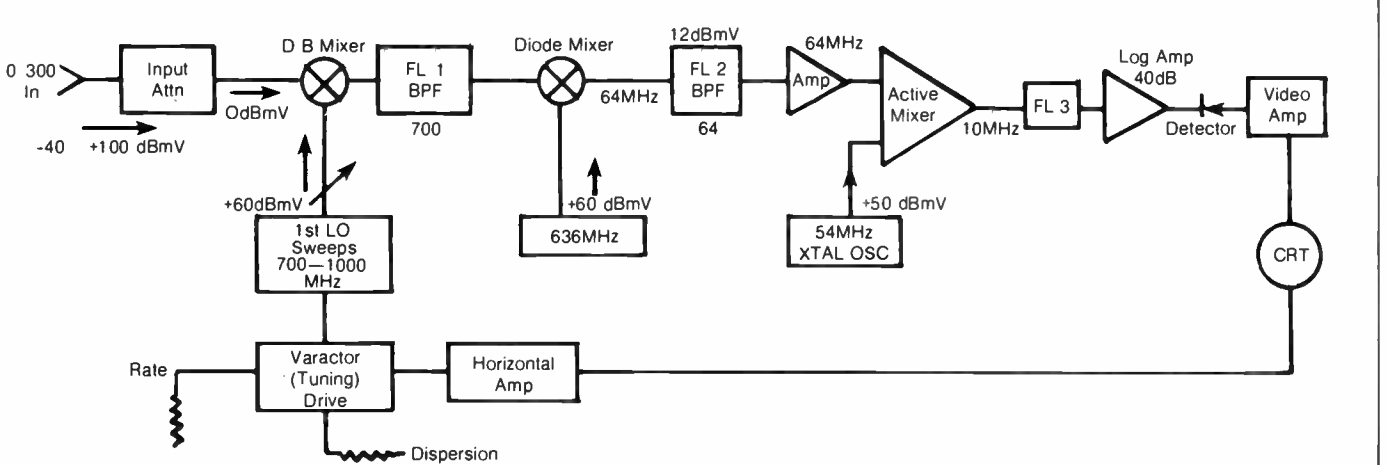
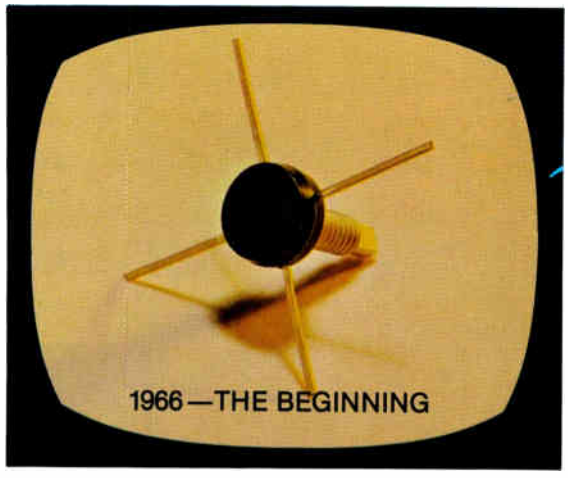
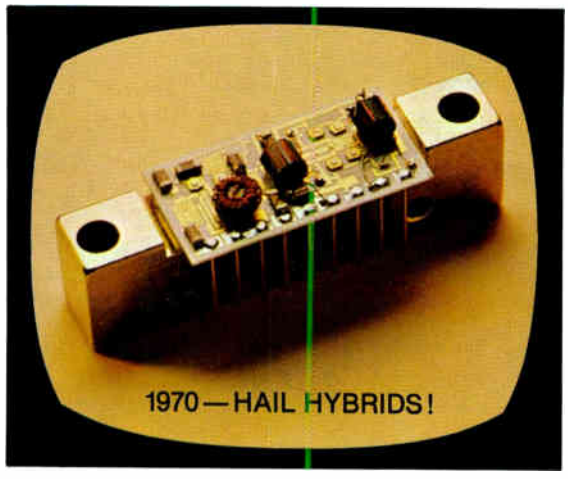


Figure 7

Four Major Milestones in CATV Amplifiers.



From TRW, first.
First transistors made and characterized especially for CATV amplifiers.



TRW does it first. Again.
First hybrids for CATV. Elimination of interconnects provides inherent increase in reliability, ease of field repairs. Improved performance over discrete amplifiers.

And TRW is first. Again.
First hybrids with all gold systems, the optimum for ruggedness and reliability. Gold die with ballasting resistors and fine geometry has dramatically improved the performance.

Year after year, TRW is the leader. Once again.
In 1980, we introduced extended band width.
In 1981, TRW R&D will present still another major milestone.

TRW ***RF SEMICONDUCTORS***
An Electronic Components Division of TRW Inc.

The mixer output will vary in direct proportion to the second input signal over a range of 50-70 dB depending on the quality of the mixer and the magnitude and quantity of the mixer and the magnitude and quantity of the second input signal or signals. Best performance in this respect is obviously with a single signal input.

Now that you know why a very high frequency (UHF) is chosen for the first IF, let me say that today's state of the art doesn't allow us to get much selectivity at high frequencies. Example: in the VSM-1, the 700 MHz bandpass filter is 10 MHz wide, 3 dB down.

So we have to go to some lower frequency—and since the 700 MHz bandwidth is so wide, we will convert twice more, once to 64 MHz and again to 10 MHz. Now we are down to almost DC, so we can really generate high gain and sharp selectivity. In the simplest case, the Texscan VSM-1, the selectivity is achieved by two high Q resonators. This yields a 3 dB bandwidth of 150 KHz. If we desire much greater selectivity, it is necessary to use crystal filter techniques. In the Texscan VSM-2 or VSM-5, two additional IF bandwidths are available: 10 KHz and 500 Hz. Both these filters are four-crystal lattices and are selected by front panel controls. And, since these narrow filters have more loss than the wide ones (there's no free lunch), we have to add some extra gain to make up this loss.

Some analyzers offer several types of display ranges—linear (display directly proportional to input voltage), square law (display directly proportional to input power or voltage squared), or logarithmic (dB scales proportional to log (10) input volts).

For the cable television industry, however, the most practical scale is the dB scale (logarithmic). The VSM-1 gives two choices: 20 dB or 40 dB on screen, or 1 dB/div. vs. 2 dB/dim. (the VSM-2/VSM-5 have 30 dB or 60 dB on screen). The accuracy of these displays is typically +/-0.2 dB/dB, while the linear and square law scales run from three to five percent of full scale.

Now let's convert all this to DC and drive our oscilloscope display. Detection is accomplished by a simple diode configured as a peak detector and the resultant output drives a DC amplifier to produce a vertical deflection. The horizontal line is derived from the sweep oscillator circuitry and hence is a function of frequency. If we've paid attention to our Ps and Qs, with the sweep oscillator design, the horizontal scan will be a linear function of frequency and our dial calibration will suffice for frequency identification. Most analyzer linearities are in the vicinity of +/-1 percent of the full scale frequency or +/-3 MHz for the VSM-1.

So far, we have looked only at the steady state case, a fixed tuned receiver. But, in normal operation, we are continuously tuning our first local oscillator (sweeping) and must look at the swept response. Let's keep the same initial conditions—a 100 MHz CW signal—but vary the first L.O. from 780-820 MHz. This produces a sweep width or dispersion of 40 MHz.

If we detected the output of the 700 MHz filter, FL 1, we would see something like that shown in Figure 8.

As we sweep past a signal, the resultant C frequency changed, and if we plot our filter responses, then we see a case as shown in Figure 9.

What we see on screen is the swept response of the IF filter passband. Now, let's insert the high selectivity portion of the IF at 10 MHz. Although the signal appearing at the 10 MHz IF has a width of 10 MHz, by the time we convert down to 10 MHz, we see Figure 10 (page 43) as the desired response approaches and passes 10 MHz.

The 3 dB bandwidth of the IF is generally defined to be the resolution of the analyzer and is the limiting factor in separating signals which are close together in frequency.

We can continue this narrowing process until we begin to run into some limiting factors. These factors are:

1. Desired scan speed (scan loss);

2. First LO residual greater than IF bandwidth;

3. Long term stability won't hold narrow dispersions on screen.

We'll examine these factors one at a time.

Scan loss: a phenomenon related to IF bandwidth, dispersion, and sweep speed (rate). The IF bandwidth requires a certain amount of time to pass the full energy present. If the signal is in the passband for too short a time, the energy displayed is less than actually present. This situation is more exaggerated the lower in bandwidth we go.

We can solve scan loss problems by changing any of three parameters: sweep speed (too fast), dispersion (too wide), IF bandwidth (too narrow). Adjusting any of these items until the amplitude displayed ceases to increase assures the operator that scan loss is not occurring.

Remember:

For wide dispersion, use wide IF B/W and fast rate.

For narrow dispersions, use narrow IF B/W and slow rate.

For the VSM-1, there is a rate/dispersion product which will guarantee that scan loss is not encountered. This number will vary from manufacturer to manufacturer and will also vary with resolution (VSM-1 resolution is fixed at 150 KHz).

