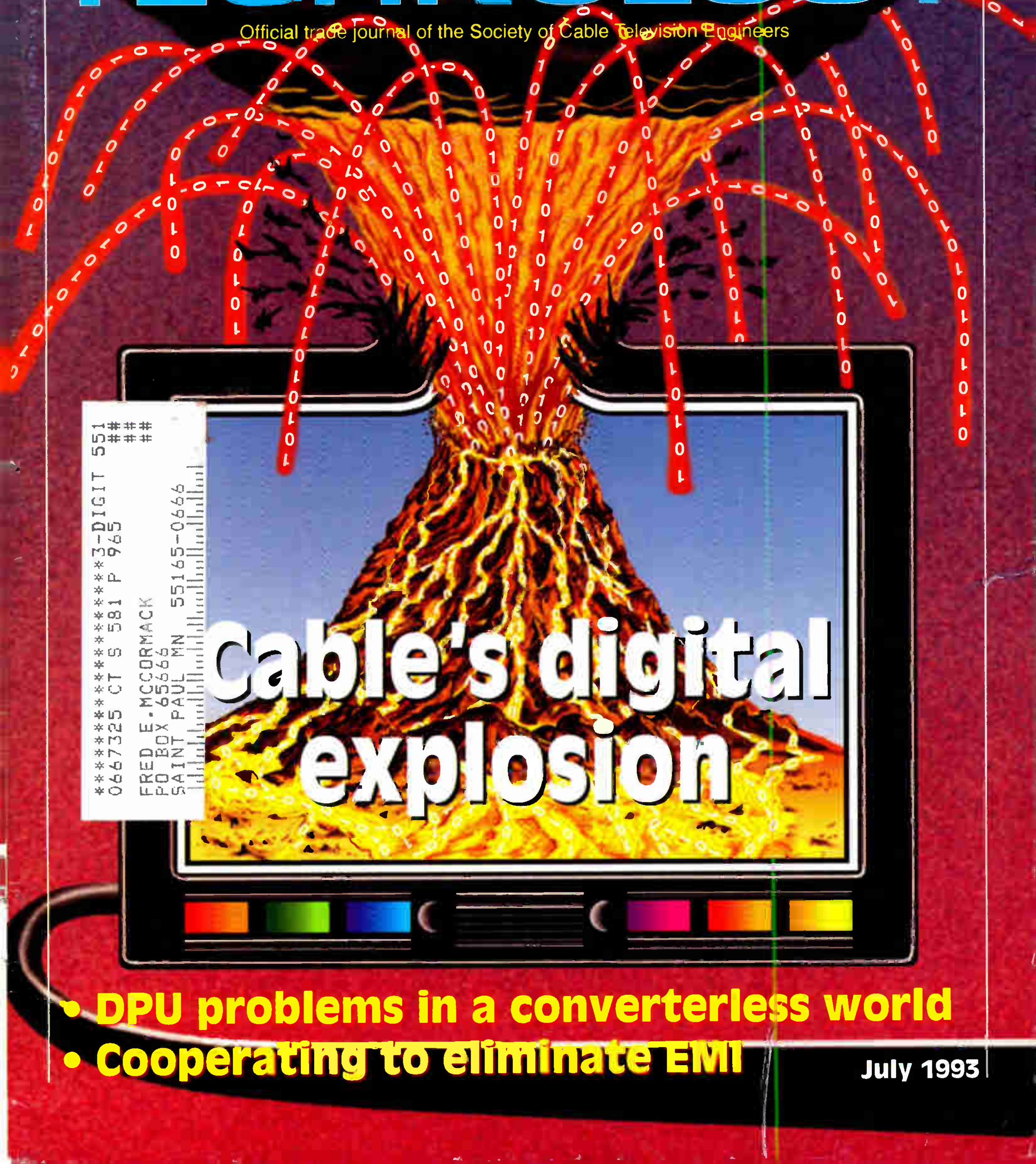
COMMUNICATIONS TECHNOLOGY

Official trade journal of the Society of Cable Television Engineers



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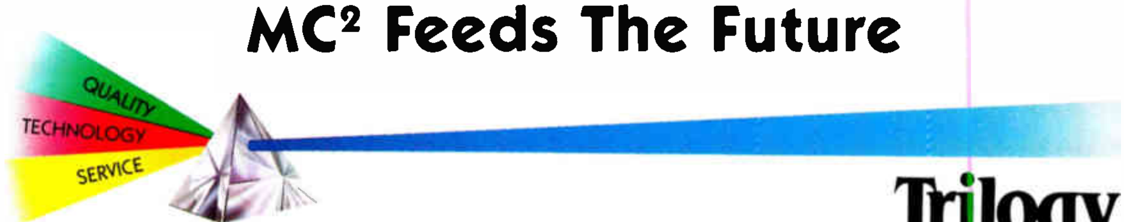

