COMMUNICATIONS TECHNOLOGY

Official trade journal of the Society of Cable Television Engineers

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- CableLabs on outages
- "Time" compressed TV?
- Improving technical service
- Providing competitive access

January 1993

INTRODUCING

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Departments

Geri Saye

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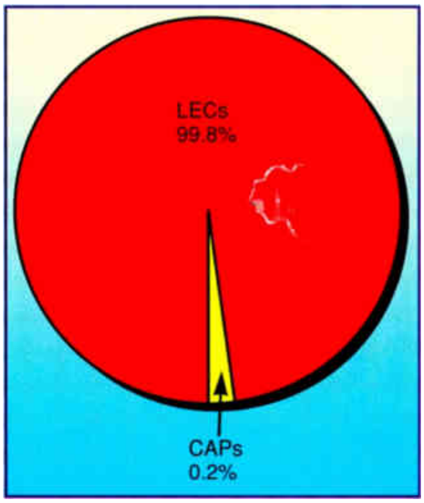

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A6: [W8] 'OTHER SATELLITE POSITIONS.
A8: [W8] 'GROUND LOCATION NAME:
D8: U [W9] 'Ft. Pierce, Fl
A9: [W8] ' North Latitude:
A10: [W8] ' Degrees
C10: U [W10] 27
D10: [W9] 'Minutes
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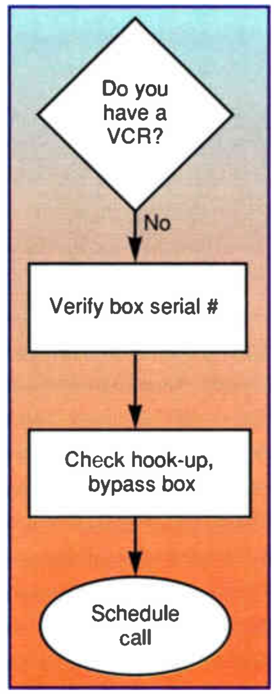

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Features

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EDITOR'S LETTER

A leadership resolution

As we enter yet another new year, many of us sit down and draft lists of resolutions for the upcoming 365 days. You know the routine: lose a few pounds, take up a regular exercise program, give up some bad habit, take an evening college course, etc. Well, I'd like to propose a change. Our industry needs to make a resolution concerning leadership, or more specifically its lack of leadership. And it needs to be a resolution that we keep!

Let's look at the fine mess this leadership vacuum has got us into.

First of all, we pay far too much attention to the short term. For much of our 44+ year history, the main concern has been the bottom line. Last quarter's P&L statement. This month's cash flow. Next year's budget. Another rate increase. And the bonus that won't be if the numbers aren't met.

This attitude has affected customer service, training, the quality and reliability of our systems, and the backbone of cable: our people. Our leaders need to stop giving these things lip service, and begin to look at the long term and think in years and decades, not weeks or months.

Customer service drives our business, yet high rates and poor service got us re-regulated. There are still too many complaints about phones that are busy or don't get answered, billing problems, installers who don't show up, poor picture quality, too many outages and other unnecessary problems. Only when our leadership fully understands what customer service is will the problems go away.

These problems have an interesting trickle-down effect relating to training, too. How many technicians and installers still can't put an F-fitting on cable the right way? How many of our field personnel know what Ohm's Law is, can sweep a modulator or processor, or measure video distortions? For that matter, how many of estimated 40,000 technical employees in the industry have never attended a local Society of Cable Television Engineers chapter meeting?

Sad, isn't it, that we think of ourselves as a state-of-the-art communications provider — with networks potentially capable of 150 or more channels and technologies such as digital video compression, high definition TV (HDTV) and video-on-demand just around the corner — yet we may not be ready for our own future. Our leaders have to take us there, but I'm not so sure that they're even ready.

Just as discouraging are the really good ideas and some philosophies espoused by CEOs at our major MSOs, but for some reason never seem to make it to the system level. I've never figured this one out.

So, as we enter another new year, I hope that our industry can look back at its mistakes and learn from them. We must further resolve to focus on truly leading this business well into the next century. If we don't, it can all too easily become another dinosaur in corporate America.

Ronald J. Hranac
Senior Technical Editor

Power by Design

The Power Source Engineered for Today's Cable TV Networks

Power Cast™ is designed for today's cable systems and unique power source requirements needed in fiber networks.

Engineered for cool, quiet and efficient performance, Power Cast power sources provide you with leading edge technology and a five-year warranty.

Power Cast is available in a variety of models that operate at 3, 6, 9, 12 or 15 amps each with the versatility of pole, pedestal or strand mounting.

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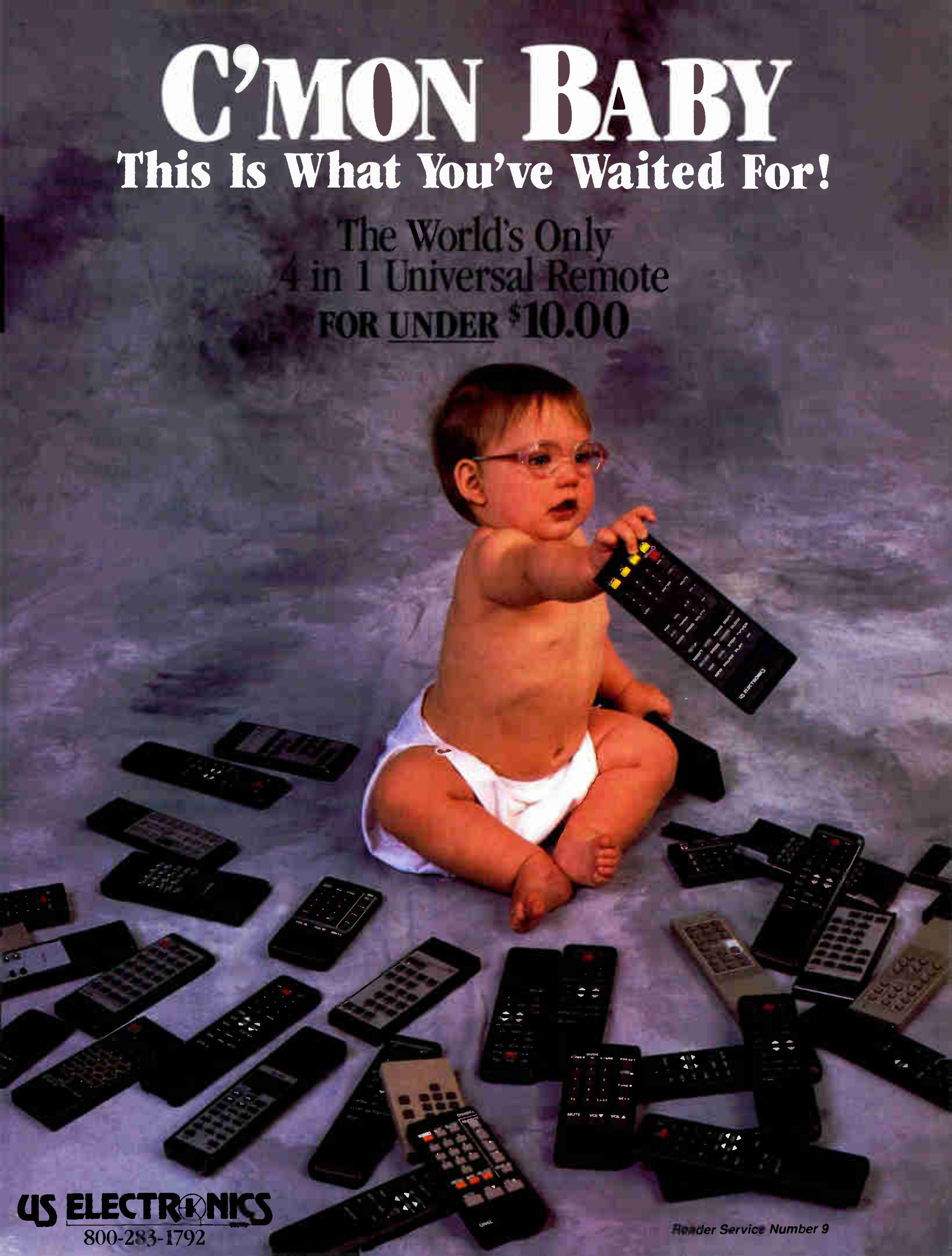

The following news stories ran in the "CT Daily" at the Western Show, Dec. 2-4, 1992.

Compressed digital set for TCI customers

Tele-Communications Inc. announced that it will begin rolling out to its cable customers a wide range of additional TV programming options, delivered in a compressed digital format, by January 1994. The technology to be deployed makes possible the eventual delivery over cable TV systems of hundreds of additional channels of TV and data options, many of them interactive, with "vastly improved" picture quality, according to the company. TCI's backyard dish customers will receive similar compressed digital services sometime in the middle of this year.

The company believes these will be the world's first major consumer applications of compressed digital TV technology.

To implement its plans, TCI announced it has signed a letter of intent to purchase up to 1 million set-top compressed digital terminals from General Instrument and AT&T, and indicated its intention to negotiate for the purchase of additional terminals and related equipment from Scientific-Atlanta and other industry vendors. As part of the agreement with TCI, AT&T and GI will license key components of their technology to other terminal manufacturers. The company believes this equipment and related systems will be consistent with international standards now being finalized by the Moving Picture Experts Group II (MPEG II). The letters of intent also call for the purchase of related uplink and cable headend equipment and compressed digital components for satellite receivers in the backyard dish marketplace. TCI will manage the technical aspects of its digital compression system from a new access, control, encryption and uplink center, using technology developed by GI.

