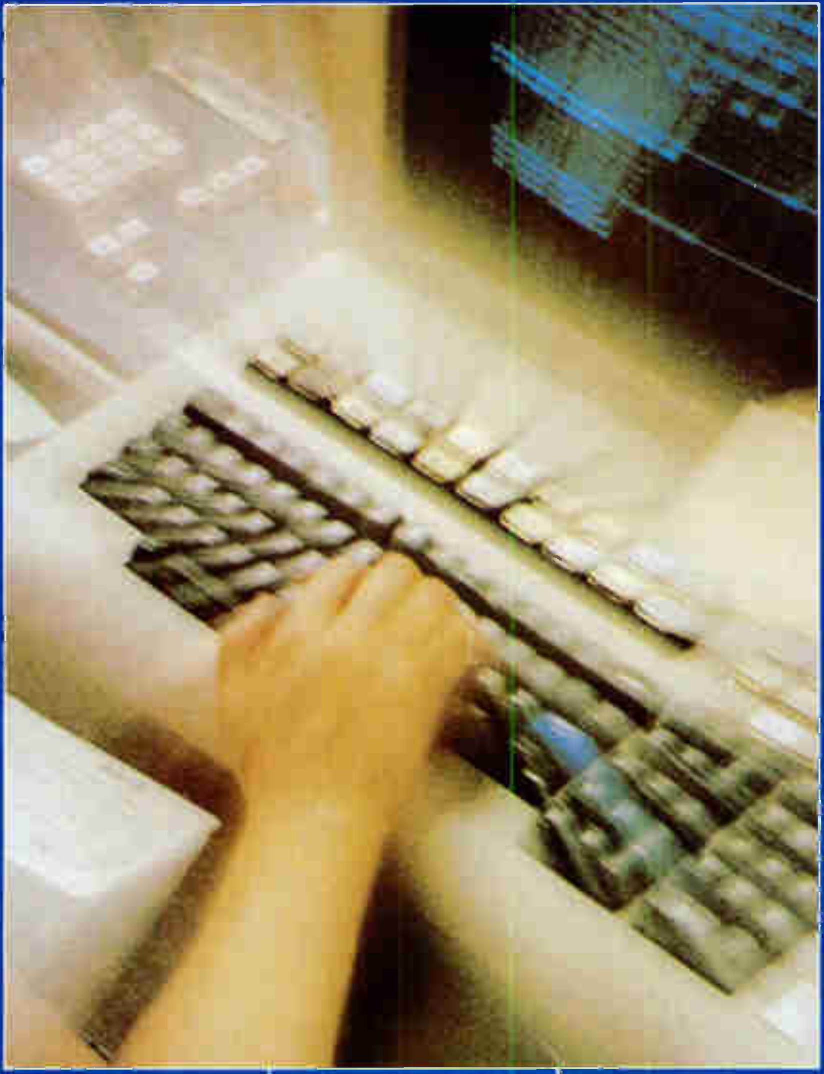
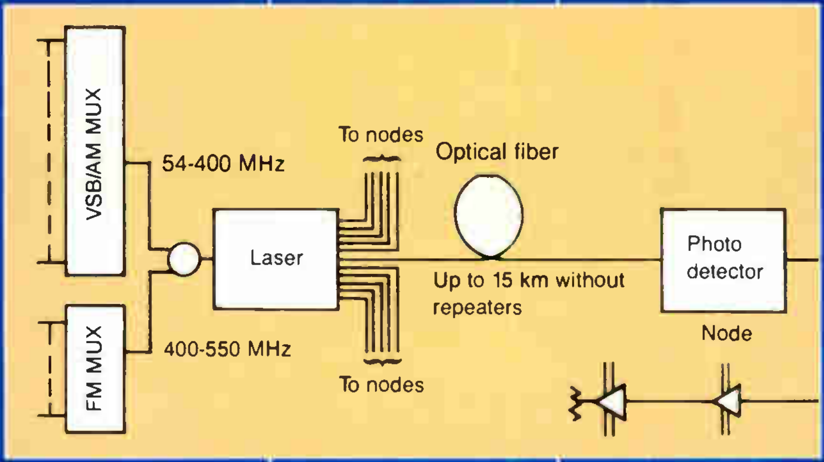
# COMMUNICATIONS TECHNOLOGY

Official trade journal of the Society of Cable Television Engineers



**Data, LAN design and applications**

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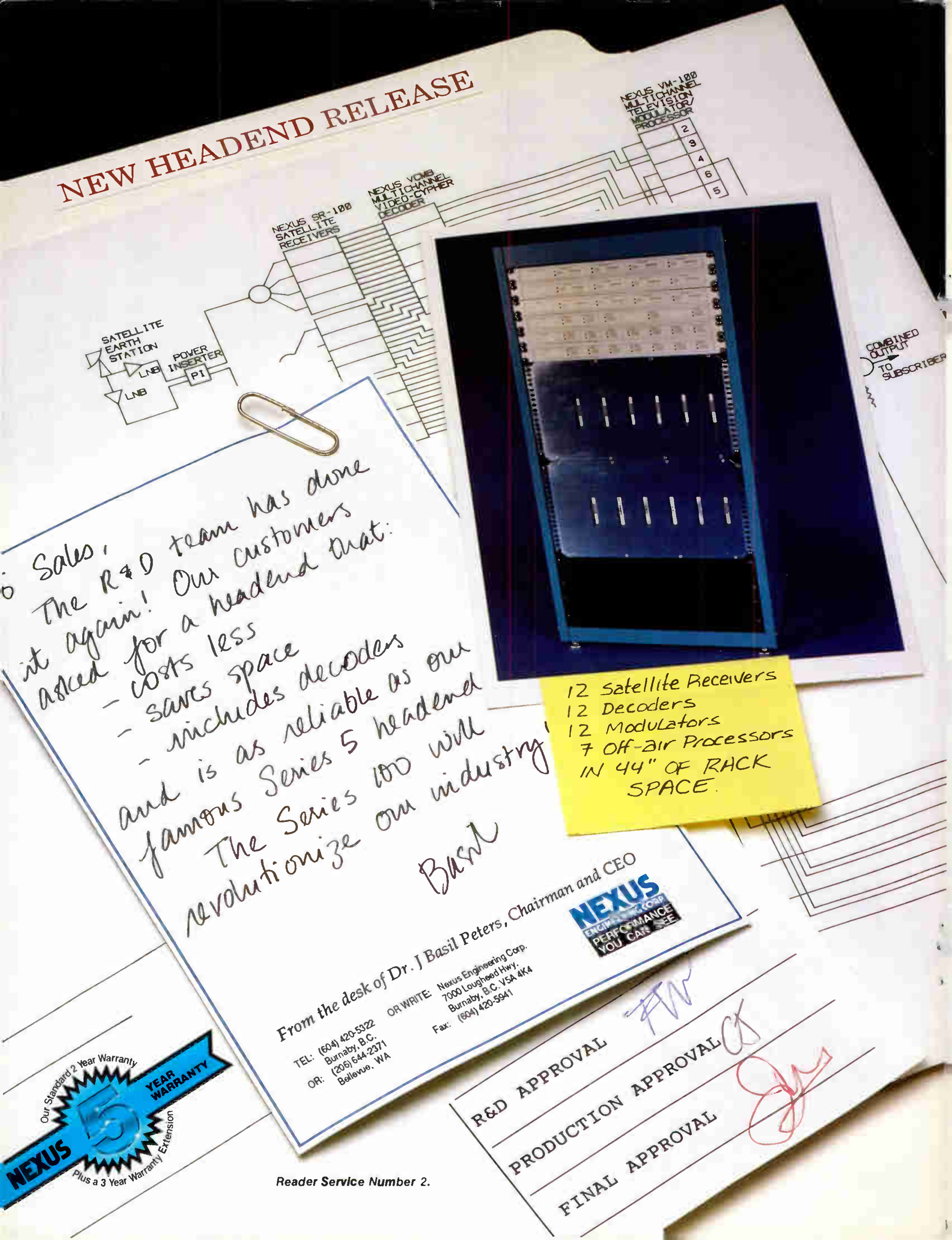
September 1988

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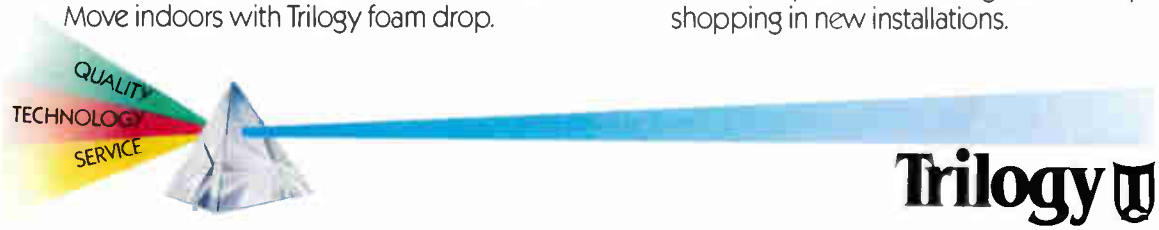


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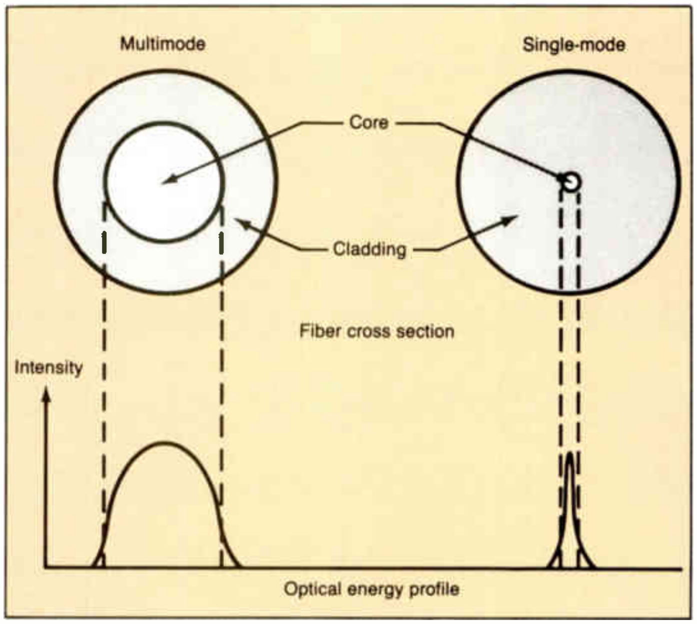



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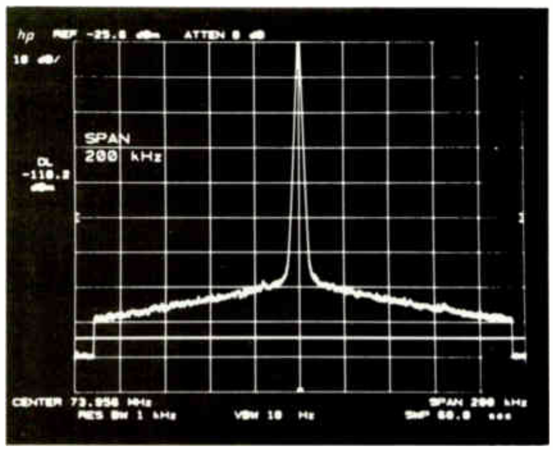



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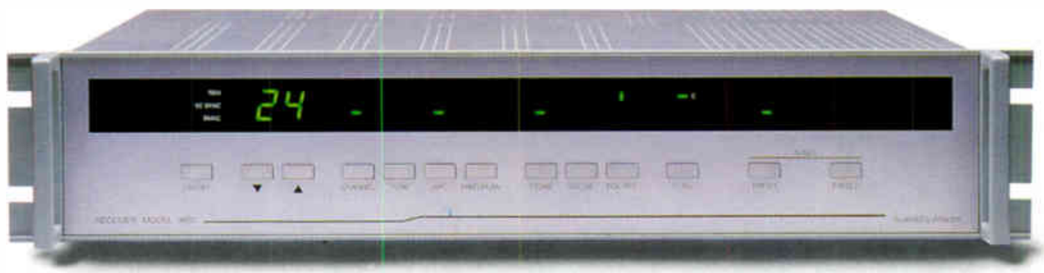


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***Reader Service Number 5.***

# The trouble with telcos

Don't you hate when your colleagues refuse to return your phone calls? We decided to ask some people in the CATV industry, selected at random to ensure scientific accuracy. As an example, here is one of those conversations:

"Hello, this is Ted."

"Good afternoon, I'm—"

"Sorry, I'm not at my desk right now; you've reached my voice mail. But if you leave your name, number and a short message, I'll be glad to return your call as soon as possible. Thank you and have a nice day."

"Ted, I'm with *CT* magazine. We'd like your response to our question of the day: In an industry like cable TV, devoted to communications, do you think it's important to return phone calls? Please call me at..."

And now, the results: Of the 18 who participated in the survey, two actually returned my call. However, I was away from my desk on both occasions, so they left messages on my voice mail. Of course, it is my intention to get back to them if I have time. (By the way, these results are accurate with a standard deviation of ±3 percent.)

You might not have to worry about non-returned business calls for long. In the not-too-distant future, perhaps the only time you'll need to pick up the receiver on the job will be to connect it to a modem at your local area network/electronic mail microcomputer terminal, from the office or in the field. At least one MSO's engineering department already has implemented this (see "LANs and electronic mail," page 32).

As you might have guessed, this month's *CT* focuses on broadband data communications and LANs. Providing data transmission capability is a venture that some cable systems are finding profitable by wiring factories, schools, libraries, military bases, etc. However, telcos have been players in this game much longer than CATV. And with optical fiber already in place in many areas of the country, telcos have the capability to transmit data faster and more cost-effectively than the cable industry can over coax.

### Telcos and video

What's more, the telcos' entry into the transmission of video via fiber to the home is practically here. Last month's announcement in Cerritos, Calif., with others sure to follow, may lead to eye-opening results. In a year from now, a consortium of Bell Operating Companies plan to stage a cross-country digital video test (see "Correspondent's Report," page 93).

Although the CATV industry can't stem the tide of competition from telcos (or any other source), it has taken a bold step to influence its own technological future with the founding of Cable Television Laboratories. Cable Labs intends to 1) initiate research and development projects, 2) serve as a central source for information about technical developments affecting cable and 3) facilitate technological innovations in the marketplace. Its interim board recently named as president and CEO Dr. Richard Green, currently senior vice president of broadcast operations and engineering for PBS. (For more about Cable Labs, see "News," page 10.)

### SCTE happenings

This month's *Interval* features the Society of Cable Television Engineers' must-save guide to chapter development. This manual is a step-by-step account on how to start an SCTE meeting group, handle finances, hold meetings, arrange speakers and (eventually) become a chapter. There are nearly 45 SCTE chapters and meeting groups in the country already. Why not get your co-workers together and start one in your area?

And, whether your group is having its first or 101st meeting, be sure to let us know your meeting date, location and discussion topics at least 45 days in advance. This will not only facilitate its appearance in our calendar, but your group also can receive copies of *CT* and our new publication *Installer/Technician* for distribution at the meeting.

The SCTE is having a seminar of its own, its inaugural "Technology for Technicians" Sept. 12-14 at the Harvey Hotel in Dallas. SCTE's Director of Chapter Development and Training Ralph Haimowitz (a CATV training veteran) will provide three days of comprehensive technical theory as well as hands-on experience in a lab environment. Registration is limited to 40 attendees; at this writing, the first course is almost sold out. Stay tuned for upcoming dates and locations, or call SCTE national headquarters at (215) 363-6888.

That's not all. Next month Denver will host "HDTV and beyond," Oct. 28-30 at the Sheraton Denver Tech Center, coordinated by the SCTE and its Rocky Mountain Chapter. If you've never seen the various proposed high-definition TV systems side by side (and compared with NTSC), this is your chance. In conjunction with the event, next month's *CT* will publish the seminar agenda as well as special articles on HDTV. For more information or to register, contact Jan Vicalvi at (303) 691-8380. And hurry, this is not to be missed!

Rikki T. Lee

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## Cable Labs announces president and CEO

CAMBRIDGE, Mass.—The interim board of directors and selection committee for Cable Television Laboratories, a research and development consortium for the cable industry, recently named Dr. Richard Green president and chief executive officer. Green is currently senior vice president of broadcast operations and engineering for the Public Broadcasting Service.

The Cable Labs board of directors, chaired by John Malone of Tele-Communications Inc., is composed of the National Cable Television Association's Research and Development Committee. Other members are James Doolittle, American Television and Communications Corp.; Joseph Gans, Cable Television Co.; Edward Horowitz, Home Box Office; Richard Leghorn, Eidak Corp.; John Rakoske, Continental Cablevision; Brian Roberts, Comcast; Richard Roberts, TeleCable; and James Robbins, Cox Cable Communications.

The consortium is soliciting participation from the entire cable industry. Sept. 30 is the cutoff date for founding member status; a full 18-member board will be elected by founding members shortly thereafter.

Cable Labs was formed by several cable operators in May to initiate R & D projects, serve as a central source for information about technical developments affecting cable and facilitate technological innovations in the marketplace.

## Working with telcos: The fiber connection

CERRITOS, Calif.—With fiber optics already a common medium for voice communications, the telephone companies (telcos) are beginning to expand their services to include video and data. Telcos are working with a few cable companies to improve existing systems and create new ones using fiber.

GTE California and Apollo CableVision announced plans on Aug. 13 to conduct a technological and marketing test in Cerritos. Citizens of this community will participate in the tests when GTE operates a fiber network serving approximately 5,000 homes. This will allow them to compare telephone wire, coaxial cable and fiber cable as transmission systems for video, voice and data services. Some of the services GTE hopes to test include video on demand, home banking, home shopping and security. According to Darrell Hughes at GTE, the ultimate goal of this test is to determine how to develop a network that best utilizes these transmission systems in a user-friendly and economical way. Siecor Corp. provided passive transmission subsystem products for the test.

A similar test involves Bell of Pennsylvania and Helicon Cablevision, who are waiting for FCC approval to begin their "Future Light" trial in Perryopolis, Pa. If the FCC issues a Section 214 waiver, as it did in Cerritos, 100 residents will receive telephone and cable TV service over the same fiber-optic line.

In a non-telco related use of fiber, American Telecom Services recently completed and activated a 13-mile fiber-optic cable link in Clearview Cablevision's system in Surfside Beach, S.C. The link between the existing headend and a new hub site replaces traditional coaxial trunk that was part of a 52-amplifier cascade.

## SCTE to offer tech seminars

DALLAS—The Society of Cable Television Engineers will present "Technology for Technicians" here Sept. 12-14 at the Harvey Hotel. This training seminar, the first in a series, is designed for installer/technicians, service technicians and their field supervisors, to be conducted by SCTE Director of Chapter Development and Training Ralph Haimowitz.

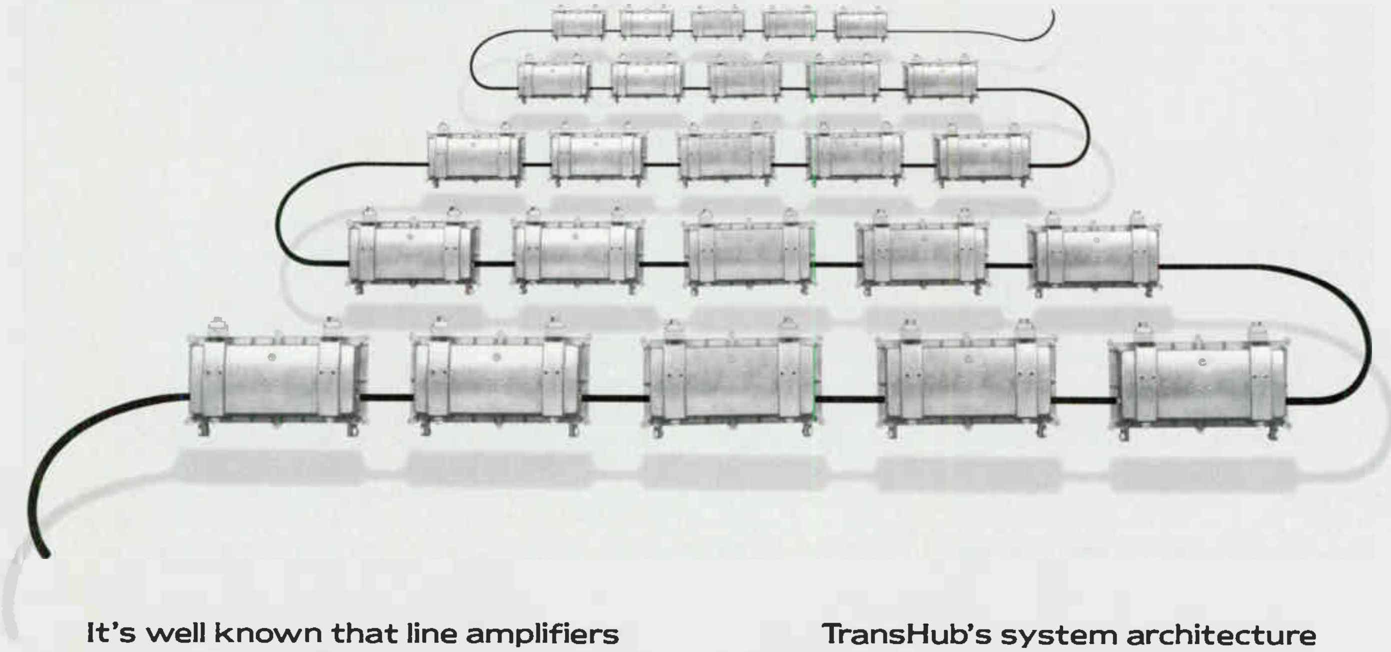
The seminar offers a combination of comprehensive technical theory and hands-on training in a lab environment. Topics to be covered are customer relations, safety, installation materials, cable and connectors, drop procedures, the service connection, testing and troubleshooting, and customer education. In the lab, attendees will learn cable preparation, proper fitting installation, working with signal level meters and volt ohmmeters and testing for signal leakage.

Registration is limited to 40 people and costs $245 for SCTE members (the nonmember rate of $285 includes the membership fee). For more information, contact Howard Whitman (215) 363-6888.

**Corrections**

In the August issue's "Product News," page 113, the phone number of GNB Inc. should have read (612) 681-5000. Also, Polychem Electronics' new location is 1248 Sussex Turnpike, Randolph, N.J. 07869, (201) 895-4919.

# NO SIGNAL SHOULD HAVE TO GO THROUGH ALL OF THIS



It's well known that line amplifiers directly diminish CATV signal quality. Yet today's cable distribution systems rely upon an architecture in which signals must pass through as many as 60 amplifiers before they reach a subscriber.

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# Triphonic sound for television

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

The science of sound simulation by artificial means, in my opinion, has received more attention from amateurs and engineers than has the production of visual images. The psychological impact of sound waves impinging upon the ears is substantially less subject to scientific analysis than visual stimuli. This probably accounts for the proliferation of curious and often fraudulent systems of sound recording and reproduction that have deceived even physicists into proclaiming the virtues of such systems that violate the most fundamental laws of physics.

To illustrate some of the lamentable scenes in sound, the first deception I remember appeared in an ad for Victor phonographs. A distinguished audience of music critics and artists faced a stage with drawn curtains. Behind the curtain was a prominent diva backed by a large orchestra flanking a phonograph in center stage. It was proclaimed that the audience could not tell the difference between the acoustical phonograph and the live performers as they alternated in performing the concert!



Remember when stereo recordings appeared in the '50s, and every stereo phonograph came with a demo record to convince the gullible public that the higher priced stereo was the technical wonder of the world? Invariably, the show business charlatans cut the bass and treble regions for the monaural selections. When the glorious stereo burst upon the eardrums, it was with full fidelity and quality, as well as possessing some of the dubious depth of sound we associated with the stereo recordings.

Indeed, what is delivered today on stereo electronics? Twenty-four or more soundtracks manipulated for a trademark sound by a master technician? Is it really stereo, or just a musical bag of tricks to cajole dollars out of the public purse?

And how about the recording instruments; the delivery system—wire, wireless; the receivers; the audio amplifiers; and finally, the speakers? Space does not permit an assessment of the many violations of basic physics principles of the previously mentioned, but I would like to comment particularly on the sound reproducers. There seems to be an infinite number of speaker configurations, each being proclaimed by some mysterious manipulation of the atmosphere to create a miraculous quality of stereo sound never before achieved. If I see one more advertisement pronouncing a small speaker as infinitely superior to the traditionally baffled reproducer, I will be convinced that world is populated by madmen from Mars!

## Sound science

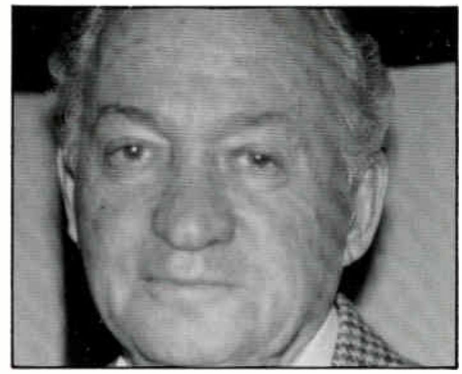
However, the true subject of this paper is stereo sound for television—HDTV, to be sure. Emil Torick, one of the bright lights from the murdered CBS Technology Center, presented a seminar lecture called "A triphonic sound system for television broadcasting" in 1982, just in time to be considered (and rejected) by the BTSC TV stereo committee. I am indebted to Torick for his clarity and insight into the science of sound, which I will try to abstract for the edification of all.

The current system of U.S. FM stereophonic broadcasting employs a symmetrical matrix:

$$M = (L + .7C) + (.7C + R), S = L - R$$

The left channel = M + S = L + .7C, the right channel = M − S = R + .7C. Thus, the center signal is presented as a virtual or phantom image created by the acoustic power summation of sound of equal amplitude and phase from each of the loudspeakers. It is immediately obvious that the average listener will be physically unable to properly locate the source of the sound. Indeed, without a visual companion to the sound, who cares or notices?

However, a curious and inexplicable psychological phenomenon occurs with most listeners. Instead of the phantom center appearing on a direct line connecting the two speakers, the location of the source appears to rise as it is panned from left through center to right. The degree of elevation appears to be related to the angle subtended from the listener to the speakers. Try out this "leaky" effect yourself. I place the virtual sound image at about seven feet above the stereo speakers separated by 15 feet.



So what? This is what: The TV screen is small, and with a 15-foot speaker base in a typical home environment, the voices converge at the ceiling level. And that is the case for the home viewer located at the center line of the speakers. When you are dealing with a phantom center, the inequality of speaker outputs, position and orientation of the viewer's head, the acoustic environment, hearing deficiencies, etc., two-channel stereo sound is inferior. Also, don't forget the poor signal-to-noise ratio of BTSC compared to digital delivery.

Thus appears triphonic and perhaps quadraphonic ("surround sound") systems. A center channel is imperative for a sound that is compatible with television. We must bring the speaker's voice to the speaker's lips! The center speaker should be 3 dB higher than the side channels and should use the following matrix:

$$M = L + 1.4C + R, S = L - R, T = -1.4C$$

Torick recommended a variant of the analog quadraphonic systems successfully tested 10 years before NTSC, but the digital explosion of today will allow the carriage of four audio channels in the TV spectrum. The fourth digital channel, as proposed for HDTV, is intended for a fourth speaker located behind the viewer to enhance the feeling of being inside the visual scene portrayed on the large screen—maybe. The home environment is so non-standard that the fourth speaker may detract from rather than add to the enjoyment of the entertainment.

Whatever HDTV audio standard is finally formalized, I hope it will be guided by science and not by some of the sound magicians still practicing their spurious art. Triphonic systems will triumph!

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# Design, installation and certification of a broadband LAN cabling system

*Recent completion of broadband local area network (LAN) standards, combined with the inherent advantages of the technology for large-scale LAN situations has resulted in increased LAN implementation. This demand opens career opportunities for many CATV industry individuals experienced in the same broadband RF technology. But the differences in implementation of a CATV plant and a broadband LAN are many.*

**By Larry C. Brown**
Vice President, LAN Division, NaCom

The differences between broadband CATV systems and LANs begin with terminology. An implementation of either can be viewed as a three-stage process. In LAN terms, these are design, installation and certification.

*Design* includes site survey, route planning, any makeready by utilities (generally little to none in LANs because facilities are often entirely privately owned) and the LAN equivalent of strand mapping of the results, given a knowledge of the outlet or tap port density required by the end-user for the LAN's intended applications. A broadband cabling layout and design are then generated and the results often computer drafted to yield a finished result with the high quality appearance many LAN end-users (Fortune 500 companies, etc.) require.

*Installation* consists of physically installing both backbone (trunk and feeder) and station (drop) cabling, as well as user outlets, plus splicing of all electronics—amplifiers, passives, taps—in the LAN. If interbuilding outside plant is involved, installation also includes all construction associated with it.

*Certification* includes activation, sweeping and balancing, loop loss (round trip inbound-outbound) testing of user outlets and/or tap ports, reconciliation of installed results with design predictions and proof-of-performance (intermodulation, noise, leakage, etc.) testing of the completed LAN for final acceptance.

In a broadband CATV system, we deal with taps, passives (splitters, directional couplers, power inserters), trunk amplifiers and line extenders. Concepts and terminology in a broadband LAN are nearly identical, but frequently the implementation of broadband cabling in a facility for a LAN also is accompanied by the simultaneous implementation of "subnetwork" cabling and components used in LAN architectures other than broadband. These include the baseband coaxial cabling associated with the popular Ethernet networking scheme, typically found in two forms: standard (or "thickwire") and a smaller cable diameter version (called "thinwire"). Ethernet components include transceivers (analogous to broadband taps) and electronics devices like repeaters, bridges and servers.

The IBM cabling system is another popular data cabling scheme. It includes a handful of different cabling types, many shielded, from which end-users can select to best match their applications. It also uses a unique hermaphroditic connector. AT&T's Premises Distribution System is another approach, which includes 110 series interconnect and crossconnect hardware, fiber-optic ST and biconic connectors, multimode fiber cables and a variety of patching options. DecConnect, Netware, Appletalk, SNA, OSI, ISO —the list of new terms the good LAN installer will be comfortable conversing with sometimes seems endless.

