# CED™

Communications Engineering & Design/The Magazine of Broadband Technology

September 1985

**Chiddix: Fiberoptic supertrunking**
**Leffingwell: Broadband modems**
**Brugliera: Is two-way dead?**
**Hunter: Standby power**
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**VCR interfaces**

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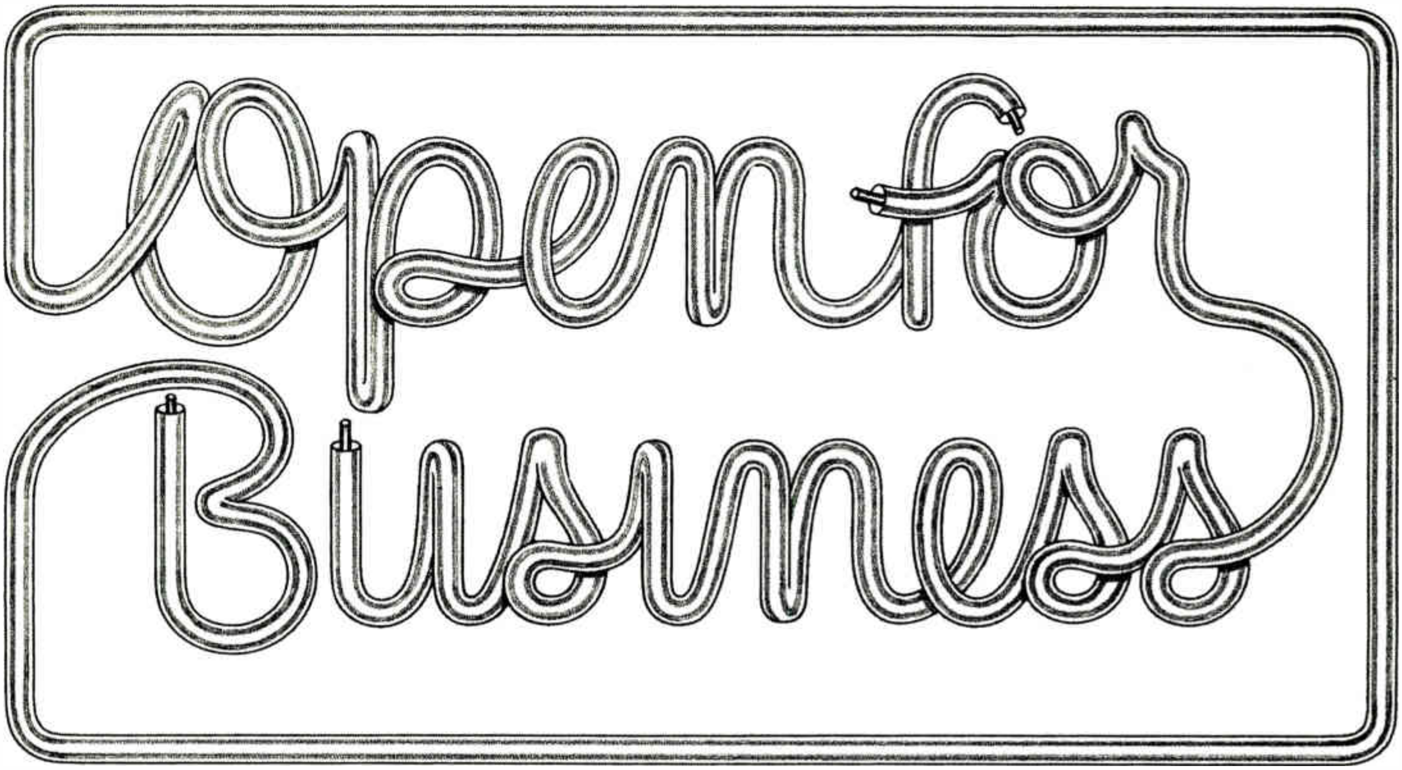


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**Reader Service Number 2**

CED

September 1985



**About the cover**

Pictured is an unterminated fiberoptic cable. Photo courtesy of Times Fiber Communications.

 CED. (USPS 300-510) (ISSN 0191-5428) is published monthly by International Thomson Communications Inc., 600 Grant St., Denver, CO 80203. September 1985, Volume 11, Number 9. Subscriptions free to qualified industry readers. All other one-year subscriptions are $26, prepaid in U.S. funds only. Second-class postage paid at Denver, CO. *CED* is published on behalf of the cable television and broadband communications industries. POSTMASTER: Please send address changes to P.O. Box 5208 T.A., Denver, Colorado 80217. MEMBERS OF THE BPA.

BPA

# Brian James

Brian James is switching hats and changing horses. He's been the Canadian cable industry representative to the NCTA Engineering Committee for about a year. But in September he takes the reins as NCTA director of engineering. It's a big saddle, but he's used to that. What's new is how much the horse bucks.

"The U.S. is somewhat ahead of Canadian cable in that it has a better regulatory climate. If someone wants to try something, well, go ahead and do it. That really isn't encouraged in Canada at this point. Operators are allowed only two U.S. services for each Canadian service—and there are not that many Canadian services. This is part of the CRTC philosophy—trying to protect the Canadian culture. That's sort of been its driving force since it came into existence, and I'm not totally convinced the philosophy is worthwhile.

"Certainly, pay TV had been talked about for Canada as long as it had been in the U.S.," says James. "1958 or '59 was the start of the Canadian interest, but nothing was gained until the CRTC finally allowed pay TV in the early 1980s. Also, rate increases were held to a minimum during inflationary periods until the operators' bottom line started to hurt. They couldn't spend money expanding systems or improving them. Over the last couple of years, things have improved somewhat. Operators are sort of encouraged to look at other areas of adventure and use the cable for more than just transporting television."

James began his cable career while attending the University of Waterloo, Ontario, studying electrical engineering. As a student he was employed by a cable company to install second outlets. From installations, James went into service maintenance, design and some construction. On the final work term, he was with Jerrold Canada. "At that time, I decided that cable was an interesting field and I wanted to continue there," says James. After graduation, he joined Switzer Engineering and worked for Sruki Switzer until December 1981 when he moved to Cablesystems Engineering.

In his position with Rogers Cablesystems, James supervised technical audits of the cable systems. He also worked as an engineering consultant, the most recent assignment being an NCTA-commissioned test of competing multichannel sound formats on cable systems. "I feel I was doing worthwhile work with Rogers, but the NCTA job looked more challenging. Living in the States will be different, but I don't have a problem with it," says James. "I like the idea of keeping up on technology. The NCTA job seems like a good spot for me to stay on top of everything."

In his new position, James feels keeping on top of changing technology is of the highest importance. One of the issues he is prepared to deal with is signal leakage and the interaction with amateur radio hams. "It hasn't been followed the way it should because of the overwhelming work load of the NCTA. I'll be attending regular meetings with the ARRL to go over signal leakage." Part of his job also will be interfacing with the FCC on proposed changes to regulations. The effects these changes will have on cable systems is of interest to James. "I'll be discussing those effects with operators and interfacing between them and the FCC."

Data communications and the marketing of premium services should be targeted for improvement throughout the industry, James believes.

"I think cable has to find areas where it can do a good job, better than the telephone company, and get into data communications. We have to get into dedicated systems, sort of an institutional route, rather than trying to piggyback them with television services."

If pay growth rates are slowing down, duplication is to blame, James argues. "If a consumer buys HBO and Showtime, he sees a lot of duplication there, and people are wondering whether they need both. If the economy stays healthy, they'll keep both services," he says. "The whole industry is somewhat economy driven as far as the discretionary channels go."

Marketing also has to change so people know what cable offers and what to expect, he adds.

*—Kathy Berlin*

# The decibel

*By Archer Taylor*
*Malarkey-Taylor Associates Inc.*

**Q:** What is a decibel?
A: One tenth of a bel, stupid!

I believe most engineers and technicians recognize that the decibel always represents a power ratio. According to Ohm's famous law, a power ratio also can be stated as the square of the corresponding voltage ratio, but only if the voltages are measured across the same resistance.

$$P_1/P_2 = (E_1^2/R)/(E_2^2/R)$$
$$= (E_1/E_2)^2 \text{ decibels}$$
$$= 10 \log (P_1/P_2)$$
$$= 10 \log (E_1/E_2)^2$$
$$= 20 \log (E_1/E_2)$$

However, I have discovered that some technicians, and even some engineers, do not realize that "dBmV" represents a power level, even though the "mV" stands for millivolts. This is because the "dBmV" is *always* measured across a 75 ohm resistance (or is corrected to 75 ohm). "dBmV" is a special case of the decibel in which the denominator of the ratio ($P_2$ above) is always the power level represented by one millivolt across 75 ohms, or 13.33 nanowatts (billionths of a watt).

$$P_2 = (0.001)^2/75 = 13.33 \times 10^{-9} \text{ watts.}$$

Whether you define the dBmV as 10 times the logarithm of the power relative to 13.33 nW, or 20 times the logarithm of the voltage relative to 1 mV across 75 ohms, **"dBmV" is a power ratio.**

The chief engineer of an old-line, prestigious, pre-World War II instrument company once called me to complain about what he called the "ambiguity" of the dBmV unit of measure. He pointed out, quite correctly, that the 1 millivolt output from the 100,000 ohm terminal of his signal generator was not the same thing as 1 millivolt measured by a signal level meter with 75 ohm input (sometimes incorrectly called a field strength meter). He had failed to note the important part of the dBmV definition that specifies voltage across 75 ohms.

dBmV is a power level. Remembering that will make it easier to understand splitters, couplers, combiners, matching transformers and even fiberoptical transducers.

I wish we had a better designation for our power levels. In the early days of cable TV, 35 years ago, Jerrold invented the term "dBj." After a couple of anti-trust judgments, the dBj gave way to the dBmV.

At one time, the Engineering Committee considered dBn, referenced to one nanowatt, or about -11.25 dBmV. But the risk of confusing dBn and dBm is just too great.

A serious proposal was made to use the term dBc (c for cable) to avoid any inference about voltage. But, just at that time, three Canadian CATV equipment suppliers were merged to form a new company now known as Delta-Benco-Cascade—DBC. So, it was back to the drawing board.

Maybe *CED* (or the SCTE) should run a contest for an acceptable substitute. The winning suggestions would have to be accompanied by a foolproof plan for promoting the new term. The winner could be enshrined in the Cable Hall of Fame.

If you ever have occasion to convert decibels (db) to power (or voltage) ratios, but do not happen to have a conversion chart, calculator or even a slide rule (remember them?), here is an easy way to make your own chart while watching TV in the motel. If you remember that zero dB is a ratio of 1.0, and 10 dB is a power ratio of 10.0, you only need to know two other facts:

- A 3 dB increase doubles the power ratio.
- The square root of 10 is 3.16.

Write the numbers 0 to 10 in the left hand column (see chart).

**Step One.** Starting from a ratio of 1.0 at 0 dB, double the ratio for each 3 dB increase.

**Step Two.** Starting from a ratio of 10.0 at 10 dB, half the ratio for each 3 dB decrease.

**Step Three.** The ratio for 5 dB (half of 10 dB) is the one-half power (i.e. square root) of 10. Write the square root of 10, or 3.16, opposite 5 dB. Reduce by half for 3 dB down, and double for 3 dB up. There you have your power ratio table, accurate to ±0.7 percent.

To get voltage ratios, multiply the dB column by 2. For odd numbers of dB, simply average the ratios above and below.

I won't bore you with what to do with it now. CED

| dB | STEP 1 | STEP 2 | STEP 3 | POWER RATIO | ERROR | dB | VOLTAGE RATIO | ERROR |
|---|---|---|---|---|---|---|---|---|
| 0 | 1.00 | | | 1.00 | --- | 0 | 1.0 | |
| | | | | | | | 1.125 | +0.3% |
| 1 | | 1.25 | | 1.25 | -0.7% | 2 | 1.25 | |
| | | | | | | | 1.415 | +0.2% |
| 2 | | | 1.58 | 1.58 | -0.3% | 4 | 1.58 | |
| | | | | | | | 1.79 | +0.7% |
| 3 | 2.00 | | | 2.00 | +0.2% | 6 | 2.0 | |
| | | | | | | | 2.25 | +0.5% |
| 4 | | 2.50 | | 2.50 | -0.5% | 8 | 2.5 | |
| | | | | | | | 2.83 | +0.4% |
| 5 | | | 3.16 | 3.16 | -0.1% | 10 | 3.16 | |
| | | | | | | | 3.58 | +0.9% |
| 6 | 4.00 | | | 4.00 | +0.5% | 12 | 4.0 | |
| | | | | | | | 4.5 | +0.7% |
| 7 | | 5.00 | | 5.00 | -0.2% | 14 | 5.0 | |
| | | | | | | | 5.66 | +0.7% |
| 8 | | | 6.32 | 6.32 | +0.2% | 16 | 6.32 | |
| | | | | | | | 7.16 | +1.1% |
| 9 | 8.00 | | | 8.00 | +0.7% | 18 | 8.0 | |
| | | | | | | | 9.0 | +1.0% |
| 10 | | 10.00 | | 10.00 | --- | 20 | 10.0 | |

## Broadband LANs

Your June editorial solicited input on what can be done to make the world take broadband technology seriously for LAN applications.

As you know, General Motors has selected the 10 Mbps broadband version of IEEE 802.4 to provide layers one and two of their Manufacturing Automation Protocol (MAP). MAP has been endorsed by a very impressive cross section of the U.S. manufacturing industry. These companies are planning to use broadband technology as an integral part of production lines where the cost of downtime can exceed $10,000 per minute. For this reason, both the potential end-users, like GM, and the vendors of equipment, like Scientific-Atlanta, have been working very hard to ensure that the proposed networks meet the required performance objectives.

The major formal activity to ensure correct operation of broadband LANS has occurred under the auspices of IEEE 802. A group called the Broadband Technical Advisory Group (BBTAG in this acronym-ridden industry) was established as 802.7. This group includes experienced members of the CATV community and has as its charter the review of all proposed 802 broadband standards (802.3, 802.4 and 802.5) to ensure that the standards as written are, in fact, consistent with networks using CATV technology.

One outcome of their activities will be a book called: *802.7: Broadband LAN Recommended Practices*. This book will summarize the specifications to which the broadband LAN must be built (SNR, group delay, return loss, etc.); the recommended medium usage (frequency allocations, signal level assignments); system documentation requirements; system installation and certification practices and, finally, system maintenance recommendations.

All of the vendors and users involved in 802.7 are very sensitive to the need to avoid $10,000 per minute failures which can be blamed on the broadband medium. Their efforts should ensure that the broadband LANs planned for the next decade will be reliable and functional.

In short, members of the CATV vendor community are taking very seriously the challenge of ensuring that the technology originally developed for CATV is transferred to its new application in a professional manner. Interested parties wanting to further the cause of broadband for LANs should involve themselves in the activities centered on the GM "MAP" program and IEEE 802.

***Norman Toms, Ph.D.,***
***Engineering Manager, Data Products,***
***Scientific-Atlanta***

## Sensitive issue

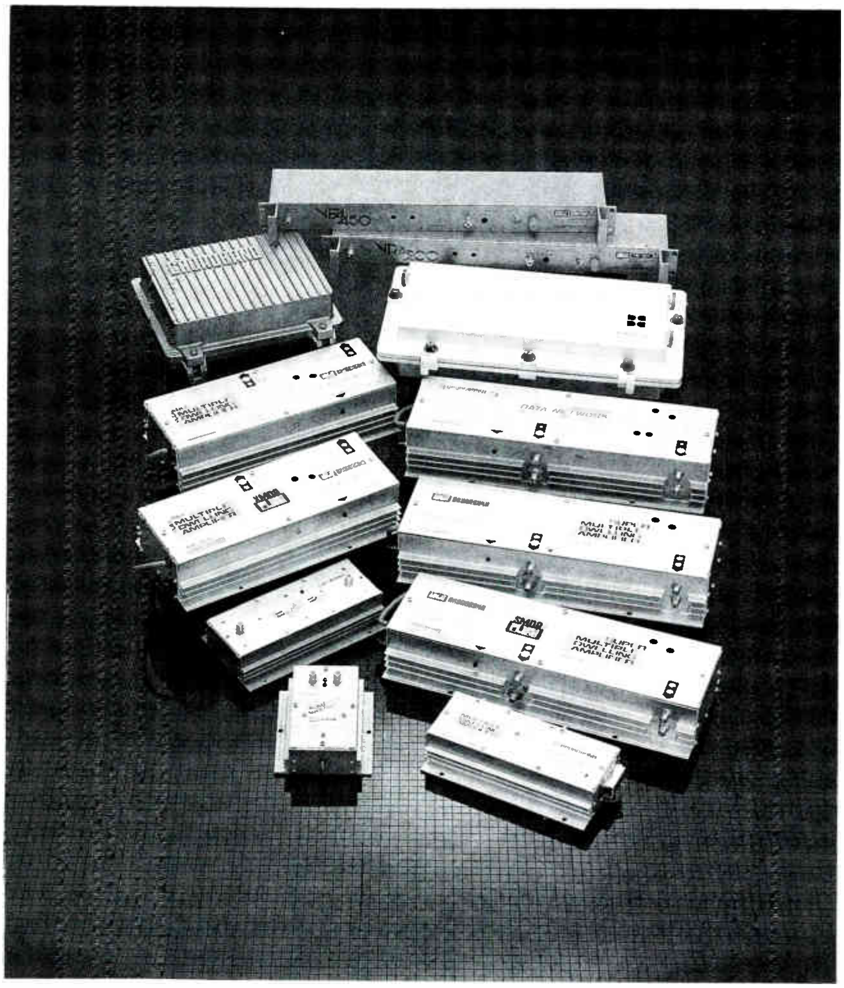
We have received a number of phone calls from several of our customers who are, understandably, concerned about conclusions drawn by Archer Taylor's interpretation of a calibration chart which first appeared in the "Final Report of the Advisory Committee on Cable Leakage." In Mr. Taylor's words, published in the third installment of his treatise on CLI in the May 1985 issue of *CED*, "Section 76.614 requires that the monitoring system be capable of detecting leaks producing field strength of 20 microvolts per meter or greater at 10 feet. Evidently, the Sniffer in 1979 would not meet that requirement."

This is a serious misstatement of fact. All Sniffer I models were designed with an aural perceptibility threshold of better than -76 dBmV. At 108.625 MHz, this translates to about 0.07 microvolts per meter. Available terminal sensitivity provides a margin of about 35 dB, thus allowing a measurement distance of 40 feet minimum.

How did the incorrect perception take place? The FCC engineers, when performing tests under the guidance of the Advisory Committee on Cable Leakage, were not concerned with how little signal leakage was present in a given CATV plant environment. Their primary goal was to determine the degree of correlation between two ground-based measurement technologies. The comparison was between the classic dipole and field strength meter at a distance of 10 feet versus the less time-consuming use of a device, specifically designed to perform the measurement from a moving vehicle outfitted with a vertical monopole.

To this end, the Sniffer I Detector "Sensitivity" control was set to allow FCC staff members to monitor leakage within the window of interest, i.e., 50 microvolts per meter to 1,000 microvolts per meter. The calibration graph subsequently presented as Figure H.1 in the Final Report of the Advisory Committee was generated from a larger number of actual readings taken with the Sniffer I adjusted in this manner. Therefore, the result graphically displayed is an indication only of the meter scale reading as a function of intercepted field strength at that particular "Sensitivity" control setting, which was not intended to provide an accurate display of 20 microvolts per meter.

***Richard L. Shimp,***
***Vice President,***
***Advanced Concepts and Systems Services,***
***ComSonics Inc.***



Volume 11, No. 9

CED

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In Perspective

# Lighting the local loop

It's no secret that AT&T, the Bell operating companies and virtually all major telecommunications vendors share a common vision of the future of the public telecommunications system in the United States. Perhaps as early as the mid-1990s, they foresee movement of all voice, data and video signals over a unified digital, switched network using fiber optic cable.

The first U.S. trial of such an Integrated Services Digital Network (ISDN) is slated to begin soon, under the auspices of Illinois Bell. ISDN offers fully digitized and integrated voice and data, and conforms to international standards proposed by the International Consultative Committee for Telephones and Telegraphs (CCITT). The CCITT is an international standards-setting organization reporting to the International Telecommunications Union.

But ISDN is only the start. AT&T, for one, sees ISDN as a step toward the real future—the Universal Information Service. UIS would transmit video, voice and data through a single standard wall interface. One cable into the home that provides all communications services.

The implications for CATV should be clear enough. And there's no question the required wideband network will be built. But how soon?

Perhaps sooner than you think. Widespread replacement of long-distance and local feeder cable is proceeding at a torrid pace. There's virtually nothing but fiber going in for long-haul, and even local loop migration to fiber is brisk.

Nynex spent about $1.9 billion for capital construction last year and should hit that range again this year. Most of that sum goes toward digitizing the network and converting to fiber. By the end of 1985, Nynex should have 87,500 fiber miles installed. By the end of 1986, perhaps 127,500 miles.

Southern Bell is spending $2.57 billion this year, and installed about 38,400 miles of fiber last year. This year it will add 41,500 or so.

Bell Atlantic spent about $1 billion last year on fiber and digital systems, and the company projects a $1.2 billion upgrading this year. That's 39,000 miles for 1984 and another 34,000 this year.

Ameritech is looking at 83,000 total fiber miles by the end of the year; 128,000 miles by 1986.

Pacific Telesis is looking at 37,000 miles in 1985, while Southwestern Bell is eyeing 11,000 or so miles.

This migration to fiber once was thought to be a matter for the long haul and trunking segments of the telephone network. But duct congestion in metropolitan areas and the threat of bypass have changed the calculus.

And while not every metropolitan area has the concentration of large customers that New York Telephone has, the spread of microwave and other private networks is serious business. Perhaps as much as $147 million in lost annual net revenues by 1987, one report suggests.

So fiber in the local loop is coming. Certainly not because telcos are worried about CATV. But once that network is in place, you're looking at an overbuild with capacity beyond comprehension.

Most of that local loop fiber is in feeder right now. But, ultimately, it's going to go the last mile and terminate at a customer's home.

So while we're cheering deregulation—and we've won some significant victories recently—let's not forget that deregulation cuts both ways. Level playing fields simply mean that the better team wins.

