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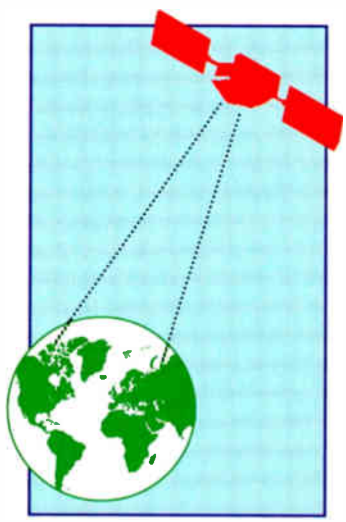

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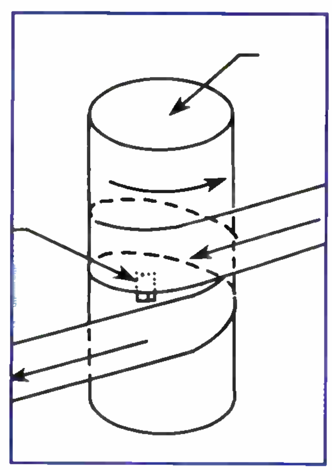

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Glowing fiber ©Stock Imagery/Chris Rogers; inset fiber-optic construction photo courtesy Corning Inc.

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EDITOR'S LETTER

The powers that be

I remember attending a city council meeting in a small Pacific Northwest town about 10 years ago as a guest of the local cable system manager. (I was an engineer with that company's regional office at the time.) Our system manager was pleading his case for a nominal rate increase to offset normal inflationary increases in the cost of doing business.

He presented considerable evidence to support the need to bring the rates up something like 3 or 4 percent. P&L statements, system budgetary information and other documents justified his request. Since this time period was in the days before deregulation, the council had the final say in the matter.

Well, after a fairly lengthy presentation, the city council told him "no." He asked why they wouldn't approve his request for a rate increase, particularly since he had been pretty thorough and very reasonable in his justification. "Because we don't want to," was the answer.

That memory of a ridiculous show of authority by some country yokels who had obviously let a little power go to their heads came rushing back when I saw the recent *CableFAX* story about the fiasco in Springfield, Mo. City officials there are preventing the local cable operator from upgrading its system with fiber. The city apparently also refused to let Southwestern Bell install fiber to upgrade its telephone facilities!

Another show of authority? Sort of. It seems Springfield's city-owned utility company has already installed a fiber network of its own, and wants to lease that network back to Bell and TeleCable (the CATV company). And of course, the city has to justify its questionable investment of taxpayer dollars by generating revenue with that new network.

I wonder if they thought to ask TeleCable or Southwestern Bell if either company would be interested in such a lease-back arrangement before they decided to go ahead and build the fiber network. Probably not. I imagine that officials were too busy dreaming how they would spend all the new income that this great city-owned fiber system would create.

In any case, this thing has caused quite a stir. TeleCable has filed in federal court to seek a declaratory ruling on the matter. This one has to go down as one of the better (?) examples of city officials abusing authority. As the vice president and general manager for the system, Jerry Rutherford, so eloquently put it: "Springfield is apparently the only city on the planet opposing this kind of technological improvement in its cable services."

Keeping you informed

From time to time we present reprints of CATV engineering conference papers. National conferences attract a lot of people, but most in the industry will never hear the quality technical presentations or read the fine papers that are presented at these confabs. So every now and then we select a few of those papers for publication in *CT*. This month we have three such papers, two from NCTA and one from SCTE. We like to think of this as one way to bring the best of these shows to those of you who aren't able to attend. *Enjoy!*

Ronald J. Hranac
Senior Technical Editor

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Proposed rule making

The following is taken from a Federal Communications Commission Notice of Proposed Rule Making on cable TV technical and operational requirements adopted June 13, 1991 (released June 27). This installment covers technical standards. See last month's "News" for the proposed performance tests.

2. Section 76.605 is proposed to be amended by revising paragraphs (a) and (b), and by revising Note (1), by redesignating Note (2) as Note (3) and by adding a new Note (2) to read as follows:

§ 76.605 Technical Standards.

(a) The following requirements apply to the performance of a cable television system as measured at any subscriber terminal with a matched impedance at the termination point or at the headend of the cable television system as noted. The requirements are applicable to each analog NTSC video downstream cable television channel in the system:

(1) The cable television channels delivered to the subscriber's terminal shall be capable of being received and displayed by TV broadcast receivers used for the off-the-air reception of TV broadcast signals, as authorized under Part 73 of this chapter.

(2) The aural center frequency of the aural carrier must be 4.5 MHz ±5 kHz above the frequency of the visual carrier.

(3) The visual signal level, across a terminating impedance which correctly matches the internal impedance of the cable system as viewed from the subscriber terminal shall be not less than 2 millivolts across an internal impedance of 75 ohms (6 dBmV). At other impedance values, the visual signal level shall be 2 times the square root of 0.0133(Z) millivolts, where Z is the appropriate impedance value.

(4) The visual signal level on each channel shall not vary more than 12 decibels within any six month interval which must include tests performed during a 24-hour period in July or August and a 24-hour period in January or February and shall be maintained within:

(i) 3 decibels of the visual signal level of any visual carrier within 6 MHz nominal frequency separation;

(ii) 12 decibels of the visual signal level on any other channel;

(iii) A maximum level such that signal degradation due to overload in the subscriber's receiver does not occur.

(5) The rms voltage of the aural signal shall be maintained between 13 and 17 decibels below the associated visual signal level.

(6) The frequency response of the system shall be within a range of ±2 decibels across the 6 MHz band of fre-

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quencies of the cable television channel.

(7) The ratio of RF visual signal level to system noise and of RF visual signal level to any undesired co-channel television signal operating on proper offset assignment, shall not be less than 43 decibels. However, for class I cable television channels, this requirement is applicable only to:

(i) Each signal which is delivered by a cable television system to subscribers within the predicted Grade B contour for that signal;

(ii) Each signal which is first picked up within its predicted Grade B contour;

(iii) Each signal that is first received by the cable television system by direct video feed from a TV broadcast station, a low power TV station, or a TV translator station.

(8) The ratio of visual signal level to the rms amplitude of any coherent disturbances such as intermodulation products, second and third order distortions, or discrete-frequency interfering signals not operating on proper offset assignments shall be as follows:

(i) The ratio of visual signal level to coherent disturbances shall not be less than 53 decibels for noncoherent channel cable systems; or

(ii) The ratio of visual signal level to coherent disturbances shall not be less than 47 decibels for coherent channel cable systems.

(9) The terminal isolation provided to each subscriber terminal shall not be less than 18 decibels, and shall be sufficient to prevent reflections caused by open-circuited or short-circuited subscriber terminals from producing visible picture impairments at any other subscriber terminal.

(10) The peak-to-peak variation in visual signal level caused by undesired low frequency disturbances (hum or repetitive transients) generated within the system, or by inadequate low frequency response, shall not exceed 3 percent of the visual signal level.

(11) The chrominance-luminance delay inequality or chroma delay, which is the change in delay time of the chrominance component of the signal relative to the luminance component after passing through the system, shall be within 150 nanoseconds.

The following requirements apply to the performance of the cable television system as measured at the processing facilities or headend of the system:

(12) The differential gain for the color subcarrier of the television signal, which is measured as the difference in amplitude between the largest and smallest segments of the chrominance signal, divided by the largest and expressed in percent, shall not exceed ±20 percent.

(13) The differential phase for the color subcarrier of the television signal, which is measured as the largest phase difference in degrees between each segment of the chrominance signal and reference segment, the segment at the pedestal level of 0 IRE shall not exceed ±5 degrees.

(14) As an exception to the general provision requiring measurements to be made at subscriber terminals, and without regard to the type of signals

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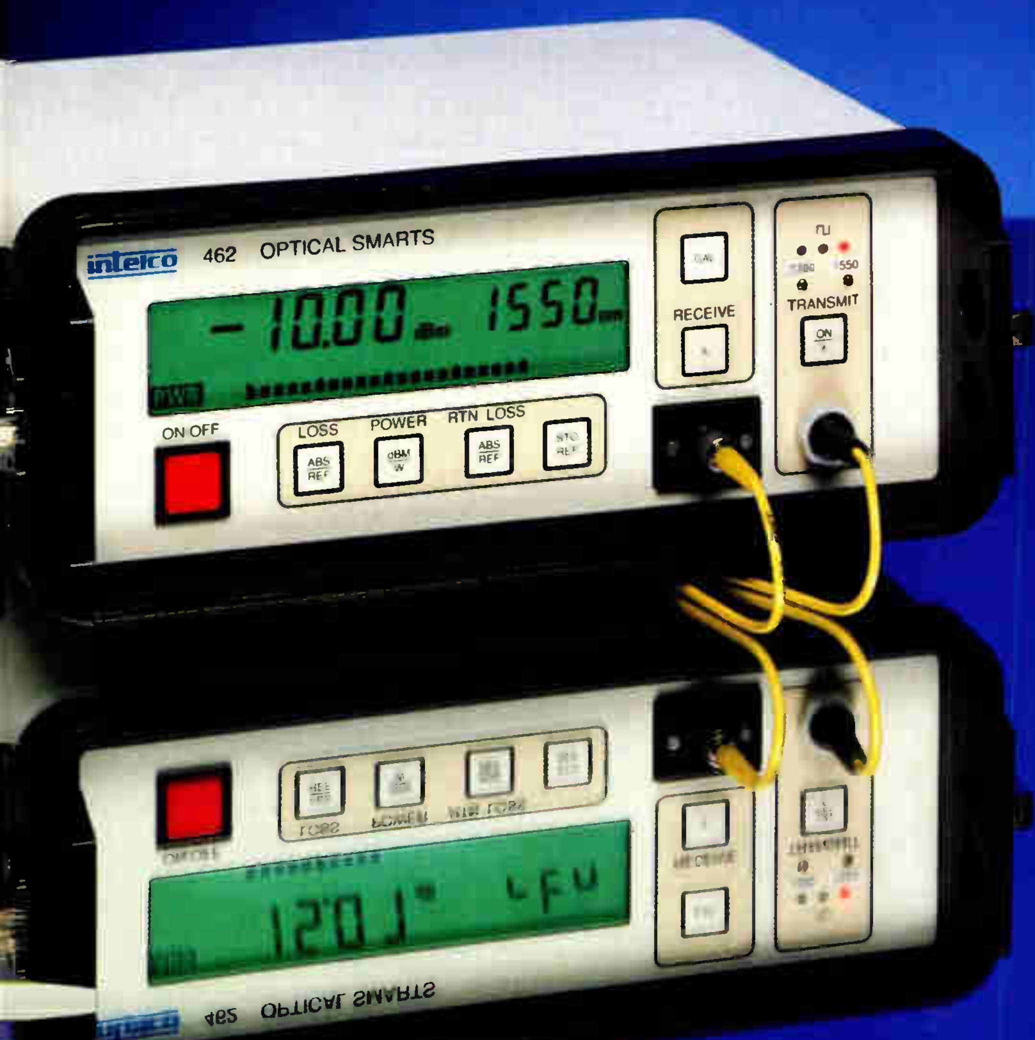

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carried by the cable television system, signal leakage from a cable television system shall be measured in accordance with the procedures outlined in § 76.609(h) and shall be limited as follows:

Frequencies	Signal leakage limit (µV/m)	Distance (m)
Less than and including 54 MHz, and over 216 MHz	15	30
Over 54 up to and including 216 MHz	20	3

(b) Cable television systems distributing signals by using methods such as nonconventional coaxial cable techniques, non-coaxial copper cable techniques, specialized coaxial cable and fiber optical cable hybridization techniques or specialized compression techniques or specialized receiving devices, and which, because of their basic design cannot comply with one or more of the technical standards set forth in paragraphs (a) of this section, may be permitted to operate: **Provided,** that an adequate showing is made which establishes that the public interest is benefited. In such instances, the Commission may prescribe special technical requirements to ensure that subscribers to such systems are provided with an equivalent level of good quality service.

Note 1: State or local franchising authorities may incorporate the requirements in § 76.605(a) into a cable system's franchise. The Commission will not apply these requirements to cable systems serving fewer than 1,000 subscribers, although franchising authorities may apply these or less stringent requirements to such cable systems.

Note 2: For systems serving areas, in whole or part, with fewer than [ ] homes per mile, the system may negotiate with its local franchising authority for standards less stringent than those in §§ 76.605(a)(3), 76.605(a)(7), 76.605(a)(8), and 76.605(a)(10). Any such agreement shall be reduced to writing and accompany the system's proof of performance records.

*****

3. Section 76.609 is proposed to be amended by revising the last sentence in paragraph (e), by revising the first sentence in paragraph (h) and by revising paragraph (i) to read as follows:

(e) ***Alternatively, measurements made in accordance with the NCTA Recommended Practices for Measurements on Cable Television Systems, 2nd edition, November 1989, on noise measurement may be employed.

(h) Measurements to determine the field strength of the signal leakage emanated by the cable television system shall be made in accordance with standard engineering procedures.

(i) Measurements made to determine the differential gain, differential phase, and the chrominance-luminance delay inequality (chroma delay) shall be made in accordance with the NCTA Recommended Practices for Measurements on Cable Television Systems, 2nd edition, November 1989, on these parameters.

Cable industry talks to be uplinked live

In conjunction with the National Cable Television Center and Museum (NCTCM), SCTE will co-sponsor the live transmission via satellite of two cable TV lectures to be presented at Pennsylvania State University as part of the NCTCM's "Museum Series."

The NCTCM plans to provide a toll-free 800 number to allow viewers to call in and ask questions of the speakers as the events occur.

Patrick Michaels, chairman of Communications Equity in Tampa, Fla., is set to give a presentation on "The Globalization of Cable Television" Sept. 10 from 1-2 p.m. Eastern time. ATC Senior Vice President of Engineering and Technology Jim Chiddix is scheduled to speak on "Cable Technology" Oct. 30 from 11 a.m. to 12 noon Eastern time.

This joint effort between SCTE and the NCTCM will be uplinked on the satellite used for SCTE's monthly Satellite Tele-Seminar Program, Transponder 6 of Galaxy 1. For further information on these programs, contact SCTE at (215) 363-6888.

Classic equipment contest winners announced at expo

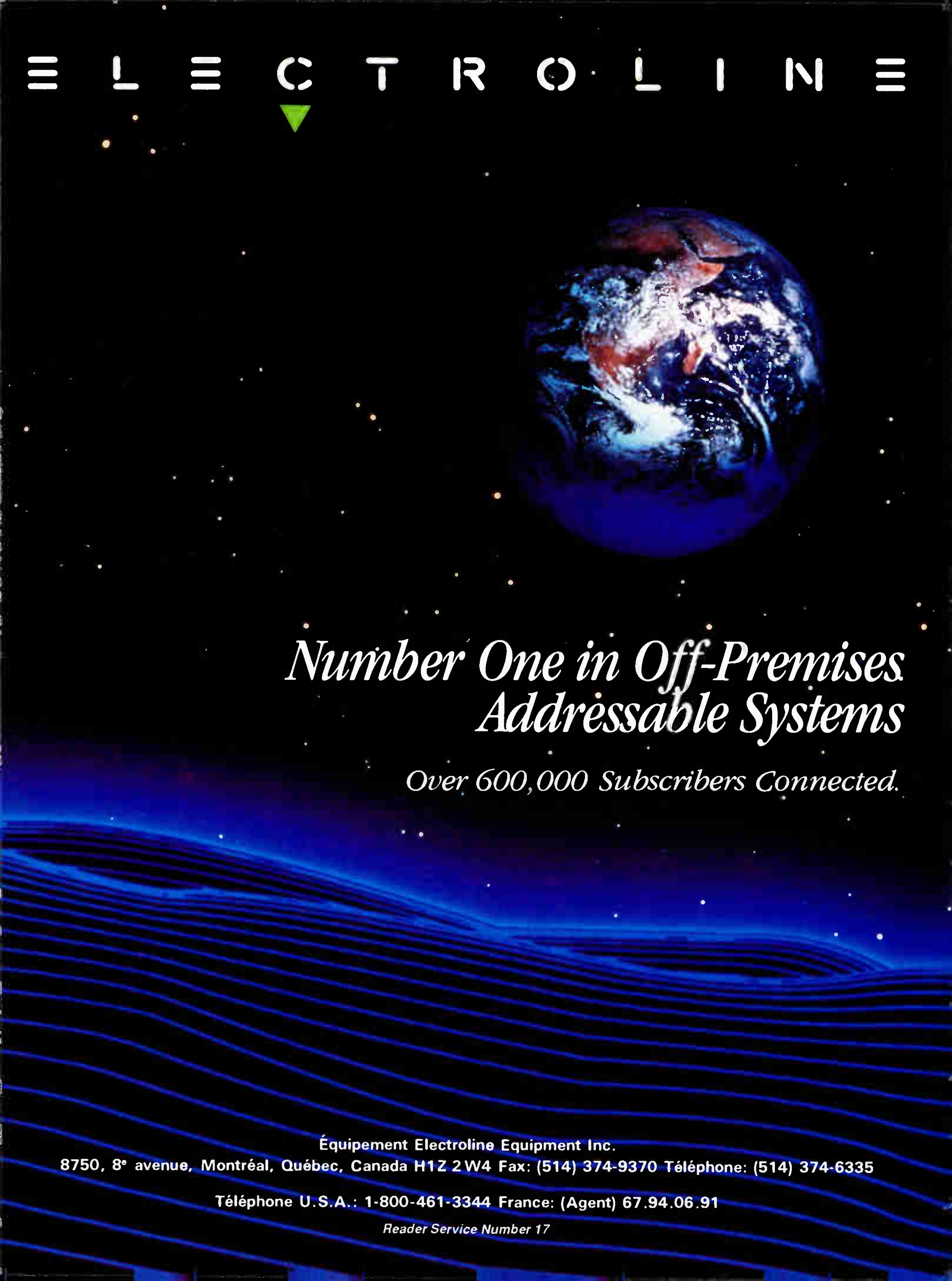
An SKL 12-channel trunk amplifier entered by Par Petersen of Western Communications in California won first place in the 1991 Classic Equipment Competition held at Cable-Tec Expo '91 and sponsored by SCTE and the National Cable Television Center and Museum. The competition is held annually at the expo, with all entries going to the collection of the center and museum at Pennsylvania State University in University Park, Pa.

The first prize award of $300 was presented to Petersen by SCTE Executive Vice President Bill Riker. The second prize of $200 went to Ken Degraffenreid of TCI in Kings Beach, Calif., for his entry of a Jerrold Tele Trol Model TM modulator. Jack Gobbo of United Artists Cable in Scotts Valley, Calif., was the winner of the $100 third prize for his entry of an early 1960 Ameco power supply.

The judges in the competition were Len Ecker of the the Len Ecker Corp., Jim Stilwell of Teleservices and Riker. The three winning entries will be on display in the NCTCM through 1991, and will then be entered in its collections for cataloging and preservation, according to NCTCM Director Marlowe Froke.

Senior member Ken Foster dies

Kenneth Foster, 63, a senior member of the Society, died May 31 after a short illness. A long-time resident of Troy, N.Y., he was the director of the New York State Commission on Cable Television's telecommunications divi-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sion. Prior to his appointment to the commission staff, he was the assistant director of engineering for the State University of New York's (SUNY) TV network and had designed its facility as well as numerous TV studios and communications networks for SUNY campuses. He joined SCTE in 1972.

Foster had been chief engineer of radio station WVOS in Liberty, N.Y., and held a number of supervisory positions at the NBC and CBS networks and the Reeves Broadcasting Co. in New York City prior to joining state service. He served on several national TV broadcast, recording and cable standards committees. He served on the FCC's Cable TV Advisory Committee on Technical Standards and acted as consultant to several agencies of state and federal government.

Foster is survived by his wife, Anne. Contributions may be made to the St. Joseph's Church Tiffany Window Fund, 416 3rd St., Troy, N.Y. 12180.

Annual Membership Meeting held at expo

The Society held its Annual Membership Meeting on June 13 in conjunction with Cable-Tec Expo following the conclusion of the Engineering Conference. Most of the members' questions concerned the BCT/E Certification Program. One member asked what is being done with the comments and questions that candidates write on the back of their BCT/E exam answer sheets. Others inquired as to when the existing exams will be updated, as many are based upon data and standards that have changed as technology has advanced.

It was announced that a new group of subcommittees has been established under the Society's Training Committee chaired by Walt Ciciora, Ph.D., to resolve these specific problem areas. The BCT/E Exam Review Subcommittee has the task of reviewing and updating exams. New tests are already being completed for Category II, "Video and Audio Signals and Systems," and Category III, "Transportation Systems," along with updated bibliographies. Category III will be reviewed for question sequence, as well as realignment of the program outline, particularly Section IV, "Alternative Transportation Methods," to reorganize microwave, satellite systems, coaxial supertrunk and optical fiber trunks into separate sections. Other exams are almost complete for Category V, "Data Networking and Architecture," and Category VII, "Engineering Management and Professionalism." This same subcommittee also will review comments submitted by members who take exams and question the validity of the questions or answers. The exact procedures have not been established at present, but action in this specific area is expected to be taken quickly.

The question of the Society publishing an affordable study guide for the BCT/E Program similar to the old FCC exam study book was raised again. The board and the Exam Review Subcommittee have both stated very strongly that the Society will not publish any kind of question-and-answer reference book. The feeling is that the candidate will memorize the questions and answers and will not necessarily know the answers or how to look them up in the appropriate reference materials. New bibliographical references are being developed by category as the exams are being rewritten. The Society plans to make these available, by category, as soon as they are completed.

Fiber cable placement: An overview of the basics

The following article is reprinted with permission from the Society of Cable Television Engineers' "Fiber Optics 1991" proceedings manual.

By K. Charles Mogray Jr.
Applications Engineering Manager, Comm/Scope Inc.

Although commercial fiber cable systems have been in service since 1977, it has only been within the last several years that CATV operators have begun to aggressively install fiber-optic cable. As these new system architectures utilizing fiber gain wider acceptance and as fiber penetrates deeper into the CATV network, the quantity of fiber cable installed in those networks will dramatically increase. Fiber installation will be used to complement as well as supplement existing coaxial cable systems. Managers at all levels need a general understanding of what is required to place that passive fiber cable system in service.

Figure 1: Fiber-optic transmission system

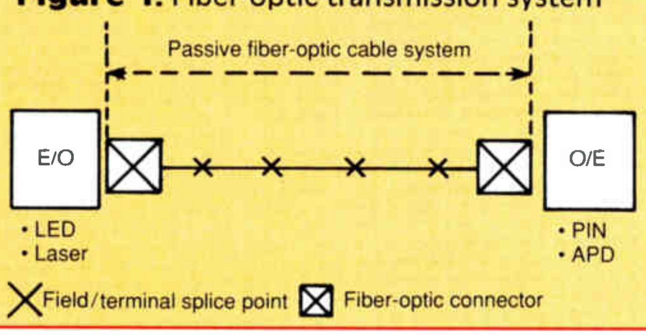
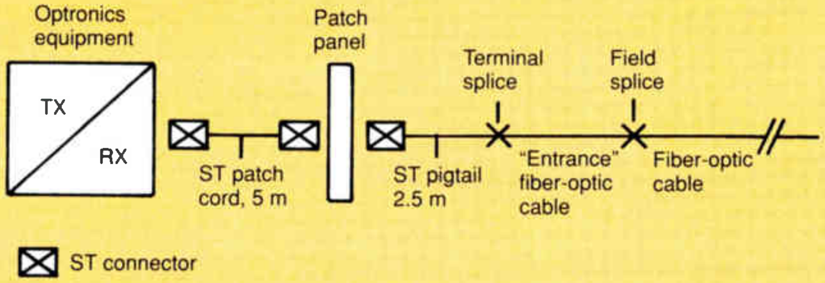


Figure 2: Typical end termination detail (not to scale)



Passive cable system

The passive fiber cable system is defined as the cable installed from connector tip to connector tip as shown in Figure 1. It consists of the "outdoor" cable and any "pigtails or connectors" attached directly to it. The connector tip may be terminated directly at the laser transmitter/receiver (TX/RX) equipment or in a "patch panel" as shown in Figure 2. For clarity, terms that are commonly used to describe the components of the passive fiber cable system are as follows:

- *Pigtail*: A relatively short piece of tight buffered fiber (usually 900 micron outer diameter) jacketed with a fire-retardant polyurethane or PVC outer covering with a connector installed on one end.
- *Patchcord/jumper:* A relatively short piece of tight buffered fiber (usually 900 micron outer diameter) jacketed with a fire-retardant polyurethane or PVC outer covering with connectors installed on both ends.
- *Sleeves/adapters:* Mechanical devices installed in patch panels or at equipment that are used to connect and align two connectors.
- *Distribution shelves/patch panels:* A box used at the headend where large outdoor cables terminate. These shelves/panels provide easy access to the outside plant cable and the electronic equipment for testing, troubleshooting, fault locating and cross-connection of fibers.
- *Connector:* A mechanical device de-

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Figure 3: Pulling grip with swivel (typical)

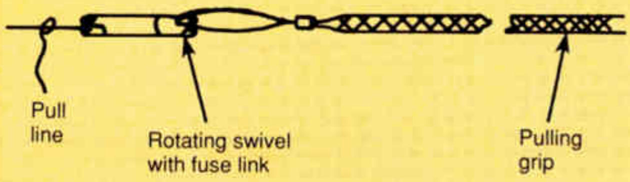
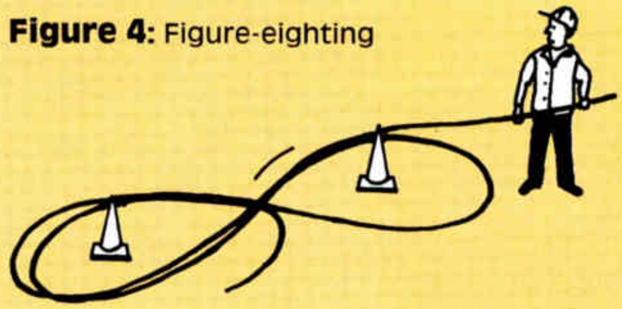


Figure 4: Figure-eighting



signed to permit the coupling of the fiber to the TX/RX equipment or other fibers.

• *Splice closure:* A plastic or metal protective housing designed to provide environmental protection to the fiber splices in the field.

Construction administration

Before beginning any construction activity, proper and thorough engineering must be done. Complete engineering drawings and specifications should be provided to the construction team. A joint review of the actual cable route should be conducted by both engineering and construction. Ideally, this review should occur prior to the final issuance of the engineering drawings and specifications. Significant costs in time and money can be incurred by the operator because of poor engineering that results in field changes. Value engineering will optimize the design and preclude most changes during the construction of the passive cable system.

Assuming all rights-of-way have been obtained, necessary permits must be obtained from the authorities with jurisdiction over the cable route. Permits normally are acquired from local, state and federal agencies and these permits may dictate the use of certain construction techniques. The construction crews must be aware of any constraints placed on their operations by permit-issuing authorities. Most commonly these constraints will apply to traffic control, bridge attachments, working hours, boring methods and/or clearances.

Once the contract has been awarded, a joint survey or ride-out by engineering and construction personnel should be mandatory. The purpose of this pre-construction survey is to identify problem areas, locate splice points and determine any special requirements of the work. All permits should be made available to the construction contractor for review.

The detailed planning for the actual cable placement can now begin. The construction management team will locate construction yards and begin to mobilize the necessary labor, material and equipment required to build the passive fiber cable system. Labor, material and equipment will be a function of the size and type of construction required to install the plant. The logistics involved in building a large fiber cable system are extremely complex.

During the ride-out, the contractor should visualize how each cable will be placed. Detailed schedules and plans should be developed to ensure that all preliminary work is done prior to start of cable placement. Because of the long lengths of cable that are typical for fiber optic systems, the contractor must plan a strategy in great detail for placing each cable. Cable lengths of 20,000 feet are not uncommon and require special handling.

Preparatory activities

The construction crews are now ready to begin field work. The first call should be made to the local utility locating service. Utility locates are required by law in most states. In addition, safety and economic reasons demand that all contractors make use of this service. The cost associated with inadvertently cutting a buried service can be extreme.

For aerial plant, the initial activity loosely defined as "makeready" consists of numerous tasks. Pole clearances and rearrangements, if required, among various utilities on joint-use poles must be completed. The National Electrical Safety Code and local codes should be strictly followed. Tree trimming, anchors, downguys, hardware and strand placement can begin as well.