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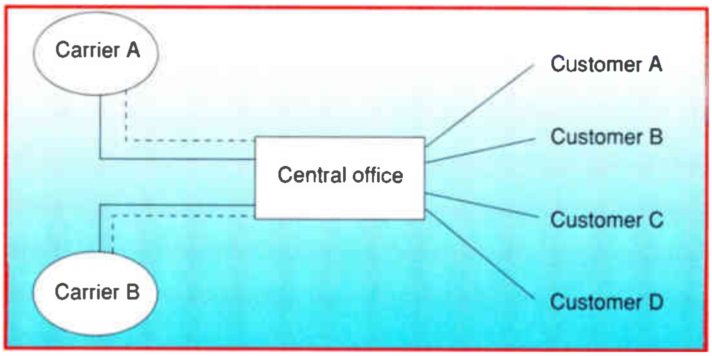

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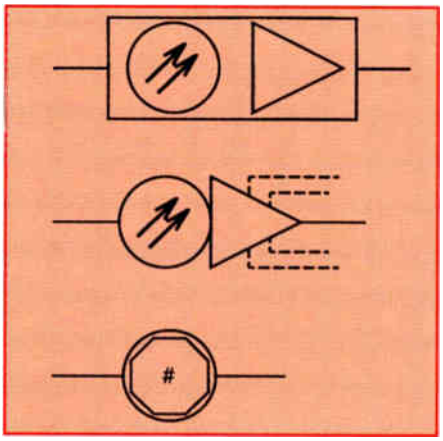

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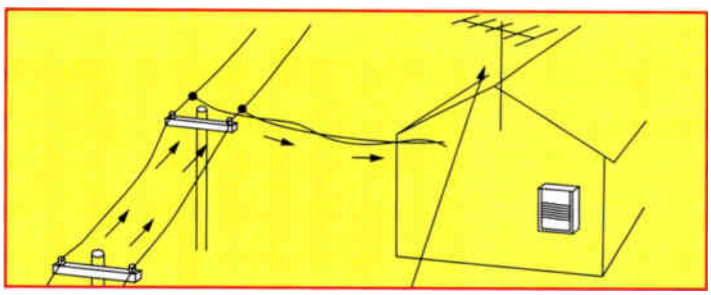

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NEWS

From the National Show ...

☛ Current SCTE Chairman **Tom Elliot** of TCI received the **NCTA's** Science & Technology Vanguard Award.

☛ **Kaleida Labs, Motorola** and **Scientific-Atlanta** signed a memorandum of intent to develop next-generation open architecture software and hardware for the delivery of interactive and multimedia services via cable. The companies plan to provide new forms of consumer-oriented cable TV services, including single- and multi-user interactive entertainment, shopping, information and educational programs. Kaleida will supply ScriptX, its core technology, to S-A for creation of next-generation interactive services and the delivery of these services using home terminals and networks manufactured by S-A. Motorola will provide microprocessor technology based on the PowerPC architecture.

☛ **TV/COM** and **Tektronix Microelectronics** have a technology development agreement for low-cost digital receivers to be used in upcoming TV compression systems. It covers integrated circuits for satellite broadcast applications. TV/COM also signed an agreement with **AVEX Electronics** for the manufacture of its new range of satellite and video compression products. As well, TV/COM and **LSI Logic** are jointly developing digital compression components to facilitate transition from analog to digital TV.

☛ **ANTEC** said Bolivia's **Video Cable Universal SA** activated the first fiber-to-the-feeder project in South America. The project, overseen by ANTEC technical personnel, entailed the installation of 12 miles of optical fiber cable, four Sumitomo optical transmitters, seven Harmonic Lightwaves HLR-3000 optical receivers, and eight AT&T UCB1 splice enclosures as part of a three-phase construction/installation project to provide cable service to 60,000 Bolivian homes. ANTEC also announced over 60 cable systems purchased optical transition node (OTN) units. As well, ANTEC and **AT&T Network Systems** are making possible the delivery of telephony services to residential customers over hybrid fiber/coaxial networks with the CLC-500 (Cable Loop Carrier) system. ANTEC made an agreement with **Alpha Technologies** to market its CFR series of uninterruptible power supplies for headend and office use. ANTEC also has an exclusive agreement with **Harmonic Lightwaves** to market its new transmitter products, the RPT 3005 and RPT 3006.

☛ **Silicon Graphics** and **Time Warner** will develop technology for the full service interactive digital cable TV network in Orlando, FL, based on the MIPS microprocessor architecture. Initial plans include R&D funding by TW to enable Silicon Graphics to bring its digital multimedia and graphics technologies to home markets.