*Atlantic Cable Show, Atlantic City*

## September

**2-4: SPACE/STTI Satellite Earth Station Convention**, Opryland Hotel, Nashville. Contact: STTI, 800/654-9276.

**3-5: Jerrold Technical Seminar**/Pittsburgh. Contact: Beth Schaffer 800/523-6678.

**3-7: Electronic Messaging Week '85**, Washington, D.C. Contact: Mike Cavanagh, 202/293-7808. Sponsored by the Electronic Mail Association.

**9-13: M/A-Com MAC Training Seminar**, MAC Training & Conference Center, Burlington, Mass. Contact: Carolyn Calorio, 617/272-3100.

**10-11: Society of Cable Television Engineers Technical Seminar**, Denver. Contact: Sally Kinsman, 303/698-0380.

**11-12: Fiberoptics for the Non-Technical Manager**, Washington, D.C. Contact: Phillips Publishing, 301/340-1200.

**11-13: Magnavox Mobile Training Seminar**, Worchester, Mass. Contact: Laurie Mancini, 800/448-5171.

**16-18: Magnavox Mobile Training Seminar**, Worchester, Mass. Contact: Laurie Mancini, 800/448-5171.

**16-20: FOC/LAN Exposition**, Brooks Hall, San Francisco. Contact: Information Gatekeepers, 617/232-3111.

**17-19: C-COR Technical Training Seminar**, Toronto. Contact: Debra Cree, 800/233-2267.

**18-20: Atlantic Cable Show**, Atlantic City. Contact: 609/848-1000.

**25-27: Great Lakes Expo**, Convention Center, Indianapolis. Contact: Ohio Cable Television Association, 614/461-4014. Sponsored by the Illinois, Indiana, Onio and Michigan Associations.

**25-27: Local Area Data Communications Network**, Washington, D.C. Contact: Shirley Forlenzo, 800/424-9773.

**30-Oct. 3: Implementing Statistical Control Methods For Productivity and Quality**, Ottawa, Canada. Contact: Harry Belflower, 800/424-9773.

## Looking ahead

**October 2-4, 7-9: Magnavox Mobile Training Seminar**, Atlantic City, N.J. Contact: Laurie Mancini, 800/448-5171.

**October 8-10: Jerrold Technical Seminar**. Atlanta, Ga. Contact Ann Pliscof, 800/523-6678.

**October 15-17: Satellite Communications Users Conference**, Louisiana Superdome, New Orleans. Contact: Kathy Kriner 303/694-1522.

**October 16:** The **Delaware Valley Chapter of the Society of Cable Television Engineers** will hold a seminar titled "Technical Management" at the Fiesta Motor Inn in Willow Grove, Pa. Contact Beverly Zane, 215/674-4800.

**October 22-24: Mid-America CATV Show**, Kansas City, Mo. Contact: Rob Marshall, 913/841-9241.

**November 6-8, 11-13: Magnavox Mobile Training Seminar**, Greensboro, N.C. Contact: Laurie Mancini, 800/448-5171.

**November 12-14: Jerrold Technical Seminar**. Toronto, Ontario, Canada. Contact Ann Pliscof, 800/523-6678.

**November 25-26: Lightning Protection** Seminar, Detroit, Mich. Contact: Shirley Forlenzo, 800/424-9773.

**December 4-6: Western Cable Show**, Convention Center, Anaheim, Calif. Contact: California Cable Television Association, 415/428-2225.

**December 10-12: Jerrold Technical Seminar**. Philadelphia, Pa. Contact Ann Pliscof, 800/523-6678.

**December 16-19: SAW Devices and Their Signal Processing Applications**, Washington, D.C. Contact: Cliff Hopkins, 800/424-9773.

**December 18:** The **Delaware Valley Chapter of the Society of Cable Television Engineers** will hold a seminar titled "Test Equipment: Field and Bench" at the Fiesta Motor Inn in Willow Grove, Pa. Contact Beverly Zane, 215/674-4800.

# Fiber optic supertrunking

***By James Chiddix,***
***Senior vice president,***
***Oceanic Cablevision Inc.***

This article is not intended to be a definitive study of fiber optics, but to provide pertinent background information to CATV system engineers wishing to evaluate the fiber alternative to traditional supertrunking. It represents a collection of information from technical literature, fiber optic cable and equipment vendors who have targeted the CATV market, and CATV engineers with fiber optic experience. This information was gathered while researching fiber for a specific application and is intended as a starting point rather than an answer.

Applications for fiber in CATV may include system hub interconnects, earth station links and advertising interconnects between systems. Much of the information presented also is applicable to systems that carry data and other kinds of information.

Optical fiber transmission of video can be cost competitive with RF transmission, depending on distance, number of channels, performance requirements and system configuration; and it is inherently more reliable. There are a growing number of fiber optic systems in use, and their experience indicates that great strides have been made in the last few years in this technology.

The three alternatives compared are: FM video carried over traditional coaxial cables, analog video carried via fiber and digital video via fiber.

## Video FM via coaxial cable

Transmitting video FM via coaxial cable has been done for at least a decade and is fairly familiar in the CATV industry. Video channels (with their associated audio information) are frequency modulated at different frequencies. The resulting RF carriers are combined onto one or more coaxial cables, depending on trunk bandwidth and the number of channels required. These systems typically require 12 to 16 MHz of bandwidth per video channel. Cable-powered broadband amplifiers are located every 2,000 to 3,000 feet to compensate for cable losses. The coaxial network can undergo almost unlimited branching using conventional CATV techniques. The video signals are recovered at the destination point or points through demodulation.

The performance of these systems is largely determined by the noise and distortion introduced by the cascade of trunk amplifiers. Reliability also is determined by the number of active devices in use, primarily trunk amplifiers, and by their dependence on the local power utility. Preventing ingress and egress of RF signals is of significant concern in both construction and operation.

The costs of these systems, in addition to labor and supporting structures, include the cable or cables, trunk amplifiers and power supplies as well as the FM modulators and demodulators. There also are significant ongoing costs for trunk powering and preventive/corrective maintenance of the amplifiers. These costs must be included in a meaningful comparison of this system with others.

An opportunity exists to optimize costs through the use of extended bandwidth amplifiers for high capacity trunks to avoid the use of a second cáble, and by spacing high gain amplifiers farther apart than normal CATV practice because of the noise improvement inherent in frequency modulation. Reliability can be improved through the use of redundant amplifiers, status monitoring and standby power supplies.

The costs of the conventional broadband plant required are typical of CATV plant. Video FM terminal equipment typically costs about $5,000 per video circuit.

## Fiber optics for CATV

The use of optical fiber has become widespread in recent years in interconnecting telephone switching centers, among other applications. This has provided a fair amount of experience in the manufacture and installation of fiber.

An increasing amount of the fiber being installed is of the single-mode variety, with its low loss and high bandwidth. This fiber suggests itself for most CATV trunking applications.

Single-mode optical fiber consists of highly refined glass which has been doped in such a way that its inner and outer cores have a different refractive index. While the fiber is mechanically homogeneous throughout its diameter, its refractive index undergoes a 1 percent transition to define a very small light waveguide within the fiber. The waveguide diameter (5 to 9 microns) is within the same order of magnitude as the wavelength of the light being transmitted (1300 nanometers or 1.3 microns). The fiber is termed "single-mode" because the waveguide diameter has been selected to avoid multipath reflections, which create signal dispersion (time domain distortion) characteristic of large diameter "multimode" fibers. Dispersion effects are magnified with distance.

Figure 1 shows the loss versus wavelength in single-mode fiber. The peaks are a function of the atomic spectral absorption characteristics of the glass used. The shape of the curve yields two "windows" of potential use centered at 1300 nM and 1550 nM. The 1300 nM window includes the area of mini-

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mum dispersion, and the 1550 nM window includes the wavelengths of lowest fiber loss.

Fiber is available today with a nominal loss of 0.5 dB per kilometer at 1300 nM and less than 0.4 dB per kilometer at 1550 nM. Somewhat lower loss fiber may be specified at additional cost.

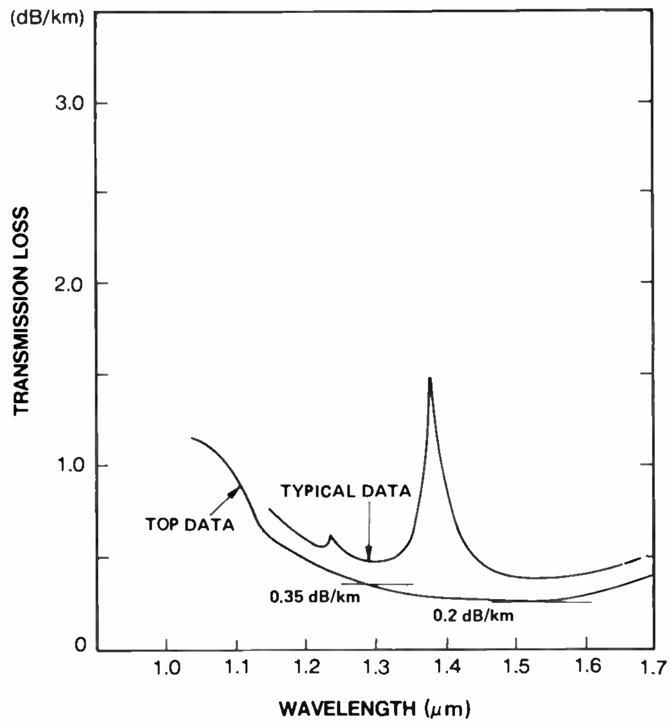
Research indicates that the potential exists to construct fiber with losses as low as 0.16 dB per kilometer at 1550 nM, allowing very long fiber runs. The current record for fiber transmission in experimental systems involved transmitting data at 2 gigabits per second over 130 kilometers of fiber without repeaters.

Single-mode fiber used at both 1300 and 1550 nanometers clearly is of potential use in CATV systems since the low loss allows long distance interconnection without repeaters, even with a certain amount of power splitting.

Fiber cables are available packaged in a variety of ways appropriate for CATV. In addition to containing different numbers of fibers, they may be ordered with different kinds of strength members, jacketing and armoring. Cabled fiber is available in reels of 2 kilometers and more, and cabled lengths may be specified in ordering.

While the cost of single-mode optical fiber cable has come down substantially in recent years, there still is a great incentive to carry as many video signals on each fiber as possible. Costs for cable configurations appropriate for CATV applications, containing two to eight fibers, range from 55 to 80 cents per fiber meter. A typical four-fiber cable might cost approximately 75¢/ft.

**Figure 1**
**Spectral transmission loss of typical single mode fiber**




## Plant construction

Cabled fiber is relatively tough, and its handling characteristics are, in most ways, as good as or better than CATV cable. Because cable lengths are large (2 KM) and splices must be kept to a minimum, the penalty for error may be greater than CATV crews are accustomed to, and pulling tension and bending radius should be closely monitored. This is not to indicate that CATV engineers should be reluctant to undertake fiber projects where appropriate, but rather that the differences in technique in working with a new medium be recognized.

For the most part, normal CATV practices can be used for both overhead and underground construction. It probably is advisable to obtain experienced help from cable vendors, telephone construction personnel or other sources when embarking on a first project.

## Splicing

Single-mode splices done in a laboratory can have extremely low losses. Because of the very small diameter of the core, however, splice loss involves some element of chance.

Fibers may be spliced either with very expensive fusion devices which align and melt the fibers together or with mechanical splices which clamp the fibers in proper alignment. While fusion splices have been favored in original construction, mechanical splices have been developed with average losses nearly as good as fusion splices. The sensible approach today may be to do initial system splicing with fusion and to use mechanical splices for changes or repair.

Studies of many field splices indicate a mean splice loss of about 0.2 dB. Once a fiber trunk has been constructed, it can be examined with an optical time-domain reflectometer (OTDR), and the relative loss of each splice can be approximately measured. Splices especially high in loss can be redone until they are optimized. The time devoted to splice optimization depends on the length of the trunk and the size of the system power margin. The combined loss of fiber and splices can be measured with an optical field strength meter.

Transmitters for fiber systems contain solid state, temperature-controlled lasers. They may be modulated with either analog or digital information of a fairly wide bandwidth or high data rate. They are limited in terms of linearity, and intermodulation products are of concern, particularly in analog systems. Present transmitters are highly reliable, but laser linearity does change somewhat with aging. Because lasers are expensive, it is advantageous to share as many video signals on each laser transmitter as possible. Typical outputs coupled into the fiber are in the -3 to -5 dBm range.

## Optical receivers

Optical receivers use two basic types of detectors: PIN-FETs (field effect phototransistors) and avalanche photodiodes. While the photodiodes are potentially more sensitive, PIN-FETs currently are more widely used at 1300 nM and beyond. Detector operating levels are in the -15 to -40 dBm range, depending upon the type of modulation used. Because it is necessary to operate these devices close to threshold in order to maximize the power budget, the type of modulation selected is critical. For analog systems, wide deviation frequency modulation, similar to that used in satellite video systems, most often is used (for similar reasons). Digital systems may be operated at lower input levels because of their superior noise performance.

Detector operating levels in available systems range from -15 to -20 dBm for narrow deviation FM analog systems, -25 to -30 dBm for wide deviation analog systems and -34 to -40 dBm for digital systems. In digital systems, operating levels are best at lower speeds and decrease at higher data rates.

Experimental developments in detector technology and fiber system modulation techniques promise substantial improvement in detector operating levels in the next few years. These improvements may be as great at 10 to 20 dB.



## System design and power budgets

The assumptions behind any optical power budget depend on the type and configuration of the terminal equipment and the fiber and construction techniques to be used. Unless there are wide power margins, fiber systems must be designed with a fair amount of attention to the number of splices. This, combined with the physical constraints of cable routing, often requires that specific splice locations be designed and that fiber cable lengths be ordered to fit the spans between those splices. Since cabled fiber is available on reels of 2 kilometers or more, the opportunity exists to greatly minimize the number of splices when power budgets require.

Figure 2 shows a power budget for a digital system using moderate data rates and combining lasers onto a single fiber through wavelength division multiplexing. The 0.6 dB per kilometer path loss assumes one splice every 2 kilometers, with a mean splice loss of 0.2 dB. Although a system margin of 4 dB has been used, careful design and construction techniques would be necessary to keep splices to a minimum and to ensure that both cable and splice losses were within specifications if such a system were used near its maximum distance.

Figure 3 shows the same power budget for a wide deviation FM analog fiber system. The only difference is in detector operating level, which illustrates the advantage of digital over analog systems. This becomes significant in links long enough to require an analog repeater with its additional costs and its additive intermodulation and noise contribution.

Obviously, the generation of a power budget is a key step in examining fiber for a given application and in reviewing both equipment specifications and construction plans for such a system.

A number of developments will continue to make fiber more attractive for CATV supertrunking applications. Both

### Figure 2
### Fiber transmission power budget
**(digital single-mode system)**

| | |
|---|---|
| Transmitter Output | -4 dBm |
| Detector Sensitivity | -36 dBm |
| TOTAL SYSTEM LOSS | 32 dB |
| WDM Losses | 3 dB |
| Connector Losses | 1 dB |
| System Margin | 4 dB |
| AVAILABLE FOR SYSTEM LOSS | 24 dB |

Distance @ 0.6 dB/km Path Loss: 40 km ≈ 25 mi
(fiber & splicing)

### Figure 3
### Fiber transmission power budget
**(analog single-mode system)**

| | |
|---|---|
| Transmitter Output | -4 dBm |
| Detector Sensitivity | -28 dBm |
| TOTAL SYSTEM LOSS | 24 dB |
| WDM Losses | 3 dB |
| Connector Losses | 1 dB |
| System Margin | 4 dB |
| AVAILABLE FOR SYSTEM LOSS | 16 dB |

Distance @ 0.6 dB/km Path Loss: 27 km ≈ 16.5 mi
(fiber & splicing)





cost and loss will improve somewhat for fiber cables. More economical circuitry will be developed capable of processing and multiplexing digital information at higher data rates. Laser costs will decrease and coupled power output will increase, allowing larger power budgets. Detector sensitivity will increase as avalanche diodes are economically produced which work reliably at longer wavelengths. New and more refined analog approaches also will be developed that may be attractive—economically and from a performance standpoint.

A properly designed and built fiber trunk using today's dual window single-mode fibers can be expected to have a higher channel capacity in the future as new terminal equipment is developed and as more exotic existing equipment becomes less expensive.

## Analog video via fiber

In an analog video fiber transmission system, video signals are frequency modulated and combined. The center frequencies are selected to minimize intermodulation effects caused by laser non-linearities. The combined broadband signal then is used to modulate a laser, and the output of two lasers at different optical wavelengths is combined to feed a single fiber. Wavelength division multiplexers can be related to the RF diplex filters which are common in CATV. These multiplexers and de-multiplexers have some insertion loss, ranging from a few tenths to about 2 dB.

At the destination, a de-multiplexer is used to separate the different optical frequencies, and two optical detectors are used. The broadband RF outputs of the detectors are split and demodulated. The FM modulators and demodulators in these systems often are identical to those used in video FM coaxial systems, except that they usually have wider deviations (often substantially wider) to improve detector performance.

A repeater, if required, is relatively straightforward, and its effective cost depends on the number of channels being carried per fiber in the system. In the event wavelength division multiplexing is being used, de-multiplexing (and multiple detectors and laser transmitters) as well as re-multiplexing, would be required. The addition of repeaters to an analog system raises performance concerns, both in terms of video signal-to-noise ratios, and additional inter-modulation products.

One technique used to achieve economies in analog optical fiber systems for earth station links is taking the 70 MHz IF outputs of the satellite receivers (which carry wide deviation FM video information) and frequency converting each to avoid the cost of FM modulators.

The primary performance limitations for analog video fiber systems are intermodulation products caused by laser nonlinearity, the signal-to-noise performance of the detectors and the resulting lower power budget of these systems compared to digital systems.

Obviously, intermodulation degradation increases with the number of FM frequencies applied to each laser. Typically, between three and six frequencies are used per laser, although some systems carry more. Because laser nonlinearities change with aging, expected changes must be taken into account in examining long-term intermodulation performance and effective laser life.

The cost of analog systems currently is in a state of flux. The key factors are the number of video channels per laser and the number of lasers combined onto a single fiber. Terminal costs for multi-channel systems presently are in the range of $7,000 per video circuit.

## Digital video via fiber

Figure 4 shows a block diagram of one approach to digital video fiber transmission. Video signals are converted from

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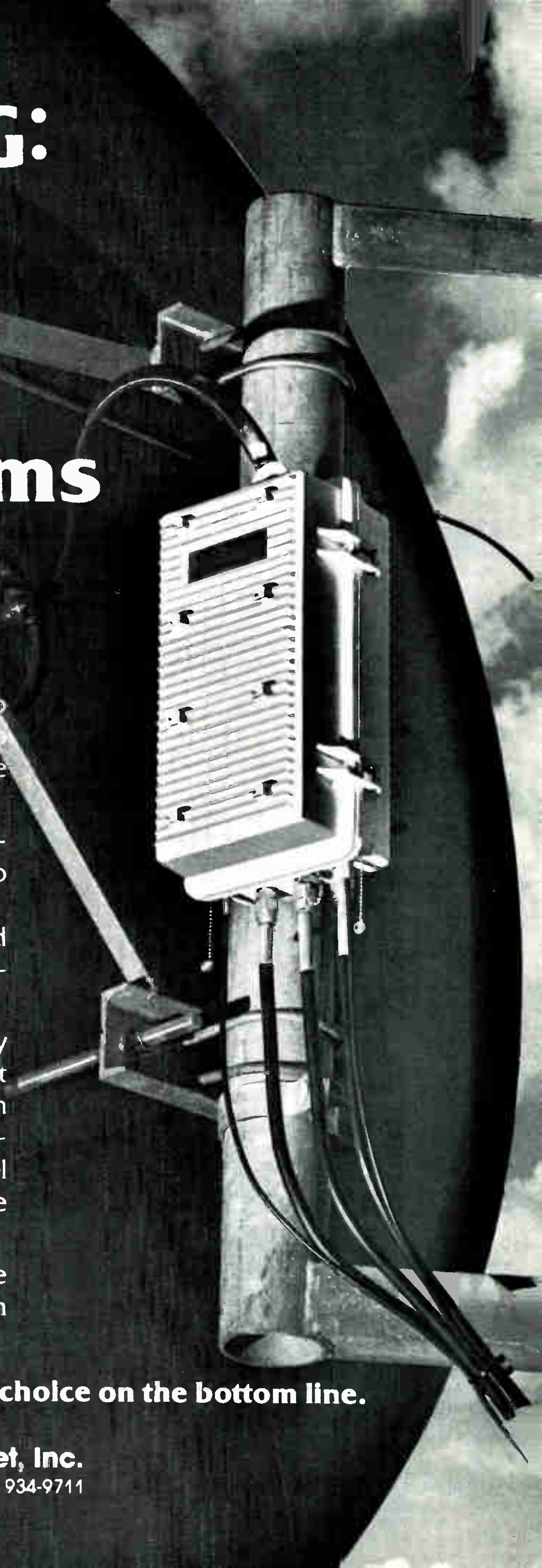

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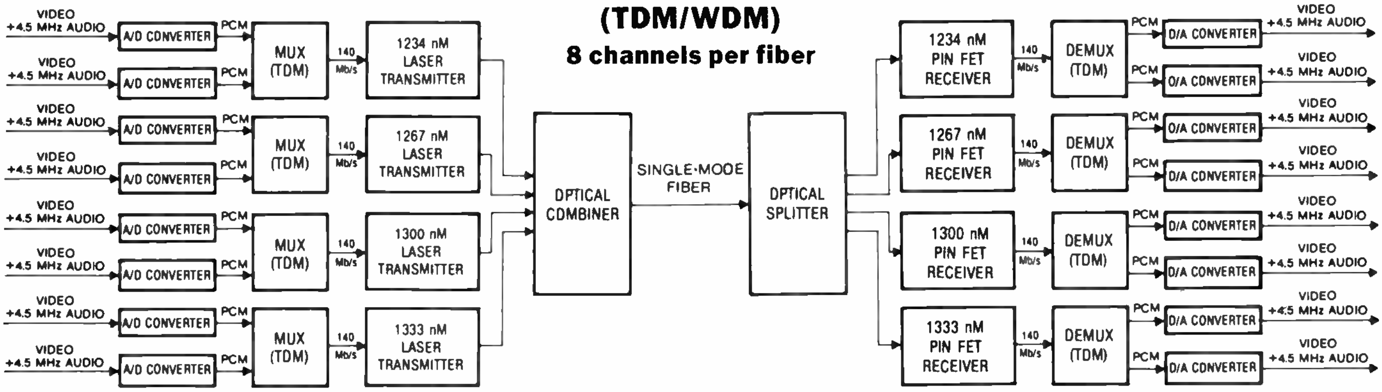
**Figure 4**
**Digital video fiber optic transmission (TDM/WDM)**
**8 channels per fiber**




analog to digital form. Devices for this application are reliable and have been refined for video use through applications in the broadcast industry. This conversion process almost solely determines the video quality of the entire transmission link. Eight-bit encoding, which is favored by broadcasters, yields signal-to-noise ratios of approximately 63 db. Seven-bit encoding (resulting in the sensing of 128 instead of 256 discrete levels) yields signal-to-noise ratios in the vicinity of 57 db. In the context of most CATV transmission, this is considered sufficient. The use of seven-bit encoding allows multiplexing of a larger number of video channels in a given bandwidth at a lower cost.