S-A to acquire Nexus Engineering

Scientific-Atlanta announced an agreement in principle to acquire the business of Nexus Engineering Corp. The acquisition will establish S-A's presence in the international SMATV market as well as provide new distribution channels for its digital video compression products abroad. The terms of the transaction were not disclosed.

In making the announcement, S-A CEO William Johnson said, "There are many pluses from this acquisition for Scientific-Atlanta. Nexus' reputation for quality and innovation is one of the highest in the industry. Their strong presence in key growth markets abroad, especially Southeast Asia, the Middle East, South America and Canada, complements Scientific-Atlanta's global strategy in key product areas."

Under terms of the transaction, Scientific-Atlanta will acquire the assets of Nexus Engineering headend and am-

plifier product lines in Burnaby, BC. In addition, the two management founders of Nexus, Dr. Basil Peters (chairman and CEO) and Peter van der Gracht (president), will be joining Scientific-Atlanta's management team.

Wavetek/Laser Precision ink OEM deal

Wavetek Communications announced it signed a broad OEM contract with Laser Precision. This agreement allows Wavetek to sell a complete line of Laser Precision products under the Wavetek brand name.

A line of power meters, visual fault locators, LED/laser sources and Laser Precision's new fault locator will be sold under the Wavetek name. Wavetek also will distribute Laser Precision's Feature Finder and optical time domain reflectometer products.

Digital voice system to be tested

Time Warner Cable, MCI and First Pacific Networks (FPN) announced plans to launch a test of FPN's Personal Xchange (PX) fully distributed digital voice switching system. The test will provide alternative telephone access to MCI's network using a portion of Time Warner's Queens, New York City, cable system. The PX system's distributed switching architecture will enable the delivery of telephone services to customers over the existing CATV infrastructure. The test is expected to begin during the first quarter of this year.

The PX system technology delivers two-way video, voice and data services simultaneously to homes and businesses over a single fiber-optic, coax or hybrid wire. Where regulations permit, cable TV operators can broaden their billable services by selling excess capacity to long distance carriers to connect cable subscribers to the long distance telephone company, reducing access charges and potentially lowering rates.

In addition, Canby Telephone Association and North Willamette Telecom of Canby, OR, local providers of telephone and TV services respectively, have launched a test of the PX system. It is being deployed in 40 homes for a one-year trial period to allow customers to receive their telephone service over the same cable that brings them their TV signals in addition to providing distance learning, medical link, energy management and meter reading services.

☛ Flight Trac Inc. has been selected again by both Time Warner Cable and Jones Intercable to be their exclusive nationwide provider of airborne signal leakage testing services. The new contracts cover 1993.

☛ Satellite AdNet chose Channelmatic's Adcart random access ad insertion equipment along with a CompEdit videotape compiling/editing system for an upgrade of its eight-system interconnect in the Wilkes-Barre/Scranton, PA, area.

☛ Playboy Entertainment Group set Jan. 1 for its official move to Hughes' Galaxy V, Transponder 2. The service will continue to use Satcom IV, Transponder 22 until Jan. 11 to ensure a smooth transition.

☛ American AML, specializing in AM/FM microwave equipment and full service field engineering, has opened new manufacturing facilities in San Diego. The firm also announced that Rolland Harrah has joined its staff.

☛ TeleCable signed a new contract with CableData under which the MSO will migrate to the DDP/SQL relational subscriber management system. The three-year contract covers TeleCable's 21 systems, serving over 700,000 subs. TeleCable also will upgrade to a RISC-based Tandem CLX 2000 under the agreement.

☛ Oak Communications changed its name to TV/COM International to highlight the company's emphasis on complete cable and satellite TV subscriber systems and international activities.

☛ Videoway subscribers will soon be able to listen to CD-quality music via a digital audio technology developed jointly with Digideck Inc. and the David Sarnoff Research Center. The technology is capable of providing more than 80 digital audio channels without using any additional bandwidth by transmitting in a "hidden way" a CD-quality channel within each video channel. In other news, Videoway was awarded the Roland-Major Prize for its multimedia subscriber terminal by the Regroupement québécois pour le sous-titrage (the Quebec Closed-Captioning Association). The prize is awarded to members of the TV industry that, through their research efforts, make closed-captioning available to more Quebec homes.

In other news ...

Production Products settles suit with LRC

MANLIUS, NY — Production Products Co. settled the patent infringement suit that it filed earlier this year against LRC Electronics, a unit of Augat Inc. The suit had charged that LRC's Multi-Fit F-connector infringed a patent issued to Production Products for its Universal F-connector.

LRC agreed to stop making and selling the Multi-Fit connectors. As well, LRC will pay an undisclosed sum of money to Production Products.

A similar patent infringement suit filed earlier this year by Production Products against Pyramid Connectors remains pending in U.S. district court for the Northern District of New York.

DirecTv demos compressed DBS

LOS ANGELES — Hughes Communications reported direct broadcast satellite service for American TV viewers took a significant step forward recently. DirecTv, a subsidiary of Hughes, announced achievement of a successful demonstration held in November of development hardware employing compressed digital signal processing technology via satellite. "Excellent" compressed digital video and "CD-quality" audio signals were successfully transmitted via Hughes Communications' SBS 6 satellite in a demonstration with Thomson Consumer Electronics held at the David Sarnoff Research Center in Princeton, NJ.

☛ Scientific-Atlanta has split its two top offices. Bill Johnson continues as CEO. James V. Napier, former president/CEO of Contel Corp., has been named chairman. S-A also announced a strategic business relationship with Motorola to develop the earth terminals for the Iridium global, digital satellite cellular project. (See "Correspondent's Report," *CT*, February 1992, page 74.)

☛ Pyramid Industries announced that Underwriters Laboratories Inc. listed Fire Flex plenum duct for fiber-optic cable in plenum spaces. According to the company, the lightweight nonmetallic duct is ideal for plenum and wire applications for added protection of fiber and ease of installation.

☛ David Castellini joined Focus Resources as president and CEO. Previously he was president, COO and a director of Channelmatic Inc.

Meet the modulator that's igniting a revolution in cable.

Future hybrid digital/analog transmission systems will require advanced, multi-purpose modulators. If you envision conventional fixed-channel modulators as the technology to take you into the 21st Century, you have obviously not seen the Standard TVM450S.

Join the revolution.

The TVM450S offers features and performance old-style technology cannot begin to match. The integration of a pre-calibrated CSG-60 BTSC stereo encoder eliminates the guesswork of setting audio performance standards to meet OET60 guidelines. Extremely stable RF circuitry and high quality video processing ensure compliance with NTC7 and FCC regulations. More importantly, in-band/out-of-band noise and spurious performance have impressed the most demanding cable TV engineers.

Talk to us. We'll demonstrate how the TVM450S can simplify integration, expansion, setup, operation and maintenance; how it can save time, money and rack space; how it can make adding stereo channels as easy as joining this revolution.

The army is growing.

More and more major MSOs have ordered — and re-ordered — the TVM450 series. To find out why they and others are switching to Standard, call our Revolution Hotline at 1-800-745-2445. We'll send you technical specs on the TVM450S, arrange a demonstration — or even your own demo unit.

The future is here.

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Vive la Révolution!

Sparkman recognized for Society support

At the Western Show, Tele-Communication Inc.'s J.C. Sparkman was recognized by the Society of Cable Television Engineers' Ron Hranac and Bill Riker, and the SCTE Rocky Mountain Chapter's Radiene Watson for his loyalty and support to the Society. Sparkman helped increase sagging chapter meeting attendance by writing a letter sent to system managers.

Can you meet new tech standards?

"Just do it," and "document, document, document" were themes repeated throughout the "Implementing the new technical standards" SCTE-sponsored technical session at the Western Show moderated by ONI's Chris Middelton.

Joe Mardesich of Comcast Corp. began by outlining the benefits of good maintenance that comes with routine testing, such as higher system performance. He urged attendees to use good engineering procedures and practices, document everything, and not to fight the process. He said the bottom line is that it's not all that painful, and it provides insurance of system performance. He estimated that the time required for testing would be three hours per test point, with a crew of two, plus one in the headend.

Scientific-Atlanta's John Sweeney discussed what engineers could do if technical performance falls short. First, determine exactly how you stand, then develop an plan of action to comply. To improve carrier-to-noise ratio, focus on the trunk; to comply, a partial trunk upgrade or cascade reduction should do the trick. To improve distortion, focus on the feeder plant; modify operating levels or do a trunk and/or feeder upgrade.

Jonathon Kramer of Communications Support Corp. revealed how to survive proof-of-performance testing and your franchising authority. Preparation should include a reviewing current rules and franchise obligations, carefully selecting the staff, performing a dry run and letting CSRs and the franchising authority know about the testing. If you find that your system won't pass, he suggests that you document plans to fix the problems and let your superiors and the franchising authority know of any problems. When the time to test arrives he said, "Begin early, expect a slow start, take your time and log everything at the time of testing." After testing, he said that a flash report should be issued to the boss, and that someone else should proof the proof.

Digital: Why the move?

Gratz Armstrong of Hewlett-Packard explained the basics of digital processing and outlined its advantages over analog at an SCTE tech session at the Western Show. Digital is better quality, increased capacity, improved security because the information is encoded, and additional services availability have all ensured digital's success.

The fundamental difference between analog and digital modulation formats was highlighted, as well as A/D conversion and pulse code modulation. In addition, I/Q for analog modulation, bi-phase shift keying, quadrature phase shift keying, I and Q signals, eye diagrams and constellations, 16 QAM, bit error rate, amplitude slope across the channel, overdrive of TWT and multipath propagation were all covered.