☛ **Jerrold/General Instrument** and **TV Answer** have plans for TVA's interactive services to be made available through the architecture and software of Jerrold's next-generation, PC-based converters. Jerrold will manufacture an optional RF return path module for insertion by cable techs into the converters. GI's **VideoCi-**

The evolving cable network: Coping with digital transmission

By Jack Bryant
Vice President, Marketing
ANTEC Network Systems

With technological innovation challenging the cable industry almost daily, one issue clearly stands out: the need to prepare cable systems to accommodate greater bandwidth and digital transmission. Over the last two decades the industry has experienced a steady and predictable appetite for increased bandwidth, and just a couple of years from now digitally compressed signals will deliver an explosion of programming. Overwhelmingly, cable operators are responding to this rapidly changing environment by deploying fiber optics further out into their cable systems and installing 1 GHz taps and line passives today in order to prevent a rebuild of the feeder system tomorrow.

Over the next five years as digital compression makes "true" video-on-demand (VOD) or switched video services possible, additional bandwidth will be chewed up and digital transmission will be brought online. Add to this the promise of high definition TV with its own high bandwidth requirements and any number of other potential options — interactivity, transactional services and personal communications networks (PCNs), to name just a few — and very quickly system requirements will have exceeded 850 MHz and in many cases could reach 1 GHz.

A case in point: Time Warner Cable's ambitious undertaking in Orlando, FL, where the company will be testing its "full service network." The Orlando system has grown from a classic 300 MHz cable system, expanded to 550 MHz, and will now be evolving into a 1 GHz system that will be capable of delivering from 4 to 51.8 Mbps data streams to each subscriber with 1.5 Mbps return signal available from each home. Time Warner plans to implement a fully interactive plant that offers both analog and digital transmission services for a wide variety of applications including traditional CATV services, full VOD, interactive TV and gaming, long distance access, voice services, videophone and PCN. The aim of the 4,000-home test project is to explore the application of new technologies and to discover how the buying public will perceive and buy the additional services a 1 GHz plant will make possible.

But clearly other operators are evolving as well to meet the coming expansion of cable systems that will provide both analog and digital transmission services. As the coaxial plant (including the drop) is upgraded to 1 GHz, operators are preparing them-

Geri Saye

selves to provide the most powerful interactive communications and entertainment medium to the home. Part of the key to future success is in understanding how digital transmission differs from the traditional analog capabilities most cable systems enjoy today.

What happens when we go digital

Strides in digital compression offer the potential to squeeze four, eight or even 10 NTSC channels into 6 MHz. While this capability does provide for digitally compressed video within a typical 550 MHz system, bandwidth needs will clearly stretch beyond 550 MHz as programming options continue to grow.

However, due to the nature of digital signals, drops that provide satisfactory NTSC signals today will in many ways be insufficient for digital signal quality in the future. To assure optimal signal quality and avoid the need to revisit many drops when it comes time for the upgrade to compression, the drop should be viewed as one of the most vital links in providing high-quality analog and digital transmission services. Unlike analog signals, which degrade to a still-viewable picture when connections are not secure, digital signals will sometimes be subject to a complete loss of picture, frozen frames or unrecognizable images under the same conditions.

How digital signals will be received in the subscriber's home and what part outside interference plays on those digital signals have become critical issues the industry is now beginning to investigate. Distortions arising from microreflections, return loss, off-air ingress and impulse noise each have an impact on digital transmission. Some are minor problems, others more critical.

Digital signal distortion — an explanation

Microreflections result from imperfectly matched or slightly damaged components. If there is even a minor dent in a cable caused by improper installation or outside means such as animal bites to the cable, as the signal passes along the cable it will encounter the imperfection and deflect part of the original signal back toward the originating device. TV sets and VCRs also have been known to produce microreflections since they generally provide poor return loss. And

"How digital signals will be received in the subscriber's home and what part outside interference plays on those digital signals have become critical issues the industry is now beginning to investigate."

while the return loss (whatever its cause) is lower in value than the original signal (when created at multiple times and from numerous devices), these microreflections can create serious distortions to — if not a total loss of — a digital picture.

Off-air ingress is another cause of distortion to digital signals. Put simply, ingress is caused by any off-air signal (broadcast TV signals, airplanes, automobile ignition systems, etc.) that distorts the picture. With analog signals, one might see shadowing or a sudden still frame when subjected to ingress. With digital signals, one could again experience a complete loss of the picture, depending on the severity of the problem.

Impulse noise is a third cause of digital distortion. While somewhat less threatening than microreflections and ingress, impulse noise also impacts digital transmission through sudden power surges or similar situations. Impulse noise, unlike the other causes of distortion, is generally self-correcting within a matter of minutes.

Ways to cope with digital distortion

Today, operators can reduce the problems associated with these problems by taking special care to choose components that do not affect the impedance of the cable. High shielding and effective connectorization will continue to be critical issues in the installation process as the industry moves into the digital world. High shielding standards for passives, connectors and cable not only reduce higher frequency impulse noise effects but also can help to minimize the effect of off-air ingress, which can do substantial damage to a digital information stream.