If the plant is to be underground, ducts should be cleared by rodding, brushing or using a mandrel. Pull lines and/or subducts can be installed. For direct buried plant, the construction crews can begin bores, install conduit and make bridge attachments.

Bores and bridge attachments must be carefully engineered and specified. Many locales restrict the use of certain types of bores; permits normally will define permissible boring methods. Trench boxes and/or shields should be mandatory.

Cable placement

There are three basic types of cable plant: aerial, underground and direct buried. The decision as to which type of construction is done is based on engineering, regulatory agencies and economics. It's not uncommon to see all three construction types used on any one project.

Construction crews have certain methods of cable placement they are more inclined to use; every construction project is unique. Equipment, labor and previous training/experience will usually dictate the exact methods used. Within reason, don't specify the techniques to be used provided the construction crews are working safely; adhering to the plans, specifications and permits; meeting the schedule; and not jeopardizing the integrity of the cable. *Do* enforce the following rules during the construction process:

1) Practice safe operations at all times.

2) Know the maximum allowable pulling tension for the cable being placed and do *not* exceed that tension.

3) Use tension monitoring/limiting devices when placing fiber cable.

4) Know the minimum allowable bending radius for the cable being placed and do *not* exceed that bending radius.

5) Use a swivel between the pull rope and fiber cable to avoid twisting (Figure 3).

During the placement of fiber cable, it may need to be unreeled and reeled for various reasons. This technique,

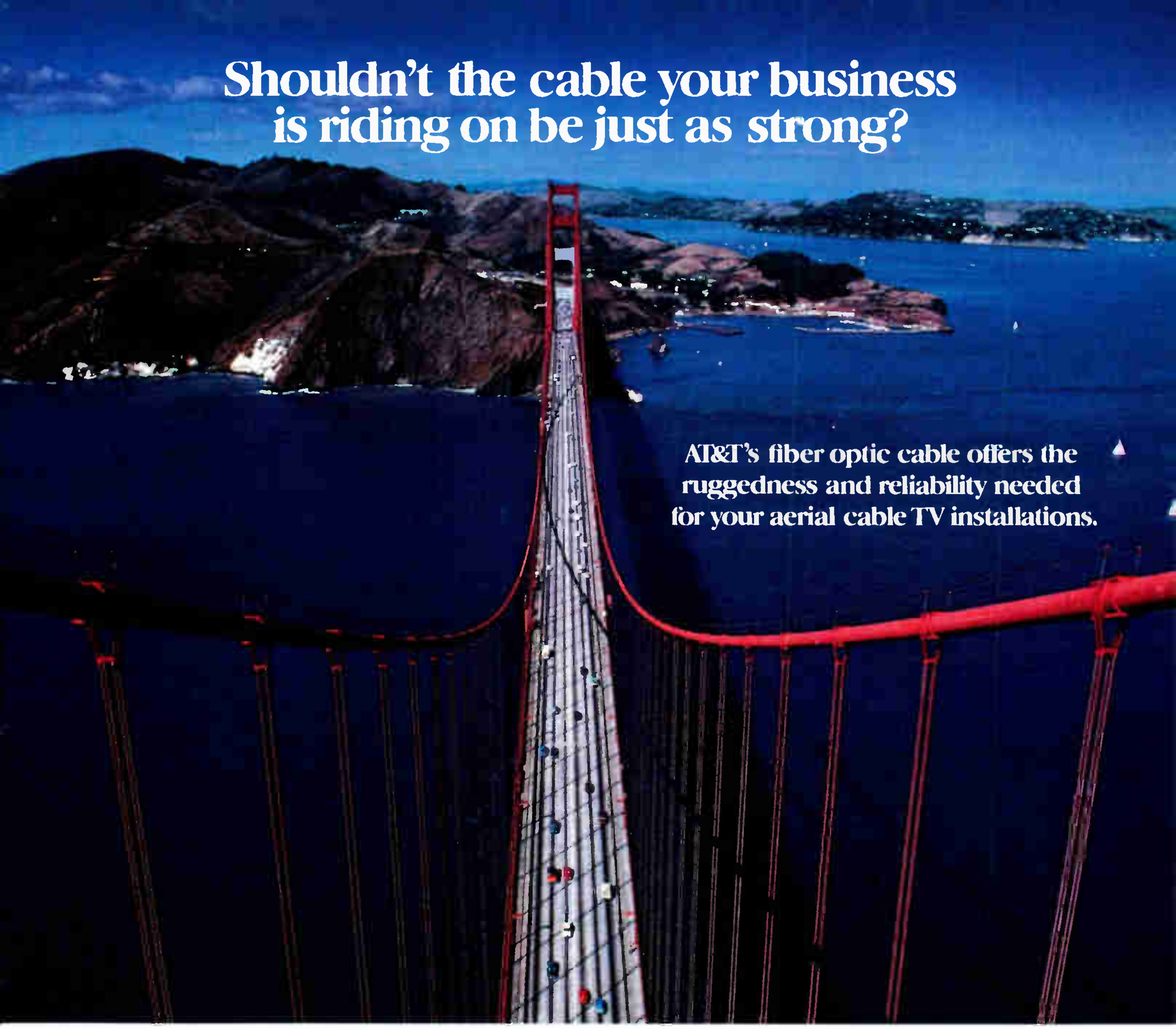


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Figure 5: Stationary reel (back pull) installation method

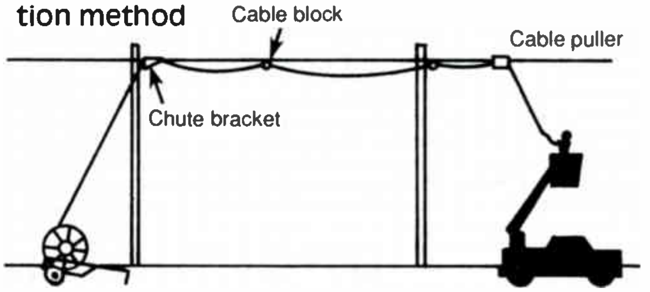
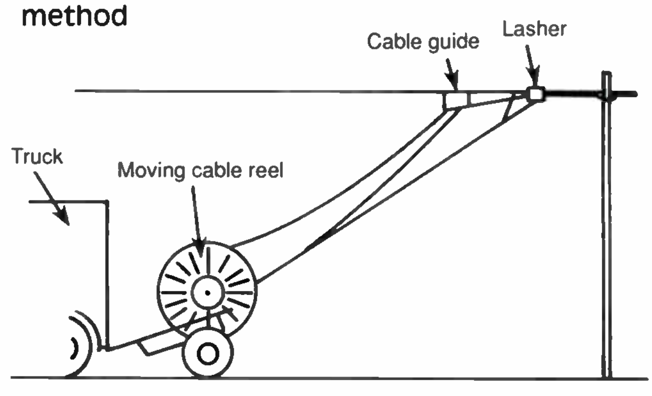


Figure 6: Moving reel (drive off) installation method



known as "figure-eighting," is a time-consuming but very necessary process. Figure 4 shows this procedure. Unless specifically approved by engineering/construction management, a fiber-optic cable should not be cut. Additional splices are very costly and will add loss to the fiber system. Adequate precautions must be taken at night to secure the unplaced cable from vandals, thieves, etc.

Pulling grips suitable for use with fiber are applied to the ends of the cable. Fiber cable's strength elements vary from manufacturer to manufacturer, therefore, the contractor should consult with the cable manufacturer to determine the appropriate pulling grip and attachment method. Breakaway or fuse links should be used at the pulling grip; these units are sometimes combined with a swivel. Ensure that the correct "fuse pin" is installed in the fuse link.

Portable radios or phones must be used during the cable placement process. The length and high cost of fiber cable dictate that the placement process be closely controlled and coordinated. Without proper communications, the risk of damaging a fiber cable is very high.

Safety should be foremost in everyone's mind. Pay close attention to the hazards of electrical shock, gas and cave-ins during construction.

Aerial cable

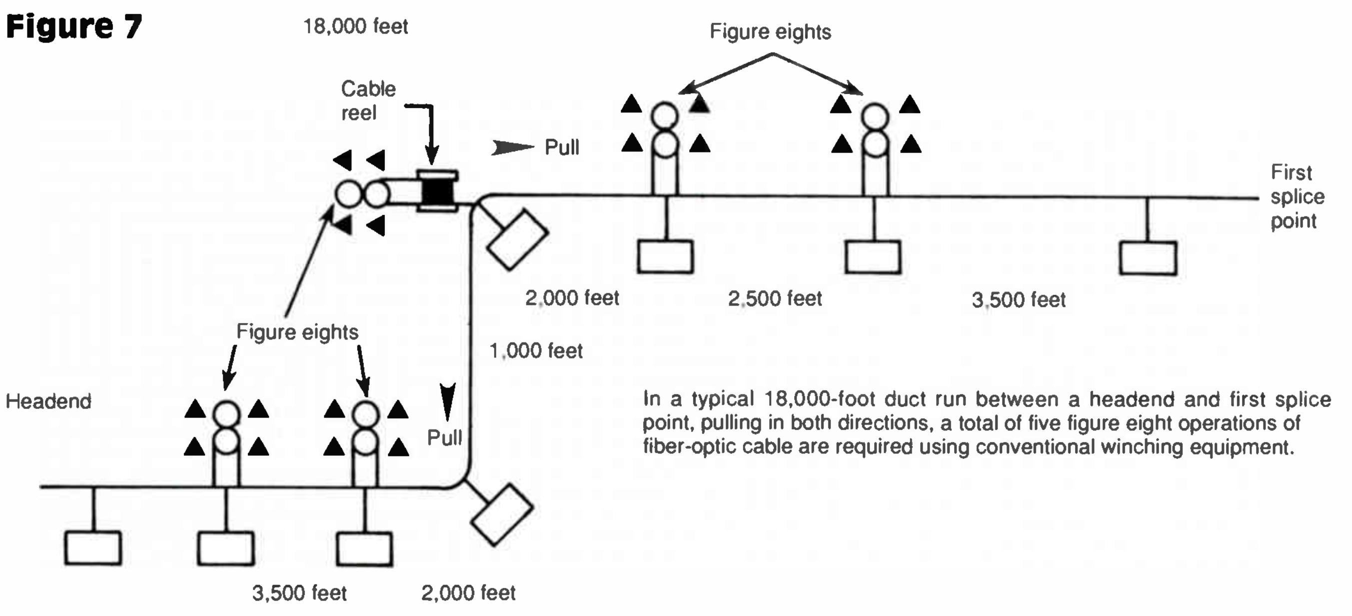
Aerial cable placement is normally done using two techniques: stationary reel (backpull) and moving reel (drive-off), Figures 5 and 6, respectively. If using the stationary reel method, adequate rollers, blocks, rings or hangers must be provided to support the cable. It is recommended that a worker be placed at the cable reel trailer to prevent the reel from "hanging up" and limit tail loading of the cable during placement. Helicopters have even been used to place fiber-optic cable under some rather special circumstances.

Standard aerial construction techniques can be used for cable placement. Drip loops are recommended although not mandatory. A small 2- to 4-inch loop at all poles provides strain relief during the expansion and contraction of the strand. In addition, some added protection is provided should mechanical damage occur to the strand or pole line. It is recommended that the fiber-optic cable is double-lashed during the lashing operation. Many operators store slack adjacent to areas where future construction may necessitate the moving of the pole line. This slack should be stored along the strand or protected in a closure at the pole. Slack for the splicing operation also is stored along the strand.

Bonding and/or grounding should comply with normal regulatory or company operating standards. As a minimum, all metallic components in the fiber-optic cable should be grounded at the splice points.

(Continued on page 55)

Figure 7



In a typical 18,000-foot duct run between a headend and first splice point, pulling in both directions, a total of five figure eight operations of fiber-optic cable are required using conventional winching equipment.

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Painless wide-scale AM fiber node deployment

By John Holobinko
Vice President, Marketing and Sales
American Lightwave Systems Inc.

The use of strand-mounted AM fiber nodes to improve picture quality and reduce amplifier cascades has become widely accepted. However, most early AM fiber installations have consisted of a small number of remote nodes. When planning a small AM fiber system, it is quite easy to overlook some issues that appear unimportant in the small-scale fiber deployment. However, in a large-scale fiber deployment these issues may result in higher maintenance and personnel expenses, lower overall system reliability, and significant hidden costs.

In a wide-scale fiber backbone implementation, key considerations include the following:

- Training costs and staff competence (i.e., the degree of specialized optical training required of CATV technicians),
- System reliability (of all system hardware components),
- Installation time and mean time to repair (how does equipment hardware design affect these), and
- Hidden costs (including the additional cost and durability of optical test equipment required for long-term system maintenance).

Training for AM fiber

It is common knowledge that technical training of staff is one of the most expensive and time-consuming activities in a CATV system. In a large-scale AM fiber implementation, the expertise required of technicians and the difficulty of installation procedures is not a trivial issue. Avoidance of retraining or additional training is key to keeping maintenance costs down and system reliability high. Therefore, a goal of any AM fiber system should be to look as much like standard CATV electronics at the headend and at the strand as possible so that existing RF amplifier technicians can be used to maintain the system without retraining.

The ideal AM fiber system should have an installation procedure almost identical to an RF amplifier (actually simpler) and require no fiber expertise from the technician. At the strand-mounted node, fiber splicing is the only installation procedure that should require specialized skills. At the node, since fiber attenuation is flat across the bandpass, the input equalization procedure normally required in an amplifier should be eliminated. (This assumes there is adequate linearity in the optical electronics.) The technician should be required only to set RF levels and adjust for output slope via standard CATV procedures.

Simpler installation for fiber vs. an RF amplifier can be attained. Making installation of fiber nodes easier than RF amplifiers (after fusion splicing) is achievable today. However, it requires that the optical system utilize a pilot carrier AGC or other means to automatically optimize receiver performance independent of optical span loss; otherwise, a matching or optimizing procedure must be made for each and every fiber-optic receiver.

A counter argument to this needs to be examined. If one or more technicians are specially trained to install fiber systems involving special calibration and installation procedures, is there really a negative side? The answer is yes, and is based on the following two assumptions:

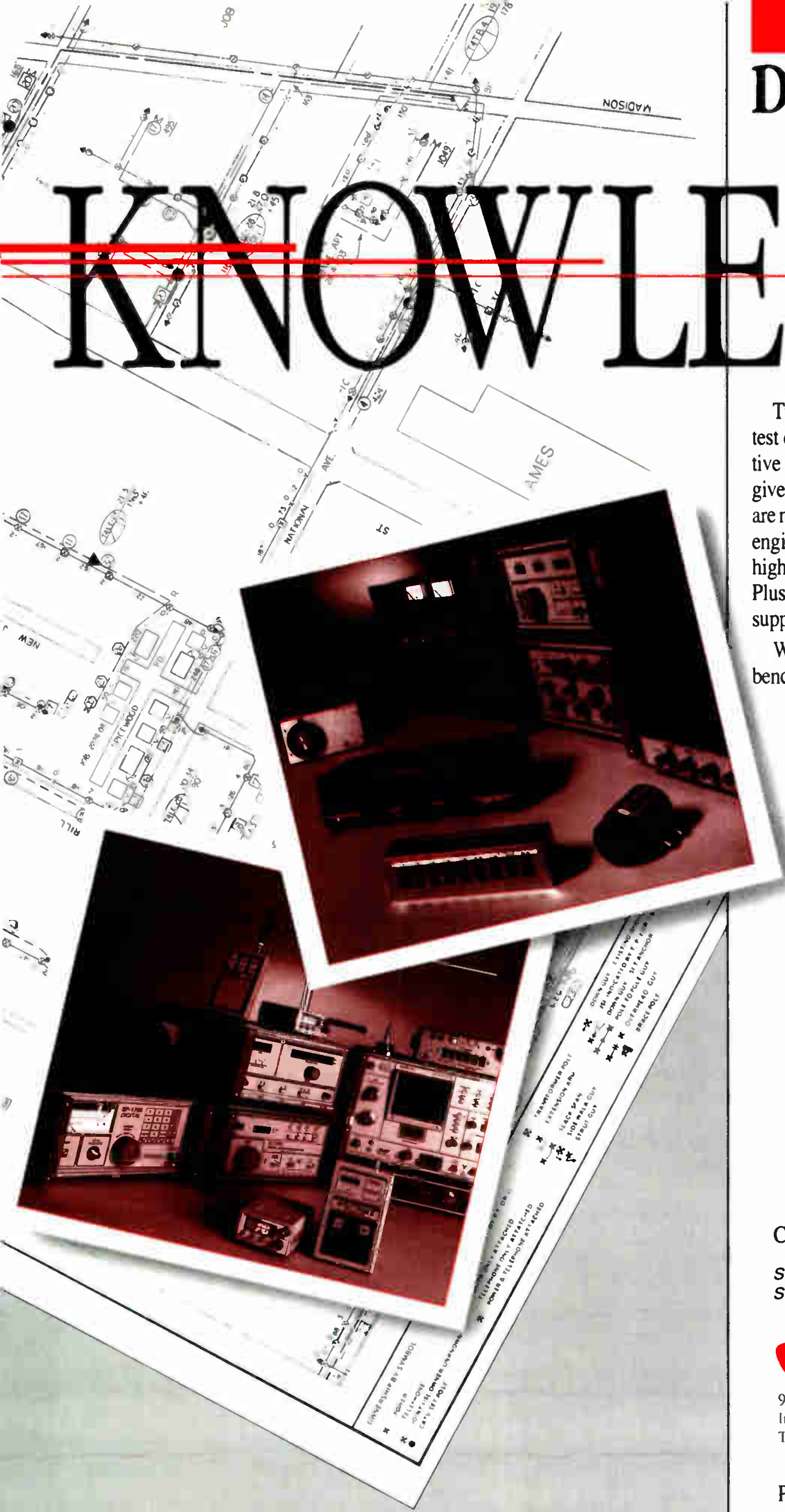
1) *One technician is not adequate to cover the system at all times.* If a fiber system failure occurs, one cannot guarantee that the failure will occur between 8 a.m. to 5 p.m. Monday through Friday, or when the technician is not on vacation or ill. Therefore, multiple technicians per system must be trained to ensure 24-hour/7-day fiber system coverage. This complicates system staff scheduling, since a specialist must always be available.

2) *Knowledge that is unused becomes lost.* Assuming that the optical equipment is reliable, technicians will lose some of their skills from the time they learn the procedures until the time that they need to perform a fiber system repair or diagnosis. There is a good probability that technicians will experience difficulties under the pressure of restoring subscribers after not using the information for a period of time. If the procedures for fiber node maintenance are similar to amplifier maintenance, this can be reduced significantly.

"The cost of training and time for installation, plus any costs for additional personnel required over the life of the system should be given close examination."

A major argument in favor of fiber systems is the fact that elimination of long amplifier cascades results in higher reliability to cable subscribers. However, the hardware design of the AM fiber system can have a significant impact on overall subscriber reliability. Consider a system with 30 optical transmitters serving 90 remote nodes (an average of three nodes per transmitter). Examine a hardware design in which each optical transmitter is rack-mounted separately — each with its own AC power supply. If the power supplies are located within the transmitter chassis and each power supply has a reliability of 75,000 hours MTBF, what are the system reliability implications? Given that there are 30 transmitters, the system MTBF contribution from power supply reliability is 2,500 hours. Since there are approximately 9,000 hours in one year, this means that there could be a failure of 3.5 transmitters and 10 nodes per year.

How fast can the system be restored? Consider that fiber is often fused to the transmitter without any optical connector. To restore the system means breaking the fiber splice



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"The ideal AM fiber system should be easier to maintain than its coaxial counterpart ..."

and replacing the transmitter, since the power supply is inaccessible. Where will the fusion splicer be located — at each headend? Who will be qualified to make splices? A customer outage could easily last from one hour to one day depending on the availability of splicing equipment and trained personnel.

An alternative hardware design that eliminates this exposure is a modular architecture where a common module shelf is employed at the headend. Optical transmitters and switching type power supplies are modular. One power supply module can serve multiple transmitters installed in the same shelf. Examine this configuration for its reliability to the previous example: If a power supply can serve six transmitters and has an MTBF of 100,000 (high quality switching supply), then the MTBF is 100,000 ÷ 5 = 20,000 hours, or 2.2 years. Further, the mean time to repair is under one minute, because replacing the supply is a simple slide-out and slide-in procedure, and the fiber optics do not have to be disturbed. No special tools or procedures are required.

Now, if multiple optical transmitters are in a shelf, more nodes fail with the failure of a supply. Therefore, in a large-scale fiber implementation it is desirable to provide an economic means to add a second load-sharing power supply for backup. The second supply can be added at any time after the initial installation if desired without interruption of service. Redundancy eliminates a classic CATV problem vis a vis power supplies. If this sounds extravagant, consider that the average additional cost for complete power supply redundancy per node from a current manufacturer is about $25 in the previous example. Redundancy significantly reduces the possibility of power supply failures. The probability of two concurrent supply failures in the same shelf is 1/100,000.

Installation and repair

Hardware modularity has its advantages in other areas of the system as well. If all modules in the strand-mounted nodes are universal plug-ins, they conform to the standards of CATV amplifiers. Debates have been made about the value of transimpedance receivers optimized (i.e., customized) to a specific link loss. It has been demonstrated that hybrid matching transformer designs can match or exceed transimpedance receiver designs without requiring customization to the link.

But the real litmus test is a large-scale fiber deployment. Would an amplifier customized to the coaxial cable span loss be acceptable in a modern cable plant? Wide-scale fiber deployment demands the same flexibility as coaxial electronics. Universal modules with high performance are most desirable compared to modules that must be specifically matched to individual fiber spans.

Another key to system reliability and maintainability is documentation. Documentation goes far beyond clear and precise manuals. Extraordinary measures are required to meet the demands of modern fiber system deployment. For example, if a technician is trying to service a fiber node at 3 a.m. in the rain, will he take the manual with him? The ideal solution is a system that is self-documenting (i.e., the technician opens the strand-mount cover and each module shows signal flow, test points and proper signal test ranges on all module covers). This is not a luxury but should be viewed as a necessity for system serviceability.

The ideal AM fiber system should be easier to maintain than its coaxial counterpart. Given fiber's superior performance to coaxial cable, there is no technical reason why this is not attainable today.

Hidden costs

Evaluating the true cost of fiber systems requires an analysis of initial cost, installation costs, manpower requirements and the cost of additional test equipment required. For example, initial costs can vary dramatically. If an amplifier is required before the optical transmitters in order to provide adequate input signal level, is the true cost differential just that amplifier? Or is the true cost penalty much higher? Consider a design in which four amplifiers are allowed in cascade with the fiber system. If one of the amplifiers is before the transmitter, then only three amplifiers are possible after the optical receiver. This means that more nodes will be required to achieve identical performance. The cost of these additional nodes must be factored into the cost comparison.

"... Given fiber's superior performance to coaxial cable, there is no technical reason why this is not attainable today."

Earlier in this article a discussion of manpower requirements was presented. The cost of training and time for installation, plus any costs for additional personnel required over the life of the system should be given close examination.

Test equipment is costly and sometimes difficult to justify. For example, consider if each service vehicle requires an optical power meter at over $1,000 each. It will be used infrequently, but be very necessary for system diagnostics. What if it could be eliminated? Some optical receivers are made today with a built-in power meter function. By placing a digital voltmeter on an optical test point, millivolts are read directly as microwatts of power. At least one manufacturer supports this today in combination with self-optimizing receivers. Therefore, the AM fiber system can be maintained without the need for any new test equipment in the service van.

Conclusion

Wide-scale AM fiber deployment requires consideration of a number of factors beyond initial product cost. Installation, maintenance, ease of operation, factors relating to system reliability and time of restoration, plus hidden costs must all be evaluated. Today, a properly designed wide-scale fiber network can be more reliable and easier to maintain than a coaxial plant without the need for extensive retraining of system personnel. This is only possible if the philosophies presented in this article have been adapted and integrated into the fiber-optic hardware equipment as part of the core product design. **CT**


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Fiber-to-feeder design study

The following article is reprinted with permission from the "1991 NCTA Technical Papers." It begins with the fiber-to-feeder (FTF) design approach analyzed in comparison to tree-and-branch (T&B) design for rebuilds. Data from numerous design studies will be used to develop a "typical" FTF design and total material cost will be compared using several alternative FTF design approaches. An optimal solution, known as fiber-to-the-serving-area (FSA), will be recommended and system performance and material costs will be compared to conventional designs for varying plant densities. Additional benefits of FSA design also will be discussed, including improved picture quality, increased reliability, reduced operating costs and compatibility with future services.

By John A. Mattson
Director of Marketing, Fiber-Optics Products
Scientific-Atlanta Inc.

Table 1: Sample design parameters

Project type: Rebuild
Plant size: 750 miles
Bandwidth: 550 MHz
Density: 100 homes per mile

Conventional design
Trunk cable: 0.875" P-3
Trunk electronics: Feedforward
Feeder cable: 0.625" P-3
Feeder electronics: Power doubling
Fiber cascade: Node + 12 trunks
Headend cascade: 16 trunks
Feeder cascade: Bridger + 2 LEs

The FTF architecture is dramatically different from the traditional T&B design in a rebuild situation. It should be noted that this article is confined to the study of rebuild architectures only. In an FTF design, AM fiber links comprise the trunk portion of the system, performing the function of a cascade of trunk amplifiers in a T&B design. The feeder portion of the cable system in an FTF design is similar to a conventional plant in that it is made up of RF amplifiers, which perform as bridgers and line extenders. A schematic of a generic FTF design is presented in Figure 1. From a system engineering standpoint, FTF offers significant improvement over T&B by eliminating cascades of trunk amplifiers, thereby removing a major source of noise. In fact, in an FTF design the target for end-of-line carrier-to-noise ratio (C/N) is generally around 48 to 50 dB.

The only way to achieve this type of performance using a T&B architecture is to run AM fiber nodes to every bridger location. At today's AM fiber prices, however, this approach is not practical from a cost standpoint. Therefore, it is necessary to reconfigure the feeder plant in order to improve the design's economics. The key features that separate FTF from T&B designs (and in fact determine the success of a particular FTF design) are the technology and architecture used in the feeder.

Table 2: Sample design comparison

	Conventional trunk and feeder	Fiber-to-feeder (conventional feeder) P-P	PHD	FF	Fiber to serving area (express feeder) FF
End-of-line C/N (dB)	46	49	49	49	49
Serving area size (miles)	2.0	4.5	5.5	7.5	12.0
Material costs ($ per plant mile)					
Coax					
Coaxial cable	2,275	2,000	1,950	1,900	2,050
Actives, passives	3,225	3,250	3,050	3,000	2,850
Total coax	5,500	5,250	5,000	4,900	4,900
Fiber					
Optical cable	175	1,000	725	550	300
Actives, passives	325	3,500	2,775	1,950	1,200
Total fiber	500	4,500	3,500	2,500	1,500
Total material	6,000	9,750	8,500	7,400	6,400
% of conventional	100	163	142	123	107

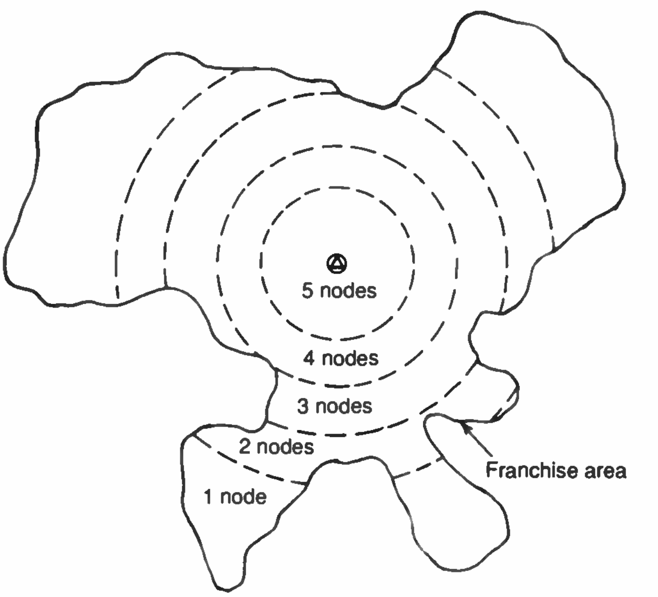
Notes:
1) Conventional trunk and feeder design required some fiber overlay to achieve end-of-line performance required.
2) All systems 550 MHz bandwidth.
3) AM fiber is dual tier.