Let's stop for a moment and take a short look at the theory of spectrum analysis. Reams of applications notes have been written on the use of spectrum analyzers for specific types of tests, so we won't belabor that here.

First, let's consider our CW signal. In theory, it occupies only one position in the frequency domain—it's an infinitely thin line in the spectrum. But, since the analyzer has finite bandwidth, the CW signal also appears to have "width," (depends on the IF B/W).

If these are harmonics, and we change the frequency of the fundamental, the

Figure 8

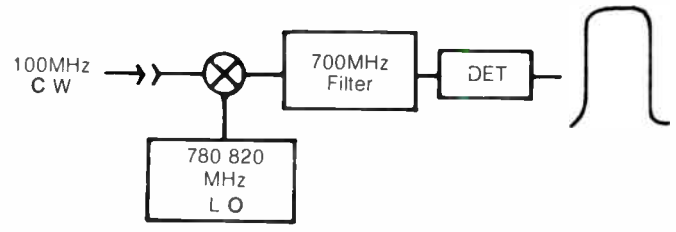
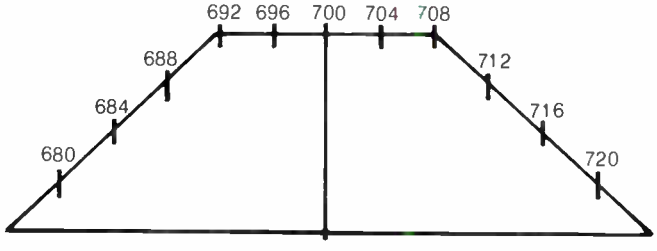


Figure 9



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WISI AM MICROWAVE LINKS are used throughout Europe, and exclusively in Switzerland to transport television broadcasts from neighboring countries to CATV systems throughout the country. The performance of WISI AM LINKS is virtually unmatched by any other manufacturer of AM MICROWAVE SYSTEMS. WISI AM MICROWAVE LINKS were developed in Europe, by the Wilhelm Sihn Jr. KG., to pass the toughest technical requirements. These same high quality WISI AM MICROWAVE SYSTEMS have since become available in the United States.

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- ★ Dual conversion techniques are employed in both the transmitters and receivers.
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- ★ Pilot Controlled AFC/AGC.
- ★ Antenna mounted downconvertors eliminate wave guide losses at the receive site.

After the installation of your new WISI AM MICROWAVE SYSTEM our Applications Engineering Department remains at your disposal for any assistance you might need for operation and expansion.

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second harmonic moves twice as fast (far) and the third, three times.
Example:

Fundamental from 100 to 80 MHz
2nd harmonic from 200 to 160 MHz
3rd harmonic from 300 to 240 MHz

See, the fundamental changed 20 MHz, the harmonics 40 and 60 MHz, respectively.

Now we don't see the harmonics because our dispersion (sweep width) is too small, only from 95-105 MHz.

If the picture moves slowly back and forth, or off screen, either the source or the analyzer is drifting.

If the picture now jitters back and forth rapidly, the problem is residual FM in either the source or analyzer. VSM-2/VSM-5 residual FM is 500 Hz or less and will not be visible in this presentation.

If any residual FM is present, it will show up now—with a crystal source, as specified, the analyzer residual FM can be checked. It will appear as a ripple or thickening of the line.

The carrier of an off air TV station is crystal controlled and provides a fine source for this test.

A few comments are in order for some of these measurements. In measuring the visual carrier, you must measure the level of the vertical sync pulse. Depending on the setting of the rate control, this pulse will appear to "roll" through the display. Adjust the rate to stop the pulse for easiest reading. The amplitude of the audio carrier (FM) is just the peak amplitude displayed so long as the resolution is much larger than the modulating frequency.

As our resolution gets narrower, we begin to resolve some individual frequency components of the signal. One of the most prominent is the 15 KHz horizontal sync pulses. Since this pulse is essentially square, it is very rich in harmonic content and produces many sidebands at multiples of 15 KHz. We just begin to separate these at 10 KHz resolution. At 500 Hz resolution, we can clearly define these sidebands. Be very cautious of scan loss during these narrow resolution measurements. If necessary, go to manual sweep to verify peak readings. Also note that the peak carrier reading is 6 dB lower than the reading obtained in the 200 KHz resolution. This is a result of averaging the signal information—we are seeing only the energy in the carrier, not the carrier plus sideband energy.

In order to aid your understanding of the analyzer presentation, let's consider some of them in detail.

Let's look at some modulated signals. As we all know, a TV signal is made up of three types of modulation—AM (video), FM (audio), and phase modulation (color)—and, in day-to-day use, you may also see narrow band FM, FM stereo and even radar or aircraft navigation signals.

In our business, we often see FM stereo broadcast. A regular FM carrier with no modulation looks just like our CW signal—but, as the modulation is applied, the carrier "jitters" back and forth and makes a "smeared" presentation. The width of the smear is an indication of the bandwidth occupied by the signal, but it is not an accurate measurement. FM deviation can be measured with the analyzer, but we won't go into that now.

FM stereocast has a unique appearance. There are two "side signals" (sidebands) close to the carrier. During "quiet time" (no modulation), we can easily detect these and measure their separation (19 and 38 KHz, respectively) from the carrier. This cannot be done during program as the picture is too "squiggly." Occasionally, you may note a third sub-carrier at 65 KHz spacing. This is the SCA or storecast or Muzak subcarrier and it is present only on stations offering this service.

Narrow band or communications FM is usually present from HF to VHF. These signals are intermittently present. That is, on and off as the communication is exchanged.

While we're about this, let's determine a way to listen to these FM signals. If we stop the analyzer scan, we have a fixed-tuned-receiver with selectivity equal to the IF bandwidth. If we tune it to one of these FM signals, here's what happens. As the carrier deviates (shifts frequency), it begins to move into and out of the passband. As it moves up and down the IF curve, it shifts in amplitude.

We all know about AM (amplitude with respect to time). If the FM carrier deviates at an audio rate (it does), then the recovered AM is audio. A high impedance headphone or amplifier connected to the video-out connector produces an audible signal.

Select manual (auto manual switch) and adjust the rate control to place the spot on the side of the IF response. As the FM occurs, the spot will "jitter" up and down (AM). This is slope detection.

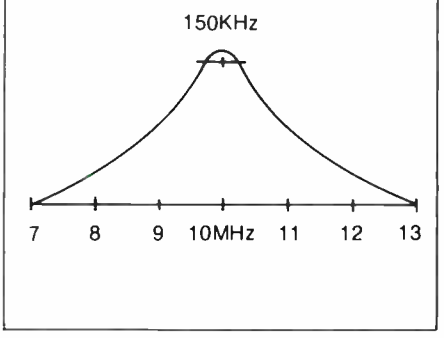
A similar technique is applied to AM broadcast except we stop the spot on the top of the response curve instead of the side.

Since we have mentioned AM and FM, let's look at what happens when we modulate our CW signal with AM or FM and see what differences there are. As always, these observations are for a given set of conditions and the display may change for other conditions.

The prime consideration is that the modulation frequency be a constant and initially a sine wave.

If we amplitude modulate a CW carrier at a fixed rate and examine the result on our analyzer, we will see the carrier and two other responses, one on each side of the carrier. These responses are spaced away from the carrier by a distance

Figure 10



(frequency) equal to the modulation rate. These responses are called sidebands. The amplitude of these sidebands is related to the percentage of modulation as follows:

Percent AM	Sideband dB
100%	*-6 dB*
50%	*-12 dB*
25%	*-18 dB*
12.5%	*-24 dB*

If distortion of the sine wave occurs due to overmodulation or nonlinearities in the modulator, harmonics of the modulating frequency appear at regular intervals related to 1, 2, 3 . . . times the modulating frequency. The amplitude of these sidebands is not easily predictable, but they should be lower in amplitude than the fundamental sideband.

In narrow band FM, the number of sidebands present is a function of the modulation index. The modulation index is defined as the deviation divided by the frequency of modulation:

$B = \Delta F / fm$

Where: B=modulation
ΔF=deviation
fm=modulation frequency

For small B, the FM signal has only one significant sideband. As B gets large, the number of sidebands approaches the modulation index. So an FM signal can require much more bandwidth to transmit the same information as a similar AM signal. The case of an AM signal with distorted modulation will not be confused with FM because we can observe the "jitter" from FM by using wider resolution. This jitter is not present on AM.

Raleigh B. Stelle III has been with Texscan for nine years, two years in his present capacity. He is working with Ralph Haimowitz on the newly formed Engineering Committee of the Community Antenna Television Association to develop technical seminars for cable television engineers.