Near future is digital compression

Digital compression as a just-around-the corner widely spread technology was expounded on in the "Bandwidth management and digital compression" SCTE-sponsored tech session at the Western Show. Panelists considered the types and uses of digital transmission on broadband systems including various architectures to support regional headend/hub loops, digital video transport, telecommuting services and compressed storage and retrieval of video for advertising sales applications.

Tom Elliott of Catel Telecommunications moderated and introduced the first speaker, Carl McGrath of AT&T Bell Labs. He considered what the desired features at the transport interface would be: variable bit rate; high throughput efficiency; support simplified combining process; complexity defined by applications, not transport; asynchronous feedforward timing; and identical format for wide range of transmission media.

Ed Moura of Hybrid Networks considered "the hybrid way" of digital transmission on cable TV. This included the fact that no changes would be needed in cable infrastructure and any channel is fine for channel assignment. As well, he reported it is inexpensive.

The next generation of bandwidth management was discussed by Roger Hay of CableLabs who covered for his colleague Stephen Dukes. His comments included information on interactivity, switching/multiplexing, control/synchronization, traffic/contention, spectrum availability and compression.

What happened in tech re-reg negotiations?

With the first proof-of-performance tests required by the FCC looming close, attendees packed the "FCC/Washington update" session sponsored by the SCTE at the Western Show.

SCTE President Bill Riker moderated the session, which was kicked off by the National Cable Television Association's Wendell Bailey. He was involved in negotiations and the petition for reconsideration with the FCC regarding technical re-reg issues. As for the recent acceptance of the petition for reconsideration with the FCC, Bailey said the measuring in-band frequency response with converters ruling now allows operators seven years to comply. Also, the number of test points is now based on the number of subscribers in the system.

Communications Support Corp.'s Jonathon Kramer also worked on the tech standards on the cable re-reg bill. He said negotiations turned out to be "a very good deal for both sides after reconsideration." But he cautioned, "There's a real rough time coming up. The first round of proof-of-performance tests will be scary for some operators."

Jan. 30, 1993, is the deadline for cable operators to have their first proofs to the FCC. Steve Ross of Ross & Hardies (who represented the endearingly dubbed "engineers from hell" during tech re-reg negotiations with the FCC) said the January date may not exactly be set in stone, but ops should do their very best to meet the deadline.

How to select fiber-optic test equipment

By Dennis Horwitz
Vice President, Sales and Marketing
RIFOCS Corp.

This selection guide will survey the five most important types of optical test sets used in characterizing fiber-optic systems in field applications:

• *Optical power meters (OPMs)* are used to measure optical power or optical power loss over a fiber-optic path. The measurement of optical power is the most fundamental measurement in fiber systems. The OPM is the workhorse of fiber measurements, much like the digital multimeter of electronics. Every fiber technician should have one! An OPM can assess the performance of the optical terminal equipment by measuring the absolute power being injected into or emerging from the fiber network. When an OPM is used together with a stabilized light source, the combination can measure link loss to verify continuity and help assess the quality of the transmission path through the optical fiber.

• *Stabilized light sources (SLSs)* launch light of known power and wavelength into the optical system. An SLS is used along with a power meter to measure the optical loss of a fiber system. If the system is already installed, you can often use the system transmitter (XMTR) as the SLS. Only when the system XMTR is inaccessible is a separate SLS required. The wavelength of the SLS should match as well as possible the wavelength of the system XMTR. Frequent measuring of end-to-end loss of a system after installation is necessary to determine if the link loss — including connector, splice and fiber losses — meet the design specification.

• *Optical loss test sets (OLTSs)* are used to measure optical power loss over a fiber-optic path. There are the following two types of OLTSs: 1) component equipment comprised of separately packaged OPM and SLS instruments, and 2) integrated test sets that combine the OPM and SLS into one unit. With short LAN spans within walking and talking distance of the ends, the technicians at either end can successfully utilize the economy of a single component OLTS with the SLS on one end and the OPM at the other end. For long distance networks, technicians should each be equipped with complete component or integrated OLTS configurations.

• *Variable optical attenuators (VOAs)* are used to simulate system losses in order to measure system margin, receiver operating range and receiver linearity. System margin is the difference between the actual received power vs. the minimum received power level needed to operate reliability. Performance reliability is usually characterized as bit error rate (BER) in digital systems when it is necessary to characterize the system performance under various conditions. BER is expressed in number of failures per bit. A typical error rate of 10^{-9} means that one bit out of 100 million may be received wrong.

"Temperature is probably the most stringent criteria when selecting an instrument ... Bellcore recommends that field portable equipment should operate over a range of -18°C (uncontrolled humidity) to 50°C (95% humidity)."

• *Optical time domain reflectometers (OTDRs)* and *fault locators* are used to characterize fiber loss as a function of distance. With an OTDR, the technician can profile discrete components of the entire system, identifying and measuring fiber spans, splices and connectors. OTDRs are the most sophisticated as well as most expensive instruments of the fiber troubleshooting equipment. Loss measurements can be made with access to only one end of the fiber unlike two ends required by OPMs and OLTSs. An OTDR trace shows the fiber attenuation for the system and the location and magnitude of any losses from connectors, splices, fiber anomalies or fiber discontinuities. OTDRs can be used for the following three applications: 1) to characterize (length and attenuation) a cable before placement; 2) to obtain a signature trace of the fiber span; and 3) to locate catastrophic failure points when trouble arises and the link goes down. A fault locator is a specialized version of an OTDR that attempts to automatically find fiber faults in a fiber link without the user having to learn the complexities of OTDR operation.

The selection process

We will approach the selection process by defining the following four steps that will always lead to the most informed buying decision:

1) Identify your system parameters.
2) Specify your operating environment.
3) Compare performance factors.
4) Instrument maintenance.

Identify your system parameters

This step involves the following:

• *Operating wavelength(s) ex-*

pressed in nm. The three major transmission windows are nominally 850 nm, 1,300 nm and 1,550 nm.

- *Source type (LED or laser).* Most low-speed LANs (≤100 Mb/s) use LED sources for their economy and usefulness for short-haul applications. Most high-speed digital and analog AM systems use laser sources to extend the signal over long distances.
- *Fiber type (SM/MM) and core/cladding diameter (in µm units).* Standard single-mode (SM) fiber is 9/125 µm, although other specialty SM fibers exist and should be properly identified. Typical multimode (MM) fiber sizes include 50/125, 62.5/125/100/140 and 200/230.
- *Connector(s) used (number of connectors and types).* Popular connectors include Biconic, D4, FC-APC, FC-PC, FDDI, SC, SMA, ST, DIN, HP and Diamond.
- *Maximum loss in the link to be expected.*
- *Loss budget/system margin.*

Specify the operating environment

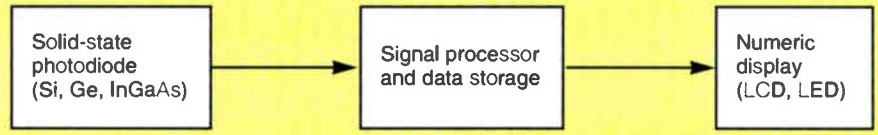
Temperature is probably the most stringent criteria when selecting an instrument whereas packaging style, looks, etc., may be more subjective to the buyer/user. Often, field measurements have to be performed under severe environmental conditions. Bellcore recommends that field portable equipment should operate over a range of -18°C (uncontrolled humidity) to 50°C (95% humidity), as well as storage conditions down to -40°C (uncontrolled humidity) and up to +60°C (95% humidity). Laboratory instrumentation need only be specified over a narrower, controlled range of 5-50°C.

Unlike laboratory instrumentation requiring AC line operation, the power requirements of competitive field portable instruments can be quite diverse and have a direct impact on overall work efficiency. The user should consider the following criteria and the potential tradeoffs:

1) The internal battery pack should be easily accessible and removable for replacement.

2) The minimum service life should be 10 hours (equal to one extended work shift) either on a full charge or new batteries. However, the objective should be 40-50 hours to allow for optimum operating efficiency of both technician and instrument over an entire week.

Figure 1: Block diagram of the OPM



OPM selection criteria

Operating wavelengths	Optimum detector choice(s)
850 nm only	Silicon (Si)
850 and 1,300 nm only	Germanium (Ge) and InGaAs
1,300 and 1,550 nm only	InGaAs
850, 1,300 and 1,550 nm	InGaAs

3) Use of popular battery cell styles, such as the common 9V transistor and 1.5V AA, C and D cells. These are easy to obtain from local sources on a moment's notice (even from a local convenience store).

4) Standard disposable batteries are preferred over rechargeable types (i.e., lead-acid and NiCad types). The latter have become less desirable because of their nonstandard packages, general lack of availability, "memory" problems that plague their ability to hold a full charge, and emerging environmental public policy requiring users to implement special handling and disposal procedures.

A few years ago, finding portable test equipment that could meet all four objectives was virtually impossible. Today, state-of-the-art OPMs with the most modern CMOS circuitry can operate over 100 hours on just two common AA alkaline cells available from the neighborhood convenience store. In addition, some laboratory models offer dual-power capability (both AC line and internal battery operation) for increased flexibility.

Fiber-optic instruments also are available in a variety of packaging styles. Hand-held devices usually are under 3 pounds and offer essential features and performance without many frills. Semiportable "luggable" units (under 3 pounds) usually offer more sophisticated features and extended performance. Lab packaging is designed for controlled laboratory/production environments where AC line operation always is accessible.

Compare performance factors

This is the third step in the selection process. It involves detailed analysis of each of the optical test set types.