Beyond the analog-to-digital conversion point, the system is processing digital pulses, and unless bit error rates become significantly higher than 10 as detector thresholds are approached, essentially all the information will be recovered with no loss in quality.

The output of two or more D/A converters can be combined into a higher rate data stream. This process is termed Time Domain Multiplexing (TDM). The multiplexed digital information is applied to a laser transmitter, and the output of two or more lasers may be combined through wavelength division multiplexing (WDM) to increase the number of video channels carried per fiber.

Figure 5 shows an eight channel per fiber digital scheme which involves multiplexing all eight videos together into a high-speed data stream. Systems have been built combining up to 16 eight-bit encoded video channels into a 1.2 gigabit/second data stream but are not within economic reach at present. Data rates as high as 560 megabits per second may be

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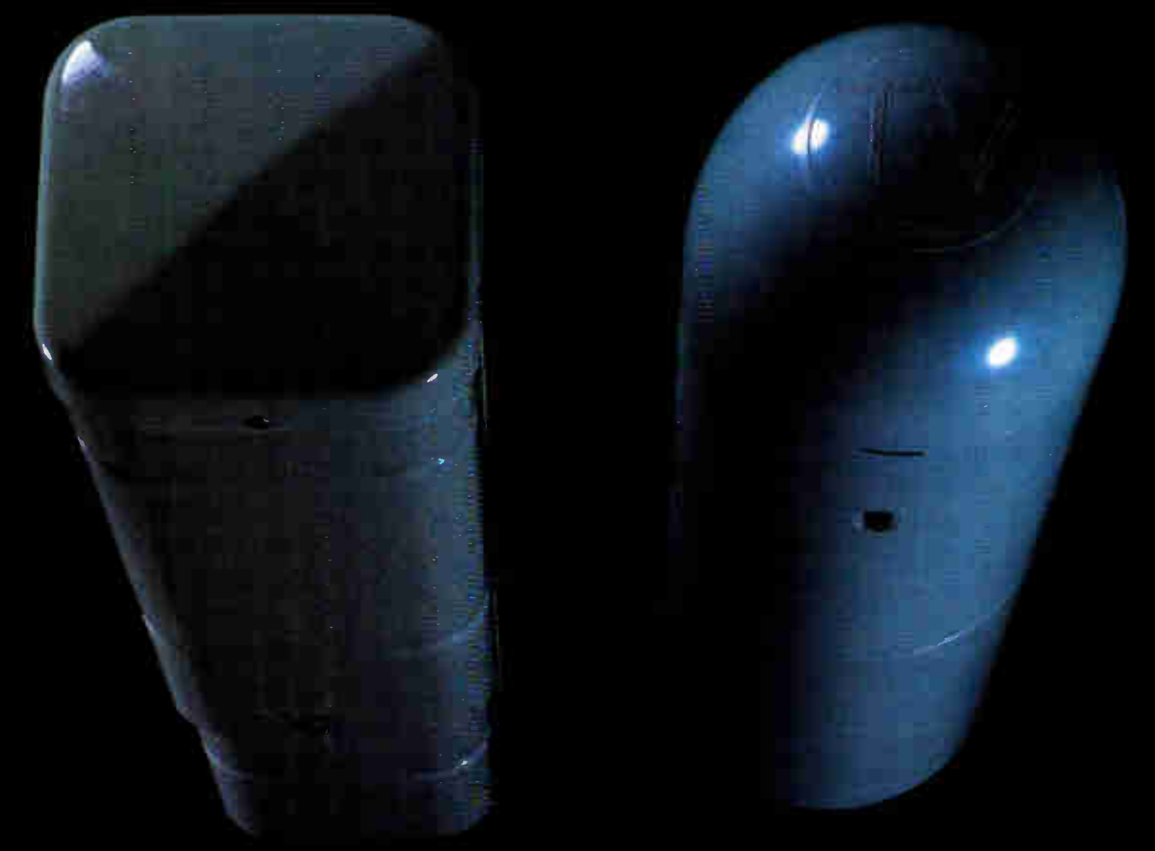

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multiplexed through commercially available equipment.

In very long systems where repeaters are required, digital systems are especially advantageous since data can be received, regenerated and transmitted transparently any number of times. At the destination, the digital data stream is recovered from the optical detector, and the individual video data streams are de-multiplexed. The analog video signal is generated through digital to analog (D/A) conversion.

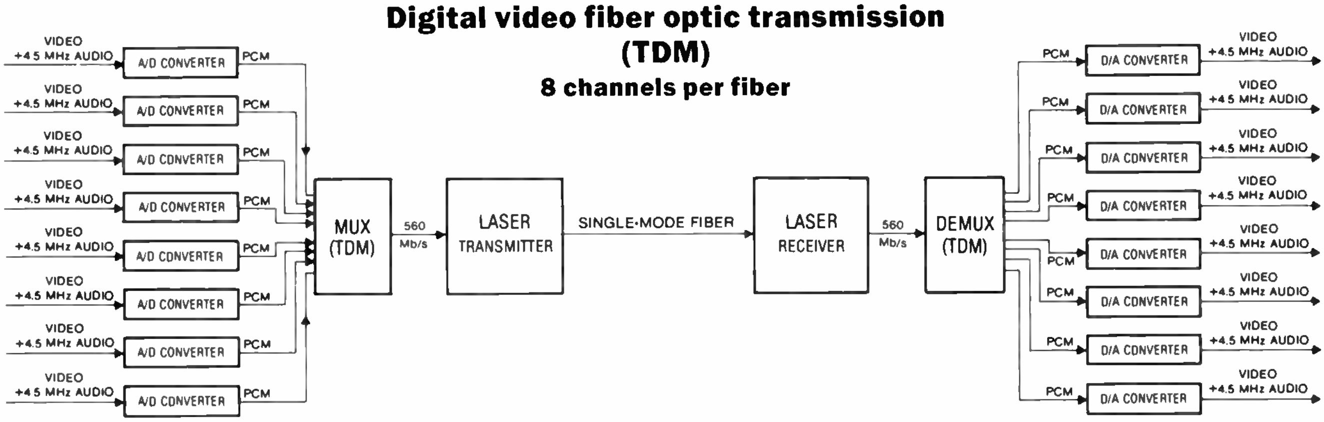
The advantages of digital video fiber transmission are its relative transparency, indifference to laser nonlinearities and improved detector sensitivity over analog methods, as well as a high degree of reliability and stability of terminal equipment, which complements fiber's high reliability. The advantages also include the body of experience which has been gathered in telecommunications applications.

In terms of cost, digital optical systems also are in a state of flux. Systems currently are planned which have eight video signals per fiber, with a terminal cost of approximately $9,000 to $10,000 per video channel.

With an understanding of the trade-offs involved in the above three transmission schemes with regard to reliability, performance, branching ability and other non-economic factors, the primary remaining factor to examine is their comparative costs.

The cost comparison graphs include the assumptions listed below. These assumptions are general and demonstrate the dynamics of the comparison but must be tested and changed for specific applications. In addition, changing technology and the entrance of new vendors into the market will date these assumptions rapidly. It also is assumed that physical

**Figure 5**
**Digital video fiber optic transmission (TDM)**
**8 channels per fiber**



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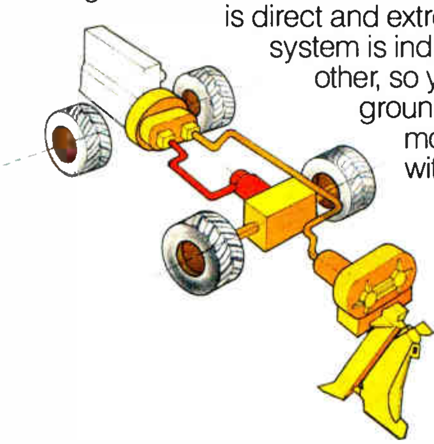

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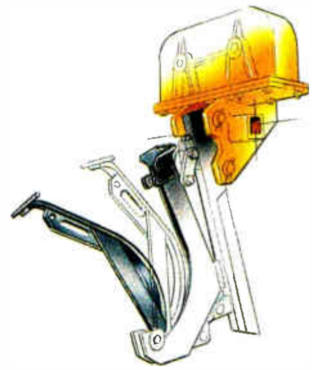

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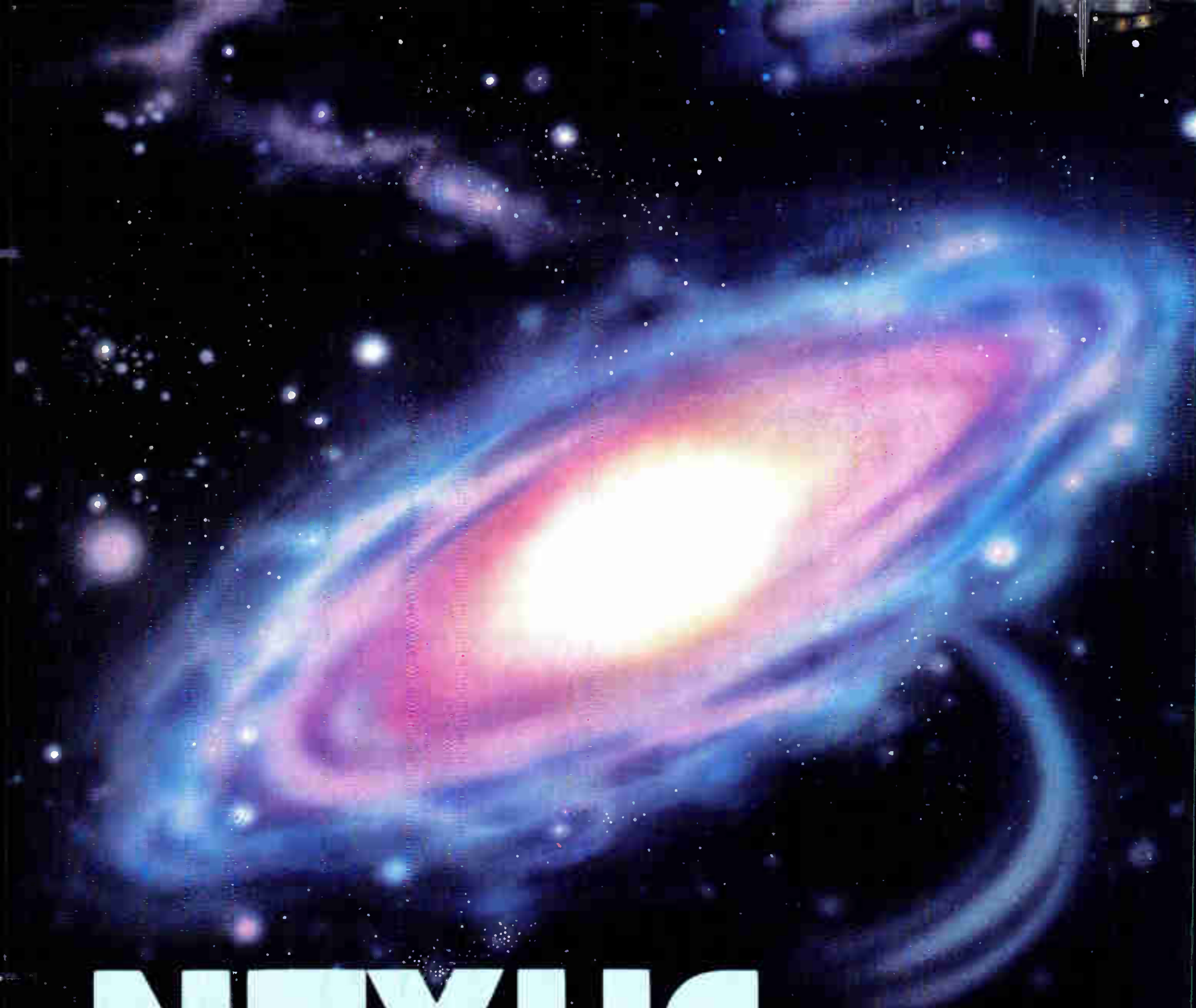


support plant (strand, duct, hardware, etc.), labor, make-ready and construction costs are comparable for installing a fiber cable containing any number of fibers, as well as any number of coaxial cables.

**Video FM Coax**

| | |
|---|---|
| Cable, amplifiers & power supplies: | 66¢/ft |
| Present value, assuming 10 yr. life and a 12 percent discount rate, of power (assuming average power consumption and rates) and one technician per 200 miles of plant: | 33¢/ft. |
| Terminal equipment costs, assuming a point-to-point system with no branching: | $5000/ch. |
| Channel capacity per cable, assuming 14 MHz channels on a 330 MHz trunk with standard trunk amplifiers: | 20 ch./cable |

**Analog Video On Optical Fiber**

Single-mode fiber cable costs for the following configurations:

| | |
|---|---|
| Single fiber: | 30¢/ft. |
| Two fiber: | 45¢/ft. |
| Three fiber: | 60¢/ft. |
| Four fiber: | 75¢/ft. |
| Five fiber: | 90¢/ft. |
| Terminal equipment costs: | $7200/ch. |
| Channel capacity: | 10 ch./fiber |
| Number of miles before repeater is required: | 16 miles |
| Repeater cost: | $2600/ch. |

**Digital Video On Optical Fiber**

| | |
|---|---|
| Cost of fiber cable: | Same as above |
| Video terminal equipment cost: | $9000/ch. |
| Channel capacity: | 8 ch./fiber |

Figures 6 through 9 are comparisons of per-channel costs for the three supertrunking approaches being discussed under various conditions. Figure 6 represents cost as a function of mileage for fixed channel loading. Figures 7 through 9 represent cost as a function of channel loading for fixed mileages.

## Observations

In the cost versus channel comparisons, breakpoints occur where repeaters are added to analog fiber systems. Because the per-mile cost of building and operating coaxial systems is greater than that of fiber systems, longer systems approach and exceed the per-channel cost of fiber systems.

In the comparison of per-channel cost versus the number of channels to be transported, breakpoints occur for fiber systems where additional fibers are required. In coaxial systems, a major breakpoint occurs where it is necessary to add a second cable to carry additional channels. Video FM on coaxial cable is at its most attractive when heavily loaded with channels, illustrating the premium to be gained by expanding cable bandwidth before adding a second cable. Fiber systems are especially competitive for longer and more lightly loaded links.

The results shown are colored by the assumptions made, but the dynamics of the cost comparisons should be clear in demonstrating the strengths of each approach.

## A practical example

Much of the information presented here was gathered in examining a practical application for a CATV system on the island of Oahu in Hawaii. The acquisition of a neighboring system led to a need for a high-capacity interconnection between hubs on both sides of a major mountain range. Because of site access and availability problems, microwave was ruled out as an option. While video FM coaxial trunking was a possibility, the available 16-mile route passes through a rain forest and a major highway tunnel. Long power interruptions are common at the points where power would be supplied to a coaxial system. Access to trunk amplifiers also was a concern in the highway tunnel and its approaches. The length of the interconnection and the channel capacity required, as well as the reliability factor, argued strongly in favor of a fiber approach on both a cost and a performance basis.

It is expected that a fiber link will be implemented in mid-1985. The first increment of channels will be delivered using digital transmission, and analog techniques will be tested to explore possible cost savings on additional channels while maintaining acceptable performance.

The information presented here was gathered in evaluating a specific potential application for fiber optics. Each individual vendor has a story to tell, and it is important to develop a broad perspective if fiber is to be examined in a balanced manner. If a fiber project is being considered, it is suggested that this information be updated and supplemented with information from current vendors. Conversations with CATV engineers who have constructed and operated fiber systems will prove invaluable.

It is strongly recommended that a CATV engineer considering the use of fiber technology review the technical papers contained in *Fiber Optic Communications*, edited by Henry F.

**Figure 6**

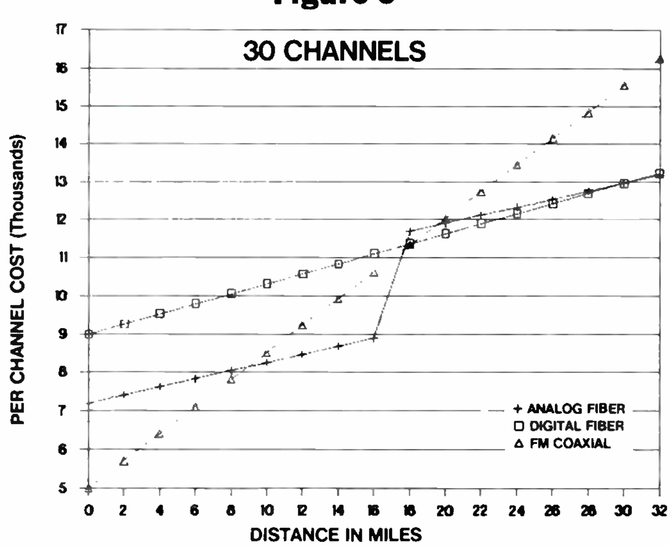
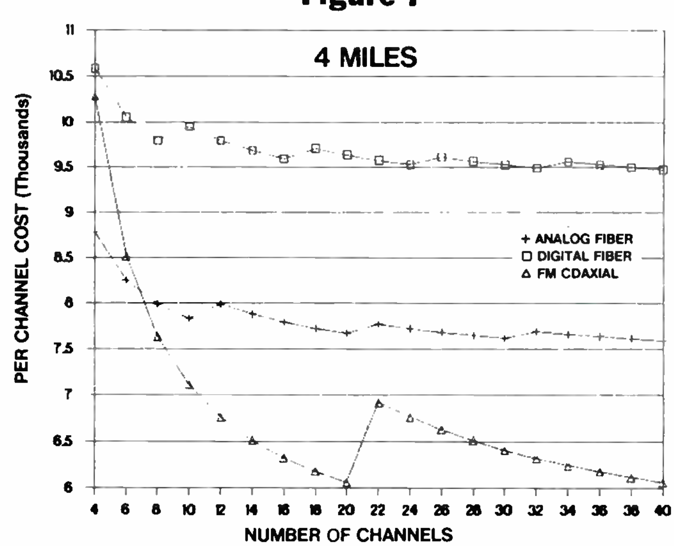
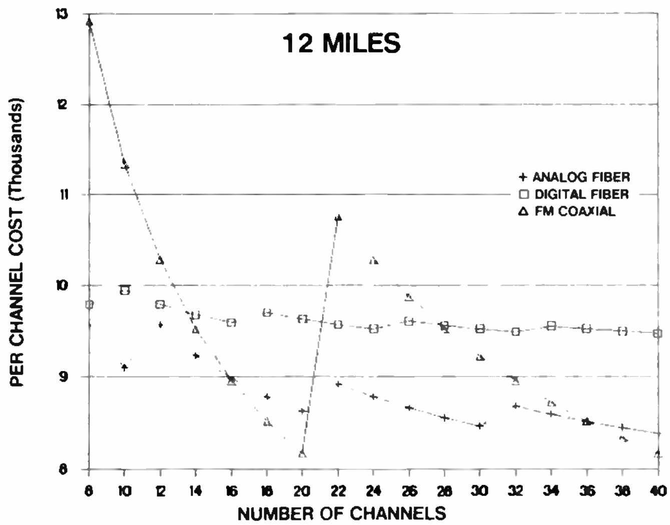


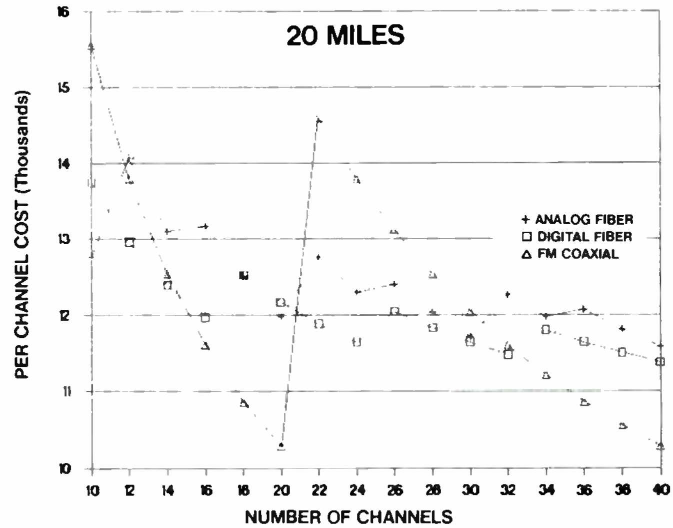

**Figure 7**



## Figure 8




## Figure 9




Taylor (Artech House, Dedham, Mass., 1983). This excellent collection brings together a wealth of information, much of which is applicable to CATV systems.

For some combinations of distance and channel capacity, fiber optic systems are the correct choice with today's technology. This may be further influenced by the relative weights given to performance, cost and, in particular, reliability. It is only fair to assume that the number of applications for fiber optics will increase with future technological developments in the field. CED

### *About the author*

*Jim Chiddix is senior vice president of Oceanic Cablevision, which serves 160,000 homes on Oahu, Hawaii. He is a senior member and former director of the Society of Cable Television Engineers. In 1983 Chiddix received the NCTA's Engineering Award.*

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**Reader Service Number 21**

# Is two-way cable dead?

***By Vito Brugliera, Vice President, Marketing & Product Planning, Zenith Cable Products, with Richard Citta, Thomas Rossen, Semir Sirazi, William Thomas***

Is two-way cable dead? Not in San Antonio, Texas, where Rogers Cablesystems is reporting great success with impulse pay-per-view. In the first three months of pay-per-view programming there, subscriber revenues in the 191,000-subscriber system were more than three times original projections.

