CED

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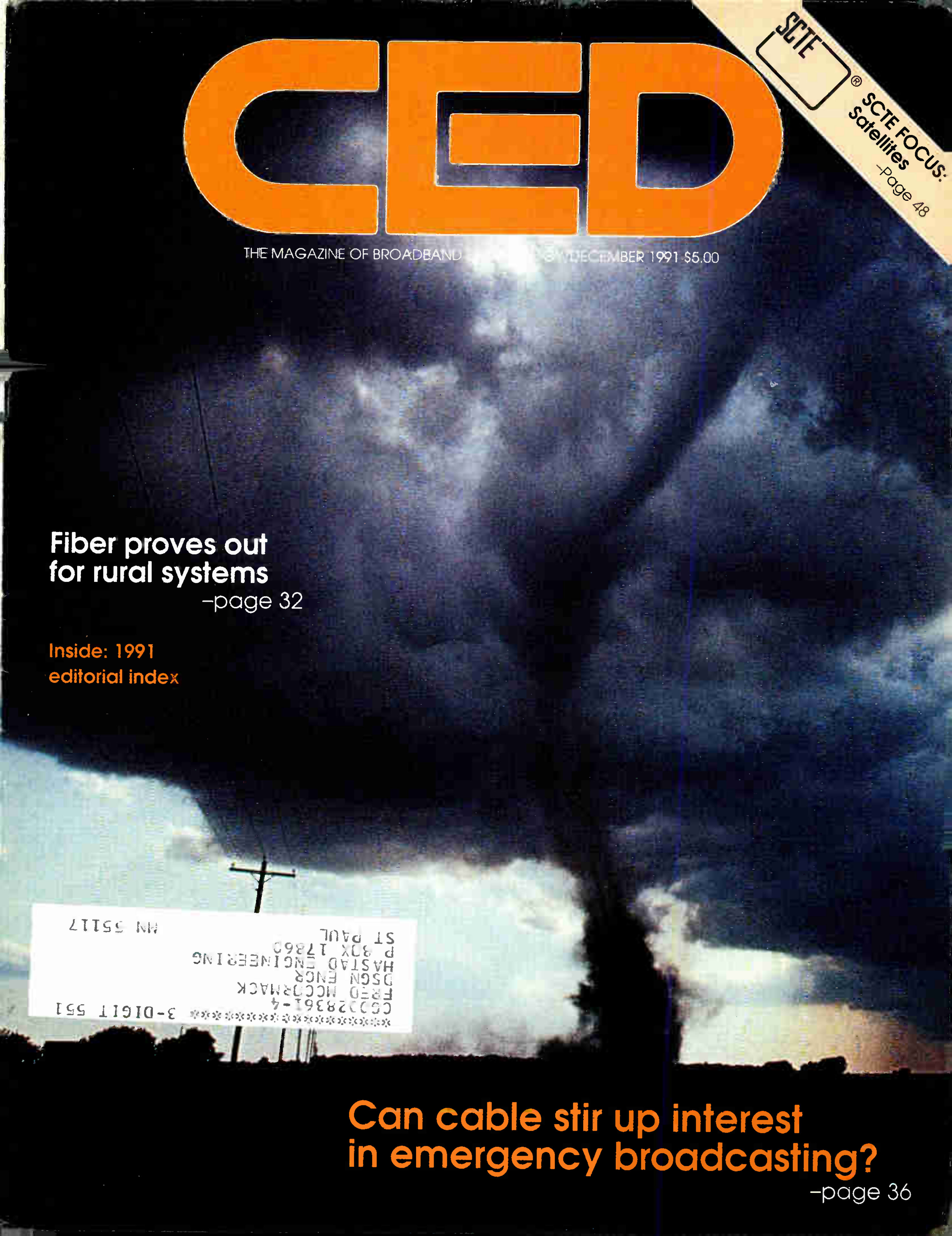

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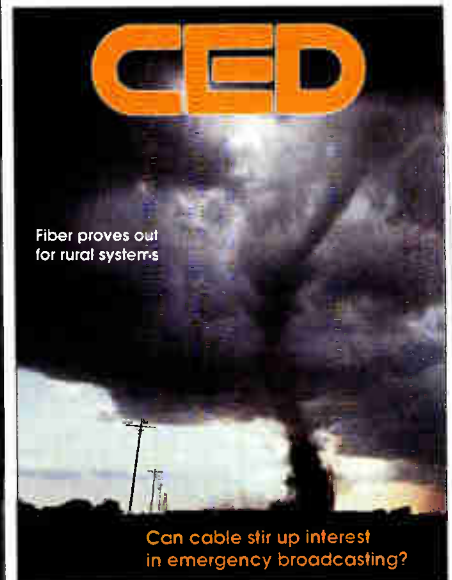

About the Cover:
How cable TV can deliver EBS signals. Photo by The Stock Market.

DEPARTMENTS

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Composite triple beat

Like much of the technology in cable TV, intermodulation in frequency division multiplexed (FDM) transmission systems was described and analyzed by the Bell Telephone Laboratories many years before CATV was born. As early as 1935, M.A. Weaver struggled with a form of intermodulation he called non-linear crosstalk. In 1953, Elmendorf and others demonstrated by measurements on FDM voice frequency group transmission cascades that second order intermodulation product amplitudes tend to add as a power law function of the number of tandem amplifiers (10 log N); while third order products tend to add as a voltage function (20 log N).

In 1970, Ken Simons of Jerrold Electronics published an excellent and comprehensive mathematical power series analysis of The Decibel Relationship Between Amplifier Distortion Products (Proc. IEEE July 1970). This was an expanded version of the analysis in his famous "Blue" and "Red" books published by Jerrold several years earlier.

Power Analysis

The power series equation defines the total instantaneous output voltage E resulting from an input voltage e:

E = k1e + k2e2 + k3e3 +...knen

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

Modern push-pull circuitry tends to cancel out the even ordered products (k2, k4, etc). Modern cable TV amplifiers are so nearly linear that terms of higher than third order can safely be neglected in normal practice. Furthermore, power law build-up of second order products in amplifier cascades is much slower than the voltage build-up of the third order.

Thus, the k3e3 term provides the controlling contribution to intermodulation in amplifier cascades.

The instantaneous input voltage, considering any three carriers in the system, is:

e = A cos f1 + B cos f2 + C cos f3

Mathmatic equations

Ken Simons (and others) have carried out the rather complex algebraic and trigonometric computations to show that the third power expansion of e (i.e. e3) results in sets of trigonometric functions (i.e. cosines) of the following combinations of the three frequencies, f1, f2, and f3:

(1) f13; f23; and f33. *Third harmonics.*

(2) 2f1 +- f2. *Sometimes called intermodulation.*

(3) f1 - f2 + f3. The *triple beat.*

Ken Simons (and others) have also shown that the third harmonics are 15.5 dB weaker than the triple beat component; and the 2f1 +- f2 components are 6 dB weaker than the triple beat. Thus, the triple beat component is dominant.

Moreover, when the triple beat frequencies are equally spaced at, say, multiples of 6 MHz, and one frequency is negative while the others are positive, one of the products comes out equal to the negative frequency.