Optical power meters

Optical power measurements are a vital part of the manufacture, installation, operation and maintenance of any fiber-optic transmission system. No engineering lab, production floor, telephone or CATV maintenance facility in the fiber-optics field can operate without power meters. To give a few examples, optical power meters are used to measure optical power of lasers and LEDs. They also are used for the verification of the power budget of optical fiber links. Most important of all, the power meter is the key instrument in the characterization and performance test of components (fiber, connectors, splices, attenuators, etc.).

In selecting the appropriate OPM for a given application, the potential user should focus on the following attributes:

1) Select optimum detector type and interface.

2) Evaluate calibration accuracy and manufacturer's calibration procedure for suitability to your range of fiber and connector requirements.

3) Identify models with suitable measurement range and display resolution.

4) Need for dB function for direct insertion loss measurements.

The optical detector is the most critical element of the optical power meter by which almost all performance issues are derived. The optical detector is a solid-state photodiode that receives light coupled in from the fiber network and converts it to an electrical signal. Input to the detector can be a dedicated interface that can accept only one connector type, or a universal interface that via screw-on adapters can accept a wide range of industry-standard connectors. The OPM circuitry translates the detector output signal, applies a calibration factor based on the selected calibration wavelength, and displays the optical power on a digital readout in dBm units (absolute dB referenced to 1 mW — i.e., 0 dBm = 1 mW). Figure 1 is a block diagram of the OPM.

(Continued on page 40)

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When your technicians are under pressure to restore service, the one thing they don't need is a fiber that's difficult to work with.

They need a fiber that will help them get the job done as quickly and efficiently as possible. The fiber that fits that description: Corning™ fiber.

It's easy to work with and splice because of its excellent geometry, and because it's consistent—reel after reel, year after year. And it's consistent because we're very, very nit-picky. So much so that, during manufacturing for example, we measure our fiber diameter 500 times per second to within a fraction of a micron. (You don't get more nit-picky than that.)

What's more, we're constantly looking for new ways to improve our fiber. We twist, bend, snap and otherwise torture fiber, testing it in our harsh environments so it'll measure up in yours.

We'd also like to help technicians by helping them share what they've learned about handling fiber. If you or any of your people would like to let us know of an unusual or especially tough fiber-handling challenge (and its solution, if you have one), we'll spread the word.

Make your people's jobs easier by making sure they work with Corning fiber. The fiber designed to be as hassle-free as possible—no matter how tough the job might be.

For more information (or to share your real-life fiber experiences) write to Corning Incorporated, Opto-Electronics Group, MP-RO-03, Corning, N.Y. 14831, or call (800) 525-2524, extension 501.

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Reader Service Number 15

Fiber protective coating design for evolving telecom applications

The following is adapted from a presentation given at the last International Wire and Cable Symposium held in Reno, Nev.

By Harish C. Chandan
Member of Technical Staff
James R. Petisce
Member of Technical Staff, Materials Engineering Department
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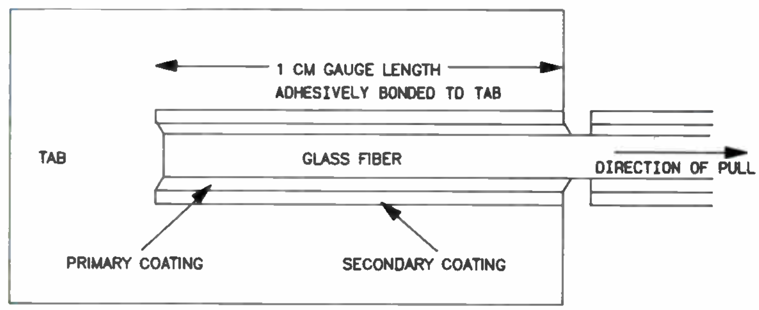
Supervisor, Plastics Applied Research Properties and Processing Group
Daryl Inniss
Member of Technical Staff, Optical Fiber Research Department
And Lloyd Shepherd
Supervisor, Plastics Chemistry Research and Engineering Group
AT&T Bell Laboratories

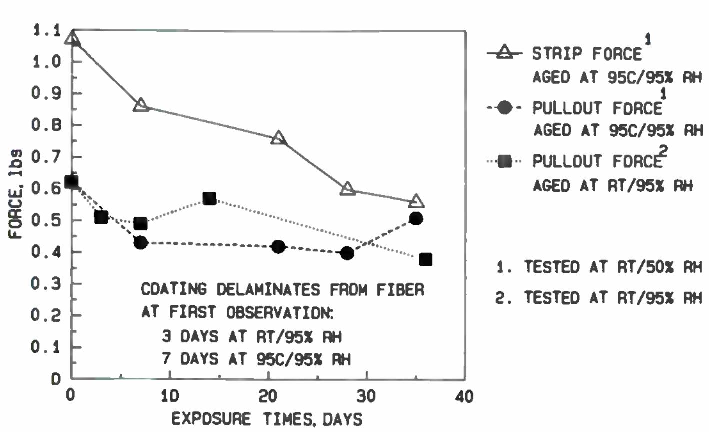
Figure 1: Schematic of coating adhesion test



Today's evolving telecommunication and CATV applications for optical fibers are demanding higher performance in handling properties and reliability. The performance requirements for UV-cured acrylate coating systems have become more stringent since the late 1970s when these coating materials were introduced into optical fiber manufacture. Initial design requirements for UV cured optical fiber coatings focused on low temperature transmission loss[1] and fiber strength.[2] The late 1980s presented special end-use applications of optical fiber such as fiber-optic guided missiles and high temperature resistant aircraft cables, which expanded or exceeded the performance limits of UV-cured acrylate coatings.[3]

In 1988, many of the first fiber-to-the-subscriber (FTTS) applications for several telephone companies occurred.[4] Coatings on optical fiber utilized in FTTS applications can undergo oxidative degradation due to high temperature exposure[5] or hydrolytic degradation due to simultaneous exposure to high temperature and high humidity.[6] Other applications of optical fiber that have been evolving in the 1990s include cable TV and long distance aerial installations, which can expose optical fiber coatings to the same degradation mechanisms encountered in FTTS installations. The greater likelihood of more frequent handling of the coated optical fiber in the previous applications prompted us to generate a technology platform containing a thorough understanding of the critical coating properties that can affect fiber handling in the field. This paper presents data and its interpretation related to the following critical coating properties: 1) strippability, 2) fiber strength retention, 3) solvent/solution resistance, and 4) aging/reliability. Some coating characterization tools previously developed have been utilized in this work.[7]

Figure 2: Pullout and strip force of coating D

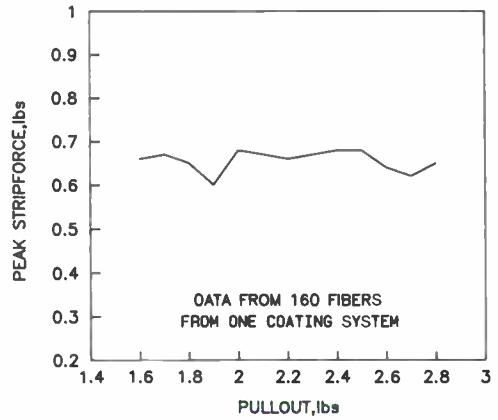


Strippability

In the evolving applications for optical fibers the ability to cleanly remove the coating from the glass for splicing and connectorization is critical. In order to provide a coating that can be removed with low force and will not leave residues that can interfere with splicing and connectorization, it is necessary to understand the coating properties that affect strippability. To clearly understand these effects, it is first necessary to distinguish between coating adhesion and coating strippability.

A method of measuring adhesion of coatings to glass fiber[8] has been employed and is illustrated in Figure 1. A 1 cm gauge length of coated fiber is bonded to a rigid tab (glass slide, hard cardboard, etc.) using a rigid adhesive (i.e., cyanoacrylate). The fiber is not encapsulated by the adhesive. The coating is then severed at the edge of the tab. The sample is mounted in an Instron and the force required to pull the glass from the coating is measured. The sample fails in shear on the primary coating/glass interface and represents an adhesive failure at that interface. The method for measuring strip force for optical fibers is defined by EIA-FOTP-178. The need to distinguish strip force from adhesion is shown in Figure 2 where a fiber with a very high strip force (>1 pound) has a low pullout force and in fact delaminates when exposed to high humidity, even at room temperature. Even after the fiber coating is delaminated from the glass, the strip force remains relatively high. As a further illustration (Figure 3), a study of 160 fibers of widely varying adhesion as measured by pullout force showed essentially no variation in strip force.

Figure 3: Strippability vs. pullout — commercial optical fiber



With this background, the effect of coating properties on strippability can now be examined. Figure 4 shows the failure mode of three different coatings during strip force testing. In Case 1 the coating shreds away from the fiber as the sample is stripped, resulting in a low, uniform strip force. In Case 2 the coating tends to "accordion," creating a high strip force followed by a cracking of the coating and a drop in strip force. This alternate behavior between the accordion and "shredding" modes continues, resulting in a jagged force/time curve until the coating comes off. In Case 3 the coating accordions over the whole length, resulting in a low force followed by an increasing level of force as the coating is stripped.

The relative behavior of these three coatings is determined by the behavior of the high modulus secondary coating with only minor contributions from the low modulus primary. An example of the dominant behavior of the secondary coating is shown in Figure 5. Two different secondary coatings were used with the same primary coating to prepare fibers. Secondary coating 2 had a lower elongation (11%) than secondary coating 1 (33%). Adhesion (pullout force) and strip force were measured over a range of cures. While both coating systems showed the same adhesion behavior, as measured by pullout, a 50% reduction in the force required to strip the coating was observed for the lower elongation secondary.