FTF design principles

In order to illustrate the important aspects of FTF, a sample FTF design will be used as a reference point. The system under study is essentially a "typical" cable system, which is the result of averaging the data from a number of FTF designs. Table 1 summarizes the basic elements of the sample design system. The comparative results of various design approaches are presented in Table 2.

The simplest approach, followed in many of the early FTF designs, is to parallel the T&B approach by locating a bridger at the output of the AM fiber node and then cascading two or three line extenders from there[1]. As designers became more proficient, it became apparent that the critical factor in producing an economical FTF design is the miles of plant served by each AM fiber node. As the "serving area" of the AM fiber node increases, the FTF design becomes more and more economical. The approach previously described — essentially copying a conventional feeder layout — is the least efficient in terms of the size of the serv-

Figure 3: AM fiber range from headend (nodes served per transmitter)



port further subdivision of the serving areas. The design is most cost-effective when the serving area is equal to or greater than 12 miles of plant.

The most significant factor impacting an FSA design is the density of the homes in the system being designed. (See Table 3.) As the system density decreases, the length of the amplifier cascade in each serving area increases. However, even in the densest systems, the minimum number of amplifiers in cascade is four, so at least every third amplifier in each cascade must be equipped with automatic gain control (AGC) to maintain constant output over temperature. The C/N at the last tap is targeted in the range of 48 to 50 dB, as opposed to 45 to 47 dB in a comparable T&B design. In an FSA design, the fiber links add virtually no distortions and the amplifiers add very little noise. As demonstrated in Table 4, the relatively short amplifier cascade sets the composite triple beat performance of approximately 56 to 57 dB, which in combination with the essentially transparent fiber distortions results in end-of-line distortions of about 54 dB. In the same fashion, the fiber link sets the noise limit at about 50 dB, with no more than 1 dB noise addition in the amplifier cascade.

Reliability

The number of outages experienced by each subscriber is dramatically reduced as compared to a conventional plant. In an FSA design, the total number of active devices between any subscriber and the headend is reduced to a maximum of five in the typical case. Even compared to a fiber backbone with four trunk amplifiers in cascade, the number of hybrids in cascade is reduced by 40 percent. This means that any single failure affects a much smaller group of subscribers than in a conventional plant.

In addition, the number of outages in the plant as a whole is reduced. The total number of active devices employed in the system is reduced, so the number of system outages is lower as well. In fact, the FSA design uses 10 percent fewer hybrids plantwide than a comparable fiber backbone or trunk and feeder. In previous AM fiber design approaches, while the reliability experienced by individual subscribers has improved, the overall system reliability has actually been degraded. This phenomenon is intuitive, since fiber cable and electronics were added to the existing cable plant. However, in FSA designs there is a net gain in reliability, since fiber and electronics replace trunk cable and amplifiers[3].

Operating costs

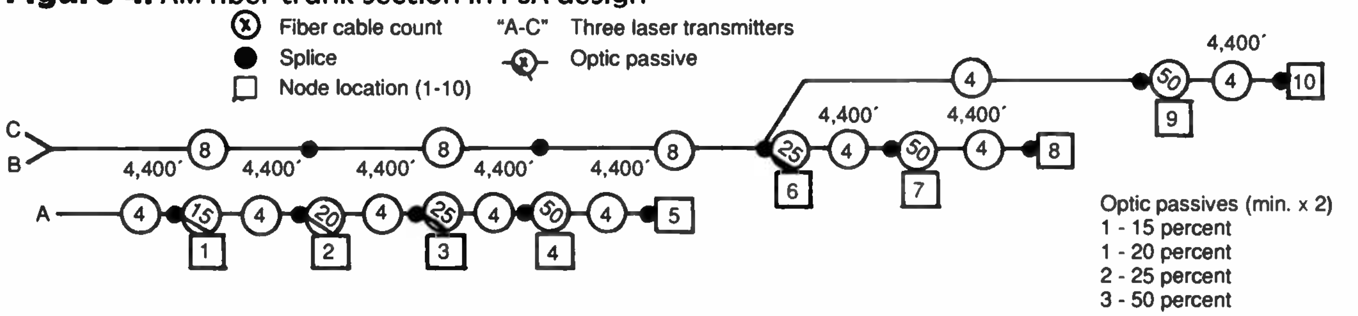
The plant operating costs in an FSA architecture are lower than a T&B design. The total power consumption of an FSA plant is lower than conventional trunk and feeder or fiber backbone designs. There are two primary reasons for this: 1) Fewer hybrids are used and 2) a standby power supply can be used for the optical receiver and surrounding amplifiers while the remainder of the feeder is served by much lower cost non-standbys. The maintenance requirements are lowered by at least an order of magnitude. It is relatively simple to balance and align the short amplifier cascades in an FSA plant. The combination of fewer failures and simpler maintenance procedures reduces the number of truck rolls and simplifies the tasks required with corresponding reductions in spare parts inventories, technical training, employee turnover, etc.[4]

Compatibility with future services

The FSA architecture supports future services. The overall quality of the signals delivered to the subscriber is compatible with high definition TV (HDTV) standards. Bandwidth expansion can be accommodated by electronics upgrades and digital compression offers even more dramatic expansion capabilities. The double-star configuration is compatible with telephony type services. (The 2,000-home serving areas are roughly parallel to those of the local telephone system.) The use of express feeder lends itself to further overlays of fiber nodes. By locating

(Continued on page 60)

Figure 4: AM fiber trunk section in FSA design



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Reader Service Number 28

Back reflection in AM fiber CATV systems

By Vedrana Stojanac
Sales Engineer, EXFO E.O. Engineering

The cable TV industry is undergoing an expansion to achieve greater spectrum capability by using optical fiber to provide additional channels of video programming as well as some form of high definition TV. This is due in part to cable's goal of being more competitive at a time when the Federal Communications Commission may rule out the opening up of the protected market.

Optical fiber is already being used extensively in the telecommunications industry — specifically in long-haul intercity and undersea links for telephony. In turn, fiber technology is now being applied to existing CATV systems to improve them. Without discussing the advantages of various topologies, implementing optical fiber offers the following: exceedingly high potential information bandwidth, very low loss, small size, rugged physical/chemical properties, and electromagnetic (EM) interference immunity due to its dielectric nature.

However, as with any system, there are losses that must be examined so that design requirements are met. For a CATV system using AM fiber, back reflection is a primary concern. This article deals with some of the causes of back reflection and presents the instruments that can be used to test a system incorporating fiber at both its installation and maintenance stages.

CATV system and back reflection

Traditional distribution systems are based on the use of coaxial cable in a tree-and-branch architecture; here, multiple feeder cables, referred to as branches, are connected to a main trunk cable. This basic network now is being upgraded and modified to allow increased channel capacity and multiple service levels. One such system may use fiber links to reinforce the coaxial networks (hence the name fiber-reinforced coaxial systems). The basics of these systems involve long cascades of trunk amplifiers broken up into segments being fed with point-to-point fiber links from the headend or nearest hub location. In using the fiber links the average number of series-connected amplifiers may be reduced, thus increasing reliability and signal quality. This evolution to shorter cascades is expected to continue. There are numerous other topologies that deploy fiber closer to the home, but these are beyond the scope of this article and our interest remains with the causes and effects of back reflection in the optical fiber links.

Back reflection, also commonly referred to as back scattering or return loss, is defined as the ratio of the light scattered in the opposite direction of propagation to the light in the original direction of propagation. That is:

$$\text{Reflection (in dB)} = 10 \log_{10}(P_{reflected}/P_{transmitted})$$

It results from the fiber's intrinsic properties as well as from components within the system. Rayleigh scattering is a type of scattering caused by inhomogeneities in the fiber much less than a wavelength in size, such as refractive index fluctuations from density and compositional variations in the fiber. Much of this light will enter the fiber cladding and be dissipated.

In a good quality fiber the actual amount of back scattered light captured by the core and carried back toward the transmitter due to Rayleigh scattering is very low, typically in the order of 65 dB below the transmitted signal. It is therefore known that the components in the system are the key factors contributing to the reflection loss. Potential sources of these reflections typically include optics packaging, the in-line optical isolator, connectors, splices and the PIN detector. These sources produce back reflections that are classified as Fresnel reflections, which occur at the planar junction of two materials having different refractive indices.

Splicing normally refers to an interconnection method for joining the ends of two fibers in a permanent manner, while a connector is a disconnectable device used to join a fiber to a source, detector or another fiber; the latter is designed to be connected and disconnected with ease. Splices and connectors aim to couple light from one component to another with as little disturbance as possible. Therefore, precise alignment of the mated fiber cores is desirable.

Splices and connectors are required for various reasons. For example, in a long link, since fibers are offered at limited lengths, they must be spliced end-to-end. Connections also are required at building entrances, wiring closets, couplers and equipment. One common type of splice is the fusion splice that uses an electric arc to weld two glass fibers together. The fusion splicers available today are extremely efficient, thus rendering the amount of back reflection at the splice negligible. Connectors and mechanical splices should therefore be seen as the main contributing factors in back reflection. The cause of reflection is a change in refraction index caused at a discontinuity by either lateral displacement, end separation, angular misalignment or surface roughness. All of these backscatter light since each involves having the electromagnetic light wave travel from one medi-

"Back reflection ... is defined as the ratio of the light scattered in the opposite direction of propagation to the light in the original direction of propagation."

"Pay particular attention to the linearity and calibration accuracy of (power meters) ... Some methods of calibration do not last long, which is a major drawback."

um to another of different refractive index.

Lateral displacement refers to the misalignment of two fibers from their center axes. Some light is back scattered if the wave should exit the core of one fiber and hit the cladding of the next. End separation is a problem with some connectors or mechanical splices. The two fibers to be connected in this case do not make physical contact thus leaving an air gap. Back reflection occurs at both the exit from the first fiber and at the entry to the second fiber even if an index-matching gel is used. For a glass fiber having a refractive index of 1.475, the reflection loss caused by an air gap is about 14.5 dB. Furthermore, back reflection at an air gap may create constructive or destructive interference and the total effect over the two joining fibers can even get as bad as -8.5 dB.

Losses are minimized by using index adaption liquid, which reduces the beam divergence. The refractive index of this liquid or gel is very near to that of the fibers. However, reflections are not entirely suppressed since the liquid usually chosen is one having a refractive index equal to the average refractive index between the fiber core and cladding. Angular misalignment is not as common as lateral displacement; it occurs when the ends of mated fibers are not perpendicular to the fiber axes, thus leaving an air gap. Surface roughness suggests that the fiber has not been polished down to a flat surface free of residual particles; geometrical patterns of the EM waves are therefore disrupted and reflections will occur at the fiber end face.

Measurement equipment

CATV systems operate at VHF and UHF frequencies, typically at 300 to 400 MHz with the newest systems operating at 550 MHz or greater. The influence of back reflection at this bandwidth is substantial. Problems may arise since the reflected light will travel back toward the transmitting laser. The laser is a semiconductor diode having an optical cavity required for lasing. At low drive currents the laser acts as an LED, while operating at its threshold level will induce lasing action. The laser is then biased just below the threshold current to make it work in its linear laser mode. Having a light pulse return to the laser will result in a varying power level of the signal (rendering the laser unstable). To protect the transmitters, the latter are always specified to operate up to a certain back reflection tolerance, which is a function of the operating wavelength.

When installing a fiber link, attenuation is a parameter that must be measured. A power meter and dual-wavelength laser source combination built into a single unit is preferable to minimize the number of instruments carried out to the field. Optical time domain reflectometers (OTDRs) also can be used to characterize fiber attenuation.

In dealing with back reflection there are three invaluable instruments: a variable back reflector, a back reflection meter and a variable attenuator featuring low back reflection characteristics. A variable back reflector can be used to simulate a certain amount of calibrated back reflection into a fiber, thus making it possible to determine the performance of a system as a function of the back reflection level. This can be used to verify the tolerance of the transmitter and verify if it does meet specifications. The ideal of such a unit would incorporate a high-quality filter and star coupler in order to provide an output port that would be a sample of the input signal attenuated by 20 dB or so.

A back reflection meter, according to ANSI-FOTP-107, should incorporate a laser light source and power meter of specific design in connection with a wavelength independent coupler (WIC) having a splitting ratio that is very stable across the optical spectrum. It is preferred to a wavelength division coupler (WDM coupler). This is because the latter has a splitting ratio that is a function of the wavelength, thus requiring the laser to be extremely stable in wavelength. Furthermore, the wavelength of a laser varies with temperature. Therefore, the choice of a WIC over a WDM coupler greatly reduces the temperature stabilization time of the laser.

The ideal unit should be bearing absolute calibration, but a user-calibration mode also should be provided for applications where a large level of attenuation does take place between the instrument and the point from where return loss is to be measured.

Another useful instrument for testing a CATV fiber link is an optical variable attenuator. It is used to simulate loss of the fiber, thereby testing the system's dynamic range. (A spool of fiber with a known loss also can be used if available, although several would be required to obtain various attenuation values.)

Attenuators should not create optical reflectance, which in turn would influence the transmitters. One very important optical specification to look into when selecting a variable attenuator is level of reflectance. A specification of -40 to -45 dB should be considered minimum.

In CATV, optical power levels are uniquely high (up to +15 dBm) and, as a matter of a fact, cannot be measured by most optical power meters currently on the market. It is essential to select power meters that can read up to +15 dBm. Pay particular attention to the linearity and calibration accuracy of such products; it is always a good idea to ask how calibration is performed on such units. Some methods of calibration do not last long, which is a major drawback.

CATV systems are turning toward fiber optics as part of evolving architectures — and improvement in picture quality and extended services will be the direct result. The quality of fiber-optic test equipment available also has facilitated this transition since it provides full testing capability for both installation and maintenance. **CT**

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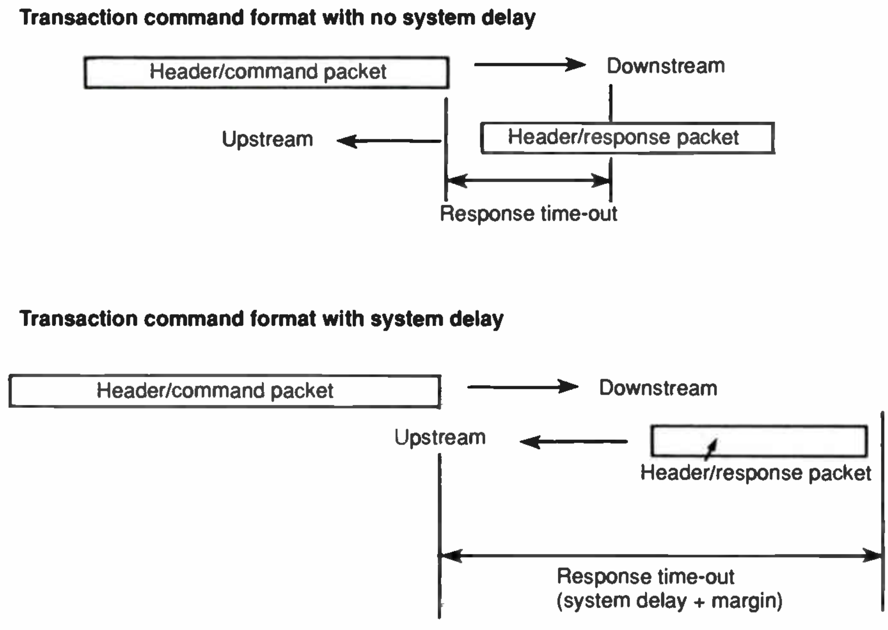
Timing considerations in RF two-way data collection

The following article is reprinted with permission from the "1989 NCTA Technical Papers." It presents several scenarios for data transport serving an out-of-band data carrier addressable system utilizing combinations of RF band, microwave and telephone line transmission technologies for data signal delivery. Definitions are given for both continuous and discontinuous data streams. Since discontinuous data formats are most sensitive to delay and phase distortion, special solutions are developed for compensating these parameters. (The author was employed by Jerrold at the time of this article's writing.)

By Daniel F. Walsh Jr.

Figure 1: Transaction command timing diagrams



The maturation of addressability as a technology, coupled with the advent of pay-per-view (PPV) and impulse PPV (IPPV) services has effectively turned the CATV system into a two-way data communications network. Regardless of the format of data transport over the cable, some basic principles of data communications govern the behavior of the data streams.

The CATV system can be represented as a tree-and-branch network. In the forward direction (controller to terminals), there is a single source, multiple destination data signal. Since various components in a CATV addressable communication network are located at geographically distinct sites and interconnection between the sites may be done with various media, depending on the particular geography and availability of resources, a means to transport the addressable control data (one- and two-way) must be provided.

In most implementations, the forward data stream runs continuously, and is transported either on an out-of-band carrier or in-band in the video itself from the headend or hub to the converter. If the addressable controller is at a business office that is located remotely from the headend or hub, data must be transported from the controller to the headend or hub. This may be done through various media (e.g., RF cable, telephone lines, microwave, etc.).

In the return direction, data is transmitted from the converter to the hub or headend site, where it is received and routed back to the addressable controller, over whatever medium has been selected. In the case of multiple hubs or headends, return data is routed from each of the hubs back to the addressable controller and combined for reception.

In the case of one-way data, propagation and processing delays in the one-way path are of no significant consequence. However, in a two-way system, delays in both the forward path and the return path are critical to ensure collision-free, high-speed polling operation.

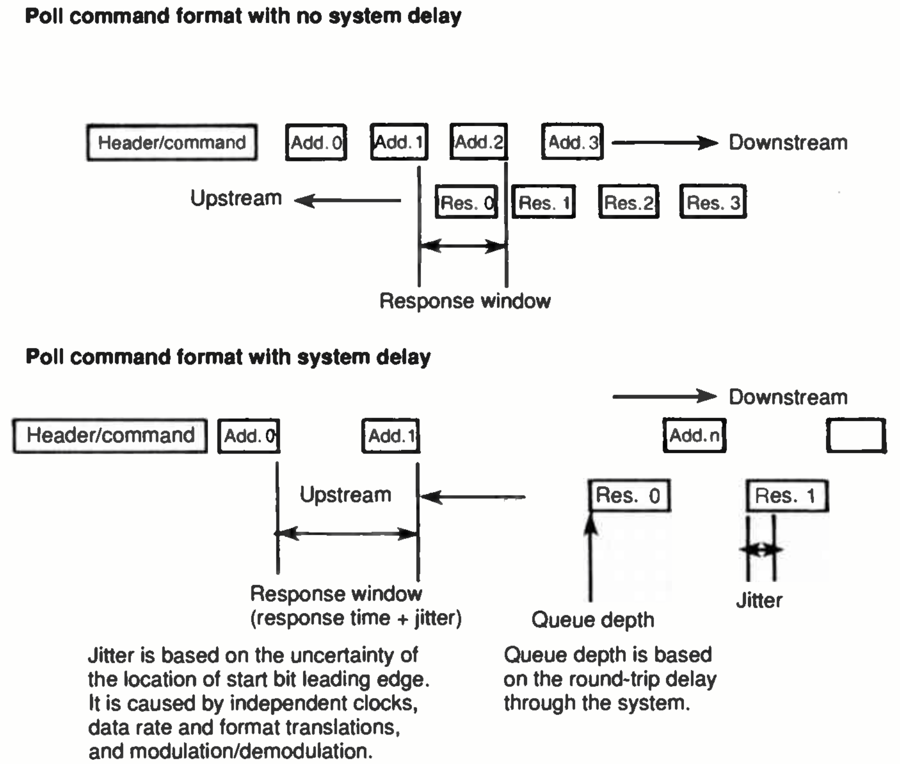
Time division multiple access

Time division multiplexing (TDM) is a technique used in communication networks to allow multiple, unrelated lower speed data streams to be transported on a single higher speed data stream. The technique provides time slots in a given, predefined sequence for segments of each component data stream to be inserted at the transmit site and extracted at the receive site. An advantage of TDM is the ability to carry multiple signals on a single wire or channel, with the associated savings in equipment over what would have been required if each signal was carried over its own wire or channel. In a TDM system, the multiplexing operation occurs at a single site, thus delays for each component data stream are identical. A typical application of TDM is the transport of telephone signals from one central office to another.

Time division multiple access (TDMA) is an extension to the TDM concept that allows each component data stream to be inserted from different geographical locations. The complication involved in designing and operating a TDMA system is the difference in propagation delays from each source to a single destination.

Since collisions would be detrimental to operation, each source must be time-compensated so as to ensure that the arrival of its transmission at the destination site occurs during its allocated time window. The time compensation must account for any processing or propagation delays in the path from a particular source to the destination. TDMA systems are typically used in digital telephony over wire, terrestrial or satellite channels. The advantage is that multiple lower speed users, located at multiple origination sites, can share a single higher speed channel, with the associated saving in equipment and channel space as compared to individual channels from each source to the single destination.

Figure 2: Poll command timing diagrams



CATV application

As stated earlier, the typical tree-and-branch CATV system provides, in the forward direction, a single source with multiple destinations. In the return direction, multiple sources provide transmission to a single destination. This architecture is analogous to the TDMA system just described. One major difference between the typical TDMA system and a two-way CATV system is the number of operating nodes. A large CATV system may have on the order of several hundred thousand operating nodes in the network. Time-compensating each of the nodes in a network of this magnitude would be an extremely time-consuming task. Another major difference is the low-cost nature of the subscriber terminal.

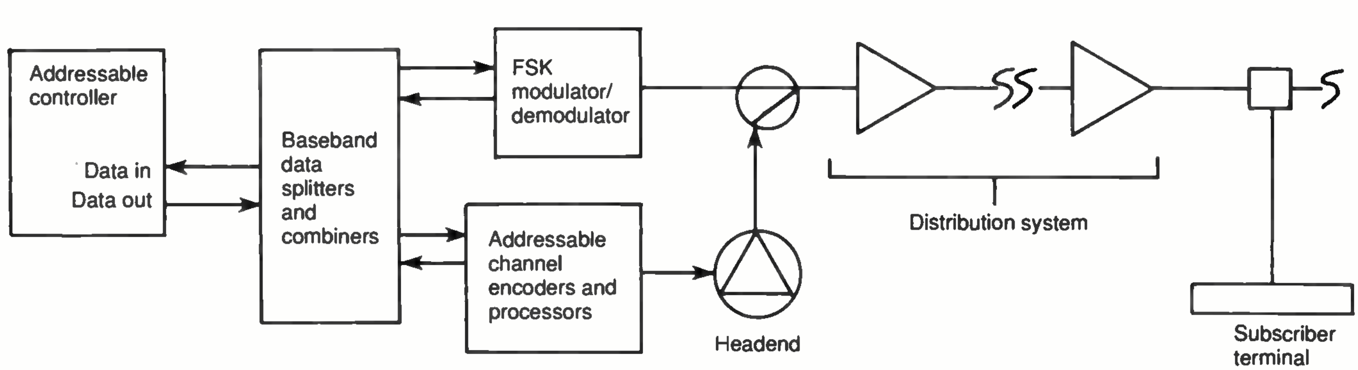
For these reasons, an approach requiring time compensation down to the hub level (but not to the subscriber node level) is more appropriate. In addition, because the base of subscribers defined on the network is in a constant state of flux (box swaps, churn, etc.), fixed time slot assignment would slow the network down. Thus, a more efficient system allows assignment of time slots to subscriber terminals on the fly. The following sections of this article introduce several system scenarios and describe the impacts of each technology.

When data passes through a communications channel, they are affected by the physical properties of the channel. Of particular importance to this discxussion is the propagation time of the transmission through the cable (fractions of the speed of light).

If the channel is actually comprised of several separate media with electronic translation on the end points of each segment, the propagation parameters are no longer the prime impact. The delay and delay parameters of each electronic translation is orders of magnitude more significant than the propagation time through the channel.

Delays are generally incurred due to baseband data rate translations or format translations. Digital signal processing (DSP) operations and other digital data manipulations also contribute to delay. RF modulation and demodulation do not of themselves contribute significant delay to the channel relative to other delays. →

Figure 3: Collocated single hub addressable system



Jitter, or delay uncertainty, is introduced whenever the clock phases of an asynchronous baseband transmitter and receiver at the end points of a channel differ. This occurs whenever data are re-clocked (for processing by data path devices), or when data are sourced from numerous different devices running from their own, noncoherent clock sources or located various distances from the receive point, with corresponding propagation delay differences (see poll format data that follows).

Transaction formats

The most straightforward format for data transmission has been shown to be a command/response transaction. In this format each transmission of information is framed by synchronization and error-checking data to assist in interpretation. This packet format is used extensively in CATV control and other applications. The transaction format provides a coherent query-response sequence for communicating with addressable devices. It is constrained to communication with one device at a time in that the return channel can only accommodate one packet at a time.

Figure 1 shows a transaction system. The addressable control system provides a query command requiring a response from the addressed device. It then waits a prescribed period to allow that device to answer before continuing with more transmission. In this fashion,

"It is possible to compensate even the most complicated networks for timing to ensure efficient, reliable data communications performance."

a controller can maintain coherence between queries and responses. The top of the figure shows the time-out period for a simple RF-only system. (That is, one with minimal propagation delays.) The lower portion includes provision for an arbitrary delay inserted at some point in the channel. The optimum time-out period is based on worst-case delay time through the system. Too large a time-out value causes inefficiency in a system where many network nodes will not respond during various activities. Too small a value may cause some valid responses to be ignored because they reached the receiving node after the time-out had expired.

Poll formats (TDMA)

Poll formats can be described as transmission schemes that allow for maximum communication throughput at the cost of error-checking and framing. This technique borrows from the TDMA technique discussed previously, in that several responding devices share a single response channel by synchronizing their transmission to some marker in the request data stream after their address is recognized. In this fashion, the responses are queued in the same order as requested and each responding device is given a time slot for its response to arrive, if all delays are equal. A single command can initiate a response sequence from a range of addressable devices. The primary advantage in using this type of system is to achieve a very high poll rate for a given data rate.

Figure 2 shows a poll format protocol in which a command is presented, followed by the addresses of all devices expected to respond. Each device formats and transmits a response on encountering its address in the data stream following a command. As can be seen, there is then an expected order and time slot in which the response will arrive at the addressable controller. The upper portion of the figure shows the sequencing in a non-delayed system. The lower makes allowances for both round-trip channel delay and delay uncertainty from data translations.