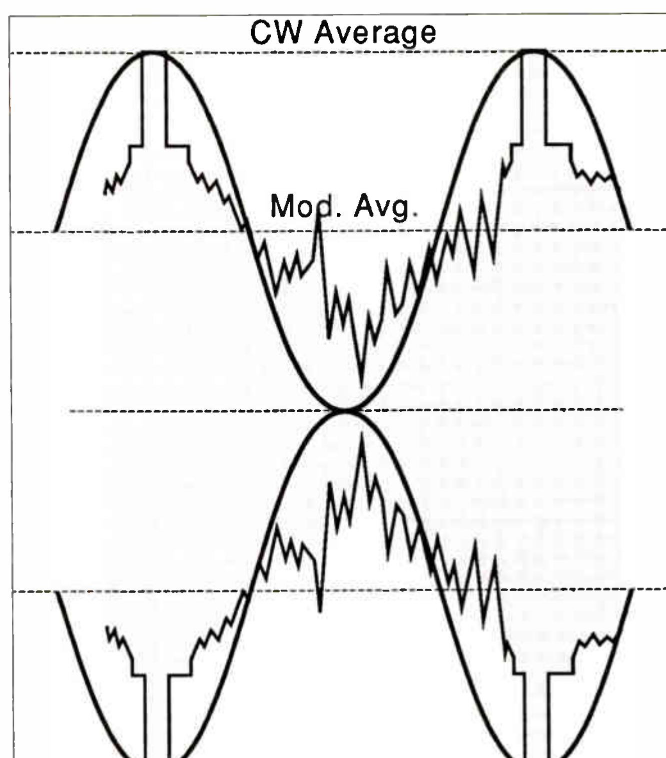
For example, 288 - 300 + 312 MHz = 300 MHz. In 1973, Bert Arnold, of the former RCA Community Television Systems, showed that with 30 FDM channels, there would be 239 such combinations close to the frequency of the center channel. With 50 to 60 channels, there will be 900 to 1,200 such co-channel products. For a "non-coherent" headend, these hundreds of triple beats will occur in a bundle generally within +- 20 kHz of the desired carrier.

The accepted NCTA measurement method employs a spectrum analyzer, set for 30 kHz IF bandwidth, in order to measure the combined, or composite, magnitude of the bundle of hundreds of intermodulation products close to a desired carrier frequency.

The ratio of the desired carrier to the composite value indicated by the spectrum analyzer is called the composite triple beat (CTB) voltage ratio, expressed in decibels. Sometimes the ratio is turned upside down, with a negative value of the decibel ratio of CTB magnitude relative to the carrier (I/C). I prefer the positive value for carrier-to-interference (C/I).

Removing modulation

For repeatable and reliable measurement, the modulation should be removed from all carriers during the test. Obviously, this would not be possible in any operating system with connected customers. The magnitude of the carrier-to-CTB ratio measured in the same



way, but with normally modulated carriers will be considerably greater than with unmodulated (CW) carriers. This is because the average value of the instantaneous peak RF voltage of the video modulated waveform is about half (-6 dB) that of the unmodulated waveform (see Figure 1). This suggests that the resulting carrier-to-CTB ratio would be 12 dB greater than that measured with CW carriers.

Thus, if a system measures 53 dB carrier-to-CTB ratio with CW carriers, it would probably measure about 65 dB with modulated carriers, everything else being the same.

However, intermodulation at 65 dB below the carrier may be lost in the random noise of the system and the analyzer. For this reason, NCTA recommends raising the level of all modulated carriers (except the pilots) by 3 dB, for the test. This would bring the ratio down to a detectable 59 dB, halfway between the CW and modulated carrier ratio.

Not subjective

NCTA recommends 53 dB as the performance objective for the CW measurement, and 59 dB for the 3 dB increased modulated carrier measurement. This is necessarily a subjective judgment. NCTA does not indicate whether this represents the threshold of perceptibility, or a somewhat annoying quality grade.

Recently conducted tests indicate that even at close viewing distance (5 feet from a 20-inch TV screen) interference is rated only slightly annoying by the average viewer at 39 dB carrier-to-CTB ratio, as measured with CW carriers. This is the same subjective rating as for 45 dB carrier-to-random noise ratio, at the same viewing distance. The 39 dB ratio with CW carriers would be roughly equivalent to 51 dB with modulated carriers, without the 3 dB increase in carrier level.

The proper objective for the CTB ratio using the only practicable method, modulated carriers, has not been well established experimentally. However, operators indicate that the conventional objective of 53 dB is a practical minimum acceptable working standard for maintenance testing in the field, using the normally modulated carriers at normal levels.

Nothing in the foregoing discussion relates to coherent headends, in which all carriers are phase-locked to a precise 6 MHz comb. This must be left for another column. There are some surprises! ■

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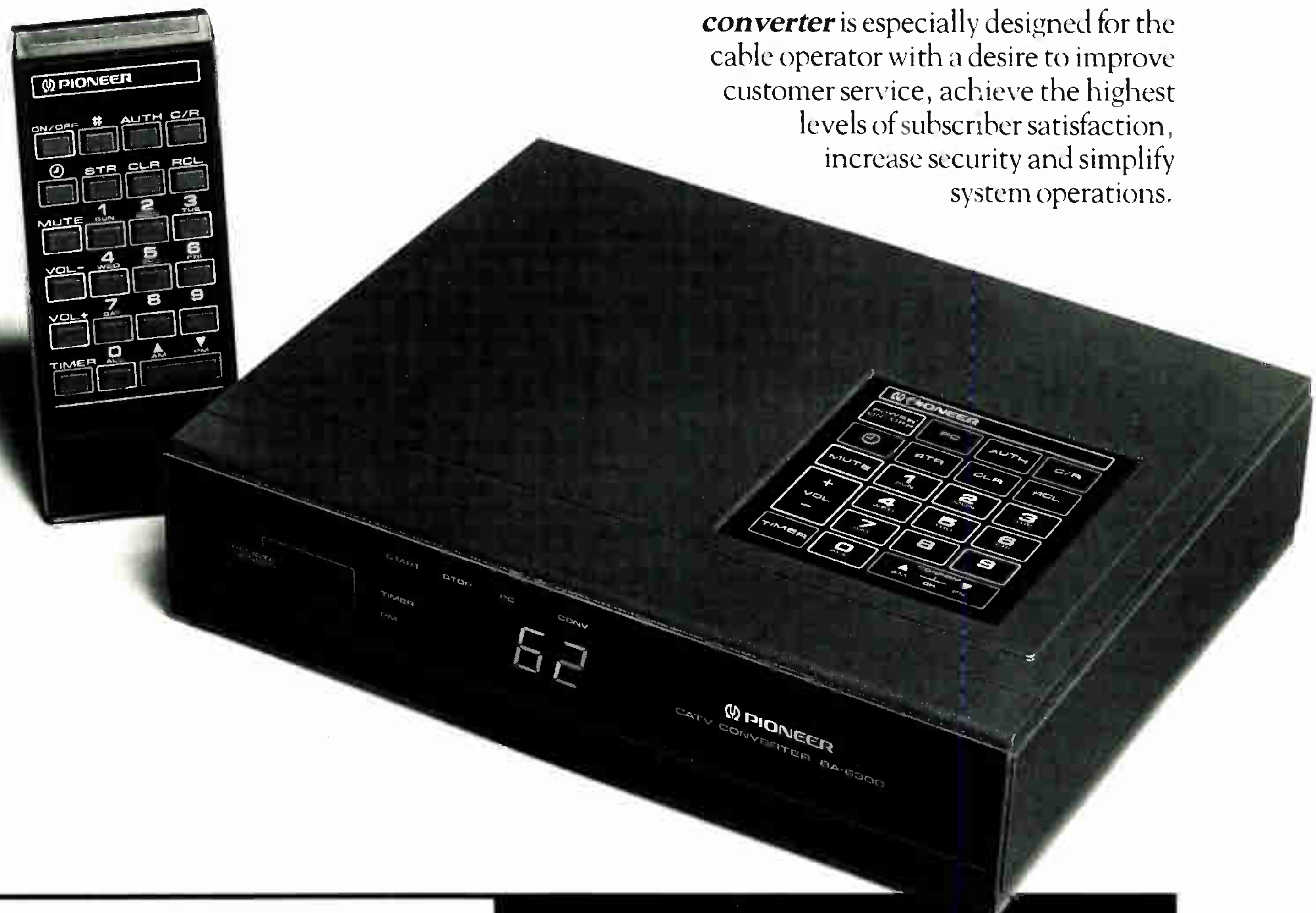

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Do we need a scrambling standard? (CED), Jeff Krauss, Telecommunication and Technology Policy of Rockville, Md., November 1990, p.22. Details on efforts by Congress and the Advanced Television Systems Committee (ATSC) to force cable operators to sell converters to subscribers.

Franchises (CED), Archer Taylor, Malarkey Taylor Associates, November 1990, p.24. Details on cable's earliest franchise agreements.