One other aspect of strippability of fibers is the presence of coating residues on the glass after stripping. These residues, if they persist after the usual alcohol wipe, can interfere with mass fusion splicing or with insertion of the fiber into the precision ferrules used in many splices and connectors. To evaluate this behavior, precision ferrules can be used to detect the presence of residues by fiber insertion following coating removal that includes an alcohol wipe. In general, few problems have been found in evaluation of most commercially available fibers as manufactured. This is demonstrated in Figures 6 and 7 (page 22), which show microscope photographs of unaged fibers and fiber ribbons following stripping of the coating and alcohol cleaning, respectively. Coating residues are present in all cases after stripping. For the fibers, the residues are gone after alcohol wiping. For the ribbons, some evidence of residue after alcohol wiping is seen. This can be caused by wiping multiple fibers at one time, leaving residues in the difficult-to-reach area between the fibers. Continued wiping results in complete residue re-

Table 1: Experimental primary/secondary coatings

Fiber code	Primary/secondary formulations	Primary adhesion promoter	Potentially corrosive ingredient
W	Base polymers	#1	No
X	Base polymers	#2	No
Y	Base polymers	#1	Yes
Z	Base polymers	#2	Yes

Figure 4: Strip force traces for various coatings

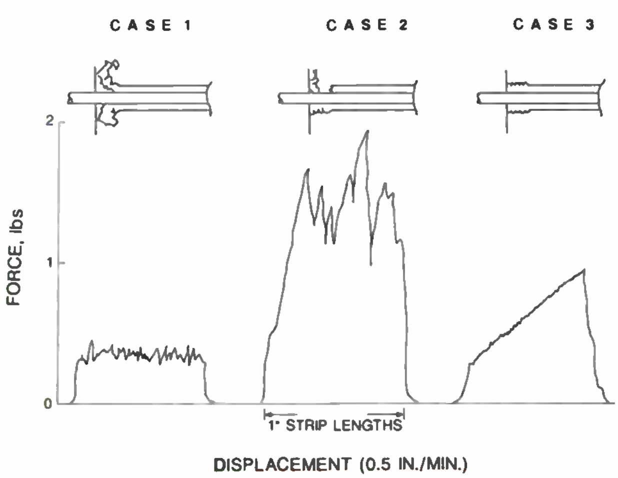
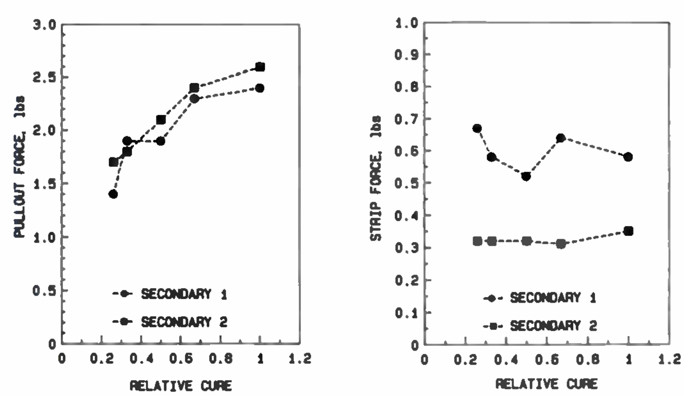
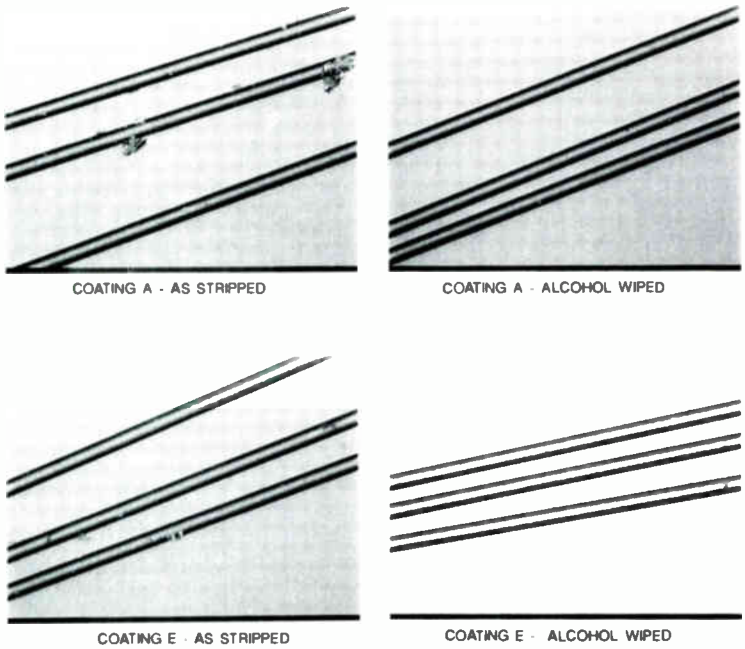


Figure 5: Comparison of pullout and strip force using two different secondary coatings over the same primary coating



moval. This result points out the necessity for careful fiber cleaning in all cases but particularly when using ribbons, since any residues may interfere in fiber alignment during mass fusion splicing.

Figure 6: Stripping residues — unaged fibers

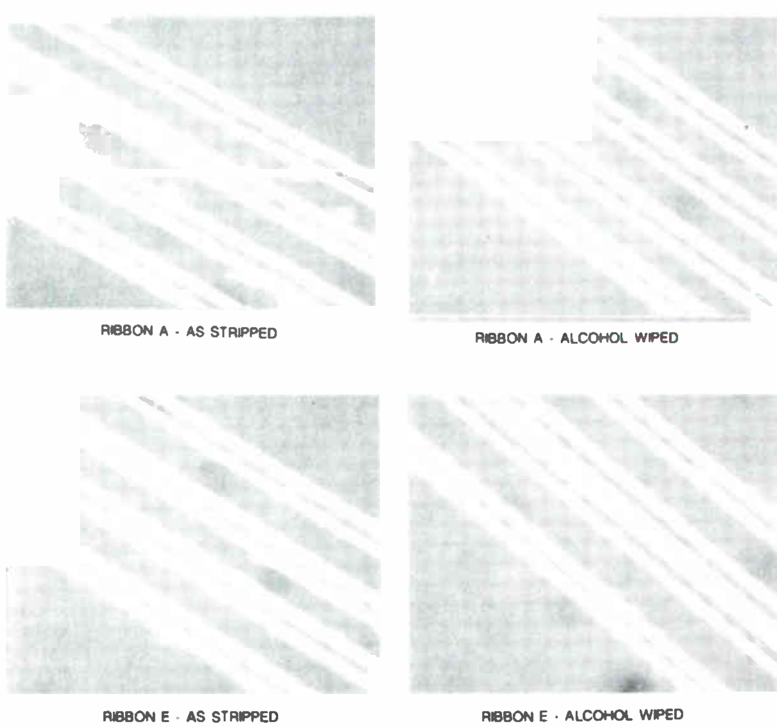


Fiber strength retention

A basic requirement for the reliability of any fiber installation is to maintain uninterrupted low loss transmission. Since glass can weaken over time due to flaw growth under stress, considerable engineering effort has gone into characterizing the static fatigue behavior of glass and controlling the stress levels applied to the glass fibers in cables and installations. FTTS and CATV applications have created additional concerns about fiber reliability due to increased environmental exposure, potential stress conditions, and handling. Recently, considerable attention has been focused on the profound influence coatings can have on fiber strength retention in elevated temperature/humidity environments. Yuce, et al,[9,10] have reported results on two coated fibers, one of which caused significant corrosion of the glass surface to produce a surface roughness (as measured by atomic force microscopy, AFM) that was shown to correlate with a strength reduction. Similarly, Kennedy, et al,[11] compared three commercially available fibers and also showed that strength degradation was accompanied by increased surface roughness. Evidence presented by Inniss, et al,[12] suggests that coating ingredients or contaminants that produce either a basic environment (e.g., a Lewis base that interacts with water to produce hydroxyl ions) or ionic environment can corrode the glass surface to produce surface roughness and a strength reduction.

We have examined the effects of a small amount of a potentially corrosive component in base polymer primary/secondary coating formulations and have results on the role that coating to glass adhesion plays in retarding corrosion/strength reduction. The primary/secondary formulations used to make fiber are listed in Table 1 (page 21).

Figure 7: Fiber ribbon stripping



The different adhesion promoters used in the primary coating both give adequate adhesion under ambient conditions but adhesion promoter #1 maintains a high quality coating/glass interface under elevated temperature/high humidity conditions whereas adhesion promoter #2 shows a substantial degradation of the interface at elevated temperature/high humidity. This is shown by the microscope photographs of the coating/glass interface in Figure 8 (page 50). For adhesion promoter #2, the pullout level is maintained but the quality of the interface degrades, giving a multitude of microscopic pockets where moisture and corrosive materials can concentrate. Adhesion promoter #1, on the other hand, maintains the integrity of the interface even under more severe aging conditions. To evaluate the effects of adhesion promoters and corrosive materials, strength tests were carried out on fibers aged at 85°C/85% RH according to EIA/TIA-455-28B using a gauge length of 50 cm and a strain rate of 2.5%/minute. The benefits of a high quality coating-glass interface are shown in Figure 9 (page 50) where the strength after aging at 85°C in 85% RH is reduced only slightly for fiber W with adhesion promoter #1, whereas fiber X with adhesion promoter #2 shows approximately 15% reduction. The benefits of the high quality coating/glass interface

(Continued on page 50)

Reader Service Number 16

Why reinvent the wheel for technical service improvement?