Despite such successes, some in the industry are tolling the death knell for two-way cable. Some of the common arguments are:

- ♦ Plant maintenance costs are too high.
- ♦ Subscriber terminal costs are too high.
- ♦ Peak ordering capabilities are limited.
- ♦ The systems don't work reliably.

Several companies have tried to develop two-way cable systems using a variety of technologies. Most of their systems have had operational problems attributed to harsh transmission environments on the upstream channel. These operational problems, as well as others related to reliability and cost, have made two-way unattractive. Thus, despite the increasing number of CATV systems built with two-way capabilities, only a very small number of active two-way systems exist. Many of these systems remain in operation only because of franchise requirements.

Zenith perceived a great opportunity for utilizing a portion of the CATV bandwidth for transmission of digital data for a real-world consumer application: pay-per-view. To realize this opportunity, the resulting system and its hardware had to be:

- ♦ Reliable
- ♦ Capable of operating in a real-world cable plant without the costly maintenance of earlier two-way technologies
- ♦ Cost-effective, with an in-place subscriber two-way transmitter terminal at $50 or less
- ♦ User-friendly and capable of true impulse pay-per-view transactions
- ♦ Secure

Security was an important parameter and weighed heavily in the choice of the final system technology. Some system compromises could have been made if store-and-forward technology had been implemented, among them the use of slower speed data, polling and no real-time operational requirements for transactions at the headend. However, a store-and-forward system would have non-volatile data and self-authorization capability within the subscriber premises, along with potentially vulnerable links among the subscriber transmitter, addressable converter and return path.

For these reasons, it was decided that the subscriber transaction should not remain on-premise, but that it should be volatile and transported immediately to the CATV headend. The obvious consequence of this was that the system technology had to be real-time and capable of handling impulse transactions with potentially heavy loads.

## CATV characteristics

The first approach to the problem was to understand the CATV upstream environment. To accomplish this, a group of Zenith engineers spent a year measuring and characterizing a sizeable sample of cable plants, lugging spectrum analyzers and other test gear all over the country. The results of these tests were reported previously*, but essentially they found white noise, common-mode distortion and ingress—expected and unexpected.

In the majority of two-way cable plants, the tree-and-branch topology is used for ease of distribution. Typically, in tree-and-branch topology, downstream or forward channels are of a broadcast type, whereas upstream or reverse channels are of a multi-access type. This implies that in the forward direction, all communicating nodes listen to the same information emanating from the system headend, the main signal distribution point. Therefore, no message interference or collision when more than one user is trying to access the channel at the same time can take place on the forward channel, since only the headend may access the CATV plant. On the other hand, there is a need for an arbitration mechanism for the reverse channel so that all nodes on the cable network follow the same rules to access the channel. In general, the system architecture dictates the type of arbitration mechanism or media access protocol that can efficiently be used on residential cable systems.

The new system being described uses no bridger switching for control of media access. With this type of architecture, almost all media access protocols developed for local area networks also can be applied to residential two-way CATV systems.

## Media-access protocol

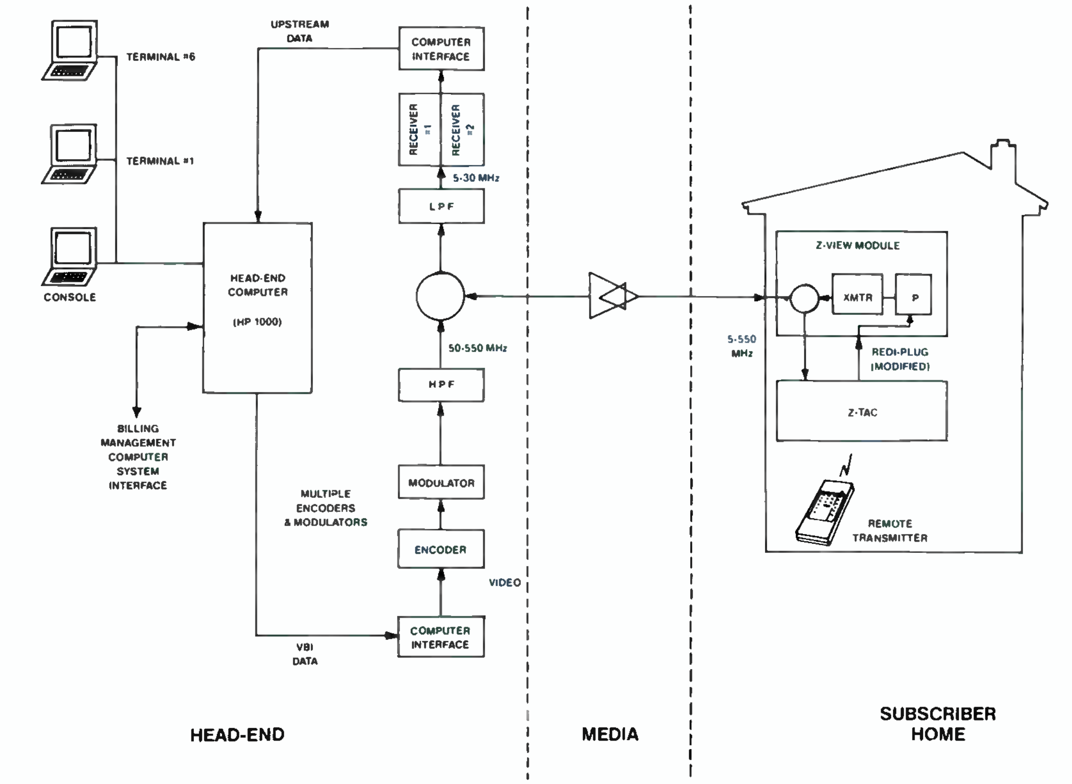
Once the system architecture is defined, the next question is: What type of media-access protocol can efficiently be implemented on residential CATV systems? Because of long propagation delays on coaxial cable, pure polling, CSMA/CD and token passing schemes may incur long delays with poor throughput. The performance of polling, CSMA/CD, CSMA and token-passing protocols degrades drastically as the propagation-delay to packet-transmission-time ratio increases.

The throughput of the Slotted-Aloha protocol in satellite networks is not affected by the propagation delay. Since the propagation delay is considered to be long in CATV systems, the Slotted-Aloha contention protocol with a proprietary backoff-algorithm was chosen for the new two-way cable system.

Additionally, this system operates in dual-modes, polling and contention,


Panasonic
N3

## Z-View system



with contention offering fast response under bursty data traffic conditions for a large number of users. For higher throughput and reliable operation, two upstream channels are used. The polling technique is used for all transactions originating at the headend, while the contention technique is the media-access control mechanism for all transactions originating at the network nodes.

For polling operation, the headend network controller can interrogate the network nodes at a speed of 60 per second. It also can automatically adjust the transmitter output power level and verify operational integrity of any node. The headend consists of a system controller, VBI data inserter (encoder and modulator), dual-channel receiver, low and high pass filters and associated computer interface hardware.

When a subscriber generates a pay-per-view transaction or responds to a poll, the subscriber transmitter builds the data packet and then transmits it in the first slot available on either upstream channel. If no acknowledgement is received within two seconds, it then enters a retransmission backoff algorithm, calculating the next retransmission slot based on a common rule established across the network; this repeats until acknowledgment is received.

The proprietary backoff algorithm is implemented such that the system will work under noisy upstream channels and heavy data traffic. The upstream channels, each with 480-slots-per-second capacity, are synchronized so that no slot-overlapping may occur.

## System design

In teletext decoders and some one-way addressable converters, the vertical blanking interval (VBI) is used to send digital information for addressing, program authorization and text data. In the new two-way cable system, the VBI data channel is the means of communicating from the headend to the network nodes, forming the downstream data channel with a capacity to address 180 nodes per second.

The total upstream channel capacity was chosen to be 960 slots per second. Since during heavy loading the Slotted-Aloha contention protocol operates at only one-third of full capacity, the downstream channel is kept fully loaded with traffic from the upstream channels, thereby optimizing the downstream and upstream data transmission capabilities.

The data rate on both upstream channels is selected to be 45 Kbps, giving an aggregate data rate of 90 Kpbs. In residential CATV systems, upstream channels occupy from 5 MHz to 35 MHz and

***With apologies to Mark Twain: "The news of two-way cable's demise is greatly exaggerated."***

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**Reader Service Number 25**

usually are not fully utilized, leading to an abundance of bandwidth. However, the spectrum utilized must not straddle 6 MHz boundaries. The upstream transmit frequencies, 5.5 MHz and 11 MHz, appear to be free of interference and are selected by the network node with a method determined in the retransmission backoff algorithm. In order to protect data from errors caused by contention collisions and noise sources, a rugged error detection mechanism was chosen.

The system used a bi-phase phase shift keying (BPSK) modulation technique for optimum performance and efficiency in the bandwidth chosen for upstream channels. By using a narrow IF, matched filtering and digital correlation techniques in the headend receiver, high message throughput still can be maintained under heavy impulse noise and ingress. Also, the individual transmitter output level can be adjusted automatically by the headend system controller for establishing better signal-to-noise ratio.

## User-friendly

From the subscribers' perspective, the two-way capabilities are simple to deal with. In the first configuration available, the two-way function is provided with an add-on module that plugs into the one-way converter using two cables. These cables are for power, control signals and an RF loopthrough.

There are no adjustments required when installing the unit so the customer can self-install, thereby eliminating a truck roll-out and help achieve the <$50 inplace cost target. On the front of the unit are three indicator lights: Wait (yellow), Error (red) and Okay (green).

In general, when the user initiates a transaction, the Wait light illuminates for a few seconds before either the Okay or Error light comes on. Additionally, if an IPPV request is made on a scrambled channel, the picture should come into the clear if the Okay indicator is on.

## Headend hardware and software

The required headend hardware and software are extensions of the elements needed in a one-way system. For downstream addressability, a system controller (computer) and data encoder are required.

The system controller is interfaced both to standalone operator terminals and to the billing/management computer. Addressing and control data from the controller is transmitted to individual converters by placing data in the vertical blanking interval of encoded channels.

To add two-way capabilities, a headend receiver must be added for the return signals. Also, more attention needs to be paid to the performance and reliability of the system controller.

Scheduling and running impulse pay-per-view events or opinion polls is complex. For IPPV, the system must take into account program start and finish times, preview times, program tagging, customer passwords and cancellation windows. During the event, the systems can process up to 10K purchases per minute. After an event the subscriber list must be posted to the billing computer. Opinion polls must be defined by question, range of valid answers and whether multiple responses will be allowed. After the opinion poll, the results also are posted.

System-related operations such as power adjustments and early warning of cable plant failures are important features of the system. Each two-way return transmitter can have its output power set from the headend automatically. Additionally, measurements of signal to noise are made available for plant maintenance issues. As an early warning system, up to 50 two-way converters can be monitored for detecting plant failures. These units are placed in strategic locations, such as hub sites and at the end of the branches of the cable plant.

Channel monitoring is offered as part of the system operation. This is performed in a way which protects the anonymity of the customer; only totals are provided on a channel-by-channel basis. If desired, this feature can be defeated within the unit in the home or by proper entry into the database.

## System performance

The new system works with two communications protocols simultaneously: polling and contention. The polling mode is used for all headend-initiated transactions, such as one-way addressability, power tuning and status monitoring. Subscriber initiated actions, such as IPPV request and opinion response, are handled with a contention protocol.

For impulse pay-per-view, the most critical application, program authorizations can be issued from the headend at a rate of 180/second. The contention protocol (Slotted Aloha) runs at a reduced efficiency during heavy traffic conditions (such as the five minutes surrounding the start of an event); for this reason, an upstream message rate of 960/second was selected. This guarantees that 180 good messages are received even during peak usage of the system.

The system was designed with upstream communications reliability in mind. The dual frequency agility, coupled with BPSK modulation, provides an excellent interference-fighting capability. Further, the headend receiver uses advanced design principles such as digital correlation, narow IF and matched filtering for superior performance. As measured, the receiver has the following characteristics:

| | Message Throughput (% of good messages received at headend) |
|---|---|
| C/N (White Noise) | 12 dB (90%)<br>7 dB (50%) |
| C/I (CW inband) | 8 dB (90%) |

The net result of the transmitter and receiver combination is a system that works well without special efforts required on maintaining the upstream plant. Normal downstream maintenance, coupled with keeping the upstream plant balanced, is all that is required.

## Conclusion

The true test of any system technology is in actual application. The technology described here currently is operational in San Antonio, Texas, with additional subscribers being added regularly in the Rogers system as part of new premium services.

The plant parameters are:

| | |
|---|---|
| Homes passed: | 385,000 |
| Miles of plant: | 4,400 |
| Subscribers: | 191,000 |
| IPPV Subscribers: | 45,000 |

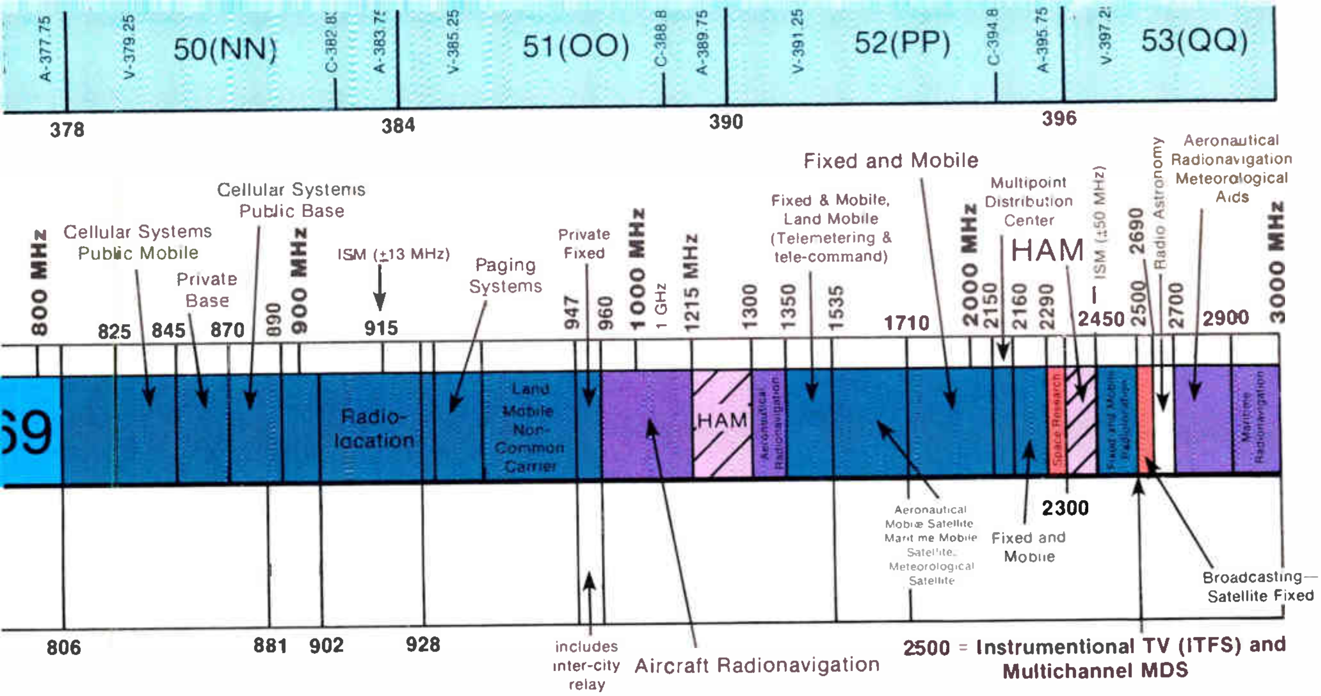
Pay-per-view subscriber penetration has been as high as 15 percent for special events and 3 to 5 percent per event for recent movies with multiple scheduling. As many as 60 percent of the impulse pay-per-view subscribers place their orders in the half-hour preceding the event.

The incremental maintenance required to make the plant two-way has become a benefit rather than a liability. The number of service calls required for subscriber terminal installation is minimal. Full implementation of the status-monitoring capability should further assist in the reduction of service calls.

Is two-way cable dead? With apologies to Mark Twain: "The news of two-way cable's demise is greatly exaggerated." CED

## Reference

* "Two-Way Cable Plant Characteristics," R. Citta, D. Mutzabaugh, *NCTA Technical Papers*, June 1984.




ier C-Chroma Carrier

7-13

23-36

37-94

Same as Off-Air

Trouble Areas

# Legend

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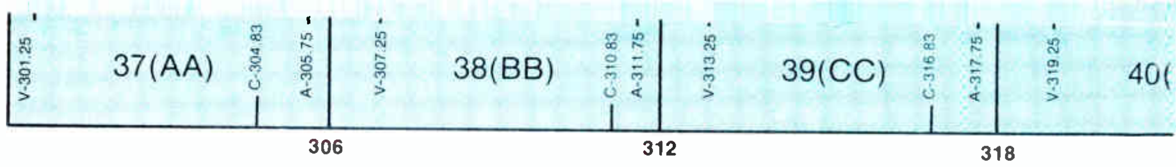


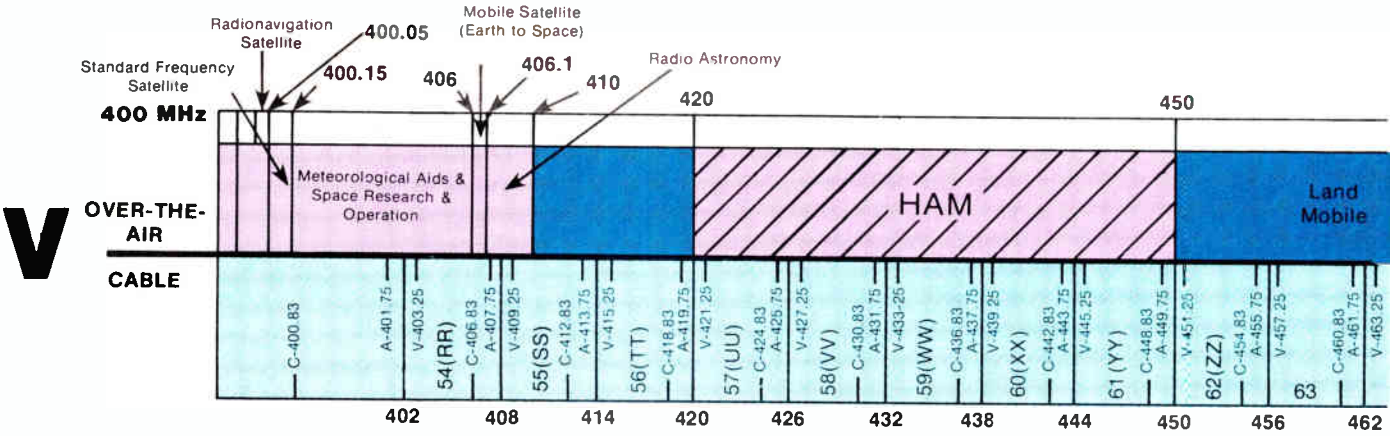


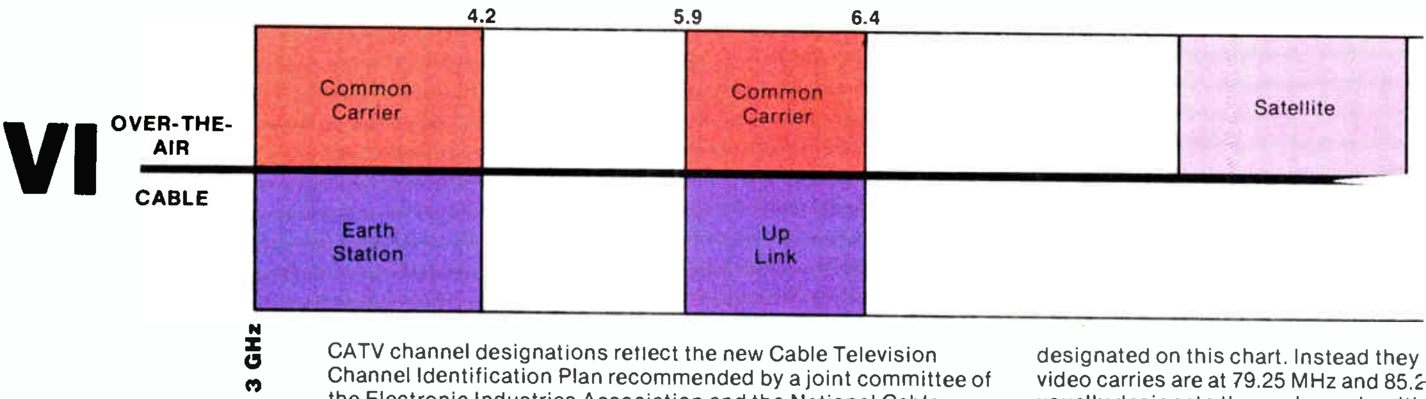


CATV channel designations reflect the new Cable Television Channel Identification Plan recommended by a joint committee of the Electronic Industries Association and the National Cable Television Association. Former standard designations appear in parentheses. It should be noted that some manufacturers using phaselock IRC channel spacing avoid using Channels 5 and 6 as designated on this chart. Instead they video carries are at 79.25 MHz and 85.2 usually designate those channels with The joint EIA/NCTA committee has no channel spacings any numerical desig

Also note that CATV channel design

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(based on .750 GID III)

| Present Upper Frequency | Present Spacing | Gain Needed to Upgrade Bandwidth to: | | | | | |
|---|---|---|---|---|---|---|---|
| | | 260 | 300 | 330 | 400 | 450 | 550 |
| 216 | 22 dB | 24.3 | 26.3 | 27.8 | 30.6 | 32.4 | |
| 260 | 22 dB | | 23.8 | 25.1 | 27.7 | 29.3 | 32.5 |
| 300 | 22 dB | | | 23.2 | 25.6 | 27.0 | 30.0 |
| 330 | 22 dB | | | | 24.3 | 25.7 | 28.4 |
| 400 | 22 dB | | | | | 23.3 | 25.7 |
| 450 | 22 dB | | | | | | 24.4 |