The HDTV selection process (CED), Jeffrey Krauss, Telecommunications and Technology Policy of Rockville, Md., October 1991, p.20. How the FCC's Advisory Committee will select the "best" HDTV proponent.

High marks go to cable ops for CLI filing efforts (CED), Roger Brown, November 1990, p.10. News brief on the FCC's John Wong's comments on 1990 filings.

Home taping of digital audio (CED), Jeff Krauss, Telecommunications and Technology Policy of Rockville, Md., March 1991, p.22. An investigation of Washington's latest debate: Digital audio taping.

Interactive TV gets a jump start (CED), Kathy Berlin, April 1991, p.84. A new proposal by the FCC may grant one half of one MHz to the delivery of interactive services.

Interactive video and data service (CED), Jeff Krauss, Telecommunications and Technology Policy of Rockville, Md., May 1991, p.20. Details on the FCC's notice of proposed rulemaking to create a new interactive video and data service.

Interference, coverage areas and the HDTV decision (CED), Jeff Krauss, Telecommunications and Technology Policy of Rockville, Md., February 1991, p.20. How all-digital HDTV proponent systems affects TV station coverage areas.

MultiPort: Another missed opportunity? (CED), Kathy Berlin, February 1991, p.40. Closed captioning legislation and how if affects (or doesn't affect) MultiPort development.

One year and counting (CED), George Sell, July 1991, p.62. An update on how well (or not well) operators are complying with FCC CLI regulations.

Peaks and valleys along the FCC paper trail (CED), George Sell, July 1991, p.65. How the FCC is updating its CLI database.

Standards (CED), Archer Taylor, Malarkey Taylor Associates, September 1991, p.22. The history and future of industry standards.

Thwarting botched jobs (CED), Wendell Bailey, November 1990, p.18. The costs of bad customer service.

Update on recent FCC action (CED), Jeff Krauss, Telecommunications and Technology Policy of Rockville, Md., August 1991, p.20. Update on effective competition, technical standards, TV captioning decoders and alternate access carriers.

Vendors say CLI fight maturing (CED), Roger Brown, July 1991, p.66. How vendors supplying CLI detection equipment assess cable leakage, one year later.

The year ahead in Washington (CED), Jeff Krauss, Telecommunications and Technology Policy of Rockville, Md., January 1991, p.20. Legislative predictions for 1991.

What we don't know about PCN (CED), Archer Taylor, Malarkey-Taylor Associates, July 1991, p.22. Discussion of spread spectrum, frequency allocation, intrabuilding of propagation and capital investments as it relates to PCN.

Fiber optics

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Aerial fiber construction (CT), Jeffrey Weech, ATC Construction, October 1991, p.70

Aerial plant fiber performs well in lightning (CT), P.D. Patel and Terry Coffman, AT&T Bell Labs, January 1991, p.32

Alternate access and the cable operator (CED), Andy Paff, Optical Networks International, Fiber Optics Special Supplement, September 1991, p.14. A review of the basic considerations surrounding alternate access including products, legal issues and recommended first steps.

AM fiber and digital compression for cable's future (CED), Aleksander Futro, CableLabs, Fiber Optics Special Supplement, September 1991, p.7. Discussion of fiber's role in the future, including AM fiber, coding constraints and microchip cube lasers.

AM fiber links: Performance limits and reliability (CED), J. Lipson, C.B. Roxlo and C.J.McGrath, AT&T Bell Laboratories, November 1990, p.66. The effects of statistical clipping, resonance distortion, shot noise and multi-path interference on analog links.

Avoiding obsolescence (CV), Chuck Moozakis, June 3, 1991, p.18. Flexible networking as a system design tool.

Back reflection in CATV systems (CED), Vedrana Stojanac, Exfo Engineering, March 1991, p.76. What back reflection is and how to measure it.

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Building cable's new communications infrastructure (CED), Andy Paff, Optical Networks International, May 1991, p.82. Using optical platforms for integrated services.

Cable: A self-renewing order (CED), Walter Ciciora, ATC, May 1991, p.98. Thoughts on fiber, 1-GHz technology, video compression and HDTV.

Cablevision plans optical amp, compression tests (CED), Roger Brown, June 1991, p.94. Interview with Cablevision Systems' Wilt Hildenbrand and Al Johnson.

Case study: Fiber to the line extender (CED), Carl Newberry, Cablevision Industries, December 1990, p.46. A step-through analysis of fiber to the line extender implementation.

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The fiber build from start to finish (CT), James Ludington, ATC, April 1991, p.20

Fiber cable placement: An overview of the basics (CT), K. Charles Mogray Jr., Comm/Scope Inc., September 1991, p.20

Fiber couplers for FTF CATV systems (CED), Herzel Laor, ATC (consultant), Fiber Optics Special Supplement, March 1991, p.30. Coupler structures, configurations and other optical specifications.

The fiber factor (CV), Fred Dawson, March 11, 1991, p.44. The real reason for the construction slowdown may lie in cable's transition to fiber optics.

Fiber to the feeder: A case study (CT), Eugene White, Paragon Cable, January 1991, p.26

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Fiber fever! (CV), Fred Dawson, December 17, 1990, p.13. Cable has less to fear from telcos and DBS as the cost/benefit of fiber networks grows.

Fiber and finances: Capitalizing on new architectures (CED), Jon K. Chester, Corning Inc., August 1991, p.66. Case study of Paragon Cable of Florida.

Fiber and finances: Understanding fiber's bottom-line benefits (CED), Jon Chester, Corning Inc., June 1991, p.40. Case study of Continental, New Hampshire's fiber implementation.

Fiber helps Continental Cablevision's quality show (CED), Scott Striegel, Continental Cablevision of Los Angeles, Calif., October 1991, p.34. How Continental replaced its headend-to-hub microwave equipment with fiber.

Fiber lights (CV), Fred Dawson, July 29, 1991, p.22. Cablevision Systems installs an optical amplifier for use at 1550 nm.

Fiber market continues to soar (CED), Roger Brown, April 1991, p.104. Corning's gains in the fiber market, particularly CATV.

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Fiber optic supertrunking: The state of the AM art (CED), George Sell, March 1991, p.55. AM vs. FM and digital supertrunking and 1310 nm versus 1550 nm. issues.

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Front burner for fiber (CV), Fred Dawson, March 25, 1991, p.61. New fiber amplifier technology could speed the implementation of fiber optics.

Full fiber deployment: Transparency in CATV systems (CED), Ronald Cotten, Engineering Technologies Group, Fiber Optics Special Supplement, March 1991, p.18. An analysis of FTF versus conventional fiber designs, including effect on converters.

Fundamentals of optical fiber communication systems (CED), Robert Harris, C-Cor Electronics, January 1991, p.69. Primer on the physics of light and key fiber optic topics including reflection, refraction, prism effects and optical fibers.

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How to examine coupler specifications (CED), James E. Matthews III, Corning Inc, July 1991, p.30. A closer look at performance factors within an optical coupler.

Improving reliability in CATV systems with optical switching (CED), John Mattson, Scientific-Atlanta, Fiber Optics Special Supplement, September 1991, p.24. Using AM fiber for more than cascade reduction.

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Reducing power-related outages in fiber optic systems (CED), Tom Osterman, Alpha Technologies, Fiber Optics Special Supplement, September 1991, p.50. Plant powering changes, FTF node powering and DC powering.

SCTE fiber seminar attracts 575 persons to Orlando, (CED), Roger Brown, February 1991, p.72. Complete technological coverage of the SCTE Fiber

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Some thoughts on fiber optics (CED), Archer Taylor, May 1991, p.22. Why fiber is a sound idea.

Specifying directional couplers for CATV distribution systems (CED), Curt Weinstein, Corning Inc., p.50. How to design with directional couplers.

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Preparing your headend for fiber optics (CT), Mike Kelly, Optical Networks Int'l, February 1991, p.36

Propagation primer (Part 1) (CED), Chris Bowick, January 1991, p.18. The ionosphere and sunspot schedules.

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QPSK and 4-QAM (CED), Chris Bowick, Scientific-Atlanta, July 1991, p.18. Using quadrature modulation for digital transmission, plus how quadrature phase shift keying (QPSK) is indistinguishable from quadrature amplitude modulation (QAM) for CATV purposes.