The geographic area covered by a LAN is, by definition (*local* area network), tiny compared with the vast extent of a typical citywide CATV system. However, the environment into which cabling is to be placed may be extremely complex and hostile despite its small area. Consider installation of cable along the interbuilding support structures associated with a chemical refinery comprised of many buildings interconnected with miles of pipeline carrying toxic chemicals. Or postwiring installation of a dual-cable, full redundant broadband backbone, with supporting messenger strand, at a 40- or 60-foot height above a factory floor. Or through the rafters of a 100-year-old office building that has been renovated six to 10 times and thus has four levels of drop ceilings with which to contend; the building coincidentally contains the office of the company president or military commanding general for the system end-user.

The accessibility time of areas for LAN cabling installation is often limited. For postwiring situations, where a LAN is being added to an already operating facility, installers may be limited to working only at night, when conflict with day-to-day facility operation can be avoided. In prewiring situations, where cabling is being installed as a facility is being erected or renovated, installation run rates may of necessity be very slow. This is done to take advantage of time-saving situations like open stud walls and ceilings and not to overrun the installation rates of the other trades involved in the building construction process. Hence, large facility wiring jobs can require a substantial project management effort maintaining progress reports and daily schedules satisfactory to the end-user's general contractor, architect, consultants and/or project engineers.

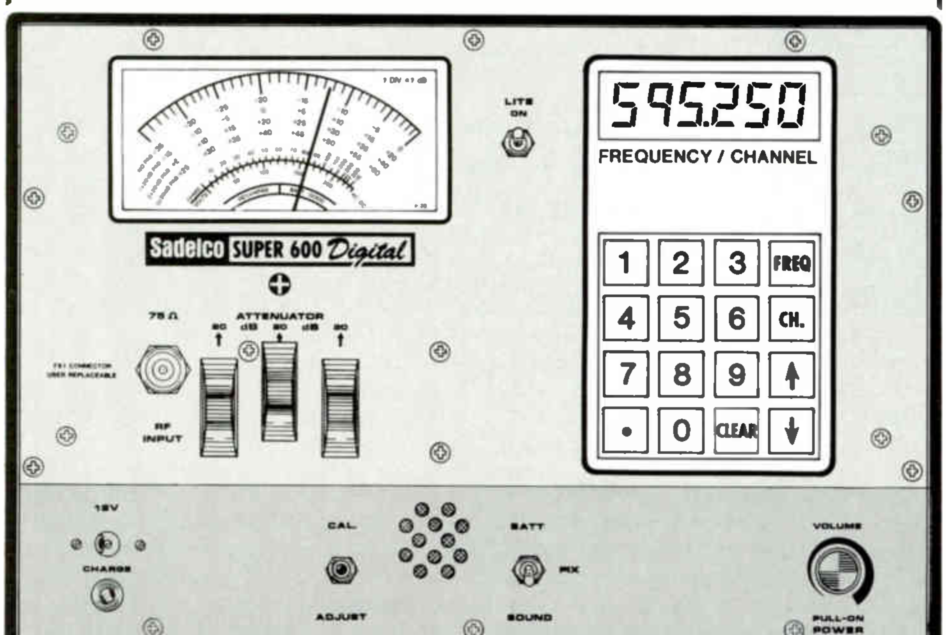
Government and military projects often have extensive military standards that must be met, in addition to standards like the NEC (National Electrical Code) and the NESC (National Electrical Safety Code) more familiar in CATV. Government compliance can include FARs (federal acquisition regulations) mandating, for example, certain minimum participation levels for minorities that must be met during project implementation. MIL-Q quality and MIL-C calibration standards also are often involved. With each comes more engineering, project management and record-keeping and reporting requirements for the LAN installer. And in non-government projects, especially those in facilities owned by large corporations, the end-user companies often have their own extensive published codes and standards that must be understood, and complied with, by the LAN installer.

Need for cabling system redundancy and status monitoring in a LAN commercial/industrial environment is generally more severe than in a CATV system. An outage of 30-60 minutes on a broadband LAN, which may be transporting critical process control factory communications, can cripple an entire production line or even the entire factory, with devastating financial consequences. Hence, broadband LANs often are designed with full redundant electronics in both cable plant and headend, status monitoring transponders at each amplifier and end-of-line location and even "redundant-path" interlaced topologies. The latter provides the ultimate reliability, since even a severe accident that physically severs a cable path (such as may be caused by a careless forklift operator in a factory) will not impair overall LAN functionality.

The window of acceptable RF operating levels on a LAN is generally much tighter than in CATV. The former Federal Communications Commission guidelines for CATV specified a minimum of 0 dBmV signal level at subscriber TV receivers; typically plant/drop designs actually supply 0 to 15 dBmV or more. In LANs, a +10 dBmV nominal outbound/downstream level and +54 dBmV nominal inbound/upstream level is common at a user outlet, with only a ±3 dB tolerance on each path to accommodate cable system components characteristics.

In broadband LANs inbound signals are usually "turned around" *en masse* at the headend and sent back outbound, as a means of effectively providing a broadband "bus" through which various user ports can conduct many-to-many communications. In single-cable broadband LANs, where bidirectional communications is accomplished by band-splitting the spectrum into inbound and outbound segments, frequency translators often perform the turnaround function. But these do nothing to clean up level variations in inbound signals received at the headend. Thus, systems utilizing these require that the data communications devices used to interface the system to user workstations have a generous dynamic range specification. An alternative approach in LANs is to use a demodulator approach at the headend, which effectively eliminates any inbound level variations before retransmission outbound, thus providing a tighter overall system loop loss operating window.

Broadband LANs frequently have unique maintainability requirements not found in CATV. For example, many users and applications re-






quire that all cable plant active devices be physically mounted at heights accessible from floor level without special lifts. In these situations, distribution cables may be routed at 50- or 60-foot heights as in, for example, a factory but descend to floor level at every amplifier, power supply and status monitor location.

### Cables and connectors

The distribution cables used in broadband LANs often are of a design that incorporates dielectric discs fused to the center conductor rather than a solid dielectric material. This gives the cable fire retardant characteristics to meet tight UL and NEC requirements for the use of cables inside building riser and return air plenum paths. Since cascade length constraints are seldom a problem in LANs, due to the restricted geography involved, large diameter distribution coax—1-inch diameter and larger, such as that often employed in CATV supertrunking—is seldom used.

Drop cables employed in LANs are frequently quad-shielded, and often connectors of a quality (and cost) greater than those found in typical CATV consumer applications are also used. These protective measures ensure ingress immunity from the very high EMI/RFI (electromagnetic/radio frequency interference) field intensities created by, for example, high current switching, welding and other fabrication processes in a factory environment.

A broadband LAN installation project sometimes requires the simultaneous installation of other data and voice cabling media to support other subnetworks, such as shielded or unshielded twisted pair, baseband coax and fiber-optic cables. In these cases, a whole host of other connectors, speciality tools, installation techniques, test equipment, handling precautions, adapters, interconnect and patching hardware can be involved.

### Taps and passives

Recent product releases among the manufacturers of LAN multitaps are moving toward available tap values of 1.5 dB increments, compared with their 3 dB counterparts more popular in CATV. The smaller increment allows the broadband LAN designer to maintain a tighter tolerance on path loss and loop loss between user ports. Some models even provide separate plug-in equalization for inbound and outbound paths, enabling an even tighter tolerance to be obtained. External in-line equalizers are generally found more often in broadband LAN designs than in CATV, for the same reasons. ■

*The author acknowledges the contributions of the entire NaCom LAN Division staff, whose working experiences contributed greatly to the content of this article.*

### References

1) *MAP/TOP Broadband Specification*, General Motors Corp., Warren, Mich., 1978.
2) *IEEE 802.7 Broadband Local Area Network Recommended Practices*, IEEE Computer Society (1988 draft).
3) *Broadband Network Technology*, Ed Cooper, Sytek Press, Mountainview, Calif., 1984.

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# Implementing a broadband LAN

*There is a certain amount of confusion and misinformation in the industry regarding the implementation of broadband systems. This article attempts to address some of the issues involved in selecting and engineering a broadband local area network (LAN).*

**By Geoff Roman**
Marketing Vice President, Jerrold Distribution Systems Division, General Instrument Corp.

Broadband systems today are unique in their ability to simultaneously provide multiple independent signals and services on the same physical medium. Like transmission in the atmosphere, broadband systems allow the independent use of each frequency assignment or channel. This capability provides not only tremendous capacity but also allows users distributed throughout the network to both originate and receive information on any of these channels.

### Frequency planning

The first issue that must be addressed in planning a broadband LAN is the frequency split to be used. Three options are available: mid-split, high-split and dual cable. Mid-split was developed nearly 20 years ago when the bandwidth of the available hardware was limited to about 270 MHz. As Table 1 shows, with today's hardware, mid-split provides an unequal bandwidth split between user transmit and receive signals. It does, however, allow distribution of Chs. 7 to 13 in their normal over-the-air assignments, permitting users requiring up to seven channels of video service to avoid using converters or cable-compatible sets. Since mid-split has been around longer, there are more of these networks installed than any other type and a wide variety of data interface equipment is available.

**Table 1:** Frequency split alternatives

| | Frequency range (MHz) | | Bandwidth | |
|---|---|---|---|---|
| | Inbound | Outbound | Inbound | Outbound |
| Mid-split | 5-108 | 162-450 | 103 MHz | 288 MHz |
| High-split | 5-180 | 282-450 | 175 MHz | 228 MHz |
| Dual cable | 40-450 | 40-450 | 420 MHz | 420 MHz |

High-split networks were developed when the bandwidth of the available broadband hardware was 400 MHz; hence, more of the available bandwidth was allocated to the return path as shown in Table 1. High-split has been embraced by the standards committees and is widely used in networks being installed today, particularly those supporting factory automation applications. As is the case with mid-split, there is a wide array of data interface equipment available.

Dual-cable networks provide twice the capacity of either mid-split or high-split. While at first glance it may seem extravagant, the actual premium for dual-cable vs. either single-cable approach is 15 to 20 percent. Dual-cable systems offer the most flexibility in frequency planning and allow transmission of all 12 TV channels in their normal assignments in either direction. Dual-cable has been widely installed in government and military applications. An advantage is that one-way devices (like TV sets) are connected only to one transmission path, eliminating possible interference in the event of a receive-only user device failure.

When making the determination of the frequency split, the capacity

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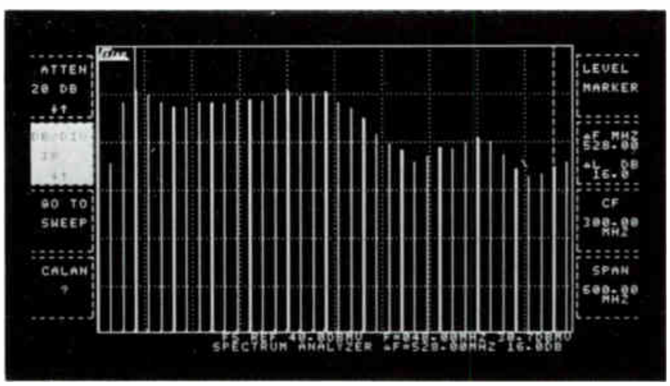
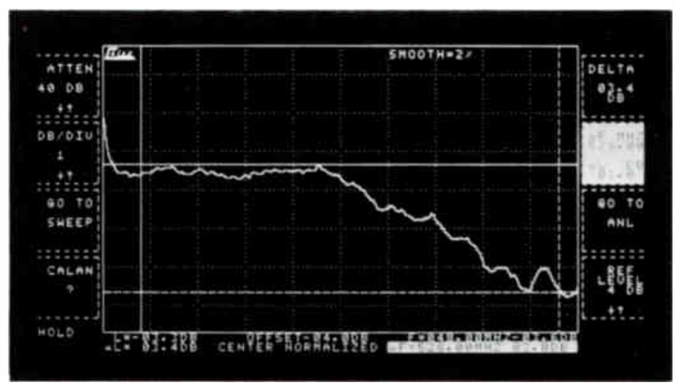
PICTURE 1
Spectrum Display




PICTURE 2
Frequency Response

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requirements should be reviewed carefully. It's much less expensive to install two cables at the outset than to install a second one later. Particular attention should be focused on inbound requirements, since high bandwidth needs will often force the decision to a high-split or even dual-cable network.

Once the frequency split has been determined, the next step is to determine a frequency allocation plan. This should be done prior to ordering the first piece of interface hardware and should consider all equipment likely to be installed on the network during its life.

In the frequency planning process, it is most useful to look at the set of frequency ranges available for all planned equipment then fix assignments first for the units with the most restrictive choices and greatest bandwidth requirements. For example, most manufacturing automation protocol (MAP) hardware is available in a small number of frequency ranges, whereas low-speed (less than 19.2 kilobits per second) point-to-point modems are available for a wide array of frequency assignments.

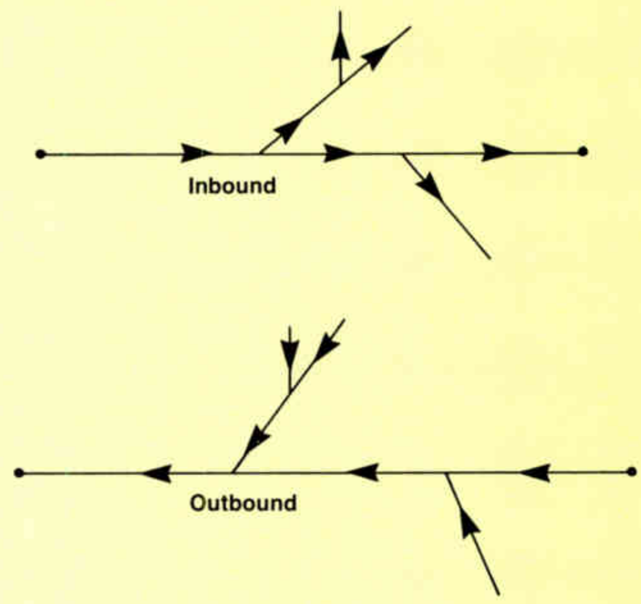
A final consideration in allocation is possible interference. Although broadband technology provides a high degree of shielding against outside RF fields, there are certain situations—e.g., RF paging inside buildings or a high-power broadcast station located next door—where some frequencies are best avoided.

**LAN architecture**

Broadband systems most often use an architecture derived from the "tree-and-branch" configurations of cable TV. This architecture is fundamentally limited by system noise and signal distortion. However, because of the smaller size of LANs compared to CATV systems, there are a number of performance improvement options available to the LAN designer that cannot be employed reasonably in a CATV system.

Whenever signals are amplified, the designer must make tradeoffs between noise and distortion. Broadband amplifiers are rated in terms of these parameters using video test signals. In a LAN, many of the signals transmitted are not video and thus correction factors must be applied to the data supplied by the amplifier manufacturer. From the standpoint of power loading of amplifiers, all signal components must be considered.

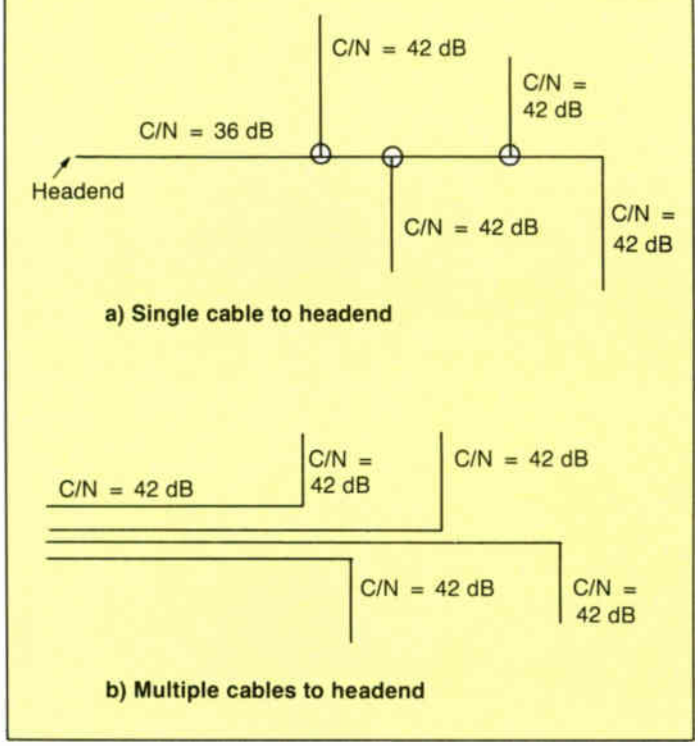
**Figure 1:** Noise summation




For example, the total power of a video signal with an amplitude of 40 dBmV and that of 20 narrowband signals, each with an amplitude of 27 dBmV, is approximately equal. On the other hand, 20 narrowband signals each with an amplitude of 40 dBmV is equal in power to a video signal of 53 dBmV. This, then, yields significantly greater distortion than the 40 dBmV video signal.

Similarly, noise power is a function of bandwidth. Carrier-to-noise (C/N)

**Figure 2**




measurements for CATV systems relate to the noise power in the 4.2 MHz video bandwidth. A correction factor relating the receiver bandwidth yields the proper result.

$$\text{Correction}_{BW} = 10\log \frac{\text{BW (in MHz)}}{4.2}$$

For example, a C/N house level measuring 40 dB in 4.2 MHz yields a reading of 56.2 dB in 100 kHz.

Distortion is specified for a particular number of TV channels. To access the impact of distortion for a number of channels other than the specified number, a correction factor must be applied. This factor is proportional to the logarithm of the ratio of the number of channels to the number of channels used to determine the rating. The coefficient will be a function of the type of distortion.

The distortion performance and C/N degrade as the network gets larger. In a cable system or the outbound portion of a broadband LAN, the overall network performance can be determined by looking at the longest amplifier cascade. Any architectural design that can reduce the number of amplifiers needed to reach a user location will improve system performance. An important feature of the outbound path is that the performance any user sees is strictly a function of the amplifiers located between the headend and that user location. Amplifiers not in that path have no effect.

The inbound path, however, is more complex to visualize. Figure 1 shows the corresponding inbound and outbound paths. With respect to inbound, every amplifier in the system contributes to the overall noise. There is no real advantage in using the branched architecture for inbound as there is for outbound.

The branching architecture that combines to hurt the inbound C/N performance aids the inbound distortion performance. Because an individual inbound signal is only present on one inbound path at a time, only those amplifiers in the path of all signals, usually limited to an amplifier or two near the headend, see the full channel loading of the system. This yields significant improvement in inbound distortion; the inbound path is limited in size by noise. The inbound limit is usually the more constraining in determining the overall system architecture.

Taking into consideration these constraints, it is now useful to look at some design techniques that can improve system performance. The example shown in Figure 2a is a large manufacturing complex with four wings. C/N is 42 dB in each of the quadrants considered individually but for the system as a whole is degraded to 36 dB because of the contributions of the other distribution cables. Figure 2b shows an alternative architecture where the four distribution cables are routed to the headend independently, yielding a 42 dB signal-to-noise (S/N) ratio at the headend. In addition to providing improved performance, this approach yields easier troubleshooting in the event of a system problem.

Another area where a designer often has considerable latitude is that of system levels. The absolute power equivalency has already been addressed, but the designer's options are often sizable. In general, it is prudent to operate at the highest level practicable in keeping with satisfactory distortion performance. This will ensure operation at maximum C/N.

However, levels cannot be increased without limit, because all amplifiers have what is known as a *compression point*—the point where distortion increases non-linearly with increasing signal level. In typical broadband amplifiers, compression points range from 48 to 60 dBmV depending upon the technology employed and the overall power loading of the amplifier.

### Administration and maintenance

A final area to be considered is the administration and maintenance of the system after it is installed. It is important to keep accurate records and updated drawings for the network. These will save considerable time in tracking down problems in the event of a system malfunction. Broadband amplifiers are very stable devices, particularly in the indoor environment of many LANs. Thus, they require minimal attention to provide reliable performance.

It is recommended that once installed and aligned the amplifiers may not be adjusted unless tests indicate performance degradation, as many a system malfunction has been caused by a well-intentioned technician trying to improve performance. Perhaps the most difficult parameter to control in the network is the users. They often connect devices to the network improperly and with poorly made cables. A recommended countermeasure is to audit each user location physically at least every six months. Problem locations may require more frequent inspections.

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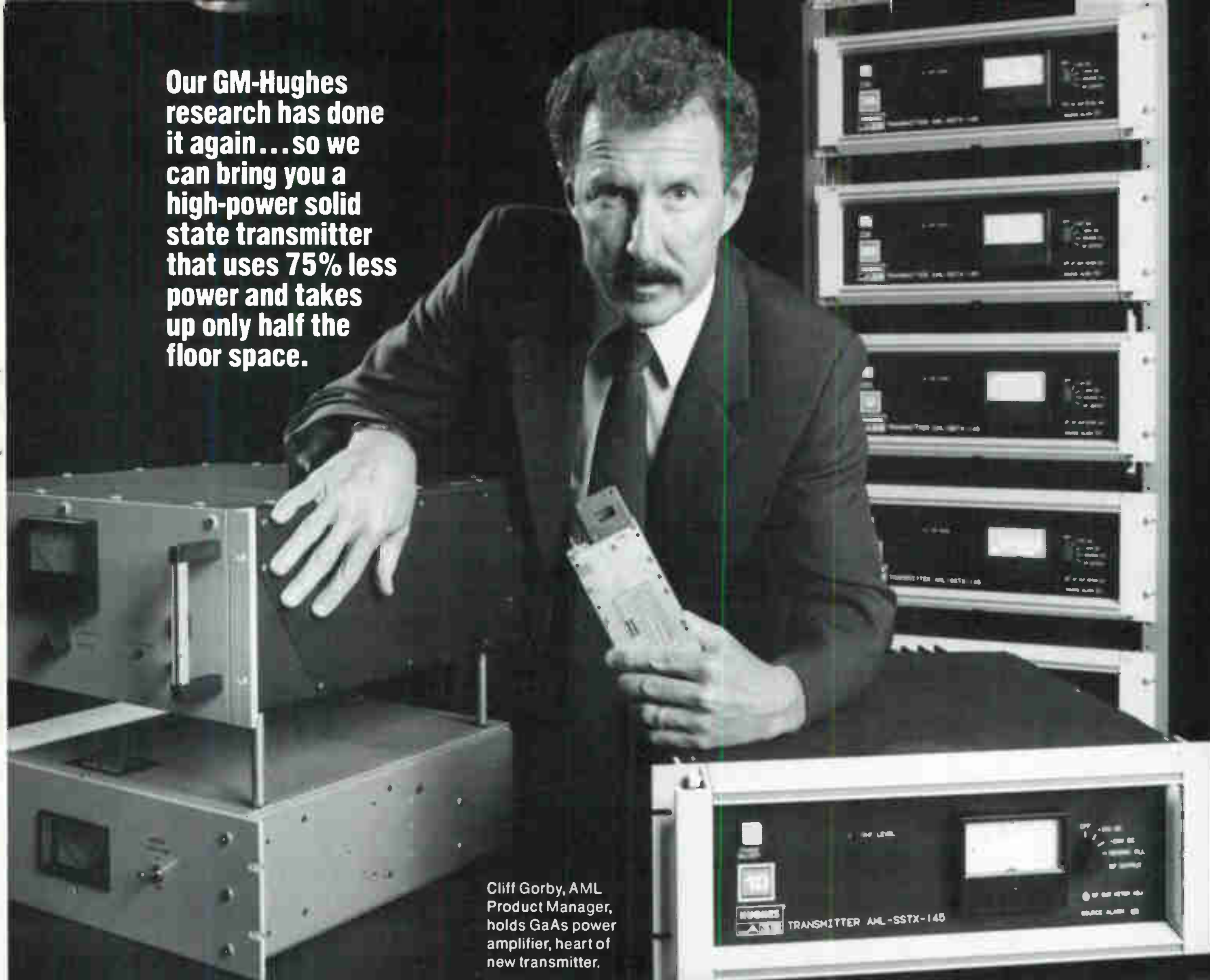


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# Spectrum allocation in broadband systems

**By Tom Saylor**
Staff Engineer, Columbia Telecommunications Corp.

Coaxial broadband communications systems are favored by users seeking efficiency and bandwidth in a dedicated data, voice and video transmission network. Borrowing heavily from proven CATV technology, broadband local and wide area networks (LANs and WANs) offer many advantages. These include parts availability, field-tested construction and maintenance practices, ease of adding user attachment points and wide bandwidth.

A typical single-cable broadband network can be constructed with one of two prevailing architectures: mid-split or high-split. The selection of a crossover point between forward and reverse transmission paths is dictated by the designer's projections of message type and volume on the planned network. Where a larger forward (downstream) traffic load is projected, as in the case of a system carrying a large number of video services, a mid-split network is indicated. In a 450 MHz network, this provides 17 video channel equivalents of upstream capacity between 5 and 108 MHz. The downstream spectrum between 174 and 450 MHz yields 46 video channel equivalents of capacity. (A video channel equivalent is defined as a 6 MHz portion of network spectrum.)

A network projected to support roughly equivalent message traffic in both directions should be configured as a high-split system. Generally speaking, a 450 MHz network will have 30 video channel equivalents of upstream capacity between 5 and 186 MHz, and 38 video channel equivalents of downstream capacity between 222 and 450 MHz. High-split frequency ranges, crossover points and channel capacities vary slightly by vendor.

In both examples, the "lost bandwidth" between the upstream and downstream passbands results from the diplex or crossover filters. These filters are provided in the system amplifiers and headend to allow separate processing of the bidirectional signals. A guard band prevents interaction of the signals during processing, resulting in a high degree of isolation.

### IEEE proposed standard

The Institute of Electrical and Electronic Engineers has developed a proposed standard outlining the "physical layer" requirements of a broadband network. Draft Document 802.7 spells out technical criteria for the underlying cable system, including recommended system frequency conversion offsets. A conversion offset is the amount (in megahertz) that a low-frequency upstream signal is increased at the headend for retransmission on the downstream network path. The IEEE recommends a 192.25 MHz offset for new systems.

In a broadband network no users are connected directly to one another. Everyone transmits back to the headend on reverse frequency assignments, where conversion and retransmission on forward assignments occurs. Everyone receives message traffic via forward spectrum carriers. This leads conveniently to a discussion about the various classes of transmission services provided by the broadband network. Each must be assigned a spectrum location consistent with demands of the service class. The most familiar will be video services, followed by data services.

Video transmissions require a full 6 MHz of spectrum per channel. Signals originate either from the headend or a remote network location. Remote video can then be retransmitted on a forward assignment if desired. Conventional CATV techniques utilizing modulators, demodulators and processors are employed.

Data services are categorized more according to configuration than speed. Point-to-point services are, as the name implies, dedicated circuits between at least two devices at different network locations. Typical examples of point-to-point traffic include digital voice (remote PBX to main switch), single terminal to host or other applications requiring a non-switched continuous path. Data rates are typically from 9,600 bits per second to 2 Mbps (megabits per second) and beyond, occupying greater bandwidth with higher speeds. Spectral efficiencies are generally between 0.8 and 2 bits per hertz. For example, a 1.544 Mbps RF modem with an efficiency of 1 bit/Hz will utilize a channel bandwidth of slightly over 1.5 MHz. This would permit the carriage of four such circuits within a 6 MHz video channel, including guard bands.

Multiplexed data services are another category. These permit simultaneous use of one circuit by several devices. They are similar to point-to-point circuits in most respects, except that multiple data ports are available at each circuit end. Use between devices is allocated according to predetermined protocols. Additionally, transmission speeds can range up to 6 Mbps and higher, making multiplexed circuits a popular choice for speed and efficiency.

The final general category includes switched or "packet" circuits. Packet modems have the ability to selectively connect with similarly equipped devices on the network; each is assigned a unique computer address. Users can establish temporary "virtual circuits" with other devices, via a network controller. Generally, transmit and receive frequencies are shared among devices, with use allocated according to various control methodologies. Transmission speeds are typically between 300 bps to 19.2 kbps.

### Time to assign

Like most other finite resources, the broadband network's spectrum must be carefully allocated, assigned and tracked. Various classes of data and video traffic have their own unique channel requirements. A deceivingly expansive bandwidth will dwindle quickly with an increasing user base. Even with an uncrowded network, prevention of conflicts and accommodation of multiple transmission modes demands astute planning.

We can now decide where to place services on the broadband network. We will use a high-split 450 MHz network in our example. Figure 1 depicts a representative high-split assignment chart; this frequency plan is currently being used on an operating network. The client's primary usage includes telephone (PBX) interconnect between buildings, packet data and two-way video.

The frequency regions between Channels T11 and 8′ (reverse) and K through MM comprise the network "paired channel" zone. This is the network "meat and potatoes area," suited for bidirectional applications. Individual channel or subchannel pairs are assigned to each user. Depending on the service bandwidth, multiple carriers can be assigned within a video channel equivalent. For example, three 2.048 Mbps PBX modems are assigned per channel. A large number of channel pairs is set aside for the developing packet network. The client will eventually occupy this area more fully; use is limited at present. Existing use of point-to-point services in the T11/T14 and K/N channel pairs can also expand into the reserved area bounded by Channels A-2′/A-1′ and AA/BB.