By Jim Cunningham
Metro State Engineer
TCI East
And Christopher Moores
Technical Service Supervisor
TCI Cablevision, New Castle, DE

During 1988 and 1989, the Wilmington, DE, system (then owned by Heritage Cablevision) was undergoing extreme pressure regarding its ability to provide meaningful, timely and credible technical service to its customers. The system was in the final throws of completing an entire system rebuild. Channel capacity was being increased from 24 to 52 channels. This activity, coupled with poor overall (technical) customer service provided a great amount of confusion, disorientation and anger for many customers.

The culmination of all of this accounted for 282,649 customer phone contacts in a year in regard to service-related problems. This was more than twice the total number of customers in the system. It also manifested itself in a report rate of nine problems per 100 customers. The abandonment rate experienced by customers who were attempting to contact the company by phone for technical service reasons was 22%.

The plan

It didn't take a rocket scientist to determine that a plan needed to be developed that would provide the following:

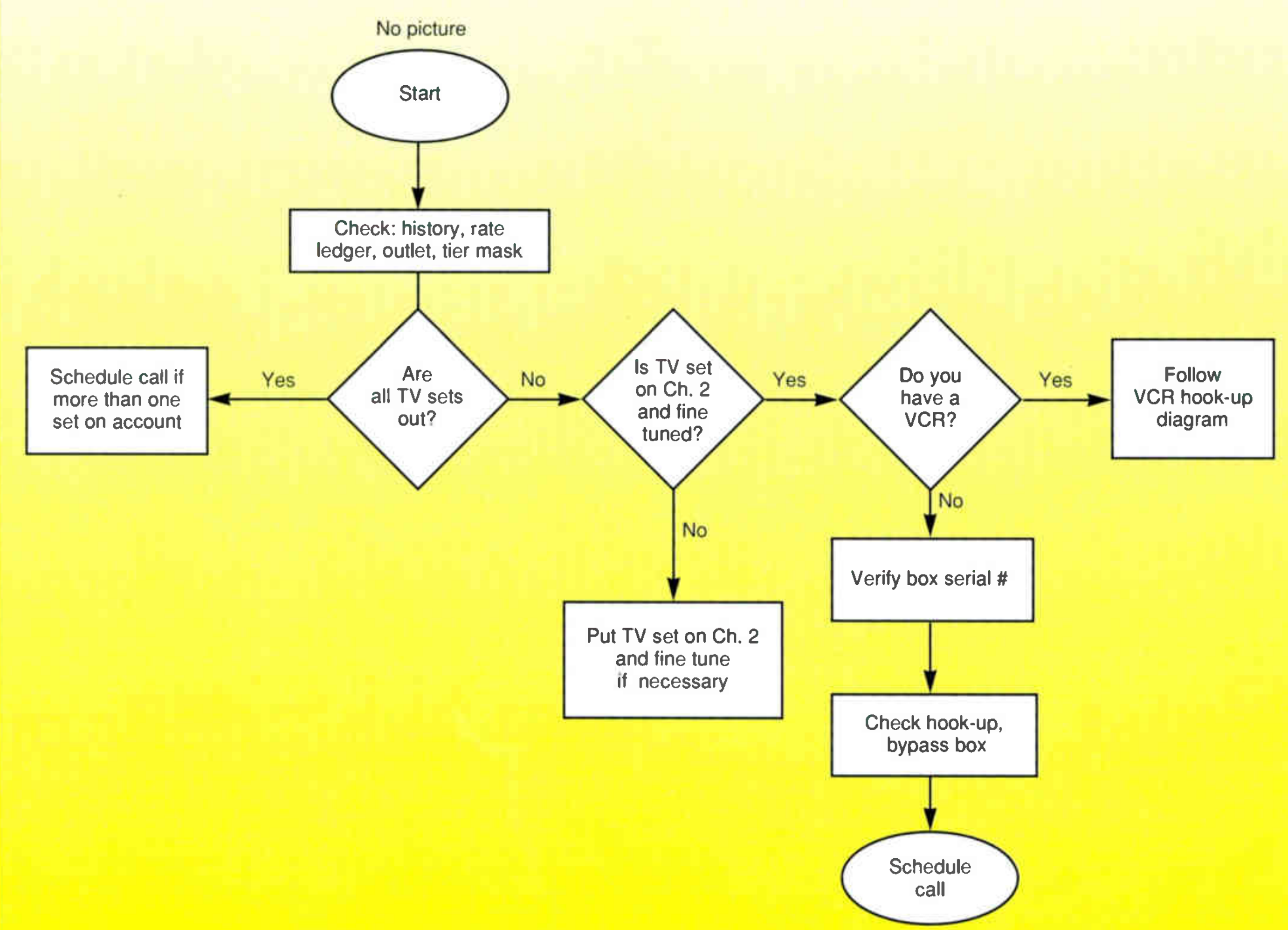
1) Improved responsiveness to customer service inquiries.

2) Service 24-hours a day, seven days a week.

3) The ability to solve the customer's problem over the phone if possible.

4) The capability of assuming the responsibility for over-

Figure 1: Customer service representative decision tree



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all improved technical operations within the company.

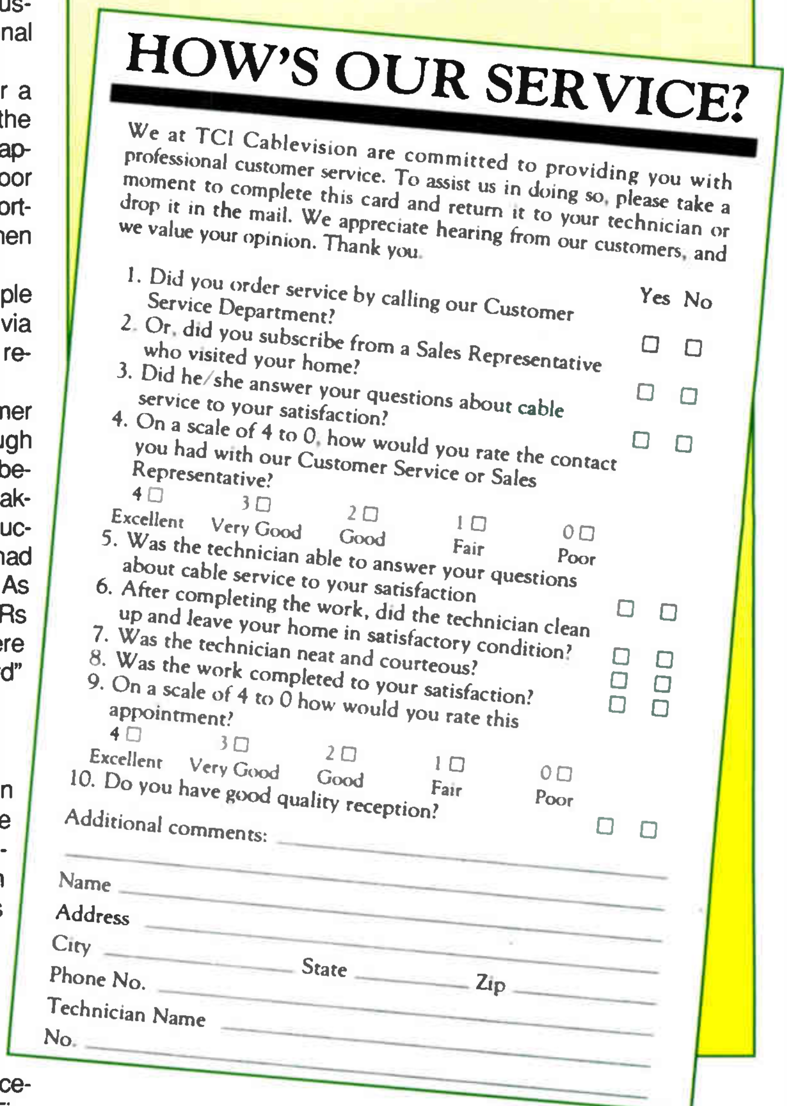
After much troublesome and agonizing "gut wrenching," a group was born that separated itself from the traditional customer service responsibilities. Its goal was to develop functional service problem reporting methods.

Phone personnel were scheduled allowing for a 24-hour a day operation, seven days a week. The customers within the system were advised via letter and various advertisements appearing on system barker channels, newspapers and outdoor advertisement that their service problems should now be reported at a separate number. Our slogan became: "No matter when you're watching TV — We're watching the phones."

Staff was chosen and training began. The group of people whose responsibility it was to answer customers' inquiries via phone had specialized training. This enabled them to resolve repair questions over the phone many times.

Figure 1 shows an algorithm (decision tree) that the customer service representative (CSR) would work his or her way through to determine if a truck roll was necessary. These CSRs also became the nerve center of all field activity (i.e., cumulative leakage index, multiple dwelling units, audits, installs and construction). Given this information on all system activity, they now had the ability to provide meaningful information to the customer. As an example, if a trunk line was to be taken down, these CSRs were notified beforehand. If outages of a particular variety were being encountered, it would be posted on a large "white board" for all to see.

Figure 2



HOW'S OUR SERVICE?

We at TCI Cablevision are committed to providing you with professional customer service. To assist us in doing so, please take a moment to complete this card and return it to your technician or drop it in the mail. We appreciate hearing from our customers, and we value your opinion. Thank you.