Quadrature modulation (CED), Chris Bowick, Scientific-Atlanta, June 1991, p.18. More terminology relating to digital video transmission.

Surround sound: Is your system ready? (CED), Leslie Ellis, March 1991, p.28. Preparing the headend for Dolby Surround sound.

Vocabulary-based automation (CED), Julie Peterson, Telecommunication Products Corp., and Tim Black, TBE, December 1990, p.114. Using sophisticated software and routing switches to automate the headend, local origination and commercial insertion. (*Editors note:* The last line of this article was inadvertently omitted. It reads: "...an automation expedition that is cost-effective and reliable.")

Well-run headend trims costs, supports revenue (CED), CableLabs' Staff, May 1991, p.24. The installation and maintenance of CableLabs' new 40-channel headend, plus basic thoughts on cost-effective methods to improve headend performance.

International

Cable technical training: Americans go where the action is (CED), George Sell, October 1991, p.12a. An update on the international training scene.

CATV cables, they can do more (CED), Norbert De Muynck, Piet Lamaitre and Maurits Van De Voorde, Electrabel, October 1991, p.20a. The technical and economic ramifications of two-way services in Belgium.

Preferred network architecture for the United Kingdom (CED), Earl Langenberg, US West, Fiber Optics Special Supplement, March 1991, p.16. Current and future U.K. fiber architectures.

Programming abroad (CED), Wendell Bailey, December 1990, p.22. A look at international programming efforts.

R&D turns academic in Canada (CED), Roger Brown, October 1991, p.8a. Specifics on the Canadian version of CableLabs.

Labwatch

(A CED and CT department, written by the staff of Cable Television Laboratories)

Major issues in network design (CED), September 1991, p.24. An investigation of CATV system design, including fiber optics, power/loss budgets, spectrum allocation, drop concerns and network migration.

Testing viewers' great expectations (CT), March 1991, p.44

Toward a CATV network architecture (CT), July 1991, p.50

Well-run headend trims costs, supports revenue (CED), May 1991, p.24. The installation and maintenance of CableLabs' new 40-channel headend, plus basic thoughts on cost-effective methods to improve headend performance.

Microwave

AML microwave power measurements (CT), Dane Walker, Hughes Microwave, November 1990, p.29

Integrated AML/FO systems (CT), Tom Straus, Hughes Microwave, March 1991, p.30

Microwave performance margin maintenance (CT), Tom Straus and Dane Walker, Hughes Microwave, April 1991, p.32

My View

(All CED columns written by Archer Taylor, Malarkey-Taylor Associates, Inc.)

Alternative access, February 1991, p.22. The history and future potential of non-commercial educational television and I-nets.

Danger ahead, October 1991, p.22. Concerns regarding FCC proposed technical standards for cable television.

Franchises, November 1990, p.24. Details on cable's earliest franchise agreements.

Imagining the future, June 1991, p.24. Things that came true; HDTV skepticism and things that have failed.

Microcellular phones, January 1991, p.24. Background and issues regarding portable PCN telephones.

Network architecture, December 1990, p.30. VSB/AM fiber optic architectures, compression, television receivers and PCN.

NQV and G-Line, August 1991, p.22. A discussion of old-fashioned "not quite video" and early coaxial cable.

Some thoughts on fiber optics, May 1991, p.22. Why fiber is a sound idea.

Spectrum for sale?, April 1991, p.24. An investigation into the traditional process of spectrum management.

Spread spectrum in personal communications, March 1991, p.24. Sharing spectrum, CDMA/TDMA concerns and telco competition.

Standards, September 1991, p.22. The history and future of industry standards.

What we don't know about PCN, July 1991, p.22. Discussion of spread spectrum, frequency allocation, intrabuilding of propagation and capital investments as it relates to PCN.

NCTA

Engineering meeting serves up full plate, February 1991, p.24. NCTA Engineering Committee reports from the December 13, 1990 meeting.

Prime's Pike takes NCTA Vanguard Award for science and technology (CED), Leslie Ellis, May 1991, p.92. Dan Pike, VP of engineering for Prime Cable, receives Vanguard award. Other award recipients also mentioned.

Where wouldn't we be? (Forty years of NCTA) (CED), Leslie Ellis, May 1991, p.27. A historical look at the NCTA's efforts.

Personal communication networks

Building business opportunities (CV), Fred Dawson, July 1, 1991, p.16. Cable/cellular alliances could lead to a more flexible broadband network.

CableLabs PCN conference attracts

Video compression

1-GHz consumer electronic interface (CED), Walter Ciciora, ATC, June 1991, p.114. How to marry GHz technology with existing consumer electronics devices, plus video compression effects.

AM fiber and digital compression for cable's future (CED), Aleksander Futro, CableLabs, Fiber Optics Special Supplement, September 1991, p.7. Discussion of fiber's role in the future, including AM fiber, coding constraints and microchip cube lasers.

An EDTV window for compression? (CV), Fred Dawson, August 26, 1991, p.18. Cable should consider employing a widescreen TV format before launching HDTV.

ATRC's all-digital HDTV proposal (CT), Lawrence Lockwood, TeleResources, June 1991, p.120

Attack of the killer bees (CED), Walt Ciciora, ATC, December 1990, p.154. Video artifacts and how they effect HDTV, compression.

Cable: A self-renewing order (CED), Walter Ciciora, ATC, May 1991, p.98. Thoughts on fiber, 1-GHz technology, video compression and HDTV.

Cable's "top guns" rally behind call for digital compression (CED), Roger Brown, May 1991, p.10. News brief on a N.Y. meeting of the Top Four MSOs and their compression ideas.

Cablevision plans optical amp, compression tests (CED), Roger Brown, June 1991, p.94. Interview with Cablevision Systems' Wilt Hildenbrand and Al Johnson.

CableLabs seeks compression info (CED), Roger Brown, April 1991, p.12. News brief on CableLabs subcommittee on digital video compression.

Compression, HDTV and interactive TV (CED), Roger Brown, May 1991, p.10. News brief on CableLabs' HDTV project.

Compression on the fast track (CV), Fred Dawson, April 22, 1991, p.22. Compression will multiply channels sooner than expected, but adopting it won't be easy.

Compression passes Cablevison's test (CED), Roger Brown, October 1991, p.12. News brief on the results of Cablevisions' Hicksville, N.Y.-based compression tests.

Compression technology draws crowds (CED), Kathy Berlin, May 1991, p.56. Coverage of 1991 National Show technical session on video compression.

Expanding cable's bandwidth: How high do we go, and when? (CED), Steve Necessary, Regal Technologies, September 1991, p.54. Discussions relating to compression, expansion and economic rewards associated with GHz technology.

The impact of digital compression on system rebuilds (CED), David Grubb III, Jerrold Communications, August 1991, p.56. Channel capacity and its impact on system design, amplifier performance and different upgrade scenarios.

Jerrold debuts compression method, PPV converter; demonstrates PCN (CED), Roger Brown, April 1991, p.10. News brief on Jerrold's product announcements prior to the 1991 National Show.

Jones sees "urgent" need to test video compression (CED), Roger Brown, August 1991, p.10. News brief on Jones Intercable's decision to test SkyPix video compression systems for terrestrial and satellite delivery.

More on video compression (CED), Walter Ciciora, January 1991, p.82. Sources of redundancy in television signals.

Network architecture (CED), Archer Taylor, Malarkey-Taylor Associates, December 1990, p.30. VSB/AM fiber optic architectures, compression, television receivers and PCN.

Race against time (CV), Tom Kerver, May 20, 1991, p.20. Skypix may be forced to lose its lead in video compression.

SkyPix digital compressed video system on cable (CT), Stephen Hatcher, Summit Design, and Theodore Chesley, Rock Associates Inc., September 1991, p.48

TCI, Viacom, Labs issue compression RFP (CED), Roger Brown, October 1991, p.10. News brief on compression RFP.

Testing compressed digital video signals: A case study (CT), Theodore Chesley, Rock Associates Inc., May 1991, p.28

Video compression artifacts (CED), March 1991, p.90. How to look for video artifacts.