In this manner, responses are pipelined with the depth of the pipeline determined by the absolute delay in the system. If the time delay for responses from each of multiple hubs differ, they must be compensated so they are equal. This is accomplished by insert-

Figure 4: RF-linked non-collocated addressable control system

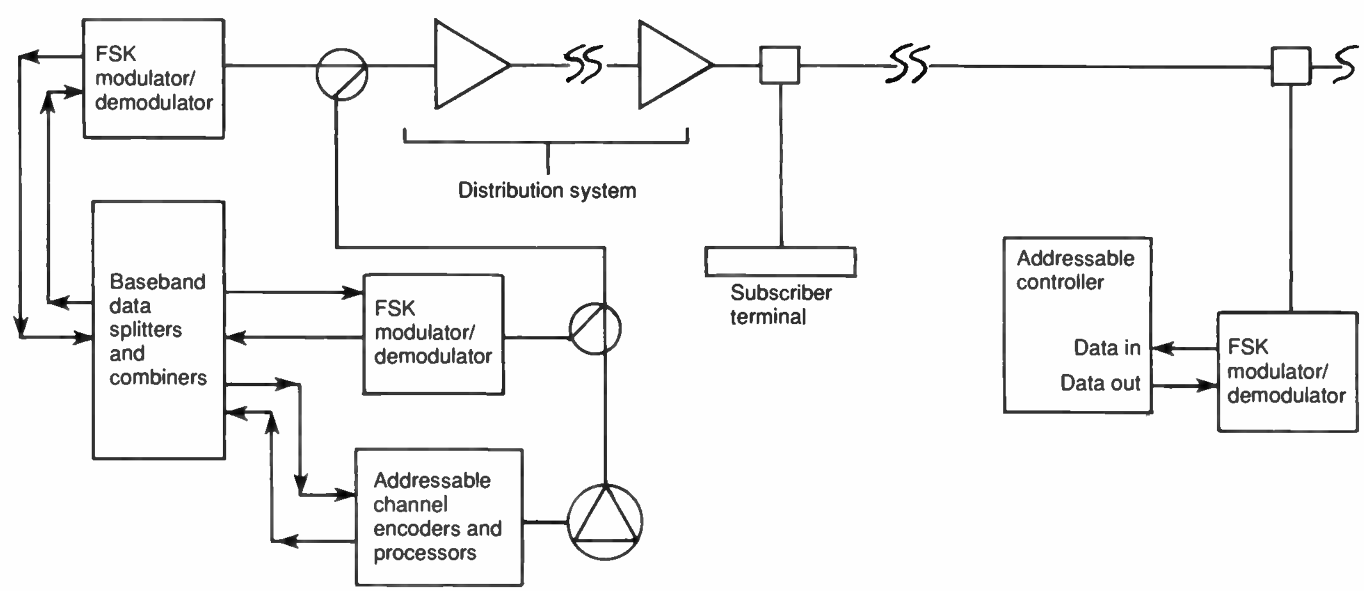


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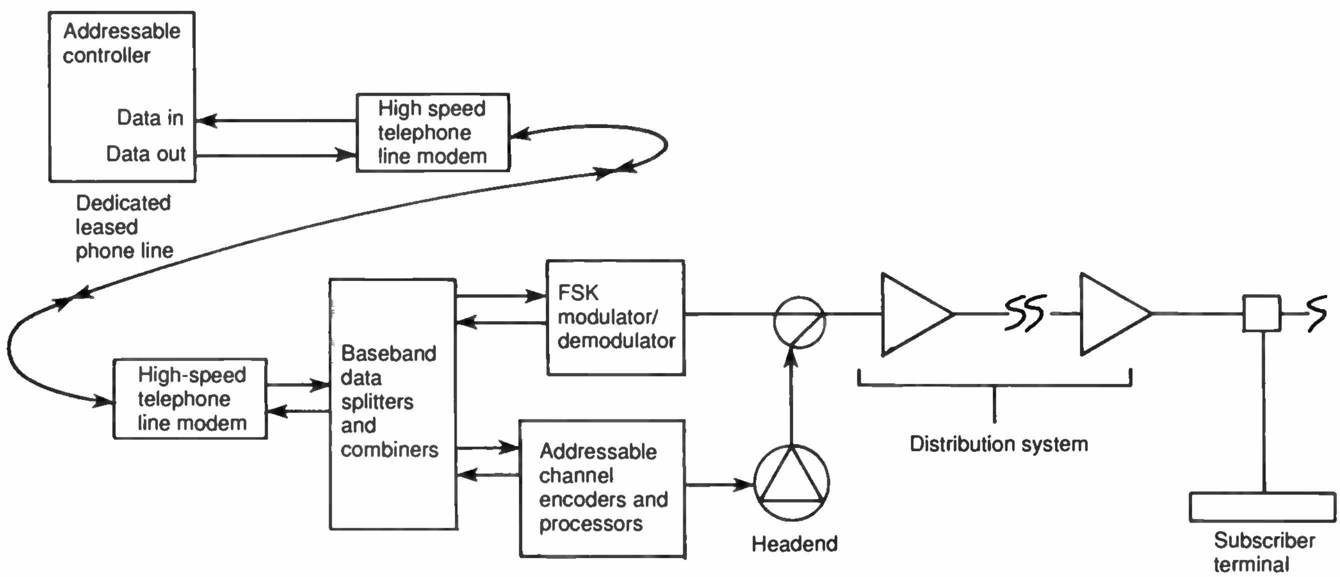
Figure 5: Telephone line-linked non-collocated addressable control system



ing additional delay in each hub interconnect that has an inherent delay less than the hub with the maximum delay. The goal of this process is to make the delay from each hub equal to the delay in the hub with the largest delay.

Differences in delay from each responding node on a given hub are accommodated by allowing a large enough response window to receive a response with the shortest and longest expected delay within that hub.

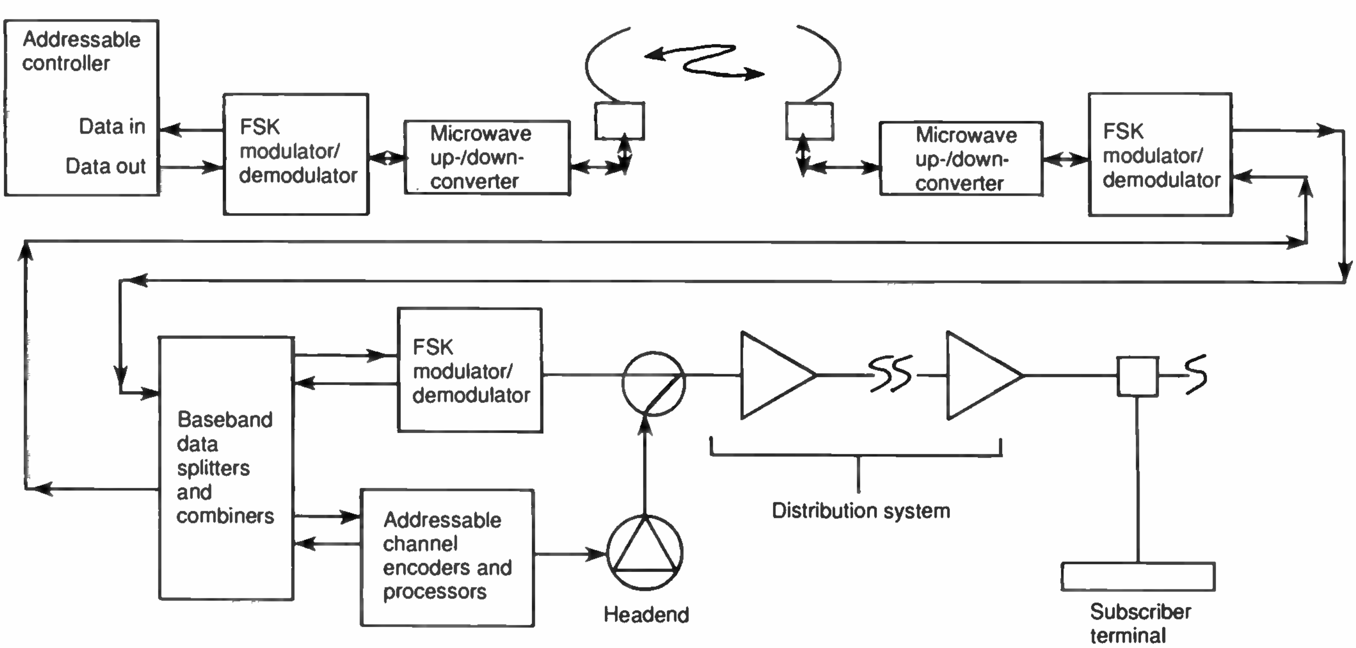
System designs

The RF plant of the CATV system is a known quantity. Any transmission delay in the signal is directly attributable to propagation delay in the amplifiers and passive devices such as combiners, splitters, directional couplers or cable. These quantities are easily calculated or measured and are relatively small.

The opportunity for time distortion of the data streams occurs wherever

(Continued on plage 62)

Figure 6: Microwave-linked non-collocated addressable control system



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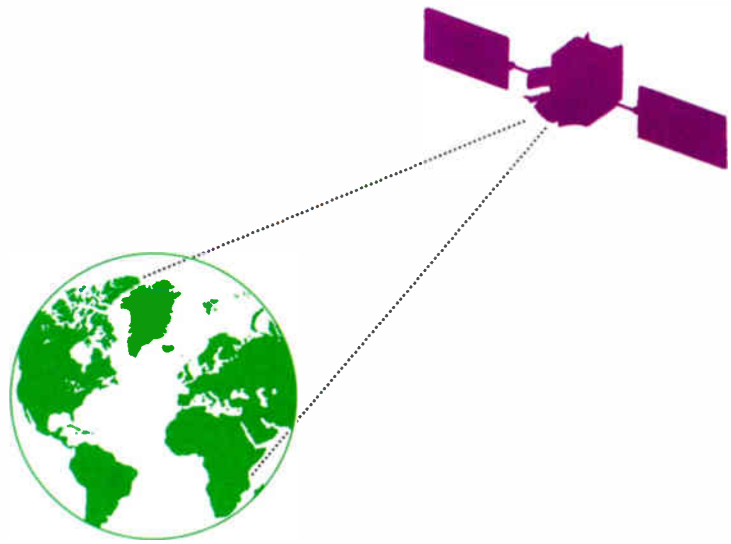
SkyPix digital compressed video system on cable



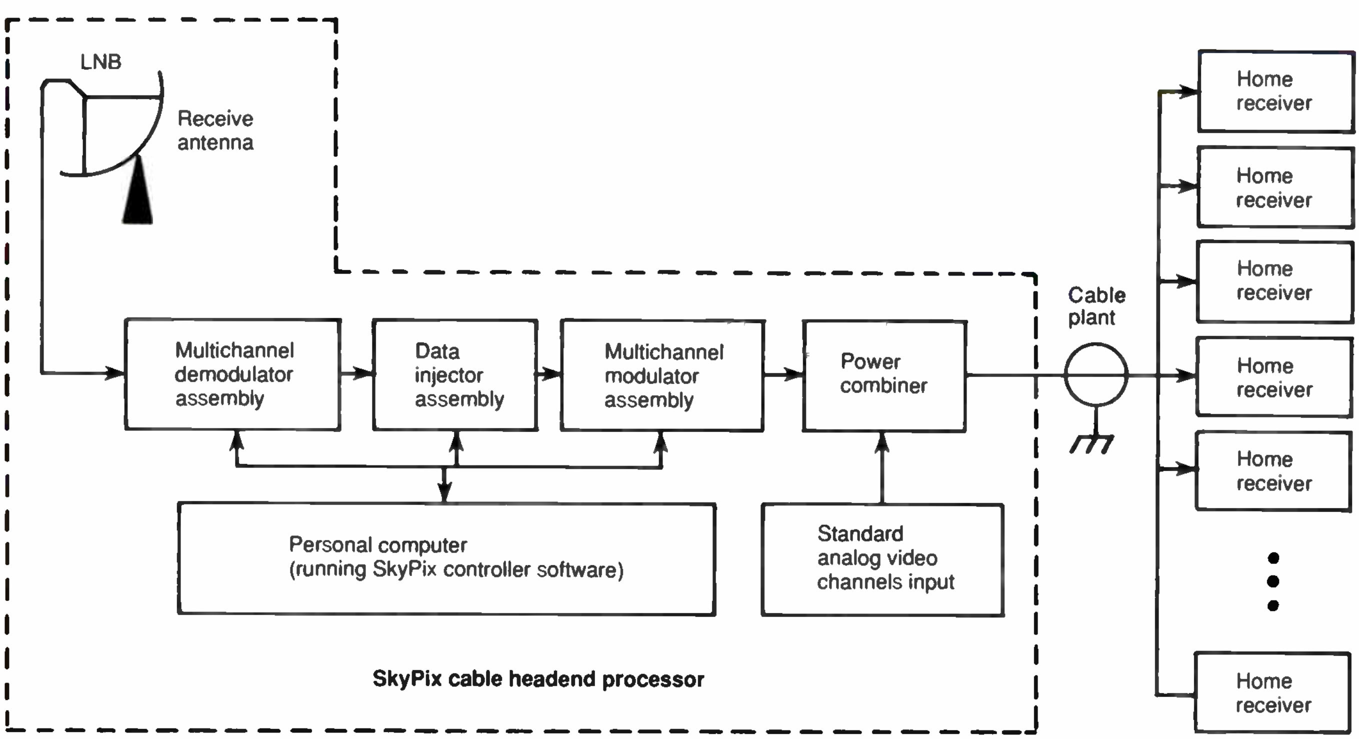
This article is a follow-up to Ted Chesley's first report on SkyPix — "Testing compressed digital video signals: A case study" — in the May 1991 issue of "CT."

By Stephen Hatcher
President, Summit Design Inc.
And Theodore Chesley
Director of Engineering, Rock Associates

"When conventional analog reception is severely degraded, SkyPix digital signals still provide clear reception."

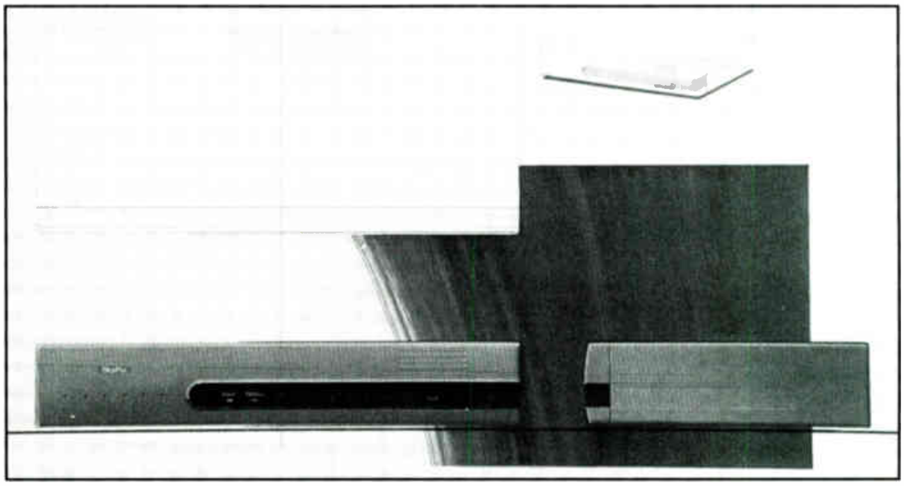
The SkyPix compressed video transmission system has been in operation in Rock Associates' Coeur d'Alene, Idaho, cable system for the past five months. Extensive testing has been accomplished on the quality and reliability of the digital signals as resident in the normal analog cable world. The results of these tests and ongoing observations have not only verified the predicted performance parameters for compressed digital services, but have demonstrated the high quality and extreme robustness of the pictures through-

Figure 1: SkyPix cable system



out the analog transportation and distribution system.

The ability to carry up to three video channels in a standard 6 MHz channel spectrum width, with consistent quality throughout the system, impacts the rebuild/upgrade equation for systems lacking spectrum availability and opens the door to a wealth of ideas in the pay-per-view, I-Net and LAN worlds. In fact, the quality of digitally modulated signals alone leads one to conceive of an all-digital world in the not too distant future.

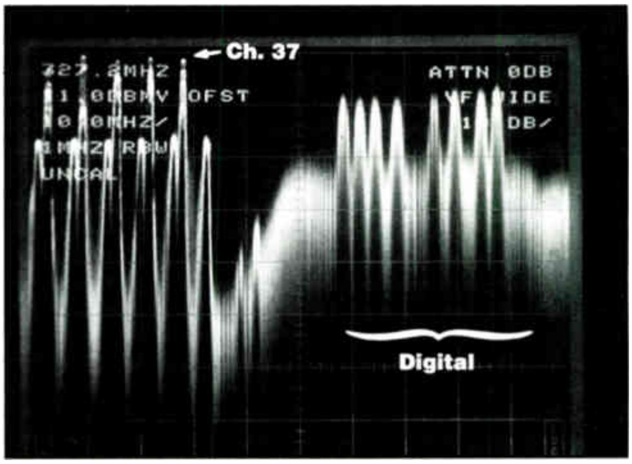


Design concept for the SkyPix cable receiver enclosure (in development).

The SkyPix system

SkyPix Cable is actively engaged in the development of cable modems to bring interactive PPV digital video and audio to the cable marketplace in the second quarter of 1992. In cooperation with Rock Associates, Jones Intercable and Home Shopping Network, SkyPix is establishing practical standards for its existing digital compression and transmission technology for cable systems.

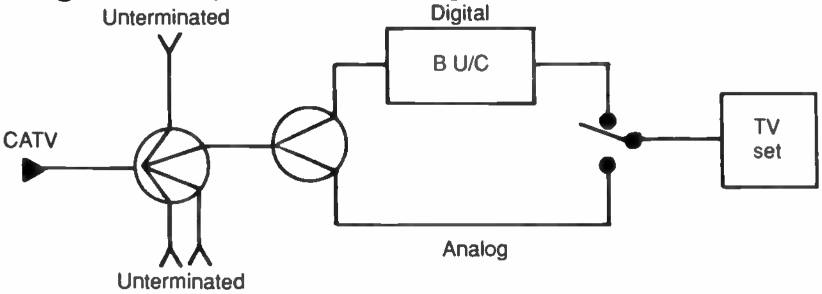
Figure 2: Digital overlay on analog



The SkyPix system consists of the cable headend processor and home receiver unit. The headend processor recovers SkyPix signals from the SkyPix satellite link and processes this data for transmission over the cable network. At the consumer home, the SkyPix receiver recovers both the digital video data as well as the conventional analog video. The compressed digital data is converted to analog for viewing yet exhibits uniform picture quality independent of the cable transmission distance. This is due to the lower susceptibility to interference characteristic of the SkyPix digital signals over conventional analog. When conventional analog reception is severely degraded, SkyPix digital signals still provide clear reception.

• The *SkyPix cable headend* is designed to provide the cable operator with a simple means to take SkyPix satellite signals and place them onto a cable network along with standard analog video carriers. Using a simple personal computer-based interface, the cable operator need only specify the available cable bandwidth and analog channel placement. The SkyPix cable headend then automatically recovers the required channels, corrects any satellite transmission errors, remodulates the signal on the required carrier frequency and combines the signals with the standard analog video carriers for transmission.

Figure 3: Impedance matching (Test 1)



Compared to satellite broadcast, the cable system is a relatively benign environment for SkyPix digital signals. On cable, SkyPix digital signals operate with much lower signal-to-noise ratios (S/N) than standard analog video carriers (10-16 dB vs. the 40-50 dB required for analog). These digital signals also have a higher channel capacity resulting in eight channels of video transmitted in each 6 MHz analog channel spectral width.

This increase in efficiency is due to the digital modulation techniques employed. Quadraphase shift-keyed modulation (QPSK) is used in the satellite link due to its relative immunity to satellite transponder distortion. At

Figure 4: Impedance matching (Test 2)

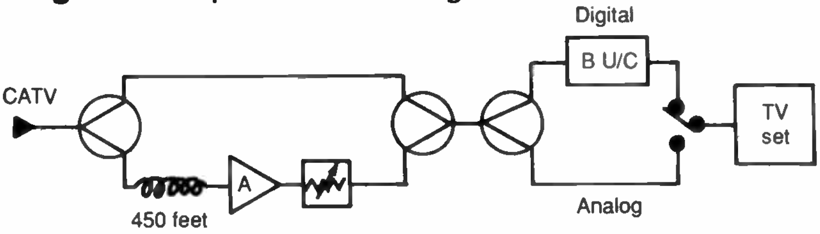
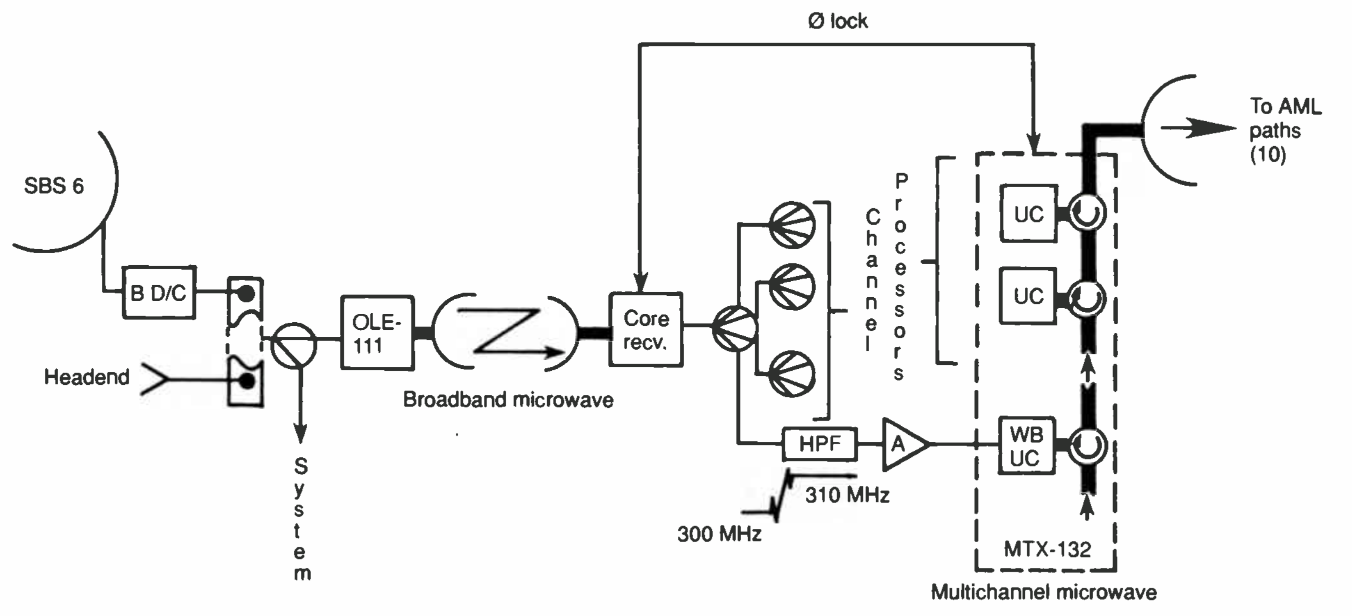


Figure 5: Microwave test



the cable end, with its highly linear amplifier stages, more sophisticated bandwidth efficient techniques can be utilized. QPSK and quadraphase partial response modulation (QPR) are currently used for system testing, and allow three SkyPix channels in 6 MHz. The actual system implementation utilizes 16 quadraphase amplitude modulation (16 QAM). The 16 QAM modem is in development and will allow eight SkyPix channels to occupy 6 MHz of channel bandwidth.

The SkyPix cable headend interfaces the SkyPix satellite service with a cable network through several signal conditioning processes. The satellite signals are recovered using a digital demodulator. The SkyPix data structure is then modified to reflect the required cable frequency assignments and cost/programming selections. The revised data stream is then time division multiplexed (TDM) with two to seven other channels and modulated to allow three to eight channels to occupy 6 MHz of bandwidth. A power combining process allows the SkyPix digital channels to share cable bandwidth with conventional analog signals.

Figure 1 illustrates the major subassemblies that receive the satellite data, update menu channel data and retransmit the SkyPix signal on cable with a signal structure that enhances the cable transmission efficiency.

• *Satellite receive antenna*. The SkyPix transmission occupies both horizontal and vertical polarizations. Using a dual-polarity, low-noise block downconverter (LNB) the full 80 channels of SkyPix broadcasting is brought to a multichannel demodulator assembly via a dual coaxial cable.

• The *demodulator assembly* simultaneously tunes to all SkyPix program channels and recovers the digital data streams for those channels. Though typically processing 80 channels of simultaneous data recovery, the demodulator assembly can be configured for less channels and readily expanded later. As SkyPix adds additional channels, this assembly can be expanded to accept up to 200 channels.

The demodulator assembly is very compact; 20 single-channel processors will fit in a single 4 x 19 inch rack assembly. As compared to the significant space requirements of standard analog processing hardware for cable headends, the SkyPix system allows tremendous channel expansion with minimal facility expansion.

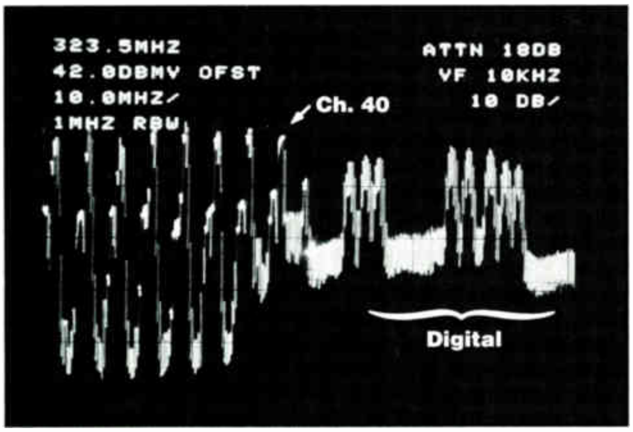
After recovering the satellite channel data stream, the demodulator corrects transmission errors with a powerful series of forward error correcting (FEC) codes. The resulting data, stripped of satellite transmission FEC overhead, is in its original compressed form. The frequency assignment table that occupies every channel is then modified in the data injector assembly.

• *Data injector assembly.* Every SkyPix channel contains the title, price and frequency assignment of all SkyPix channels. This allows real-time updates to the receiver selection tables to reflect changes in customer offerings as well as satellite frequency management. When the SkyPix signals are recovered from the satellite carriers, this data must be modified to reflect the new cable frequency assignments and customer offerings. The data injector assembly provides real-time modification of this entry in each recovered SkyPix channel. Like the demodulator assembly, the data injector assembly is a compact unit consisting of a single 19-inch rack assembly under PC control.

• The *modulator assembly* takes the recovered data, with modified channel assignment data, and combines one to eight channels into a single data stream. This data is currently QPSK and QPR modulated for field trials, with 16 QAM modulation in development for eight channels in 6 MHz spectrum efficiency. The modulator assembly generates the requisite carrier frequency, modulates the carrier, controls the output power level, provides specialized spectral shaping functions, and outputs the resultant 50-550 MHz signals to the power combiners used for analog/digital signal combination prior to transmission. The modulator assembly requires one 4 x 19 inch rack of equipment per 10 modulators.

• *Headend controller interface.* The demodulator assembly, data injector and modulator assembly are controlled by a PC running SkyPix controller software. The cable operator need only specify the available cable bandwidth that the

Figure 6: Digital/analog spectrum through AML



SkyPix channels can occupy in the cable system. Analog video channel assignments are placed in a data base to allow the controller software to determine optimal digital channel structuring (within available spectrum) for minimal intermodulation distortion of all carriers (both analog and digital video). This information also is required at the receiver to facilitate digital vs. analog tuning discrimination.

The controller software automatically controls the demodulator assembly for data recovery with error correction, determines the channel multiplexing for time division multiple access (TDMA) transmission, determines the optimum digital channel placement for minimal intermodulation generation, modifies the channel data files to reflect the carrier frequency assignments and controls the modulator assembly to create new cable digital channels. These new channels are combined with the analog video and transmitted on the cable system.

• The *SkyPix cable receiver* is placed in the home like a standard analog cable box. However, the SkyPix box accepts carriers modulated by compressed digital video and analog AM video. Carrying all digital carriers, a 350 MHz system could carry in excess of 400 channels. On a 450 MHz system, with 35 analog carriers to 300 MHz, over 100 digital signals can be overlayed.

The channel selection table contained in the SkyPix data informs the receiver as to which channels are analog and which are digital, as well as their frequency assignments. If an analog channel is selected, routing is accomplished by normal analog devices. When SkyPix channels are selected, the signal is processed by the digital decoder, which selects the channel, demodulates and decompresses the data, and creates an NTSC signal for TV input.

The SkyPix digital channels offer numerous advantages over conventional analog. As stated earlier, the digital channel is about 30 dB less susceptible to interference, which provides uniform picture quality to all subscribers regardless of their distance from the headend. The receiver controller provides a menu-driven user interface requiring only a simple remote control to program, preview and select from 80+ offerings. Through the menu, numerous additional features are made available to the end user, such as parental lockout by picture rating, personalized messages (all boxes are addressable) and current account status.

At the heart of PPV broadcasting is the question of piracy. Security is a critical design element in the receiver unit. SkyPix utilizes a state-of-the-art digital encryption technology to provide secure data delivery. The security process is on par with that used in wire fund transfers between banks.

Billing for the PPV service automatically occurs via a phone modem to the central office. Each receiver has a "cash box" allowing multiple purchases against a fixed level of credit. Through the on-screen menu, viewers can check their account status including the last 20 movies selected, the viewing times and charges. A more extensive record of viewing can be obtained through the billing offices.

The most significant threat to the RF performance of the SkyPix digital carriers are unterminated stubs in the RF installation. The resulting impedance mismatch would create transmission line distortions increasing the likelihood of transmission errors. To counter this, adaptive equalization techniques are in development, which measure line distortion and create an opposite distortion filter. The adaptive equalizer will correct the transmission error effect and result in undistorted data recovery.

Testing on cable

As mentioned earlier, on-cable testing has been in progress in the Coeur d'Alene system. The SkyPix satellite transmission of eight carriers in a single transponder has been block converted and added to the cable system in the spectrum between 330-360 MHz. The digital overlay (Figure 2) is carried throughout the 400-mile cable plant, with cascades to 43 amplifiers deep, and to outlying systems fed through Hughes broadband low power microwave using repeaters. Since much of this system is 300 MHz, this afford-

"This is one of the significant advantages of digital transmission: What you see off the headend dish is what you get anywhere in the system."

ed us an opportunity to test the transmission in a rolled-off bandwidth environment, with surprising results:

• *Basic parameters.* The quality of the received signal from the satellite as follows is significant in that these specifications are constant throughout the system, regardless of the point of reception. This is one of the significant advantages of digital transmission: What you see off the headend dish is what you get anywhere in the system.