Out Of Sync

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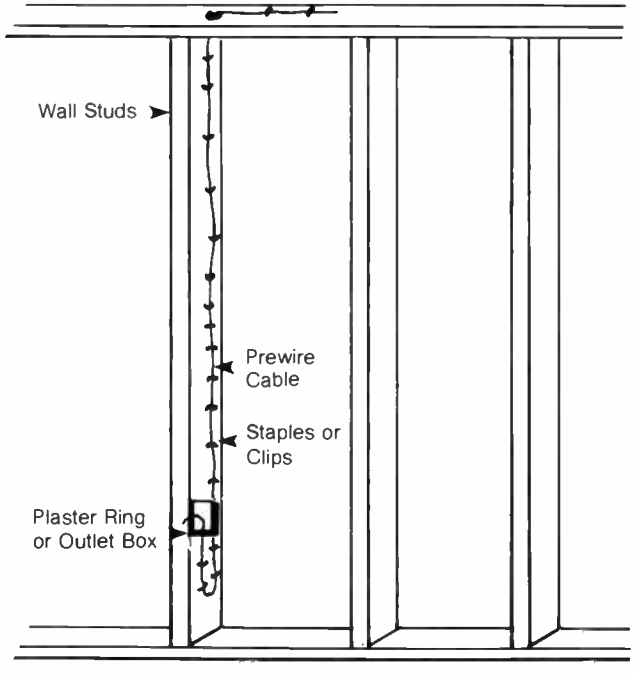
Q. We frequently get our prewire cables cut during new building construction. It is a nightmare to locate and repair the cut ends. Do you have any good suggestions?

A. One of two things is usually the cause of cut prewire cables: either your cables interfere with other workmen (such as electricians, insulation installers, lathers or drywall installers), or you have some enemies among them. If you follow the electricians and insulation installers, this narrows it down to the lathers or drywall people. If any part of your cable extends into their working space, they may cut, rather than move it.

Make sure that your cable does not extend into their workspaces at any point. Staple or clip your cable to wooden house members whenever possible. The diagram below shows how some prewire cables are attached to help prevent cutting.



If your cables still get cut, it is time for a talk with the drywall company owner or manager and the prime contractor. If they cannot resolve the problem, talk to your lawyer.

As for repairing cut drops in walls, if there is any way, you should pull out the cut cables and pull in a new drop. Repair of drywall or plaster and repainting takes too much time and costs are too high. A D'versiBit, available from most CATV suppliers, will greatly simplify wall fishing.

Q. Quite a few TV sets in our system have what appears to be a herringbone pattern on the screen on some channels. Channels 2, 5, and 7 have no visible beats but all the others are affected to some degree. When we take our test TV set in to check reception, there are no visible beats on any channel. I know that all the sets showing the beats can't be bad, although most are fairly old. We can't keep telling everyone their TV has problems if system problems are indicated. If it is set problems, why aren't all the channels affected? Sure would appreciate some help.

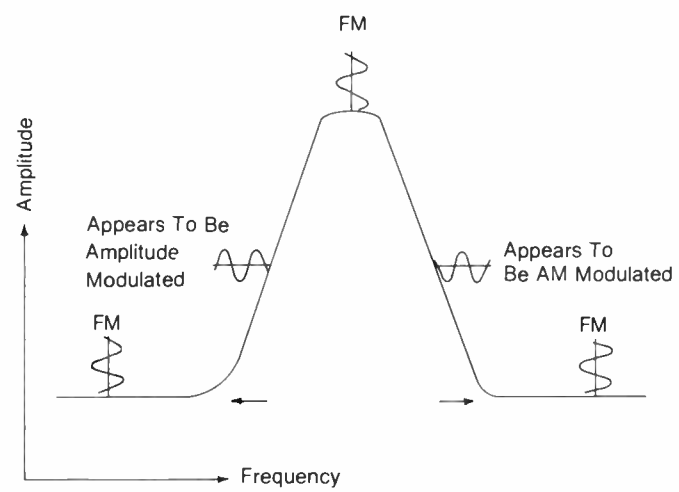
A. You have system problems, but they should be easy to correct. In fact, most systems have had the same problem at one time or another. Since the beat only shows up on channels which have a lower adjacent sound carrier, this pretty well pinpoints the problem to sound carriers which are higher than necessary. If you have a spectrum analyzer, sound levels are easy to check and set. If not, use an SLM to adjust all sound carrier levels down to about 15 dB below their associated visual-carrier levels. This should eliminate, or at least greatly reduce, the beat problems. If not, try lowering the levels another dB or so.

The reason the problem shows up more on older sets and not on your test set is probably due to sound trap aging and frequency drifting. If a few TV sets still get sound beats after lowering the sound levels, suggest that their owners have them checked by a repairman.

One caution: the Federal Communications Commission requires that aural carriers for all Class I television signals be carried 15 dB ±2 dB below their associated visual-carrier levels. This will cause you some problems should the FCC decide to check your system.

Q. We have noticed that when reading audio levels and listening to the sound on our signal-level meters that it is possible to hear the sound at two places on the dial with a dead spot between them. This may be a function of the type SLM we are using, but I can't explain it to my techs. Can you?

A. You will understand what is happening if you look for the FM detector in your signal-level meter. You will not find it! Most signal-level meters rely on slope detection of FM signals by the AM detector. As FM signals are tuned up on the slope of the detector, the normal "back and forth" of frequency modulation will appear as if it is an "up and down" amplitude modulation. When the audio carrier is tuned to the center of the detector passband, the modulation again appears as FM and no sound is heard. As the center of the passband is passed, the audio is again heard since it is on the back slope detector. The figure below illustrates how the detection of FM signals is performed.



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Making Cents of Lightning

The lightning article in this issue is particularly applicable to this time of year in many parts of the country. They are into, or are fast approaching, what is commonly known as "the lightning season."

Hundreds of thousands of dollars worth of electronics are damaged or destroyed each year by lightning induced transients or, in some cases, direct strikes. Much of the repair and replacement costs of lightning damaged equipment can be at least reduced by the use of proper grounding and by surge protection.

Last spring I heard of on system in the southeastern part of the United States which lost four LNAs due to transients induced by lightning before they finally decided to ground the equipment and antenna properly and install surge protection. A recent a call revealed that they have lost no more equipment to lightning since surge protection and grounding was installed.

In another system, this time in Missouri, the headend took what was very nearly a direct hit. The surge protection device was a charred, black mass of metal slag, but not a piece of electronics was damaged. This kind of makes you wonder what would have happened to the headend electronics if either good grounding or surge protection had been missing. Good grounding alone might possibly have saved the headend but I doubt it.

Several people have asked me what I consider a really good headend ground. The answer I give most often is "the very best you can get in your area." I know this does not tell them very much, but with the large variety of soils, varying soil conductivity and unknown watertables, this is about the best I can do. There is no magic formula that will work well for all possible situations.

One thing which always seems to help is to get ground rod into permanently damp earth, but this can be quite difficult in some areas. I remember one New Mexico microwave site which required a 200-foot deep hole and a 1.5-inch copper pipe to get any decent ground at all. Another method that I have used is to place a number of rods in a circle around the tower or equipment to be protected. The rods in this type of ring ground are then connected to each other by heavy copper wires or straps. An earth resistance tester can also help to determine lowest earth resistance.

One "ground" that I do not use and recommend against anyone using, if there is any way to avoid it, is a power company ground. Many of these will read out to hundreds, or even to thousands, of ohms of resistance. Also, since their neutral is connected to it, if they get corrosion on the neutral Kearney connector, you will be carrying all their neutral current. In a headend this could be quite a few ampheres.

Installation of good grounding for a headend, earth station and tower, and the addition of sufficient surge protection devices for the electronics, can cost you quite a bit of money and labor. The copper grounding materials alone can cost several hundred dollars. Good surge protection devices are also fairly expensive. However, when you consider that replacing a couple of LNAs and one or two processors or modulators will cost a few thousand dollars, lightning and surge protection costs don't seem to be so bad.

Also, protecting only part of the system does not make any sense to me. Half a headend is better than none, but still not very good. I suggest that if you are in an area of high lightning incidence, that you contact a manufacturer or supplier of protection devices. Most of them will be happy to design a system which fits your needs and desires exactly. Your subscribers will probably thank you the next time you pass through a bad storm with little or no damage. Your technicians will probably thank you also.

Glenn Chambers

What Tom Jokerst saw was a clean display trace that covered the 1 to 400 MHz frequency range.

"The trace didn't get noisy once the signal got out into the system."

He also liked what his subscribers *didn't* see.

"The new processed sweeping system has virtually eliminated subscriber interference complaints."

But what would the technicians think?

"Wavetek has really engineered this system with the technicians in mind. They can take it into the field with very little instruction."

What more could you ask for?

"Reliability. And we've used the Wavetek Sweep Recovery System long enough to know it's reliable. Other systems gave us downtime problems, but not this one."

The price of Wavetek's 1855 1865A System is $8015.*

"A good value."

If you'd like to see more of what Tom Jokerst saw, contact Wavetek Indiana, P.O. Box 190, 5808 Churchman, Beech Grove, IN 46107. Toll free 800-428-4424. In Indiana, phone (317) 783-3221.