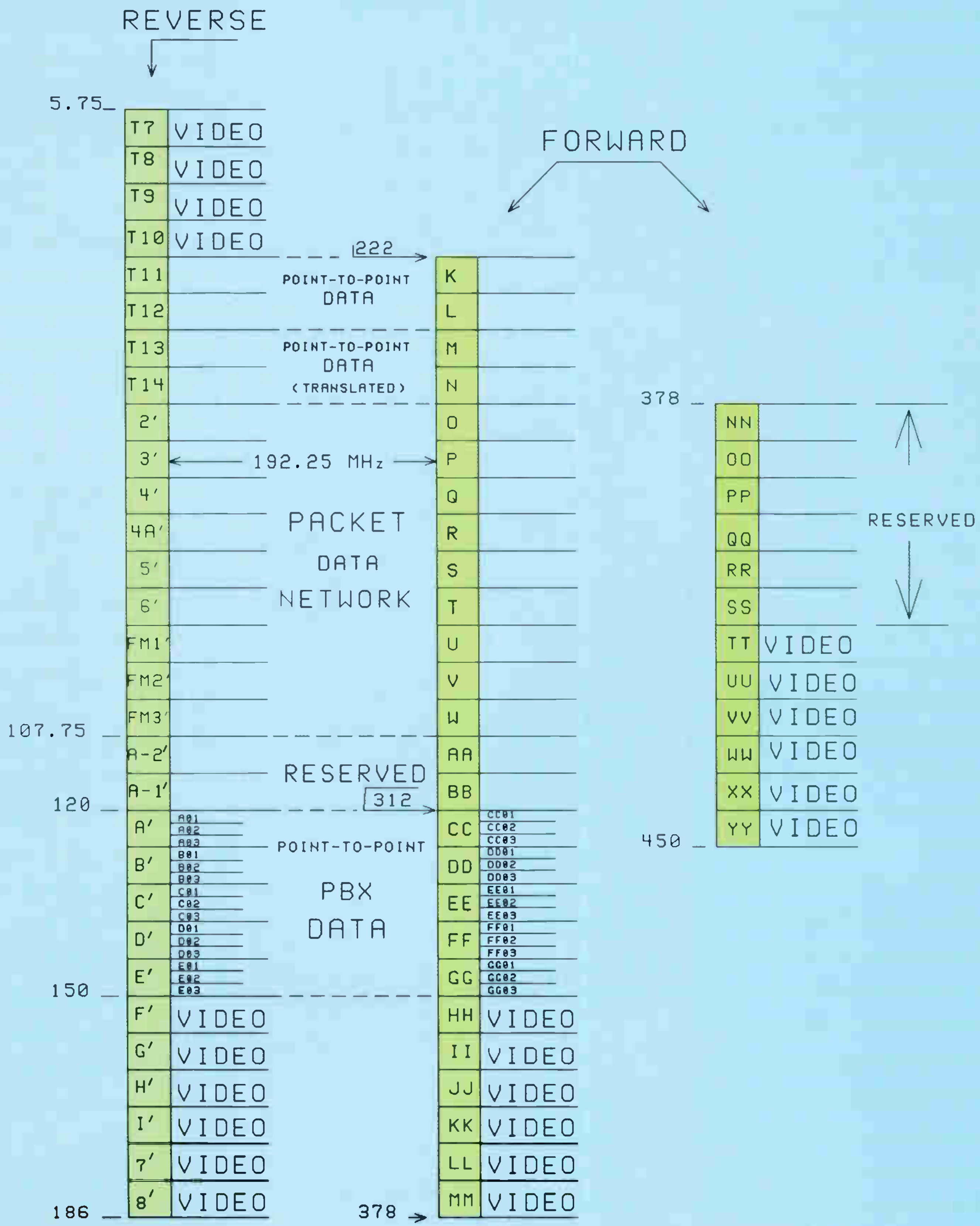
One- and two-way video services are accommodated. Channel pairs F′/8′ and HH/MM yield six circuits for remote origination. Additional one-way video can be relayed upstream via T7 through T10, or downstream via TT through YY. Future downstream-only applications (other than video) are reserved for Chs. NN through SS.

Developing a spectrum allocation plan in advance of network activation will prevent inefficient use of bandwidth resources. It is also less difficult to assign frequencies at the outset than to force a change in on-line devices. Adhering to predetermined guidelines permits network planners, engineers and users to co-exist in the broadband environment.

### References

*IEEE 802.7 Working Document D*, IEEE, 1986.
*MAP/TOP Broadband Specification*, General Motors Corp., 1987.

**Figure 1:** Frequency allocation chart

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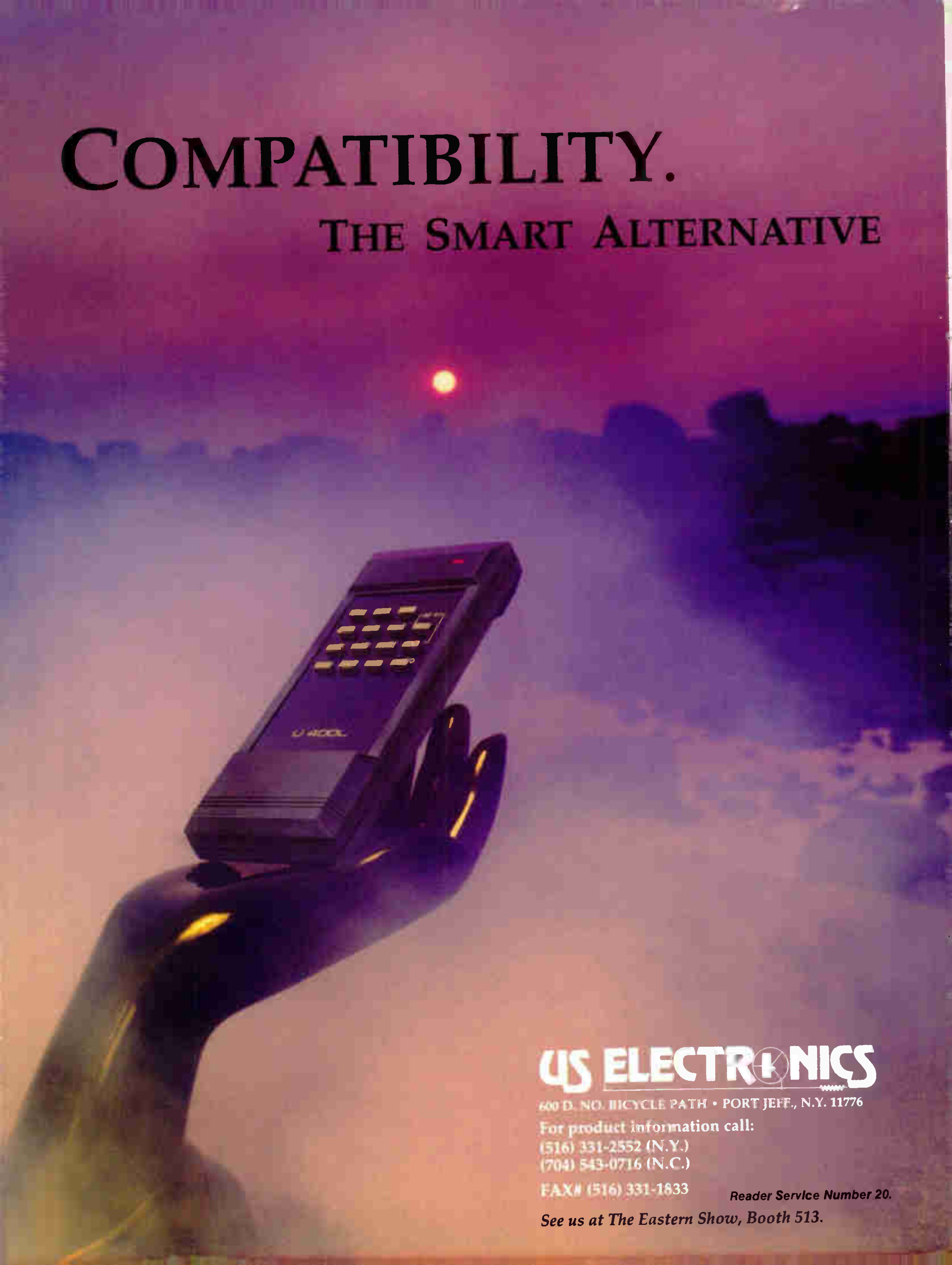
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# Fiber optics in local area networks

*This is the first of two parts on the application of fiber-optics technology for local area networks (LANs). The second installment will discuss repeaters and various topologies.*

**By Robert Southard**
Manager, Systems Technology
Electro-Optics Division, AMP Inc

The performance benefits that fiber optics provides have been well documented in long-distance transmission, office wiring and factory automation. In combination with LAN technology, fiber optics becomes a more potent tool for filling communication needs for today and tomorrow.

The telegraph, based on copper wire, was one of the first electrical communication systems developed; it was an all-digital, block-coded, pulse width-modulated system. A remarkable product development in its day, the telegraph shortened communication time from days to seconds. Today, optical fiber allows messages to flow in nanoseconds. New techniques may take even better advantage of the bandwidth capability of fiber, reducing communication time even further.

The majority of communications during the typical business day involves people in relatively close proximity to one another. LANs that address the need to move data over short distances are outstripping the ability of conventional communication systems.

### LANs vs. long-haul fiber

LANs receive fiber optics in a different form than the way fiber is commonly used in long-haul telecommunications, which demand very expensive components such as laser diodes and avalanche photodetectors. The cost of components is justified by the very high data rates produced and the ability to reduce the required number of repeater stations. Fibers and cable (to be discussed later) are also very different. LANs, on the other hand, rely on basic LEDs (light-emitting diodes) for signal generation and PIN (positive intrinsic negative) photodiodes for detection. The networks involve four basics of technology: modulation, access method, topology and media.

*Modulation*, the manner in which information is expressed on network signals, is categorized as either analog or digital. Copper wire-based communication links handle either type of modulation with ease. In contrast, practically all fiber networks use a form of digital baseband modulation in which the optical signal is turned on or off to encode the data as needed. The fiber can handle analog signals with no difficulty, but this presents a difficult problem due to the nonlinear behavior of the light emitters used. Without complex circuitry, optical emitters introduce distortion into the analog signal (difficult to overcome).

*Access methods* determine how the network resources are made available to the stations that are attached to the LAN. Techniques such as token passing and contention, with or without collision detection, are used in both copper wire and fiber networks. Even though the form of implementation may vary, access methods usually are very similar in both optical and electrical networks.

> *"Fiber attenuation of 2 to 5 dB/km, when compared to coax attenuation of 50 to 200 dB/km or more, is a major advantage."*

*Topologies* determine the physical and logical connection arrangements of the stations on the network. The logical topologies of fiber are identical to those found in copper wire networks. However, the physical arrangements tend to differ because of the closed waveguide structure of fiber. Physical attachments to waveguides tend to be more restrictive than connections to open media such as twisted pair or even coax cable.

### Differences in the media

*Media*, the fourth basic, requires a more complete discussion in order to understand the place

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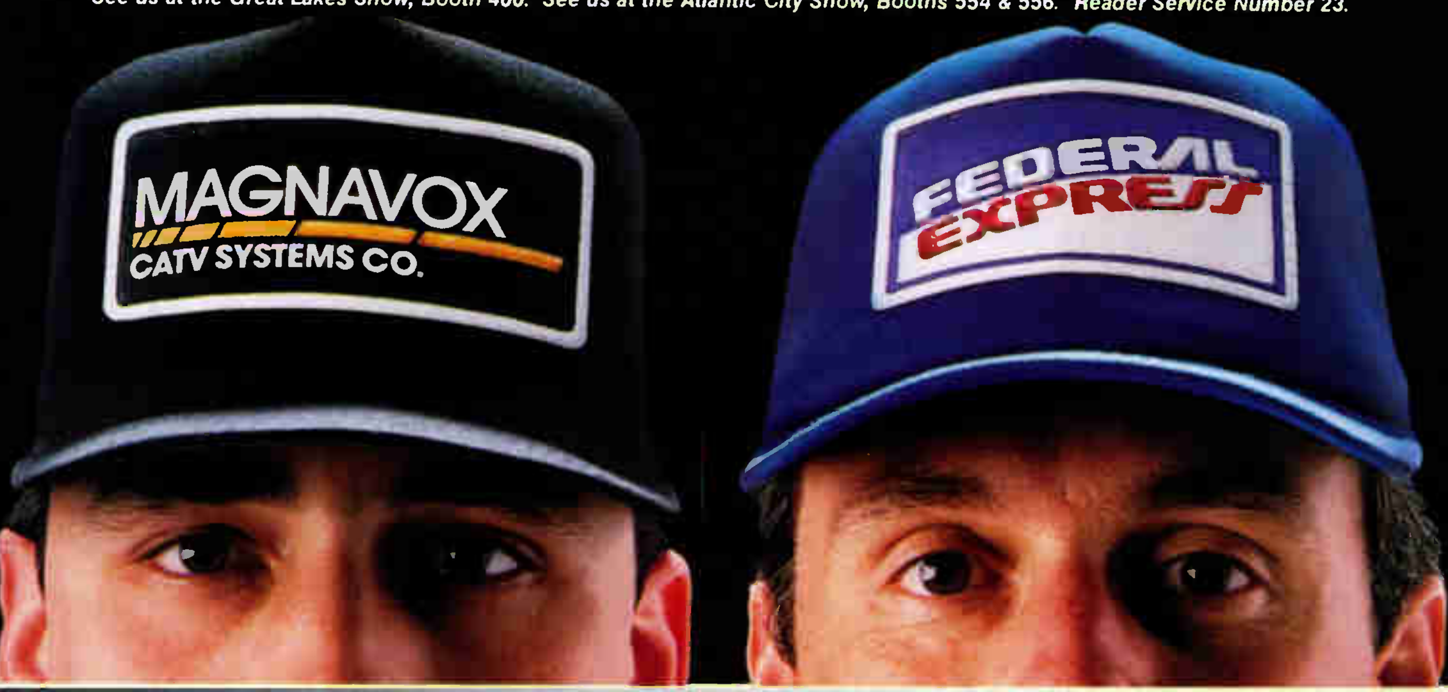


of fiber optics in LANs. Today LANs use multimode fiber rather than the single-mode commonly found in long-haul telecommunications. Although inexpensive and very high in performance, single-mode fiber requires more expensive electronics and connectors than multimode and is not economical for LAN use today.

As shown in Figure 1, multimode has a different cross-sectional design than single-mode. The difference makes it easier to couple to the relatively inexpensive LEDs and PIN photodiodes routinely used in LAN applications. Basically, an optical fiber has a core material and a cladding material. The optical signal energy is predominantly within the core, with very little energy contained within the cladding. With most fibers the core and cladding form an inseparable structure. The fact that cladding cannot be removed from the core to gain access to the signal presents both advantages and disadvantages.

Since fiber is more difficult to tap than copper wire, it provides a higher degree of security. Tapping techniques being developed for fiber usually induce some power loss in the signal being carried by the waveguide. The power changes are measurable at the receiving end of a working link. Thus, even if a tap is made, it also can be detected, giving it questionable value for surveillance. The difficulty in tapping fiber also makes some LAN topologies more difficult to implement than others.

A tap may be placed on the cable wherever it is convenient, although Ethernet specifications do specify allowable positioning to keep problems of signal reflections from growing unacceptably large. The coax tap may be installed while the network is actively transmitting data, since it involves piercing the jacketing and shielding members of the cable without requiring disconnection. Fiber taps are installed by cutting the optical cable at the point of insertion and then

**Figure 1:** Fiber cross section and energy distribution

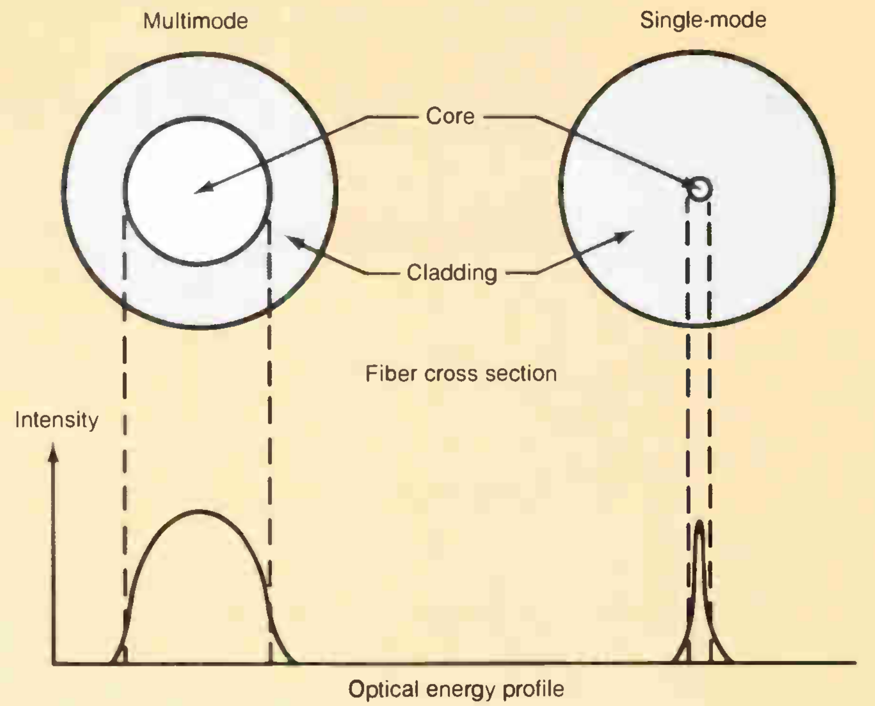
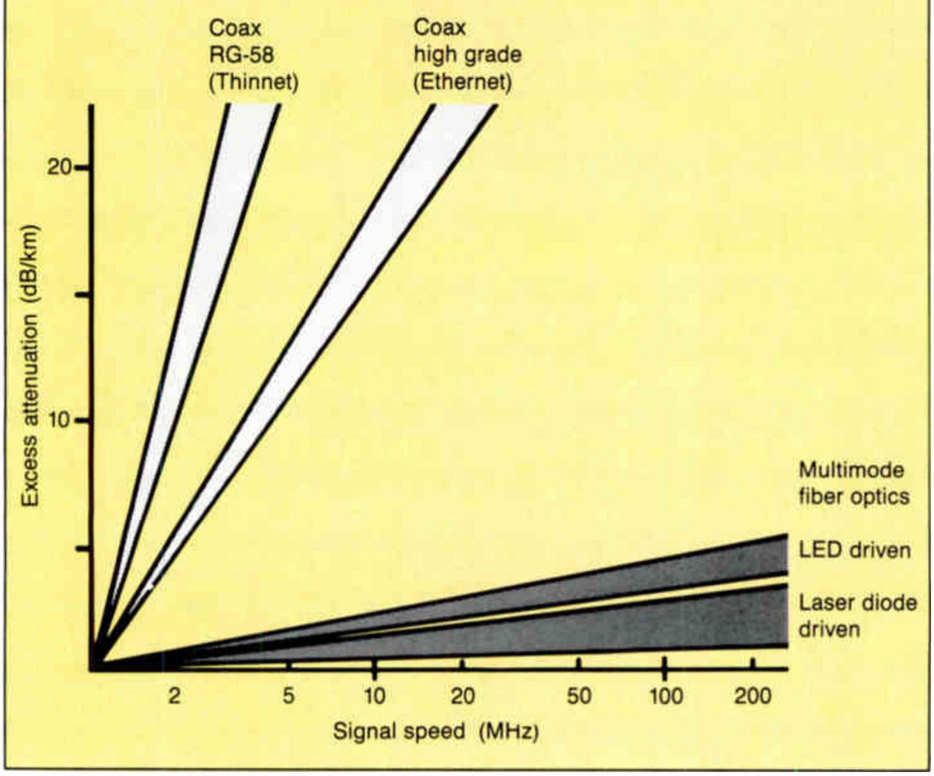


**Figure 2:** Attenuation vs. signal speed




splicing or connecting the tap in place.

In addition to signal loss at the connection points, the tap also splits the available optical signal power between its output ports. The output port may contain as little as 5 percent of the signal power, but even this much loss in the main leg can rapidly build up when many taps are used. Large networks require optical repeaters to regenerate the weakened signals caused by a large number of these devices. No equivalent of a high impedance tap exists in fiber optics.

LANs that normally use several taps on the media require rethinking when fiber is being considered. Alternatives to the invasive tap must be employed to arrive at a satisfactory network design.

**Signal levels**

Another distinction between copper wire and fiber networks involves signal levels. Transceivers generating Ethernet signals induce currents of 45 mA (peak) into 50 ohm coax. This amounts to a signal power level of about +20 dBm (100 mW). A typical optical transmitter, when connected to a fiber with a 62.5 micron core diameter (a popular LAN fiber), will launch anywhere from −20 to −14 dBm (0.01 to 0.04 mW). Although larger core fibers will allow somewhat more launched power, the message is clear: Copper wire allows much higher signal power levels to be employed.

Offsetting copper wire's potential advantage in launched power, fiber has much lower attenuation of the signal. Once the signal is put in the fiber, it does not degrade as rapidly. Fiber attenuation of 2 to 5 dB/km, when compared to coax attenuation of 50 to 200 dB/km or more, is a major advantage in many networks. Even relatively short distances can be advantageously implemented in fiber.

Receiver sensitivity levels for either copper wire-based or fiber-based systems are determined by the electronic design of the preamp circuits in the transceivers. Although receiver capability often determines the ultimate performance of the network, little fundamental difference exists between electrical and optical designs.

The attenuation produced by a cable is related to the speed of the signals being carried, as well as the length of the cable. Higher speed signals are attenuated to a far greater degree than low speed signals in copper media. Such non-uniform attenuation also causes signal distortion that can adversely affect performance. This speed-dependent attenuation places a practical limit on the information-carrying capacity of the media.

On the other hand, fiber exhibits a remarkably low attenuation until very high speeds are reached. Figure 2 shows the attenuation that is attributable to data rate alone for various media. Note that the figure does not include low frequency (DC) loss. As shown, the bandwidth of the fiber link does depend on the type of emitter that is used; specifically, the spectral characteristics. The high speed capability of fiber is one of the most important factors in selecting a medium for network implementation.

Since fiber can be used either for low speed or very high speed signals, providing flexibility in building wiring and installation as well as network design, it is unique. In many cases, the capacity of the media is upgraded easily by employing different electronic components at the ends of the fiber links. Comparing this to the total rewiring of a facility makes the ease of upgrading fiber networks a major advantage.

Fiber networks also benefit from the dielectric properties of the fiber. EMI/RFI (electronmagnetic/radio frequency interference) immunity can be of major importance where noise on the network is expected to be a problem. Fiber provides benefits where message error rates must be very low or packet retransmissions must be avoided. High noise environments, typical of most factories and many other facilities, are obvious candidates for an EMI/RFI-proof medium.

Fiber networks also cure any ground current problems that might affect copper wire systems since no ground wires are used in the cable. Similarly, lightning strikes or high-voltage lines in close proximity have no effect on fiber.

In some applications, the size of higher performance copper cable is a problem. Very often, wiring ducts are filled to capacity. Small fiber cables that replace larger, bulkier copper cables are a major advantage. Weight may be an additional concern. IBM twin-ax cable weighs about 70 pounds per 1,000 feet, while Ethernet cable may weigh a hefty 150 pounds. Fiber cable weighs only 5 to 10 pounds for the same length and has higher data-carrying capacity.

Finally, fiber-optic media are generally considered to be intrinsically safe. Breaking the fiber produces no sparks that could ignite flammable material and presents no electrical shock hazard. Since optical energy is emitted from the fiber, however, the specific situation would have to be evaluated to assure totally safe operation.

# LANs and electronic mail

**By Del R. Guynes**
Engineering Administrator, Jones Intercable Inc.

The engineering department of Jones Intercable recently implemented a local area network (LAN) and electronic mail in order to provide the appropriate backbone for the strategic flow of information. We estimate that over 90 percent of our intradepartmental communications can happen more efficiently in batch mode instead of in the real-time interactive mode of a phone conversation. This means that a request for information is stored until it can be processed; then, the information is given to the person requesting it.

Having the responsibility for managing millions of dollars in assets, an engineering staff requires swift and efficient messaging. This is often not possible with the telephone due to the unavailability of system engineers who are frequently in the field. This lack of availability produces callbacks and return-call attempts, often when the information needed does not have to be communicated by phone. "Telephone tag" can be frustrating and a financial drain.

The information flow in a corporate engineering department is diverse. Regularly scheduled reports include Federal Communications Commission compliance, service call percentages and personnel data. In addition, there are unscheduled, irregular requests for information.

*Case #1:* Last year, one of our systems on the East Coast had a major malfunction in a particular brand of set-top converters. This caused randomly intermittent failure in the descrambling of premium channels. The manufacturer claimed it was not at fault, and our technicians had great difficulty isolating the cause. After several months of service calls, research, testing and retesting—and cancelled subscribers, we discovered that there had been an incorrect voltage setting in the descrambler circuitry at the factory. This problem cost the system tens of thousands of dollars, much of it unrecoverable from the vendor apart from legal action.

Weeks later it was learned that the identical problem had existed in another Jones system in the Midwest. This problem had been corrected two years prior to the incident on the East Coast. If an information network had existed that conveniently allowed the system engineer to originate a message explaining the problem to all Jones systems, the solution could have been speedily sent and a system could have saved significant dollars.

*Case #2:* A decision made at corporate headquarters affected the programming of Jones systems. Most of them needed special electronic components to accommodate the change; only a few days were available to install equipment before the changeover to the new configuration. Specific information concerning the changeover had to be sent on at least two occasions via overnight mail to all affected systems. If an information network had existed that would have allowed messages to be sent electronically instead of by overnight courier at $8 per message, the savings potential could have again approached thousands of dollars.

### Finding a solution

In mid-1987 when travel, telephone and postage costs caused by these kinds of events began to escalate, we looked to electronic mail (E-Mail) as part of the solution. Analysis was begun to determine which kind of E-Mail should be chosen.

The engineering corps of Jones is microcomputer-intensive. From the local system engineer to the engineering managers and department head at the corporate office, Lotus 1-2-3 spreadsheets and other applications are regularly used to communicate between the system and corporate. Microcomputers are on the desks of most system engineers or, if not, one is usually available on demand.

Since microcomputers in the field exist on a stand-alone basis (not networked), most were already equipped with Hayes or Hayes-compatible 1,200 or 2,400 bps (bits per second) modems used for connecting through the dial-up telephone network to a microcomputer at corporate. A LAN-based E-Mail solution could easily take advantage of the existing dial-up network.

Another possibility was a public E-Mail network. This is a good solution for the stand-alone user who already has a modem. In this configuration, all users subscribe to a public E-Mail service and can dial a central processing site that acts as a post office by distributing mail to other subscribers. There is a subscription charge as well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as a charge for the transmission of the message.

Since all subscribers need their own modem, each user at corporate would have to be equipped with a modem, which would be costly. If a LAN exists, users can share modems by the use of a specially dedicated workstation or by a special board inserted in the file server. However, the cost for this arrangement exceeds that for most LAN-based E-Mail packages.

An additional cost of public E-Mail is the pricing scheme. Public networks are usage-sensitive in pricing: The more one uses it, the more one pays in addition to the communication line cost. Mainframe and LAN E-Mail networks are more capital-intensive, but ongoing costs can be less than in a public network, depending on volume of traffic. Our estimated E-Mail volume justified the costs for a private dial-up network.

A mainframe-based solution was not chosen since its software costs more than LAN-based software. Being designed for large networks, a mainframe solution usually provides more features but requires terminal emulation from the computer. In addition to this expense, mainframe software is significantly more expensive than LAN software residing on a file server.

**It starts with a LAN**

To operate a LAN-based system one obviously must have a LAN, which consists of multiple microcomputers with network adapter cards connected to one another via a common medium. Normally, one or more of these microcomputers is bigger and faster, serving as the file server. While the need for a LAN in the engineering department was primarily driven by a desire for E-Mail, it is not accurate to include the cost of a LAN as part of an E-Mail solution, since LANs provide some cost justifications of their own.

With approximately 20 users, equipping each with a printer would have been expensive. All users do not need a printer all the time, some need a printer most of the time and most need it some of the time. Attaching a local printer to a single microcomputer and assigning several users to that particular combination is highly impractical. The LAN we chose supports five printers, each one available to all users. This provides the capability of routing a print job to any of five printers and makes different kinds of printers (plotters, dot-matrix, laser, etc.) available.

Accessing an IBM mainframe through the use of microcomputers is now a requirement at the corporate office. Instead of using 3278 emulation cards in each microcomputer, a 3278 gateway can be shared by users. Also shared by all users are software and data bases, which eliminates duplication of hardware and effort within the engineering work group.

Users are encouraged to save their data if their unit has a hard disk drive. But this is inconvenient and can be a poor usage of time. Since a lot of microprocessing done needs to be saved, the LAN uses a streaming tape device to make a daily backup of all files on the file server. If a file needs to be shared, it can be copied to a common user directory and accessed by another user.

Having justified the costs of the LAN without considering the benefits of E-Mail, research was begun to determine which LAN-based E-Mail software would be the best purchase. The prominent concerns were the remote unit cost and ease of implementation and use. The first products examined were part of the LAN operating software. Awkward and difficult to use, they appear to have been an afterthought to the main concerns of local area networking. (Ironically, the leading LAN operating software has been unofficially rated as having the worst E-Mail feature.) As demand for E-Mail grew, software vendors developed their LAN software-based versions to be more user-friendly.

Following a user evaluation, a third-party product was chosen for its Lotus-style menus and flexibility in connecting remote users. The remote site cost was significantly less expensive than the leading LAN operating software product. It is inevitable that the existing E-Mail solution for Jones will be obsolete one day, requiring a different strategic information system. If a better solution were to be found as soon as in one year, the current system would be well worth the $11,000 for its year of use.

The number of LAN installations is continuing to increase. The LAN is continuing its strategic role in the development of connectivity of mainframe computers with microcomputers. The advantages of local area networking apart from electronic mail are alone sufficient to justify the related costs. And, as we see it, E-Mail is an added blessing.


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# Developing a community network

**By Karen Kalergis**
Manager, Communications Services, Austin CableVision

Network management faces new challenges when the network is a shared resource (like Austin's institutional network or I-Net). Providing the community with a communications system using voice, video and data services is the goal of Austin CableVision, the city of Austin, Texas, and the Austin Cable Commission. But most importantly, it is the goal of a myriad of potential users, for it is a user-driven network in a true sense. Potential non-commercial users ask for services they want through an application process; the commission then either awards or rejects the proposed project.

The franchise provides a starting point by describing the system as one that connects "various institutions such as schools, colleges, universities, hospitals and governmental facilities." And, indeed, the nearly 190-mile network already constructed does this. Fifty percent of the network is available to the Austin system to market voice, video and data services commercially. But the franchise makes the other half of the capacity of the network available free of charge to non-commercial users. This amounts to eight duplex channels, as well as $60,000 worth of modems and modulators and $1.1 million for the mileage remaining to achieve the 225-mile build-out.