Video signal parameters are as follows:

S/N (unweighted) = >55 dB
Lines of resolution = 480 lines
Noise threshold (to tiling) = 9 dB*
IM threshold (to tiling) = 12 dB*

(**Note*: Threshold to digital peak. Corresponding analog C/N and IM depends on digital/analog signal level ratio. At the same signal level, analog C/N would be 12 dB and IM would be 12 dB. Analog signals are unusable at these distortion levels.)

• *Receiver input parameters.* Testing has been performed with the satellite box, using an upconverter to reconvert the VHF spectrum to 950-1,450 MHz. The receiver is very sensitive, operating at dBmV levels of -26 to -30 dBmV. This presents another significant advantage of this type of transmission: Reception can be guaranteed in high loss, or rolloff, areas of the plant. It is only necessary to filter the higher level analog band from the receiver input and, if needed, amplify the signal to above the threshold. We have obtained reliable operation from drop levels weaker than -30 dBmV using this method. An external amp might be necessary in some weak signal cases. It is, of course, important to point out that analog signals at this low level would be basically unusable, amplified or not.

Another consideration for operation in the analog world is the effect of impedance mismatch on the digital signals. In analog, we can expect ghosting of various amplitudes and delay offsets, depending on the type and magnitude of the mismatch. To determine how this might affect digital, we set up two experiments. In the first, a standard CATV four-way splitter was set up with one leg feeding the analog/digital TV sets and each of the other three legs having 150 feet unterminated drops connected (Figure 3). An obvious ghost was present in the analog signal with about 1/16 inch offset. No difference was observed in the digital picture. Reflections were in the -30 dB range. To enhance this test, back-to-back two-way splitters were used, one leg connected straight through and the other connected through 450 feet of cable, a 20 dB amplifier and an attenuator (Figure 4).

The second test involved raising the level of the reflection to the point where intermittent tiling was observed in the digital picture. This point was found to be at a reflection/digital peak ratio of 11 dB. At this level of reflection, a very noticeable ghosting, and picture degradation was present in the analog picture. Interestingly, this ratio is relatively the same as the intermodulation ratio for fringe tiling. As mentioned earlier, adaptive equalization techniques will be use to minimize the effect of mismatch.

• *Microwave transportation.* We had previously determined in our earliest testing that broadband microwave was transparent to the transmission of the digital spectrum. To determine the effects of transmission through multichannel AML microwave we set the digital system up in our Moscow, Idaho, cable system. This is an excellent location to make these tests because Moscow is unique in using a broadband OLE-111 transmitter/receiver to deliver signals to a multichannel MTX-132 transmitter feeding 10 sites. This is done on a frequency reuse plan (the transmitters are on the same frequency) requiring tight intertransmitter phaselocking. To transmit the 30 MHz wideband of digital signals, a Hughes wideband tuneable upconverter was used (Figure 5). Normal MTX-132 upconverters are 10 MHz wide, so would not suffice for the wider required bandwidth.

The digital spectrum was overlayed on the analog through the microwave (Figure 6), received at the microwave receive site and processed the same as off the system. Digital level was carried 6 dB below the analog levels. No intermodulation products were observed through the microwave and stability was as good as experienced on the system without the microwave in the path. Due to the facts that a 310 MHz high-pass filter was used to pass the digital spectrum to the wideband upconverter and that this system uses analog carriers to Ch. 40, two of the analog carriers were passed through the upconverter with the digital. These higher coherent carriers did not impact the digital transmission, but some low level IM was noted on them. In practice, only the digital spectrum would be carried through the upconverter.

The overall result of this test did determine that the prospect of carrying wideband digitally compressed signals through channelized low-power AML microwave is not only feasible but easily accomplished.

• *System sweep testing.* A result of our earlier testing was that a high-level sweep would interfere with the digital transmission. With the help of Wavetek, we found that the sweepless sweep type of system works well with the digital carriers. The normal sweep refresh differential of <.25 dB with analog carriers is slightly greater over the digital spectrum but <.5 dB. Interestingly, we found that unmodulated carriers of levels higher by 3-6 dB inserted anywhere over the digital 2 MHz spectrum had no effect on the digital transmission as long as the interfering carrier did not move (indicating that a comb generator type of fixed carrier sweep might work with this type of system).

The future

With compact, high-efficiency signal processing and a simple user interface, the SkyPix cable headend provides tremendous enhancements to the effective cable plant channel capacity with minimal impact on the headend transmission facility. The addition of SkyPix digital video channels can be made while continuing to offer conventional analog services. The SkyPix cable receiver is designed to accommodate both transmission technologies thus providing a smooth, single receiver box transition into the future of all-digital TV. **CT**

Fiber cable placement

(Continued from page 26)

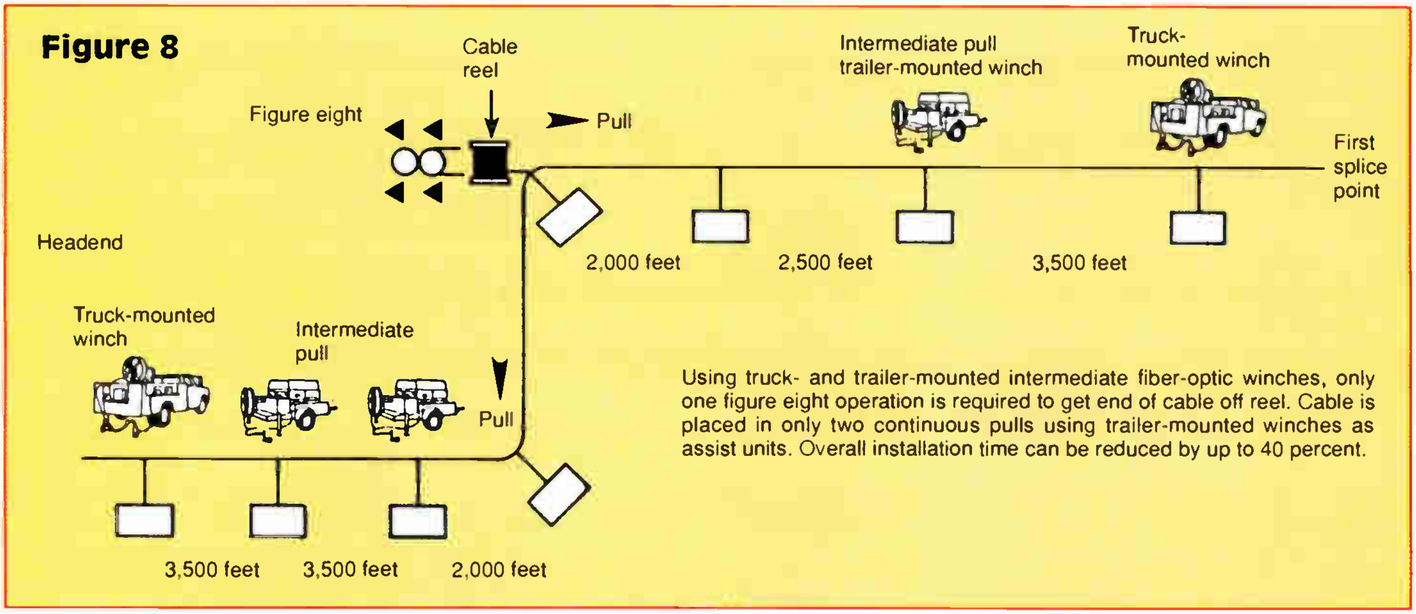
Underground cable

As is the case with aerial cable placement, techniques used to place fiber cable in the underground plant are very similar to those used to place conventional cable plant. After clearing the ducts by rodding, brushing and/or passing a mandrel through the larger ones, subducts are installed. Many subducts are provided with a pull line already attached. One should verify the suitability of the pull line for pulling the fiber cable prior to using it. It may be necessary to install suitable pull line by rodding or blowing it in place.

Cable lubricant is highly recommended for all but the shortest pulls. This lubricant will considerably reduce pulling tensions during cable placement. The lubricant should be applied in accordance with the manufacturer's recommendation. Compatibility of the lubricant with the cable jacket should be verified.

The cable route survey will usually dictate the cable

Figure 8



Using truck- and trailer-mounted intermediate fiber-optic winches, only one figure eight operation is required to get end of cable off reel. Cable is placed in only two continuous pulls using trailer-mounted winches as assist units. Overall installation time can be reduced by up to 40 percent.

"Before beginning any construction activity, proper and thorough engineering must be done. Complete engineering drawings and specifications should be provided to the construction team."

during the construction process. At minimum, information recorded on these drawings should include cable footage markings, all deviations from the engineered plans and confirmation of actual cable placement.

Splice losses should be recorded as they are made using either an optical time domain reflectometer (OTDR) with a chart recorder or other electronic recording device. Upon completion of all splicing, including the pigtails, end-to-end OTDR traces should be made to provide a permanent record for maintenance and troubleshooting. These traces can be used for comparative purposes should a problem develop over the life of the cable. In addition, and depending upon system configuration, power loss measurements should be made using the cutback or insertion loss test method. These values should be compared to those predicted by summing the optical loss of the cable plus splices.

These two tests and calculated data provide complementary information about the passive fiber cable system that is required to accurately characterize that system. Actual measured results may vary slightly between test methods but this is more a function of test equipment and measurement technique rather than any real difference.

Final acceptance

After the plant is installed, the optical and mechanical properties of the passive fiber cable plant should be reviewed by construction and engineering management. Field data in the form of as-built drawings, transpositions, cable data sheets and any other pertinent information should be turned over to the operator. Optically, the contractor should provide calculated data obtained from the cable data sheets and splicing logs, OTDR traces obtained from end-to-end cable test and power measurements. Mechanically, a visual inspection of the plant should be done to verify the completeness of the work.

It is essential that any operator of a fiber cable system maintain adequate information about the system for maintenance, troubleshooting and emergency restoration procedures.

In many ways, fiber cable is easier to install than coaxial cables. It is a rugged product, but it does require some special handling and care. The construction process is unique and requires careful, detailed planning. Because of the long length, cost and difficulty of splicing fiber-optic cable, the entire sequence of events required to place that cable must be carefully orchestrated. With sound engineering, good planning and competent contractors, passive fiber cable systems of superior optical and mechanical properties can be economically placed in service. **CT**

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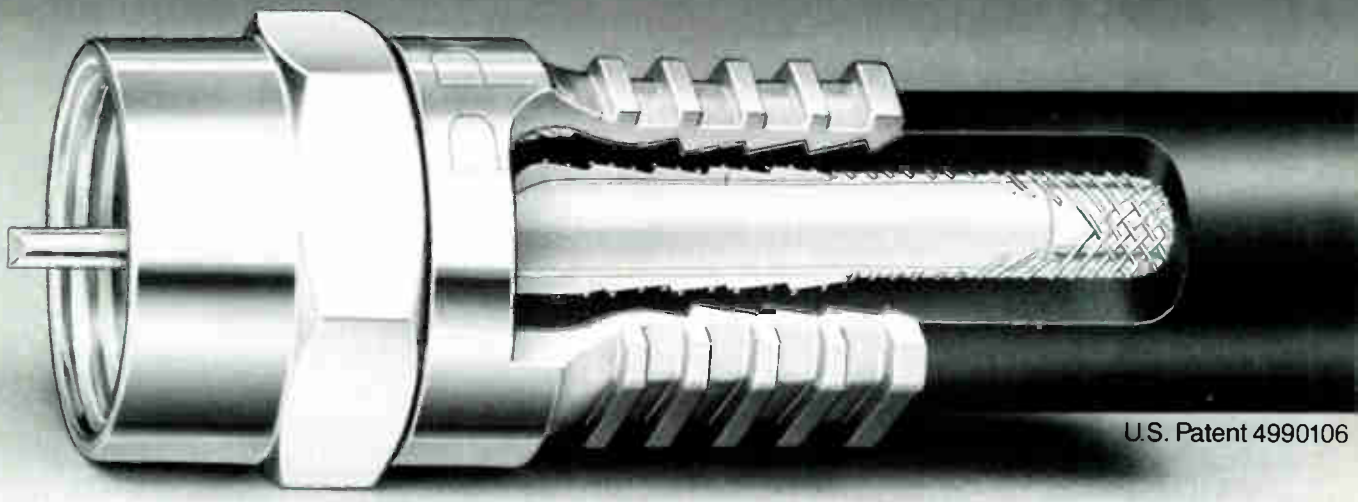

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Fiber-to-feeder design

(Continued from page 36)

future nodes at the termination of the express feeders, miniserving areas of 500 homes each are established and the design becomes a triple-star. Cells of this size are compatible with switched services, such as video-on-demand. In fact, the advent of personal communications network (PCN) technology makes even the transmission of voice and data services a real possibility.

Conclusions

In a rebuild situation, FSA brings cable operators a number of benefits for about the same capital investment as a conventional trunk and feeder plant design. The picture quality viewed by subscribers is greatly enhanced — the C/N at the last tap is from 49 to 50 dB. The number of outages experienced by each subscriber is dramatically reduced and the number of outages in the plant as a whole is reduced as well. The plant operating costs are lower. The total power consumption of an FSA plant is lower than conventional trunk and feeder or fiber backbone designs. Finally, the FSA architecture supports future services, including HDTV, switched services such as video-on-demand, and telephony-based services such as PCNs.

Fiber optics has the potential to revolutionize the landscape of cable as we know it today. Once in a great while, a technology and a market come together to create a dramatic opportunity. In 1975 the marriage of cable TV and satellite transmission technology opened up a whole new world for the CATV industry. Today AM fiber-optic technology, combined with the vision embodied in FSA, positions the cable industry to serve the video entertainment and information needs of the 21st century. **CT**

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Table 3: Material cost comparison

	Low density (60 homes/mile)	Medium density (125 homes/mile)	High density (200 homes/mile)
Trunk and feeder	$6,200	$5,975	$6,785
Fiber-to-serving area	$6,625	$6,155	$7,070
FSA premium	6.9 %	3 %	4.2 %

Notes:
1) All systems 550 MHz bandwidth.
2) AM fiber is dual tier.

Table 4: FSA performance comparison

	Feeder level	Fiber		Coax		Total	
		C/N	CTB	C/N	CTB	C/N	CTB
Low density (4-amp feeder)	47	50	65	60.2	57	49.6	54.1
Medium density (5-amp feeder)	46	50	65	58.2	57	49.4	54.1
High density (8-amp feeder)	44	50	65	54.2	56.9	48.6	54

Notes:
1) All systems 550 MHz bandwidth.
2) AM fiber is dual tier.
3) Optical loss budget is 10 dB.
4) In 4- and 5-amp cascades: Every third amp operated in AGC mode.
5) In 8-amp cascades: Every other amp operated in AGC mode.

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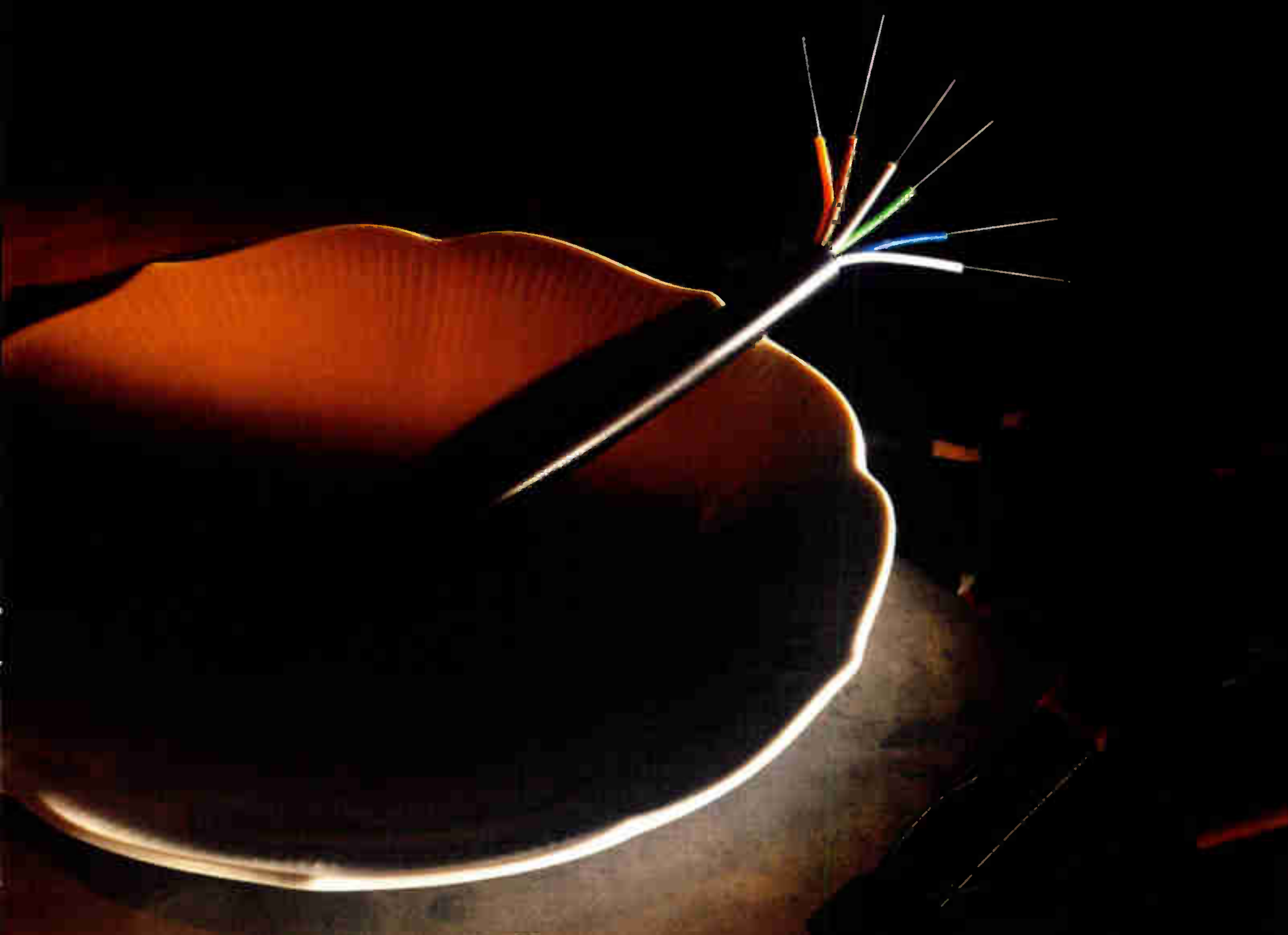

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WAVETEK

Reader Service Number 42

Timing considerations

(Continued from page 46)

there is a translation from one medium to another. The most common place for this is the link between the addressable controller and the RF headend or hub sites. Often the controller site is geographically separated from the headend site. If there is a cable link, the delay will be minimal. This cable link can be a direct connect baseband connection between the controller and headend or an RF modem link to the headend. If there is no cable link, alternate technologies must be employed. When they are used, there is an impact on the communications system timing. Most sensitive are systems with multiple headends connected to the same addressable controller through different media and at different distances.

The following sections describe some of the more common interconnect options available for the link between the addressable control system and the RF CATV plant.

RF systems

In systems where the addressable controller is located at or near the RF headend, it is possible to make direct baseband connection to the RF modulation/demodulation equipment. This is the most efficient means for transport of data. This system exhibits only cable propagation delays in the channel. This basic configuration is shown in Figure 3. RF system delays are calculated from the physical parameters of cables and distribution equipment, such as amplifiers. In addition, an addressable controller must compensate for worst-case response set-up time in the subscriber terminal. These values, once specified, become the baseline timing for the system. That is, a simple RF direct connect system defines the minimum timing compensation for any CATV data system.

More complex is the situation where the addressable controller is located on the cable plant downstream from the headend site. This is shown in Figure 4. To accomplish this, two additional modems must be installed in the system. Forward data intended for the terminals are modulated onto a sub-band carrier for transmission to the headend. There, the stream is demodulated and remodulated onto a carrier in the FM band for transmission back downstream to the subscriber terminals. In addition, the demodulated forward

baseband stream is distributed to addressable video processing equipment within the headend. Terminal responses are received in the sub-band at the headend (on a unique frequency from that used to carry the forward stream) and demodulated. Responses from the addressable baseband equipment at the headend, along with the demodulated responses of the subscriber terminals, are modulated onto a unique FM frequency for transmission back to the addressable controller downstream.

RF modulation and demodulation do not add significantly to the delay found in a minimal configuration system. However, if the demodulation process is coupled to any form of error detection and/or recovery device that manipulates data at baseband, there is some affect on the overall timing of the system. In the RF non-co-located system described before, there are three opportunities for delay and uncertainty changes (one at each modem). These will add to the original baseline timing values. Depending on the addressable controller, additional delay and timing compensation may be necessary.

Telephone interconnect systems

When there is no cable interconnection between the RF headend and the addressable controller site, alternative technologies must be used to transport the data streams between the two sites. Several different systems are available for this purpose, including telephone lines and microwave.

Telephone line communications can take two forms: one within the normal telephone network using dial-up modems, or the other using dedicated point-to-point lines that are always connected. Due to the heavy data traffic and the time sensitivity of the communications, dedicated lines are used for this type of activity.

High-speed modems encode data into a trellis format that allows very high bit rates to be transferred via a low bandwidth channel (3 kHz). These data format and rate translations are usually the work of one or more microprocessors within the modem block itself. The delay and clock phase variations encountered are the result of not only propagation delay, but different clock rates, and phases and non-linear delays due to run time variations in the formatting software of the signal processing microprocessors. In fact, these run delays can be sizeable. For example, a 14.4 kbps, V.33-compatible trellis code modem may induce a 23-25 msec delay in each direction. This amounts to an approximately 50 msec round-trip delay.

If the clock rate of the telephone modem is not identical to that of the incoming baseband stream, there are bit slippages and bit insertions that occur during encoding and decoding of the trellis-coded stream. This contributes to the jitter or delay uncertainty.

There is a final factor in the timing of a telephone-linked system that needs consideration. The point-to-point telephone line connecting the addressable controller with the headend may be longer than the geographical separation of the two sites (see Figure 5). In fact, it is possible that a relatively short separation (<30 miles) can be connected by a very long telephone line (>100 miles). Although propagation delays through a four-wire telephone line are small, they are no longer insignificant in relation to the data rate when distances start to increase. This is why direct measurement of the round-trip delay of the channel is desirable. Most modems can be placed into loopback modes. This allows the round-trip delays in a given channel to be measured directly. If this is the last link before the RF interconnection to the distribution plant, the total delay can be calculated for that network leg.

Microwave systems

Another alternative for a non-cabled data path is via microwave point-to-point transmission. A full duplex system capable of supporting two-way RF terminals must incorporate transmission and receiving equipment for both directions between the addressable controller site and the RF headend or hub. (Two-way satellite systems are generally not feasible due to large uplink costs at each remote site. One-way systems are in use in several locations.)

The system design is shown schematically in Figure 6. The baseband data streams are first modulated by FSK modems and then presented to a microwave upconverter for the appropriate frequency translation. At the receiving end, a downconverter translates the stream back to its original carrier frequency. In most AML microwave systems, there is little discernible time delay for a continuous data stream. Propagation delays through the channel (upconverter, transmit, downconverter) are not significantly different from those in an FM band and subband RF system.

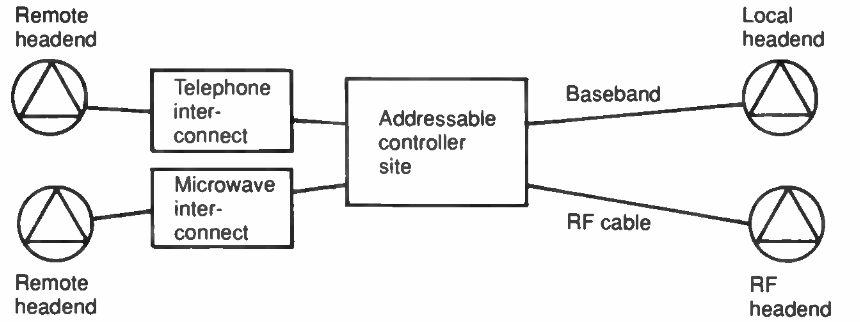
Combination systems (multihub)

A system where several headends or hubs are serviced by one addressable controller is the most sensitive to differences in timing from hub to hub. When there are several different transport technologies implemented, the timing becomes more complex. Figure 7 shows a multiple hub system that utilizes all of the previously described transport scenarios.

If timing between terminal and hub is considered constant, then the remaining areas for timing differences are in the data path equipment. The effects can be considered a combination of each single technology impact described in the preceding paragraphs.

In a multihub system, if delays are not accounted for, the command data in the forward stream does not arrive at the subscriber terminals simultaneous-

Figure 7: Multihub, multiple data path addressable system



ly. In many applications it is not desirable to control addresses of terminals by geographic location, thus it is possible that consecutive addresses will be on different hubs. In fact, depending on the delay in a given channel, a command can arrive at consecutive address devices at very different times. This is significant in polling command formats where the expected response position identifies the responding device. If there is disparity in the arrival time of the command, the response cannot return in the proper order and may collide with responses from other devices.

The solution in a multihub system is to equalize the delay in all hubs so that responses from devices on each hub arrive at the destination at the same time regardless of the delay incurred on that leg of the network. The compensation is described in detail in the following section.

Timing compensation

There are two places where timing compensation is required to accommodate the various data transport technologies. The first is in the data path itself using additional electronics to provide for the delay values. The second place is within the addressable controller software. The data communications parameters and protocols should be adjustable for the full range of delay and jitter that can be encountered in a CATV data path and distribution system. Ideally, in the controller, this adjustment should be automatic. That is, the addressable controller can determine the type of network it is using, make timing measurements and provide automatic compensation.

In single hub systems, the compensation required is minimal. Adjustment of timing parameters within the addressable controller is usually sufficient to assure adequate system performance. However, in multihub systems, timing must be equalized between hubs. The concepts of aggregate delay and delta delay become important as one deals with several differing length network leg timings.

In the data path

Aggregate delay is calculated separately for each leg of the data path network. It is the combination of data path equipment delays, delays in translation to RF equipment, the propagation delay of the distribution system and the turnaround time of the subscriber terminal.

If there is more than one telephone-linked leg in the network, do not assume that the delays are the same. Each telephone line may have different delays.

Delay uncertainty is based on the accumulated uncertainty for all data path devices in the chain. Each device must be carefully characterized, both through device specification and empirical measurement. With the resulting base of information, the delay uncertainty can be calculated for any chain of devices.

The term "delta delay" is used to describe the difference in delay between a response from a given leg (hub) of the network and a response from the leg (hub) with the longest delay. This is the amount of additional delay that must be inserted in that leg to equalize it (make it equal to the delay in the longest leg).

Delay insertion can be implemented using a programmable device under addressable control. It should be programmable on a channel-by-channel basis for a wide variation of delay values. The controller can then program the device to insert the appropriate delta delay for each channel in the network. When unequal delays are not compensated within the data path,

"The maturation of addressability as a technology coupled with the advent of PPV and IPPV services has effectively turned the CATV system into a two-way data communications network."

there is a risk of collision between responses returning from different hubs.

In the addressable controller

An addressable controller operating in the environment presented can be thought of as a half-duplex system connected to a full-duplex line during transactions, and a full-duplex system during polls. The controller sends a command and waits for a response for a specific length of time. This is true in either the transaction or poll modes of operation. The treatment of the two modes of operation is different, however, and bears discussion.

In transaction mode, the addressable controller addresses a single device with a fully framed request or command. The response also is fully framed. The controller can wait for a prescribed period of time for the response to arrive or declare it failed. This wait period is the transaction response time-out. The value is the maximum aggregate delay through the network. This is shown graphically in Figure 1.

Poll format commands are structured to permit one command to provoke responses from a group of terminals on the system. As delay becomes larger, there is more elapsed between the time when the addressable controller has sent the address of a given terminal and the return of that terminal's response. In order to keep up throughput, the controller will keep sending addresses to the remainder of the group. The delay incurred has the effect of forcing the addressable controller to allow more addresses to be transmitted before expecting an answer from an earlier address. This is referred to as queueing or pipeline responses. That is, there is a set of addresses transmitted before the first response returns. The size of that set is a parameter called queue depth.

Delay uncertainty, or jitter in the system causes the response to move around within its expected window of response. The window is defined as a period of time in the response stream sized to the response plus some margin. The larger the jitter, the more margin is required to assure that the response will be received. This window size should be an adjustable parameter within the addressable controller.

Conclusions

The data communications functions of the CATV system have been described with respect to timing variations in the network. It is possible to compensate even the most complicated networks for timing to ensure efficient, reliable data communications performance.