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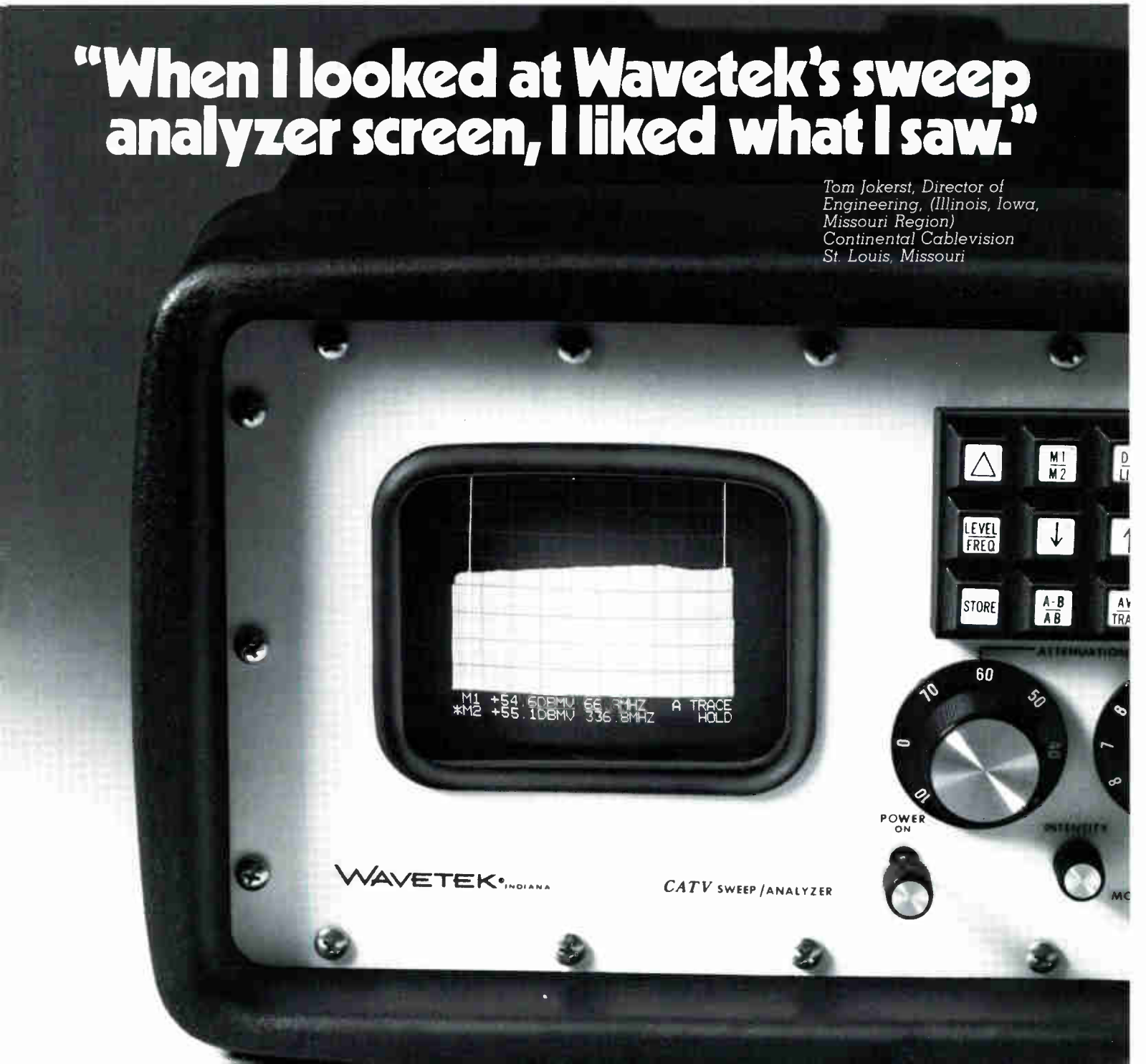
"When I looked at Wavetek's sweep analyzer screen, I liked what I saw."

Tom Jokerst, Director of Engineering, (Illinois, Iowa, Missouri Region) Continental Cablevision St. Louis, Missouri



International Cable

Canadian Cable Convention Will Discuss Piracy, DBS

QUEBEC CITY, QUEBEC—This year's convention sponsored by the Canadian Cable Television Association will include a number of issues that are equally important to companies in the United States. Among them are the rights of individuals to pilfer signals from American companies with illegal TVROs and the future of direct broadcast satellite (DBS) services.

On May 11-14, close to 2,000 attendees are expected for the CCTA affair, entitled "Time for Growth." A number of major topics will be scrutinized and debated at plenary, programming, management and technical sessions. The majority of these sessions will have American participants.

"This year in particular is a transition year for Canada," said Susan Cornell, public affairs spokesman for the CCTA. "It's a year when we have to think about the future. So many of the things happening in Canada now are directly related to the United States."

Four major plenary sessions have been scheduled. The first is entitled "The Right To Receive?" Michel Lafontaine, president of Tamec, will give a special presentation dealing with the ability and legal right to receive satellite signals from American birds. The commentators chosen for the session will be Stuart Coxford, president of Classic Communications in Ontario; Alain Gourd, vice president of the Canadian Association of Broadcasters; and two as-yet-unnamed representatives of the federal and provincial governments.

The second session, "Facing the Future: the Alternatives for Cable," will discuss the emerging technologies that will serve as an alternative to cable services. The focus will be on developing new services for the cable industry to survive the onslaught of the new technologies. Win Himsworth, vice president of Salomon Brothers of New York, will mediate the panel. Special commentators will be Thomas Wheeler, president of the National Cable Television Association; Andre Chagnon, executive director of the Videotron Group; and Ted Rogers, vice president of Rogers Cablesystems.

Another topic set for discussion at the show is "Direct Broadcast Satellite: Fact, Fiction and Future." The presentations are slated for this session, one from a Canadian point of view, and the other with an American slant. The Canadian side will be introduced by Ted Jarmain, president of Telesat Canada, the country's only satellite common carrier. The American perspective will be given by Warren Zedger, vice president and general counsel of Comsat's Satellite Television Corporation.

The final plenary session is entitled "Regulation: Does It Protect or Frustrate the Public Interest?" Regulation is stringent in Canada and the topic of regulatory reform will be broached. Jim Peterson, a member of parliament and the chairman of the committee on regulatory reform, will present the topic. Additional commentators will be Harry "Chip" Shooshan, Washington attorney. Noel Bambrough, vice president of operations for Cablecasting, Ltd., and vice president of Cable America in Atlanta, Georgia.

Other major events at the upcoming convention will be a speech by Francis Fox. Canadian minister of communications. Also speaking will be Dr. John Meisel, chairman of the Canadian Radio-Television Telecommunications Commission.

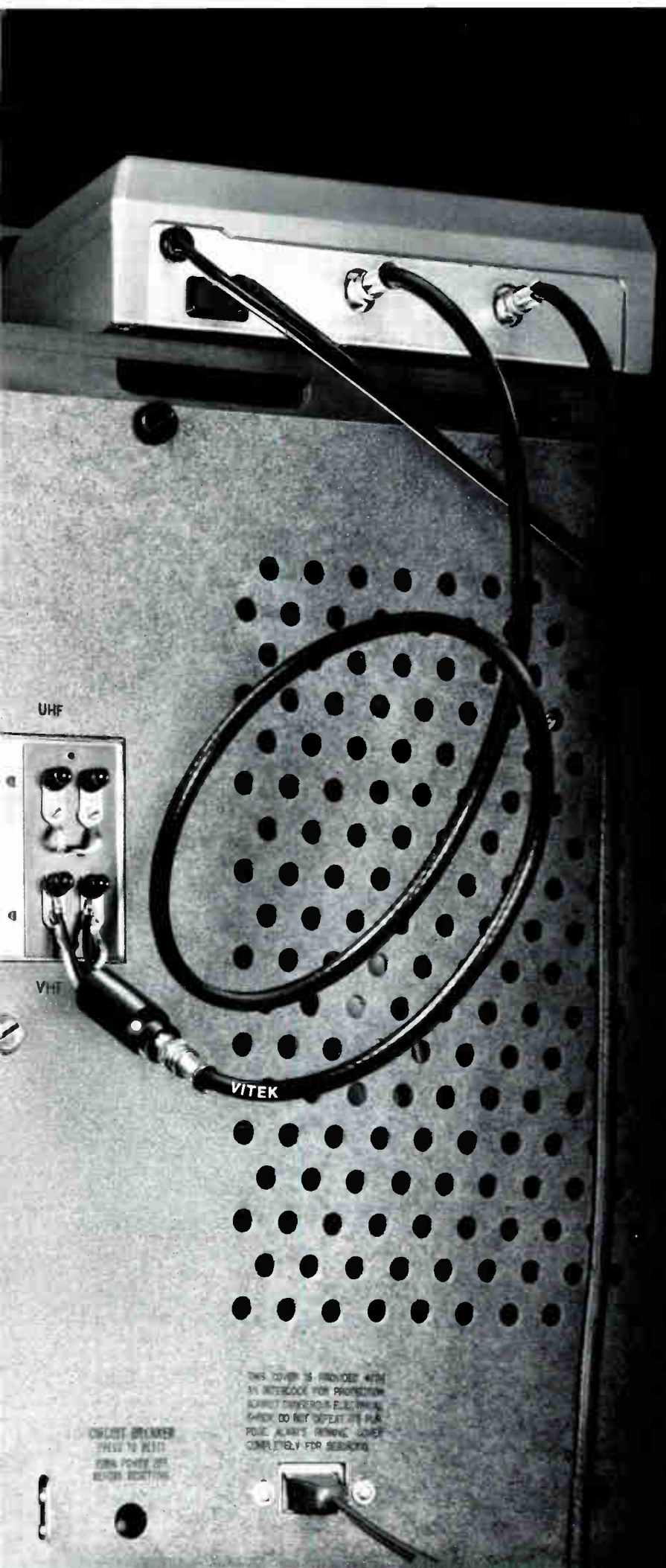
Pay television will not be one of the major issues in the planned panel discussion this year. Although the CCRT had earlier indicated that pay television hearings could be held as early as June of this year, sources believe they could be delayed until September.