### Frequency planning flexibility

Realizing that institutions spent the most telecommunications dollars on data communications, the city developed a frequency use plan that set aside most of the bandwidth for two-way services. Video now operating at Channels 2, 4 and 6 was reassigned to Chs. T7, T8 and T9 on the reverse path of this 400 MHz mid-split system. Video also will be placed on the forward frequencies, Chs. 7-13, for programming services either originated on the I-Net or downlinked by the cable system or another user.

Users will not require converters or cable-compatible sets for these channels. At least one of these channels could be secured by means of a positive trap system, should users have copyrighted programs or information not appropriate for a non-specialized audience to distribute on the I-Net.

Chs. T14 and 2′ have been paired for potential use as a VFM channel for commercial video feeds for broadcast stations or delivery to satellite uplinks. The remainder of the bandwidth, from 23.75 to 47.75 MHz and 59.75 to 108 MHz, is set aside for two-way services with a 192.25 MHz offset. As applications are approved by the commission, the channels will be assigned for a particular service within the broadband network for voice, data and packet possibilities. This allocation is expected to be consistent on the system's 10 trunks and five hubs. Some variations can occur, particularly when a signal is to be originated and distributed within the same hub.

Developing the hub equipment required for the I-Net's switching capabilites and maintaining the network are the responsibilities of the Austin system. We have installed a status monitoring system on all trunk ends and power supplies on the system. This equipment polls some 120 active devices on the network and relays them to the network management center, which is monitored 24 hours a day.

A separate technical group is responsible for I-Net maintenance and service. Users consult with the company for equipment evaluations, specifications and applications. Each application is reviewed to develop signal levels required for end-user equipment; a list of hub equipment to support the project is compiled. Bandpass filters at the hub sites and at the user's demarcation point add to the maintenance of the integrity of the network.

To provide the quick response demanded by telecommunications users, the system set up separate phone lines and dispatch procedures for I-Net service calls. This allows us to work with I-Net users to develop their own troubleshooting procedures.

### I-Net applications

Current users have a number of expansions for existing projects. Potential users, on the other hand, have their own ideas for new services they want added. The Austin Independent School District, the only institution that is specifically allocated spectrum in the franchise, is ready to embrace the network's capabilities in its four full-duplex channels. The school district's plan positions the I-Net as its network backbone with other media filling in the gaps. A key area for its use of the I-Net is the dedicated lines to provide hourly attendance records from all the high schools to the main administration building.

The school district is currently using Chs. T11 and K for a 9.6 kbps (kilobits per second) data retrieval service. A second project on that channel pair targeted for expansion is an energy management program. Three schools are now connected on a polled system operating at 1,200 bps, with about seven others ready to be added to the program.

The city has the use of one duplex channel within the company's commercial bandwidth. A 256 kbps CAD/CAM (computer-aided design and manufacturing) application uses 500 kHz of Chs. T13 and M. Last May, 16 of the city's library data links were converted to the I-Net, with four libraries sharing a 100 kHz circuit at 9.6 kbps.

The ability of I-Net to handle high throughput data services has increased user interest in seeing bandwidth set aside for this application. This would provide local area network communications performance across an entire metropolitan area. To accomplish this, the adoption of the IEEE 802.4 standard for a token bus service within the non-commercial bandwidth has been advocated. This standard would offer users the capability of a 10 megabit aggregate throughput on a 12 MHz duplex channel and be consonant with the physical dimensions of the I-Net. Non-commercial users would be able to share in this token bus bandwidth. They would select their own equipment from those vendors who support the standard and meet network specifications.

While most initial uses of the network are geared toward institutions connecting with remote sites, a service like the token bus promotes an interconnectivity among network users. With the potential for every major institution in the city to be connected to this network, we hasten the day when institutions can talk to one another. And when the focus becomes more on cost savings across agencies and not within single groups, then the network has met its true mission: that of a community communications network.

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**By T.M. Straus**
Chief Scientist, Hughes Aircraft Co., Microwave Communications Products

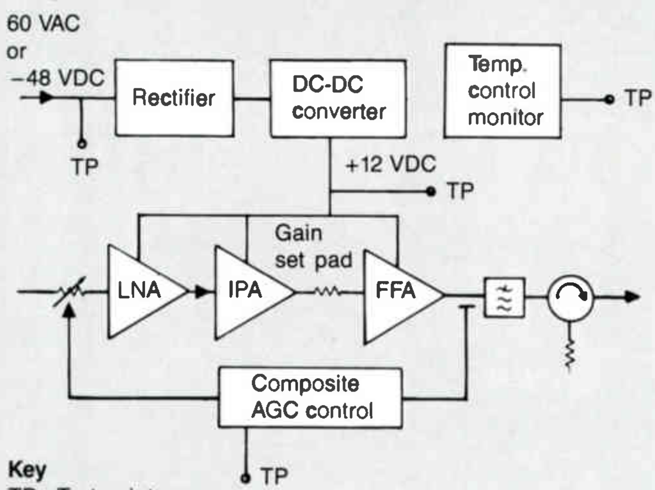
One of the primary motivations for the development of local distribution service (LDS) microwave in the late 1960s was the potential for improvement in cable system signal quality. The idea was to reduce the length of trunk amplifier cascades, thereby improving carrier-to-noise (C/N) delivered to the farthest subscriber. It also was felt that maintainability would improve if shorter trunk cascades were utilized. This, in fact, has proven to be the case in numerous instances. Robert Bilodeau has provided the example of Suburban Cable in Essex County, N.J.[1] That reduction of trunk amplifier cascade lengths tends to improve quality and maintainability and reduce outages is a fact that has more recently been recognized to potentially apply to other transmission technologies.[2] A key requirement is that each hub site, and the connection to it, be low in cost and simply implemented.

While AML (amplitude-modulated link) microwave has been utilized since 1971, the quality requirements imposed on the microwave link have become increasingly stringent over the years. Initially, the receiver microwave AGC (automatic gain control) threshold was set for 45 dB C/N, but already in 1972 this was increased to 48 dB. In 1976, the factory-set threshold was raised to 50 dB, and by 1981 it was raised to 53 dB. The threshold could, of course, be adjusted in the field to any desired value, limited only by the link margin and distortion considerations, but the progression of C/N settings is indicative of the increasingly tighter standards imposed by the CATV industry. To accommodate these requirements and still maintain link margins, especially over longer paths, it was necessary to provide 11 dB increased transmitter output capability with a klystron amplifier dedicated to each channel and then to provide a further 3 dB increase through improved upconverter linearity. At the same time, the receiver noise figure was reduced from 13 dB to 10 dB, and then through the introduction of low-noise amplifiers (LNAs) to 7 dB and 5 dB.[3]

Most recently, the increase of channel loading up to 80 channels necessitated improvement in second- and third-order distortion characteristics.[4] This steady evolution of the AML microwave in response to tighter CATV system needs also has witnessed the introduction of new classes of equipment, such as the active repeater and the microwave feedforward amplifier.[5,6] These past developments have set the stage for further improvements required to meet the future needs of CATV systems approaching the era of high-definition television.

Overall minimum CATV system performance recommendations can presently be found in *NCTA Recommended Practices* for measurements on cable systems. Similar information is contained in the *Canadian Technical Standards BP-23.* These are minimum standards and, in many cases, cable systems are even today designed to meet tighter requirements. In anticipation of the advent of advanced television (ATV) systems, including HDTV, there exist presently ongoing investigations to more fully characterize actual cable systems. At the same time, the various proposed ATV systems are under evaluation with regard to their robustness in the face of non-ideal transmission media. The investigation being conducted in support of the HDTV Subcommittee of the NCTA Engineering Committee will contribute to a wider study by the Advanced Television Systems Committee, which will formulate recommendations dealing with delivery standards for HDTV.[7]

**Figure 1:** Microwave feedforward repeater




Key
TP - Test point
LNA - Low-noise amplifier
FFA - Feedforward amplifier
IPA - Intermediate power amplifier

Although a general consensus exists to the effect that some improvements in the cable plant will be required to accommodate ATV, there are as yet no agreed-upon numbers to provide firm guidance to the CATV system design. The problem is compounded by the fact that different ATV systems will undoubtedly exhibit a varying degree of susceptibility to transmission system impairments. However, it has been tentatively suggested that a 6 dB improvement of C/N (to 49 dB at the farthest subscriber) might be a logical design objective.[8] C/N is, of course, only one of several system performance parameters under investigation. Other parameters also of potential concern to elements of a CATV system and the LDS microwave are reflections, phase noise, frequency response, envelope delay and distortion, including quadrature intermodulation.

A scenario that nearly meets the 49 dB C/N objective has been proposed by I. Switzer.[9] In his article, he allocates 56 dB to the supertrunk, the role that can be played by AML microwave. Although this can represent a challenge when utilizing the lower cost block conversion-type transmitters, this C/N requirement can be met in a large number of existing AML systems and also is furthered by recent AML improvements. Other CATV system parameters, although not yet allocated to the subsystems, including supertrunk, can be improved with new AML developments.

If the signal being carried is reasonably robust, there is no intrinsic reason why existing CATV systems cannot provide a satisfactory transportation medium. This was most recently demonstrated at the 1987 HDTV Colloquium in Ottawa, where side-by-side HDTV display of signals directly received via satellite and satellite signals carried over cable, including AML, were essentially indistinguishable. The signal in question was, however, MUSE in FM format, so that close to 30 MHz bandwidth was required. On the other hand, carriage of spectrum-conservative VSB/AM (vestigial sideband/amplitude modulated) TV signals over AML microwave need not be associated with any significant degradation in picture quality. Indeed, baseband signal-to-noise (S/N) in excess of 63 dB has been demonstrated.[10] Other baseband performance criteria were generally in conformance with the rigid short-haul requirements of RS250B. However, cable systems do not normally employ the test equipment quality VSB/AM modulators (and demodulators) used in this demonstration. Nor are the baseband parameters routinely measured in AML production since, in fact, VSB/AM modulators and demodulators are not generally a part of the microwave link equipment. It is nevertheless clear that greater care will be required both in the operation and design of standard AML systems utilized by the cable industry if these systems are to meet the higher standards associated with carrying ATV signals.

### AML performance parameters

1) *C/N*—The principal source of thermal noise in AML microwave systems is usually noise generated within the receiver. In this case, the microwave AGC circuit maintains a constant C/N once the input exceeds the microwave AGC threshold. Adjustment of the threshold therefore controls C/N, provided sufficient signal is available to reach and exceed the threshold. The receiver parameter that determines the equivalent input noise level at threshold is the noise figure. For instance an 8 dB noise figure receiver has an equivalent input noise power per 4 MHz bandwidth of −100 dBm. If the AGC threshold is set to −47 dBm input, the C/N will be 53 dB. The recently introduced 550 MHz receiver, which incorporates a single-stage LNA inside the AGC loop, is factory set in just such a manner and provides an 80-channel composite triple beat (C/CTB) of 80 dB.

If, instead of a single-stage LNA, a two-stage LNA is inserted into the AGC loop, the receiver noise figure is improved to under 6 dB. The AGC threshold could then be set for −49 dBm, while still providing the same

**Table 1:** Microwave feedforward link

| | | | |
|---|---|---|---|
| Transmitter output power | | 40 channels (dBm/Ch.) | 0.8 |
| Transmit circular waveguide | | 100 feet | −1.6 |
| Transmit elliptical waveguide | | 15 feet | −0.6 |
| Transmit antenna | | 10 foot | 48.8 |
| Free space loss | | 6.0 miles | −134.3 |
| Receive antenna | | 10 foot | 48.8 |
| Receive circular waveguide | | 100 feet | −1.6 |
| Receive elliptical waveguide | | 15 feet | −0.6 |
| Receiver input AGC attenuation | | | −2.5 |
| Field factor | | | −2.0 |
| Receive carrier level | | | −44.6 |
| Receiver noise figure | | 6 dB | |
| Transmitter C/N | 61.7 | Transmitter CTB | 65.9 |
| Receiver C/N | 57.4 | Receiver CTB in AGC | 72.5 |
| Overall C/N in AGC[1,3] | 56.0 | Overall CTB in AGC[2,3] | 65.0 |
| **Statistical estimates** | | | |
| Multipath factor (A × B) = .025 | | | |
| CCIR climate region = D2 | | | |
| Hours per year below 35 dB carrier-to-noise: multipath | | | 0.0 |
| Hours per year below 35 dB carrier-to-noise: rain | | | 0.6 |
| Total hours per year below 35 dB carrier-to-noise | | | 0.6 |
| Percentage reliability | | | 99.993 |

[1] Denotes power addition
[2] Denotes voltage addition
[3] Overall C/N and CTB to be added to those of transmitter input

53 dB C/N. However, because of the increased LNA gain, the 80-channel C/CTB would be degraded to 70 dB. If one then wished to improve C/N to 56 dB by resetting the AGC threshold to −46 dBm, the resultant 80-channel C/CTB would be further degraded to 64 dB. Although this still allows margin to the 53 dB C/CTB (CW measurement) NCTA CATV system performance objective, it does eat into the overall budget, particularly if the calculation assumes voltage addition of third-order distortion products. Further improvement in receiver linearity was therefore desirable if 80-channel operation at 56 dB C/N was contemplated.

A receiver designed to accommodate this requirement incorporates both an LNA and separate microwave and VHF AGCs. The main change is that a temperature control housing is not being used, thus making possible a substantial reduction in weight and power consumption. This permits use of a high-power solid-state source to drive a high-level mixer with improved distortion performance in the dual-stage LNA version of the receiver. The distortion performance thus achieved allows setting the C/N to 56 dB, even with 80-channel loading.

Alternatively, a dual-stage LAN could be housed within the receiver, but outside the AGC loop as in a tower-mounted LNA application. In that case, the receiver noise figure is less than 5 dB, but the receiver is now vulnerable to a signal overload condition. The third-order intermodulation output intercept point of the LNA is specified as a minimum of 24 dBm. From this, and a nominal LNA gain of 15 dB, one can calculate that 80-channel C/CTB would fall below 69 dB for input signals in excess of −44 dBm. Thus, for heavy channel loading and/or strong signal conditions, careful consideration should be given to assess which receiver/LNA configuration is most suitable.

Further improvement in overall receiver performance is possible if the LNA noise figure is improved without degrading the third-order distortion performance. Recent FET (field-effect transistor) technology improvements make a two-stage LNA noise figure of 2.5 dB readily achievable. Investigation is presently under way to determine whether this can be done while maintaining the 24 dBm third-order intermod intercept. If so, the aforementioned overall 6 and 5 dB receiver noise figures would improve to better than 5 and 4 dB, respectively.

The receiver is not the only possible source of thermal noise. The transmitter, particularly a low-cost block conversion transmitter in which the output signal must be backed way off to avoid excessive C/CTB, also can degrade overall link C/N. Of course, if a path fade occurs, the transmitter noise is attenuated along with the signal, so the transmitter's contribution to a faded 35 dB C/N is negligible. However, during clear weather, the transmitter contribution (as well as any other headend noise) must be considered. Careful design is required to ensure that no active element within the transmitter operates at a signal level low enough to significantly degrade the microwave system C/N. The problem is really no different than in classic CATV system design, when both distortion and noise need to be taken into account. The situation becomes particularly acute if the microwave link is to provide 56 dB C/N with 65 dB C/CTB. For instance, this level of performance with 40-channel loading of the microwave feedforward transmitter is possible only if the noise figure of the 2 watt amplifier within the OLE-111 microwave line extender drive stage is lowered to 6 dB.

Fortunately, a solution seems near at hand so that, even with a heavily loaded feedforward transmitter, the 56 dB link C/N criterion can be maintained. The block upconversion-type transmitter link calculation is summarized in Table 1, which further illustrates that with average propagation conditions, the feedforward amplifier can support a six-mile path with less than one hour per year fade below 35 dB C/N. Note that the requirement is made tougher by waveguide losses, in that both transmitter and receiver are assumed to be ground-mounted for ease of maintenance and minimum downtime in the event of a component failure.

If the link calculations indicate that insufficient signal level is supplied to the receiver to obtain the desired C/N, use of an active repeater may solve the problem. Generally, the repeater is used only in situations where direct line-of-sight cannot be established between transmitter and receiver. If the repeater is used to improve C/N, this is usually possible only if the repeater output capability is equal to or greater than that of the originating transmitter. This is because the repeater will itself degrade system C/N (and C/CTB).

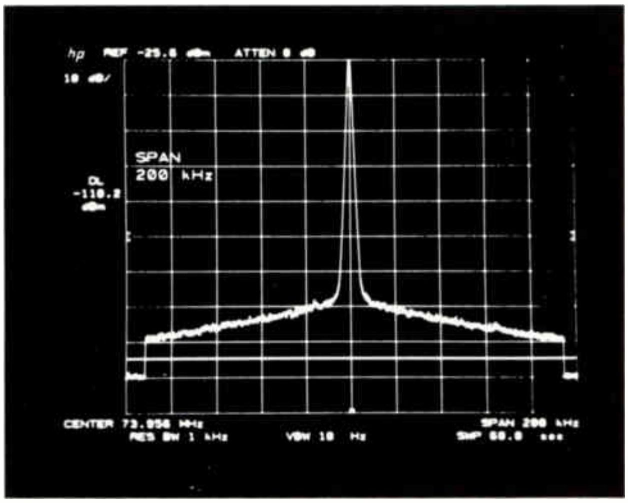
The block diagram of the FFR-123 microwave feedforward repeater (Figure 1) illustrates the point. The AGC threshold is set to obtain the desired CTB. Table 2 summarizes the key performance parameters; consider, for instance, a 40-channel application in which the repeater C/CTB link contribution is 65 dB. The output is then set for 1 dBm per channel. Since the gain is 45 dB, the input level at AGC threshold is −44 dBm. With 6 dB noise figure, C/N must then be 58 dB. Since this must still add to receiver C/N, a repeater with too much gain cannot provide the desired quality signal. Where input signal level to the repeater is always below −42 dBm, the LNA could be taken outside of the AGC loop (shown in Figure 1) without excessive degradation of C/CTB, but this would limit the range of possible system application.

Even channelized transmitters can sometimes be a significant contributor of thermal noise when overall 56 dB C/N is demanded from the microwave link. Noise power output of the STX-141 high-power microwave transmitter is determined by the klystron gain and noise figure. After attenuation by the output filter and allowance for spillover from the adjacent channels, noise power is typically −30 dBm/4 MHz. Comparing this to the +33 dBm signal, the C/N is seen to be 63 dB. As the klystron current drops due to cathode aging, both gain and noise figure can be expected to deteriorate. If, then, the klystron is retuned to re-establish 45 dB gain, the output noise may be a few dB worse than when the unit was delivered from the factory. With the introduction four years ago of the long-life klystron, one can expect that the aging process will be stretched out to over 10 years.

One solution for obtaining better C/N in a high-power AML transmitter is to upgrade the unit so that its output capability is raised to 36 dBm. The difference lies in the linearity of the upconverter, which is provided with a higher level local oscillator (LO) signal. A further 3 dB increase in output power capability is possible with a predistortion circuit.[11] It is, of course, obvious that increasing transmit output power has the double benefit of increasing link margin and, therefore, the ability to better sustain 56 dB C/N at the receiver, as well as make transmitter noise contribution an all but negligible entity.

Another possible approach to obtaining better C/N in a channelized

**Figure 2:** Receiver pilot tone output spectrum




| | |
|---|---|
| Vertical scale: | 10 dB/div. |
| Horizontal scale: | 20 kHz/div. |
| Resolution bandwidth: | 1 kHz |

high-power AML is to utilize a high-power FET amplifier in place of a klystron in the output stage of the transmitter.[12] The noise figure of the FET amplifier is much lower than that of the klystron, thereby making transmitter C/N contribution as insignificant as it is in the medium-power MTX-132 multichannel transmitter. The drawback in the FET amplifier approach is that with currently available devices, one must give up several dB in output power capability (relative to the +33 dBm of the high-power AML transmitter) to maintain good distortion performance. AM-to-PM (amplitude modulation-to-phase modulation) conversion in FET amplifiers operating close to saturation may be a particular limitation for some type of ATV signals. The primary advantage of this new type of channelized all solid-state transmitter has less to do with HDTV than with floor space and prime power requirement in new or expanding transmitter system installations.

A final thought dealing not so much with C/N as with baseband S/N is that: If the television signals carried by the AML supertrunk are frequency modulated rather than VSB/AM, one can, of course, more easily obtain very high quality signals. The drawback, as with any other supertrunk scheme carrying FM video, is the cost and complexity of converting each of the FM signals back to the VSB/AM format before delivering the product to the subscriber.

2) *Distortion*—In the channelized AML transmitters, the distortion is similar to that encountered in other headend equipment. In particular, the rise of third-order intermodulation products limits the output power of the multichannel and the high-power transmitters. Those products fall both in-band (the 920 kHz beat caused by a combination of video, color and audio carriers) and into the next lower channel (audio-video beat 1.5 MHz above the adjacent video carrier). The transmitter specification for the audio 17 dB below video and color 20 dB below video (CW measurement) is a carrier-to-interference (C/I) of 58 dBc. Since there is then considerable margin with respect to the W-curve specified by *Canadian Technical Standards BP-23*, the 58 dBc specification will presumably also be adequate for most ATV systems. If an even better number is desired, one can back off the transmitter output to obtain a 2 dB improvement in C/I for each dB reduction in output power. Alternatively, high-power transmitter linearity can be improved through higher LO power or predistortion.

Differential gain is typically better than 3 percent and differential phase is under 2°. However, if a significant performance degradation is introduced by overdriving the upconverter or klystron, a phenomenon somewhat akin to differential gain can interfere with proper operation of descrambler units in the home. This is caused by transfer of AM onto the FM audio subcarrier. Normally, the effect is barely measurable and well below the threshold

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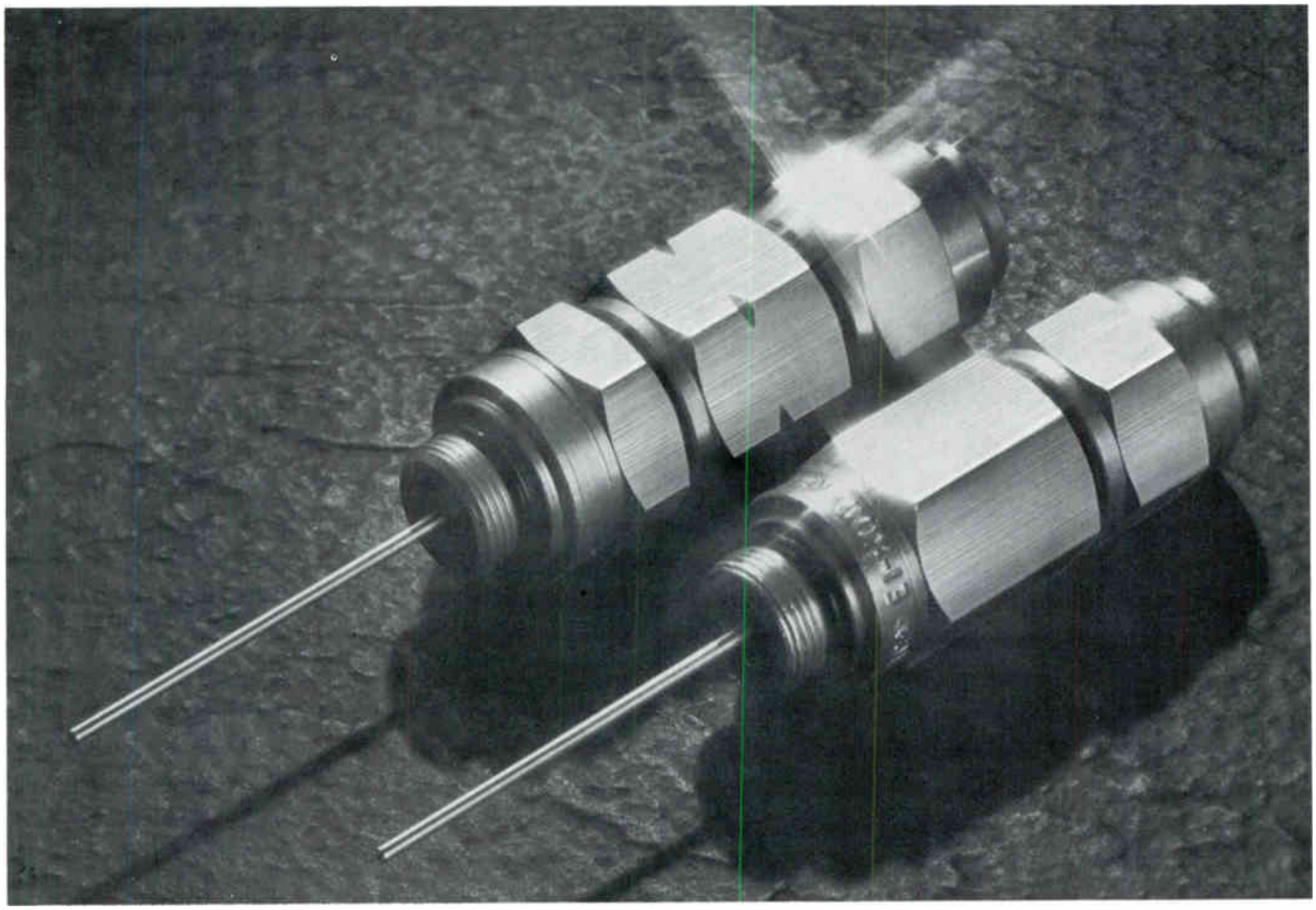

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**Table 2:** Microwave feedforward repeater performance

| | |
|---|---|
| Power output for 65 dB C/CTB, dBm | |
| 21 channels | +5 |
| 35 channels | +2 |
| 60 channels | −1 |
| Gain, dB | 45 ±½ |
| Noise figure | 6 dB |
| AGC | |
| Range | 25 dB |
| Flatness | 1 dB |
| Threshold adjustment range | 10 dB |
| Frequency response, 12.7 - 13.2 GHz | ±1 dB |

of greater than 0.5 dB modulation riding on top of the audio signal, at which certain types of descrambler units may begin to experience some problems. Generally, keeping the C/I to 58 dBc will keep AM transfer to audio at a negligible level.

Another type of distortion that occurs in AML systems can be found in the broadband receivers and the block upconversion-type transmitters. This distortion is the second- and third-order intermodulation between video carriers. In discussing C/N, reference has already been made to the improvement in C/CTB and C/CSB (composite second-order beat) in the receiver with a dual-stage LNA. Second-order distortion does not play a role at microwave, since the percentage bandwidth is only 4 percent, but it does occur in the VHF end of the block upconversion and down-conversion process.

In CATV system calculations, such third-order distortions as CTB are assumed to add on a voltage basis in a cascade of amplifiers. If, however, the distortion generating elements in the cascade are not identical, it is not necessarily true that the phase vectors representing the distortion products will all line up with one another. In a careful set of experiments involving a microwave line extender, a microwave feedforward amplifier, a two-stage LNA, a 440 MHz AML receiver and a CATV hybrid amplifier, it was found that C/CTB did not always add on a voltage basis. Sometimes it added on a power basis (90° angle between voltage vectors) and sometimes it didn't add at all (120° angle between vectors). Therefore, although it may not be totally rigorous, as a practical matter, the C/CTB performance of a CATV system including AML can be conservatively calculated by first separately voltage-combining the microwave-based elements and then power-combining the microwave resultant with the VHF (i.e., receiver and cable amplifier) resultant.

3) *Phase noise*—Figure 2 shows the phase noise on the AML pilot tone signal as it appears at the output test point of the receiver. The performance shown is typical of present production. Note in particular the value at 20 kHz offset from the carrier: better than 70 dBc in a 1 kHz resolution bandwidth. Depending on the phase noise limitation of the spectrum analyzer and the thermal (flat) noise at the measurement point, corrections to the apparent measured value may be required at this low level of phase noise. Thermal noise limit after external amplification of the test point signal is indicated by the display line while the thermal noise of the analyzer itself is shown at the start and end of the trace. The analyzer phase noise contribution can be calibrated by using a known ultralow phase noise signal, such as the 74 MHz crystal oscillator within the AML transmitter. This crystal reference must be extremely clean, since it is multiplied up in frequency by a factor of 171 before emerging as the microwave LO signal. The multiplication process worsens the crystal phase noise by a factor of $171^2$ or 45 dB. The phase noise also is degraded by contributions internally generated within the transmitter solid-state source. The same elements exist in the receiver and, in addition, one has the contribution of the receiver phase lock loop. The bandwidth of this loop is quite narrow, so only at offset frequencies under 5 kHz is there any hope of tracking out any of the incoming phase noise.