The various data transport technologies may cohabit a system if their delay and jitter parameters are understood and accounted for within the system. This "fine tuning" is necessary in systems where high traffic polling and RF-based data collections are necessary functions.

If the time delays are understood and the delay uncertainty can be measured and/or calculated for each leg of the CATV data network, the integrity of data responses from subscriber terminals will be reliable regardless of the complexity of the network. This results in more accurate and complete data collections from the terminals.

Since timing compensation is done only down to the hub level, a typical system will have a relatively small number of nodes requiring compensation. Since compensation is based on a mathematical model, all measurements may be done under computer control. The entire compensation process can be automated, relieving the cable system operator from the laborious calculations. Once timed, a system should only require re-timing when data path devices or configurations are changed.

While the concepts have been presented in reference to an out-of-band data path system, it is possible to extend them to in-band systems as well. If there is a means for measuring or calculating the delay in the data channel between the addressable controller generation of a command and the arrival of the response, the delay values can be ascertained. If real-time polling or other time-sensitive communication is used, it is possible to measure the delay uncertainty of the return channel. These two parameters can be incorporated to fine tune the system for maximum reliable throughput. **CT**

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Reader Service Number 53

Digital videotape recording — from NTSC to HDTV (Part 1)

A recent column (see April 1991) was about film and television. This one (which will appear in two installments) is about videotape recording — especially digital videotape recording. Part 1 provides a synopsis on the birth and growth of analog VTRs. The final installment next month details the various digital VTR systems.

By Lawrence W. Lockwood
President, TeleResources
East Coast Correspondent

What with all the various proposed compression schemes, the digital HDTV schemes, not to mention the amount of digital signal processing currently used in so many NTSC TV receivers today, it looks as though even the electronic world of entertainment will progress into the all digital. Videotape recorders (VTRs), both analog and digital, are a significant part of the present NTSC TV order and they (the digital ones) will be an important part of the HDTV future.

Of necessity, digital systems are detailed and sometimes complex. Much of the detail of digital VTRs is beyond the scope of this column. However, I believe the digital cognoscenti will have little trouble filling in missing details and I hope those not intimately familiar with digital techniques will find the following intuitively instructive.

One must always remember a fundamental canon: The world is analog; digital schemes, no matter how clever, are merely tools to accomplish tasks in the real analog world. In television, the image starts out analog and the eye views it analog. The in-between is the activity that is progressing digitally.

Birth and growth of analog VTRs

In a 1951 speech renaming the "RCA Laboratories" in Princeton, N.J., the "David Sarnoff Research Center,"

Table 1: Quadraplex VTR parameters

Signal system	FM analog, composite video
Peak-white frequency	10 MHz
Black-level frequency	7.9 MHz
Scanner type	Transverse, four heads
Scanner diameter	2.064 inches
Scanner rotation	240 r/s
Head-to-tape speed	1,550 ips
Media type	2-inch wide, gamma-ferric oxide, 350 Oe*, particles oriented transversely
Tape speed	15 ips
Track length	1.818 inches
Track angle	89.43°
Wrap angle	115°

*Oe is the abbreviation for oresteds, a measure of magnetic intensity

Table 2: SMPTE Type C VTR parameters

Signal system	FM analog, composite video
Peak white frequency	10 MHz
Black level frequency	7.9 MHz
Scanner type	Helical, three heads
Scanner diameter	5.35 inches
Head-to-tape speed	1,009 ips
Media type	1-inch wide, cobalt modified gamma-ferric oxide, 650 Oe
Tape speed	9.6 ips
Track length	16.1718 inches
Track angle	2° 24 min.
Wrap angle	330°

"One must always remember a fundamental canon: The world is analog; digital schemes, no matter how clever, are merely tools to accomplish tasks in the real analog world."

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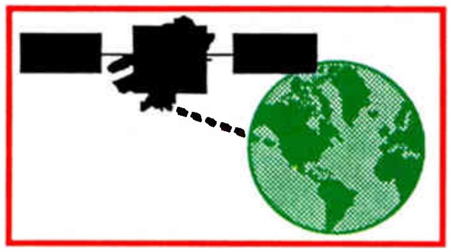

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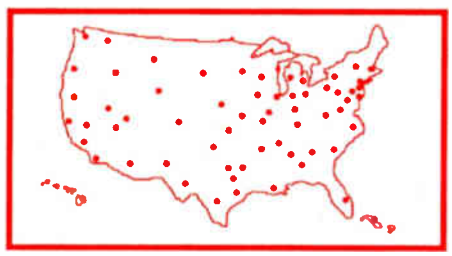

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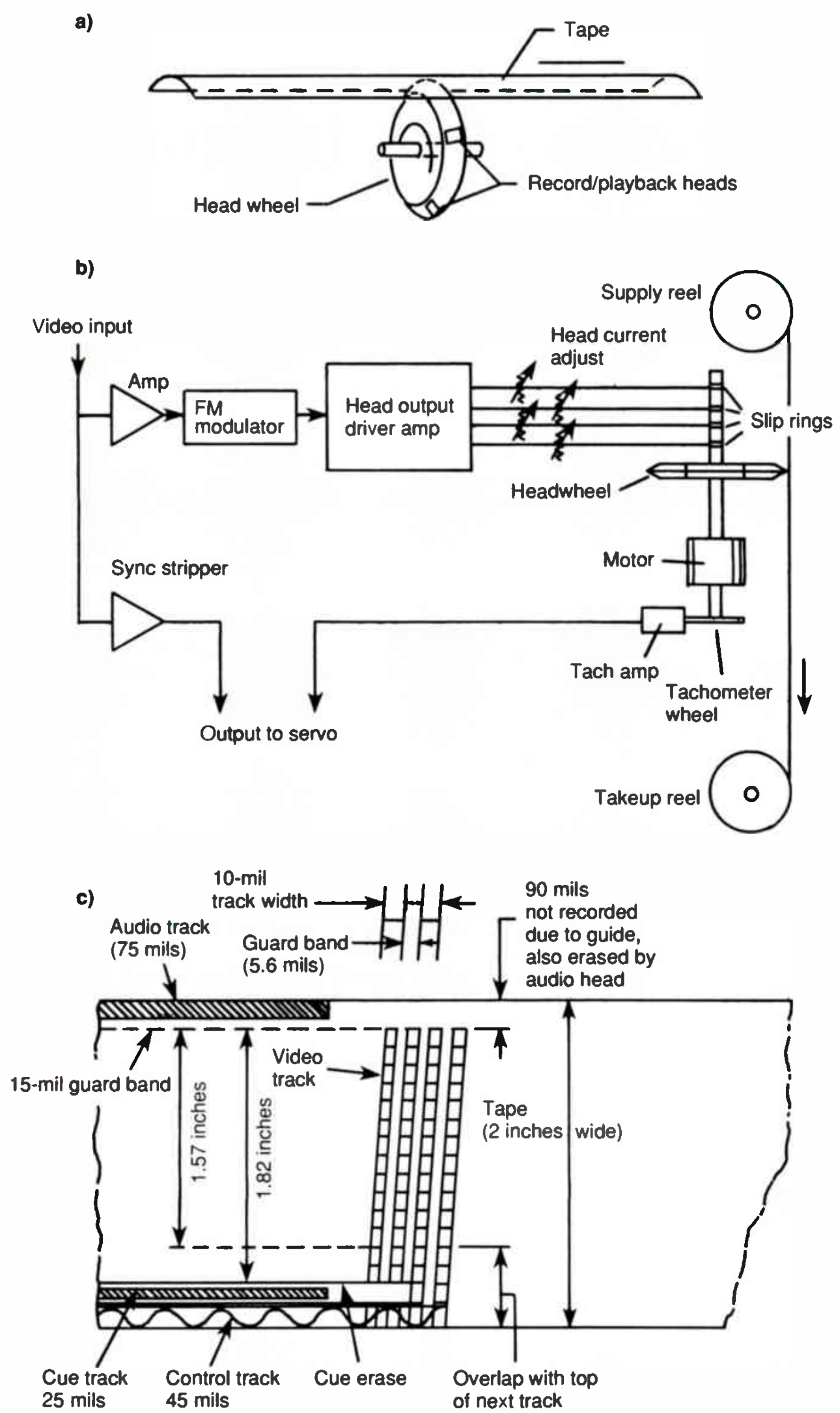
Gen. Sarnoff requested of his researchers three birthday presents for his 50th anniversary in radio due in a little over five years. They were: 1) an electronic light amplifier, 2) an electronic refrigerator and 3) a TV tape recorder. This set off intensive activity not only in RCA but in other companies.

In 1951, professional audiotape recording produced a 15 kHz response at a 15 inches per second (ips) tape speed. Linearly speeding up the tape would require a 4,000 ips (333 feet/second) speed to record a 4 MHz video.

Sarnoff never received his VTR birthday present largely because the RCA approach was a variation of the speed-up-the-tape approach. They did produce a lab unit that ran at 20 feet/s. It required a 20-inch reel to hold enough tape for only 15 minutes of playing time. An amusing side note: The inertia of a fully loaded reel, rotating at a high speed, was enormous and the huge brake required in case of a tape break (which was not infrequent at those speeds) sometimes did not work quickly enough resulting in a growing pile of tape on the floor until everything came to a halt.

Figure 1: The Quadroplex VTR



Ampex (a small company at that time compared to RCA), noted for its professional audiotape recorders, also started its work on a VTR in 1951 and they succeeded in 1956. Its approach was radically different than anything in use then.

The unique solution to the tape speed problem that Ampex developed was to move the heads as well as the tape. Ampex called it a Quadraplex VTR because four heads were mounted in a wheel that rotated against a 2-inch tape that moved slowly past the wheel as shown in Figure 1a. A simplified block diagram of this system is seen in Figure 1b. In some newer VTRs the slip rings have been replaced by rotary transformers. Separate tracks for audio and control were made in a standard manner with stationary heads. The layout of the resultant tracks are shown in Figure 1c. The 2-inch tape moved at 15 ips. The Quadraplex VTR operating parameters are shown in Table 1. Ampex sold the first Quadraplex VTRs for $50,000.

When rigorously maintained, the Quadraplex produced excellent signals. However, it was particularly difficult to keep the outputs of the four heads precisely matched; if they were not, "banding" resulted. Banding is the division of the picture into horizontal bands of 16 to 17 TV scan lines because that number of TV lines is recorded by each head in its path across the 2-inch tape. The eye is particularly sensitive to small discontinuities in any picture characteristic such as brightness, contrast, noise or colorimetry.

The inherent problems associated with the Quadraplex prompted efforts to find a simpler approach. The format that evolved was the helical scan or slant track and was first developed at Ampex. The tape path is a helix, and the diagonal configuration of the

Figure 2: Helical scan recording

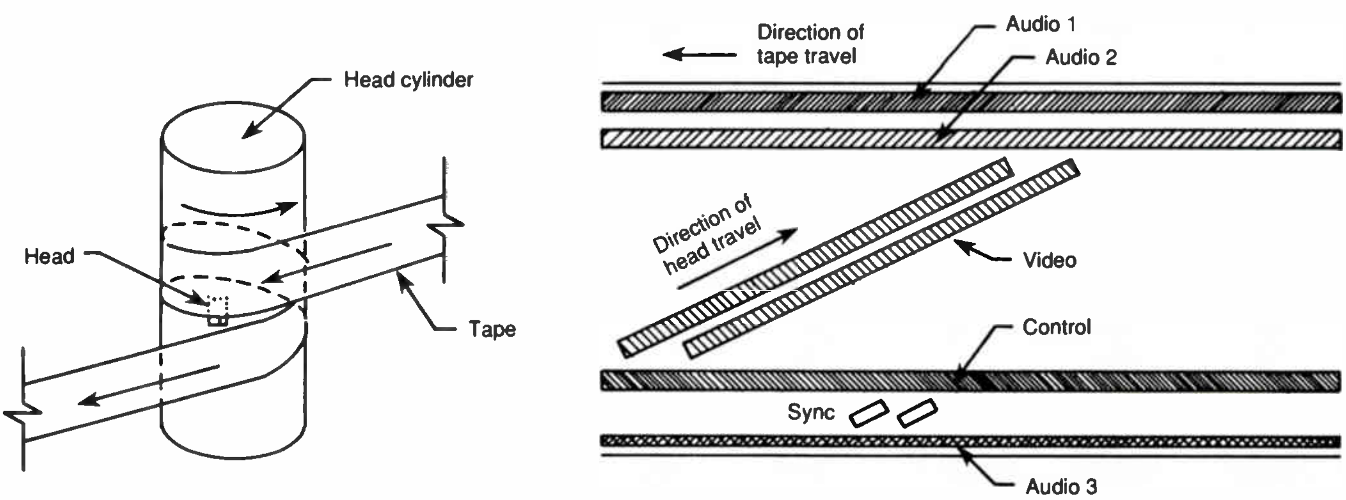


Figure 3: Helical tape wrap configurations

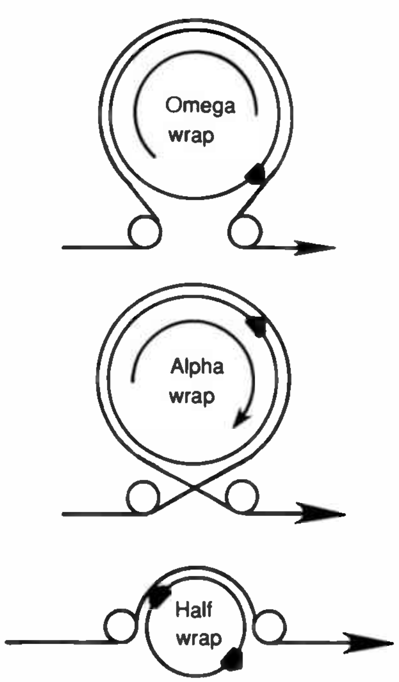
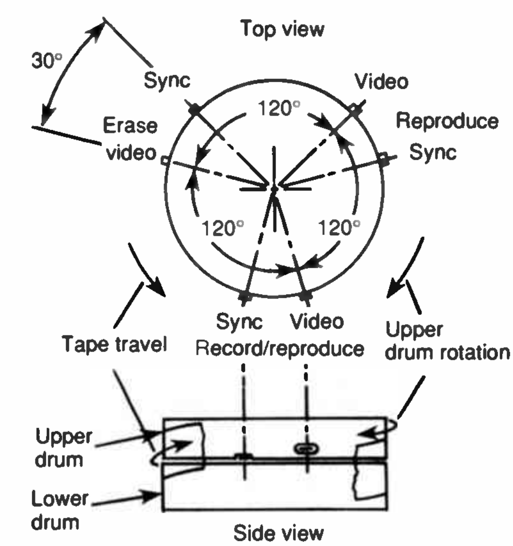


Figure 4: SMPTE Type C head layout



recorder tracks gave rise to the expression "slant track." (See Figure 2.)

The tape is wrapped in a helix around a cylinder or drum on which the recording head is mounted. As the drum rotates, the tape is pulled past in the opposite direction. Again, the fast moving head and the much slower tape speed combine to achieve the required high head-to-tape speed. The resulting recording format is a series of tracks recorded at a slight angle to the edge of the tape. The angle is exaggerated in the drawing. It is only about 2.5° in one widely used format.

The helical scan format has several important advantages over the Quadraplex. The banding problem was eliminated because of its ability to record a complete TV field in one pass of the head across the tape. Additional important features include the ease with which certain helical scan formats can be made to produce still frame, slow motion, variable speed and direction tape shuttling, etc. Helical recorders began to be used by broadcasters as early as 1970 and by 1981 Quadraplex VTRs were no longer being manufactured.

The helical scan format is extremely versatile with many possible variations as seen in Figure 3. Variable parameters include the number of heads, the amount of tape wrap around the drum, the drum diameter and speed, the tape width and the tape speed. Three of the tape wrap configurations are shown. The omega wrap and alpha wrap are full wrap types. A complete TV field is recorded with each revolution of the drum. With the half wrap configuration, a complete field is recorded with each half revolution of the drum and alternate fields must be recorded with different heads. Half wrap is universally used with cassette recorders because of the ease of threading.

A number of helical formats were made and promoted by different manufacturers causing such confusion that the Society of Motion Picture and Television Engineers (SMPTE) was requested by the broadcasters to set a standard, which it did in 1977 — SMPTE Type C. The format in Type C was a compromise between one being made at the time by Sony and one by Ampex.

Type C uses an omega (full wrap) format of 1-inch tape moving at 9.5 ips. The head layout of the recording drum of a Type C VTR is shown in Figure 4. The drum records one field per slant track as shown in Figure 2 but the drum has six heads. They are split into three functions: record, playback and erase — two heads for each function, one for video and one for sync. The recording track format of the Type C is the same as shown in Figure 2, and the operating parameters are shown in Table 2. **CT**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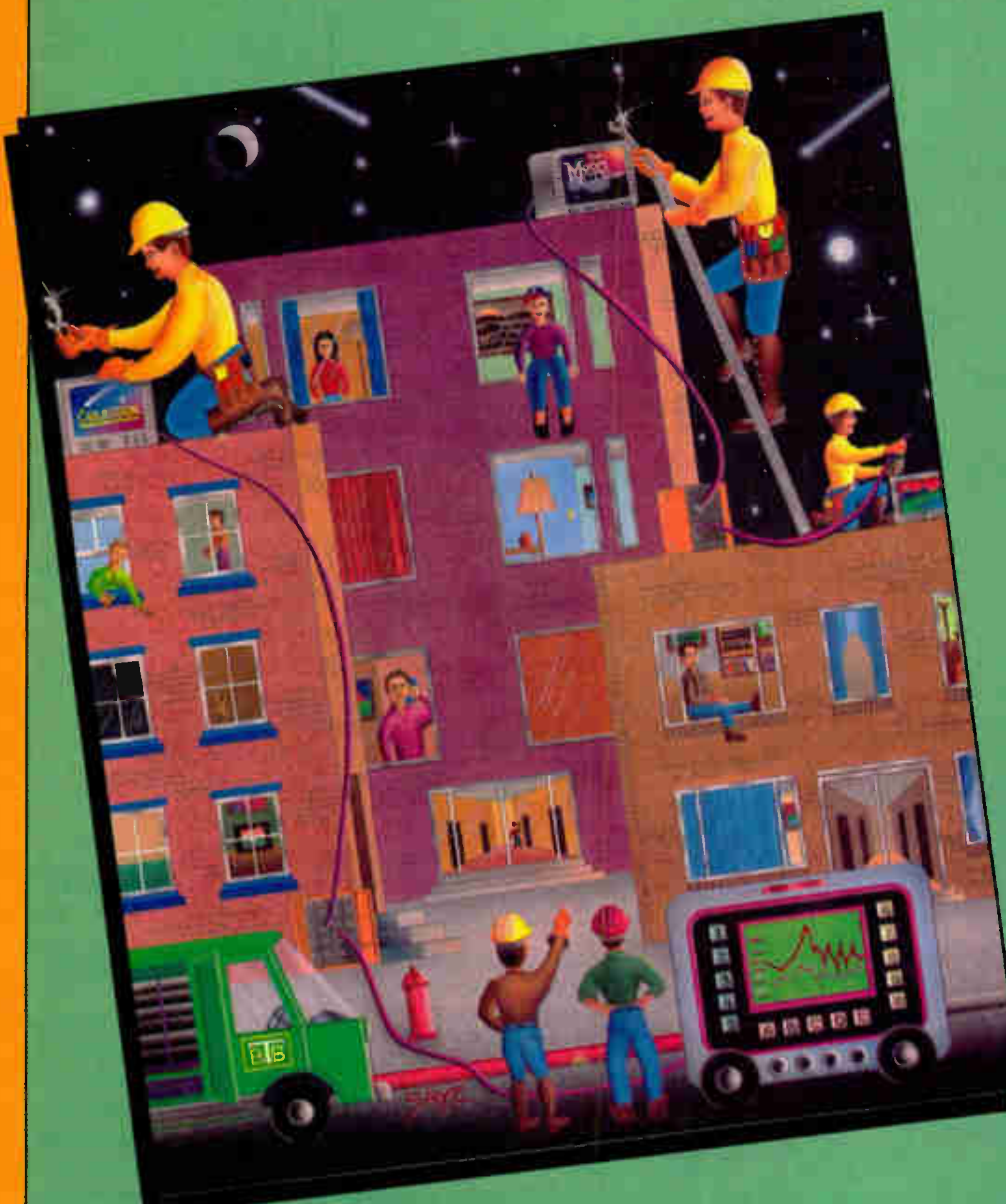
Spotlight on MDUs



Geri Saye

Table of Contents

Troubleshooting tips for MDU installations

The following is adapted from a new National Cable Television Institute lesson, "Troubleshooting MDU Picture Distortions," in the Installer Technician course.

By The National Cable Television Institute

In this article, we will cover the procedures for isolating the cause of snowy pictures and snow/no pictures in multiple dwelling units (MDUs) beginning in the apartment, going to the lock box, and ending at the hot tap. Troubleshooting MDU drops can be more difficult than troubleshooting single-dwelling unit drops. Lock box location, crowded working space containing multiple taps and drops, and identifying/inspecting a customer's drop cable in molding and/or cable bundles makes it more difficult to troubleshoot the MDU drop. Therefore, quick and efficient isolation of the cause of snowy pictures or snow/no pictures on all cable-installed TV sets in an MDU requires using the proper test equipment and appropriate troubleshooting procedures.

At the apartment

In some instances, the customer cannot personally be home but has made an appointment for the manager or custodian to accompany you during the service call. To avoid being accused of damaging or stealing any customer property, never be left alone in an unoccupied residence.

When responding to a service call in an MDU or a single-dwelling unit, question the customer to quickly and efficiently isolate the cause of snowy pictures or snow/no pictures. What follows is a list of some common questions you should ask the customer. These can be especially useful when the snowy pictures or snow/no pictures are intermitent:

• When did the distortion start?

Figure 1: Checking for snowy pictures on all TV sets in a series-fed MDU

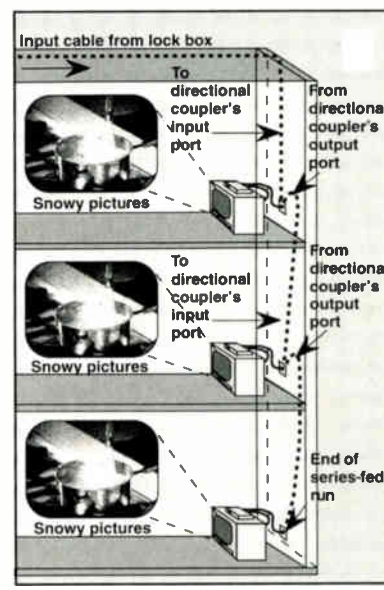


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Figure 2: Measuring low video carrier signal at CATV wall plate

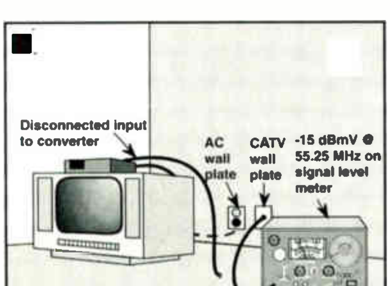

Figure 3: Checking at the wall plate with customer's TV set

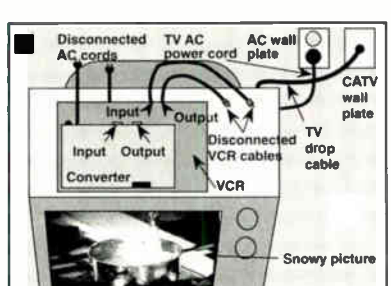

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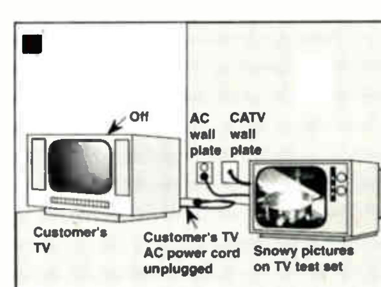
Figure 4: Checking wall plate with test TV set



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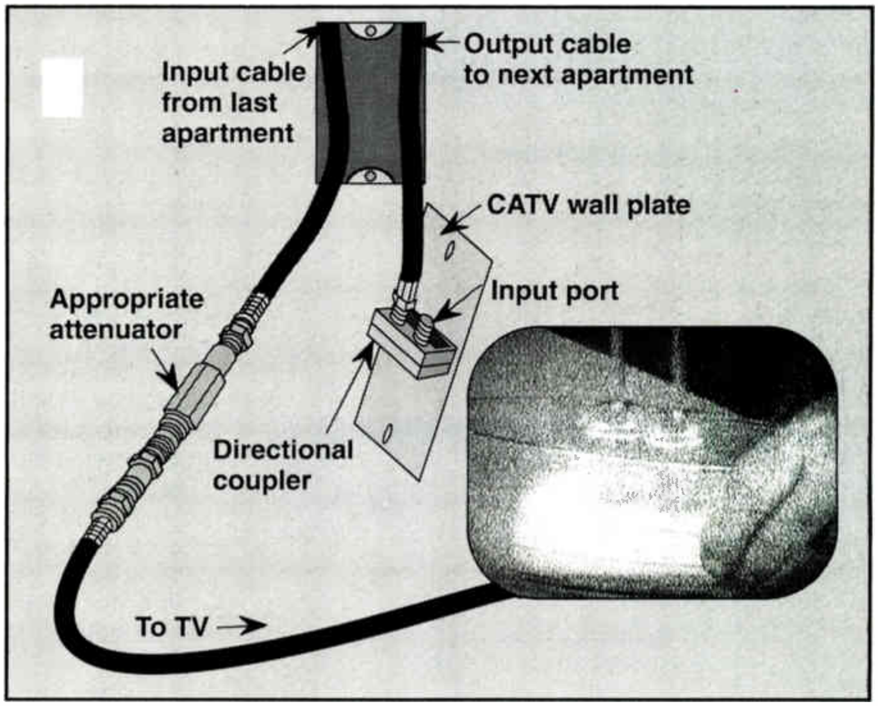
• What time of day does the distortion happen?
• Are all the cable channels affected?
• How long does the distortion last?
• Has anyone changed the cable TV/VCR connections or moved the TV set?
• Does the distortion change with the weather?
• Does the distortion happen after the TV set, VCR and/or converter warms up?
• Does the distortion appear when any appliance is turned on in the house?
• Does the distortion happen only when the VCR is playing?
• Does the distortion happen when the A/B switch is used?
• Does the distortion happen on all cable-installed TV sets?
• Does the distortion happen on only the local off-air channels?
• Is there a videotape of the distortion? (If the distortion is not currently present.)

Figure 5: Observing picture quality on input cable



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Inspect all cable-installed TV sets

When there is more than one cable-installed TV set in the customer's unit, first check each set for snowy pictures

Figure 6: Calculating tap loss of DC

Measured DC input level at a specific frequency
- Measured DC tap port level at a specific frequency
= Tap loss of DC at a specific frequency

+28 dBmV @ 61.25 MHz
- (-)15 dBmV @ 61.25 MHz
= 43 dB tap loss @ 61.25 MHz

Figure 7: Subtracting output level from input level to determine insertion loss

Measured DC input level at a specific frequency
- Measured DC output port level at a specific frequency
= DC insertion loss at a specific frequency

30 dBmV @ 61.25 MHz
- 22 dBmV @ 61.25 MHz
= 8 dB insertion loss @ 61.25 MHz

or snow/no pictures. The findings from this quick check will indicate whether the problems are occurring before or after the drop splitter that commonly supplies signal to all cable-installed TV sets. Snowy pictures or snow/no pictures on only one of the two or more cable-installed TV sets indicate a defect between the TV set and the output of the splitter/directional coupler (DC) that feeds all of the TV sets.

Snowy pictures on all cable-installed TV sets indicate a defect either at the tap, feeder or in the drop between the lock box and the CATV wall plate. If snowy pictures are caused by the feeder or trunk, all cable customers in the MDU building also will have snowy pictures. In a series-fed MDU, snowy pictures on the input cable to the first directional coupler will cause all cable customers on that run to have snowy pictures as shown in Figure 1.

Check CATV wall plate

To isolate the cause of snowy pictures when there is only one cable-installed TV set in the MDU, use either a signal level meter (SLM) or test TV set. Check for snowy pictures at the CATV wall plate by measuring video carrier signal level with the SLM (Figure 2), or check picture quality with the customer's TV set (Figure 3) or your test TV set (Figure 4). Use the test TV set to confirm that the snowy pictures are either caused by the TV set, by a defect between the CATV wall plate and the TV set, or by a defect in the drop, feeder or trunk system before the CATV wall plate.