ANTEC Communications Services formed a committee for integrated drop standards to assist operators in reducing some of these problems. The committee is helping to ensure drop system reliability and performance, thereby reducing drop-related service calls, improving subscriber satisfaction and ensuring component compatibility. That single issue — component compatibility — will prove crucial as the industry moves toward 1 GHz of bandwidth and digital transmission.

The primary focus of the committee has been to encourage a standardized approach to drop installation. By thoroughly training staff personnel on proper standards for each drop installation, many current and future drop-related problems can be eliminated. Further, by following the on-going development of standards by the Society of Cable Television Engineers regarding in-home wiring, interface procedures and cabling specifications, cable systems can move toward the permanent installation of drops that will be effective for both analog and digital transmissions.

Summary

The advent of so many new technologies (interactive TV, VOD, PCNs, etc.) will require cable operators to take a look at the methods currently used for installation and upgrading of the passive system. As more cable operators move toward 1 GHz capacities and the ability to handle digitally transmitted signals, preparing for the future also warrants an examination of how installation and maintenance of the drop system may impact digital signals. While most of us are used to traditional analog transmission, the expanded role digital compression will play on the future will further accelerate the industry, bringing with it potentially profitable new areas for cable operators to pursue.

Time Warner's Orlando project will prove not only how digital transmission can be handled technologically, but whether consumers will embrace a revamped, more powerful hybrid analog/digital network as well as the new and different programming approaches it affords. In the end, however, technology will act as the enabler; it will be up to the consumers to determine whether interactivity, PCNs and access to digital information is something they're willing to pay for. **CT**

The nuts and bolts of digital circuit provision via CATV fiber

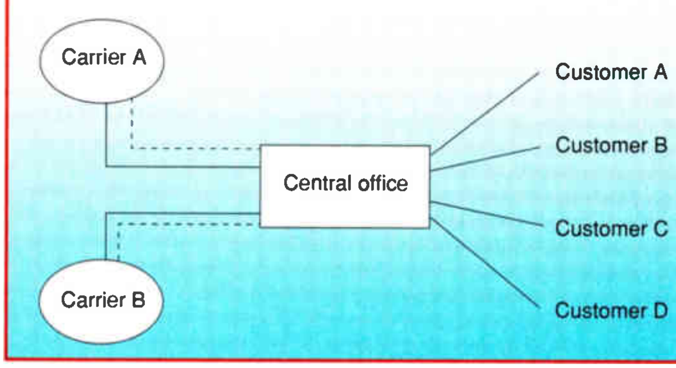
By Jack S. Burton
Manager, Fiber Optics
Cablevision Systems Corp.

The implementation of fiber optics in cable TV has created a new opportunity to serve business customers with data transmission. Many cable operators are installing extensive fiber cable plant systems that, if provided with sufficient extra fiber counts, may be extended to connect businesses to long distance telephone carriers and to each other. In the future, these connections might even be used to provide basic telephony for residential subscribers.

A quick and profitable way to take advantage of the opportunity this plant presents is to provide the high-capacity services that fiber is best suited for. Most commonly, these services will be DS-1 (T1) transmission at 1.544 Mbps and DS-3 (T3) at 44.736 Mbps. These data channels are directly compatible with telephone company offerings and therefore interface easily with your customers' and carriers' equipment.

Business plans and revenue possibilities are beyond the scope of this article. In addition, I will not cover the data signals themselves, since there is extensive material available elsewhere to cover these matters. What I hope to show, however, is that once your customers are identified, connections may be made easily using equipment and techniques that are widely available, though not generally familiar to cable operators.

Figure 1: Plant connections

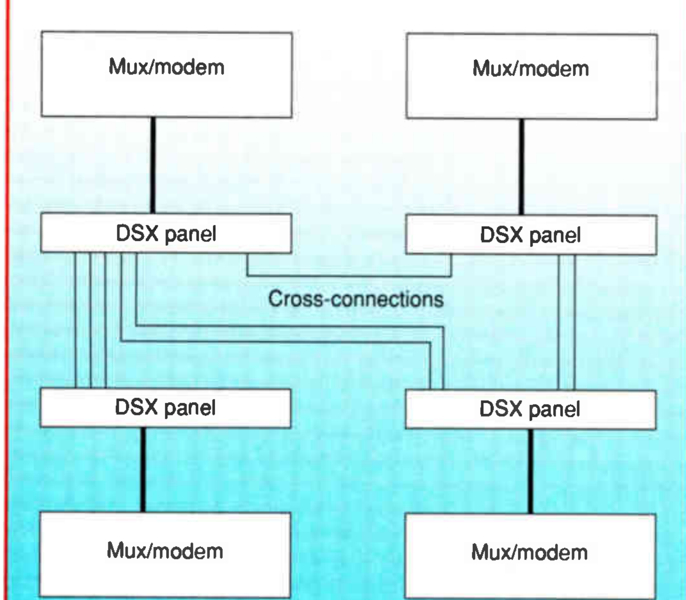


Plant requirements

In order to interface with transmission equipment, usually two or four dedicated fibers are required between the two served locations (Figure 1). Operators intending to seriously enter this business will wish to bring all signals back to a central hub for concentration, switching and monitoring before distribution to their final destinations. (This central hub, probably located at the operator's main headend site, is the equivalent of a central office or terminal in the telephone world.)