What about Skypix? (CV), Chuck Moozakis, April 8, 1991, p.24. Gordon Rock says his experiments prove compression is commercially viable.

What is video quality? (CED), Walter Ciciora, ATC, April 1991, p.112. Factors involved in measuring video quality.

When one wire equals three wires (CED), Walter Ciciora, ATC, November 1990, p.82. Compression and what it means for telco video "wanna-be's."

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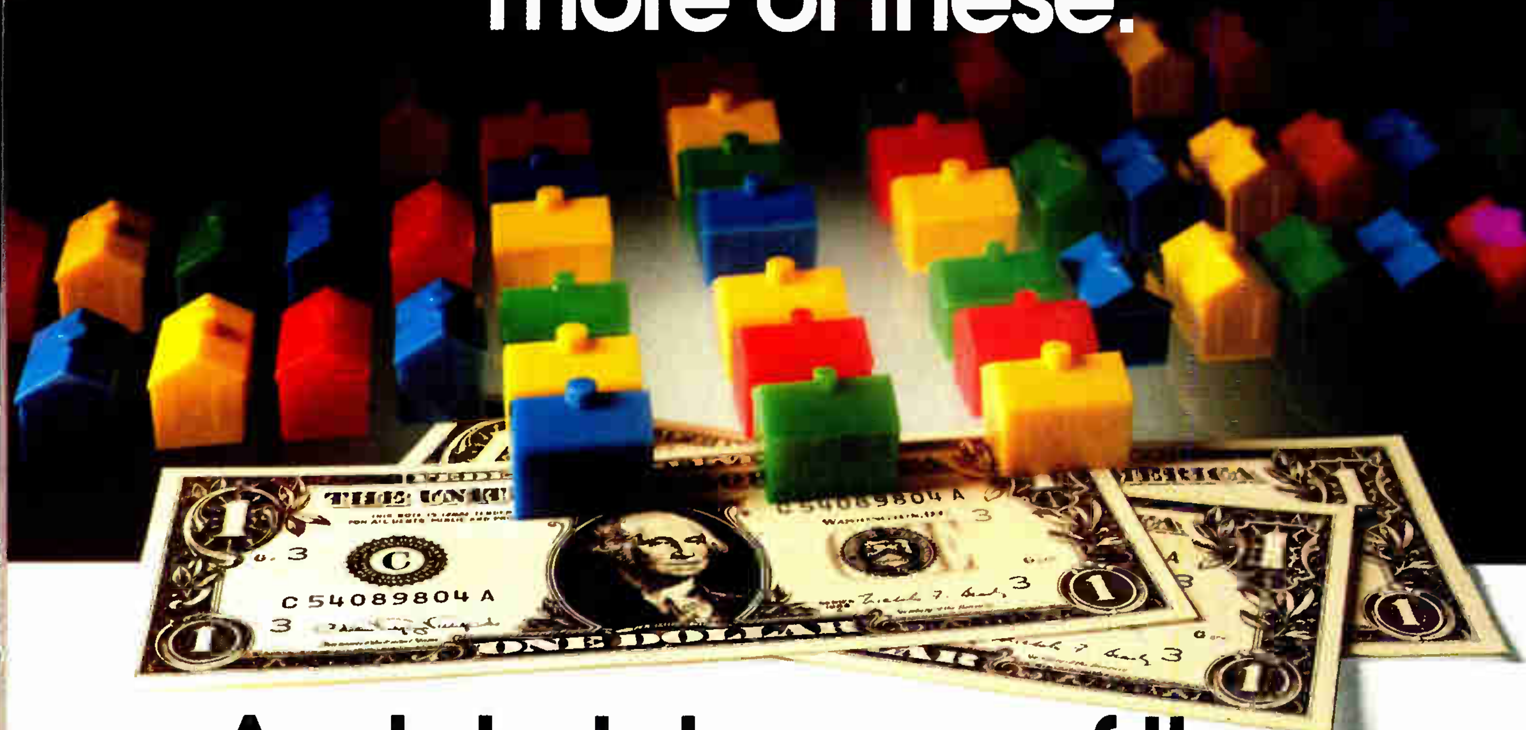

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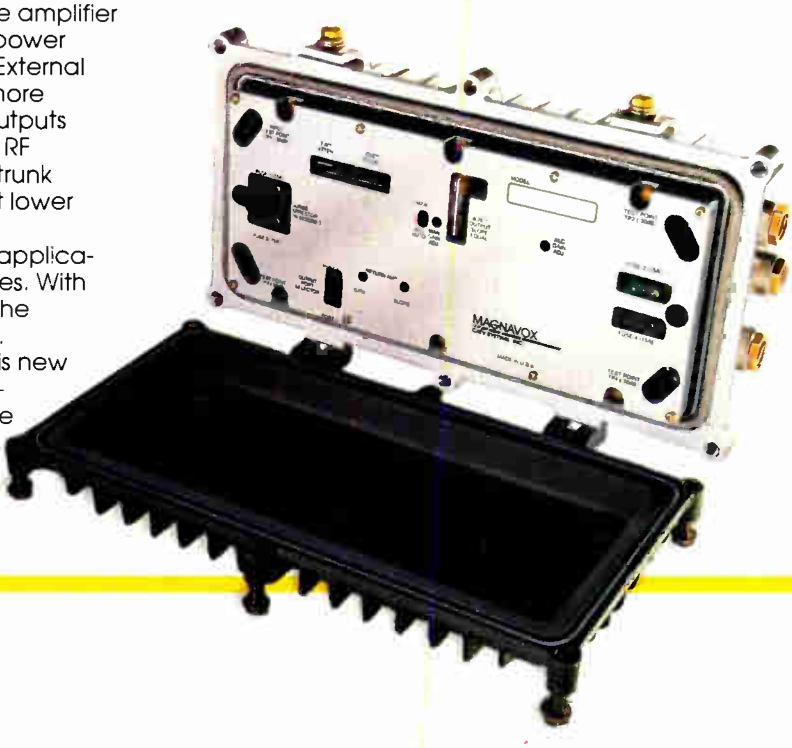

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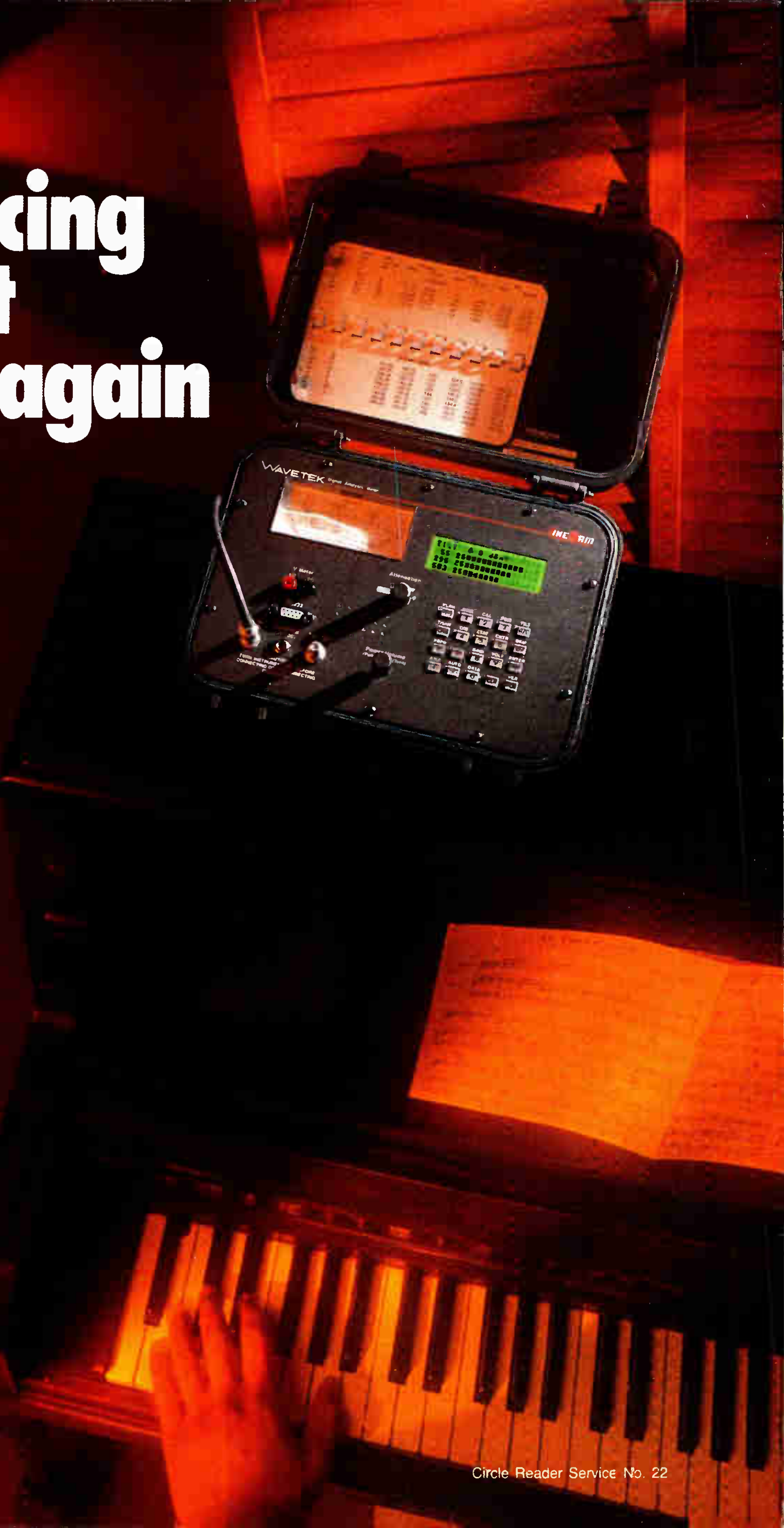