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HEAD

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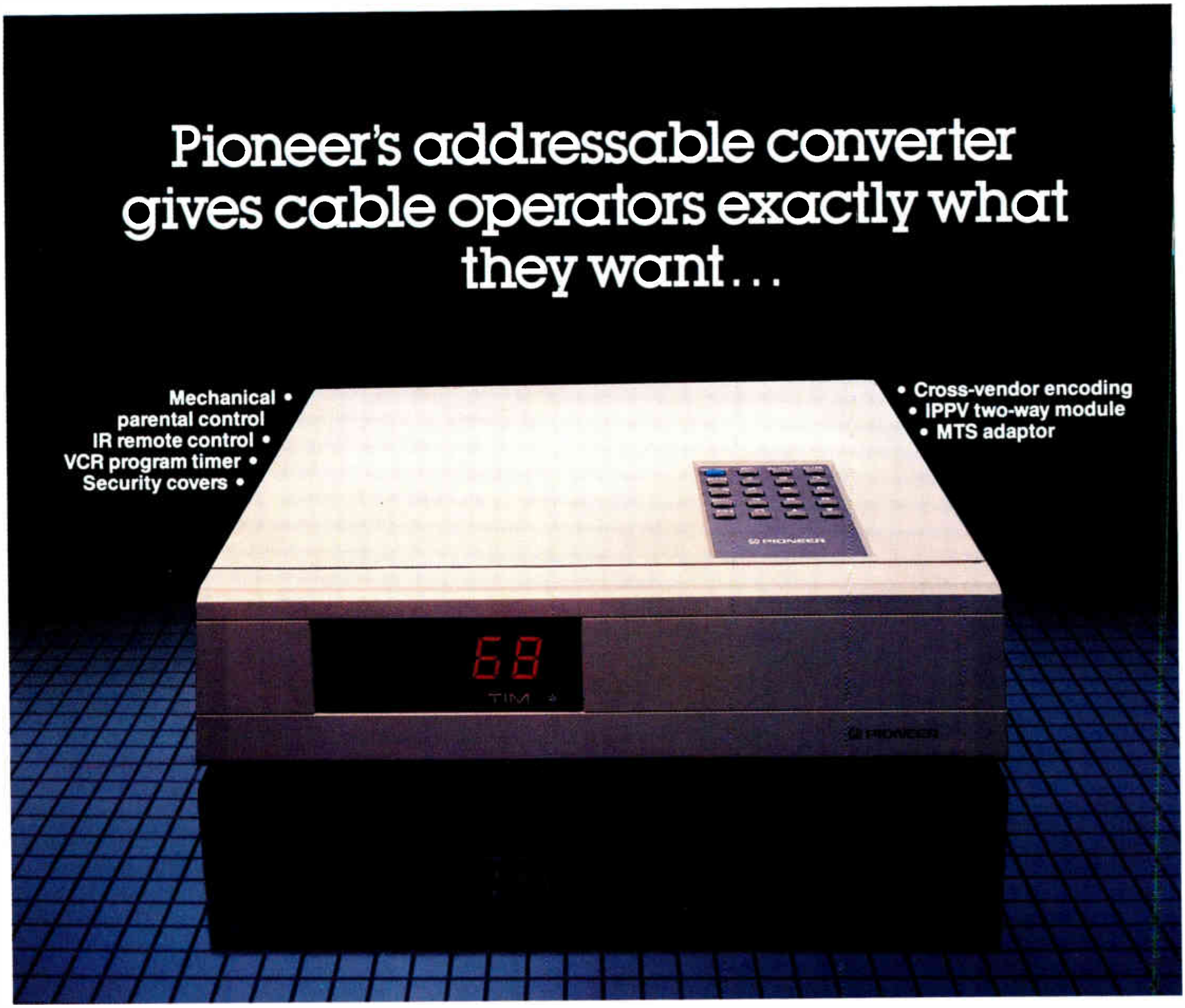


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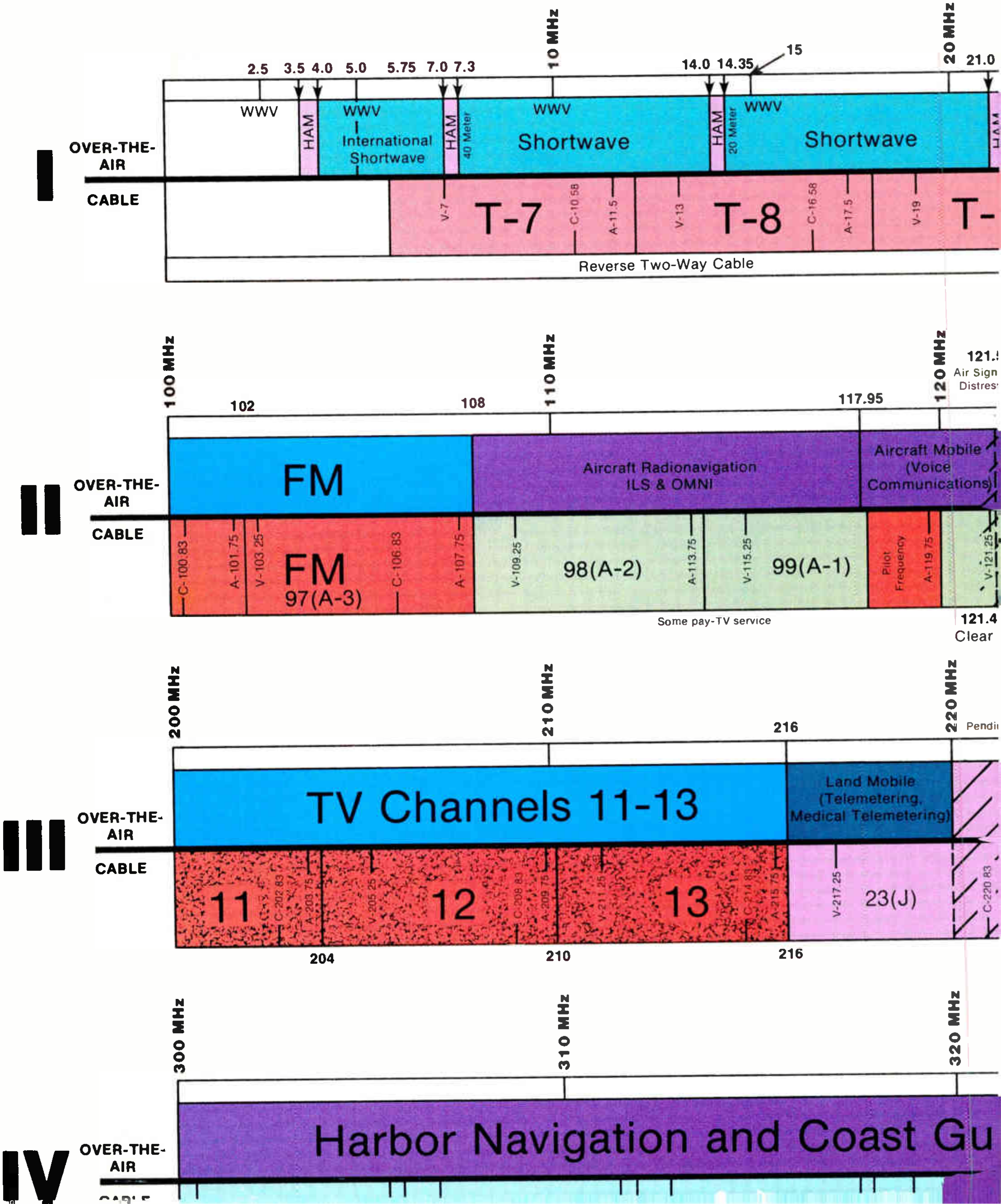
# CED's 1985 CATV Frequency Allocation Chart

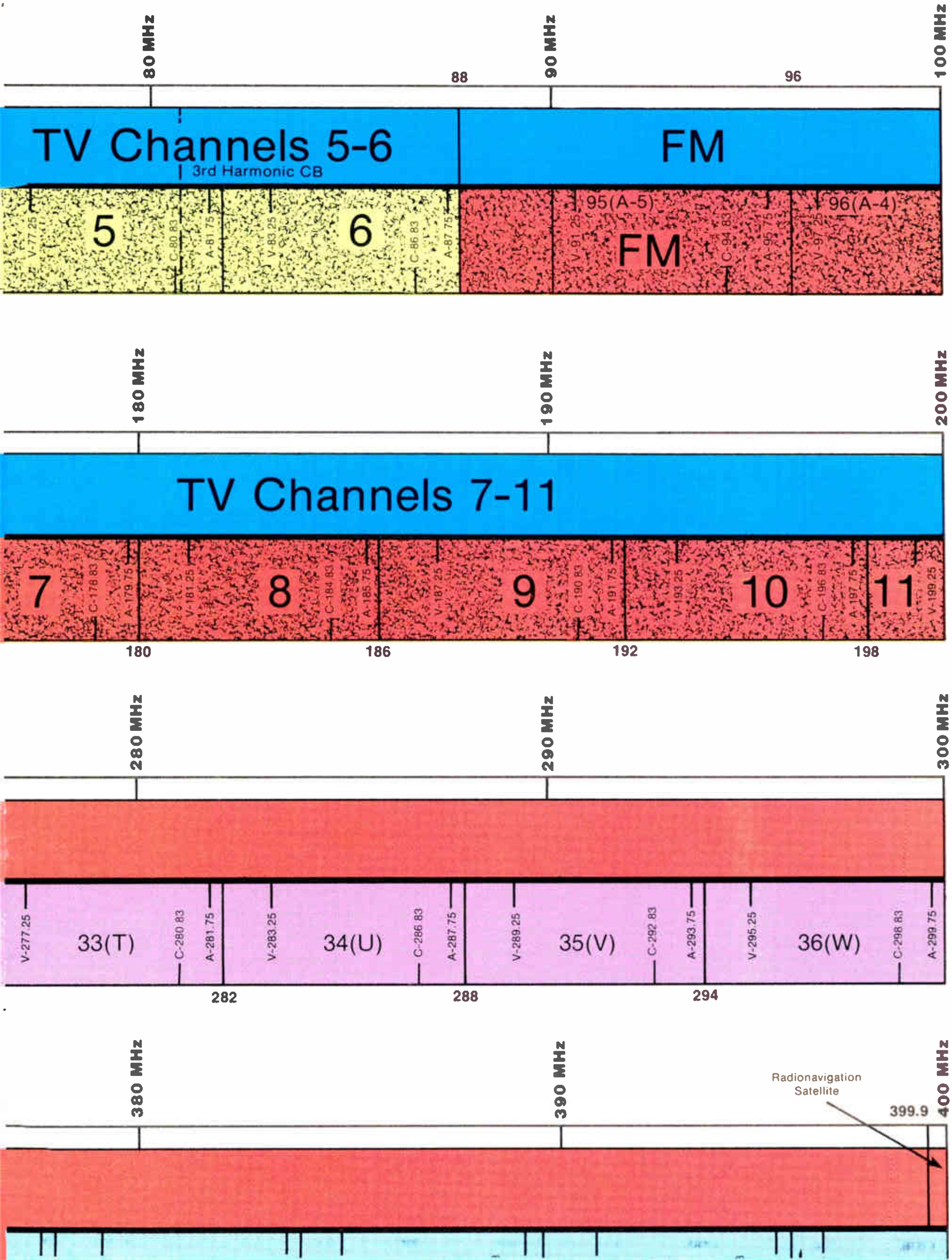


Reader Service Number 28

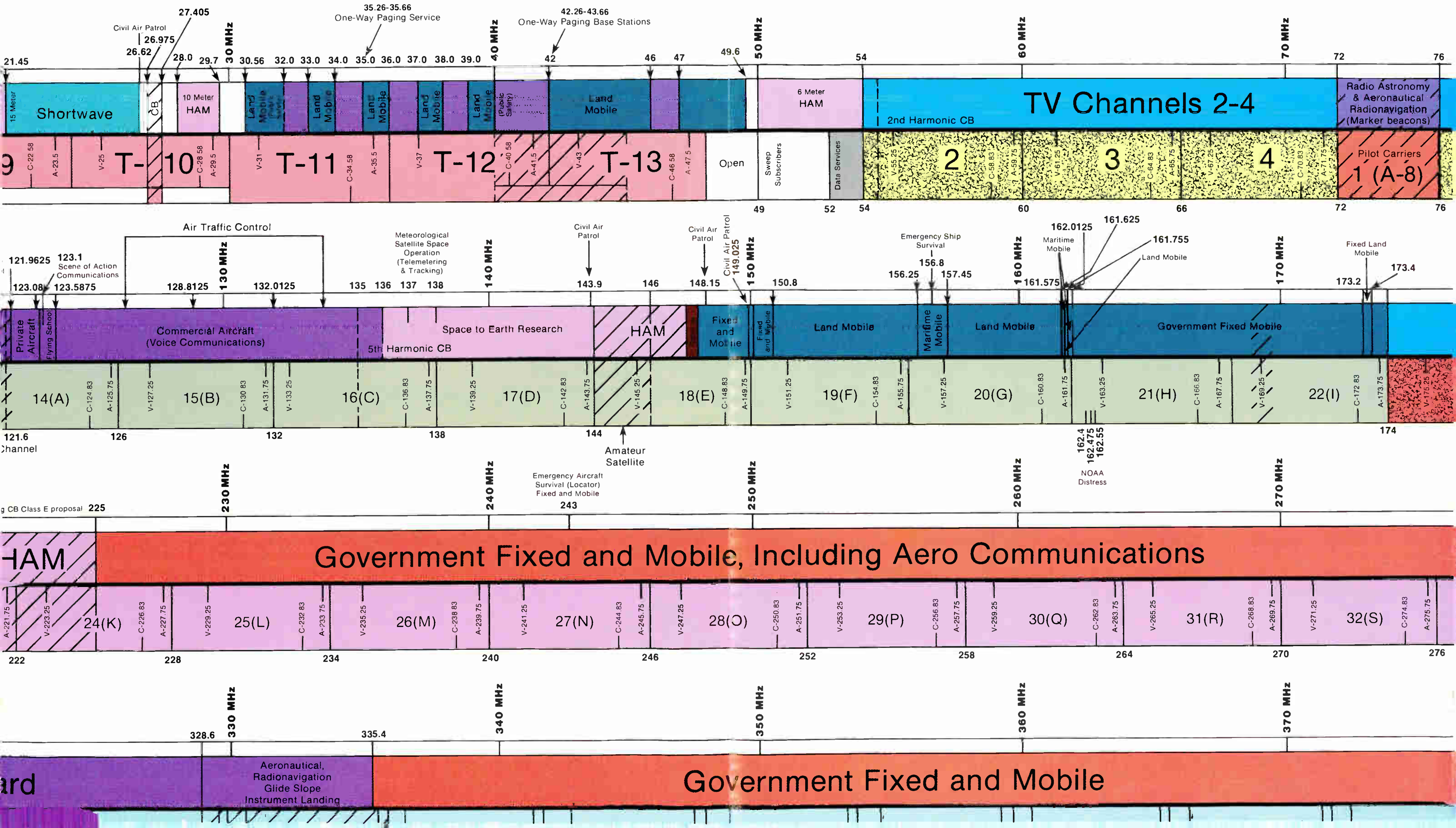
# CED's 198

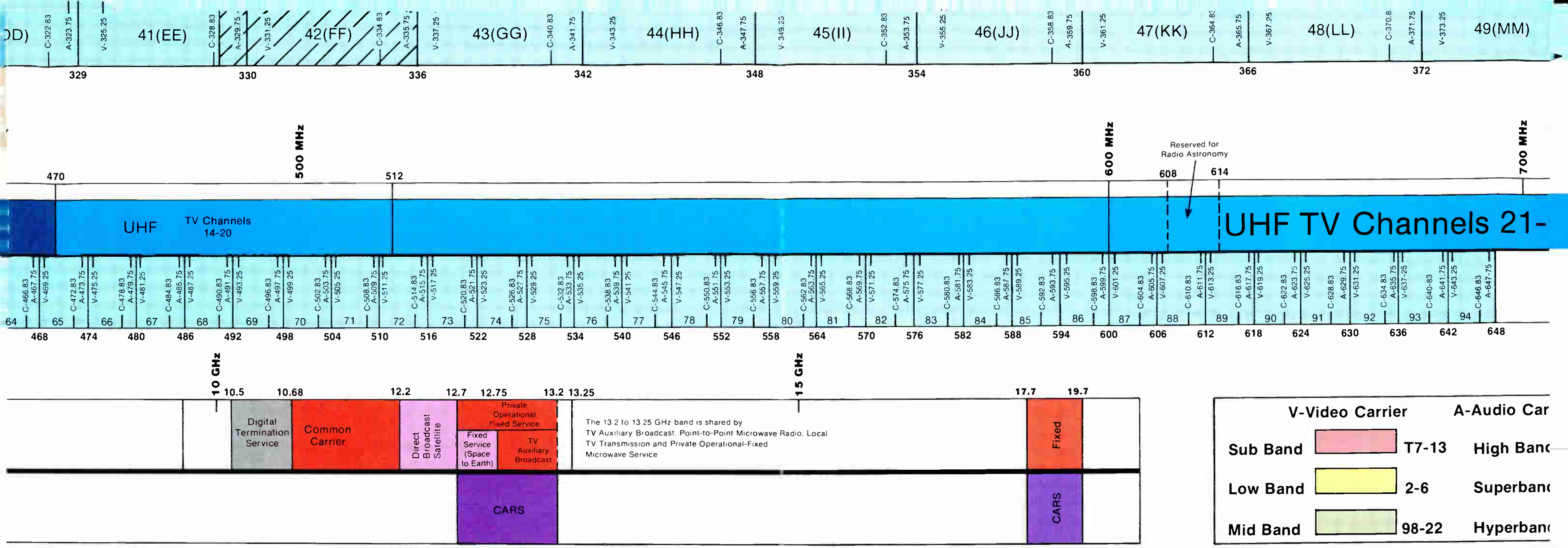

I
OVER-THE-AIR
CABLE
10 MHz
20 MHz
2.5
3.5
4.0
5.0
5.75
7.0
7.3
14.0
14.35
15
21.0
WWV
HAM
WWV
International Shortwave
HAM
40 Meter
WWV
Shortwave
HAM
20 Meter
WWV
Shortwave
V-7
T-7
C-10.58
A-11.5
V-13
T-8
C-16.58
A-17.5
V-19
T-
Reverse Two-Way Cable
II
OVER-THE-AIR
CABLE
100 MHz
110 MHz
120 MHz
102
108
117.95
121.
Air Sign
Distres
FM
Aircraft Radionavigation ILS & OMNI
Aircraft Mobile (Voice Communications)
C-100.83
A-101.75
V-103.25
FM
97(A-3)
C-106.83
A-107.75
V-109.25
98(A-2)
A-113.75
V-115.25
99(A-1)
Pilot Frequency
A-119.75
V-121.25
Some pay-TV service
121.4
Clear
III
OVER-THE-AIR
CABLE
200 MHz
210 MHz
220 MHz
216
Pendi
TV Channels 11-13
Land Mobile (Telemetering, Medical Telemetering)
11
C-202.83
A-203.75
V-205.25
12
C-208.83
A-209.75
V-211.25
13
C-214.83
A-215.75
V-217.25
23(J)
C-220.83
204
210
216
IV
OVER-THE-AIR
300 MHz
310 MHz
320 MHz
Harbor Navigation and Coast Gu

# ion Chart


80 MHz
88
90 MHz
96
100 MHz
TV Channels 5-6
3rd Harmonic CB
FM
5
6
V-77.25
C-80.83
A-81.75
V-83.25
C-86.83
A-87.75
95(A-5)
96(A-4)
V-91.25
C-94.83
A-95.75
V-97.25
180 MHz
190 MHz
200 MHz
TV Channels 7-11
7
8
9
10
11
C-178.83
A-179.75
V-181.25
C-184.83
A-185.75
V-187.25
C-190.83
A-191.75
V-193.25
C-196.83
A-197.75
V-199.25
180
186
192
198
280 MHz
290 MHz
300 MHz
V-277.25
33(T)
C-280.83
A-281.75
V-283.25
34(U)
C-286.83
A-287.75
V-289.25
35(V)
C-292.83
A-293.75
V-295.25
36(W)
C-298.83
A-299.75
282
288
294
380 MHz
390 MHz
400 MHz
Radionavigation
Satellite
399.9

# 35 CATV Frequency Allocat






set the frequencies so the
5 MHz, respectively, and
numbers other than 5 or 6.
chosen to give these
nation.
ated carrier frequencies in

the bands 108 to 136 MHz and 225 to 400 MHz are subject to the frequency offset and notification requirements in sections 76.610 through 76.619 of Part 76 of the Federal Communications Commission's Rules and Regulations.

# WEIGHING STANDBY POWER

STANDBY

STANDBY

***By Thomas Hunter, Jr.,***
***President,***
***Data Transmission Devices Inc.***

This is a practical guide to selecting a reliable standby supply, using the "Standard of the Industry," a ferro resonant transformer, as the base from which all power supply specifications are derived.

The ferro resonant transformer is the base power supply for cable. This type of transformer produces a constant voltage output, over 20 percent changes in input voltage and was originally used for street lighting and later cable, both of which are immune to the effects of square wave harmonic distortion.

A properly designed ferro resonant transformer, typical of those used in cable, has the following specifications:

| | |
|---|---|
| Voltage @ full load & 120 V input | ± 1% |
| Voltage @ full load and 95-130 V input | ± 2% |
| Voltage @ varying load and 120 V input | ± 2% |
| Total Voltage Tolerance | ± 5% |

Since the tolerance for all conditions of line, load, etc., is typically ±5 percent, and this tolerance has been accepted for cable since its earliest beginnings, there does not appear to be any gain in specifying a tighter tolerance for standby power supplies.

The second factor in a ferro resonant transformer is its overload and short circuit characteristics. The output short circuit current varies greatly with input voltage. For a typical 12 amp rated transformer, the short circuit current can vary from 14 amps at 102 volts (low line) to 23 amps at 135 volts (high line).

The output voltage will, however, hold up under very low line voltage conditions if the transformer is operated at less than full load. For example, if a 12 amp transformer is operated at 6 amps, it will maintain its 60 V output down to a 70 V line. Therefore, if you are in a low voltage area, or are subject to brownouts, by operating the power supply at less than full load, you can avoid loss of signal under low line conditions, and the problem of burning up passives under short circuit or overload conditions is greatly reduced.

If you are in a high line voltage area, you can operate the transformer at a greater percentage of full load without worry, but some form of overcurrent protection may be necessary.