Canadian Ministers Plan Communications Conference

OTTAWA, ONTARIO—Canadian Communications Minister Francis Fox confirmed today that preparations are underway for a federal-provincial conference of Ministers of Communications in late spring or early summer.

In accordance with the decision made by federal and provincial Ministers of Communications at their last meeting, in Toronto on October 17, 1979, the conference will take place in Winnipeg and will be co-chaired by the Manitoba Minister, Donald Orchard, and the federal Minister of Communications.

The 1979 federal-provincial conference requested working groups of federal and provincial officials to prepare reports on competition and industry structure, the industrial impacts of communications policies and the sharing of responsibilities over cable. These reports are not yet final. Fox said he was encouraged by the co-operative approach to deal with these matters and felt that the reports will be invaluable to a meaningful conference.



Do your set top converters cause TV overload?

VITEK Jumper Trap is the solution.

The jumper cable with the built-in video notch filter solves TV overload problems by reducing the level of the upper adjacent video carrier without affecting the signal-to-noise ratio of the desired output channel.

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The VITEK Jumper Trap is a combination jumper cable and video notch filter, which is installed between the set top converter and the subscriber's TV set, replacing the attenuator pad. It has the same physical appearance and characteristics as regular RG-59 cable but it utilizes the patented VITEK Cable Trap technique, used so successfully in Pay TV. It reduces *only* the interfering signal level, with absolutely no affect on the signal-to-noise-ratio of the desired channel.

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Microdyne Markets Communications Terminal

The MS-1 terminal from **Microdyne** was designed to improve corporate communications while decreasing corporate travel cost. The integrated electronics package (patent pending) is capable of simultaneously outputting baseband video and audio and additionally incorporates a television modulator for direct use with a conventional television receiver.

The MS-1 provides dual polarization using a single low-noise amplifier which can be automatically polarized by remote control. Channel selection is also controlled remotely. The MS-1 integrated electronics is mounted at the feed of Microdyne's 12-foot prime focus antenna. The relatively small size antenna provides for ease of installation and use, however, when conditions warrant, the MS-1 can be adapted to any of Microdyne's antennas.

For information, contact Microdyne Corporation, P.O. Box 7213, Silver Springs Shores Industrial Park, Ocala, Florida 32672; (904) 687-4633.

Hughes Introduces Expandable Earth Station

A satellite receiving antenna that measures 3.7 meters in diameter and is readily expandable to five-meter diameter on site has been introduced by **Hughes Aircraft Company's** microwave communications products.

The dish is designed for the 3.7-4.2 GHz frequency range. It operates with the Comstar and Westar satellite series and offers protection against future satellite changes and signal degradation. It provides significantly better performance—including 52 percent more gain—than a conventional three-meter antenna, which means an additional safety margin against normal signal degradation due to transponder aging and terrestrial rain and snow storms.

The expansion feature, whereby the unit is convertible to a five-meter configuration using the same foundation and mount structure, will be able to overcome interference from adjacent satellites that is deemed likely when current orbital spacing is reduced.

For information, contact Hughes Microwave Communications Products, P.O. Box 2999, Torrance, California 90509; (213) 517-6100.

Miscellaneous

Panduit Announces Heat-Shrink End Caps

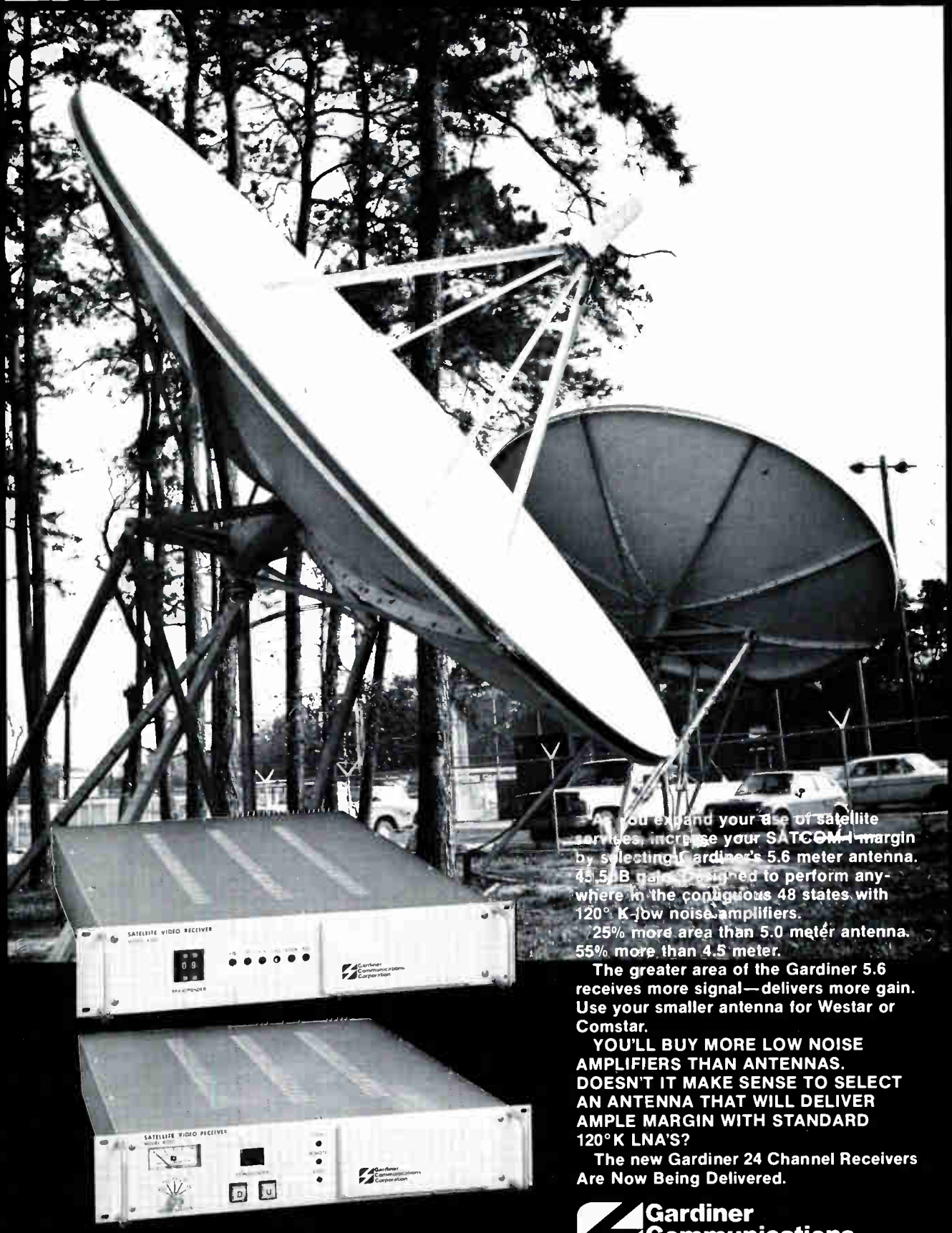
A line of heat-shrink end caps has been added to the compression connector installation accessories offered by **Panduit Corporation**, Electrical Products Group. The end caps

Heat-shrink caps from Panduit Corporation.

provide a means of protecting and environmentally sealing cable ends in sizes from #8 AWG through 1000 MCM. They are manufactured from a thick-walled, cross-linked polyolefin. All sizes are lined with a factory-installed adhesive sealant. The minimum shrink temperature, 135°C (275°F), allows the caps to be installed with either an electric heat gun or a propane torch.

For information, contact Panduit Corporation, 17301 Ridgeland Avenue, Tinley Park, Illinois 60477; (312) 532-1800.