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out with the crawl message to capture the viewer's attention.

A "bare-bones" ACM system that addresses four channels would cost a cable operator about $7,000, according to Ken Lawson, VP of marketing at Dynatech Cable Products. The system can be expanded in increments of four channels at about $2,500 per chassis, he added.

In New Jersey, the ACM system can be accessed from a variety of locations and by different means, including the microwave network, telephone modem and voice (see Figure on page 32). The ACM chassis are installed in the headend ahead of the modulators and each chassis feeds up to four channels.

KAS Cable, which operates the on-base cable system at Wright-Patterson Air Force Base in Dayton, installed the ACM system on all 36 channels about two years ago, according to Dan Kinney, system technician. Since then, it's been used to warn the base's 2,500 subscribers of high winds and tornadoes. It's also been used to deliver "Welcome Home" messages to troops returning from the Persian Gulf, for syndex switching requirements, to advise of impending outages and for pay-per-view.

Kinney said the system cost about $20,000 to install and has worked flawlessly. The base's headquarters command post serves as the home for the remote control terminal, he added.

These systems are fine for anyone watching television, but what happens if an emergency occurs when the television isn't on or if it's being used for another purpose (i.e. video games)?

Hollyanne Corp. has one answer. The Safety Alert Monitor system can alert even sleeping residents by delivering an audio alert for impending disasters or emergency situations. An in-home receiver about the size of a cable converter is connected to the cable system is addressed by a headend controller. Large geographical areas can be split up into as many as 31 zones and each zone can be addressed separately or in any combination.

The headend controller requires no cable system intervention; it is activated by local emergency officials via touchtone telephone, two-way radio or by the National Weather Service. Besides the controller, a cable system needs a National Weather Service receiver and a modulator to make the system work. The frequency agile system requires just 30 kHz of bandwidth to send its message.

The in-home receivers cost about $70 each, although cable operators using the receivers are expected to rent the units to their subscribers for just a few dollars per month.

So, will cable operators commit to EBS? At this early stage, it's hard to say. But one thing is certain: If cable is to participate, the system must be inexpensive and not require additional personnel to monitor its functions. The rest is a policy question that will have to be answered by cable industry officials.

But on the technology front, things are beginning to happen. The SCTE, under the auspices of its Engineering Committee, has established an EBS subcommittee to help establish recommended practices for cable operators who are willing to interface with EBS. The subcommittee's goal will be to design an applications standard and disseminate information to all members.

According to Tom Elliot, vice president of research and development at TCI and the chairman of SCTE's Engineering Committee, this subcommittee will rely heavily on cooperation from the NCTA and its engineering committee, as well as input from Cable Television Laboratories. ■

—Roger Brown

with no sharp bends. The strand attachment needs to be a by-metal connection (press-type preferable). The ground rod attachment needs to be a solid connection to a clean surface. Any resistance at the connections will reduce the value of the ground.

If an existing ground is in place, it would be preferable to use a separate down lead and bond at the ground rod. The parallel down leads will provide a lower impedance path for the higher frequency transients. This needs to be approved by the administrator of the pole attachment agreement.

Should this location be a problem area, the ground resistance could be reduced by the addition of another ground rod. The ground rods are most effective when separated by a distance of 1.1 times the length of the rods. Separate ground rods need to be bonded together with #6 or larger copper wire.

Places to avoid. Grounding should be avoided at pole locations where the electric utility has spark gaps, lightning arresters or primary switching. These locations have the capability to discharge some extremely high electrical potential. A significant portion of that discharge could be transferred to the CATV plant. Grounding should also be avoided at locations that indicate a high current in the bonding conductor.

Cost. Grounding costs will vary in different parts of the country, again depending on labor costs. Material costs will differ only slightly unless there is a requirement for some exotic types of grounding like chemical rods or extremely long rods.

> Longitudinal sheath currents are an unwanted electrical energy induced on the messenger and sheath of the cable.

Estimated costs for labor and material for grounding to an existing electrode would require a separate down lead, exposing and cleaning the electrode to make the bend. This costs about $ per hour for labor and materials. Driving an additional separate grounding electrode can have a wide range of pricing. If access is available for a normal grounding electrode to be driven, the cost for labor and materials is about $30.

If minimum grounding is completed by installing a down lead and using the power company electrode, the cost for four contacts per mile would be about $80 per mile. One the other hand, if a down lead and newly driven electrode is required, the cost could be $1 per mile or more. These costs do not consider the cost of removing sections of concrete and then repairing the opening after the grounding is complete.

Any area that experiences multiple failures that indicate they are because of power-related problems needs to be investigated in the following method: Test grounds; measure sheath currents; measure bonds for current flow; and lift bonds if there is high current.

Problems of high currents or high ground resistance should be referred to the power company and their assistance should be requested to resolve the problem. Improving the ground resistance and lowering neutral current flow is a benefit to both parties.

If the power company is unable to provide the assistance needed, the bond could be relocated to another location. The important requirement is that four bonds per mile remain.

Longitudinal sheath currents

Longitudinal sheath currents (LSC) are an unwanted electrical energy induced on the messenger and sheath of the cable. This is the result of bonding to the power company multigrounded neutral.

Most of the power distribution systems today are wye-connected four wire primary and three wire secondary with one of the wires being the common neutral. When all the loads are perfectly balanced there is zero current flowing in the neutral.

The probability of all loads being perfectly balanced is unlikely. Consequently, there is usually some current flowing most of the time.

It is not unusual to find 50 to 150 amperes of neutral current under normal conditions and well in excess of 300 amperes in a fault condition. The strand and coaxial cable system that has multiple cables will carry a substantial portion of the neutral currents.

Not only will the cable company share the load—in many cases, it will carry the major portion of the load. Typical

GROUNDS # Ω	NEUTRAL Size Type	CATV Strand +	%LOAD CATV	%LOAD Neutral	%LOAD Ground	CATV Amps*
4 20	4-0 ALM	412+500	26.0	52.0	22.0	15.6
4 20	4-0 ALM	500+750	36.7	44.5	18.8	22.1
4 20	4-0 ALM	625+750	41.5	41.1	17.4	24.9
4 20	4-0 ALM	1+750+625	65.3	24.4	10.3	39.2
4 5	4-0 ALM	625+750	27.3	27.0	45.7	16.4
4 5	4-0 COP	625+750	21.3	43.1	35.6	12.8
4 5	# 4 COP	625+750	32.7	12.9	54.5	19.6
16 20	4-0 ALM	625+750	27.3	27.0	45.7	16.4

* Total potential 60 Amperes

Table 1

trunk feeder systems may be strand, .750-inch and .625 cable, with a total parallel resistance of .099 ohms per 1,000 feet. The power company neutral may be a 4/0 aluminum which would also have a resistance of 0.1 ohms per 1,000 feet. With the same resistance in each path and both paths bonded to the same grounding electrodes the neutral currents would be shared equally (see Table 1).