It can be shown that the phase noise of the magnitude shown in Figure 2 would, through conversion to AM by the Nyquist filter of an ideal VSB/AM envelope detector, contribute better than 65 dB baseband S/N. With that type of TV receiver, one would expect that phase noise could be worse by as much as 15 dB before becoming visible on the screen. Recent tests

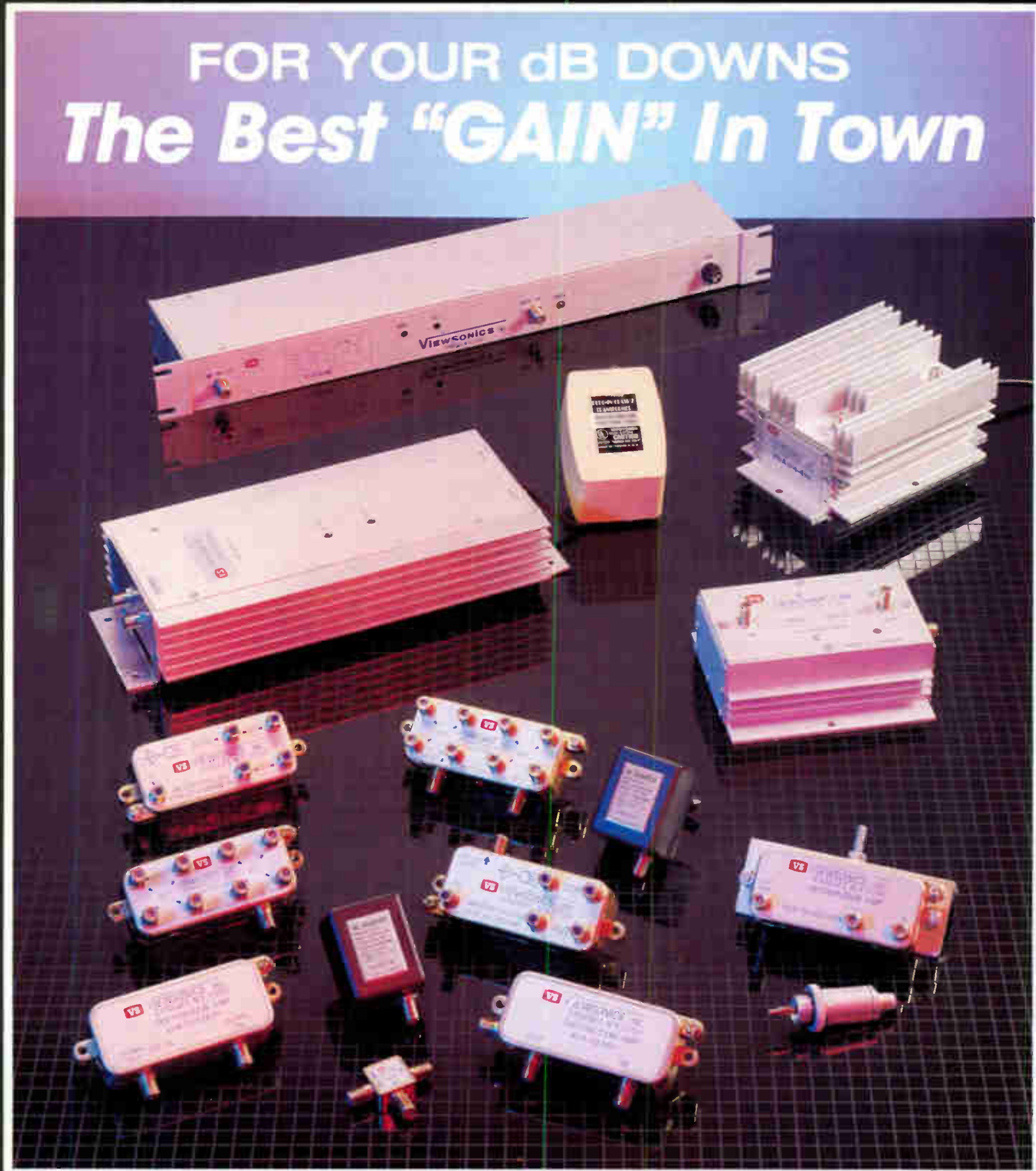


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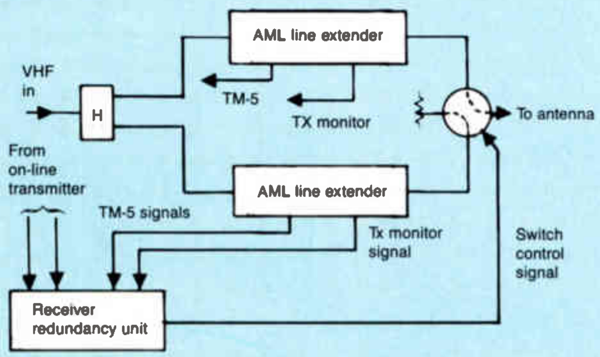
**Figure 3:** Microwave line extender automatic redundancy




with quasi-synchronous-type TV receivers indicate visibility thresholds on the order of 53 to 60 dBc phase noise at 20 kHz offset in 1 kHz resolution bandwidth.[13] Although phase noise in a CATV system is typically limited by elements other than AML, investigations have been under way to see whether AML phase noise performance can be further improved in case ATV requirements eat substantially into the existing margin.

4) *Reflections*—It is expected that some forms of ATV signals will be much more sensitive to close-in ghosts than with standard NTSC. In particular, reflections as close in as 30 ns may become a concern. It has been suggested that an overall CATV system echo rating objective of 34 dB may be suitable.[8] To contribute negligibly to this objective, reasonable care should be taken in the design of the microwave system.

Consider Figure 1 again. Note the isolator at the output of the transmitter. Because it is implemented in waveguide, a return loss of 23 dB should be achievable if required. The transmitter must be connected to an antenna, which is typically specified to have a VSWR (voltage standing wave ratio) of 1.1:1. This is equivalent to a return loss of about 26 dB. Thus round-trip return loss with a 15-foot length of elliptical waveguide interconnection would be about 50 dB when waveguide loss is taken into account. Longer waveguide lengths will lead to greater than 30 ns delay echos, but not necessarily greater round-trip loss, since a circular guide may be used. In either case, microwave return loss should contribute negligibly to the overall CATV system echo rating.

5) *Frequency response*—Two types of frequency response are of concern. ATV signals could require greater bandwidth and thus push out the maximum frequency limit on the CATV system. AML equipment can be fully compatible with operation to 550 MHz. Most broadband units, whether they are transmitters or receivers, can be upgraded to 550 MHz operation if they are not presently compatible with this requirement. If CATV system requirements were to expand to a maximum of 600 MHz, AML systems could conceivably still fit within the broadened 12.7 to 13.25 GHz frequency allocation. Another option, and one that would not be limited by the 550 MHz wide microwave allocation, would be to employ microwave frequency reuse, such as that demonstrated in Dallas.[14] A suitable choice of LO frequency would automatically keep the UHF signals carried on the auxiliary microwave link within the CARS band limits.

The second question relating to frequency response concerns itself with the limitations of the channelized transmitters. The $TE_{011}$ mode filters used in such transmitters can be designed for bandwidth as large as 30 MHz. Existing transmitters designed for 6 MHz channel plans would require modification for wider band ATV signals.

6) *Group delay*—This is of concern only in the channelized transmitters. The multichannel AML transmitter typically exhibits less than $\pm$15 ns delay. The high-power AML transmitter may have as much as $\pm$35 ns delay. This can, however, be reduced by exchanging the upconverter output filter for a broader bandwidth unit. Since the klystron is typically the primary source of video-audio intermodulation (falling in the next lower channel) and the output multiplexing filter attenuates this product, performance should otherwise be unaffected. With the modification, delay may typically run about $\pm$20 ns.

7) *Availability*—The calculation in Table 1 resulted in a predicted path reliability of 99.993 percent. Similar reliabilities are possible over considerably longer paths using channelized transmitters. Since there is no threshold effect with VSB/AM, the pictures are still viewable, even below 35 dB C/N. Nevertheless, one can speak of an availability of signal for the indicated percentage taking only rain and multipath into account. One also must be concerned with the twist of the antenna during high wind conditions. The design must be consistent with the ½° beamwidth for 10-foot dishes.

Availability is, of course, a key element of the quality of signal provided to the subscriber. If pictures are simply not available, this is the worst kind of quality imaginable. Fortunately, the microwave link service interruption is seldom influenced by such factors as drunken drivers knocking down telephone poles, intentionally severed cables during labor disputes and "backhoe fades" resulting from construction activities. If an equipment failure occurs, it can be rapidly localized to either of two sites: the transmitter or receiver.

Since a failure in the receiver will affect all channels, the desirability of a redundancy arrangement has long been recognized. In many systems, a simple headend for local off-air channels is automatically switched in if the signals are temporarily unavailable over the microwave path. A more sophisticated redundancy arrangement is provided with the receiver redundancy unit (RRU), which monitors the pilot tone output level and phase lock alarms from a standby receiver, as well as a primary receiver. If the RRU logic circuits detect a failure in the primary receiver, the switch is automatically activated to connect the standby unit directly to the antenna. If the problem lies with the microwave path or the transmitter, the RRU will automatically switch to the local headend signals. The RRU has recently been redesigned to make it fully compatible with carriage of signals to 550 MHz.

Another application of the RRU is shown in Figure 3. Here, automatic redundancy is applied to the transmit end of a broadband AML link. Another form of block conversion transmitter redundancy,[6] although not automatic, provides an added 3 dB output capability when the application calls for two or more receive sites.

**References**

[1] R. Bilodeau, "Practices to Minimize Outages," *First Annual Conference on CATV Reliability*, February 1976.

[2] D. Pangrac, "Part II: A Fiber Backbone System," *Communications Technology*, October 1987.

[3] T.M. Straus and I. Rabowsky, "LNAs for Multichannel Microwave Receivers," *NCTA Convention Record*, June 1984.

[4] R.T. Hsu, et al., "Advances in AML Transmitter and Receiver Technology," *NCTA Convention Record*, May 1987.

[5] E.G. Pastell and T.M. Straus, "Boosters for CARS-Band Microwave Systems," *CCTA Convention Record*, May 1986.

[6] T.M. Straus and R.T. Hsu, "Application of Feedforward to CARS-Band Microwave Transmitters," *CCTA Convention Record*, May 1987.

[7] B. Crutchfield, "HDTV Delivery to the Consumer," *IEEE Transactions on Broadcasting*, Vol. BC-33, December 1987.

[8] N. Hamilton-Piercy, "Memorandum to NCTA Engineering HDTV Subcommittee," September 1987.

[9] I.S. Switzer, "Video Transport Systems for Optimizing CATV Systems," *CED*, December 1987.

[10] T.M. Straus, et al., "Spectrum Conservation with High Performance SSB Microwave Carriage of Multiple Television Signals," *NAB Conference Proceedings*, April 1984.

[11] R.T. Hsu, et al., "Improved AM Microwave Performance with Predistortion," *NCTA Convention Record*, June 1985.

[12] R.T. Hsu and T.M. Straus, "Solid-State High Power AML," *CCTA Convention Record*, May 1988.

[13] D. Pike, Communication to Members of NCTA HDTV Subcommittee. Tests were performed at Cable Systems Engineering and at Scientific-Atlanta. See also R. Pidgeon and D. Pike, "Oscillator Phase Noise and its Effects in CATV Systems," *NCTA Convention Record*, April 1988.

[14] Hughes Microwave Communications Products Application Note, "Reusing CARS Frequencies for Signal Distribution."

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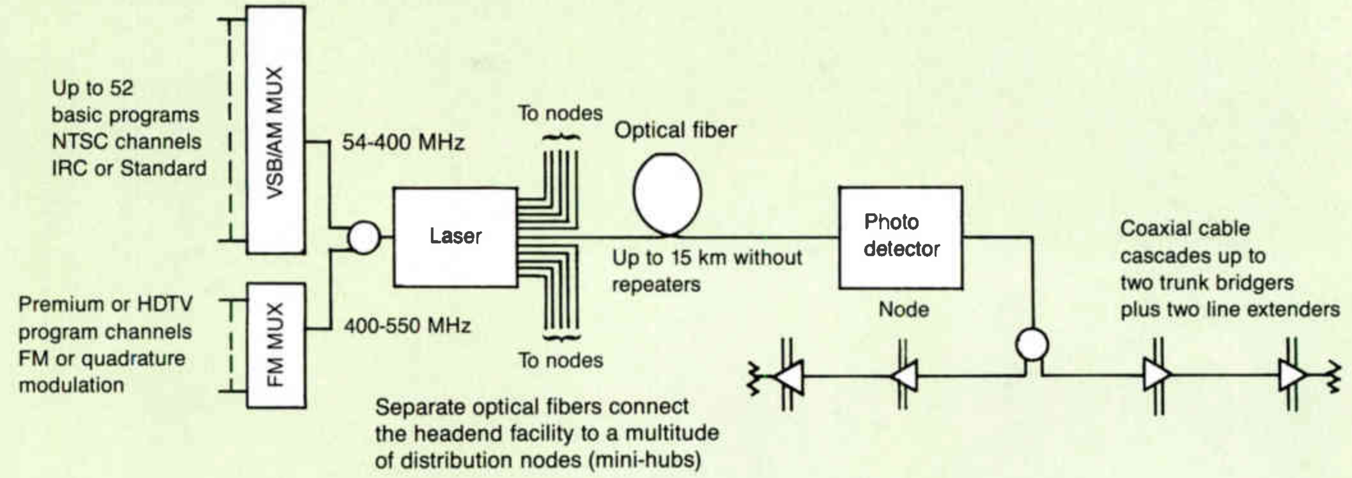
**Figure 1:** Hybrid fiber-coaxial distribution network

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- Advanced and high-definition TV.
- Competitive technologies: Super-VHS, extended and high-definition videocassettes, MMDS, DBS, integrated telephone video services.

The plain truth must be faced: Cable TV networks need to undergo significant change in the next 10 years or so in order to survive the demands and competitive activities brought about by new technology. There may be a window of five to 10 years, but now is not too soon to prepare.

## Fiber optics

The advantages of optical fibers have been thoroughly and properly touted over the past few years. Very low attenuation means long hauls without repeaters. Very wide bandwidth means enormous information transfer capacity. However, delivering TV signals to subscribers has been stymied in large part by the non-linearity of electro-optic transducers that severely limit the VSB/AM (vestigial sideband/amplitude modulation) channel capacity of fiber-optic links. Moreover, fiber is more readily adapted to switched video networks than to tree-and-branch configurations. Recently, lasers with greatly improved amplitude linearity have made it possible to combine the desirable characteristics of fiber with short coaxial tree-and-branch networks.

The fiber backbone technology, using VSB/AM/FDM (frequency division multiplexing) transmission, based on developments at American Television and Communications Corp., Choice (Irving Kahn), Ortel, Synchronous Communications, American Lightwave, Scientific-Atlanta, General Optronics and others, seems to be a logical and practical first step. One way or another, the hybrid network comprising optical fiber trunks interconnecting a multitude of short coaxial distribution nodes is well on the way toward operational success in the next two or three years. Published projections show it to be an effective and relatively inexpensive retrofit for existing systems, especially for those already committed to 550 MHz coaxial technology. The fiber backbone promises to raise the minimum carrier-to-noise (C/N) and carrier-to-composite triple beat (C/CTB) performance levels for new or rebuilt systems to the equivalent of a system with only five or six cascaded trunk amplifiers, plus a bridger and two line extenders. Best of all, the effective transparency and enormous inherent bandwidth of the fiber backbone opens the door to further improvements in transmission technology not possible with long cascades of active devices.

At the recent National Cable Television Association convention in Los Angeles, NHK demonstrated its HDTV (MUSE) format, using VSB/AM transmission in a 12 MHz channel on the coaxial cable network. Many who saw it commented that the HDTV display seemed noticeably inferior to the old standard NTSC display because of a distinctly visible "close ghost" in the HDTV picture. A plausible explanation would have to be the group delay distortion frequently characteristic of VSB/AM reception. The requirements for the phase characteristics of the Nyquist filter in the VSB receiver can be met, using carefully designed and constructed SAW (surface acoustic wave) technology. Nevertheless, it appears to be at least possible that VSB/AM may be too critical for universally satisfactory performance of consumer electronics products intended for public viewing of advanced- and high-definition TV pictures, especially when Nyquist filters in set-top converters and VCRs are cascaded with the TV set. Time will tell.

*"To continue to serve our customers, we have to deliver programs in the VSB/AM format as we have always done."*

Frequency modulation would be nearly ideal for video transmission on optical fibers; only digital transmission could be better. FM requires more bandwidth than VSB/AM but considerably less than digital. The noise improvement and favorable intermodulation characteristics of FM make it particularly desirable for greatly improved TV reception quality.

However, all of the 162 million TV sets in use today are VSB/AM. To continue to serve our customers, we have to deliver programs in the VSB/AM format as we have always done. It is not too hard to imagine a set-top converter that could demodulate multiplexed FM inputs and modulate the baseband signal as VSB/AM on Channel 3 (or whatever). But that would tend to reinforce the practice of delivering all TV programs on a single channel. There would be a lot less flak from customers with top-of-the-line, cable-compatible TV sets if they could use the set as it was intended, instead of tuning to Ch. 3 for all programs. The EIA/NTSC multiport connector, IS-15, does just that for VSB/AM, and there is no reason to hope it becomes a universal feature of new TV sets. However, it would be a step backward to transmit FM/FDM on cable and convert it to a single VSB/AM output. While it could improve C/N and C/CTB ratios, it would nullify the IS-15 feature without helping to alleviate the situation that frustrates our customers.

Actually, the converter is not needed for selecting non-scrambled channels on the growing population of cable-compatible sets, which may already constitute close to half those in use. Why not let the customer select all non-scrambled basic channels without using the converter? Then, Ch. 3 (or whatever) could be reserved for premium channels. The customer would only

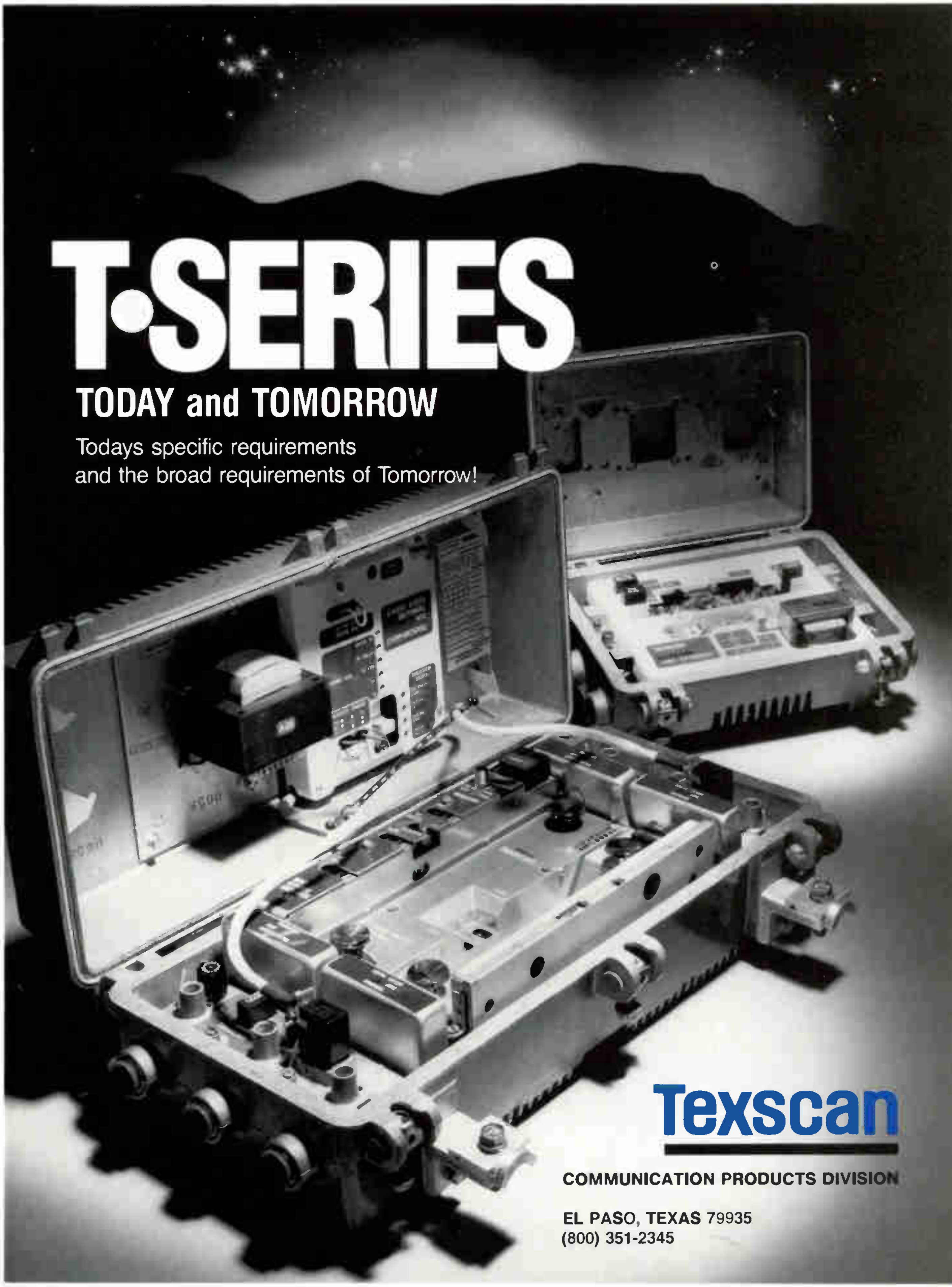


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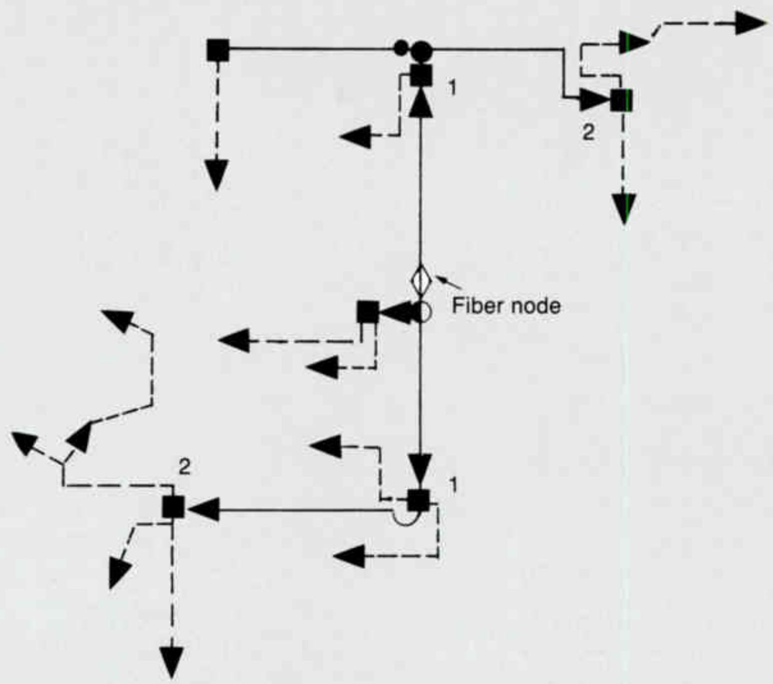
**Figure 2:** Typical diagram for fiber node plus two trunk bridgers and two line extenders




Source: "A technical analysis of a hybrid fiber/coaxial cable television system," Perry Rogan, Raleigh B. Stelle III and Louis Williamson, *1988 NCTA Technical Papers.*

need to use the converter to select the particular premium program desired. The remote volume control provided with the set would control the sound level even of the premium channels. The correct channel number would be superimposed on the screen for all basic programs. Second channel inserts would function as intended.

The advantages of this arrangement are obvious, but there are some negatives. For example, systems operating with HRC channel assignments would probably still need the converter, since not all cable-compatible TVs or VCRs are equipped for HRC reception. Except for Chs. 5 and 6, changing to the IRC coherent plan would take care of this problem. In most locations, either Ch. 5 or 6 could be used as the premium converter output instead of Ch. 3, which could not be used for program carriage anyway. Even without a coherent assignment plan, the premium converter output channel would necessarily be unavailable for transmitting programs.

Another limitation is that parental control is available only with a converter. Thus, the premium converter could provide parental control for the premiums but not the basics. For the few cases requiring parental control of basics, a full-service converter or external lock-type trap would have to be supplied.

The specifications for a premium converter would be different from the normal one. If the input channel selection were mapped with PROM according to the subscriber's request or downloaded in an addressable model, no more than a five- or 10-channel capacity would be needed. If all premiums were assigned frequencies within a single octave, dual heterodyne conversion might not be necessary.

**Remote possibilities**

Some means should be devised, however, to enable the TV remote to switch premium converter channels through a separate infrared (IR) receiver in the converter. One possibility would be to use the remote code signal for Ch. 3 (or whatever channel might be designated for premium programs) to activate a sequencing switch. Keying Ch. 3 once on the TV remote control unit would tune the set to Ch. 3 and whatever authorized program had last been selected on the premium converter. Keying Ch. 3 twice in quick succession (as on some microwave oven controllers) would advance the premium converter to the next authorized channel. Selecting any channel other than Ch. 3 would automatically bypass the premium converter. Other schemes may occur to imaginative inventors for selecting an authorized channel on the premium converter without requiring either a second remote IR transmitter or customer-operated keys on the premium converter itself. (It would be particularly impressive if the converter could display a lighted three-letter code to identify the premium channel presented on Ch. 3; e.g., HBO, MAX, SHO, DIS and so forth.)

Customers who do not have cable-compatible sets would, of course, require the conventional converter/descrambler as usual. Customers with sets equipped with the multiport connector would require only the baseband decoder with-

**Figure 3:** Premium channel converter with basic bypass

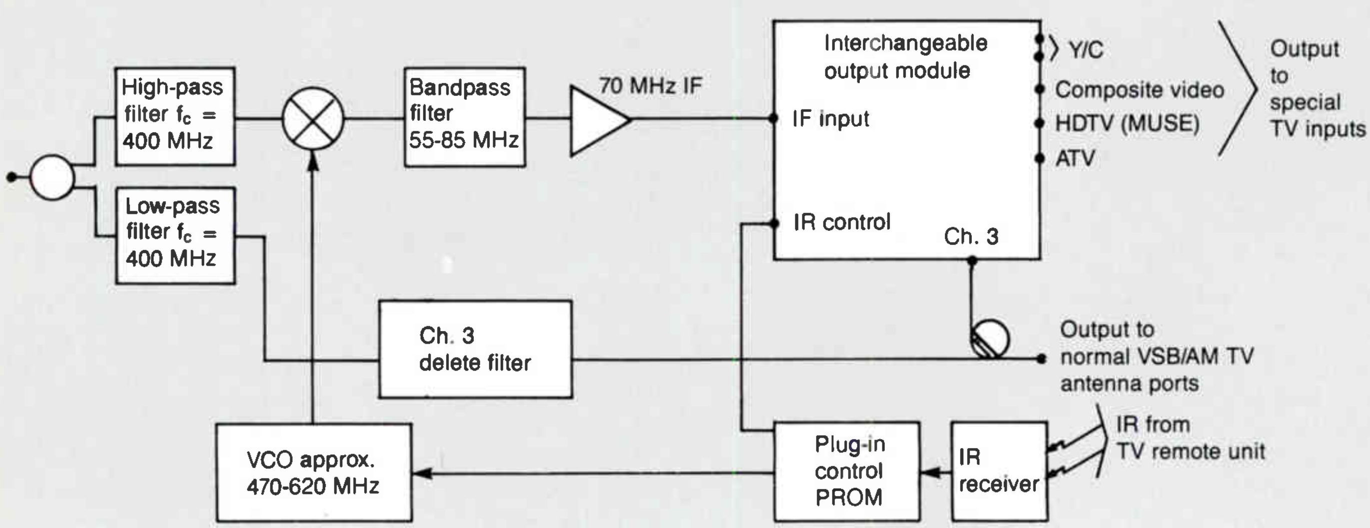
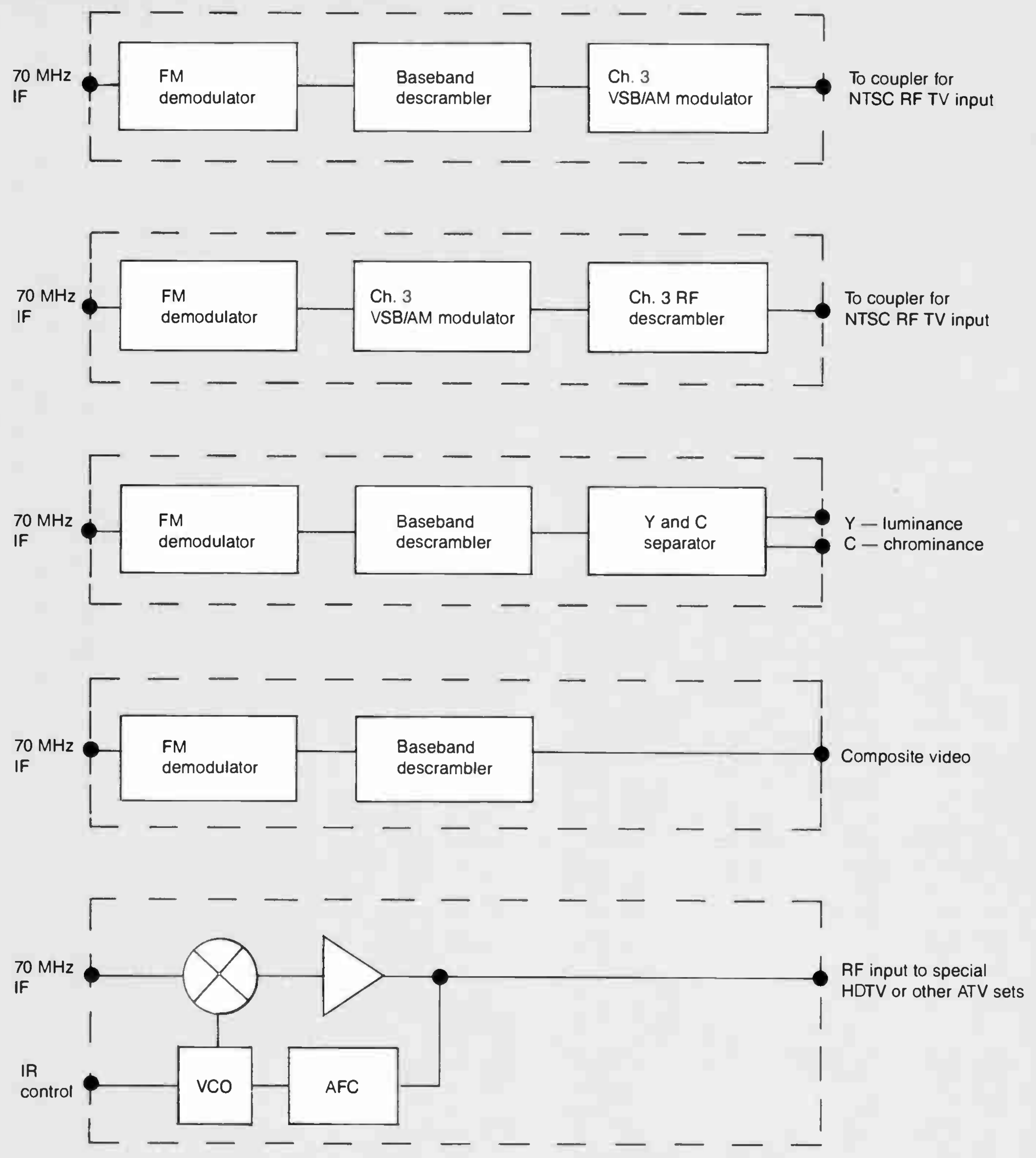


**Figure 4:** Various possible output modules




out either a conventional converter or the proposed premium converter.