EXPAND WITH GARDINER



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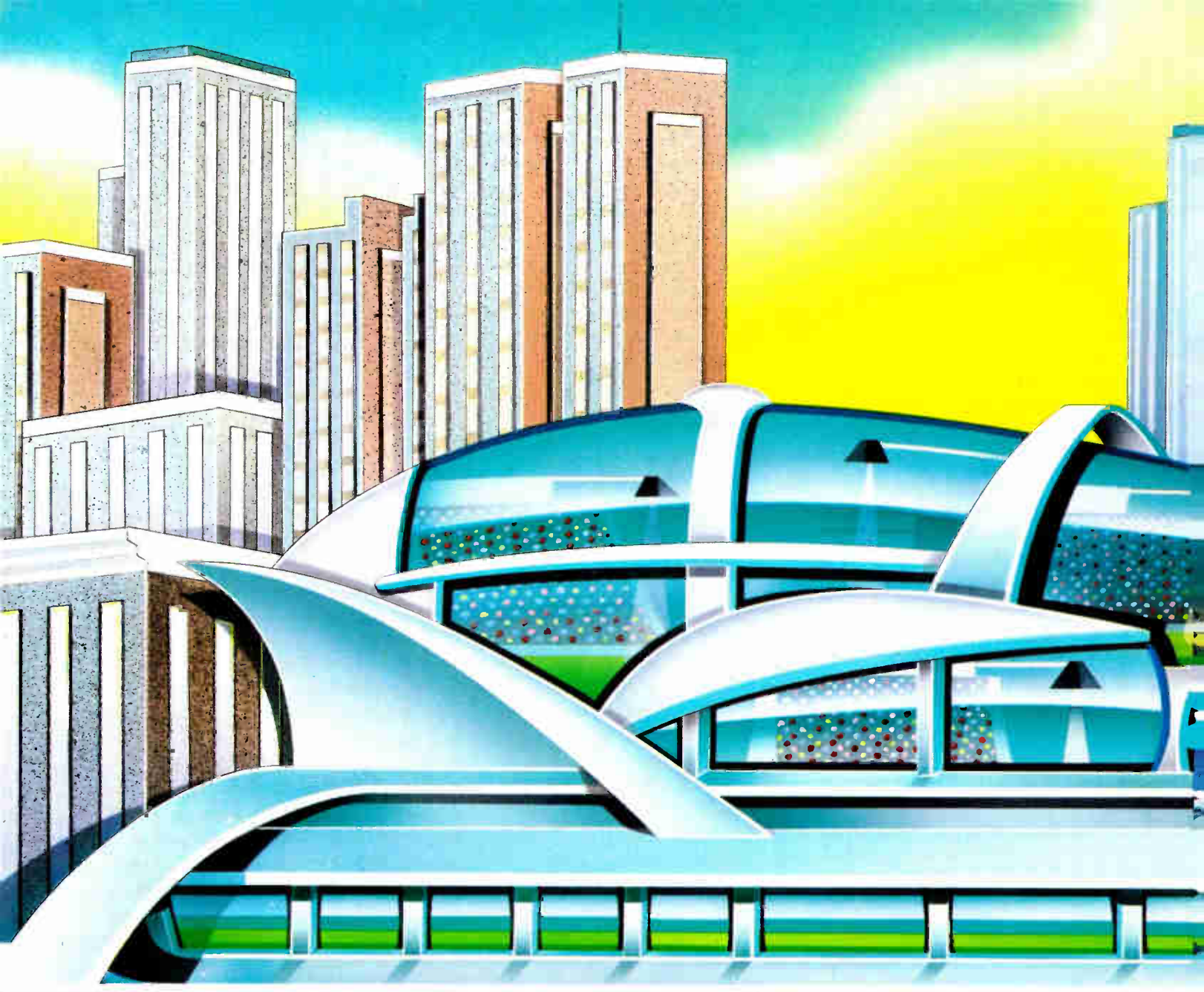

VR-3X: Tunes manually across 24 channels with a single screwdriver adjustment.

VR-4X: 24 channel frequency agility with remote tuning option. Optional automatic vertical/horizontal polarization switching.

Both feature Automatic Frequency Control □ Digital Demodulator with threshold extension delivers 3 dB extension when compared to 30 MHz IF bandwidth □ 4.5 MHz Subcarrier Composite of video plus program audio simultaneously feeds cable modulator and/or microwave system □ Options include in-chassis cable modulator that operates off receiver power supply and up to 4 audio subcarrier demodulators.

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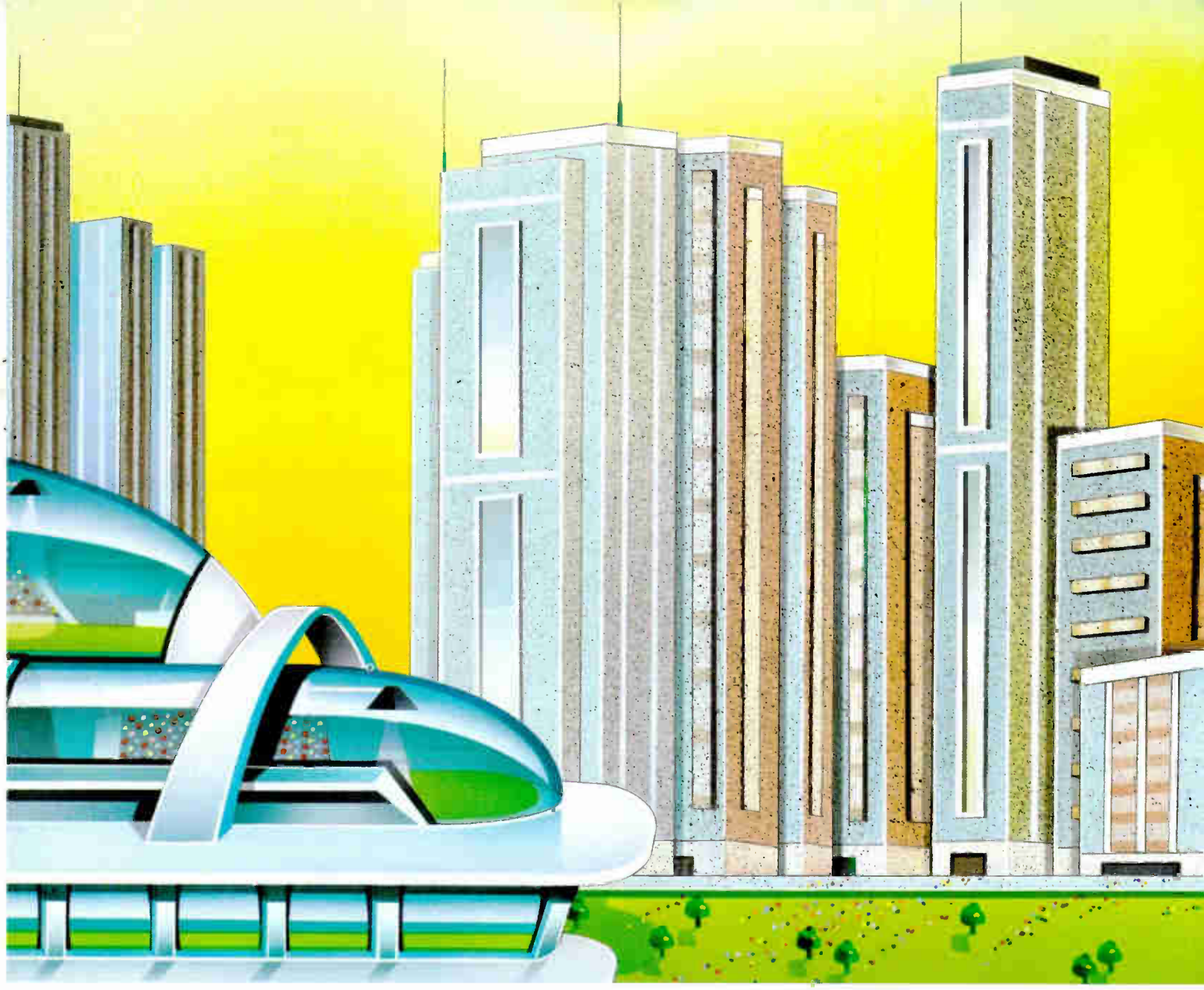

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Converter Noise Fig.	4.2dB typical	2.5dB typical

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People News

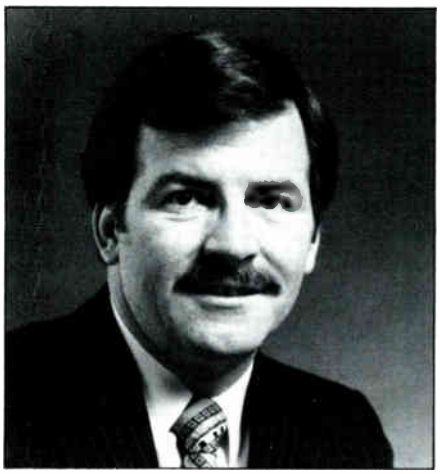
★ **Lewis D. Suders** has joined **Erie Telecommunications, Inc.** (ETI), Erie, Pennsylvania, as chief engineer for the new cable television system Suders brings 15 years of cable television experience to ETI. Since 1966, he has worked for Westmoreland Cable Company in New Kensington, Pennsylvania. As that company's operations manager, he supervised installation, maintenance, new construction, safety, purchasing, hiring and inventory control. Prior to becoming Westmoreland's operations manager, Suders worked as the company's chief engineer, chief technician, line/headend technician, service technician and installer. Suders will assume responsibility for engineering operations of ETI and will work with utilities, contractors and customers while supervising purchasing and project authorizations. Suders attended Penn Technical Institute and currently is attending Penn State University where he has completed courses in cable telvision and management. He also has attended several training seminars with the Jerrold Electronics Corporation, a manufacturer of cable television components. ETI expects to begin construction on the Erie system early this summer, according to Jay Satterfield, the system's general manager. He said the company plans to connect the first customers by late summer. ETI, a subsidiary of American Television and Communications Corporation (ATC), currently has a temporary office in the C. Daniel Baldwin Building, Suite 1207.