Following are detailed steps for checking snowy or snow/no pictures at the CATV wall plate:

1) Check the home-run CATV wall plate barrel and F-connector. Snowy pictures on the customer's TV screen at the output of the CATV wall plate can be caused by a defective, damaged CATV wall plate barrel connector or improperly installed F-connector. If the MDU is wired home-run, remove the CATV wall plate from the wall and disconnect the input cable from the CATV wall plate. Inspect the F-connector and CATV wall plate barrel connector for damage or improper installation. Replace any defective, damaged or improperly installed F-connector and barrel connector. Recheck the video carrier signal level on the SLM or the picture quality on the customer's TV set.

2) Check the series-fed DC and F-connector. In a series-fed MDU, remove the CATV wall plate to inspect the input cable and DC. Remove the input cable to the DC-30 and inspect the F-connector for damage or improper installation. If there are snowy pictures at the output of the CATV wall plate, check the DC's input cable by disconnecting the input cable from the DC and connecting it to the SLM or the TV set with an appropriate attenuator connected to the TV input cable (Figure 5). Snowy pictures or an unacceptable video carrier signal level (e.g., +28 dBmV at Ch. 3, 61.25 MHz) at the input to the DC-30 indicates a defect in the drop between the DC and the apartment lock box, at the lock box or in the feeder/trunk system. This condition also causes every cable-installed TV in this series-fed MDU run to display snowy pictures. Acceptable signal levels or picture quality at the input to the

Figure 8: Checking picture quality at customer's tap port with test TV set

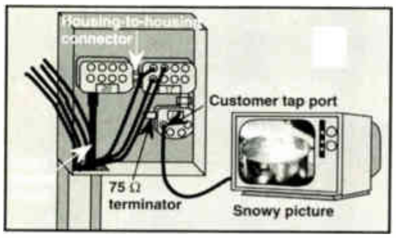


Photo courtesy of Mile Hi Cablevision

DC-30 and unacceptable signal levels or picture quality at the tap port indicate a defective DC.

3) Check for excessive DC tap port loss. To determine if there is excessive video carrier signal level loss at the tap port of the DC:

a) Disconnect the input cable from the DC and connect it to the SLM,

b) Measure and record a CATV video carrier signal level (e.g., +28 dBmV at 61.25 MHz) on the input cable,

c) Disconnect the input cable from the SLM and reconnect that cable to the input port of the DC,

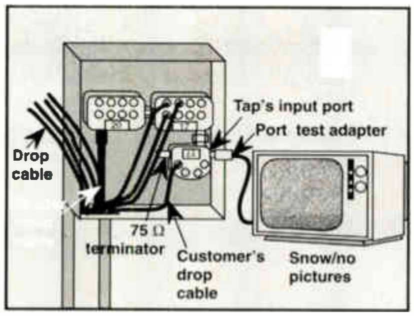
d) Connect a short jumper from the DC's tap port to the SLM,

e) Measure and record the same video carrier signal level (e.g., -15 dBmV at 61.25 MHz),

f) Subtract the tap port level from the input level (Figure 6), and

g) Compare this difference in levels with the number on the name plate of the DC that indicates the correct tap port loss. For example, a DC-24 attenuates the signal 24 dB at the tap port.

Figure 9: Checking picture quality with test TV set at tap's input port



A loss greater than that specified on the DC indicates it is defective and requires replacement.

4) Check for excessive DC insertion loss. To determine if the insertion loss of the DC is excessive:

a) Connect the SLM to the input cable of the DC,

b) Measure and record a CATV video carrier signal level (e.g., +30 dBmV at 61.25 MHz),

c) Disconnect the input cable from the SLM and reconnect it to the input port of the DC,

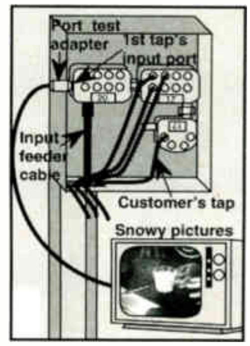
d) Disconnect the output cable from the DC and connect the SLM to the output port,

e) Measure and record the same video carrier signal level (e.g., +22 dBmV at 61.25 dBmV) on the output port, and

f) Subtract the output level from the input level (Figure 7).

The insertion loss on the output port for directional couplers will typically range from 0.5 dB for a DC-35 to 3.8 dB for a DC-4. If the insertion loss at a given frequency is greater than the specified loss for a particular DC, replace it. Then, recheck the video carrier signal level or picture quality at the output port of the directional splitter.

Figure 10: Checking picture quality with test TV set at first tap's input port



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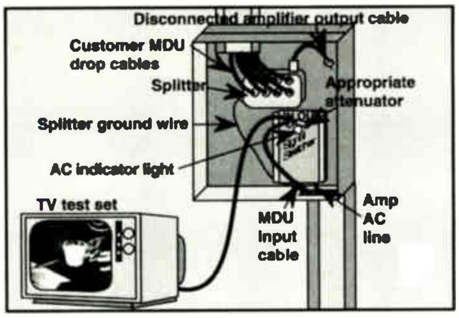
5) Check for proper DC installation. It may be typical in a series-fed MDU for a customer to remove the CATV wall plate, disconnect the DC, and change the cabling to receive a stronger CATV video carrier signal. The customer usually either:

a) Connects the TV directly to the input cable with an F-81 barrel connector to bypass the DC,

b) Connects the TV directly to the output of the directional coupler, and connects the output cable to the tap port, or

Figure 11: Connecting test TV set with attenuator to output of apartment amplifier



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c) Does not reconnect the output cable.

The connections in *a* and *c* cause the loss of cable TV service and snow/no pictures on the customer's TV set in the next unit(s) at the output of the DC. The connection in *b* causes reduced video carrier signal levels and snowy pictures in the unit(s) at the output of the DC.

Check for technician error

After confirming that the snow/no pictures are being caused prior to the CATV wall plate input connector, verify that the customer's drop cable is connected to the correct tap port in the lock box and the tap port is not broken. Snow/no pictures on a customer's TV set can be caused by technician error at the lock box during the initial installation, activation of the MDU, technical audit, maintenance of the customer's tap inside the lock box, or reconnection of services to a customer.

Inspect the drop cables for incorrect identification and connection. Incorrect identification can result in connecting the wrong apartment to the tap during activation, further resulting in the reception of unpaid services for one apartment and snow/no pictures for another apartment.

Disconnecting and terminating a paying customer's drop in error during a technical audit causes snow/no pictures and an irritated customer. Incorrectly trapping the customer's drop during tap maintenance or while reconnecting a customer can cause a loss of all channels, the loss of a trapped channel, or reception of an unpaid premium channel.

Visually inspect the customer's drop cable and confirm that it is properly trapped and connected to the tap in the lock box. Snow/no pictures also can be caused by breaking the customer's trap off at the tap during the installation of another customer's drop.

Inspect the tap port

Check for the cause of snowy pictures at the tap port by measuring the video carrier signal levels with an SLM or by checking picture quality with a test TV set (Figure 8). Snowy pictures at the tap port indicate a defect in the tap/splitter, MDU feeder cable, hot tap or feeder/trunk system. Acceptable picture quality at the tap port indicates a defect between the CATV wall plate and the customer's tap/splitter in the lock box. Snowy pictures at the tap port indicate a defect at the tap face plate or splitter, other taps before the customer's tap, or a defect in the feeder/trunk system.

If there are snow/no pictures at the customer's tap port, measure the video carrier signal level at the tap's input port with a port test adapter and the SLM, or check the picture quality with your test TV set. No measurable video carrier signal level on the SLM or

Figure 12: Adding 20 dB to the measured video carrier signal level

Measured input or output video carrier signal level
\+ 20 dB test point compensation
= Actual input or output video carrier signal level

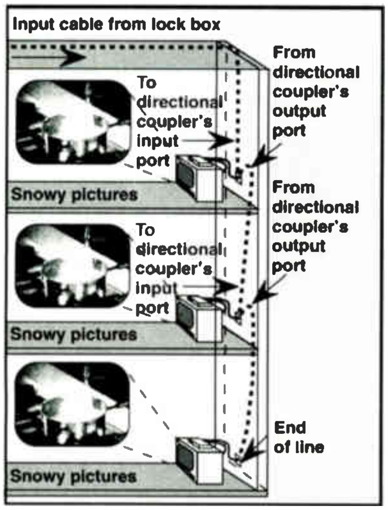
Figure 13: Determining actual input video carrier signal level

-10 dBmV at 433. 25 MHz
\+ +20 dB test point compensation
= +10 dBmV at 433.25 MHz

Figure 14: Determining actual output video carrier signal level

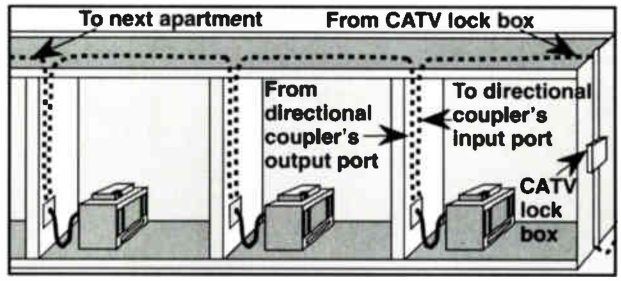
+28 dBmV at 433. 25 MHz
\+ +20 dB test point compensation
= +48 dBmV at 433.25 MHz

Figure 15: Vertical apartment runs



Photos courtesy of Mile Hi Cablevision

Figure 16: Horizontal apartment runs



snow/no pictures on the test TV set (Figure 9) at the input to the tap indicates a defect at the tap's housing-to-housing connector, another tap, an apartment amplifier, the drop between the hot tap and the lock box, the hot tap, or the feeder or trunk system. More than one customer will be affected. Acceptable video carrier signal level on the SLM or good picture quality on the TV test set at the tap's input port indicates a defective tap face plate. Replace the tap's face plate and recheck the picture quality.

Check the CATV lock box

If the customer with snow/no pictures has a tap that is not the first tap in the feeder line in the lock box, but is one of two or more taps in the lock box:

1) Measure the video carrier signal level or check the picture quality at a tap port of the first tap, and

2) Check the input or output port to the first tap with a port test adapter and an SLM or a test TV set (Figure 10) to determine if the snow/no pictures are caused either before or after the first tap in the lock box.

Snowy pictures at the first tap's input port indicate a defect before the first tap. Acceptable picture quality at the tap's input port indicates a defect between the first tap's output and the customer's tap. This condition requires measuring the video carrier signal level of each tap's input and output ports that are before the customer's tap.

Inspect the apartment amp

Perform the following procedures to check for a defective apartment amplifier (that will affect all cable customers at that MDU):

1) Check for snowy pictures at the apartment amplifier's output. If the picture quality and video carrier signal level is acceptable on the input cable to the apartment amplifier, connect the SLM or a TV test set (with an appropriate attenuator on the TV set's input) to the output of the apartment amplifier (Figure 11). Snowy pictures or an unacceptable video carrier signal level at the output of the apartment amplifier indicates the amplifier is causing the snowy pictures and requires replacement. Have the appropriate technician replace the amplifier and adjust the new amplifier to the correct video carrier signal levels. Recheck the output of the amplifier with an SLM or test TV set. Acceptable picture quality and video carrier signal levels at the output of the apartment amplifier indicate a defect between the output of the amplifier and the customer's tap. Check the picture quality at the input and output of each tap between the amplifier and the customer's tap to isolate the cause of the snowy pictures.

2) Check the apartment amplifier's test points. Some apartment amplifiers have built-in test points next to the input and output ports. These test points are usually 20 dB below the actual input and output video/audio carrier signal levels, which means the 20 dB needs to be added back into the measurement to accurately determine the video carrier signal level at the input and output (Figure 12). If the input video carrier signal level to the apartment amplifier measures -10 dBmV at 433.25 MHz (Figure 13) on the SLM, the actual input video carrier signal level would be +10 dBmV at 433.25 MHz. If the output video carrier signal level measures +28 dBmV at 433.25 MHz on the SLM, the actual output video carrier signal level would be +48 dBmV at 433.25 MHz (Figure 14).

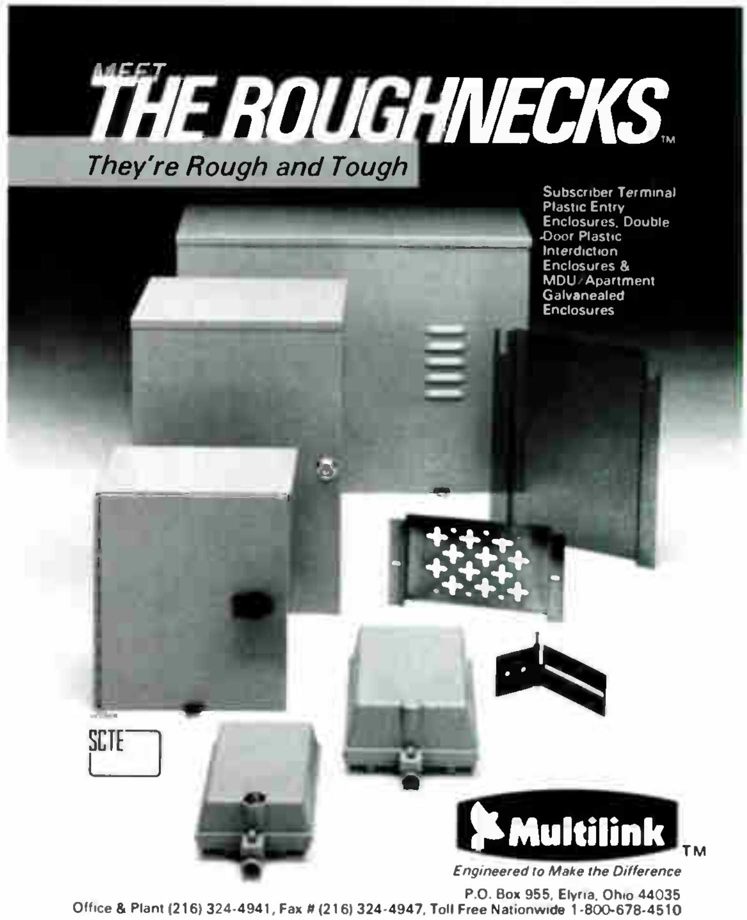
"Lock box location, crowded working space containing multiple taps and drops, and identifying/inspecting a customer's drop cable in molding and/or cable bundles makes it more difficult to troubleshoot the MDU drop."

Check between CATV wall plate and lock box

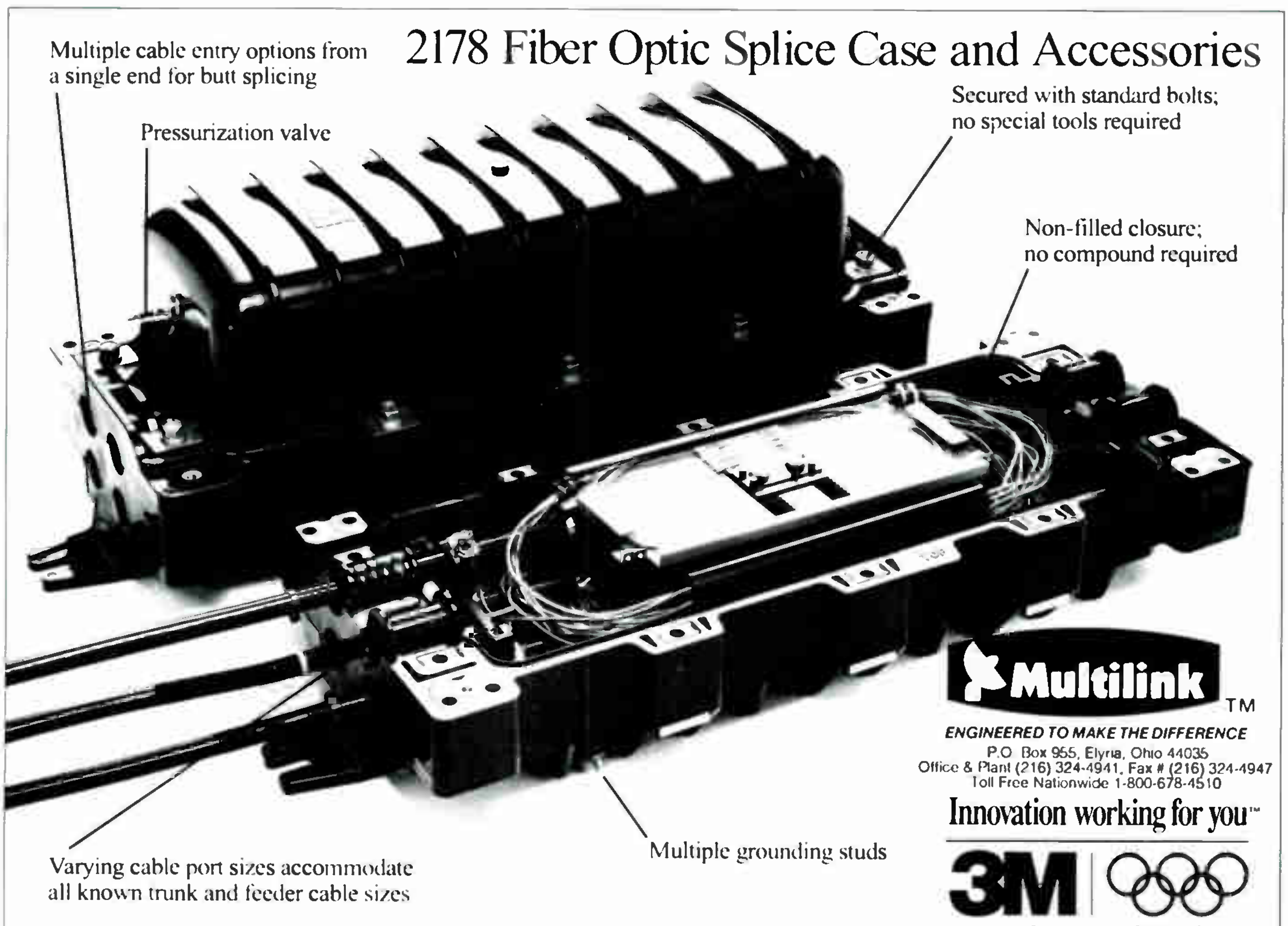
Upon determining that the cause of snow/no pictures is after the lock box but before the CATV wall plate, check the drop cable between the CATV wall plate and the lock box in either a home-run or a series-fed MDU. Troubleshoot the cause of snow/no pictures by using the "halfway" method and the proper test equipment (Cable Designator or volt-ohm meter).

Snow/no pictures can be caused by defects in the drop cable, connections or drop passives during or after the initial installation. Snow/no pictures also can be caused by other cable customers in a series-fed MDU. Isolating the cause of snow/no pictures in a series-fed or home-run MDU may require identifying the customer's drop cable.

To employ the halfway method in a series-fed MDU, you first must determine the type of apartment run. An MDU has a vertical apartment run if the



Reader Service Number 48



Reader Service Number 62

Figure 17: Selecting halfway apartment

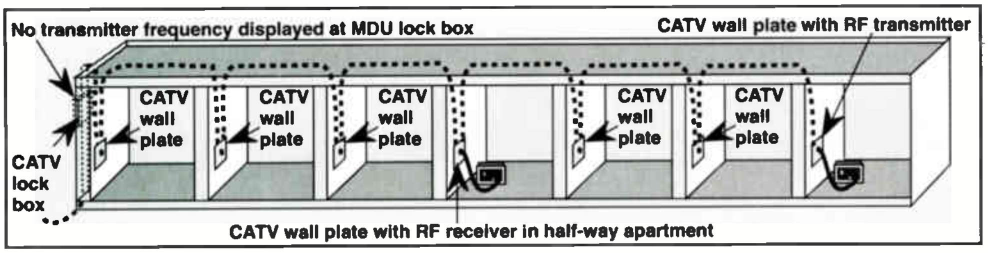


Figure 18: Checking for snowy pictures with test TV set at hot tap's tap port

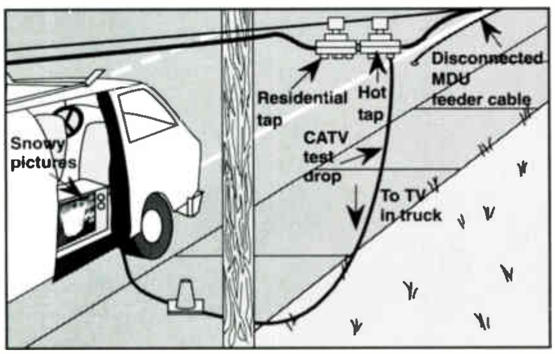


Photo courtesy of Mile Hi Cablevision

CATV wall plate of one apartment feeds the CATV wall plate of the next apartment above or below it (Figure 15). The MDU has a horizontal apartment run if the CATV wall plate of one apartment feeds the CATV wall plate of the next apartment on either side of it (Figure 16). Determine the type of apartment run by checking the drop cable tags in the CATV lock box or the MDU design plans.

After determining the type of apartment run, select the apartment that is halfway between the CATV lock box and the customer's apartment. Go to the halfway apartment to check for the presence of the Cable Designator RF transmitter frequency at the output cable of the directional coupler by removing the CATV wall plate, disconnecting the output cable from the directional coupler, and connecting the output cable to the Cable Designator RF receiver (Figure 17).

A transmitter frequency number displayed on the Cable Designator receiver indicates the CATV signal interruption is between the halfway apartment and the lock box. No transmitter frequency displayed on the receiver indicates the CATV signal interruption is between the customer's CATV wall plate and the halfway apartment. Next, go to the apartment that is halfway in between the CATV lock box and the first halfway apartment or the first halfway apartment and the customer's CATV wall plate. Repeat this test procedure in each consecutive halfway apartment until you determine the cause of the CATV signal interruption.

Check the hot tap

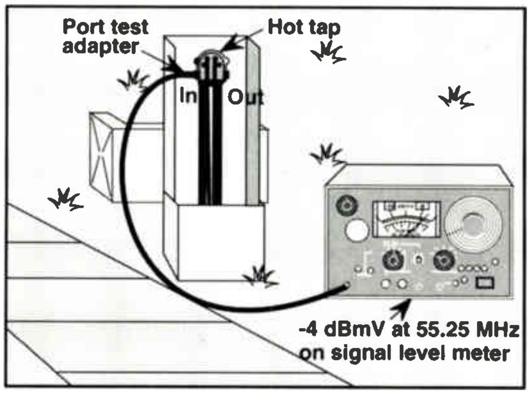
After determining there are snow/no pictures at the input to the lock box, check picture quality or video carrier signal level at the hot tap's tap port and input port. Also, inspect the condition of the MDU feeder cable.

If there are snowy pictures or unacceptable video carrier signal levels on the input cable in the CATV lock box, check the picture quality or measure video carrier signal levels at the tap port on the hot tap that feeds the apartment lock box. Connect the SLM or the TV test set (Figure 18) to the hot tap's tap port to determine if the snowy pictures are caused before the tap's face plate. Snowy pictures or unacceptable video carrier signal levels at the tap port indicate a defect in the tap face plate, the tap, the feeder system, or the trunk system. Good picture quality or acceptable video carrier signal levels at the tap port indicates a defective MDU feeder cable between the hot tap and the lock box.

If there are unacceptable video carrier signal levels or snowy pictures at the tap port, measure the video carrier signal level at the hot tap's input port with a port test adapter and an SLM (Figure 19) or check picture quality with a test TV set to determine if the cause of the snowy pictures is before the tap in the feeder or trunk systems. Acceptable video carrier signal levels or good picture quality at the input port indicates a defective tap face plate. Replace the tap face plate and recheck the picture quality. Unacceptable video carrier signal levels or poor picture quality indicates a defect in the feeder or trunk systems.

In some cable system designs, the MDU is fed from a DC. In that case, measure the video carrier signal level at the input port of the DC with a port test adapter and an SLM or check picture quality with a test TV set to determine if the feeder system is causing the snowy pictures. If the picture quality and/or video carrier signal level is acceptable at the input port, measure the video carrier signal level at the output port of the DC with a port test adapter and an SLM or check picture quality with a test TV set. Unacceptable video carrier signal level or poor picture quality at its output port indicates a defective DC.

Figure 19: Measuring video carrier signal level at hot tap input port with port test adapter and SLM



Inspect the MDU feeder/drop cable

Unacceptable video carrier signal levels at the CATV lock box input cable but acceptable video carrier signal levels at the output of the hot tap indicate a defective MDU feeder/drop cable. Inspect the MDU feeder/drop cable at the hot tap and at the CATV lock box for damaged or improperly installed connectors or cables. Repair or replace any damaged connectors or cables.

Then, recheck the video carrier signal level and picture quality. If there is no visible damage to the MDU feeder/drop cable and the lock box's input video carrier signal levels are still unacceptable, replace the MDU feeder/drop cable. Recheck the video carrier signal level and picture quality. If replacing the MDU feeder/drop cable or connectors is not your responsibility, contact the appropriate department to expedite the replacement of the cable and connectors. **CT**

Technical consultation for this material was provided by: Dan Fisher, technical field safety supervisor, and Tom Schnell, mainline technician for Paragon Cable of Minnesota; Joel Raguindin, technician level 5, Greg Stone, construction supervisor, and Brian Strand, maintenance supervisor for Mile Hi Cablevision; Jerry Trautwein, president of Dynasty Communications Inc.; and Mike Dietrich, service technical supervisor for Conti-

Hands On

(Continued from page 88)

from electronic distributors.) I found that when I connected the 6.8 V secondary of the transformer across (or parallel) to the winding of a transformer under test, the output voltage would be practically the same as the open circuit voltage of the unloaded filament transformer. If the suspect transformer had a shorted winding in it, the voltage would drop by 25-50 percent or more. So, by merely placing an AC voltmeter across the winding I could identify a defective transformer with no further fuss.

A second check is necessary, and that is a continuity check with an ohmmeter to assure that the winding is not open. When making a continuity test with an ohmmeter, look for a very low resistance reading, making sure the meter is set to its lowest range. Transformers may register several ohms depending on the number of turns in the winding. This of course relates to the length of wire in the winding and its DC resistance.

What actually is taking place is an AC inductive impedance is paralleling an unknown reactive element such as a coil or winding. Since the secondary of the filament transformer is relatively low in impedance, it will, in most cases, be "looking" into a higher impedance so it will not be loaded down. Impedance, by the way, may be thought of as AC "resistance." If the device has shorted windings, then the impedance (AC resistance) will (in the majority of tests) be less than the filament transformer, and will result in a lower than normal voltage reading.

Other applications

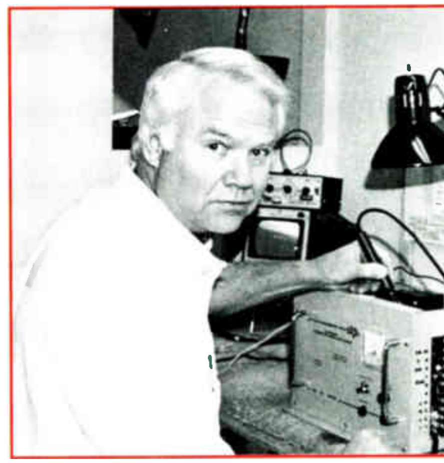
Not only will this test work for power transformers, it is very useful for testing relay coils, solenoid coils, chokes, ferroresonant transformers, AC adapters, inverter transformers, electric motors and fans, etc. Almost any device containing a winding may be tested. So there you have it — a simple and very conclusive way to check transformers, regardless of their type. **CT**

Readers wishing to ask questions or discuss the contents of this article are invited to call the author at (404) 475-3192 or write to P.O. Box 947, Roswell, Ga. 30077.

A simple test for transformers

By Jud Williams
Owner, Performance Technological Products

One of the most perplexing components to troubleshoot is the ordinary power transformer. It is particularly difficult to tell if the windings are shorted since an ohmmeter is rather ambiguous below 1 ohm.