	Yes	No
1. Did you order service by calling our Customer Service Department?	☐	☐
2. Or, did you subscribe from a Sales Representative who visited your home?	☐	☐
3. Did he/she answer your questions about cable service to your satisfaction?	☐	☐
4. On a scale of 4 to 0, how would you rate the contact you had with our Customer Service or Sales Representative? 4 ☐ Excellent 3 ☐ Very Good 2 ☐ Good 1 ☐ Fair 0 ☐ Poor		
5. Was the technician able to answer your questions about cable service to your satisfaction	☐	☐
6. After completing the work, did the technician clean up and leave your home in satisfactory condition?	☐	☐
7. Was the technician neat and courteous?	☐	☐
8. Was the work completed to your satisfaction?	☐	☐
9. On a scale of 4 to 0 how would you rate this appointment? 4 ☐ Excellent 3 ☐ Very Good 2 ☐ Good 1 ☐ Fair 0 ☐ Poor		
10. Do you have good quality reception?	☐	☐

Additional comments: ____________________

Name ____________________

Address ____________________

City ____________ State ________ Zip ________

Phone No. ____________________

Technician Name ____________________

No. ____________________

Training

The goal of training was to have all information available "in the mind" or "at the fingertips" of the CSR. The group would be able to provide uniform answers to the same questions regardless of which customer was inquiring. Various uniform "verbiage responses" were authored such that all responses seemed to parrot each other.

All this information was incorporated into a universal technical operations manual, which became the bible. The manual contained verbiage that might be used when responding to questions regarding a rebuild, what the schedule was for each area of the county, VCR hookups, outage escalation procedures, etc. It also had the necessary algorithms (as shown in Figure 1) for troubleshooting and common types of repair requests.

Along with written materials, the group went into the field and performed installation and service calls with the various departments. This provided the CSR with overall hands-on experience for the problems that they were attempting to troubleshoot. They were able to attain the respect of both the customer and the field technician.

Classroom training was conducted to give each of the representatives a thorough understanding of cable TV. This program was conducted through Delaware Technical Community College. At this time, the CSRs were given basic instruction in the theories of electricity and cable. This was reinforced with field work and lab exercises conducted at the college.

The knowledgeable customer

As things progressed, it was found that a great deal of inquiries to the CSRs were simply for basic information. Many of the incoming calls usually required only a very simple explanation or a yes or no answer. This observation led to a campaign to educate the customer.

Infomercials were developed to explain such things as VCR hookups, ordering pay-per-view (PPV), sun outages and various other forms of technical information. Frequently, the only thing a customer wanted to know was what was going on and why it was happening.

Results

It became necessary to get a "report card" from the customer (Figure 2). Every customer who had a recent visit from either an installation technician or a service technician was called in order to evaluate service. For this to be most effective, the contact had to be made within 24 hours of the visit. Customers would be asked five basic questions (all of which were formatted to illicit a positive response). If a negative response occurred, a field service technician or installation technician, as appropriate, was dispatched either immediately (if available) or at the customers' convenience. The rating scale was from 1 (poor) to 5 (excellent) and negative comments by customers were forwarded to the plant manager for resolution the following morning. This allowed a real-time, hands-on measurement technique.

The program was highly flexible. When problems were identified, they were recognized quickly and solutions were determined to help rectify customer service issues. The overall technical quality improvement during the life of this program has

(Continued on page 66)

Competitive access: A new market for cable providers

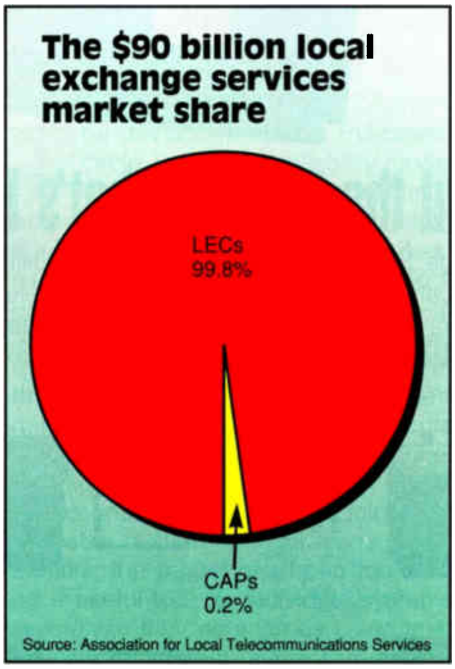
By George Lawton

The Federal Communications Commission has been rewriting the rules of the communications industry to bring telephone companies into the video business — and cable companies into the telephone business. Shortly after opening video dialtone opportunities up to the telcos last July, the FCC ruled that local exchange carriers are required to interconnect with whoever demands it, for special access telephone services.

Mark Lowenstein, an analyst with Boston-based The Yankee Group, estimates that 60% of all competitive access providers (CAPs) are either owned by or otherwise connected with cable TV companies. The largest single player in this new arena is Teleport Communication, owned jointly by two cable TV powerhouses, Cox Enterprises and Tele-Communications Inc. Some see this as a trend that could eventually open full blown competition across the local exchange market — worth $90 billion in 1991.

Lowenstein estimates that 32 cities had at least one CAP last February. By the end of 1993, he expects that nearly all of the top 50 metropolitan service areas (MSAs), plus a handful of areas outside this tier will have an alternative to the local exchange carrier (LEC).

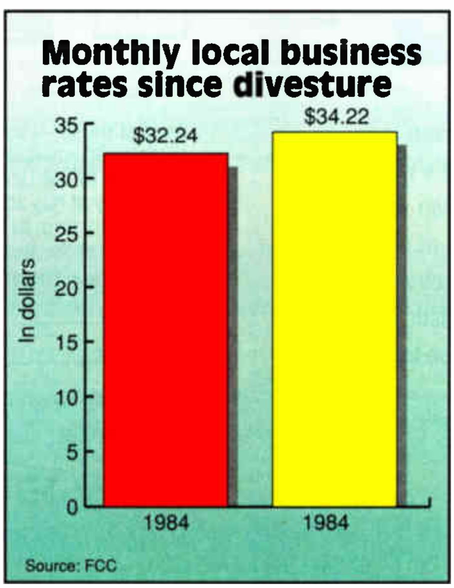
The Yankee Group has estimated that revenues from CAPs were $140 million in 1991 up from $100 million from a year earlier. The recent ruling by the FCC, requiring LECs to interconnect their networks with CAPs for special access services, has opened up competition to a market worth half a billion dollars by FCC estimates. Other proposals on the burner, for interconnection of switched access services, could open a $6.7 billion market by the end of this year.



Competition cuts costs, improves service

In 1913 the basic telecommunication network based on co-monopoly was established by the U.S. government in what was called the Kingsbury Commitment. This established the Bell System and the independent local exchange carriers as exclusive monopolies and established a basic telecommunication infrastructure through interconnection agreements between AT&T, the Bell System and independent operators.

Fifty-five years later, in what was called the "Carterphone" decision handed out in 1968, the FCC began the process of bringing competition into the telecom industry by forcing the Bells to allow non-Bell equipment to connect to the public network. However, the Bells still held a vast majority of the strings of power, being the primary consumer of telecommunications gear.



In 1971 the FCC began to allow interexchange carriers (IXCs), like MCI, to establish competitive long distance networks for providing specialized private line services. However, this opened only a fraction of the total market for competition, leaving virtually all of the long distance revenues in the hands of AT&T. In 1978, the federal courts forced the Bell companies to interconnect to the IXCs in what was known as the "Execunet" decision.

Even with this ruling, it left the strings of control within the hands of the Bell Operating Companies. Judge Harold Greene, who heard the case, observed that in most cases market power is a function of a company's size and sheer strength. The regional bell operating companies (RBOCs) power is in their almost complete domination of the last mile of the telephone network.

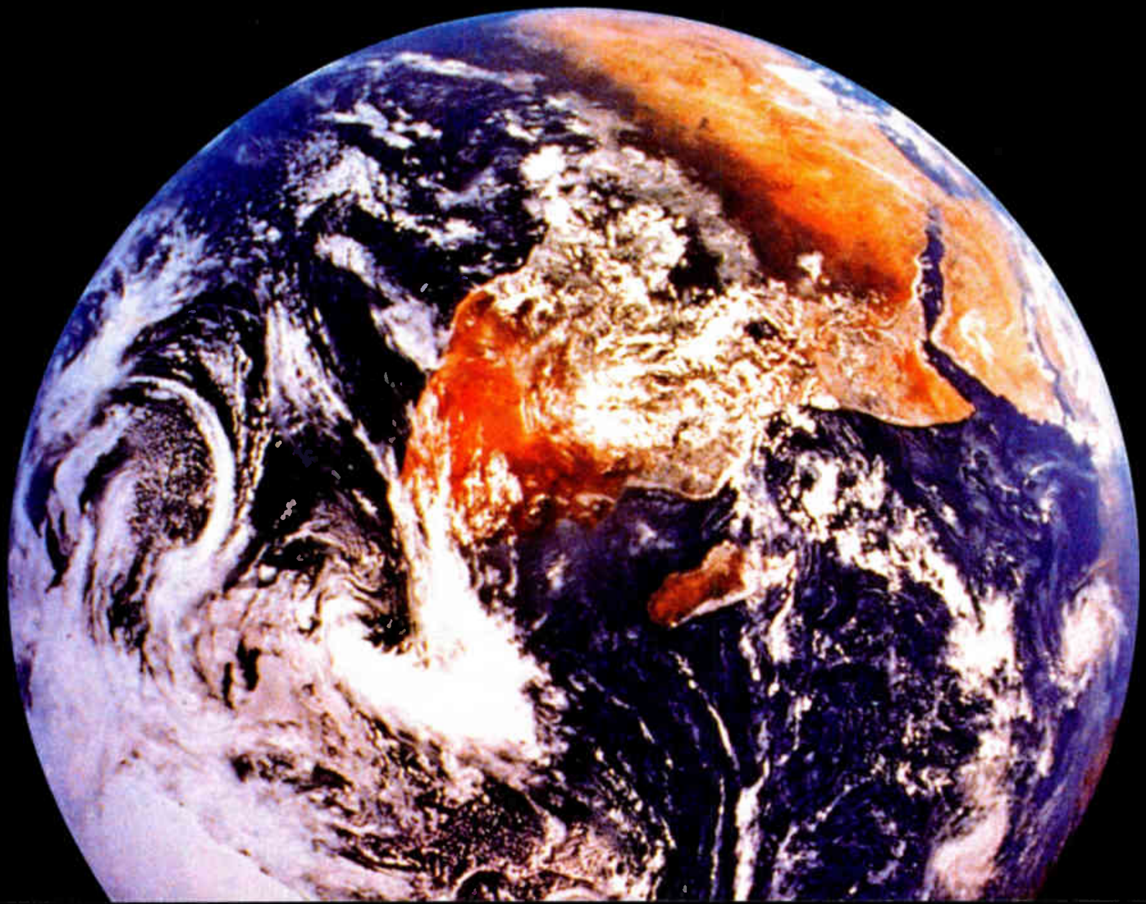
Greene finally forced the whole Bell complex to divest itself into the collection of regional holding companies as we know them today. This decision completely rewrote the rules of the telecom game, reducing the cross-subsidization that skewed the tariffs of various services out of line with what they cost to maintain. In the eight years after this decision, long distance rates have gone down as much as 55%, while local loop tariffs have increased by an average of 5% according to FCC statistics.