By not complicating the reception of basic non-scrambled channels, the premium converter would make FM transmission of a few premium channels much more realistic. Premium channels are relayed by satellite on FM transponders and demodulated to baseband. Optical fiber has plenty of bandwidth. If the coaxial part of the hybrid fiber backbone were designed for 550 MHz, the top 100 to 150 MHz could be dedicated to eight or 12 premium FM channels at 12 MHz each, six to 10 at 15 MHz each or some combination of VSB and FM channels. The premium converter would downconvert to the intermediate frequency and demodulate these FM or AM channels. If the set were equipped with Y and C baseband input ports, an output module could be designed for the premium converter to separate the components and deliver them to the set without ever being subjected to VSB/AM signal mutilation. For conventional sets, the output module could be a VSB/AM Ch. 3 modulator, or even DSB/AM (double-sideband AM), thereby largely avoiding the group delay distortion commonly generated by VSB/AM except for the contribution of the TV receiver itself.

HDTV transmissions will almost certainly be carried as premiums at first. How they will be transmitted and what bandwidth will be required

are still not known. Bandwidth projections range from 6 to 12 MHz for terrestrial transmission and up to 30 MHz for satellite and high-definition. Whether cable TV will have to provide sufficient bandwidth to match the performance of HDVCRs remain's to be seen.

This concept of a converter limited to use with premium channels, sequenced by the TV set remote, could be used in existing systems or as an upgrade for the VSB/AM fiber backbone. The concept is sound either with VSB/AM or FM inputs, because it allows the cable-compatible TV set to function as it was intended on all non-premium channels, and indeed in almost all respects even on premium channels. All that is needed is an appropriate premium converter.

Here is the bonus: The telco's integrated service (ISDN) will inherently and necessarily be based on central switching. Like the late, unlamented off-premise converter, the switched video system does not and cannot allow the modern TV set to function as the manufacturer intended. Programs will be delivered by the telcos to video subscribers either on a designated channel (e.g., Ch. 3) or as baseband video, composite or component, depending on the nature of the subscriber's viewing equipment.

Anyone who has experienced the anger and frustration of subscribers unable to enjoy many of the convenience features provided by top-of-the-line sets will fully recognize the competitive advantage provided by multichannel over single-channel delivery. The consumer electronics industry viewed with considerable disdain a Sanyo petition (eventually granted by the Federal Communications Commission) for a single-channel display device for use with cable converters, VCRs and PCs. Why should it surrender to cable TV or to telcos the many innovative, user-friendly, convenience features that form the foundation of its marketing strategy? Single-channel delivery with our present converters is a source of continuing conflict with TV manufacturers and dealers and an aggravation to viewers. Cable TV can avoid this, if it will; telcos, with switched video, cannot.

Pictures are worth more than words. The block diagrams of Figures 1 through 4 have been prepared to illustrate the premium converter concept. These diagrams are meant only to be suggestive, since they really could not be definitive. We do not know, for example, how the advanced TV (ATV) receiver will be arranged. Will it have an NTSC/ATV transfer switch? How will the augmentation channel be designated? Will there be several VCR inputs, such as RF, composite video, Y and C, Y and color differences, or RGB? Until ATV standards have been adopted and we can see how they will be embodied in consumer electronics equipment, we should maintain as much flexibility as technically and economically possible.

In Figure 3, for example, the output module could be plug-in, or at least interchangeable, according to any one of several configurations shown. The control processor might be a relatively simple PROM, programmed in different ways to accommodate a variety of different situations. The voltage-controlled oscillator (VCO) could probably be designed with sufficient flexibility without module replacement.

The IF bandpass filter might be changed, depending on whether the input signals were 6 or 12 MHz VSB/AM, 12 MHz FM, 30 MHz FM, 6 or 9 MHz quadrature modulation or in some other form. In some situations, the Ch. 3 elimination filter (shown merely to reduce the input noise in the otherwise idle channel) might not be needed.

**Start the ball rolling**

Maybe someone will start the ball rolling by producing such a converter with non-premium bypass and a means for using the TV remote control to sequence the few premium channels on Ch. 3 or other suitable input to the TV set. Such a box would not only improve present performance but could also be an adaptable transition as the fiber backbone and HDTV technology progress.

I have heard of no better way to meet the challenges cited at the beginning of this article. As the characteristics of TV receivers and VCRs for advanced TV become better defined, other ways may become apparent. We have a few years left to prepare for the brave new world of fiber, HDTV and integrated telephone video services. I believe we can meet the challenge. Someone needs to begin showing the way.

This is my suggestion. What is yours?

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AU
PRG
RCL
13
Scientific Atlanta
EVENT
LEARN
ENTER
PROM
DELETE
A/B
Jerrold SRC II
35
Jerrold STARCOM
GENERAL INSTRUMENT

Figure 1

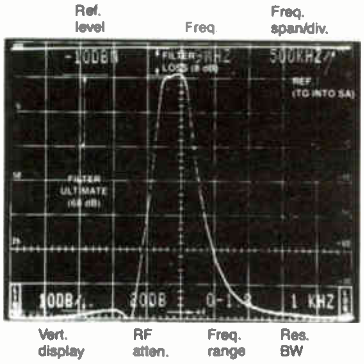



Figure 2

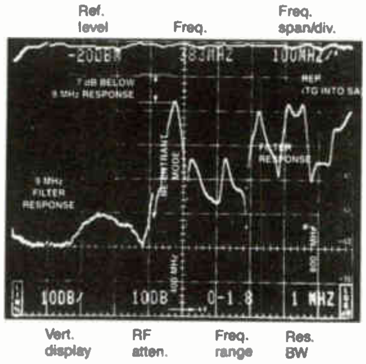
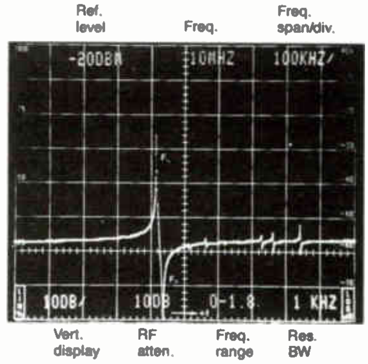



Figure 3




# Fundamentals of spectrum analysis

*As a continuing service to BCT/E candidates, "CT" is reprinting excerpts from various bibliographic sources that may not be readily available. This application note from Tektronix is listed in the Category I bibliography. This is the final installment of a four-part series.*

**By Bill Benedict**
Engineering Operations Manager
Frequency Domain Instruments, Tektronix Inc.

Figure 1 shows a 9 MHz filter being swept with a spectrum analyzer/tracking generator (TG) system. We can determine the filter loss as being approximately 8 dB by noting the difference in amplitude between the TG response and the filter response. The filter is approximately 400 kHz wide 3 dB down from the peak. Note the unsymmetrical shape near the base of the filter. The filter ultimate is better than 68 dB. Figure 2 shows the same filter when being swept over a wider frequency range. The filter is being tested from 0-900 MHz. At 350 MHz we can see the filter is only capable of 7 dB of ultimate due to a re-entrant mode.

Figure 3 shows the response of a crystal. The series resonance ($f_s$) and parallel resonance ($f_p$) frequencies are identified. Also note the crystal spurs located between 300 kHz and 400 kHz above the crystal resonance.

In Figure 4, an amplifier is being tested. The input is at −40 dBm and the output is at −10 dBm; thus, a gain of 30 dB is realized. The 3 dB roll-off is in excess of 1,100 MHz. The flatness up to 1,100 MHz is less than 3 dB peak-to-peak. Further tests might include increasing the level of the input signal in 1 dB steps and monitoring the output level for 1 dB increases to determine the 1 dB compression point (approaching saturation where output does not follow input with linear changes).

### Pulsed RF (radar)

Pulsed waveforms when viewed in the time domain will appear as in Figure 5. Different types of modulation will generate different types of pulses, but the commonality is a carrier that is turned on for a period of time, then off for a specified period. The period of time the pulse is on will be referred to as $t_{pw}$ and the pulse repetition rate will be $f_r$. The same pulse waveform when displayed in the frequency domain would appear as shown in Figure 6. Note that the pulse width ($t_{pw}$) and the repetition rate ($f_r$) can be determined from the spectral display. Repetition time ($t_r$) is the reciprocal of $f_r$.

$$t_r = \frac{\text{sweep time/div.}}{\text{\# pulses/div.}} = \frac{10\ \text{ms}}{10} = 1\ \text{ms}$$

$$t_{pw} = \frac{1}{\text{lobe width}} = \frac{1}{200\ \text{kHz}} = 5\ \mu\text{s}$$

In Part I of this series we learned that all waveforms can be described as a combination of various sinusoidal waveforms of differing amplitudes. The pulses of Figure 5 are likewise composed of an infinite number of discrete sinusoidal frequencies of differing amplitudes. Since there are an infinite number of signals, we are primarily interested in the envelope of the amplitude of the signals. In our example, this is described by a sin x/x display shown in Figure 7. We can see that the amplitudes in Figure 6 lie within the area described by Figure 7. The big question is, "Why do we see discrete signals in Figure 6 if the waveform is composed of an infinite series of frequencies?"

The answer lies in the fact that swept frequency analyzers only select a specific frequency at a specific time as the beam traces across the screen. Each time a pulse is generated, the analyzer will select the amplitude of the frequency component at the frequency being analyzed at that instant. If the pulse repetition period ($t_r$) of the pulse was 1 ms and the analyzer was sweeping through the frequency spectrum at 1 ms/div., we would see one spectral line/div. If we slowed the sweep speed to 100 ms/div., we would obtain 100 spectral lines/div., which would clearly show the envelope display of Figure 7. We need to remember that although we are varying the sweep speed, we are not changing the span of frequencies being ana-

Figure 4

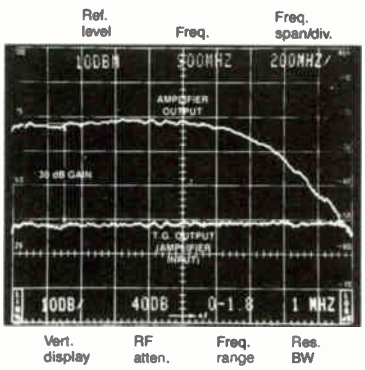



Figure 5

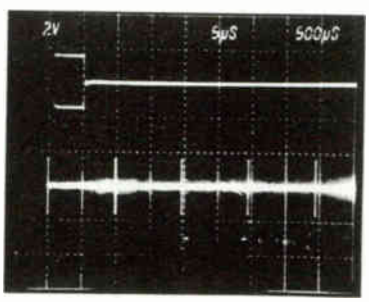


Figure 6

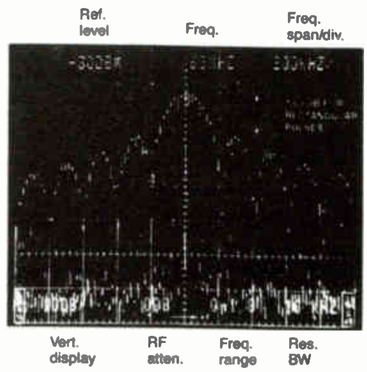



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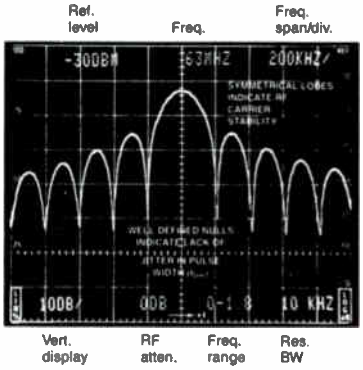
**Figure 7**




lyzed, just the rate at which we are analyzing them. To compute the repetition rate from Figure 6, determine the number of divisions/spectral line and multiply by the sweep speed/division.

To display an optimum waveform of pulsed RF, the resolution bandwidth (RBW) should be selected narrow enough to display each spectral line. As the RBW is narrowed, the amount of energy from the pulse reaching the detector within the analyzer is reduced and the display will indicate a lower level signal than is actually present. The optimum RBW is approximately 0.1/pulse width ($t_{pw}$) or $t_{pw} \times RBW \lesssim 0.1$

Figure 8 shows the optimum RBW as a function of pulse width, and Figure 9 shows the approximate sensitivity loss or signal amplitude loss as a function of the product of $t_{pw} \times$ RBW (pulse

**Figure 10**

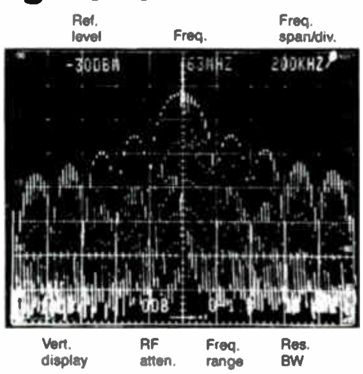



**Figure 11**

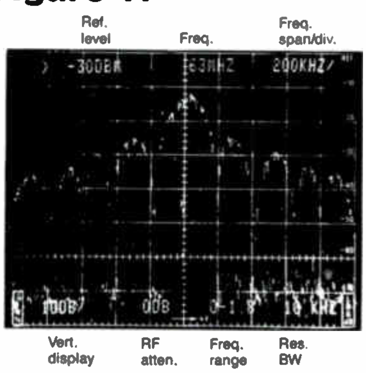
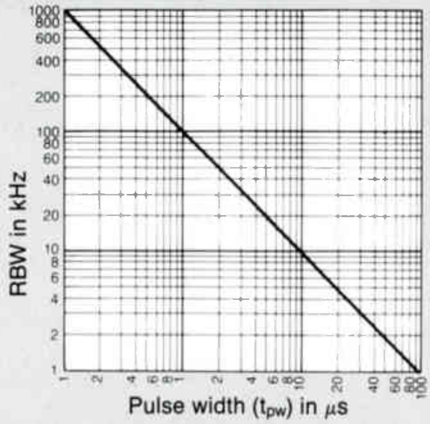


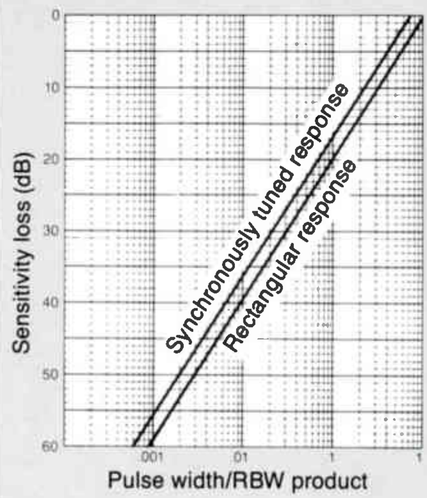

**Figure 8:** Optimum resolution bandwidth as a function of pulse width




width × resolution bandwidth). Note that the type of RBW filter in the analyzer will vary the amount of loss between pulsed RF and a CW (continuous wave) signal of equal amplitude. Since there is no signal loss through an analyzer due to RBW limitations, it is important to remember that the front end of the analyzer is being driven harder than the signals on the screen indicate. Care should be taken not to overdrive the input mixer.

For best results when analyzing pulsed RF, digital storage should be disabled until the optimum combination of sweep speed, span/div. RBW and reference level have been achieved. Once the desired waveform has been acquired, the storage can be activated with the peak/average cursor placed at the bottom of the screen. The auto sweep speed (time/div.) and auto RBW should not be used, as the algorithm used to compute the optimum setting is not valid

**Figure 9:** Sensitivity loss of pulsed signals vs. continuous wave




for pulsed RF.

Typical observations of an RF spectrum would be the following:

1) For a rectangular pulse, the first sidelobe should be approximately 13.3 dB below the main lobe (Figure 6).
2) If the nulls are not well defined, the pulse width ($t_{pw}$) is FMing (Figure 7).
3) Poor carrier on/off ratio shows up as a response buried under the main lobe (Figure 10).
4) If the carrier is FMing, the lobes could be unsymmetrical (Figure 11).

Warning: Radar applications require relatively large amounts of power for proper operation. Signal access points on radar systems often have large signal levels that can be lethal to both peo-

**Figure 12:** Amplitude correction for signals located with 10 dB of analyzer noise floor

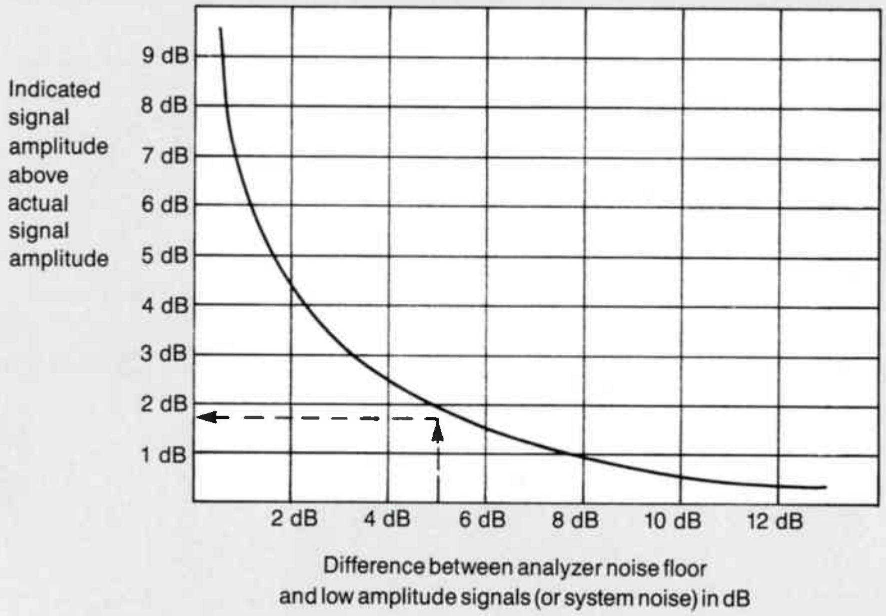



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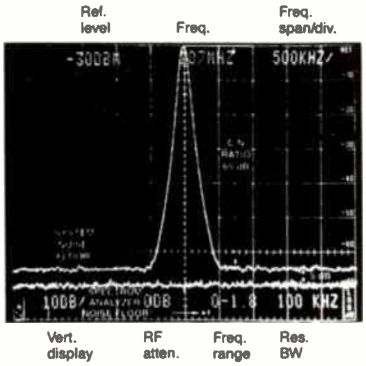
Figure 13




ple and spectrum analyzers. The input circuitry of spectrum analyzers is fragile. Use caution and plenty of external attenuators when observing unknown signals.

Noise measurements are often made as carrier-to-noise (C/N) measurements, oscillator spectral purity, white noise level, etc. The noise referred to is the level of the baseline signal or "grass" of a spectrum display. The unit of measure when dealing with random noise is usually dBm/Hz or watts/Hz. The noise bandwidth must always be specified, because each decade of change in noise bandwidth will vary the measurement by 10 dB. Random noise implies the noise is being analyzed through an idealized square-shaped filter. Since most filters are not of the idealized square shape, a correction factor may have to be generated to convert from the spectrum analyzer RBW to the effective noise bandwidth of each filter. If this correction is not made for the RBW used, errors of up to 2 dB can occur in the measurement.

Another source of error when making noise measurements occurs in the detector and logarithmic circuitry. These two errors cause the measured noise to appear lower in level than the actual noise by the following factors:

LIN display mode: 1.05 dB
LOG display mode: 2.5 dB

An additional source of error involves dealing with very low level signals or, in this case, system noise located close to the noise floor of the analyzer. To test for the analyzer's noise floor, disconnect the input and note the amplitude of the noise. When a signal or system noise is located within 10 dB of the analyzer noise floor, the amplitude of the measured signal or system noise will be indicated as being higher than it really is by a factor as determined in Figure 12.

In our example of Figure 13, the difference of analyzer noise floor to system noise floor is 5 dB. From Figure 12, a correction factor of 1.7 dB must be subtracted from the indicated system noise amplitude to obtain the true noise level. (Remember that two signals of the same amplitude will indicate 3 dB more power than the amplitude of either of the signals. Thus, a signal measured 3 dB above the noise is actually at the same amplitude as the noise.) A system will quite often have a noise specification of a noise bandwidth in other than a common spectrum analyzer RBW. To get from one bandwidth to another bandwidth, the following formula can be used.

$$\text{C/N at specified BW (dB)} = \text{C/N at measured BW (dB)} - 10 \log \left( \frac{\text{specified BW (Hz)}}{\text{measured BW (Hz)}} \right)$$

Using Figure 13 as an example, we measured the carrier-to-noise ratio of a system as being 65 dB in a 100 kHz RBW. The system specification

**Figure 14:** Standing wave ratio test setup

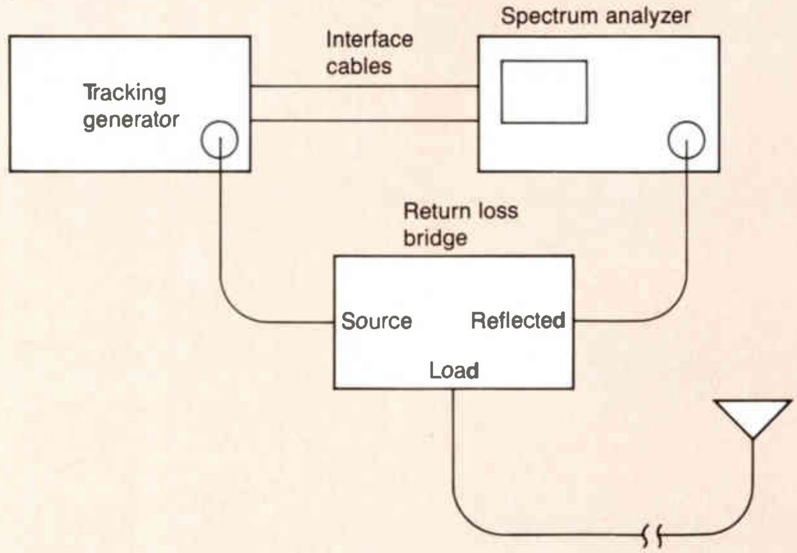



Figure 15

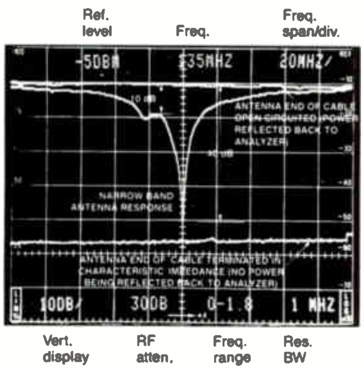
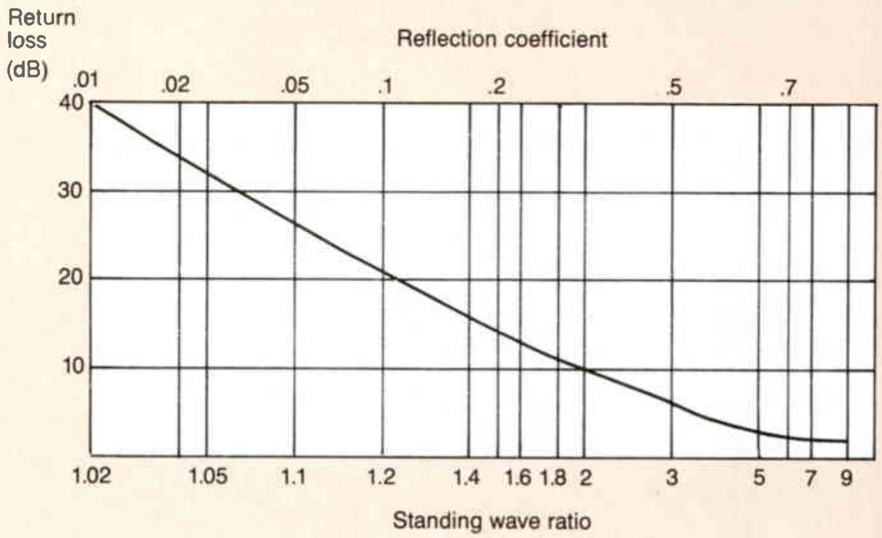



**Figure 16:** Standing wave ratio, return loss and reflection coefficient




$$\text{SWR} = \frac{1 + 10^{-\left(\frac{\text{return loss dB}}{20}\right)}}{1 - 10^{-\left(\frac{\text{return loss dB}}{20}\right)}}$$

requires the result to be a 4 MHz noise bandwidth.

$$\text{C/N at 4 MHz} = 65\text{ dB} - 10\log\left(\frac{4\text{ MHz}}{100\text{ kHz}}\right)$$
$$= 65\text{ dB} - 16\text{ dB}$$
$$= 49\text{ dB at 4 MHz RBW}$$

The actual C/N at 4 MHz noise bandwidth is then determined by accounting for the analyzer's log error and RBW/noise bandwidth correction factor and signal noise floor/analyzer noise floor correction factor. Each analyzer's RBW/noise bandwidth correction factor must be compiled. Let us assume a 1 dB error.

C/N at 4 MHz noise BW = C/N at 4 MHz RBW + signal noise floor/analyzer floor correction – RBW/noise BW correction factor – log error

For our example, then:

C/N at 4 MHz noise BW = 49 dB at 4 MHz RBW + 1.7 dB – 1 dB RBW/noise BW – 2.5 dB = 47.2 dB at 4 MHz noise BW

**Antenna sweeps (SWR)**

Antenna sweeps are performed on antenna systems to determine if the antenna is "tuned" for the frequency at which it will transmit or receive. An improperly tuned transmitting antenna can cause much of the energy created by a transmitter to be reflected back into the transmitter, causing intermodulation distortion and thus a loss of effective power being radiated. A properly tuned antenna will have its characteristic impedance at the frequency of intended use. The measurement of a system standing wave ratio (SWR) can be made using a spectrum analyzer, return loss bridge, and a tracking generator or sweeper capable of operating at the frequency of antenna operation. From the SWR, you can determine the system impedance at any frequency over which the SWR was measured. SWR measurements are made using the mentioned equipment and connected as shown in Figure 14. A return loss bridge designed for the characteristic impedance of the antenna must be used.

The system operates by the signal source (tracking generator in this case) launching a signal at a specific frequency to the return loss bridge. The bridge routes the signal to the antenna or system under test but not to the analyzer. If the termination at the end of the line looks like the system characteristic impedance, all the energy is absorbed and nothing is reflected. If the termination is not at the characteristic impedance, a portion of the energy will be reflected back to the bridge where it will be routed to the spectrum analyzer and displayed on screen. As the sweeper or tracking generator sweeps across the frequency band selected, the analyzer will plot a graph of return level or return loss (in dB) vs. frequency.

System calibration requires terminating the antenna end of the cable with an "open" or "short" to reflect all the energy back, and adjusting the analyzer with a display at the top of the screen. Then, by terminating the antenna end of the cable into the characteristic impedance, the operator can determine the display level representing the characteristic impedance. Figure 15 shows a typical display of an antenna trimmed or tuned for operation at 135 MHz. It demonstrates a narrowband antenna being swept from 35 to 235 MHz. The antenna is showing a 40 dB "return loss" at 135 MHz. From Figure 16 we can determine the antenna's SWR as being 1.02:1. At 110 MHz, the SWR = 2:1.

One of the limitations and problems associated with the setup of Figure 14 is: Most signal sources are only capable of generating between 1 mW and 1 W of power. Therefore, the analyzer will be set with very little RF attenuation. If another nearby transmitter broadcasts during the period the test is being conducted, excessive power could be received by the antenna being tested and damage the spectrum analyzer. If an amplifier is available to place between the tracking generator and the bridge to boost the power (amplifier system should be checked for flatness), then external attenuators can be placed between the bridge and spectrum analyzer to reduce the signal and protect the analyzer. The return loss bridge specification should be checked for power handling capability. Warning: Extreme caution must be practiced when operating an analyzer near high power RF equipment. Excessive power applied to the input will damage a spectrum analyzer.

*Reprinted with permission from "Fundamentals of Spectrum Analysis," Tektronix Application Note 26W-5360-1.*

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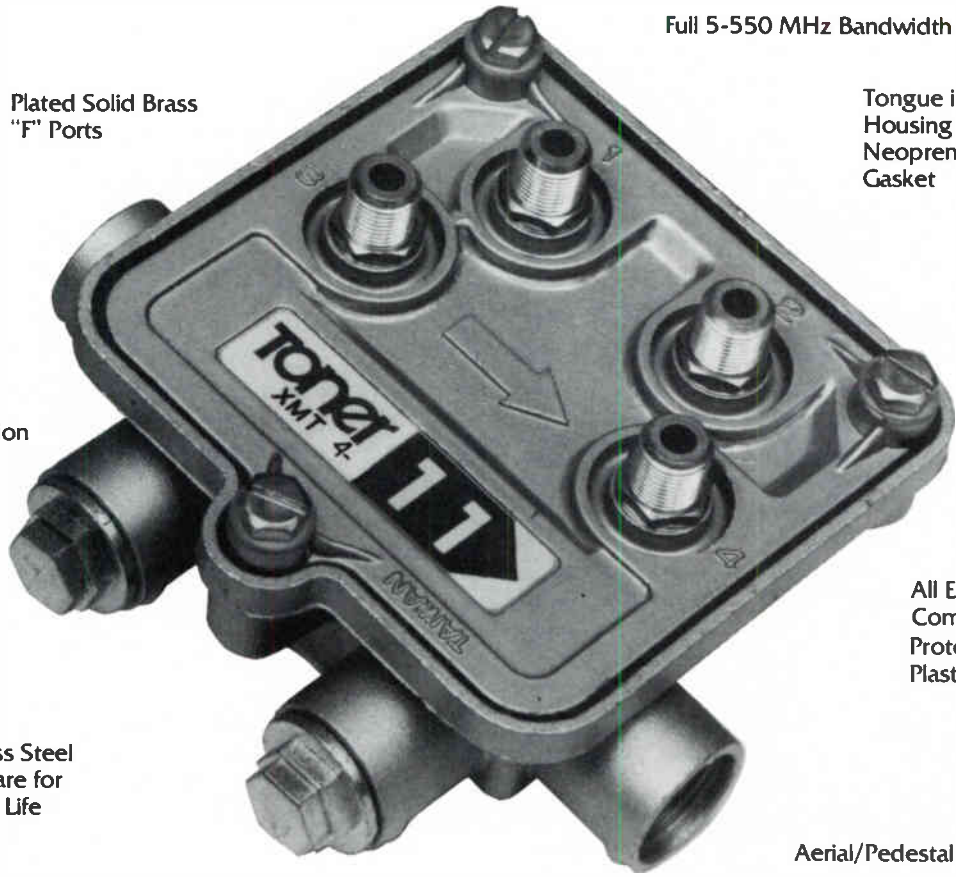


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***Reader Service Number 47.***

# Four elements of success

**By Dan A. Neiman**
Technical Operations Manager, Times Mirror Cable Television

The elements needed for a successful preventive maintenance (PM) program include attitude, ability, pride and time.