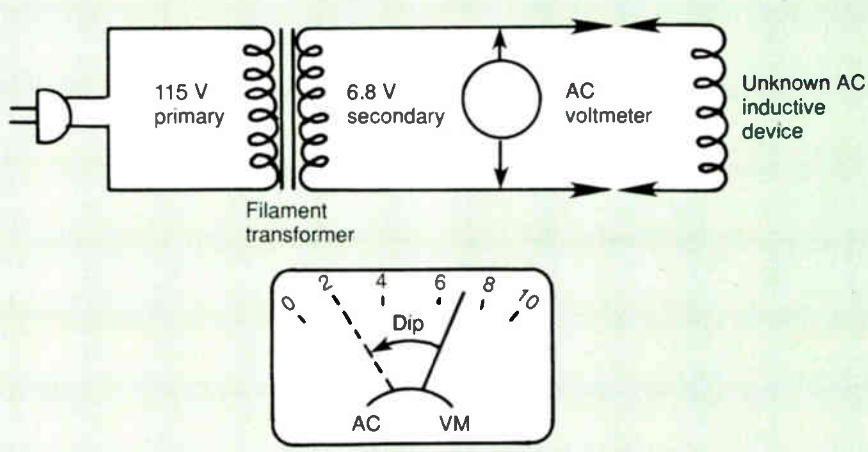
Troubleshooting idea

When I first got into the repair of power supplies, the idea came to me to take an ordinary 6.8 volt (V) filament transformer and buck it against the winding of a transformer I suspected was bad. (By the way, the reason the transformer is called a "filament" transformer is that it was used back in the vacuum tube days to power heater elements, also known as filaments. These transformers are still widely available

(Continued on page 87)

"By merely placing an AC voltmeter across the winding I could identify a defective transformer."

Simple transformer tester



Shorted winding indicated by dip in AC voltage reading

All Cable's drop labeling system

By Ron Hranac
Senior Technical Editor

This year's Society of Cable Television Engineers Cable-Tec Expo in Reno, Nev., provided many companies a chance to introduce new products to the technical community. One that caught my eye was a clever drop labeling system from the folks at All Cable.

Over the years I've seen and used a variety of methods to label drops, particularly in multiple dwelling units (MDUs) or underground installations. Among them were lead or other metal tags with the address scribed on them, paper-based tags with information written using a pencil or pen, prestamped serial numbered tags, and even the old standby, the Dymo label maker tags. Some are obviously better than others, depending on the application.

The labeling system from All Cable is a bit different from all of these. Not only is it suited for the usual drop labeling requirements, but it also would work well for headend and studio wiring, and probably could be used for about anything that uses drop cables or wiring of a similar size. So after the expo, I contacted All Cable to obtain one of their drop labeling systems for this month's lab report.

The product

A complete package includes a battery operated electronic labeling machine, instruction manual, carrying case, 34 replacement tape cartridges, and 10,000 transparent plastic sleeves — they actually resemble small tubes — to cover the labels. The labeling machine prints the labels on pressure sensitive adhesive-backed tape. (Note: These labels are not the same as ones you create with something like a Dymo; the tape used for the All Cable labels is thinner and more flexible, and the lettering is printed instead of embossed.) After trimming to length, simply peel the protective backing off the tape, stick it on the coax, then cover the label with one of All Cable's plastic sleeves.

The labeling machine itself resembles a miniature computer or electronic typewriter, and features a QWERTY-style keyboard. The machine measures 6-9/16 inches (W) x 5 inches (D) x 2-1/8 inches (H), and weighs just over a pound without the five C cell batteries that normally power it. The typewriter keys are the rubber "Chicklets" kind, and the front also includes a small (1-1/8 x 7/16 inch) LCD readout that displays up to six of the typed characters at a time. The left side of the machine has an integral cutter next to the label exit slot.

The top has a font cartridge slot and a jack for external power, and on the back of the unit you'll find the battery compartment cover and tape cartridge compartment. Each tape cartridge contains 25 feet of 3/8- or 1/2-inch wide tape. One tape cartridge should be good for about 300 1-inch long labels. Available character colors include black, red, blue, gold or white, and tape colors are available in clear, white or black.

While not included with the system, an optional AC adapter also is available as is an external font cartridge. The labeling machine's standard built-in 150 character font is LORI PS; it includes 52 letters (upper and lower case alphabet), 19 keyboard symbols and the 10 numbers. There are also 69 additional symbols embedded in the keyboard. The labeling machine and tape cartridges are manufactured by Brother Industries.


Bob Sullivan

Carrying case loaded and ready.

When making labels using the built-in font, you have a choice of five different character sizes: standard, double height, double width, double width/double height and 4x width/double height. As well, you can choose from among five different print styles: normal, outline, bold, shadow (these first four styles print horizontally on the tape) and vertical print.

The plastic sleeves are semitransparent, and are made from PVC (the same material used to make the jacketing on most CATV coax). All Cable's labeling system includes sleeves for either RG-59 or RG-6; by the time you read this, sleeves for RG-11 also should be available. Standard sleeve length is 1-1/2 inches.

The black plastic carrying case is 12 x 8 x 3 inches, and comes lined with foam. Cutouts are provided for the labeling machine, spare cartridges, and a small supply of plastic sleeves.

Making a label is pretty straightforward. For a basic label, turn the labeling machine on, type the desired text such as address, apartment number, etc., and press the "print" button. The machine will print the label at a rate of 12 characters per second, so creation seems almost instantaneous. The printed label will come out of the tape exit slot on the side of the machine; pull out the tape cutter lever next to the exit slot to cut the tape, and remove the label. If desired, you can trim the length as necessary with scissors before removing the backing and applying the label to the coax. Then slip one of the sleeves over the label. For installation on a cable with a connector already in place, the sleeve can be split before putting it over the label. All Cable also can provide split sleeves.

At the time of the evaluation, the price of the complete labeling system was $1,170 (which includes 10,000 sleeves). The machine by itself is $150, the carrying case $20, additional tape cartridges $12 to $15 each depending on quantity, and extra sleeves 6 to 8 cents each (again depending on quantity).

Lab test

While the most useful application for a labeling system such as this might be primarily MDUs and similar installations protected reasonably well from the environment, it just as easily can be used for normal drop identification. For this

(Continued on page 93)

AD INDEX

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CT's Lab Report

(Continued from page 89)

reason we wanted to test the PVC sleeves in an accelerated environment to see how they would hold up outdoors.

Several samples of RG-6 sleeves were sent out to be subjected to an ozone chamber test. The samples were prestressed by folding them in half and clipping the ends together. The ozone chamber test period was 72 hours at 104° F and 100 ppm ozone concentration.

After the test, no cracking or brittleness was found. A slight crease was evident where the sleeves had been folded over. Other samples that had been subjected to strong sunlight for an extended period showed slight stiffening and discoloration, as well as a small amount of shrinkage. Even so, the sleeves still maintained their flexibility and semitransparency. A piece of coax with a label and sleeve also was subjected to the ozone test with no detrimental effects. The only other concern might be possible long-term sunlight-induced fading of the lettering on the tape itself, although we saw no evidence during our lab tests that this might be a problem. Additional testing was limited to using the labeling machine to produce a variety of labels, which worked as indicated. While the labels might be able to be used in some cases without the sleeves, best results occurred with the sleeves installed over the labels.

Bob Sullivan

Bob Sullivan

Top: Labels can be printed in black, red, blue, gold or white on black, white or clear tapes. Bottom: The semitransparent plastic sleeves can be split (or order pre-split) to install on cables with connectors attached.

Comments

All Cable's drop labeling system is a unique and effective way to label CATV drops. It also should find use in other applications such as labeling cables in a headend or similar environment, allowing neat professional-looking labels to easily be made on the spot.

Because it is battery operated, field personnel will find it convenient to use. But like any electronic instrument that gets regular field use, it should be kept clean, and used with reasonable care. Considering the initial system purchase price of $1,170, label cost works out to be about 12 cents each.

About the only recommendation I would make for this product is to consider the use of rechargeable NiCd batteries instead of alkaline cells. Regular use in a system might make you real friendly with your neighborhood Eveready supplier using conventional batteries, while a rechargeable unit could be plugged in each night just like your signal level meter.

For more information, contact All Cable at 5 Colony St., Meriden, Conn. 06450; (800) 232-0883 or (203) 235-0883.

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Reader service #132 (T710), #131 (T730)

Event controller

The PRO-16 event controller was released by Leightronix. It features a built-in 16x4 video/stereo audio routing switcher, control capacity for 16 tape machines, and a PC-based event manager. It also includes listing/logger printer output and 1,000 event capacity.

It is rack-mountable, two rack units high, and has a back-lit, high contrast 80-character LCD. It has one year data retention without power.
Reader service #130

Isolators

E-Tek Dynamics added a new series of polarization-insensitive fiber isolators to its product line. The isolators offer 0.7 dB typical for "A" grade insertion loss, greater than 50 dB isolation, greater than 65 dB return loss, less than 0.2 dB polarization sensitivity and stable isolation over 0-70°C temperature range and 60 nm bandwidth.

They provide compatibility to 1,300, 1,480 or 1,550 nm fiber interface with minimum mechanical stress. Options include various connector terminations, customer fiber specifications and packages.
Reader service #131

Fiber patching

The 12-fiber wall distribution panel (WDP) from FOCS is said to be a cost-effective solution for interconnection and patching of fiber-optic cables. The panel can be used with single- or multimode cables in either loose tube or tight buffer construction.

The WDP construction is durable sheet metal painted in a no-mar office white. Each WDP can accommodate up to 12 standard connectors. A screw driver is all that is needed for installation and the WDPs can be stacked.
Reader service #130

Modulators

United Technologies Photonics unveiled it high-linearity lithium niobate amplitude modulators that have a 1 dB electrical bandwidth of 600 MHz and have low amplitude and phase ripple, low insertion loss, single polarization operation, low back reflection, low drive voltages and improved power-handling capability. They are fabricated in $LiNbO_3$ using the company's annealed proton exchange (APE) process.

The low amplitude ripple is less than 0.25 dB and the low phase ripple is less than 2°. According to the company, these features make the devices especially well-suited for CATV applications.
Reader service #129

Fiber cable

A new fiber-optic cable to the D-Series product line was introduced by Optical Cable Corp. It allows easy access to each subunit as well as to each of the fibers within the subunit through the use of color-coded rip-cords.

The cable jacket is color-coded yellow to designate the single-mode fiber type. A 900 micron elastomeric buffer coating protects the fiber from moisture and bending. The coating also is color-coded for easy terminating in the field. The subunits contain from six to 12 buffered fibers for patch panel routing.
Reader service #128

Downconverter

A new C-band downconverter, Model C30944-3, was announced by California Amplifier. It has built-in DC pass through capability and is available with the standard input frequency of 3.7 to 4.2 GHz and output frequency of 950 to 1,450 MHz. It also allows DC pass through from output to input.

The product also features 18 to 24 dB gain. The built-in DC gets rid of the need for DC power insertion blocks to be placed in-line between the downconverter and the LNA.
Reader service #127

FO connectors

ST (AT&T's connector), FC, D4 and SMA connectors from Light Control Systems incorporate a universal backshell design that will accommodate 900 micron buffered fiber through 3.8 mm OD loose tube cable. They use precision drilled ceramic ferrules for 0.3 dB (typical) insertion loss and -35 dB (typical) return loss with simple hand polishing techniques. The connectors are available with either ceramic or metal ferrules. Custom metal hole sizes up to 1 mm are offered.
Reader service #126

Brake lock

The MICO brake lock is a supplemental safety device, which when used with a vehicle's existing mechanical parking brake it will provide additional brake holding action. Installation is said to be simple because the valve can be installed in the hydraulic line to the wheel cylinders without additional plumbing. The electrical connection from the valve to the toggle switch in the cab also is a simple procedure, according to the company. No current is drawn except during the moment the valve is activated.

When the brake lock is activated and the hydraulic service brakes applied, hydraulic pressure is locked in the service brake system and therefore the hydraulic service brakes continue to be applied after the operator removes his foot from the brake pedal. The lock does not increase brake pressure. It only locks pressure generated by pushing on the brake pedal. The harder the operator pushes on the brake pedal, the higher the pressure in the brake system. The low pressure warning switch, when wired to an audible or visual alarm, alerts the operator(s) in or around the vehicle of a possible reduction in brake pressure and holding capability.
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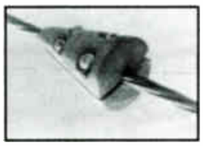

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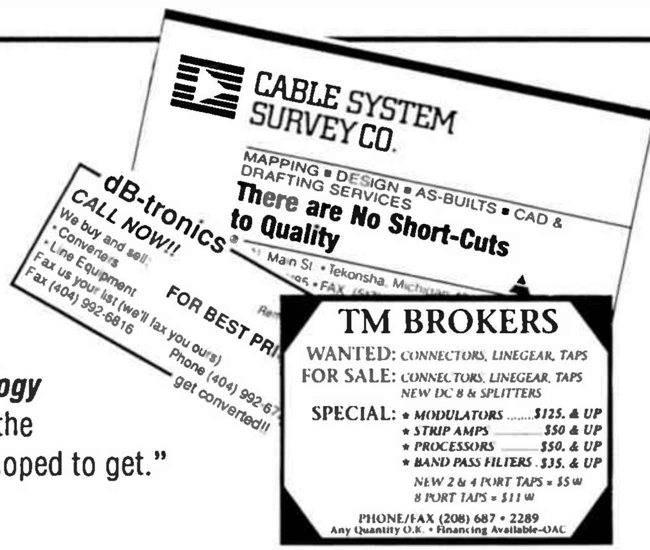

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Don't miss out on the bonus distribution at the Western Show of **CT'S** November issue.
Deadline September 26.

CALENDAR

September

10: SCTE Desert Chapter seminar, installer training. Contact: Chris Middleton, (619) 340-1312.

10: SCTE New York City Chapter seminar, DOT operation and interdiction. Contact: Rich Fevola, (516) 678-7200.

10-11: SCTE Dakota Territories Chapter seminars (held in conjunction with South Dakota show) on OSHA and safety, and BCT/E Category VII. Contact: Kent Binkerd, (605) 339-3339.

11: SCTE Greater Chicago Chapter seminar, distribution. Contact: Bill Whicher, (708) 438-4423.

11: SCTE Inland Empire Chapter seminar, new technologies and fiber. Contact: Gerald Boyd, (208) 667-5521.

11: SCTE North Country Chapter seminar, BCT/E Categories IV and VII; plus exams (tentative). Contact: Rich Henkemeyer, (612) 522-5200.

12: SCTE Badger State Chapter seminars (held in conjunction with Wisconsin state show) on fiber optics vs. coax for rebuilds, and fiber-optic and laser applications. Contact: Gary Wesa, (414) 496-2040.

12: SCTE Iowa Heartland Chapter meeting with exams in BCT/E Categories II, III, IV and V (tentative). Contact: Mitch Carlson, (309) 797-9473.

12: SCTE Lake Michigan Chapter seminar, spectrum analyzers and headend testing. Contact: Grant Pearce, (616) 247-0575.

14: SCTE Central California Chapter installer program review. Contact: Deborah Abate, (408) 578-1790.

15-16: SCTE Old Dominion Chapter meeting with BCT/E and installer exams. Contact: Margaret Davison-Harvey, (703) 248-3400.

16-17: SCTE Bluegrass Meeting Group seminar (held in conjunction with Kentucky state show) on system maintenance; BCT/E exams Sept. 16. Contact: Liz Robinson, (606) 299-6288.

18: SCTE Appalachian Mid-Atlantic Chapter seminar, fiber-to-feeder technology. Contact: Richard Ginter, (814) 672-5393.

18: SCTE Golden Gate Chapter seminar, BCT/E Category III; plus exams (tentative). Contact: Mark Harrigan, (415) 785-6077.

18: SCTE Sierra Chapter seminar, headend operation and planning, and headend proofs. Contact: Eric Brownell, (916) 372-2221.

18: SCTE Penn-Ohio Meeting Group seminar and roundtable discussion, fiber-optics. Contact: Bernie Czarnecki, (814) 838-1466.

21: SCTE Central California Chapter meeting; in installer exams to be administered. Contact: Deborah Abate, (408) 578-1790.

21: SCTE Chaparral Chapter seminar, system balancing basics; election of officers to be held. Contact: Joe Roney, (505) 761-6224.

23-25: Great Lakes Cable Expo with **SCTE** co-sponsored seminars on fiber surge protection, digital compression and rebuilds, plus BCT/E exams, Detroit. Contact: Diane Drago (517) 482-9350.

25: SCTE North Country Chapter, testing in BCT/E Categories I, IV, V and VII and installer program, written and practical (tentative). Contact: Rich Henkemeyer, (612) 522-5200.

Planning ahead

Oct. 1-3: Atlantic Cable Show, Atlantic City, N.J. Contact (609) 848-1000, ext. 304.

Oct. 8-10: Mid-America Show, Kansas City, Mo. Contact (913) 841-9241.

Nov. 20-22: Western Show, Anaheim, Calif. Contact (415) 428-2225.

BOOKSHELF

The following is a listing of videotapes currently available by mail order through the Society of Cable Television Engineers. The prices listed are for SCTE members only. Non-members must add 20 percent when ordering.

☛ *Construction Techniques for Extended System Life* — Cable, strand, connectors and mechanical devices are detailed. Loop configurations, bonding clamps, lashing wire and strand are examined. Construction techniques to minimize plant problems are outlined. The program also deals with placement of loops and installation of equipment on the pole. (30 min.) Order #T-1015, $35.

☛ *Safety Awareness Around Electrical Conductors* — Using slides, movies and demonstrations, this videotape provides information about the hazards of working around power. It reviews amperage and its effects and graphically depicts the results of injuries and burns. Clearances and dangers of energized conductors are discussed. Power line handling techniques, clothing, flashes and insulators, wire, aerial and underground cable and wire, conductors and their hazards are included. Produced by the New Jersey Cable Television Association with the cooperation of the Office of Cable Television of New Jersey, New Jersey Bell, Public Electric and Gas, Suburban TV-3 and Maclean Hunter. (30 min.) Order #T-1016, $35.

Note: All videotapes listed were produced in 1981, are in color and are available in the 1/2-inch VHS format only. Videotapes are available in stock and will be delivered approximately three weeks after receipt of order with full payment.

Shipping: Videotapes are shipped UPS. No post office boxes, please. SCTE pays surface shipping charges within the continental U.S. only. Orders to Canada or Mexico: Please add $5 (U.S.) for each videotape. Orders to Europe, Africa, Asia or South America: SCTE will invoice the recipient for additional air or surface shipping charges (please specify). "Rush" orders: A $15 surcharge will be collected on all such orders. The surcharge and air shipping cost can be charged to a Visa or MasterCard.

To order: All orders must be prepaid. Shipping and handling costs are included in the continental U.S. All prices are in U.S. dollars. SCTE accepts MasterCard and Visa. To qualify for SCTE member prices, a valid SCTE identification number is required, or a complete membership application with dues payment must accompany your order. Orders without full and proper payment will be returned. Send orders to: SCTE, 669 Exton Commons, Exton, Pa. 19341; or Fax with credit card information to (215) 363-5898.

SCTE sets engineering standards?

By Wendell Woody
President, Society of Cable Television Engineers

Fact or fiction? Currently, the primary goal of the Society remains that of training cable TV installers, technicians and engineers. This dominant function will always receive paramount attention for support and growth.

CATV standards

The U.S. cable TV industry presently functions with no established or approved set of engineering standards for components, equipment, system specifications, nor tests and measurements. Only the Federal Communications Commission provides some regulatory rules and guidelines. Three engineering groups serve our cable industry: NCTA Engineering Committee, CableLabs and the SCTE. Each serves a a segment of the industry with a specific function. Not until this past year did the three groups commence jointly collaborating on industry engineering standards.

It is mutually agreed, the SCTE is the only group that can meet all the requirements to officially develop and establish CATV engineering standards. The Society has open membership with eligibility available to all those sincerely interested in development and furtherance of cable TV or broadband communication technologies. However, much of the new research and its documentation will be supplied to the SCTE Engineering Committee by CableLabs and the NCTA Engineering Committee.

Engineering Committee

In 1988, the national SCTE board approved a proposal by Tom Elliot, TCI, to establish an SCTE Engineering Committee. Tom followed by editing a "Manual of Organization and Procedure for Engineering Committees" that also was approved by the board. The engineering subcommittees can be divided into recommended practices (standards) subcommittees or engineering support subcommittees, such as CLI or the most recent request for an EBS (Emergency Broadcast System) subcommittee.

EBS

President Bush has signed the White House Statement of Requirements for the Emergency Broadcast System. It directs the FCC and the Federal Emergency Management Agency (FEMA) to determine the technical arrangements necessary for establishing an *optimum* EBS. Since over 60 percent of U.S. households now have cable TV, no emergency alert system would be effective without cable TV participation. Therefore, FCC Chairman Al Sikes has asked SCTE for a productive and cooperative effort in supporting the commission and the cable industry on this matter. We need members to work on this SCTE engineering subcommittee ... *you!*

"The SCTE is the only group that can meet all the requirements to officially develop and establish CATV engineering standards."

Engineering subcommittees

The Interface Practices Subcommittee was the first to be established and currently has 113 working members consisting of CATV operators, engineers, technicians, manufacturers, suppliers, consultants and testing lab personnel. The subcommittee is working on standards for aluminum cable, drop cable, connectors, fittings, etc. To date it has established a standard for the F-connector with its documentation now being finalized.

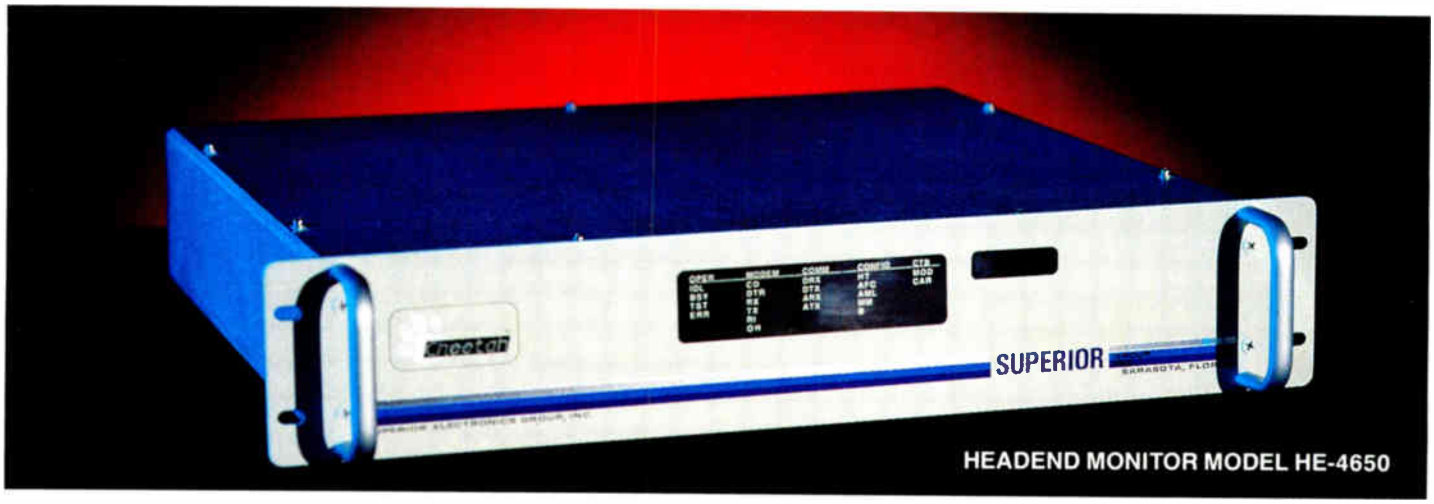
A standards project requires about two years in time to follow all the procedures and meet each standard-setting requirement. The SCTE engineering subcommittee organizational structure and operations are patterned after the IEEE engineering committees. However, the SCTE follows every detail procedure of the American National Standards Institute (ANSI) for establishing standards. Using ANSI procedures adds excellent validity to all the SCTE standards work. The "In-home wiring" is the newest SCTE engineering standards subcommittee. It has been board-approved and is now being formulated with Larry Nelson as chairman. The NCTA Engineering Committee has worked on this subject the past year; it also receives strong support from CableLabs.

You are needed

SCTE membership is not a prerequisite to participate on an SCTE engineering subcommittee or working group (however, we would hope everyone would want to be a member anyway). Personnel participating in such programs as the representatives of members of the industry shall be technical personnel who shall not have primary responsibility for marketing. We seek a good representation of application engineers, technical users and managers, suppliers, manufacturers, product design engineers, industry association members and particularly *you and your talents!* Fax me a note stating your interest to serve on one of the SCTE engineering subcommittees at (816) 454-5097.

Meeting the members

The enthusiasm at the recent Great Lakes Chapter (Detroit) meeting was most rewarding. It's a good reflection on the dedication of the officers that were present: Rob Austin, Jerry Lasecki, Jim Juhns, Wayne Robson, Marv Nelson, Rob Summers and Dennis Sartori. Grant Pearce, president of the Lake Michigan Chapter (Grand Rapids, Mich.) also was present along with national Region 7 Director Victor Gates. **CT**



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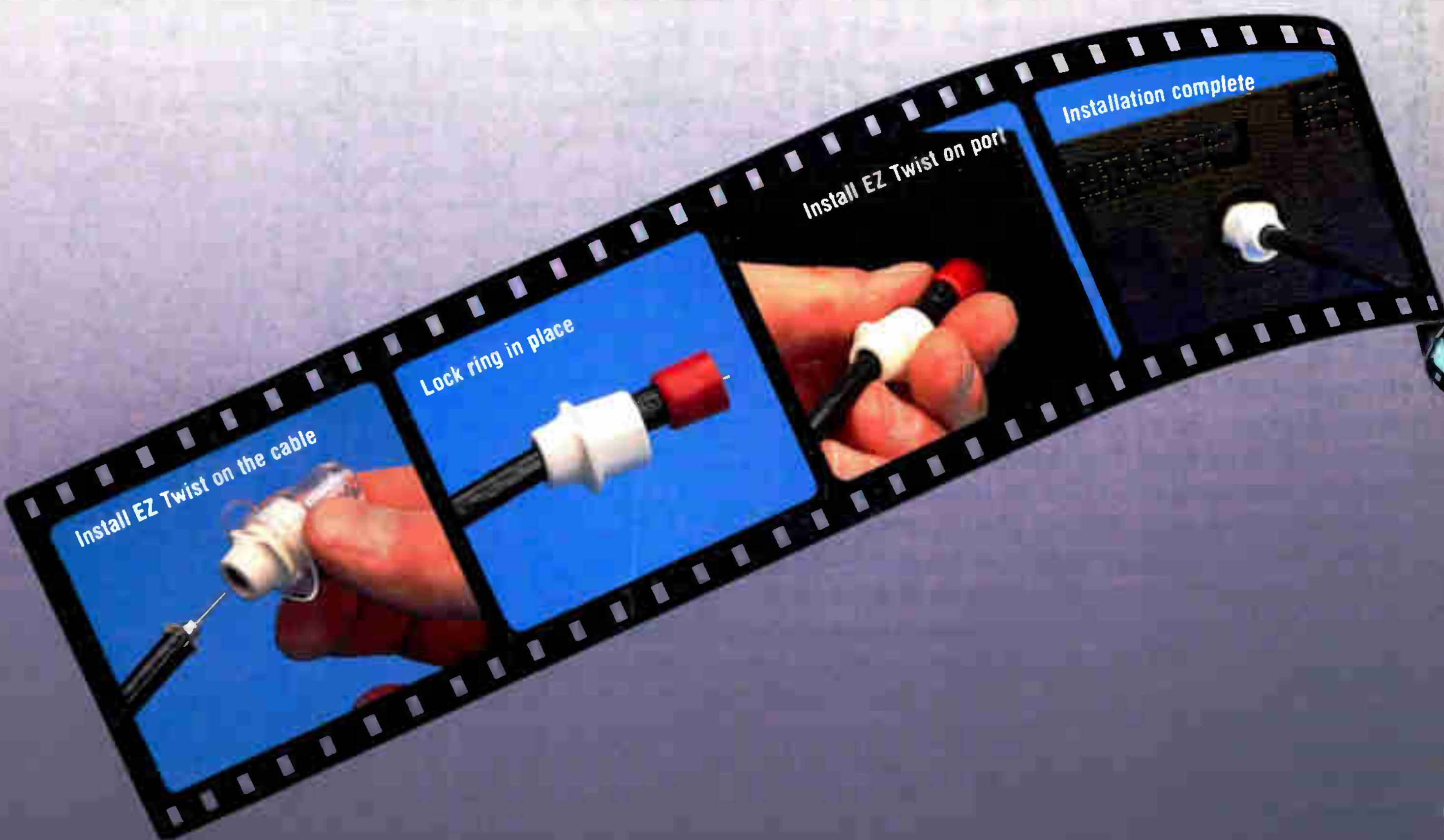
Introducing EZ Twist™...



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