★ **Arthur F. Schoenfuss** has joined **Heritage Communications, Inc.**, Telecommunications Group as director of engineering. Heritage is based in Des Moines, Iowa.

Schoenfuss has extensive background in the technicial area including more than 20 years with the CBS Television Network in New York City. More recently he worked with Teleconsult International, Inc., as a consulting engineer. His primary assignment was a $150 million expansion project in Indonesia. He also supervised the construction of 23-hop microwave transmission system in Indiana and Ohio and was actively involved in bringing the Westar Satellite System to operational status.

A registered professional engineer, Schoenfuss has a First Class FCC Radiotelephone Operator's License. In his new position, Schoenfuss will work with the future development of data services, Heritage's new Iowa Cable Network and similar projects.

★ **Kevin M. Finn**, general manager of the TRW Semiconductor Division, has been named a vice president of **TRW, Inc.** Finn remains head of the division and continues to report to Ira Coron, a vice president and unit head of the TRW Electronic Components Group. Finn joined TRW in 1968 as a project manager



Kevin M. Finn

for microwave components. He later was plant manager of TRW's semiconductor operations in Bordeaux, France and CATV plant manager and then operations manager for the division's power semiconductors group. He was named division general manager in January 1979. He graduated with a B.S. in physics from Marist College in 1963.

★ The Appalachian Mid-Atlantic Group of Region Six of the **Society of Cable Television Engineers** has installed a new slate of officers. **Tom Carbaugh**, president of Jerry Conn Associates, Inc., of Chambersburg, Pennsylvania, is chapter president. The first vice president is **Jeff Tate**, general manager of TV Cable of Carlisle, Carlisle, Pennsylvania. Second vice president is **Don Rice**, chief engineer of Antietam TV Cable, Hagerstown, Maryland. Secretary/ treasurer is **Lee Burkholder**, chief technician for Warner Cable of Chambersburg, Chambersburg, Pennsylvania.

★ **Southern Satellite Systems, Inc.**, has appointed a sales representative to develop various applications for its new alphanumeric data transmission system, CableText. **Steve Vetters**, formerly a special projects engineer for the company, has taken on this new sales duty and will assist in developing a wide range of applications for the new technology. Vetters says his first priority will be to utilize blocks of the 800 channels of capacity the system has available to use. "This may include data distribution by someone like a medical organization or legal group to doctors or lawyers," says Vetters. Currently, UPI and Reuters newswires are carried by CableText on the vertical interval of the WTBS satellite signal. Before moving into the CableText position, Vetters was with SSS for a year and a half, and had consulted with the company for engineering and construction previous to that. He was a project engineer with Aubrey-Corrall, and is the former state engineer for Continental Telephone in Oklahoma. Prior to that, he was with Southern Pacific Railroad, doing engineering and communications related work for both. His experience also includes a period in the Air Force as a communications engineer.

★ **James O. Robbins** has been promoted to the post of vice president of **Viacom Cablevision of Long Island**. For the past year, Robbins has served as general manager of Viacom Cablevision of Long Island, which currently serves over 79,000 basic subscribers and 40,000 Showtime subscribers.

James O. Robbins

★ **Applied Micro Circuits Corporation** has brought in **Brian Tighe** as MOS process manager, responsible for development, technical coordination and manufacturing of all MOS products. The gate array, custom product and microcomputer lines are a primary part of AMCC's business base.

Tighe has in excess of 23 years in the semiconducter industry with an extensive processing and manufacturing background. Prior to joining AMCC, Tighe was a technical director for Northern Telecom, Inc., a major telecommunications manufacturer. His responsibilities included the design, construction and start-up operation of a captive 75,000 square-foot CMOS silicon gate ultra-modern manufacturing plant.

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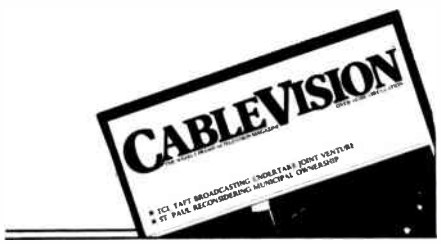

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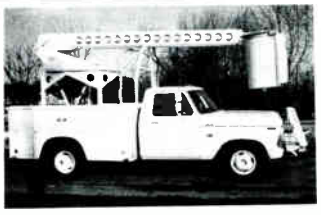

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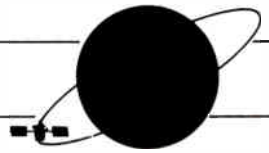

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CBN		24 hrs.	None	F1,#8
CNN		24 hrs.	None	F1, #14
Cabletext		24 hrs.	None	F1, #6 Vertical Blanking
C-SPAN	Weekdays	12:00 p.m./6:30 p.m.	195°/1#	F1,#9
ESPN		24 hrs.	None	F1,#7
Front Row		2:30 p.m./2:30 a.m.	481°/#	F1, #12 (E,C) F1, #10 (P,M)
HBO			Program	F1,#24
	April 1	5:00 p.m. 2:18 a.m.	729°/#	F1,#22
	April 2	5:30 p.m. 2:27 a.m.	Scramble	F1,#23
	April 3	5:30 p.m. 3:55 a.m.	835°/#	F1,#20
	April 4	3:00 p.m. 3:15 a.m.	Duplication	
	April 5	3:00 p.m. 3:06 a.m.	940°/#	
	April 6	5:30 p.m. 2:41 a.m.	Take-2 E.	
	April 7	5:30 p.m. 3:14 a.m.	592°/#	
	April 8	5:30 p.m. 2:00 a.m.	Take 2 W.	
	April 9	5:00 p.m. 1:55 a.m.	681°/#	
	April 10	5:00 p.m. 3:23 a.m.		
	April 11	3:00 p.m. 3:07 a.m.		
	April 12	2:45 p.m. 1:40 a.m.		
	April 13	5:00 p.m. 2:10 a.m.		
	April 14	5:30 p.m. 2:36 a.m.		
	April 15	5:30 p.m. 2:53 a.m.		
	April 16	5:30 p.m. 2:01 a.m.		
	April 17	5:00 p.m. 3:52 a.m.		
	April 18	2:00 p.m. 4:00 a.m.		
	April 19	2:30 p.m. 2:17 a.m.		
	April 20	5:00 p.m. 2:35 a.m.		
	April 21	6:00 p.m. 2:23 a.m.		
	April 22	5:00 p.m. 1:50 a.m.		
	April 23	5:30 p.m. 2:55 a.m.		
	April 24	5:30 p.m. 3:59 a.m.		
	April 25	3:30 p.m. 4:43 a.m.		
	April 26	2:00 p.m. 3:07 a.m.		
	April 27	5:30 p.m. 3:19 a.m.		
	April 28	5:30 p.m. 3:03 a.m.		
	April 29	5:00 p.m. 2:06 a.m.		
	April 30	6:00 p.m. 2:14 a.m.		
HTN		8:00 p.m./10(11:00) p.m.	517°/#	F1,#21
KFIX		2-4 hrs./day	None	F1,#1
KTVU			None	F1,#1
	Weekdays	7:00 a.m./1:00 a.m.		
	Weekends	7:00 a.m./4:00 a.m.		
Modern Talking Pictures			243°/#	F1,#22
	Weekdays	12:00 p.m./5:00 p.m.		
	Weekends	7:00 a.m./12:00 p.m.		
The Movie Channel		24 hrs.	None	F1,#5 (E,C) F1,#11 (M,P)
Newstime		24 hrs.	276°/#	F1,#6
PTL		24 hrs.	None	F1,#2
Reuters	Weekdays	4:00 a.m./7:00 p.m.	None	F1,#18