A simple way of estimating the reliability of a power supply is to set it up carefully in a lab so that it is properly ventilated, bring it up to full rated load and, after 12 hours, measure both the transformer iron stack temperature and the capacitor temperature. Since the life of both components is very temperature dependent, the cooler the parts, the longer they will live.

## Batteries

Batteries are the least understood element in a cable plant. These paragraphs will help you gain an understanding of batteries and how to get the most out of them.

Lead calcium, liquid electrolyte batteries offer the most cost-effective operation over the life span of any cable power system, provided the location is one where temperatures are normally within 40°F to 90°F and high shock or vibration are not present. Excursions from 30°F to 110°F can be tolerated but should not exceed 24 hours. For extended periods, every degree above this range tends to shorten battery life and increase maintenance. A British study in 1974 showed that by raising battery environmental temperature from 70°F to 104°F, the water loss increased four times, with an estimated decrease in life of a similar magnitude. Other studies show that battery life decreases by 50 percent for each 15°F rise over 77°F. There are many communication grade batteries installed in factory signal systems where temperatures go as high as 110°F, but they require frequent watering and have a much shorter life.

Cable-grade lead acid batteries are designed to hold a greater volume of electrolyte than a simple automotive battery, thus reducing scheduled maintenance. Their construction is much

***The real cost of a power supply or any piece of equipment is the initial cost plus the annual maintenance costs.***

sturdier than the simple lead calcium gel types, with a stronger, much larger plate and long life separator material. Terminations are much heavier and equipped with terminal bolts, lock washers and nuts to ensure positive contact with connectors.

In the design of a battery for use in a non-utility standby power system, one must recognize that there usually is little or no maintenance performed on the batteries, and environmental temperature often varies seasonally over 100°F. By contrast, telephone system and utility switchgear batteries guaranteed for 20 years on a pro-rata basis are very carefully cleaned and watered and, therefore, can be maintained on a regular schedule in a virtually constant temperature environment.

Low temperatures tènd to extend battery life but reduce the amount of power the battery will deliver. For example, at 20°F the battery will be reduced by nearly 40 percent. Therefore, a thermostatically controlled battery heater is recommended.

In a non-utility environment, what can be done to design and build a battery with maximum life and minimum maintenance? First, for the grid structure use a lead alloy which has demonstrated life in this service of at least ten years, with a closely regulated temperature compensated battery charger. Lead calcium is the best alloy for cable which is a "float" application.

Lead calcium and lead antimony differ somewhat in their response to float charging. Lead calcium, when floated at 2.17 volts/cell, consumes considerably less water than lead antimony and requires a periodic equalize charge. Some lead calcium manufacturers suggest float charging at a higher potential (2.25 V/C), thereby eliminating the requirement for periodic equalizing but using more water. This has a detrimental effect on battery life—a rather bad exchange. Also, it demonstrates that the charger output to this type battery must be temperature compensated, well regulated and properly adjusted, for a rise in output voltage of 1.5 percent will substantially shorten battery life. Charging is mentioned briefly further on in this section.

Lead antimony batteries have a much longer cycle life than lead calcium and are always used in electric trucks, fork lifts, etc., where they are charged and discharged very frequently. Lead antimony batteries consume considerably more water than lead calcium at installation, and as they age, the water consumption increases as a result of chemical changes in the cells. Industrial grade antimony batteries have improved in this respect over the last few years, though they are seldom found in cable applications where communications type batteries are most common.

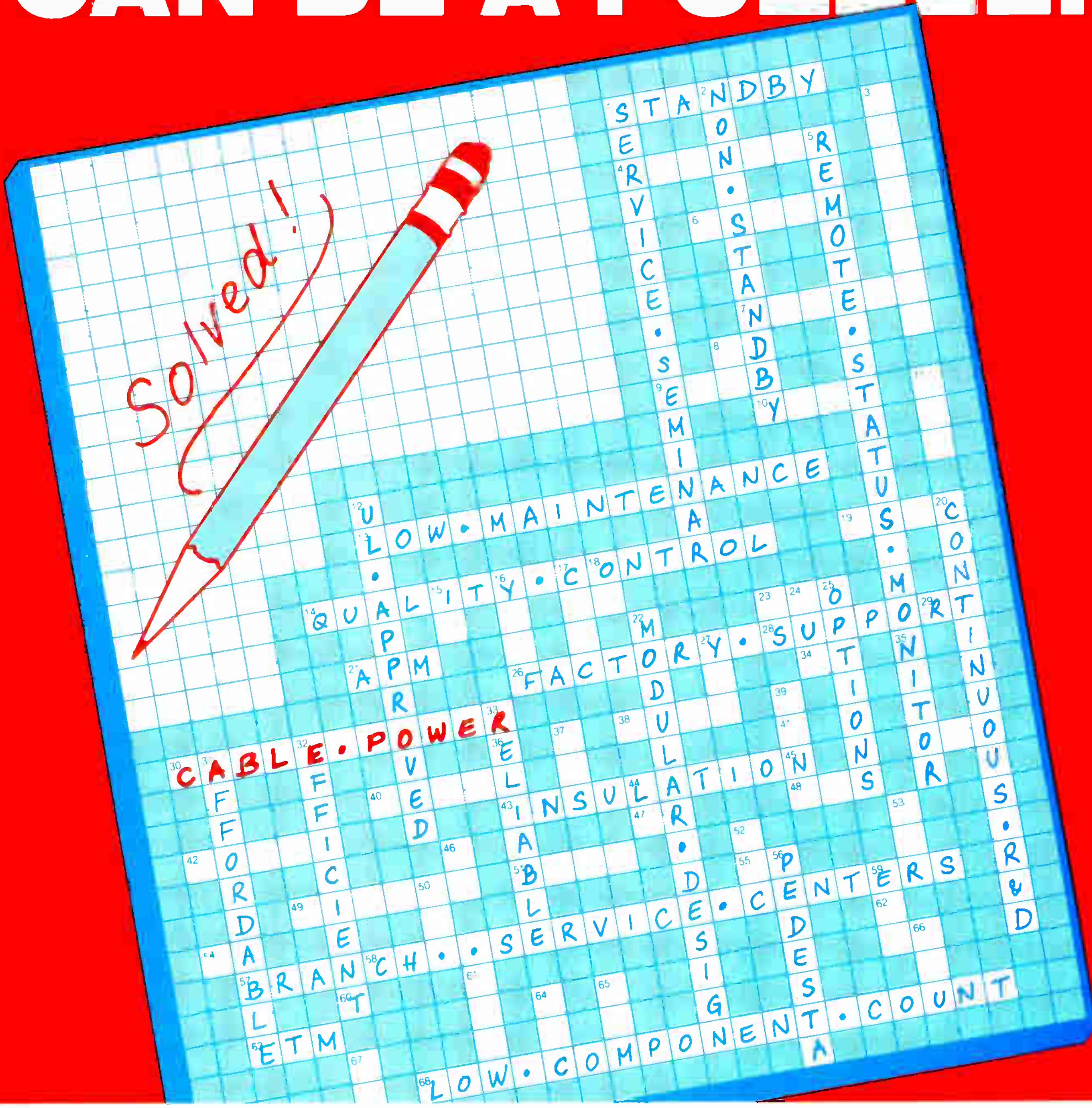
Antimony batteries have relatively the same properties as calcium batteries on float charge, with the exception that their life is not generally stated to be as long, and they require frequent maintenance. It also is used in "maintenance-free automotive batteries," where again the design life is about 3 to 5 years and the implied reliability of a "maintenance free" battery is a big selling point.

## Battery life

Unless a battery fails abruptly, it is difficult to determine precisely when it should be replaced. Recordkeeping is very important in the maintenance of battery systems to assist in making this determination, yet recordkeeping at battery installations is seldom found. If battery life is equal to a known portion of the system life or, at least, equal to the system life through major reevaluations, then a higher reliability exists for that battery.

The conditions of each geographical application must be reviewed separately to perform an estimate of battery life but, if estimated and sized properly, a lead calcium plate battery should last 5 to 10 years. This is not true for other types since the mechanical structure

# FINDING THE RIGHT POWER SUPPLY CAN BE A PUZZLE!

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cannot withstand the years of service, and frequent maintenance is required.

The Institute of Electrical and Electronics Engineers Inc. (IEEE) Std., 450-1972(9), recommends battery replacement within one year if its capacity is below 80 percent of the manufacturer's rating as this is considered to be the end of a battery's useful life.

## Gel cells versus wet cells

The gel-cell battery type commonly used in cable sytems has about 20 percent less capacity than an equivalent, i.e. same size and weight, wet battery. Why? As it is being manufactured, the gel battery is virtually exactly the same as its wet cell equivalent up to the point of final acid fill. The wet cell is filled with acid.

As the gel cell acid flows into the battery, it is mixed with a gelling agent which, over a 24 hour period, causes the liquid acid to gel just like jello. It is wet to the touch but will not flow.

Why the loss of capacity then? Since a gel will not flow like a liquid as the battery discharges and uses up the acid in the plates, fresh acid cannot circulate freely into the plates to keep the current flowing, therefore, reducing the battery capacity. In addition, as any wet or gel battery ages, the electrolyte (which is about 75 percent water) decomposes and is vented as minute amounts of hydrogen and oxygen gas.

In a wet cell as this happens, the liquid level drops. Even in so-called "sealed" batteries it can be replaced with distilled water to help extend battery life. In a gel cell, the gel around the plates dries out, starving the plates of electrolyte which cannot be replaced by gravity or adding distilled water.

## Common battery problems

Boiling over is a symptom of overcharging, excessive battery temperature or both. Very often the defective battery will have a shorted cell, but this is usually the effect of boiling, not the cause.

As a remedy, all the batteries in the power supply should be replaced and the charger voltage checked and reset for a lower voltage if necessary. Figure 1 shows float voltage versus temperature and will serve a guideline for your geographical area.

Gradual loss of standby running time is indicative of a loss of battery capacity. If it occurs over a period of 6 to 12 months with new batteries, it generally means that the charger voltage is set too low or the charging current is too small and, therefore, the batteries are not being properly charged. The charger should be reset for 26.2 to 26.8 volts at 70°F to 75°F with new, fully charged batteries and the temperature compensation checked.

If the batteries are over three years old, the gradual loss of capacity is probably caused by positive plate failure. The most likely causes are overheating in hotter climates or the charger voltage is set just a bit too high.

For maximum battery life and minimum maintenance (they are inseparable), a dual voltage charging scheme should be used. The battery should be maintained at a low voltage (2.17 to 2.20 VPC) and, during recharges, brought up to a higher voltage (2.3 to 2.5 VPC) and held at that voltage until the cell is fully charged and gassing to circulate the electrolyte.

At 2.17 to 2.20 VPC, the battery will remain in a fully charged state and water loss (electrolyte decomposition) held to a minimum—essentially evaporation losses. It will not, however, recharge properly at this voltage.

While battery life is very sensitive to float voltages, it is not very sensitive to recharge voltages if the recharge is stopped when the battery is fully charged. Therefore, a recharge voltage range of 2.25 to 2.40 VPC will work fine, provided the charge is stopped when the battery is fully charged.

The ideal method of battery charging

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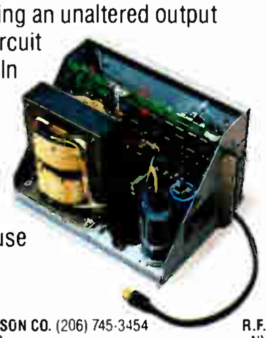

This concept needs fewer components which translates into **higher reliability**. Because the inverter cannot be activated, even with the line relay contact "stuck", this concept also gave us the fail-safe feature that helped us to obtain both **UL** and **CSA** approvals. And that gives a good product a good name.

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## October 21, 22, 23, 1985
## Hyatt Regency—Fort Worth, Texas

## Program:

### Monday, October 21

| | |
|---|---|
| 8:00 | REGISTRATION |
| 9:00 | OPENING SESSION: "State of the Industry Address" |
| 10:30 | LEGAL SESSION: "Forced Access-Will It Put You Out Of Business?" |
| 12:00 | KEYNOTE LUNCHEON |
| 1:30 | EXHIBITS OPEN |
| 1:45 | FINANCIAL SESSION |
| 4:30-6:30 | COCKTAILS IN THE EXHIBIT AREA |

### Tuesday, October 22

| | |
|---|---|
| 7:00 | ROUNDTABLE BREAKFAST: "Nuts and Bolts" Issues |
| 8:30 | PROGRAMMING SESSION: "Paying for Program Services" |
| 10:00 | MARKETING SESSION: "What Are You Selling, To Whom?" |
| 12:30 | DELI LUNCH |
| 12:30 | EXHIBITS OPEN |
| 1:30 | TECHNICAL SESSION |
| 4:30-6:30 | COCKTAILS IN THE EXHIBIT AREA |

### Wednesday, October 23

| | |
|---|---|
| 7:00 | ROUNDTABLE BREAKFAST: "Discussions with Programmers" |
| 9:00 | TECHNICAL SESSIONS |
| 9:00 | EXHIBITS OPEN |
| 11:00 | GRAND PRIZE DRAWING |
| 11:30 | SHOW CLOSES |

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***Early registration ends October 1, 1985.** Reader Service Number 37 is to use a feedback charge to bring the battery up to a higher voltage, similar to cycle charging, but then keep the voltage up until the battery signals via a feedback signal that it is fully charged. At this signal the charger should slowly reduce its voltage, thus keeping the gassing and electrolyte circulation going, for an hour or longer, then reduce the voltage slowly to a maintenance level which will keep the battery charged but virtually eliminate water loss and plate corrosion.

This type of charging can extend battery life to over 5 years and as much as 20 years if it is also fully temperature compensated.

Most cable power supplies use a float or constant voltage current limited charger. This method limits the charging current during recharge, then maintains the battery at a constant voltage which will, in time, provide a complete recharge but is too high to achieve maximum battery life. Life also is reduced because this float voltage is too low to cause any end of charge gassing which circulates the acid to prevent stratification. If lead calcium batteries are used, the constant voltage charger should be set at 2.33 to 2.38 volts at 77°F.

Trickle or taper trickle chargers are essentially constant current chargers set at a very low current without regard to battery voltage. They should be avoided in cable systems as they are battery killers.

Cycle charging is a dual voltage charging method. The idea is to cycle the battery between two voltages in order to fully recharge in a reasonable length of time and get some gassing started, then let the battery settle down to a lower voltage for a set period or to a selected voltage, then bring it back up to the high recharge voltage. This kind of cycle charging is a great improvement over constant voltage charging.

In some cases transfer time is defined as the time it takes for the transfer relay to switch the cable from one power source to another. But that does not necessarily mean that the second source is delivering power at the time that the cable is connected to it. That power-up may not occur for a relatively long time. Therefore, let us define transfer time as the period when no voltage is being delivered to the cable.

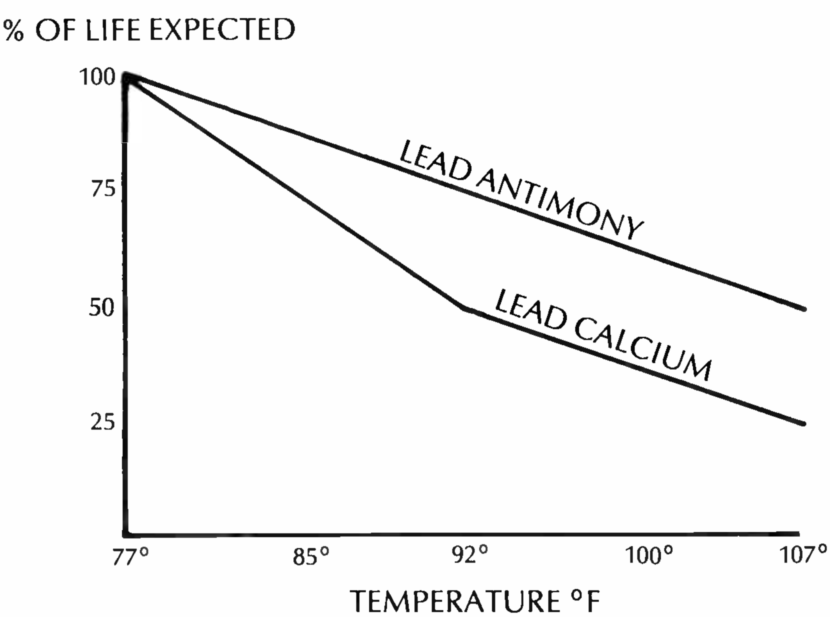
When I asked, "How long can the cable amplifiers go without power?" the answer varied from zero time to 5 cycles or 80 milliseconds, but those asked did not seem to know why a particular time had been suggested. By talking to various amplifier manufacturers, the following information was obtained. First, each amplifier has its own power supply, consisting of a transformer, rectifier, filter capacitor and switching regulator.

The transformer is an energy storage device and will deliver power for one-half to one millisecond or a bit longer after a loss of power. A much more important source is the power supply filter capacitor, which can supply an amplifier from 20 to 80 milliseconds depending upon the supply design.

Figure 2 is a simple method of estimating the time that your amplifiers will operate without power.

Since each amplifier power supply has a large filter capacitor to carry it for

**Figure 1**
**Expected life (%) at various temperatures**



a few milliseconds, there does not appear to be any requirement for a zero transfer time or UPS (uninterruptable power supply) in the cable plant. From the best information I have been able to find, a transfer time of 10 to 30 milliseconds is probably sufficient to prevent a loss of signal.

One point that has been raised is the importance of accuracy in business data transmission. In this case, a "handshake" transmission is always used. The data is sent, then returned to the sender, verified and a confirmation or "handshake" signal sent. Therefore, a signal interruption is not as devasting as one might think.

The biggest source of problems caused by overlong transfer time in cable probably will be the loss of memory in addressable converters, either on or off premises, if the refresh interval is very long, for instance once every 30 minutes or even once in five minutes. This can be helped by the electronics manufacturers if they use the largest possible filter capacitor in the rectifier power supply. Very often 50 to 100 percent more capacitance can be used for little or no change in cost or capacitor size, while the cost of reducing transfer time can be very expensive.



**Figure 2**

$$Z = \left(\frac{60}{\text{Amplifier Current}}\right)$$

$$R = Z\left(\frac{\text{Power Supply Primary DC Volts}}{60}\right)$$

Time (Milliseconds) = R x C x 1,000 x 0.8

Example:

$$Z = \frac{60\text{ Volts D.C.}}{1\text{ Amp Input Current}}$$

$$= 60$$

$$R = 60\left(\frac{50\text{ VDC}}{60}\right)$$

Input Capacitor = 1,000 ufd

$$\text{Time} = 50 \times 1{,}000 \times 10^{-6} \times 10^{3} \times 0.8$$
$$= 50{,}000 \times 10^{-3} \times 0.8$$
$$= 40 \text{ Milliseconds}$$

The type of transfer switch also is important. A solid state transfer switch is extremely fast, so fast as to make a standby power supply appear to be an uninterruptable supply. They have no moving parts and, if properly designed, can handle very large surge currents and transient voltages.

Solid state transfer switches are, however, very expensive when compared to relays, difficult to repair in the field and tend to fail as a short which can cause a cascading failure mode that will damage the standby power supply and cause a complete failure of power to the cable.

Relays are slow by comparison, and when they fail, they tend to tack weld in one direction, thus tending to avoid a cascading failure mode. If the power supply is designed properly, the failure can favor the utility power supply, thus avoiding a total failure. Since many relays are available as plug-ins or with screw terminals, they can be replaced in the field without too much difficulty.

Should you call your local utility to determine the number or frequency of power outages in your area, they will tell you that power failures of less than 30 seconds to three minutes are not considered to be outages. The cutoff period (30 seconds, etc.) varies by utility.

An informal study by the emergency lighting industry determined that most outages last for under 45 minutes. The National Electric Code calls for 90 minutes of emergency lighting or twice the average outage. There are always very long duration outages because of ice storms or other natural disasters, but during my term as President of the

Emergency Lighting Manufacturers' Association, it was felt that over 90 percent of the power outages were for under one hour and, therefore, the two hours of standby power generally specified by the cable industry is more than enough for the typical situation.

## Inverter designs

There are three basic inverter designs used in cable standby power systems. The oldest and simplest is the two transformer design. In this design the main power transformer is of conventional design, and a smaller saturable core transformer is used to generate the switching transistor drive signals and set the frequency.

This design is very simple, inherently short circuit proof and generally quite reliable. The efficiency also is high, often about 90 percent which can mean longer standby operating time on fewer batteries.

A disadvantage of the two-transformer design is that it cannot maintain a constant voltage to the cable electronics as the battery voltage falls. Therefore, the nominal 60 volts on standby will sink by about 20 percent from the initial starting voltage, usually 63 volts, to battery shut-off at 51 volts when the battery is discharged. This is a simple ratio of 27 volts, the initial battery voltage, to 21 volts, when the battery is discharged and the inverter shuts off.

A second disadvantage, which is not significant in a cable application, is that the power supply frequency will change as the battery voltage drops. Since this type of inverter must be independent of the utility company, this type of power supply usually includes a separate power supply for utility operation, thus tending to improve the overall system reliability.

The second design is later, has much better performance and uses a single ferro resonant transformer for both normal and standby operation. It has several advantages over the two transformer design. It provides a constant voltage to the cable as the battery voltage falls, has a constant frequency usually ± 1 percent and is very resistant to damage caused by overloads, open or short circuits on the cable.

This design is somewhat less expensive to manufacture than the two transformer design because it uses just one transformer for both utility power operation and battery operation. There are, however, some disadvantages. First, the transformer is not very efficient and, as a result, battery operating time is reduced. Therefore, three batteries are commonly used instead of two to obtain the 2 to 2½ hour battery operation common to cable.