*Attitude* is a manner, disposition, feeling, position, etc., toward a person or thing. The proper attitude is the foremost priority in setting up a PM program. If a technician has the attitude, "What difference does it make?", the program won't work. So the "difference" must be posted for all to see: If a system experiences a 5 percent visit to the customer base each month, then 60 percent of the base will be visited by a repair tech each year. And historically, a customer is more likely to disconnect after experiencing a service-related problem.

To create the right attitude, you don't need to go through all the facts and figures associated with the successful operation of the business. Instead, use some insight on the importance of customer satisfaction. However, what does need to be known is an expected result that is obtainable and can be tracked on a weekly basis. The tracking must show past and present results for accomplishments achieved, an expected goal to be reached in a certain time frame and the benefits to them if the goal is reached.

*Ability* is the power or capacity to act physically, mentally, etc., with competence in an activity or occupation. The ability to perform the job well goes back to establishing the right mental attitude. Some techs are naturally inquisitive and have an innate mental power to do things well.

> *"Training must be done with positive mental reinforcement and where the tech feels comfortable."*

However, others need acquired mental power to do things well; this comes only from training. Training must be done with positive mental reinforcement and where the tech feels comfortable. For example, instructing a tech about amplifiers while up in a bucket truck or hanging off a pole during a real crisis can generate confusion. On the other hand, simulation boards with actual cable losses and RF are good training devices.

In order to have the ability to perform the tasks properly, all the tools must be supplied. A tech cannot be expected to diagnose common RF problems with just a field strength meter or calculate current draws with a $20 volt ohmmeter. So, if you expect results, you must supply the right physical tools to do the job.

*Pride* in one's accomplishments is associated with the right attitude and ability to perform the task. If the system that had experienced a 5 percent visit to the customer base achieved a reduction of 1 percent, this was an accomplishment. Knowing that the efforts put forth resulted in a reduction in service calls should trigger the desire to improve the results on a continual basis. Again, this is where tracking plays an important part.

Finally, you cannot get results unless you dedicate the *time* to achieve them. A PM program is a full-time operation; it cannot be stopped and started over and over again. Set specific time frames as to when each part is to be completed and make sure that PM techs have a consistent schedule to follow.

If these four elements prevail among the preventive maintenance technicians in your system, the results of your program can be what you had hoped to accomplish at the start. ■

# Outage management

*This is the first installment of a series on minimizing service interruptions. Part II will discuss electrical storms, ice, power problems and equipment failures.*

**By Roy Ehman**
Director of Engineering, Jones Intercable Inc.

Numerous surveys have confirmed that interruption to service is the second highest cause of consumer dissatisfaction, after picture quality. This is the most compelling motive for getting outages under control, but there are others.

When outages occur during temperature extremes and amplifiers are idle for some time, secondary plant problems surface when restoration takes place. There always seems to be a rise in service calls. Also, when trying to localize the fault(s), personnel are often obliged to open housings and/or take the plant apart. This can cause the addition of moisture and the possibility of imperfectly restored connectors; this may result in new signal leakage and perpetuate the unreliability problem. Another reason for prevention is that many outages occur during extremely inclement weather when accidents of one kind or another involving repair personnel are more likely to happen. The final motive is probably the real cost and convenience of having extra staff on standby and/or work overtime during repairs.

Obviously, something must be done about outages. We can attack the problem on two fronts: First, many outages are preventable and second, those that aren't preventable can and must have their duration reduced as much as possible.

### Outage defined

The word "outage" means different things to different people. The definition we will use is: "a situation where a *group* of subscribers *in common* have *no signals* for *any reason*." Each of the italicized words is significant. For instance, 15 subs with no signals in 15 different parts of town obviously do not make an outage since the cause is not common to all. Furthermore, if one sub has no signals it is not an outage because one sub does not constitute a group. One or more subs with one or more missing or "mangled" channels, but with other channels that are OK, does not meet the criterion of "no signals." The reason for the outage can be anything at all, whether man-made or an act of God or nature.

In order to quickly convey the relative gravity of a particular outage, it is helpful to refer to them as either major or minor. A major outage is one involving a trunk or greater failure; anything less than a trunk is classified as minor. Major and minor outages obviously will require different manpower resources and procedures.

It is also helpful to differentiate between outages and impairments. An impairment is a situation where the customer is still receiving signals, but one or more channels are either missing or visibly impaired. Here again it is helpful to classify major and minor impairments the same way as outages.

Let's take a look at each outage cause.

*Underfusing:*

Manufacturers and vendors of equipment tend to fuse their products rather lightly. A fuse, by definition and its very nature, is a weak link. It is intended to be the weakest link in the chain of components and, as we all know, a chain is only as strong as its weakest link. Anytime a fuse blows, some part of the plant is deprived of power, and if that fuse is in the trunk or major distribution, extensive outages can occur downstream. The manufacturer's objective in providing light fuses is to protect its equipment from incurring damage or burnout.

It is a worthwhile and proven strategy to replace the fast-blow fuses with the slow-blow units so that they will survive very short duration minor transients. Additionally, when the original

value fuses blow, they should be replaced with a slightly higher value. For example, a one-amp fuse, when blown, would be replaced with a one-amp slow-blow. Any of these that go open should then be replaced with 1¼ or 1½ slow-blow. These values can be inched up incrementally a considerable degree, taking extreme care to observe the plant for possible serious damage or burnt-out modules. At this point, back the fuse off to the previous value. This is now the optimum compromise between equipment protection and plant reliability.

A note here about miniature automatic reclosing circuit breakers: This little device uses a glass encapsulated bimetal that opens the circuit on overload and after a brief cooling period of a few seconds recloses the circuit. There are a number of problems with this type of device. First of all, it is very slow acting and, hence, does not offer protection against fast, high-level transients. Secondly, it has a tremendous temperature coefficient. On an exceedingly cold day it may not open at all, and on a very hot day it opens at the slightest provocation. To have the cable going on and off at a cyclic rate is very hard on the customers, not to mention the equipment.

*Self-induced interruptions:*

During maintenance or equipment changeout, self-induced interruptions to service must definitely be thought of as short outages. The fact that the "hit" may only be for 15 or 20 seconds does not make it any more palatable if you are a customer involved in watching a program and unexpectedly get blasted with 15 to 20 seconds of white noise. This activity must be held to an absolute minimum and scheduled in advance. If extensive changeouts are contemplated, the subscribers in the area affected should be notified using the character generator or bill stuffers. If more than one break is going to be necessary, then the work must be scheduled for the third shift, before 7 a.m.

*Digging up underground plant or driving fence posts through it:*

Digging up plant is most often done by a utility. These occurrences can be reduced significantly by belonging to the local plant protection organization or the local organization that advises of all digs and calls for necessary locations. It need hardly be emphasized that locations are to be completed with extreme promptness and accuracy. This in turn requires properly updated as-built maps. For the remaining inevitable residual dig-ups, it is necessary to be properly equipped to make the restoration very quickly.

Little or nothing can be done about the driving of fence posts. However, when planning or locating a new underground plant, every consideration should be given to identifying the property line and trying to stay away from it.

*Poor installations causing pullouts during large temperature drops:*

When there is a drop in the ambient temperature, the cable contracts; this shrinkage of the cable must come from the drip loops. If the drip loops are not properly made, there is no slack anywhere to make good the shortfall in the length of the contracted cable. Tremendous tension is applied to all connectors, resulting in either the center conductor, sheath or both pulling out of the connector. The same problem also can occur (even though the drip loops are good) if the cable was not properly prepared and properly seated and seized in the connectors, not only at construction time, but also during rebuilds, temporary plant or troubleshooting activities.

On the question of terminology, note that a pullout is due to the cable pulling out of the connector during a temperature drop. Typically, pullouts do not occur during a rise of temperature when the cable expands, but many people erroneously talk about pullouts occurring during large temperature swings.

It is also necessary to differentiate between a pullout and a suckout. A *suckout* is the term applied to a piece of circuitry that is either deliberately or inadvertently sharply tuned to a specific frequency. It "sucks out" power from the line at that specific frequency, causing a severe dip in the frequency response. A quarter-wave stub is a good example.

*Inadequate batteries or battery maintenance supporting standby power:*

The preferred battery specially designed for standby duty is one of the maintenance-free gel cells. The deep discharge lead-acid automotive-type battery often appears attractively priced. However, it is not a good long-term investment because: 1) it is designed differently for deep discharge automotive duty, not standby; 2) when known to thieves and vandals, this type of battery becomes very attractive and 3) it requires excessive maintenance labor that eats up the capital savings and introduces unreliability.

# —950 Cable Industry Technicians and Engineers— Are Currently Enrolled in SCTE's BCT/E Program and Are on Their Way to Technical Certification.

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SCTE

*Reader Service Number 1.*

The upshot of this is that it becomes inefficient and counterproductive.

The batteries should be serviced at intervals and in the manner prescribed by the manufacturer. When batteries are purchased along with the power supply, the charging rate, which is very critical, is accurately adjusted to match the standby power supply to the type of batteries supplied. The charging rate should not be arbitrarily adjusted in the field.

*Keeping the headend alive:*

Larger systems will usually have a generator that will, in the absence of city power, automatically start up and take over the headend in about 45 seconds. It should be tested once a week during minimum viewing hours and a log kept of who, what and when. If there is proper load transfer equipment and everything stays up as it should, then the actual transfer must be made and the generator run on the full headend load for no less than 25 minutes. This allows it to get fully warmed up; any incipient problems will hopefully surface. It is *not* a *real test* to just run the machine up for 15 minutes or so on no load. For a small generator an alternative would be to construct a dummy load of the right capacity from a number of parallel 2 kW heaters!

Very often there are a couple of critical items in the headend that we would like to have function continuously, even in the total absence of power or until the generator kicks in. Examples include the pilot carriers, local stations and character generators. The reason for keeping the locals on, apart from courtesy, is that customers will not be obliged or tempted to start fiddling with antennas. This could result in undesirable comparisons with off-air quality or bad connections resulting in leakage and/or service calls. An elementary and efficient way to keep these going without a break is to float them on a 24 volt battery using the simple SP (standby power) retrofit option. Two 80 amp, 12 volt batteries similar to the ones in the system standby power units in series will keep several modulator/processors running for an hour or two with no break.

This equipment makes no demands on the batteries unless the AC power goes away; therefore, the smallest battery charger will keep the batteries fully charged. Some character generators now keep themselves going, but those that do not should be studied and fitted with a suitable battery to at least retain the memory. (There is nothing as ugly as seeing a system come back on with a screen full of flashing random characters. To the public it looks like neglect or incompetence.)

A final alternative for keeping critical equipment alive during outages until at least standby power comes through is to use an appropriately rated uninterruptible power supply (UPS). Current models do not run continuously but switch over virtually instantaneously (4 milliseconds) so that there is absolutely no break in power supplied. The big advantage to this is that little demand is made of the battery until primary power is actually required. The length of time it will support your equipment is simply dependent on the size of the battery associated with the UPS and the load. Power outputs range from small units conservatively rated at 300 watts through 1,000, 1,500 and 2,000 watts. The AC delivered is sine wave with only 5 percent total harmonic distortion and 40 or more dB common-mode isolation spikes and transients. The changeover takes place in 4 ms at zero crossing *in phase*. It doesn't miss a beat even though it only runs when required.

With a combination of one or more of the power supplies, it should be possible to eliminate or dramatically reduce the magnitude, duration and obviousness of a headend power outage.

*Vandalism:*

This occurs from time to time, ranging from a bullet through an amplifier to a hacked-off cable. Plant should be designed and maintained for minimum vulnerability. Vehicles must be equipped for rapid and effective permanent restoration of the plant in the event of such activity.

*Wind-related storm activity causing trees, etc., to fall on aerial plant:*

This will happen from time to time despite our best efforts. Here again the secret is to keep the duration of the outage down by being properly equipped and organized to deal with it quickly. Oak trees are particularly prone to split and fall on the plant. When planning new plant additions in well-treed portions of the country or portions of the franchise, consideration might be given to rerouting or going underground.

*Fletcher*

**George Fletcher** was named vice president of corporate marketing at **Texscan Corp**. Prior to this, he served as vice president of national account sales with the Jerrold Division of General Instrument. Contact: 10841 Pellicano Dr., El Paso, Texas 79936, (915) 594-3555.

**David Fellows** was appointed director of marketing for **Scientific-Atlanta**'s distribution of headend/earth station products. Prior to this, he was in charge of strategic operations for the company's Network Systems Group. Contact: 1 Technology Pkwy., Box 105600, Atlanta, Ga. 30348, (404) 441-4000.

*Breen*

**Ed Breen** was promoted to vice president of sales of the **Jerrold Division** of General Instrument. He was previously vice president of marketing for the Subscriber Systems Division.

**Ed Ebenbach** will replace Breen as vice president of marketing for the Subscriber Systems Division. Most recently, he was vice president of international marketing.

**Dan Moloney** was promoted to director of product marketing for the Subscriber Systems Division. He was previously product manager for Jerrold's non-addressable converters.

**Ivan Dieu** joined Jerrold as an account representative in the Sales Group. Prior to this, he was national accounts manager at Pioneer. Contact: 2200 Byberry Rd., Hatboro, Pa. 19040, (215) 674-4800.

**Louis Swift** was promoted to national sales manager for the **Grass Valley Group**, a subsidiary of Tektronix. He was previously Central regional manager at the company's field office in Elkhart, Ind. Contact: P.O. Box 1114, Grass Valley, Calif. 95945, (916) 478-3000.

**C-COR Electronics** appointed **David Jordan** product manager for the CATV group. He was formerly international sales coordinator before returning to school to obtain an MBA. Contact: 60 Decibel Rd., State College, Pa. 16801, (814) 238-2461.

*Blake*

**Dick Blake** joined **Reliable Electric/Utility Products** as Western regional sales manager. Prior to this, he spent 10 years with General Data Communications. Contact: 11333 Addison St., Franklin Park, Ill. 60131, (312) 451-5521.

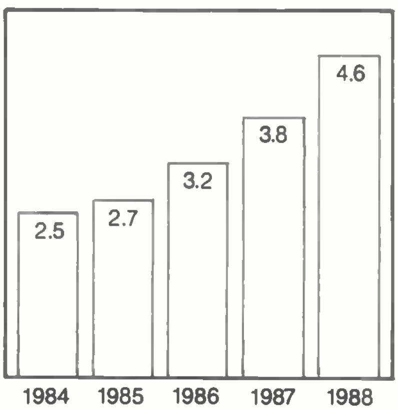
**Telecrafter Services** named **Jeri Amstutz** national accounts manager. She was previously director of national accounts for Cable Value Network. Contact: P.O. Box 27960, Denver, Colo. 80227, (303) 987-2900.

# SCTE—A growing concern

**By Ron Hranac**
President, Society of Cable Television Engineers

The Society of Cable Television Engineers was formed in 1969 as a non-profit professional organization charged with the task of promoting "the dissemination of operational and technical knowledge in the fields of cable television and broadband communications." To that end, the Society has established a number of very successful programs geared toward technical excellence in the industry. Among these are BCT/E certification, tuition assistance, local chapters and meeting groups, satellite tele-seminar video training, national and regional seminars, a library of publications, tapes and premiums, and the granddaddy of cable technical trade shows, the Cable-Tec Expo.

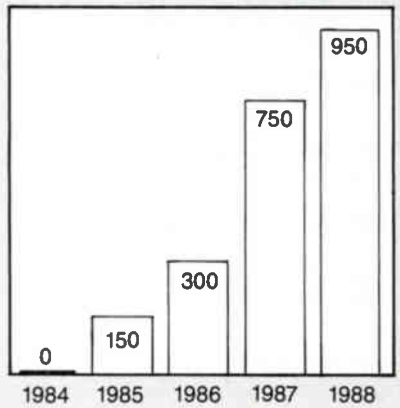
**Figure 1:** SCTE active members




Perhaps more important than the variety of available programs is the acceptance of the SCTE by the industry. This acceptance is mirrored by the growth of the Society. Consider the past five years: SCTE's active national membership has increased from 2,500 in 1984 to nearly 4,600 halfway through 1988 (Figure 1). Membership is expected to top 5,000 by the end of the year.

At the local level, chapters and meeting groups are doing an outstanding job of addressing training needs. In 1984, only nine chapters and meeting groups were doing this. So popular has this training vehicle become that today 43 such groups are conducting technical seminars and administering BCT/E exams. And speaking of BCT/E, Figure 2 details the incredible growth of the number of people enrolled in that program.

**Figure 2:** BCT/E candidates




That figure has climbed to nearly 1,000 since BCT/E was introduced at Expo '85. Over 3,000 exams have been administered, and 15 candidates now are fully certified.

Want to be part of this exciting growth? I invite you to join the SCTE (an application is included in this issue's card section) and become active in the group whose membership includes cable engineers and technicians, manufacturers, installers, construction personnel—even system owners and their operations staffs!

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We often don't take time to say "Thank You" to our customers, and I feel I must say THANKS to the System Operators, Engineers, Technicians, and Installers who have, over the last 14 years, supported and assisted us in our growth and development.

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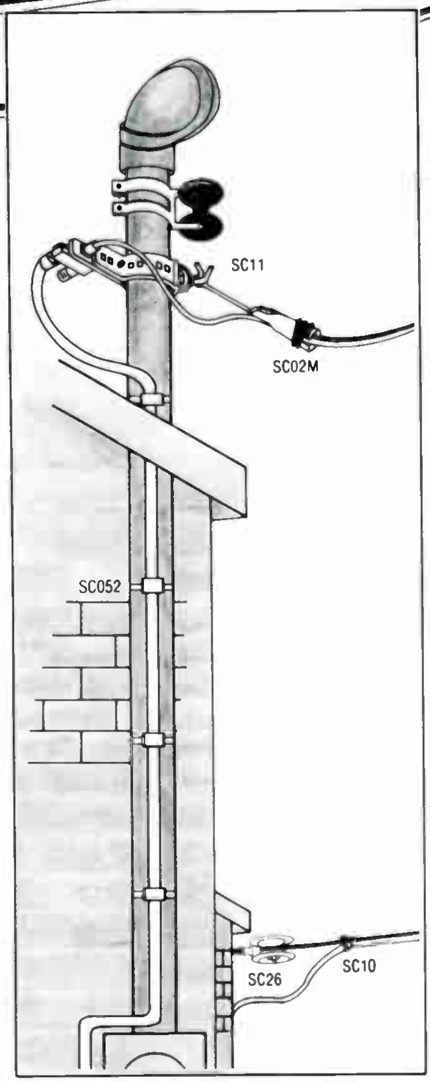


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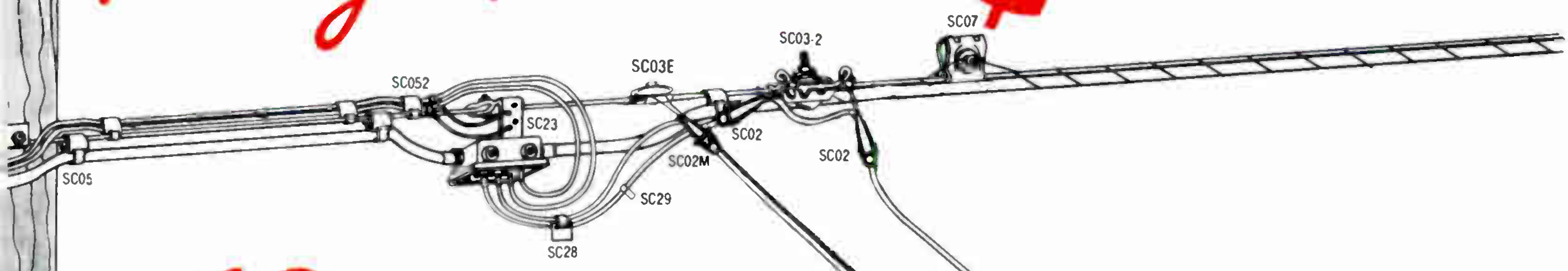


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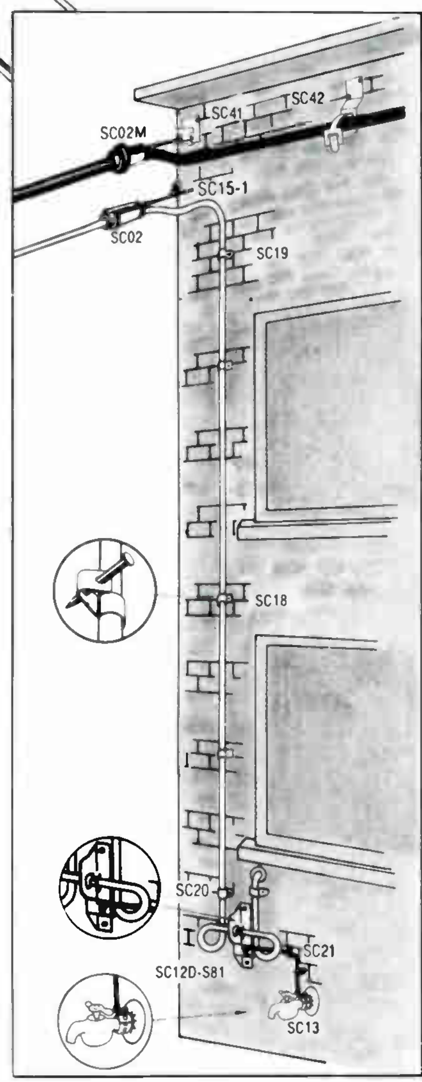


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| SC10-2: | "S" CLIP |
| SC12DS81: | GRD BLOCK WITH F81 CONNECTOR |
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| SC15-1: | "P" TYPE HOUSE HOOK |
| SC18-19: | "SAXXON" CABLE CLIP |
| SC19: | "U" CABLE CLIP |
| SC21: | "U" CLIP FOR GROUNDWIRE |
| SC22-6: | COPPER GROUND CONNECTOR |
| SC25-1: | FASTENING/MOUNTING SCREWS |
| SC26-1: | OMNI HOUSE HOOK |
| SC28-1: | IDENTIFICATION TAG |
| SC46D: | BRACKET, DUAL GROUND |

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|---|---|
| SC02: | DROP CLAMP, NON MESSENGER |
| SC03-2: | SPAN CLAMP WITH 2 PIGTAIL HOOKS |
| SC05-2: | 7" CABLE SUPPORT STRAP |
| SC09: | SPLITTER RING NUT |
| SC12DS81: | GRD BLOCK WITH F81 CONNECTOR |
| SC13-1: | 6 1/2" COPPER GROUND STRAP |
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CT 9/88

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# Telcos, television and fiber optics

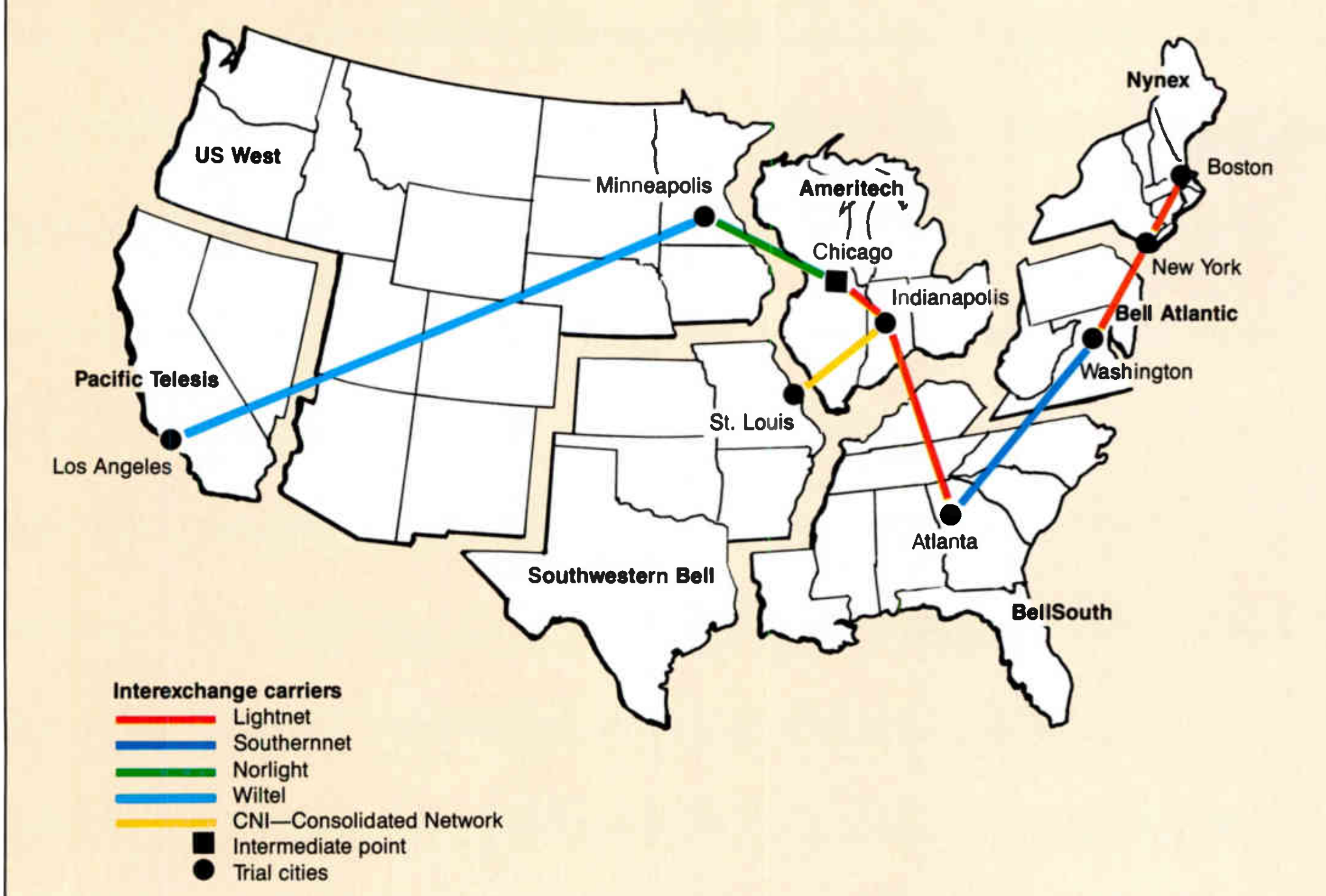
**By Lawrence W. Lockwood**
President, TeleResources
East Coast Correspondent

Well, the phone companies have announced a plan to dip their toes deeper into the TV/fiber-optics waters. Bellcore (Bell Communications Research), the research arm of the Bell Operating Companies, announced a "U.S. field trial of land-based, digital TV networks" that will start in August 1989 and last for 15 months. This operation is aimed at testing a fiber-optic (single-mode) network as a substitute for, or supplement to, satellite distribution of TV signals—currently directed to the requirements of TV broadcasters. The fiber-optic network is to be a two-way customer-controllable tree-like network, operating at a DS3 rate.

In the 1970s, AT&T established a hierarchy of digital transmission rate standards for use in North America. These rates, DS1 through DS4, are from 1.544 Mbps (megabits per second) to 274.176 Mbps. DS3 is 44.736 Mbps—usually referred to as 45 Mbps.

The reason for making this fiber-optic network customer-controllable is that network broadcasters have become accustomed to controlling or managing their own satellite network configurations autonomously (i.e., with no intervention or operations required by a phone company). A land-based digital fiber-optic network must be equally flexible and easy to control. To achieve this flexibility in the fiber-optic configuration, a portion of the DS3 rate is used for a control data signal. This signal can then direct switching in the network tree (see accompanying map) as required; i.e., 1) to switch a backup in case of failure of primary signal, 2) to serve different time zones, 3) to broadcast several sporting events of regional interest, 4) to broadcast TV commercials of regional or even individual city interest and 5) to broadcast promotional material or news segments for later use by affiliates. This embedded

**DS3 digital video trial**



*"This operation is aimed at testing a fiber-optic...network as a substitute for... satellite distribution of TV signals."*

channel for real-time network control will have multipoint units located at the branch points of the tree-like network and at the codecs (coder/decoders), which are located at the end points of the network.

Codecs perform the dual function of encoding two-way analog signals into digital data signals and two-way digital data signals into analog signals. The lowest digital data rate normally used for uncompressed or regular full bandwidth broadcast quality video is approximately 86 Mbps. The codecs used in this test have algorithms that reduce this data rate to a value less than 45 Mbps so it can be transmitted in the DS3 channel and then decode this low data rate at the receive end back into an acceptable analog video signal. Two methods of compression using two different coding algorithms are being tested —one based on differential pulse code modulation (DPCM) and the other on discrete cosine transforms (DCT). The DS3 rate has been in use for more than a year by ABC between New York and Washington, D.C., for news and regularly on Ted Koppel's show.