One fiber is used for data transmission in one direction, and a second in the other direction. Third and fourth fibers are required if optical equipment redundancy is provided. The second pair of fibers should follow a diverse route if possible. This will protect the circuit in the event of a fiber break. Diverse routing may be required by some customers and is recommended for connections to all carriers and remote hubs.

Figure 2: Manual cross-connection



Transmission equipment

To send DS-1 and DS-3 signals on optical plant, modems are required. These modems usually incorporate multiplexers that will permit carriage of multiple signals on one optical path.

• *Access equipment.* Systems to carry DS-1/DS-3 signals are available from many sources. Some of these systems are designed for stand-alone applications while others are made to be easily integrated into a central office.

Stand-alone products, such as those made by Canoga/Perkins, Fibronics, Synoptics and ADC-Fibermux are best suited for private links between one customer's facilities. These units may offer the capability to carry other signals such as Ethernet, FDDI, V.35 and synchronous or asynchronous RS-232/422 data without external equipment. Some may mix in DS-3 capability as well.

Units vary from simple desktop modems to rack-mount systems featuring in-service card replacement capability. Some of these also include their own network monitoring and control systems. Powering is usually 117 VAC.

Integrated (telco-compatible) products may be found from ADC, AT&T, Telco Systems, Rockwell, NEC, Fujitsu and others. Most of these feature different hardware configurations for the customer (typically wall-mount single units) and central office (multiple unit rack-mount shelves). Some of the central office units can accept a DS-3 input and distribute it as multiple DS-1 signals to several customer units. This capability greatly simplifies central office wiring, but may limit connection options unless a "digital access cross-connect system" (DACS) is employed. Customer units may require an outboard 48 VDC power supply or contain one internally. Central office units are always 48 VDC powered.

These systems also usually interface with standard telco status monitoring systems, including office alarm (contact clo-

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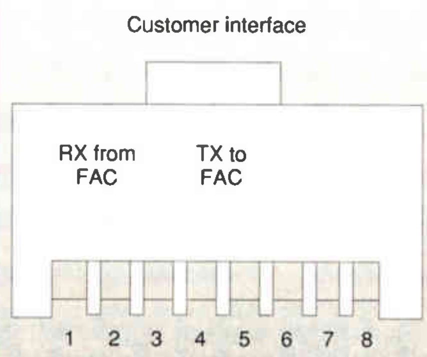
Most customer equipment that would normally connect to a CSU has a DB-15 (15-pin) interface rather than the RJ-48. In this case, pins 1 and 9 are used for transmit to the FAC, and 2 and 11 for receive to the CPE. Male or female connectors may be required.

The most popular DS-1 demarcation interface has become the RJ-48 smartjack. The smartjack is an electronic device that performs some of the conditioning and test access functions of a CSU, but is owned and accessed by the carrier of the circuit. It may be looped-back remotely by a special bit pattern generated by T1 test sets. Though this interface costs much more than a standard T1 jack, it may pay for itself in reduced service cost. If the circuit tests OK to the smartjack, chances are very good that the circuit is trouble-free. The smartjack units are available in single-line or multiple circuit configurations and have a variety of powering options.

DS-3 demarcation is normally accomplished via two types of connectors: BNCs or TNCs. These are the same connectors used for video and should be familiar to most cable operators. Demarcation panels featuring labeled, mounted BNC interfaces with or without monitor ports are available.

Figure 5: RJ-48 plug



- *Test access.* When a circuit is installed or a trouble is reported, it may be necessary to insert a test pattern generator or error detector. Both of these functions are combined in a test set.

DSX panels include jacks that allow a test set to be inserted in place of normal traffic to test the line. They also feature a monitor port that permits signals on the line to be monitored without affecting transmission. Panels at a network hub should be installed to permit access to both "directions" of a circuit span.

Tally lights may be wired to indicate normal connections. In these instances, plugging the test set into the "monitor" jack of a circuit end will flash a light at the jack, and at the monitor jack of the cross-connected equipment as well.

Miscellaneous network components

Now that we have discussed the major building blocks of a data network, let us discuss some of the incidentals.