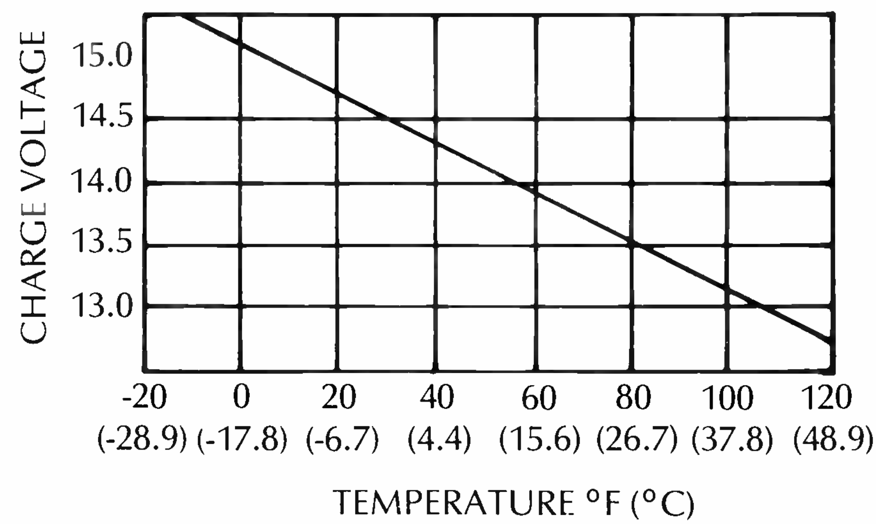
The second disadvantage lies in the use of a single transformer for both normal and standby operation. If the transformer or associated tuning capacitor fails, or more likely, a relay, battery charger rectifier or other semi-conductor connected to the transformer short-out, the entire supply stops and cable is without power. Repairing a failed single transformer standby power supply is not always easy.

The third type of power supply is a modern version of the first supply. It uses a standard ferro resonant transformer for utility operation, and for battery operation, a single transformer inverter using pulse width modulation techniques for voltage regulation and current limiting, a method very similar to that used in the switching regulators in amplifiers.

The advantages of this design are high efficiency, thereby reducing the number of batteries, good voltage regulation and good overload and short circuit performance.

Since two power supplies are used, it is possible to make the system fully redundant. That is, the total failure of one supply has no effect on the other. Therefore, they can be repaired independently and when convenient. And with this redundant design, any part

**Figure 3**




that needs attention (be it the standby power portion, utility power portion or batteries) can be removed for service without losing power to the cable. These features, combined with good voltage regulation in either the utility or standby mode, make this general type of design the most reliable.

To an MSO reliability means keeping the signal going, hopefully without spending buckets of money. As far as power supplies are concerned, a reliable supply should have the following characteristics:

- The failure of a single component should not interrupt power to the cable.
- Battery life should be at least 5 years.
- If a portion of the power supply is out of specification, it should be clearly identifiable by lower echelon field techs.
- Corrective action should be clearly indicated.
- Taking the corrective action should not interrupt power to the cable.

In short, if you can't fix it in a 3 a.m. rainstorm, it is not reliable, and it is too expensive because each service call with labor, equipment, overhead, etc., computes to about $60 plus parts. Therefore, the real cost of a power supply or any piece of equipment is the initial cost plus the annual maintenance costs.

Figure 3 shows how much can be saved over a five year period by increasing battery life from 2½ to 5 years. In a typical two-battery power supply, the saving exceeds 20 percent. For a supply with more than two batteries, it is even greater.

There are many power supplies on the market today, and I hope this article helps you select the best supply for your application.

*This article is based on a presentation made at the 1984 NCTA Technical Sessions.*

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## About the author


*Thomas Hunter, Jr., is president of Data Transmission Devices Inc. He designed inverters for Gemini manned spacecraft and the Orbiting Geophysical Observatory and holds several patents on battery chargers.*

*Hunter is a former president of the Emergency Lighting Manufacturers' Association. His principal engineering work has been with batteries, battery chargers and inverters.* CED

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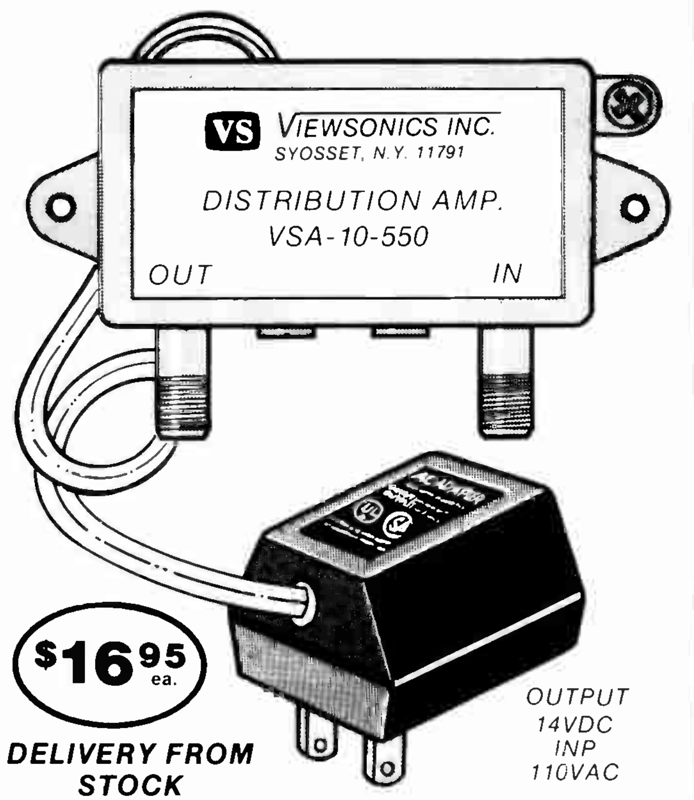


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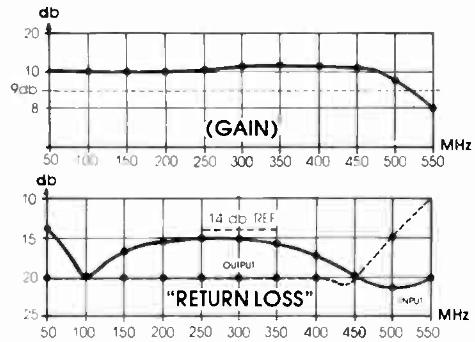


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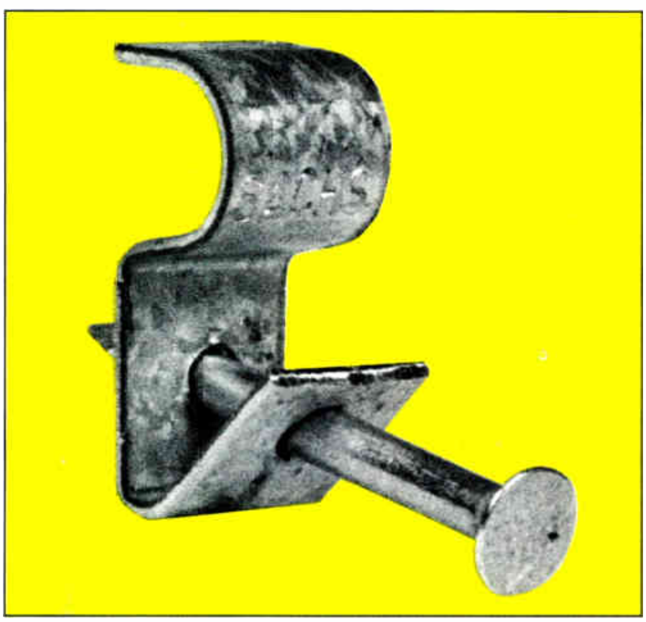

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# ADDRESSABLE MODEMS

***By Ken Leffingwell,***
***Applications Engineer,***
***Data, Distribution & Subscriber Products, Scientific-Atlanta***

As more and more cable systems turn to addressability to trim costs and increase revenue sources, the need to understand data communications methods becomes more important to the cable operator. It is the intent of this article to give a general overview of data communications equipment used in an addressable system to transfer data over the telephone system or self-installed private lines.

## Basics

Since our concern is data communications within an addressable system utilizing self-installed or telephone company lines, a digression relating to how they may be incorporated in a typical addressable system is in order. This requires a discussion of the functions and communications requirements of the various components of the system.

Most addressable systems have three basic components in common: 1) a controlling computer, 2) an addressable transmitter and 3) the addressable converter. The computer, normally located at the business office, maintains a database that contains information on each converter in the system such as its status and authorized service levels. The computer must have the capability to communicate with any one or all of the addressable converters in the system tc assure that each subscriber receives the level of service desired—no more and no less. The computer accomplishes this communication with the converters via the addressable transmitter located at the headend. It is a device that processes data sent from the controlling computer, arranges it in a format appropriate for transmission over the cable and transmits the data to the addressable converters in the subscribers' homes. The controlling computer may, in some applications, be "linked" to another computer that performs billing functions. In this instance nearly all data entry is made at the billing computer which communicates with the addressable control computer which, in turn, communicates with the converters in the system via the addressable transmitter.

The advantages and trade-offs pertaining to each particular type of system are detailed and need to be understood thoroughly when making a decision about system architecture. However, that discussion is beyond the intent of this article.

Data communication is the means by which ones and zeros in one device (stored as voltage levels) are transferred to another device. To facilitate the transmission of data between devices, the Electronic Industries Association (EIA) has developed standards that detail parameters (such as voltages levels and pin assignments) to be used in data transmissions. The interface for most data communications equipment is designed to meet EIA RS-232C standards. An RS-232C interface is intended to facilitate data transmissions at up to 19,200 bits per second (baud) for a distance of 50 feet. As a general rule, the lower the data rate, the farther the distance it can be reliably transmitted. However, even at modest data rates, the distance over which reliable communication can be maintained is limited because of line loss and noise.

If all components in an addressable system are relatively close together (within a few feet), communication between the components is a simple matter of connecting them together. This, of course, is ignoring software protocols and merely considering the transfer of ones and zeros. However, in many instances the components of the addressable system are not close enough together to permit a direct connection, and the problem of reliable communications becomes more complex.

The major considerations in determining what kind of data communications equipment (DCE) is required for a particular application are distance, data rate and cost. In general the greater the distance and the higher the data rate, the higher the cost will be. All devices discussed below communicate over what is referred to as "twisted pair." Twisted pair is quite simply a pair of wires that are insulated and twisted together to minimize interference. It is used extensively for voice and data transmission both privately and by the telephone company.

The following are some terms associated with data communications that should be dealt with before continuing:

♦ Half-duplex: a mode of data transfer where communication may occur in two directions; however, data is transmitted in only one direction at a time.
♦ Full-duplex: a mode of data transfer where communication may occur in two directions at the same time.
♦ Synchronous communication: a method of data transfer that transmits timing information as well as data. This timing information is used to lock or synchronize the receiving modem with the transmitting modem.
♦ Asynchronous communication: a method of data transfer that sends fixed-length sets of ones and zeros (called words) separated with start and stop bits. This method does not require a separate timing signal.

## Line drivers

Line drivers are relatively low-cost devices intended to communicate over short distances. Typically, they will operate in full- or half-duplex mode over a four-wire circuit, although some units will operate half-duplex over a two-wire circuit. The communication lines require DC continuity and usually are self-installed by the user. Line drivers

***The first step towards reliable data communications is effective people communication. The operator, modem supplier and addressable hardware supplier all must be aware of the requirements of the addressable system. . .***

can be expected to have a maximum range of from ½ to five miles, depending on the data rate (remember—the lower the data rate, the farther you can go). Some line drivers require AC power, while others are powered from the data terminal.

## Limited-distance modems

A limited distance modem (LDM) is a device intended (as its name implies) to be used over limited distances—typically less than 25 miles. Again, the effective range of the modem is a function of the data rate employed. Most LDMs will operate half- or full-duplex over a four-wire circuit, although some units will operate half-duplex over a two-wire circuit. LDMs are designed to operate over self-installed private lines or dedicated lease lines from the telephone company.

If you plan to utilize dedicated phone lines, there are some constraints to consider when deciding whether or not an LDM approach is appropriate. First, both modems must be located within the service area of the same telephone central office. Secondly, the length of the wire connecting the LDMs is rarely the same as the physical distance between the LDMs. For example, the actual distance between a cable operator's office and the headend may be only 10 miles—well within the expected range of an LDM. However, if the telephone central office is 15 miles from both the cable office and the headend, the actual length of wire would be 30 miles at the very least, which is beyond the expected range of the LDM. In addition, the telephone company may not take the most direct route between the central office and various points in its service area, thereby potentially increasing the distance over which the LDM must operate. Also, the telephone system often uses loading coils (which reduce the bandwidth) and bridge taps (which may place an undetermined length of wire in the circuit). For most LDMs, these devices would need to be removed by the telephone company prior to the use of an LDM, possibly increasing cost and delaying availability of the lines.

## Long-haul modems

The telephone system was designed primarily for voice communications. It follows that design considerations were bounded by the capacities and limitations of the human ear. To facilitate data transmission within the technical constraints imposed by the telephone system, standards were developed that detail the technical characteristics of modems to be used. Some of the more common Bell Standard modems are the 103, 202 and 212 modems.

## Standard 103-compatible modems

The 103 family of modems is asynchronous, operating full-duplex on two-wire circuits at data rates up to 300 baud. They can be used on private, dedicated-leased or dial-up lines. Most 103 modems have auto-answer capability, and some are available with an auto-dialing feature.

## Standard 202-compatible modems

The 202-compatible modem is asynchronous, operating full- or half-duplex on a four-wire circuit, or half-duplex over a two-wire circuit at data rates up to 1,800 baud. It can be used on private, dedicated-leased or dial-up lines. Some 202 modems have auto-answer and auto-dialing capability.

## Standard 212-compatible modems

The use of 212-compatible modems is becoming more widespread because of their flexibility and features available. They can operate asynchronously at data rates of 0 to 300 baud and synchronously or asynchronously at 1,200 baud. At rates up to 300 baud, most 212 modems are compatible with 103 standard modems. Many can automatically adjust to the data rate of the incoming data stream. The 212-compatible modem operates full-duplex over a two-wire circuit. It can be used over voice-grade dial-up lines, and many will operate over private self-installed lines. Auto-answering and auto-dialing are features often found in 212-compatible modems. Many of those that do not have auto-dialing can be used in conjunction with a separate auto-dialing unit.

Standard 212 modems possess such features as test pattern generators, loop-back capabilities and lamp displays of data activity, all of which are an aid to diagnostics. Adaptive equalization, which improves performance on marginal circuits, also is available on many units. There are 212-compatible modems designed to plug into an expansion slot in a PC that allows the PC to be connected directly to the telephone system. These generally cost less than a standalone 212 modem; however, they rely on software within the PC to control various functions.

## High-speed modems

Above 1,200 baud the price of modems climbs sharply with the data rate. In addition to the increased modem cost, other factors come into play when these higher data rates are used that can affect total system cost. At higher


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data rates the transmission becomes more susceptible to line impairments. Some modems require leased-lines with special conditioning, and error-correcting devices may need to be utilized. Many of these modems will operate only in a synchronous mode, thereby requiring asynchronous-to-synchronous conversion when asynchronous operation is required.

Recent advancements in modem design have made available high-speed modems that operate over voice-grade telephone lines. There are a few 2,400 and 4,800 baud modems that operate full- or half-duplex on dial-up lines with many of the features of the 212 modems discussed earlier. Also available are 9,600 baud modems that operate half-duplex on a dial-up line. Full-duplex operation at 9,600 baud on dial-up lines may be available by late 1985.

## Summary

In an addressable system, the data communications equipment chosen can have a large impact on total system throughput. The appropriate data rate for any given system is dependent on the number of addressable converters in the system, operational procedures and the hardware utilized for implementation of addressability. All of these factors are, of course, tempered by the funds available for data communications equipment.

A cable operator can reduce the cost of the communications system, while at the same time assuring that the system installed will meet requirements, by following some simple steps:

♦ Find out up-front what the communications requirements of the addressable system are.

♦ Get recommendations from the supplier of the addressable hardware for a reliable source of communications equipment. It may be best to work with a distributor who handles several manufacturers' equipment. This will provide a wider range of modems from which to select the proper equipment for the specific application.

♦ Consider using self-installed private lines. In applications where data communication is localized, the operator may be able to avoid telephone company fees (not to mention hassles) altogether.

The first step towards reliable data communications is effective people communication. The operator, modem supplier and addressable hardware supplier all must be aware of the requirements of the addressable system, as well as the needs of the cable operator, in order to facilitate the design of a data communications system that is cost effective and technically appropriate. CED

# Amplifier/ equalizer basics

***By Allen Kirby,***
***Sales Engineer,***
***John Weeks Enterprises***

In system balancing there is so much emphasis on proper output levels of amplifiers that technicians sometimes do not realize that the input levels to the amplifier (after pad and equalizer) are the major determining factor in whether a system proofs or has good picture quality.

The output levels are the end result of the proper input and proper gain of the amplifier, and a basic understanding of this is essential. All amplifiers have distortion specifications based on recommended operating levels (input and output). Deviating from these recommended levels results in a change in the distortion.

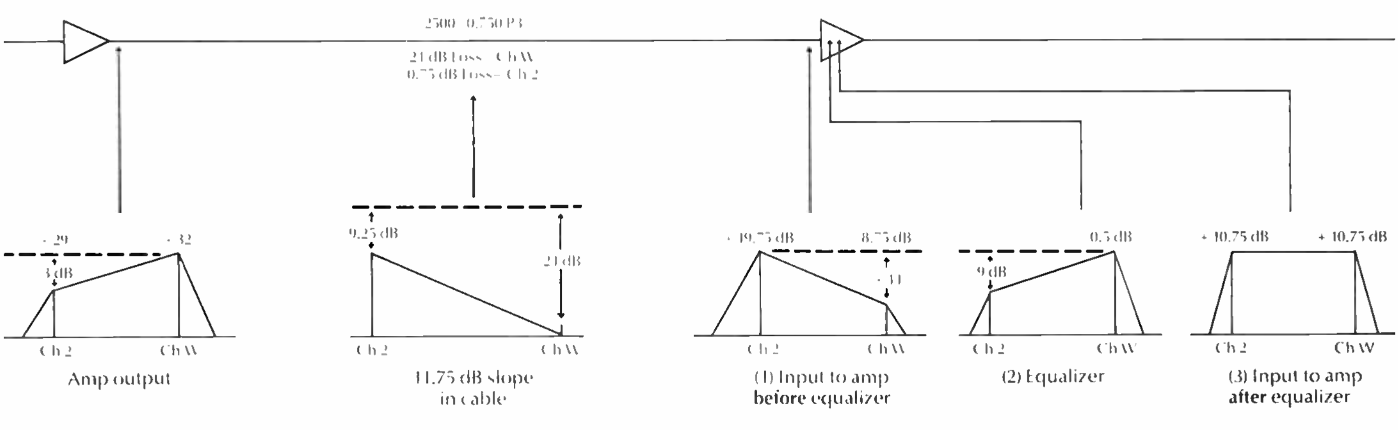
For example, if an amplifier has a carrier-to-noise ratio of -59 dB based on an input of +10 dBmV, a gain of 22 dB, an output of +32 dBmV and a noise figure of 10 dB, that same amplifier will have a carrier-to-noise ratio of -56 dB (or 3 dB worse) if the input is lowered to +7 dBmV and the gain is increased to 25 dBmV output. As you can see, the output level was achieved, but the C/N of the system worsened. This low level (+7 dBmV) can be caused by poor design or, more commonly, by installing the wrong pad or equalizer.

As you can see, the C/N difference was a one-for-one tradeoff (i.e. the input is lower by 3 dB and the C/N worsened by 3 dB). Cross-mod and composite triple beat are affected on a two-to-one basis. This occurs when amplifiers are operated at higher levels. For example, an amplifier with a -86 dB composite triple beat spec, when operated at +10 dBmV input, 22 dB gain and +32 dBmV, has a CTB of -82 dB (4 dB worse) if operated at +10 dVmB input, 24 dB gain and +34 dBmV output. As you can see, the gain and the output level increased by 2 dB, but the CTB worsened by 4 dB.

It is imperative that technicians understand the importance of the pad and equalizer as they relate to gain and output and the overall effect on distortion.