Signal	Day	Start/Stop	Alert Tones	Satellite/ Transponders
Showtime			Program	F1,#12 (E,C)
	April 1	3:30 p.m. 2:00 a.m.	576°/#	F1,#10 (M,P)
	April 2	3:30 p.m. 3:00 a.m.	Scramble	
	April 3	3:30 p.m. 9:00 a.m.	679°/#	
	April 4	9:00 a.m. 9:00 a.m.	Off-line	
	April 5	9:00 a.m. 3:31 a.m.	753°/#	
	April 6	3:30 p.m. 3:46 a.m.	Access	
	April 7	3:30 p.m. 3:27 a.m.	843°/#	
	April 8	3:30 p.m. 2:38 a.m.		
	April 9	3:30 p.m. 3:05 a.m.		
	April 10	3:30 p.m. 7:00 a.m.		
	April 11	7:00 a.m. 7:00 a.m.	April 21	3:30 p.m. 3:12 a.m.
	April 12	7:00 a.m. 2:48 a.m.	April 22	3:30 p.m. 3:21 a.m.
	April 13	3:30 p.m. 3:13 a.m.	April 23	3:30 p.m. 3:18 a.m.
	April 14	3:30 p.m. 3:45 a.m.	April 24	3:30 p.m. 7:00 a.m.
	April 15	3:30 p.m. 3:00 a.m.	April 25	7:00 a.m. 7:30 a.m.
	April 16	3:30 p.m. 3:00 a.m.	April 26	7:30 a.m. 1:30 a.m.
	April 17	3:30 p.m. 9:00 a.m.	April 27	3:30 p.m. 2:14 a.m.
	April 18	9:00 a.m. 7:30 a.m.	April 28	3:30 p.m. 3:13 a.m.
	April 19	7:30 a.m. 2:27 a.m.	April 29	3:30 p.m. 2:08 a.m.
	April 20	3:30 p.m. 2:09 a.m.	April 30	3:00 p.m. 2:13 a.m.
SPN		24 hrs.	None	Westar II, #9
SIN		24 hrs.	None	Westar III, #8
Trinity (KTBN)		24 hrs.	None	F1,#13
USA Network				F1,#9

Off-times are listed below. For on-times, see notes below.

April 1	12:00 a.m.	April 16	4:00 a.m.
April 2	2:00 a.m.	April 17	1:00 a.m.
April 3	1:00 a.m.	April 18	4:00 a.m.
April 4	2:00 a.m.	April 19	3:00 a.m.
April 5	2:00 a.m.	April 20	2:00 a.m.
April 6	1:00 a.m.	April 21	1:00 a.m.
April 7	1:30 a.m.	April 22	1:00 a.m.
April 8	2:00 a.m.	April 23	2:00 a.m.
April 9	2:00 a.m.	April 24	1:00 a.m.
April 10	1:00 a.m.	April 25	1:30 a.m.
April 11	2:00 a.m.	April 26	3:00 a.m.
April 12	3:00 a.m.	April 27	2:30 a.m.
April 13	3:00 a.m.	April 28	4:00 a.m.
April 14	2:00 a.m.	April 29	2:00 a.m.
April 15	1:30 a.m.	April 30	4:00 a.m.

USA Network. On-time is 7:30 p.m. weekdays. Saturdays: 5:00 p.m., except April 18: 4:00 p.m. Sundays: 4:00 p.m., except April 5: 7:00 p.m.; April 19: 4:40 p.m.

Calliope. Weekdays: 6:30 p.m. to 7:30 p.m. Saturdays 10:00 a.m. to 1:00 p.m.

The English Channel. April 2: 10:00 p.m. to 12:00 a.m. Saturdays: 1:00 p.m. to 5:00 p.m., except April 18: 1:00 p.m. to 4:00 p.m. Sundays: 10:30 p.m. to 12:30 a.m., except April 5: 10:00 p.m. to 12:30 a.m. Tuesdays: 11:00 p.m. to 1:00 a.m., except April 7: 10:30 p.m. to 12:30 a.m.

WGN	Mon.-Thurs. Weekends	5:42 a.m./3(3:30) a.m. Ends 3:00 a.m. on Sun.	None	F1,#3
WOR		24 hrs.	None	F1,#17
WTBS		24 hrs.	None	F1, #6
Women's Channel		24 hrs.	None	F1, #6 Subcarrier

E = eastern M = mountain
C = central P = pacific

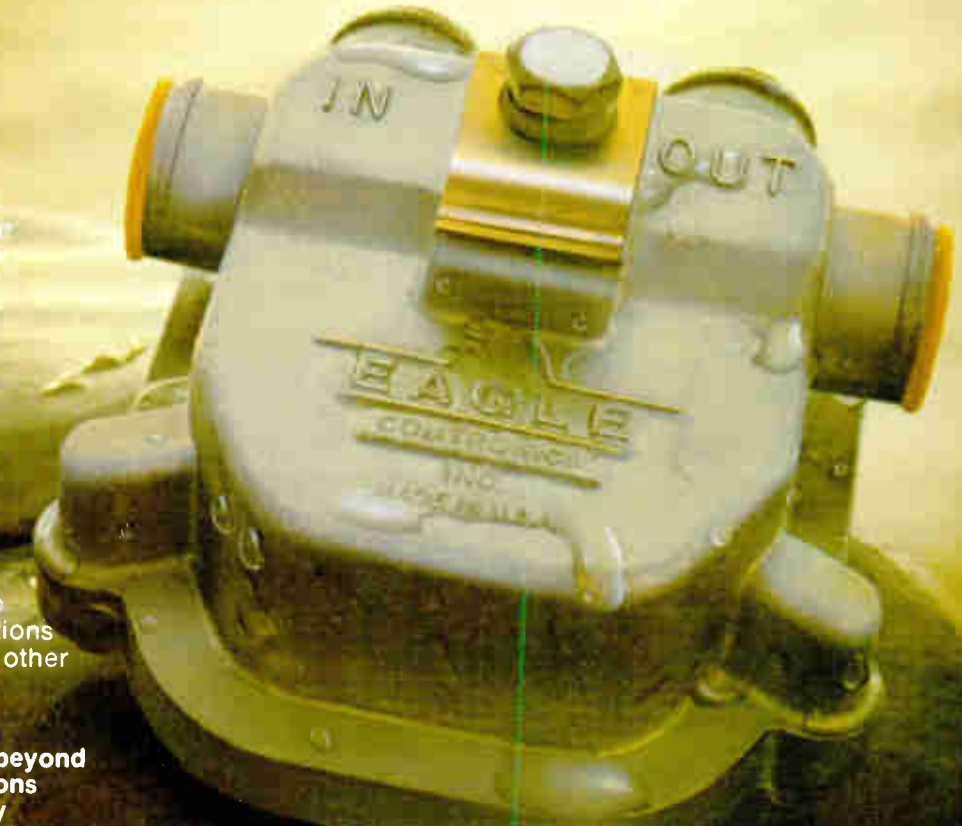
All program times are listed for the eastern time zone, unless otherwise noted.

The Eagle 500 MHz Tap True Performance...

Under The Toughest Conditions.

Designing innovative products that perform beyond the competition is fast becoming tradition at Eagle. Innovation in our tap starts on the inside with true performance to 500 and beyond. Our tap's insertion loss is lowest in the industry and R.F.I. far exceeds F.C.C. specifications. Plus you'll also find our [illegible] seizure screw is [illegible] to prevent pullout or other damage to electronic components. Plus, the Eagle Tap is easily adjustable for either aerial or pedestal mounting.

Outside, the Eagle 500 MHz tap is built tough to protect against the harshest elements. Our exterior hardware has a sandbonded finish and our die cast housing is available with either a clear iridite coating or E finish with our exclusive brass F-connectors for severe conditions like salt spray, industrial pollution or other highly corrosive elements.



COMPARE FEATURES

- **True performance to 500 MHz and beyond**
- **R.F.I. far exceeds F.C.C. specifications**
- **Lowest insertion loss in the industry**
- **Highest quality corrosion resistant aluminum alloy**
- **Moisture seal gasket**
- **Easily adjusted for aerial or pedestal mounting**
- **Sealed F-ports available in either machine threaded aluminum alloy or brass**
- **Modular design**
- **Available with either clear iridite or E coating**
- **Sand bonded finish hardware**
- **Ports are numbered for easy system audit**

The Eagle 500 MHz tap, built for true performance under the toughest conditions ... inside and out.

COMPARE EAGLE'S ELECTRICAL SPECIFICATIONS WITH THOSE OF OTHER MANUFACTURERS

VALUE	8	11	14	17	20	23	26	29	32	35
MODEL	EC4-408	EC4-411	EC4-414	EC4-417	EC4-420	EC4-423	EC4-426	EC4-429	EC4-432	EC4-435
COLOR CODE	orange	gold	white	black	green	purple	yellow	red	silver	blue
TAP LOSS										
INSERTION LOSS										
5 MHz		2.2	1.2	.5	.4	.3	.2	.2	.2	.2
300 MHz		2.7	1.4	.7	.5	.4	.3	.3	.3	.3
400 MHz		3.1	1.6	.8	.6	.5	.3	.3	.3	.3
450 MHz		3.2	1.7	.9	.7	.6	.4	.4	.4	.4
500 MHz		4.5	2.0	1.1	1.0	.9	.7	.7	.7	.7
ISOLATION- out to tap										
5 MHz		30	32	34	40	43	46	49	52	55
300 MHz		30	32	34	38	41	44	47	50	53
400 MHz		28	30	32	35	38	41	44	47	50
450 MHz		25	27	29	32	35	38	41	44	47
Tap to Tap 5-400 MHz 30DB Min.										
RETURN LOSS - In Out Two 5-400 MHz 20DB Min.										

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