Robert Blackburn, Bellcore district manager for digital radio, video and audio, gave the breakdown of the DS3, 45 Mbps network signal (with approximate values) as:

| | |
|---|---|
| 38 Mbps | — video |
| 2 (T1) each at 1.544 Mbps | — audio |
| 130 kbps | — control data |
| 60 kbps | — order wire (provides talking capability for network technicians) |

The tree-like network can be reconfigured either by commanding addressable multipoint units one at a time or by sending commands ahead of time to be placed in a program store at the multipoint unit to be acted upon simultaneously in all multipoint units when an execute command is sent. The two-way channel capability allows broadcasters to distribute and receive programs simultaneously.

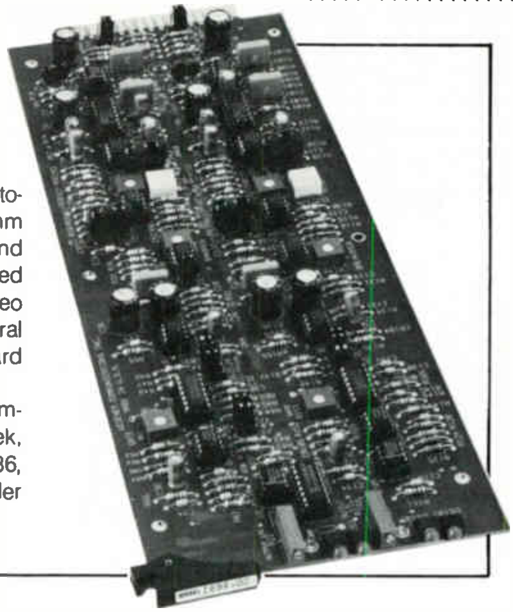
A similar but separate test also will take place in Canada conducted by Bell Canada and the Canadian Broadcasting Corp. The U.S. field trial will connect Boston, New York, Washington, D.C., Atlanta, Indianapolis, St. Louis, Minneapolis and Los Angeles.

Cooperating in the effort will be broadcasters, interexchange carriers, operating telephone companies and equipment suppliers. The major TV networks participating in the trial include ABC, CBS, NBC, Fox and PBS; five interexchange carriers (CNI, Lightnet, Southernnet, Norlight and Wiltel) will provide DS3 channels on fiber-optic transmission facilities connecting the eight cities.

Twelve equipment suppliers have agreed to provide video codecs, audio codecs, multipoint units and controller and test set hardware during the trial. They include: ABL Engineering, AEG Bayly, Anritsu America, Coastcom, Comlux, DSC Communications, NEC, Northern Telecom, RE Instruments, Tau-tron, Telettra and Telinq. Operating telephone companies in the seven regions will make two-way access channels available to broadcasters and their affiliates on fiber-optic cables (i.e., from the interexchange carrier points to the TV facilities in the cities). Every three months, a different broadcaster will participate in the trial. As noted, overall, the trial is expected to last 15 months.

Blackburn said, "With the ever-expanding capacity of fiber-optic networks, digital transmission techniques and computer algorithms, we hope to find broader applications for this system beyond broadcasting." He indicated that those currently being considered include private video teleconferencing and private video network for retailers, financial and educational institutions. With successful testing, it will be interesting to see what other applications are found.

## AGC module



Wegener introduced the Model 1694-02 automatic gain control module featuring 600 ohm balanced audio interface, low-level gating and selectable time constants. It is a single printed circuit board that can be configured for stereo or dual mono operation. Up to 16 monaural channels can be installed in one standard Wegener 1601 mainframe.

For additional details, contact Wegener Communications, Technology Park/Johns Creek, 11350 Technology Circle, Duluth, Ga. 30136, (404) 623-0096; or circle #127 on the reader service card.

## Cable stripper

The Model CX-700 cable stripper from Western Electronic Products features rotary cutters and a foot switch, allowing it to strip coaxial and concentric multiple pair cable, including semi-rigid. It will accept cable ranging from .040 to .450 inch.

The module can be adjusted for depth and length of cut and the cable holder adjusts to any size cable. A speed control and timer also are included.

For further details, contact Western Electronic Products, 915-G Calle Amanecer, San Clemente, Calif. 92672, (714) 492-4677; or circle #129 on the reader service card.

## Antennas

Available from Blonder-Tongue, the BTY line of professional broadband and single-channel VHF and UHF off-air antennas are now constructed using 6063 aluminum, a high strength Al/Mg/Ti alloy. According to the company, this combination eliminates rusting or corrosion on any part of the antenna and provides exceptional weathering properties. Its new element mounting clamp allows individual elements to be replaced without disassembling any other section of the antenna.

For more information, contact Blonder-Tongue Laboratories, 1 Jake Brown Rd., Old Bridge, N.J. 08857, (201) 679-4000; or circle #128 on the reader service card.

## Oscilloscope

Leader Instruments' Model 2100R 100 MHz CRT readout oscilloscope allows users to observe waveforms, setting conditions and measured values on a single display. On-screen cursors facilitate direct reading of measured values, voltage and time difference frequency and ratios.

It also offers three-channel capability, alternate triggering for simultaneous display of two asynchronous signals, alternate time base and six trace capability. According to the company, the unit has excellent triggering sensitivity and auto time base that displays the optimal number of cycles, video sync separators with line selector, relative holdoff, trigger slope and level control with preset.

For additional information, contact Leader Instruments, 380 Oser Ave., Hauppauge, N.Y. 11788, (516) 231-6900; or circle #139 on the reader service card.

## Combiners

Qintar's Models QAC-12 and QAC-24 are 12- and 24-channel amplifier combiners for connecting all single-channel processing equipment into a distribution system or trunk line. Both models have a frequency range of 50-440 MHz. Maximum output levels are +54 dBmV for the QAC-12 and +51 dBmV for the QAC-24 with a gain of ±17 dB and ±14 dB, respectively.

For additional details, contact Qintar Inc., P.O. Box 8060, Moorpark, Calif. 93020-8060, (805) 523-1400; or circle #119 on the reader service card.

## Frequency counter

Sencore's FC71 is a battery-operated, 1 GHz counter that provides 9.5 hours of continuous operation on a single charge and 0.5 PPM accuracy from 0 to 40°C, usable from −25 to 50°C. According to the company, it measures all signals, even complex noisy signals, and has

5 mV sensitivity average from 10 Hz to 1 GHz.

The unit provides .01 Hz resolution in one second and is double shielded for RFI immunity. Other features include crystal check and frequency ratio comparisons.

For further information, contact Sencore, 3200 Sencore Dr., Sioux Falls, S.D. 57107, (605) 339-0100; or circle #130 on the reader service card.


## Status monitoring

AM Communications is offering a status monitoring module that monitors system RF levels in both signal directions, system AC voltage, amplifier DC voltage, critical amplifier currents and temperature. In addition, it can monitor and control all of the switchable functions within the amplifier. It is available in several versions for sub-split, mid-split, high-split and dual cable installations and plugs directly into any Jerrold JN or JX series amplifier chassis.

For more information, contact AM Communications, 1900 AM Dr., P.O. Box 505, Quakertown, Pa. 18951, (215) 536-1354; or circle #123 on the reader service card.

## TV modulator

According to Olson Technology, its FCC-compatible OTM-3000 modulator is a full feature, frequency agile, SAW filtered unit with dual IF loops that will fit any modulator application. It provides high level +60 dBmV outputs on Chs. 2 through YY. All channels are selectable by front panel DIP switches including FCC offsets of 12.5 and 25 kHz.

For more details, contact Olson Technology, Star Route 1179-D, Sonora, Calif. 95370, (209) 586-1022; or circle #137 on the reader service card.

## Signal generator

The B&K-Precision Model 3017 sweep/function generator provides a signal source for sine, triangle and square waveforms, plus TTL pulse and CMOS pulse signals. It covers from 0.2 Hz to 2 MHz in seven ranges and includes internal or external sweep/source capability with continuously adjustable sweep width to a maximum 1,000:1 ratio.

For engineering applications, a variable DC offset simulates the presence of a DC signal on the generator output. Sine wave distortion is less than 1 percent, with square wave symmetry of better than 98 percent at 100 kHz and triangle wave linearity at 98 percent.

For additional details, contact B&K-Precision Division, Maxtec International Corp., 6470 W. Cortland St., Chicago, Ill. 60635, (312) 889-1448; or circle #138 on the reader service card.

## Power supply tester

Viewsonics introduced its 60/30 VAC load type power supply tester. Specifications include load voltage of 60 or 30 VAC (sine or square wave) and load current of 0, 5, 10 or 15 amperes (selective). RMS voltage and current reading meters, a selective load and voltage waveform reading port with test probe are supplied.

For further information, contact Viewsonics, 170 Eileen Way, Syosset, N.Y. 11791, (516) 921-7080; or circle #118 on the reader service card.

## Liquid semiconductor

Stabilant 22 from D.W. Electrochemicals is an initially non-conductive block polymer that, under the effect of an electrical field or when used in a very narrow gap between metal contacts, becomes conductive. The electrical field gradient at which this occurs is set so the material will not cause leakage between adjacent con-

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tacts in a multiple pin environment. It can be used wherever electrical contacts are used, such as in connections on main line or distribution amplifiers.

For more details, contact D.W. Electrochemicals, 9005 Leslie St., Unit 106, Richmond Hill, Ontario L4B 1G7, Canada, (416) 889-1522; or circle #132 on the reader service card.

## AC power supply

Performance Cable TV Products' ferroresonant power supply is designed to provide 60 VAC power required by cable systems using feedforward and power doubling amplifiers. It delivers 15 amperes of current and converts 120 VAC utility power to 60 V RMS.

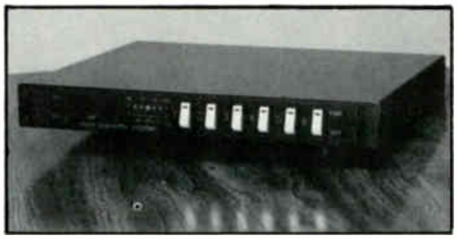
An optional cooling fan may be plugged directly into the compact unit, eliminating the need for additional wiring. The input is protected from surges by an MOV and the circuit breaker is rated at 20 amperes.

For further information, contact Performance Cable TV Products, 1770 Macland Rd., Hwy. 360, Dallas, Ga. 30132, (404) 443-2788; or circle #102 on the reader service card.

## Network analyzer

Legend Software announced LAN Patrol, a network analyzer for Ethernet and Starlan local area networks. A driver capable of monitoring activity for all users on a LAN at data rates up to 10,000 packets per second gathers network information. This information is stored within a 15 K memory resident program loaded on one PC on the network. Information can be gathered continuously for up to 30 days at a time on LANs as large as 1,024 nodes.

For further information, contact Legend Software, P.O. Box 1352, West Caldwell, N.J. 07007, (201) 227-8771; or circle #136 on the reader service card.



## Surge suppressor

Volta Diagnostic Systems introduced a multioutlet transient voltage suppressor to protect microcomputers, high fidelity audio systems and other sensitive electronic equipment from voltage spike and surges on the AC power line. It features a three-stage suppression circuit that begins to reduce a surge to safe levels in one-trillionth of a second. This circuit incorporates ultrafast PN silicon transient voltage suppressors, metal-oxide varistors and gas-discharge tubes.

For more details, contact Volta Diagnostic Systems, 421 Woodland Pl., Leonia, N.J. 07605, (201) 944-3540; or circle #124 on the reader service card.

## SCPC demodulator

According to Avcom, its SCPC-3000E single-channel per carrier demodulator features a high performance synthesized 50-90 MHz tuning module for maximum system versatility. Frequencies are tunable in 800 steps of 50 kHz each and standard expansions are 3:1 and 2:1 with others available.

De-emphasis is switchable between 2, 25, 50 and 75 $\mu$s. Selectable low pass 15, 7.5 and 5 kHz audio filters are also standard. The unit is available in wideband or narrowband versions.

For more details, contact Avcom, 500 Southlake Blvd., Richmond, Va. 23236, (804) 794-2500; or circle #131 on the reader service card.

## VC mainframe

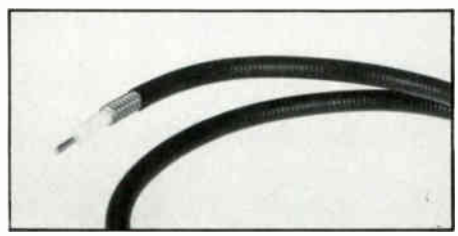
Nexus Engineering is offering its VCMB, a commercial VideoCipher (VC) mainframe. The product houses six VC descrambler modules in 10 inches of rack space and provides better cooling efficiency, according to the company. To complement the VCMB, Nexus also has designed a new line of headend equipment to further reduce rack space requirements. A typical Series 100 16-channel headend with 12 VC scrambled channels occupies less than 40 inches of rack space.

For more details, contact Nexus, 7000 Lougheed Hwy., Burnaby, British Columbia, Canada, V5A 4K4, (604) 420-5322; or circle #121 on the reader service card.

## Coax balun

The Black Box 232 coax balun is said to combine the signal-boosting power of a short-haul modem with the conversion technology of a balun to drive RS232 data up to 10 miles over coaxial cables. According to the company, designing a cabling system around these useful interface converter devices is an easy task: attach one balun to the RS232 cable coming from the host and another balun to the terminal, printer or other async peripheral. Then, connect the coaxial cable to each balun. Data speed depends on distance travelled; for example, at 10 miles, the speed is 1.2 kbps. For a short distance like one mile, the balun will drive data at 19.2 kbps.

For more details, contact Black Box, P.O. Box 12800, Pittsburgh, Pa. 15241, (412) 746-5500; or circle #120 on the reader service card.



## Coaxial cable

According to Cablewave Systems, its HCF 12-50J Cu2Y Cellflex coaxial cable is ideal for applications that require tight or continuous bending, as in interconnecting RF equipment. It has a stranded copper center conductor, foam dielectric and a corrugated copper tube outer conductor as well as weatherproof connectors.

Other specifications include a maximum operating frequency of 8,500 MHz with an impedance level of 50 ohms and 79 percent velocity of propagation. Nominal attenuation ranges between 2.3 dB/100 feet (at 400 MHz) to 5.8 dB/100 feet (at 2,000 MHz).

For more information, contact Cablewave Systems, 60 Dodge Ave., North Haven, Conn. 06473, (203) 239-3311; or circle #140 on the reader service card.

## Attenuators

According to Hughes Aircraft Co.'s Microwave Products Division, a new series of programmable millimeter-wave attenuators and instrument controllers is designed to provide precise control of signal levels in laboratory and OEM applications. The units provide better than 2 percent accuracy in standard waveguide frequency bands between 26.5 and 170 GHz. A stepper motor allows the user to program positioning of the attenuator. Resolution is 0.01 dB over the range of 0 to 100 dB.

For more information, contact Hughes Aircraft Co., Microwave Products Division, P.O. Box 2940, Torrance, Calif. 90509, (213) 568-6307; or circle #122 on the reader service card.

## 100 watt amplifier

Available from Amplifier Research, the Model 100W1000M7 broadband amplifier delivers up to 180 watts and a minimum of 100 watts of CW power for RFI susceptibility testing, antenna and component testing, wattmeter calibration and general RF lab work in the frequency band from 100 MHz to 1 GHz. Linear output at less than 1 dB gain compression is 70 watts and flatness is ±1.5 dB typical, ±2 dB maximum.

The unit has instantaneous bandwidth with no need for tuning or bandswitching. Other features include total immunity to load mismatch and ability to reproduce AM, FM or pulse modulation appearing on the input signal.

For further details, contact Amplifier Research, 160 School House Rd., Souderton, Pa. 18964, (215) 723-8181; or circle #133 on the reader service card.

## Universal counter

Available from Simpson Electric Co., its Model 714 1.3 GHz universal frequency counter is designed for R & D, breadboarding and testing applications and has three input ranges of DC to 100 MHz, DC to 2.5 MHz and 100 MHz to 1.3 GHz. Features include 1 ppm time base stability and aging, selectable time base, X1 and X10 attenuation and 150 kHz low-pass filter. It also offers adjustable triggering on Channels A and B, self-check and display of internal time base oscillator.

For more information, contact Simpson Electric Co., 853 Dundee Ave., Elgin, Ill. 60120, (312) 697-2260; or circle #141 on the reader service card.

## PAL modulator

Multiplex Technology is offering the D2V/PAL-HF in its D series Channelplus line of frequency agile modulators. The unit contains two independent PAL modulators that are digitally programmable to output on the upper UHF channels between 32 and 69, and complements the existing UHF-low model that provides output between channels 21 and 55. This product was developed specifically for the European, Middle Eastern, African and South American markets and is compatible with either PAL G or PAL I formats.

According to the company, installation and programming are simple. For each video source, the installer selects the desired output channel number by pushing front panel buttons. Calibration takes a few seconds and is done automatically by the unit's microcomputer right at the job site with no need for special instruments. The modular unit also comes with a combiner allowing the output to join with off-air or cable system inputs. It also is available for the NTSC standard.

For more information, contact Multiplex Technology, 251 Imperial Hwy., Fullerton, Calif. 92635, (714) 680-5848; or circle #101 on the reader service card.

## Bandstop filter

The Model 6430 CARS band bandstop filter from Microwave Filter Co. isolates the receive signal to prevent interference at receive and transmit sites. Passband is 12,700-13,050 MHz with a loss of 3 dB maximum. Stopband is 13,062.5-13,150 MHz with a loss of 40 dB minimum. It is made in WR-75 waveguide and measures 11¼ × 1½ × 1½ inches with rectangular cover flanges.

For additional details, contact Microwave Filter Co., 6743 Kinne St., East Syracuse, N.Y. 13057, (315) 437-3953; or circle #135 on the reader service card.


## Catalog

Wavetek's *1988-1989 Test and Measurement Instrumentation Catalog* contains detailed descriptions, technical specifications, illustrations, prices and ordering information for the company's line of signal sources and measurement equipment, plus related special equipment and components.

The 240-page catalog covers categories including instruments on a card, RF signal and sweep generators, signal level meters and signal switching systems. Twenty-five of the company's newest products are previewed in the first section.

For further details, contact Wavetek Corp., 9191 Towne Centre Dr., P.O. Box 85434, San Diego, Calif. 92122, (619) 450-9971; or circle #125 on the reader service card.

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Capitol Heights, MD 20743

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Richmond, Virginia 23220-4697
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**Greensboro, NC 27419**
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By Ron Hranac
Jones Intercable Inc.

Azimuth (in degrees relative to true north) between two locations can be calculated accurately using the great circle method. Like distance calculations, azimuth is determined using the geographical coordinates of the two locations. The great circle formula for azimuth is:

$$\text{Azimuth (degrees)}^* = \cos^{-1}\left(\frac{\sin(lat_2) - [\sin(lat_1) \times \cos(D/60)]}{\cos(lat_1) \times \sin(D/60)}\right)$$

where:

$lat_1$ = latitude of first location
$long_1$ = longitude of first location
$lat_2$ = latitude of second location
$long_2$ = longitude of second location
D = distance between locations in nautical miles

*Note: If $\sin(long_2 - long_1) \geq 0$, then azimuth = 360 − azimuth

To use the formula, you must first change latitudes and longitudes of the two locations from degrees-minutes-seconds to decimal degrees, and calculate the distance in nautical miles between the locations (see last month's "Tech Book").

**Problem:** Calculate the azimuth between a headend whose coordinates are 41°22′03″ north latitude, 105°38′56″ west longitude, and a remote hub site whose coordinates are 41°35′17″ north latitude, 105°39′32″ west longitude.

**Solution:** From the example in the August "Tech Book," these coordinates converted to decimal degrees are

**Headend**
$lat_1$ = 41.367500000°
$long_1$ = 105.648888889°

**Hub site**
$lat_2$ = 41.588055555°
$long_2$ = 105.658888889°

and the distance between the sites is:

D = 13.246713110 nautical miles

$$\text{Azimuth} = \cos^{-1}\left(\frac{\sin(41.588055555) - [\sin(41.367500000) \times \cos(13.246713110/60)]}{\cos(41.367500000) \times \sin(13.246713110/60)}\right)$$

$$= \cos^{-1}\left(\frac{0.663770305 - [0.660886272 \times \cos(0.220778552)]}{0.750486066 \times \sin(0.220778552)}\right)$$

$$= \cos^{-1}\left(\frac{0.663770305 - [0.660886272 \times 0.999992576]}{0.750486066 \times 0.003853303}\right)$$

$$= \cos^{-1}\left(\frac{0.663770305 - 0.660881366}{0.002891850}\right)$$

$$= \cos^{-1}\left(\frac{0.002888939}{0.002891850}\right)$$

$$= \cos^{-1}(0.998993380)$$

$$= 2.571028102^\circ$$

One condition of great circle azimuth calculations is if $\sin(\text{long}_2 - \text{long}_1) \geq 0$, then the actual azimuth equals 360 − the azimuth calculated with the formula. To find out if this is the case in this example, you must calculate $\sin(\text{long}_2 - \text{long}_1)$.

$$= \sin(105.658888889 - 105.648888889)$$

$$= \sin(0.010000000)$$

$$= 0.000174533$$

Since the answer is greater than 0, you must subtract the azimuth calculated with the formula from 360:

360 − 2.571028102 = 357.4289719.

The correct azimuth (relative to true north) is 357.43°.

## September

**Sept. 7-9: Eastern Show,** Atlanta Merchandise Mart, Atlanta. Contact Nancy Horne, (404) 252-2454.

**Sept. 8: SCTE Central California Meeting Group** technical seminar on satellite technology. Contact Andrew Valles, (209) 453-7791; or Dick Jackson, (209) 384-2626.

**Sept. 9: SCTE Upstate New York Meeting Group** technical seminar on fiber optics, The Lodge on the Green, Corning, N.Y. Contact Ed Pickett, (716) 325-1111.

**Sept. 11-13: South Dakota Community Television Association** annual meeting, Sylvan Lake Lodge, Custer, S.D. Contact Jerry Steever, (605) 224-0313.

**Sept. 12-13: Wisconsin Cable Communications Association** annual convention, The Abbey, Fontana, Wis. Contact Lynne Walrath or Nancy Magestro, (608) 256-1683.

**Sept. 12-14: SCTE** Technical Training Seminar, Harvey Hotel, Dallas. Contact (215) 363-6888.

**Sept. 12-16: Information Gatekeepers'** International Fiber-Optic Communications and Local Area Networks Exposition (FOC/LAN 88), Atlanta. Contact (617) 232-3111.

**Sept. 13: SCTE Central Illinois Meeting Group** BCT/E review course on Category VI, Sheraton Inn, Normal, Ill. Contact Tony Lasher, (217) 784-8390.

**Sept. 13-15: Magnavox CATV** training seminar, Columbus, Ohio. Contact Amy Costello, (800) 448-5171.

**Sept. 18-20: Kentucky Cable Television Association** annual convention, Marriott Resort, Lexington, Ky. Contact Randa Wright, (502) 864-5352.

**Sept. 18-20: Pacific Northwest Cable Communications Association** annual convention, Cavanaugh's Inn at the Park, Spokane, Wash. Contact Dawn Hill, (509) 765-6151.

**Sept. 19-21: Siecor Corp.** technical seminar on fiber-optic cable testing, Hickory, N.C. Contact (704) 327-5539.

**Sept. 20-22: Magnavox CATV** training seminar, Detroit. Contact Amy Costello, (800) 448-5171.

**Sept. 20-22: C-COR Electronics** technical seminar, Kansas City, Mo. Contact Shelley Parker, (800) 233-2267.

**Sept. 21-23: Iowa Cable Television Association** convention, Frontier Motor Lodge, Council Bluffs, Iowa. Contact Tom Graves, (515) 245-7830.

**Sept. 21: SCTE North Central Texas Chapter** technical seminar. Contact Vern Kahler, (817) 265-7766.

**Sept. 21: SCTE North Jersey Chapter** technical seminar on signal leakage. Contact Art Muschler, (201) 672-1397.

**Sept. 26-29: Siecor Corp.** technical seminar on fiber-optic installation and splicing for LANs, building and campus applications, Hickory, N.C. Contact (704) 327-5539.

**Sept. 27: SCTE Satellite Tele-Seminar Program,** "Standby power supply maintenance with automatic performance monitoring," 12-1 p.m. ET on Transponder 7 of Satcom F3R. Contact (215) 363-6888.

**Sept. 27-29: Great Lakes Expo,** Cobo Hall, Detroit. Contact Steve Smith, (517) 351-5800.

**Sept. 27-29: SCTE Great Lakes Chapter** technical seminar. Contact Daniel Leith, (313) 549-8288.

**Sept. 27-29: Magnavox CATV** training seminar, Chicago. Contact Amy Costello, (800) 448-5171.

### Planning ahead

**Oct. 4-6:** Atlantic Show, Convention Center, Atlantic City, N.J.

**Oct. 18-20:** Mid-America Show, Hilton Plaza Inn, Kansas City, Mo.

**Dec. 7-9:** Western Show, Convention Center, Anaheim, Calif.

**Feb. 22-24:** Texas Show, Convention Center, San Antonio, Texas.

**May 21-24:** NCTA Show, Convention Center, Dallas.

**June 15-18:** Cable-Tec Expo '89, Orange County Convention Center, Orlando, Fla.

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# Innovation in a competitive environment

**By Walter S. Ciciora, Ph.D.**
Vice President of Technology
American Television and Communications Corp.

I recently had the opportunity to reread a book I had first read a couple of years ago. I'd like to recommend it and discuss some of its main points and how they may relate to the cable industry. The book is titled *Innovation, the Attacker's Advantage* by Richard Foster, published by Summit Books.

Reading it now is especially timely, since the cable industry has Cable Labs, its own research and development consortium. Dick Leghorn, a major force in the creation of Cable Labs, defines three levels of technical activity: invention, innovation and the diffusion of technology. He believes that innovation is the most appropriate activity for Cable Labs. Let's look into innovation this month.

Invention is the creation of new technology where none existed before. True invention cannot be scheduled or planned and the process is not well understood. There can be long dry spells of little or no invention, which is difficult to accommodate in a profit-oriented business. True invention is best left to government, university, and large industrial laboratories; expecting invention from a modest-sized consortium is not realistic and is likely to lead to failure.



Innovation is the creative process of knitting together inventions that already exist into things of commercial significance. Fortunately, there is enough invention taking place to feed this process. The scarcity is in innovation, or making something useful out of other peoples' inventions. This is intended to be the main task of Cable Labs.

### The S-curve

Understanding innovation in a competitive environment involves a concept called the "S-curve." As we've discussed before, cable is certainly entering a period of competition. Nearly every human endeavor follows some sort of horizontally stretched-out S-curve. The progress of technological innovation is governed by the S-curve; understanding it will help us deal with competitive technologies.

What does the S-curve look like? If we plot output on the vertical axis and input on the horizontal axis, we find there are three portions to the graph. First, there is a near horizontal start-up portion followed by a near vertical growth phase, ending with another near horizontal section representing stagnation. The input might be time, money, number of employees or some other measure of effort. The output might be the quantity or quality of product, the number of innovations from an R & D lab, the efficiency of a process or some other measure of the good results expected from the activity.

Start-up involves the expenditure of effort and money with little output. The graph is nearly horizontal with just a slight upward tilt. The upfront facilitation phase is the initial investment before any returns can be expected.

The growth phase is the most exciting period. Output increases well out of proportion to increases in input. This is the payoff for deciding to do the project. The danger here is assuming that growth goes on forever. Too many become complacent and forget about the next almost inevitable phase.

The period of stagnation is well-known as the consequence of going beyond the point of diminishing returns. Here, more and more effort is required to get just a little more output. The smart thing to do is find another S-curve in which to invest the profits of the original endeavor. Unfortunately, too many folks fall in love with their first S-curve and refuse to leave it. The stagnation leads to despair and a competitor finds the new S-curve and displaces the inflexible individual who can't let go of the past.

There is another concept similar to the S-curve called the "learning curve" or "experience curve," which is really nothing more than the first two portions of the S-curve. It is an optimistic point of view that fails to account for the point of diminishing returns.

There are plenty of examples of technological S-curves. One we've recently lived through is that of the audio prerecorded disc. We've grown up with the analog record and saw its progress up its S-curve. First there were shellac 78 rpm discs, with a relatively long period of very slowly increasing quality. Then 33⅓ and 45 rpm records displaced the 78s, bringing us to the center portion of the curve. Early on, stereo was added and substantial technical progress was made in a relatively short period of time. Then stagnation set in; very little further technical progress could be made on a truly mature technology. There were some attempts, such as quadraphonic recording, to bring an improvement, but they failed. The analog mechanical record had traversed its entire S-curve.

The digital compact disc brought us to a new S-curve. It too started with a flat period of little growth. As prices came down and the number of titles increased, we made a sharp bend upwards and are now headed toward some future point of diminishing returns. We're not there yet, but we know it will come. Perhaps the next S-curve will involve recordable compact discs.

Another example of a technological S-curve is vacuum tube technology. After a period of slow growth, smaller, more powerful, more energy-efficient devices ran us up a steep path of progress. The point of diminishing returns came as we found it harder to make them smaller and dissipate the heat. The transistor gave us a new S-curve. It is curious to note that most of the important producers of vacuum tubes could not let go of their emotional ties to their old technology. The leaders of the transistor industry were companies that, for the most part, had no hang-ups over the vacuum tube business.

### Limits

The physical limits of a technology bring us to the point of diminishing returns. It is important to understand limits in order to forecast when it's time to abandon an old S-curve and to jump to another. A current and relevant example is our interest in advanced television systems and high-definition television. Color TV technology has given us increasingly better pictures. Initially, the NTSC technical specifications were able to theoretically provide better pictures than practical receivers could display in the home. We've progressed to the point where the receiver can display a better picture than can be conveyed by the NTSC signal standard. We are well into the stagnation part of the curve where getting a still better picture will require much more expensive hardware. Improved definition television will attempt to accomplish this. But perhaps it's time to jump to a new S-curve—HDTV.

Next month we will focus in a little closer on S-curves and limits in cable and what they mean for competition.

**See us at the Great Lakes Show, Booths 213 & 215. See us at the Atlantic City Show, Booths 652 & 654. Reader Service Number 65.**