- *Optical cables.* Most cable operators are now familiar with optical cable. The outside plant portion of the data network is identical to that used for transmission of cable TV signals. The drop from the outside plant to the customer's fiber panel may be installed just as if it were run into a cable headend. Alternatively, special messengered cable may be used. However, outdoor sections should use loose-buffered designs. The cable may be installed into any one of the many styles of splice boxes, but some designs may be more convenient for a customer installation. If the equipment is to be wall-mounted, a wall-mounted fiber panel can reduce occupied "real estate" in what may be a cramped telephone closet. Lockable cabinets are available that may limit the

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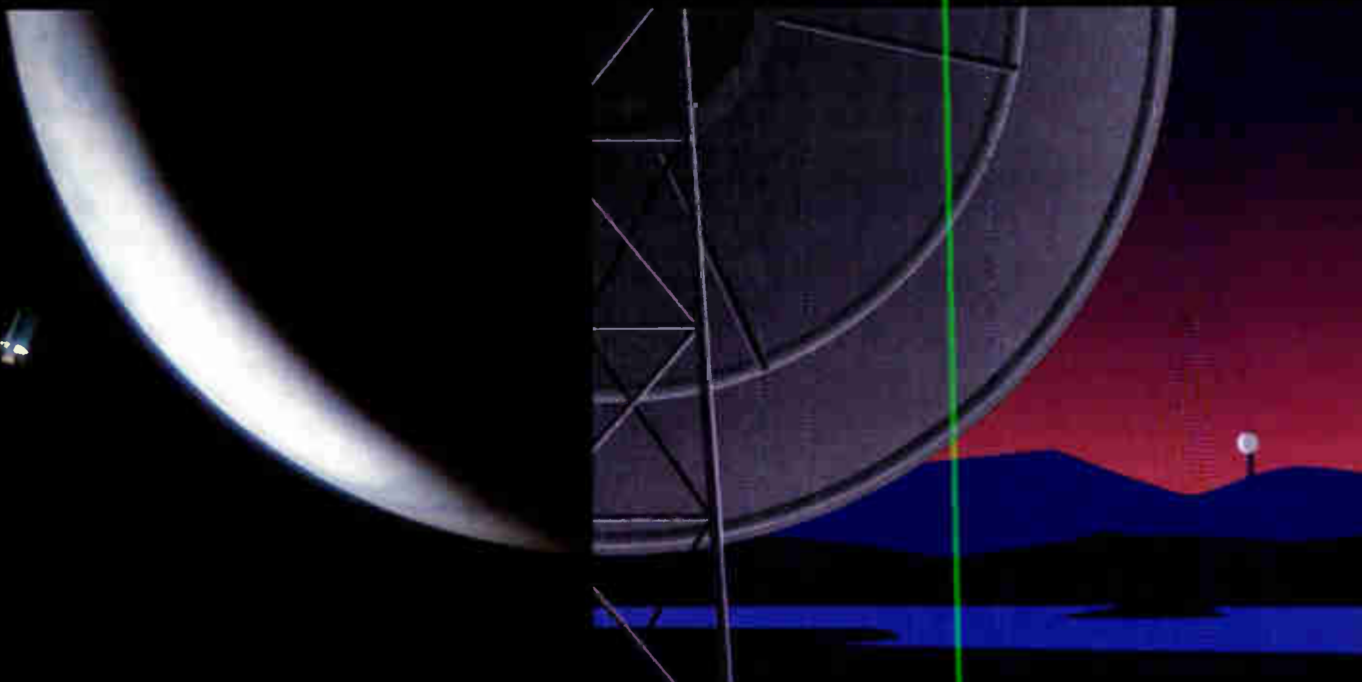

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customer's access to fiber plant if required.

From the panel to the equipment, duplex jumper cables may be used rather than simplex patch cords commonly used in cable TV. Wherever exposed, the jumpers should be run through flexible innerduct or at least be spiral-wrapped to minimize the chance of damage. Usually, excess cable may be stored in jumper storage modules in the termination panel and/or storage clips provided in the transmission equipment cabinet.

Connector choice will depend on the equipment used, with the following suggestion: Choose a termination panel connector compatible with test equipment used by fiber plant personnel. This will aid in troubleshooting if the equipment is maintained by different personnel than the plant. Jumpers with one type of connector suiting the plant on one end and a connector matching the transmission equipment on the other may be obtained from a variety of vendors, and of course several spares should be on hand.

- *DS-1 cables*. T1 cable is used to carry DS-1 signals. This is twisted-pair cable, with each pair individually shielded. A 22-gauge, solid wire is normally specified for T1 wiring. The cable may extend up to 130 feet before some equalization is required. The equalization, referred to as "line build-out," may be accomplished by option settings on the transmission gear, CSU and/or smartjack interface.

When several circuits are to be run, a common shield may be used around several different transmit wires and another common shield around receive wires. This type of cable is frequently used to connect transmission equipment to DSX-1 panels.

Solid wire is specified to permit wire wrapping or punch-down terminations, with wire wrapping being the method of choice.