Load Sharing

The cable system with a 1.0-inch supertrunk, 0.750-inch trunk and 0.625-inch feeder on quarter-inch strand would have a resistance of .037 ohms per 1,000 feet. This compares to the 0.1 ohm of 4/0 aluminum the cable system would be carrying over 65 percent of the total neutral current.

A typical system without supertrunk, with four bonds per mile to power with grounds at about ohms per ground would result in the cable system carrying 41.6 percent of the load, power neutral with 4/0 aluminum 41.1 percent and 17.4 percent dissipated to ground.

The ratios change if the power neutral changes, the ground resistance changes, the number of ground rods change or the CATV plant changes. By changing the grounds from 20 ohms to 5 ohms, for example, the percentage of the load dissipated to ground changes from 17.4 percent to 45.7 percent. The same change would also occur if the number of -ohm grounds were increased from four per mile to 16 per mile. A greater percentage of the load can be dissipated by adding additional grounding electrodes or reducing the resistance of the electrodes.

Another important component to the mix is what the power company is using for a neutral conductor. Changing from a 4-0 aluminum neutral to a 4-0 copper causes the percent of load carried by the neutral to change from 41 percent to 59 percent. Conversely, if the neutral is changed from 4-0 aluminum to #4 copper, the neutral load would change from 41 percent to 22 percent. The CATV load would increase from 41 percent to 55 percent.

While it is worthwhile to calculate all these numbers to understand the possibilities, the problem is, this is not the real orld, all grounds are not 20 or 5 ohms. There are different combinations of cables and there may be different combinations of power company neutral conductors. Other differences include changing power loads and load balance. For the CATV plant to carry 60 percent of a five ampere load would probably not be a problem—but 60 percent of a 300 ampere fault condition load is a serious problem.

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Shared Environments and Sheath Currents, J. Richard Kirn, Communications Technology, August 1987

Reducing Longitudinal Sheath Currents in Transport Trunks, Ron Hepler, Communications Technology, September 1989. ■

SCTE

Following is a list of SCTE technical seminars with contact name. If known, location and seminar topic are listed.

December 9-11 "Technology for technicians II" National SCTE seminar, Holiday Inn, Phoenix, Ariz. Intensive three-day seminar designed for maintenance technicians, chief technicians and system engineers. To be conducted by SCTE director of training Ralph Haimowitz. Contact SCTE headquarters, (215) 363-6888.

December 10 *Badger State Chapter* "System design, MDU design and construction." To be held at the Holiday Inn, Fond du Lac, WI. Contact Gary Wesa, (414) 496-2040.

December 10 *Chattahoochee Chapter* "Signal Leakage, CLI and FCC Form 320." To be held at the Perimeter North Inn, Atlanta, Ga. Contact Hugh McCarley, (404) 843-5517.

December 10 *Greater Chicago Chapter* "Video and Audio Signals and Systems. BCT/E examinations to be administered. To be held at the Embassy Suites Hotel, Schaumburg, Ill. Contact Bill Whicher, (708) 438-4423.

December 11 *Great Plains Chapter* BCT/E and installer examinations to be administered at both levels in categories I, III, VI and VII. To be held at the Crown Court Quality Inn, Bellevue, Neb. Contact Jennifer Hays, (402) 333-6484.

December 12 *Music City Meeting Group* To be held at the Bonanza Trinity, Nashville, Tenn. Contact Jim Romese, (615) 244-7462.

December 12 *Northern New England Meeting Group* "Test Equipment" with Joel Welch of Cablevision. To be held in Portland, Maine. Contact Bill DesRochers, (207) 646-4576.

December 13 *Miss-Lou Chapter* "Fiber Optics" presented by Sumitomo Electric; "Ladder Safety and Care" presented by Batavia and "Safety, Care and Maintenance of Climbers" presented by Rod Paul of Bashlin. Installer and BCT/E examinations to be administered at both levels in all categories. Contact Dave Matthews, (504) 923-0256.

December 13 *Wheat State Chapter* BCT/E examinations to be administered at both levels in categories I, III, V and VII. To be held at the Red Coach Inn, Wichita, Kan. Contact Mark Wilson, (316) 262-4270.

December 14 *Cactus Chapter* Installer and BCT/E examinations to be administered at both levels in all categories. To be held at Tucson Cablevision, Tucson, Ariz. Contact Harold Mackey Jr., (602) 352-5860, ext.135.

December 14 *Chesapeake Chapter* Installer and BCT/E examinations to be administered at both levels in all categories. To be held at Comcast offices in Timonium, Md. Contact Mike Manz, (301) 662-7734.

December 14 *Delaware Valley Chapter* "Headend maintenance" and "Lightning and surge protection." To be held at Williamson's Restaurant, Willow Grove, Pa. Contact Rich Blandford, (215) 328-0977.

December 14 *Piedmont Chapter* Installer and BCT/E examinations to be administered at both levels in all categories. To be held in Ashville, N.C. Contact Rick Hollowell, (919) 757-0279.

December 14 *Central Indiana Chapter* BCT/E examinations to be administered at the technician level in all categories. To be held at Applied Instruments, Beech Grove, Ind. Contact Joe Shanks, (317) 646-9102.

December 18 *New Jersey Chapter* "Other Technologies: Friend or Foe." To be held at the Holiday Inn, Wayne, N.J. Contact Jim Miller, (201) 446-3612.

December 18 *Snake River Chapter* "CLI, Installer Level Drop Specs and NEC Grounding" with Roger Glass of Comm/Scope and "Weak Link" with Bruce Habeck of Anixter. Installer and BCT/E examinations to be administered at the technician level in categories V and VII. To be held at the Weston Plaza, Twin Falls, Idaho. Contact Ron Kline, (208) 376-0230.

December 18 *San Diego Meeting Group* "Test Equipment Measurements." To be held at the Elks Lodge, Oceanside, Calif. Contact Kathleen Horst, (213) 831-4157.

December 19 *Big Country Chapter* To be held in Brownwood, Texas. Contact Bill Neely, (915) 236-6375.

December 19-20 *Dakota Territories Chapter* Installer and BCT/E exams to be administered. Contact Ken Binkerd, (605) 339-3339.

December 28 *Sierra Chapter* BCT/E exams to be administered at both levels in all categories. To be held at the Roseville City Hall, Roseville, Calif. Contact Eric Brownwell, (916) 372-2221.

Universal remotes: Advanced features and dumb ideas

This is the last of three columns on universal remote controls. After a couple more "advanced features and/or dumb ideas," we'll try to estimate what the subscriber really wants and see if there is a way to accommodate it.

There are a few more ideas I've seen on remote controls from satellite receiver integrated receiver descramblers (IRDs) which should be mentioned, in order to be complete.

The first is a lighted remote control. Any time a button was pushed, the translucent buttons lit up so the user could see what he was doing, even in the dark. After a few seconds, the light went out, unless more buttons were pushed. Besides cost, there is a severe battery life penalty to be paid. The reasonable approach is to provide a separate battery for illumination. This provides control after the lights have gone out.

Another idea I've seen involves a locater for the misplaced hand unit. Pressing a button on the IRD sends a signal to the remote control, causing it to emit a tone so it can be found. This is a cute idea, but not inexpensive.

What the subscriber wants?

If you talk to subscribers, visit their homes and listen, you'll find several things on their minds. If they have an older set without remote control, they consider the remote controlled converter a good feature. They don't even mind paying a modest fee.