The equalizer is probably the least understood device and, therefore, creates problems through improper usage. Basically, an equalizer could be considered a frequency selective pad. It has minimal loss (0.5 to 1 dB in most cases) at the highest frequency and the maximum loss (3 to 15 dB) at Ch 2 (lowest frequency) with all other frequencies falling between. The purpose is to reduce lower frequencies to the appropri-

*Continued on page 76*




(1) Amp output slope (3 dB)—Cable slope (11 75 dB) = Input slope (8.75 dB)
(2) As reference to flat
(3) Note insertion loss at W

# Standby power supplies

| Company/ Model | Output power | Output current/ voltage | Regulation | Battery voltage |
|---|---|---|---|---|
| Alpha Tech. AP-960 | 900 W | 15 amps/ 60 VAC | ± 3% | 36 VDC |
| C-COR NB113C | 900 W | 15 amps/ 60 VAC | ± 2% line/load normal mode | 36 V |
| Cable Power CL737-15 | 900 W | 15 amps/ 60 VAC | ± 2% normal mode (AC), standby mode (DC) | 36 VDC |
| Control Technology Citation II | 720 W | 12 amps/ 60 VAC | ± 3% (58-62 VAC) | 24 V, 2 batteries |
| Larson Electronics LE 60-9PS | 15 amps/ 60 V | 15 amps/ 60 V | ± 5% | 36 VDC |
| Data Transmission Devices SP 720 | 720 W | 12 amps/ 60 VAC | ± 3% | 24 V |
| Jerrold STPS-60-14 | 840 W (max) | 14 amps/ 60 V | ± 3% line and load | 36 VDC |
| Lectro Products Sentry II | 900 VA | 15 amps/ 60 V | ± 5% | 36 V |
| Power Conversion Products HFE-24-100B | 24 Volts | 100 amps/ 24 V | ± 0.5% from no load to full load | 24 V |
| Powerguard SB-6012-24-0 | 720 VA | 12 amps/ 60 V | ± 5% standby, 0.05% nonstandby | 24 VDC |
| RMS PS-SB30/60 | 12 amps | 30 or 60 V | ± 2% @ 95-130 V | 12 V per battery |
| Sola SPS-300A | 120 V | 2.5 amps @ 120 V | ± 3% | 12 V |
| Terado 50-168 | 175 W | 1.3 amps/ 120 V | ± 10% | 12 V |
| Texscan Series 90T | 840 VA | 14 amps/ 60 V | ± 3% (utility & standby) | 36 volts nominal; (range: 31.5-41 V) |
| Topaz Powermaker Micro-UPS | 400 VA 800 VA or 1,000 VA | 120 VAC | -15% | 12 amps |
| Tripp Lite BC-425FC | 425 W | 120 V | ± ½ cycle | 12 V |

| Charge current | Recharge time | Transfer time | Standby time | Dimensions |
|---|---|---|---|---|
| 9 amps | 12-16 hours | <5 msec. | Selectable | 24" W x 14" D x 22" H |
| 5.5 amps | 18 hours | <16 msec. | 3.75 hrs. | 23" W x 14½" D x 24" H |
| 0-9 amp | Typ. 10-20 hours | 8-16 msec. | 15 hrs-1.5 hrs. (depending on output load) | 16" W x 14" D x 23" H or 23" W x 14" D x 25" H |
| 5 amps | From low voltage cutoff to recharge: 12-15 hrs. with CD110 batteries | From line to standby & standby to line: 15 msec. | 1.7 hrs. @ full load | 16" W x 15" D x 18½" H |
| 12 amps max. | 18 hours from battery turn-off | 0.5 msec. | 5 hrs. @ 840 watts | 23" W x 14½" D x 19½" H |
| 8 amps max. | 12-24 hours | 10 msec. | 2 hrs. on full load | 17½" W x 16¼" L x 24" D |
| 7 amps | 14 hrs. (max.) | 15 msec. (typ.) | Up to 3 hrs. | 22¾" W x 15" D x 22" H |
| 3 amps | 12 hrs. | 20 msec. | 3 hrs. | 14½" W x 21½" D x 20" H |
| 100 amps + 125% current limit | Depends on load | None | Depends on amp hour of battery plant | 19" W x 14" D x 21" H |
| 3 amps | 18 hrs. typical from low voltage cutoff | 15 msec. typical | 3 hours @ 10 amps | 16" W x 8" D x 37" H |
| Cycle change | Dependent upon battery condition | 16 msec. | 2 batteries- 8 amps nom.: 3½ hrs. | 21¼" W x 14¾" D x 23¼" H |
| 0.5 amps max. | 8-12 hours | 4 msec. | 5 minutes | 4.7" W x 14.2" D x 6.6" H |
| 3 amps (max.) | 24 hours | 15 msec. | 40 min. full load | 12" W x 5½" D x 8" H |
| 10 amps | 10 x discharge time (12-24 hrs. typical) | 10-16 ms. (stabilized <30 ms.) | 80 AHR battery @25°C- 2 hrs. 20 min: 14 amp load >3 hrs: 10 amp load | 25⅞" W x 14⅞" D x 22¼" H |
| 120 VAC | 8 or 16 hrs. | 4 msec. | 75, 35 or 30 min. | 7" W x 18" D x 15" H |
| 2 amps | 12:1 | 8 msec. | 20 minutes on half load | 8¾" W x 13½" D x 6¼" H |


*Continued on page 78*



*Continued from page 73*

ate level in relationship to the design frequency (highest frequency). In most cases we are looking for "flat" levels into an amplifier after equalization. If the wrong equalizer is used, the lower frequencies will be either too high or too low, and they will be affected as previously discussed (carrier-to-noise and composite triple beat).

If the wrong equalizer is used, compensation may be made with the slope control to achieve the proper output levels, but the distortion characteristics will be worsened.

It should be apparent by now that it is possible to have a system with all the proper output levels but still have poor distortion characteristics which result in poor picture quality.

## Equalizer basics

To understand what equalizers do and why they are used, it is necessary to look at their relationship to the cable before it and the levels of the previous amplifier.

The diagram below shows signal levels and a display of what each section would look like if we swept them individually. The output of the amplifier is operating at +32 dBmV on the high end and +29 dBmV on the low end. This is a 3 dB slope going into the trunk cable. The cable itself has 21 dB of loss at the high end and 9.25 dB loss at the low end. This results in an 11.75 dB reverse slope (21 dB—9.25 dB = 11.75 dB).

The station input (1) (before pads and equalizer) is +11 dBmV on the high end and +19.75 dBmV on the low end. This is an 8.75 dB reverse slope. You will note that this is the difference between the 3 dB slope of the amplifier's output and the 11.75 dB reverse slope of the cable (11.75—3 = 8.75 dB). This is easily verified by subtracting the cable loss from the amplifier output at each frequency.

These inputs are not proper for the amplifier since most trunk amplifiers require a +10 dBmV flat (all levels the same) into the module itself. To achieve this flat input, we must select an equalizer that reduces the other frequencies to the same level as the high end.

To compensate for cable, an equalizer must have the opposite effect. The cable has more attenuation (loss) at the higher frequencies, therefore, an equalizer must have more attenuation at the low frequencies. Since the difference in attenuation varies with the length of cable, we must have equalizers of different values. We cannot use a 22 dB equalizer for 22 dB of cable if we are running sloped outputs at the previous amplifier. The 3 dB slope of the amplifier is, in effect, pre-equalizing for part of the slope in the cable. We must equalize for the reverse slope at the input to the station.

The equalizer shown below does just that. The response of the equalizer (2) by itself offsets the reverse slope at the station input and the result is a flat input (3) after the equalizer.

The purpose of the equalizer is to adjust the slope to the requirements of the amplifier. Most trunk amplifiers are designed for flat inputs, while line extenders normally require sloped inputs. A thorough knowledge of the equipment you are working with is very important.

In some cases the proper equalizer will correct the slope, but you may have to pad to bring the levels down to the proper level. You may, for example, have a +13 dBmV flat input after the equalizer and need to install a 3 dB pad to achieve the desired +10 dBmV. The pad attenuates all the frequencies equally. Once the proper module input is achieved, the gain and slope controls are used to set the proper output.

As you can see, proper outputs could be attained even though a wrong equalizer or pad is used by compensating with the gain and/or slope control of the amplifier, but the distortion characteristics (noise, triple beat, etc.) could be adversely affected.

Another aspect of equalizers that must be understood is the upper frequency cutoff. All equalizers are specified two ways: value and frequency. A 300 MHz equalizer "pivots" at 300 MHz, and the loss at that frequency is minimal (0.5 to 1 dB); but as we go down in frequency, the loss at 270 MHz is greater than 300 MHz, and the loss at 220 MHz is even greater. The equalizer "cuts off" just beyond 300 MHz. If this equalizer were used in a 400 MHz system, it obviously would create a problem because it wouldn't pass anything above 300 MHz.

A 270 MHz equalizer "pivots" at 270 MHz and the loss is minimal (0.5 to 1 dB) at that frequency. Note that the loss at 220 MHz is less than in the 300 MHz equalizer. If a 300 MHz equalizer were used in a 270 MHz system, we would have more loss at 270 MHz than with a 270 MHz equalizer.

This obviously has an adverse effect on the C/N. This effect can clearly be seen by comparing the loss at 220 MHz on the 220 MHz equalizer and the 300 MHz equalizer. If a 300 MHz equalizer were used in a 220 MHz system, obviously the loss at 220 MHz would be considerably greater.

A thorough understanding of equalizers is imperative to achieve optimum system performance. It should be apparent by now that we don't select an equalizer just to get the proper output. Equalizers and pads are used to achieve the proper input. CED

# Standby power supplies

| Company/ Contact | Options | Weight |
|---|---|---|
| **Alpha Tech.** (206) 647-2360 | Dual-system enclosures, status monitoring, automatic performance monitoring. Complete array of optional accessories and configurations available. | 97 lbs. w/o battery |
| **C-COR** (714) 993-2620 | Status monitoring, slide-mounted battery tray, pedestal mount, additional surge protection, U.L. approved. | 93 lbs. w/o battery 273 lbs. w/battery |
| **Cable Power** (206) 882-2304 | Pedestal enclosure, aux. power input, automatic performance monitor, remote performance monitor, elapsed time meter, battery harness, temperature compensated battery charging circuit, electronic current limiting (output), output RF filter, etc. | 90 lbs. 95 lbs. |
| **Control Technology** (800) 527-1263 (214) 272-5544 | Pedestal mount | 75 lbs. w/o battery 195 lbs. w/battery |
| **Larson Electronics** (817) 387-0002 | Status monitoring, available w/o ferro resonant transformer, heated battery cabinet | 100 lbs. w/battery 70 lbs. w/o battery |
| **Data Transmission Devices** (617) 532-1884 | System test switch; cable ammeter; cable voltmeter; self-switching generator input; lightning/transient protection; voltage regulation; remote status monitor; system self-diagnostic indicator lights; power failure meter; standby hours meter. | 89 lbs. w/o battery |
| **Jerrold** (215) 674-4800 | PSM status monitoring, pedestal mount, spare modules. | 85 lbs. |
| **Lectro Products** (800) 555-3790 | Input and output surge arresters, incident counters, status monitoring. | 90 lbs. |
| **Power Conversion Products** (815) 459-9100 | 24-hour equalizer timer, hi/low DC voltage alarm relay, equalize pilot light, U.L. listed, AC power failure alarm, charge failure alarm/load sharing, blocking diode. | 182 lbs. w/o battery |
| **Powerguard** (404) 354-8129 | 30/60 VAC output, 200 joule input surge protection, PIP-60 output surge protection, cycle counter, battery trays, slide-out battery shelves. | 80 lbs. w/o battery |
| **RMS** (800) 223-8312 | Standby counter, standby elapsed time meter assembly, 30, 60 & 115 volt transorbs, lightning arrestor, aux. battery pack, pedestal base mount, pole mounting bracket assembly, CA-3 and CA-4 enclosure locks, CA-1890 housing lock tool. | 160 lbs. w/o battery |
| **Sola** (312) 439-2800 | None | 21 lbs. |
| **Terado** (612) 646-2868 | 50 Hz | 30 lbs. |
| **Texscan** (800) 528-4066 | Lightning arrestor, dual configuration, external status lamps, Vital Signs (remote status monitoring), pedestal mount, elapsed time counter. | 56 lbs. w/o battery |
| **Topaz Powermaker** (619) 279-0831 | Status monitoring | 48 or 71 lbs. w/battery |
| **Tripp Lite** (312) 329-1777 | None | 38.5 lbs. |

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**Reader Service Number 51**

# ℞ for VCR headaches

VCR compatibility no longer requires a tangle of cables, A/B switches and splitters dangling behind consumer TV sets. A smart remote, several interface boxes and VCR timers are examples of products that make cable more "consumer-friendly."

Qintar, a manufacturer and distributor of video accessory products for the cable TV and VCR industries, has designed a line of video control switches. The switches were developed exclusively for the cable TV marketplace and are being marketed solely to cable companies.

The models 4004A, 4004B and 4005A are designed to allow a cable subscriber to record a pay station while watching a network station or vice versa. The model 4004A features 3 dB of gain after internal splitting losses are overcome, a low noise figure and a U.L. approved power pack. The 4005A contains a high-power transistor allowing full 54 channels of operation with cross modulation below -60 dB.

The models contain an extra auxiliary port for a game, computer, satellite dish or other RF device. Private labeling also is available for those companies wishing to have their own logos on the control center.

Marketing of the switches varies with the operator. Some systems are selling the switch for approximately $45, others lease the switch for $2 to $3 per month, while still others give the switch away with specific programming.

Panasonic's model TY-SW100P controller allows independent, simultaneous viewing and recording of multiple video sources such as antennas, CATV broadband signals, CATV descramblers, video discs or other sources. The TV System Controller/Amplifier simplifies selection of video sources for recording and playback.

Eliminated is the constant connection and disconnection associated with various hook-up methods. Five input sources are available for TV viewing along with three input sources for VCR recording.

The Archer Video/Audio Control Center from Radio Shack uses baseband signals instead of RF. The Control Center eliminates the need for repeated modulation/demodulation because it switches baseband signals. The separate video and audio signals are for use with hi-fi VCRs, stereo TVs, processors, video discs and satellite receivers. Sending the outputs of one video component to another còmponent allows for simultaneous recording and viewing.

The Control Center's key benefit is the ability to switch around stereo audio, says Radio Shack.

Zenith's VCR Interface allows simultaneous recording of a pay channel and viewing of a network channel. Unattended recording of different non-pay channels is possible with the interface. With the addition of the Zenith TAC-TIMER, unattended recording of pay channels also is available. The switcher restores full capabilities of any video recorder and provides two extra outputs for a second TV and FM stereo hookup.

An added feature of the VCR Interface is accessibility to a stereo signal. The Interface will make the decoder transparent to the stereo signal if it was previously unattainable.

Another approach to the problem is the CableMaster by JNEL Corp. The CableMaster cable/VCR programmer adds an 8-event, 2-week time control feature to the converter/descrambler, but doesn't allow taping of one channel while viewing another.

There are no connections to make between CableMaster and the converter, VCR or TV. It uses an infrared remote and requires a converter equipped for remote control. Different brands of converters may be used by changing one plug-in "personality module" in the back of the unit—much the same as a computer game cartridge. CableMaster currently is compatible with Jerrold, Oak, Zenith, Regency, Hamlin, Scientific-Atlantic, Pioneer, Sylvania, Tocom, Magnavox, Texscan, Times Fiber, Taknika and Archer.

JNEL now markets CableMaster to cable operators on an OEM basis.

General Electric's Control Central is a smart remote control. The company says it was developed to end "coffee table clutter" caused by separate remotes for the TV, VCR, converter and other electronic products.

The device controls as many as four components of any brand or model year as long as they are infrared remote controllable. When placed "head-to-head" with any remote control, the Control Central finds and retains all commands.

Cable operators will be able to purchase Control Central wholesale.

Pioneer's BA-5000 converter contains its own internal VCR timer. The timing clock can be enabled/disabled from the headend and is refreshed about once every minute. This function can be used for unattended video recording as well as morning wake-up, late-night shut-off and show reminders.

The seven-day, two-event timer can be programmed by the subscriber through the remote or the converter's set-top keypad.

Zenith's TAC-TIMER programmable remote control functions as a full feature remote control but also allows subscribers to record different channels at different times. The TAC-TIMER requires no modification to Z-TAC decoders and is fully compatible with any existing Z-TAC system.

TAC-TIMER can be used with any programmable video recorder and is capable of programming eight events in 14 days.

—*Kathy Berlin*

| Manufacturer | Model | Contact |
|---|---|---|
| General Electric | Control Central | Ron Polomski<br>(800) GE Cable<br>(804) 483-5064 |
| JNEL Corp. | CableMaster | Paul Hicks III<br>VP Marketing<br>(617) 339-7155 |
| Pioneer | BA-5000 | Jennifer Miller<br>Marketing Manager<br>(800)421-6450 |
| Radio Shack | Archer Video/ Audio Control Center | Nearest Radio Shack store |
| Zenith | TAC-TIMER | Charles Eissler<br>(312) 699-2110 |

| Manufacturer | Model | Bandwidth | Isolation | Insertion Loss | Response Flatness | Inputs | Output | Contact |
|---|---|---|---|---|---|---|---|---|
| Panasonic | TY-SW100P | Inputs: 54-900 MHz (Cable-end) 54-88 MHz (remaining) Outputs: 54-900 MHz | Better than 60 dB | 0 dB | · 10 dB | 5 | 3 | Bob Challant (201)392-4708 |
| Qintar | 4004A 4004B 4005A | 5-550 MHz | 60 dB min | 6 dB max | · 2 dB | 4 | 3 | (800)252-7889 CA (800)572-8262 Collect AK/HI: (818)706-1940 |
| Zenith | VCR Interface | 50-450 MHz | 60 dB | · 3 dB gain | Within 1 dB | 2 | 4 | Charles Eissler (312)699-2110 |


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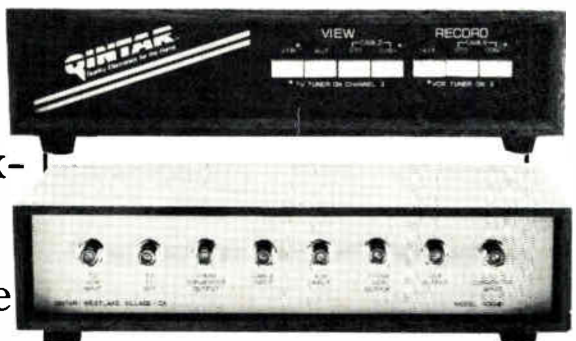


*All units can be private-labeled and custom configured. Your logo is displayed (in any color ink) on the front panel. And the switch sequences can be printed to your specifications.*

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## SPECIFICATIONS.

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|---|---|
| Bandwidth | 5-550 MHz |
| Isolation Channel 2-13 | 60 dB Min. |
| Insertion Loss at 200 MHz | 6 dB Max. |
| Inputs: 4 (CATV, AUX, CONVERTER, VCR) | |
| Outputs: 3 (TV, VCR, CONVERTER) | |
| Dual-cable compatible | |
| Private labeling available | |
| Model 4004B-Passive | |
| Model 4004A-Amplified | |
| Noise figure on Amplified version | 5.3 dB at 400 MHz |
| Input capability on Amplified version | 19 dB mV for 7Ch. |

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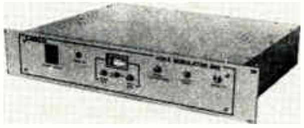

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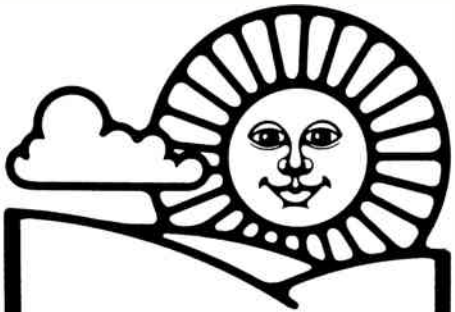

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# Advertisers' Index

# Power: conditioning and backup

*By Richard Caprigno,*
*OEM Sales Manager,*
*Sola*

Line voltage fluctuations, transients, line "noise" and momentary power loss are real problems for cable systems. And the problem may grow as the quality of commercial AC power deteriorates. But a variety of protection schemes exist.

For example, where clean power is essential but emergency backup power isn't, power conditioners offer sufficient protection. However, when line power is clean but blackouts are a threat (because of a stormy climate, for instance),the standby power source (SPS) provides emergency power without the added cost of power conditioning. For critical operations where clean power is not already assured and emergency power is essential, an uninterruptible power system (UPS) is the most appropriate choice.

The ferroresonant line conditioning voltage regulator isolates sensitive electronics from all common AC power problems except total power failure. Micro/minicomputer regulators hold output voltage steady within ±3 percent of normal even when input voltages fluctuate as much as ±15 percent. These line conditioning regulators specialize in offering a high degree of noise attenuation, typically the most common AC line problem affecting microprocessor-based electronics. Conditioners should provide transverse-mode noise attenuation of better than 60 dB and common-mode noise attenuation exceeding 120 dB. By contrast, ultra-isolation transformers usually reject only common-mode noise.

Applications requiring emergency backup power call for either SPS or UPS protection.

## SPS

The standby power source consists of an inverter, battery, battery-charger and a high-speed transfer switch. Under normal AC line conditions, the inverter is at rest and the primary AC power feeds the critical load through basic filtering provided by the SPS.

In the event of an AC voltage drop below a preset transfer point (usually -15 percent of normal), the load is transferred to the inverter, which switches on to supply AC power converted from the battery.

The choice of an SPS depends largely on how much switching time the protected equipment will tolerate. Some highly sensitive electronics cannot tolerate the power lapses that occur between these switches. Some SPS designs, however, incorporate high-speed transfer switches to help reduce power lapses during the switching process. These units offer switching times ranging between 4 to 10 milliseconds—an acceptable transfer time for most electronic devices.

When AC line power returns, the load is transferred back to the line, the inverter is shut off and the battery is automatically recharged—ready for use should another power failure occur.

The standby unit's built-in maintenance-free batteries offer from five to 30 minutes of backup power in the event of system shutdown. Although 50 percent of all blackouts are corrected within six seconds, when an extended power outage is unavoidable, the battery supply of the SPS provides enough time to achieve an orderly shutdown of operations.

## UPS

For critical applications that will not tolerate the switching time of the SPS—and for those that need power conditioning as well as blackout protection—a "true" UPS is the only alternative. Serving continuously as a power conditioner, the true on-line UPS maintains output voltage within ±3 percent of nominal despite line fluctuations of ±15 percent and provides continuous protection against overvoltage conditions and brownouts. The on-line UPS also attenuates both common- and transverse-mode noise, with attenuation of at least 130 dB to 140 dB over virtually any frequency range.

Consisting of three major components—a rectifier/charger, a battery and an inverter—the standard on-line UPS, under normal operating conditions, converts commercial AC power to DC by use of the rectifier/charger. This DC power charges the battery and powers the inverter section. The inverter then reshapes the DC power into AC, which supplies the critical load.

When a drop in the AC line power causes output from the rectifier/charger to decrease, the batteries automatically compensate for this drop and continue to provide DC power to the inverter. Since DC voltage is always present at the inverter input, neither a time delay nor switching is involved in maintaining the constant supply of clean, uninterrupted power. UPS operation continues with no break and the critical load sees no loss of power.

When line power is restored, the UPS returns to normal operation and the battery is automatically recharged by the rectifier/charger.

The bypass/transfer switch is a further precaution to protect the critical load. In the unlikely event of system overload or inverter failure, or if the load demands an input surge during the availability of commercial AC line power, the automatic transfer switch connects the load directly to the commercial AC source via a separate bypass line. Upon restoration of acceptable inverter output, the transfer switch returns the load to the UPS.

Combining an SPS with a micro/minicomputer regulator, placing the MMR downstream of the SPS, is an economical way to obtain backup power as well as the benefits of conditioned power. While the SPS/MMR combination does not offer the no-break power transfer provided by a true UPS, the SPS/MMR combination can provide a cost savings (as much as $350) for protecting equipment that can tolerate the SPS switchover delay time. The SPS/MMR combination has a longer recharge time than the UPS (from 8 to 16 hours for the SPS compared to 90 minutes to 3 hours for the UPS, depending on the model) and requires manual restart (the UPS restarts automatically).

Ultimately, the equipment selected will depend as much on the importance of the computer as on the user's budget. If your microprocessor-based equipment is performing a critical function and must remain on-line continuously, the extra cost of providing maximum protection with an on-line UPS should be weighed against all the expenses and liabilities incurred if the unit is completely shut down or damaged by power problems. If clean power is assured but the risk of power failure remains, an off-line SPS can provide back-up power economically to maintain continuous operations.

In cases where back-up power is not required but broad range power conditioning is imperative, the micro/minicomputer regulator is recommended for providing both voltage regulation and isolation from disturbances. This device is applicable in equipment where noise and transients can cause errors or low voltage, and short-term disruptions can result in a loss of memory. CED