- *DS-3 cables*. DS-3 signals are carried by 75-ohm impedance coaxial cable. Quarter-inch (approximately) diameter, such as Belden 8281, is used for most applications. Connections from transmission gear to closely located DSX-3 panels may use bundled mini-coax to reduce clutter. The equipment may include line build-out options to permit longer cables to be used.

- *Power cables*. Large gauge stranded copper cables will usually be specified by the equipment manufacturer to connect -48 VDC power to the equipment.

- *Optical connectors*. As previously stated, your choice of optical connectors will depend upon the equipment used. Most common are ST-compatible, Biconic and FC. Some equipment will feature panel-mounted connectors, while others include short pigtails for which the operator must supply sleeves.

- *DS-1 connectors*. In the office, there are usually no DS-1 connectors other than those provided for test access. Connections are made via wire-wrap panels or using push-on pin connectors provided specifically for the transmission equipment used. New DSX-1 panels commonly use a "mini-WECO" jack for test access. "BANTAM" and "WECO" styles also may sometimes be found in telephone offices. A good supply of patch cords should be available to permit circuit loopbacks and temporary patches.

Cross-connection in the office is accomplished via unshielded wire, wire-wrapped between DSX-1 panels. This wire should be twisted in five-wire bundles to permit connection of the transmit pair, receive pair and monitor tally light.

At the customer location, as discussed, RJ-48 and DB-15 connectors will prevail.

- *DS-3 connectors*. BNCs or TNCs are used, with minor exception. Some equipment uses push-on pin connectors similar

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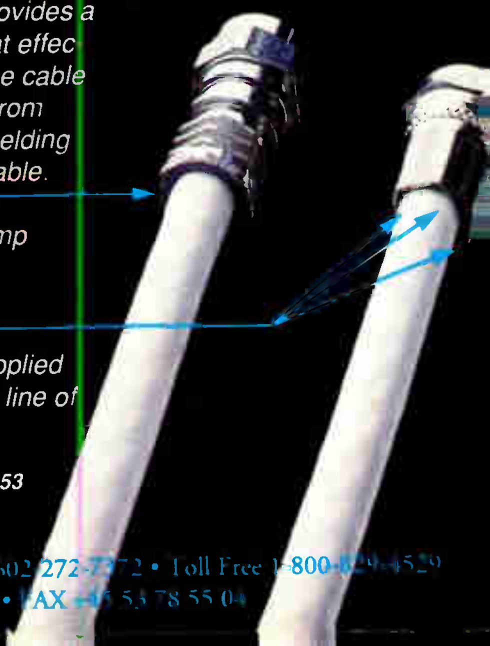

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to those provided for DS-1 equipment. In these instances, the manufacturer will supply a cable with only one end terminated. Different types of BNCs must be used for the standard and mini cables.

Cross-connection to the "normal" points on a DSX-3 panel also is accomplished via BNC-equipped coax cables, sometimes with the addition of a wire to run monitor lights.

DS-3 test access is via mini-WECO style coaxial connectors. These are not the same as video patch cords used by broadcasters, but operate in the same manner.

• *Power connectors*. Special lugs or connectors may be required for certain pieces of equipment. Most common power equipment, such as fuse panels, will have screw-on connections for wires to equipment.

Tools and test equipment

Some of the tools used to perform data circuit installation are the same as those required to perform CATV installation. Here we will examine some of the differences.

• *Equipment mounting*. No special tools or skills are normally required for wall-mounted equipment in a customer's site. You will require wood screws and a screwdriver to secure gear to the plywood walls normally furnished in a telephone room. If no plywood is furnished, it may be much easier to install some plywood yourself than to mount the equipment directly on the wall. If drywall attachments are required, anchors and Molly or toggle bolts may be used.

Motorized screwdrivers or drill adapters can be a real time saver here. The typical CATV folding ladder also will be required.

In the office or at a carrier or customer location requiring rack-mounted equipment, open bays must be secured. This may require bolting bays to a concrete floor or ceiling superstructure. If concrete attachment is to be used, a hammer drill is required to create holes for installation of lag bolts and anchors. (Remember that dish installation?) When attaching to a ceiling superstructure, special cable frames, bay supports and other hardware is suggested. Installation of this specialized hardware is beyond the scope of this article.

Note that bays for telephone equipment usually are drilled and tapped to a WECO standard equipment spacing, not the 1-3/4 inch EIA spacing to which we are accustomed. Choose a spacing

BOOKSHELF

During the Annual Membership Meeting held at Cable-Tec Expo '92 in San Antonio, TX, the national board and staff learned the importance of the development of new training programs to the membership. As a result, the Society of Cable Television Engineers enlisted the services of William Grant, author of the widely recognized textbook, "Cable Television," to conduct a series of seminars to be professionally produced as video programs and made available on videotape to the members. These programs follow the textbook, and build upon it. Together with the text, the videotapes provide a comprehensive treatment of the basics of CATV design and operation. The tapes are available by mail order through the SCTE. The prices listed are for SCTE members only. Non-members must add 20% when ordering.