It's when they have a relatively new receiver that they get upset. First, they resent having to pay an extra fee for what they have already bought. Second, they wish they could just use their own remotes. It's a pain to use multiple remotes; one to turn on the television and adjust the volume and another to change converter channels.

The universal remote can be helpful here, because it can direct the channel change signals to the converter and the volume control and mute signals to the TV.

In fact, there is little good reason to have a volume control feature on the converter. The TV is the proper place for that function. The only exception to this is when the subscriber's TV has no remote control. This is becoming a rare situation.

Use your own

A decade or so ago, when I first started thinking about remote controls, I had the idea the other way around. I thought the proper place for the intelligence was in the set-top unit. It should have the codes stored from the TVs and VCRs and be able to interpret them. The subscriber would not get a new remote control. That way, the remote control remained an inexpensive item. The subscriber wouldn't feel so bad when it got lost, chewed by the dog, or broken under the rails of the rocking chair.

There is one part of this idea which is a bit untidy. For this to work, the TV's and VCR's infrared (IR) must be covered so that it doesn't see signals from the remote control. The set-top box has to convey IR signals to those windows. The method I suggested was either a plastic fiber taped to the IR windows or an IR light emitting diode (LED) affixed to them.

VCR interface

What subscribers really want is the ability to use their VCRs for time shifting without having to program the VCR. That was the next important feature of the above mentioned configuration.

Since the set-top had to have an IR link via fiber or LED-on-a-wire to the VCR, the set-top could control it. With an electronic program guide (EPG), the set-top would know what time it was and what the start and stop times and channels of various programs were. The subscriber could simply move the flashing cursor next to the title of the program to be recorded and press the record button, and all the rest would be taken care of by the set-top's microprocessor.

Tyranny of the toggle

But there is yet another untidy detail. Most VCRs and TVs have toggle controls for some functions. One button turns the unit on if it's off, and off if it's on. (Life would be so much simpler if there were two buttons, one for "off" and the other for "on.")

Similarly, on the VCR, there is a toggle button for determining whether the signal to the TV is from the VCR's tapedeck or a bypass of the RF signal at the VCR's input. Older televisions could be plugged into a switched convenience power outlet on the back of the converter. New televisions will not come on when they are repowered. When they are turned on, they will usually be tuned to channel 2. If that isn't the converter's output channel, there's is a problem. This motivates the use of "macros" in universal remote controls (see November 1991 *CED*, p.118.)

There are a number of clever solutions to the tyranny of the toggle. They all add expense and complication to both the converter and the installation. In some cases, the converter would have to access to the VCR's output to determine the state of toggles. The signal would then be routed to the TV for display. But, this contributes to the maze of cables behind the TV.

The dangers of blasters

One last comment on remote controls. There have been a number of poorly designed systems that require careful aiming of the hand unit. Surprisingly, major brand names have suffered this problem.

In an attempt to solve this deficiency, after-market devices have surfaced which amplify the remote control's output. They are generally called "blasters."

These should be avoided. There is danger of eye damage, particularly among children who may pick up the device and look into it while inadvertently (or purposefully) pressing the buttons. The power from IR remotes must be kept low, not only for battery life, but for safety. ■

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

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24 HOUR TEST

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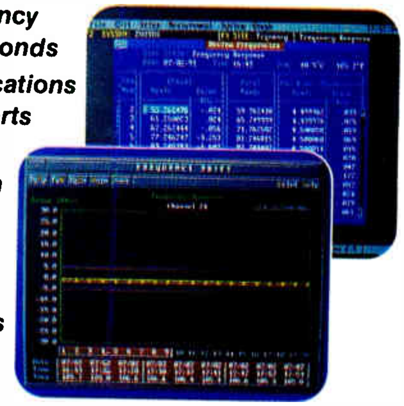

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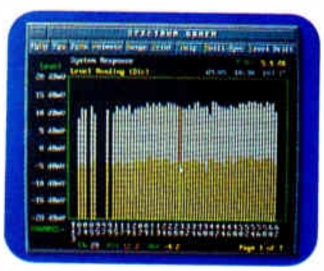

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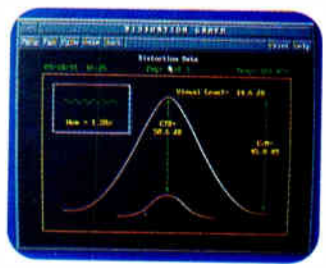

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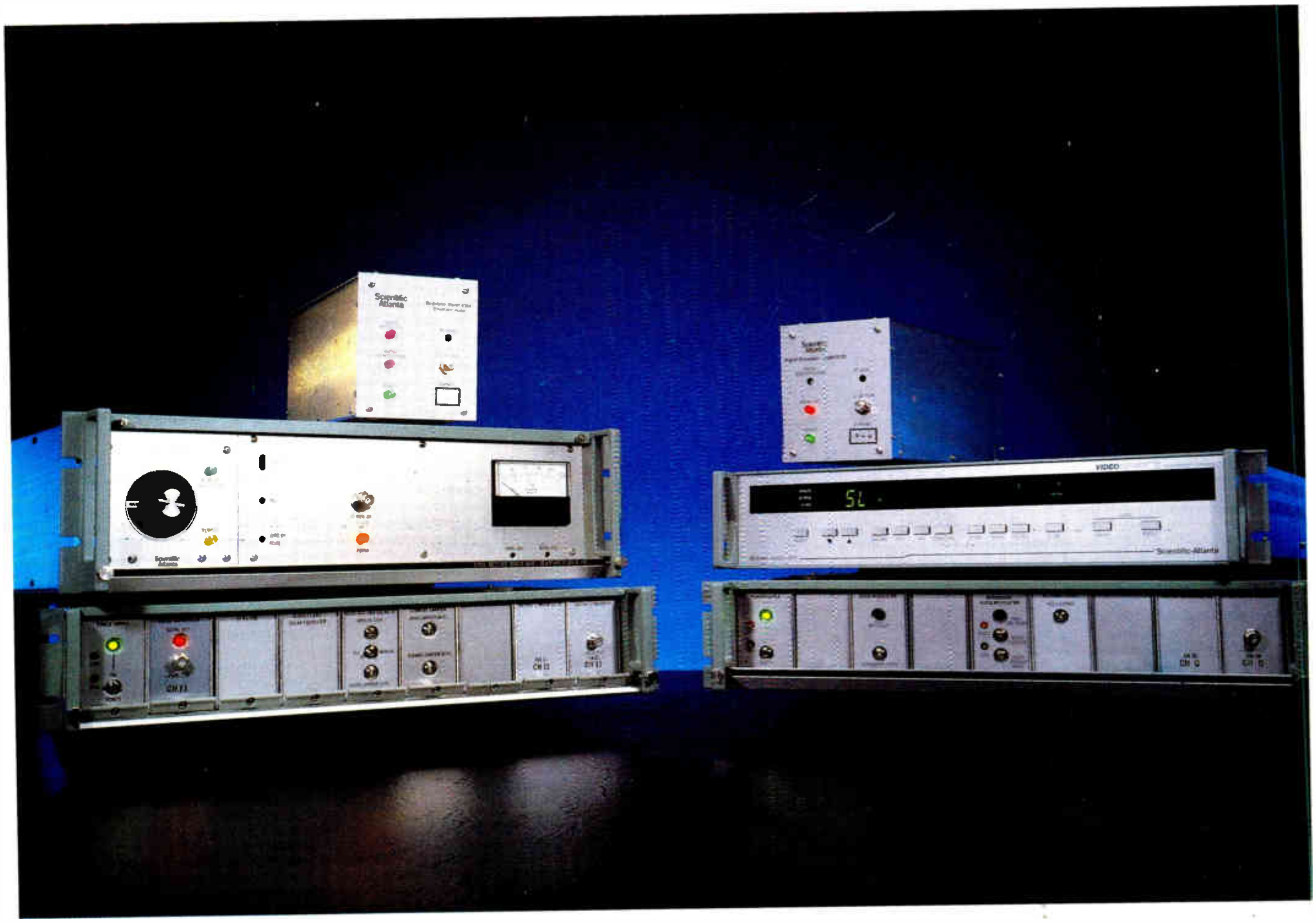

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