☛ *Noise* — A thorough discussion of the origin and nature of noise in a CATV system. By expanding upon Chapter 4 of the textbook, Grant covers factors such as noise figure and carrier-to-noise ratios, together with their applications and calculations. Equalization and equipment specifications also are covered. (55 min.) Order #T-1122, $45.

☛ *Intermodulation Distortion* — Grant deals with distortion as a system phenomenon, covering the forms of intermodulation distortion and how they relate the modern CATV system. He also discusses amplifier output levels and X-mod. Intermodulation specifications, the calculation of X-mod, combining equal and unequal X-mod distortion, and equalization and X-mod are covered. (45 min.) Order #T-1123, $45.

Note: Videotapes are in color and available in the NTSC 1/2-inch VHS format only. They are available in stock and will be delivered approximately three weeks after receipt of order with full payment.

Shipping: Videotapes are shipped UPS. No P.O. 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.

A listing of other publications and videotapes available from the SCTE is included in the March 1993 issue of the Society newsletter, "Interval."

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25	51	77	103	129	155	181	207	233	259	285	311
26	52	78	104	130	156	182	208	234	260	286	312

A. Are you a member of the SCTE (Society of Cable Television Engineers)?
01 ___ yes
02 ___ no

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Cable TV Systems Operations
03 ___ Independent Cable TV System
04 ___ MSO (two or more Cable TV Systems)
05 ___ Cable TV Contractor
06 ___ Cable TV Program Network
07 ___ SMATV or DBS Operator
08 ___ MDS, STV or LPTV Operator
09 ___ Microwave or Telephone Company
10 ___ Commercial TV Broadcaster
11 ___ Cable TV Component Manufacturer
12 ___ Cable TV Investor
13 ___ Financial Institution, Broker, Consultant
14 ___ Law Firm or Govt. Agency
15 ___ Program Producer or Distrib.
16 ___ Advertising Agency
17 ___ Educational TV Station, School or Library
18 ___ Other (please specify)______

C. Please check the category that best describes your job title:
19 ___ Corporate Management
20 ___ Management
21 ___ Programming
Technical/Engineering
22 ___ Vice President
23 ___ Director
24 ___ Manager
25 ___ Engineer
26 ___ Technician
27 ___ Installer
28 ___ Sales
29 ___ Marketing
30 ___ Other (please specify)______

D. Do you plan to rebuild/upgrade your system in:
31 ___ 6 months
32 ___ 1 year
33 ___ 2 years
34 ___ 5 years

E. In the next 12 months, what cable equipment do you plan to buy?
35 ___ Amplifiers
36 ___ Antennas
37 ___ CATV RF Distribution/ Distribution Electronics
38 ___ CATV Passive Equipment Including Cable
39 ___ Cable Tools
40 ___ Compression/Digital Equip
41 ___ Computer Equipment
42 ___ Connectors
43 ___ Converters
44 ___ Controllers
45 ___ Descramblers
46 ___ Fiber-Optic Cable
47 ___ Fiber-Optic Electronics
48 ___ Headend Equipment
49 ___ Interactive Software
50 ___ Lightning Protection
51 ___ MMDS Transmission Equip.
52 ___ Microwave Equipment
53 ___ Other Security Equipment
54 ___ Receivers and Modulators
55 ___ Remotes
56 ___ Safety Equipment
57 ___ Satellite Equipment
58 ___ Splitters
59 ___ Subscriber/Addressable Security Equipment
60 ___ Telephone/PCS Equipment
61 ___ Power Suppls. (Batteries, etc.)
62 ___ Vehicles
63 ___ VideoCiphers
64 ___ 2-Way Radio

F. What is your annual cable equipment expenditures?
65 ___ up to $50,000
66 ___ $50,001 to $100,000
67 ___ $100,001 to $250,000
68 ___ $250,001 to $500,000
69 ___ $500,001 to $1,000,000
70 ___ over $1,000,001

G. In the next 12 months, what cable test & measurement equipment do you plan to buy?
71 ___ Fiber Optics Test
72 ___ Oscillators
73 ___ Service Monitors
74 ___ Signal Level Meters
75 ___ Spectrum Analyzers
76 ___ Sweep Tester
77 ___ CATV RF Test Equipment

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I. In the next 12 months, what cable services do you plan to buy?
84 ___ Consulting/Brokerage Services
85 ___ Contracting Services (Construction/Installation)
68 ___ Technical Services/ Engineering Design

J. What is your annual cable services expenditures?
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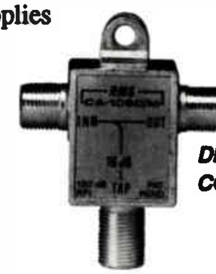

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