Many believe that if the LECs are forced to fully interconnect with CAPs, the effect on rates will be just as dramatic. When Metropolitan Fiber Systems (MFS), the second largest CAP, and Teleport announced that they were going to install networks in California three years ago, Pacific Bell cut rates on T1 interconnection lines by 30% across the state.

Rick Kozak, senior vice president for development at MFS said, "I think this is equivalent to MCI opening up the long distance market." By putting the LECs up for competition, the FCC could be forcing the LECs to expand

(Continued on page 67)

THE WORLD IS CHANGING.

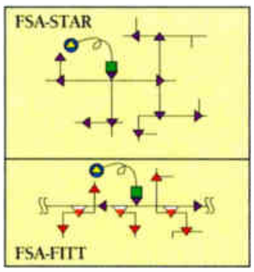


CHANGE WITH IT...

RESPOND TO

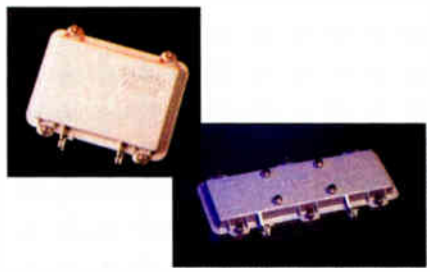
- Increased competition from all directions
- The 1992 Cable Act and FCC regulations
- New market and revenue stream opportunities
- Complicated franchise renewals

THE STRATEGY



Fiber -to -Service Area (FSA) Architectures

Series 60 Optoelectronics



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Dollar Smart - The System Amp II provides for the options necessary for future service applications and minimizes overhead costs by sharing common modules and accessories with other Scientific-Atlanta products.

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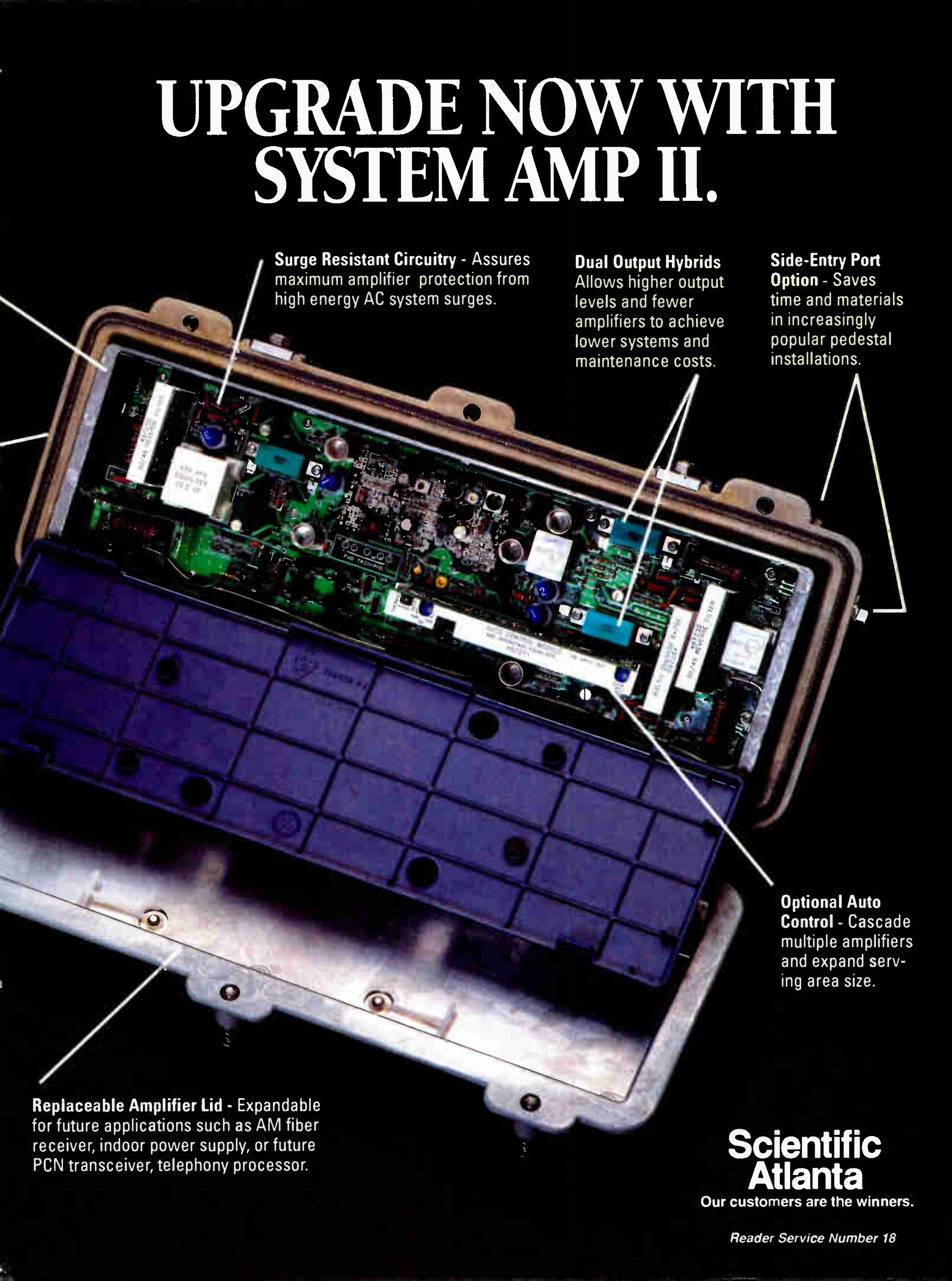

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FCC-required measurements: Amplitude characteristic, carrier-to-noise ratio, hum

The following is the fourth in a four-part series of articles that began in October on Federal Communications Commission-required measurements for cable TV.

By Jeff Noah
Technical Writer, Television Division
Tektronix Inc.

Once again we have the opportunity to interpret the new FCC regulations. Also known as frequency response and in-channel response, the amplitude characteristic specifications do clearly state the frequency band within a 6 MHz cable TV channel that must meet the ±2 dB limit. The accompany figure charts out the location of the band you must measure relative to the channel boundaries and the visual carrier. The ambiguity begins when you look for instructions on exactly how and where to make the measurement.

The two best of several possible methods have clear advantages and disadvantages. One method is to transmit a full-field multiburst test signal over the channel to be measured and monitor that channel with a spectrum analyzer. The other is to include the multiburst as a vertical interval test signal (VITS) along with program material, demodulate, and measure multiburst response at baseband. Both methods require you to take equipment into the field, but the amount of gear needed does vary between the two.

• *About Multiburst.* The multiburst test signal consists of several sine wave packets sitting side by side on a line of video. The frequency of the packets increases from left to right, and covers the normal NTSC transmission bandwidth. Packet frequencies are typically 500 kHz, 1 MHz, 2 MHz, 3 MHz, 3.58 MHz (color subcarrier frequency) and 4.2 MHz. Multiburst packets are usually 60 IRE in amplitude. The 500 kHz packet shows up on the lower as well as the upper sideband of the RF signal and exercises the lower limit of the frequency response specification. The 3.58 MHz packet is very near the upper limit of the specified measurement range, 3.75 MHz above the visual carrier.

An in-channel response that "rolls off" at or above 3.58 MHz is the most common frequency response problem. It can cause a loss of both color saturation and fine detail in the picture.

• *Multiburst at RF.* This method, while not listed in the suggested measurement methods in §76.609 (d)(2), provides fairly complete coverage of the frequency band whose response you must characterize. Also, it can be done automatically with the Tektronix Model 2714 spectrum analyzer. Its disadvantage is that it requires you to replace regular programming with a full-field test signal — a move that proves unpopular with subscribers, and therefore with management.

Measuring multiburst at RF requires transmitting a full-field multiburst test signal from the headend on the channel you intend to measure. Since most cable systems are 75Ω, and the 2714 has a 75Ω input impedance, you can connect the cable TV signal at the subscriber terminal directly to the analyzer. If you must, using an impedance matching pad won't add calculations to the process, since it's a relative measurement made between two points on the display.

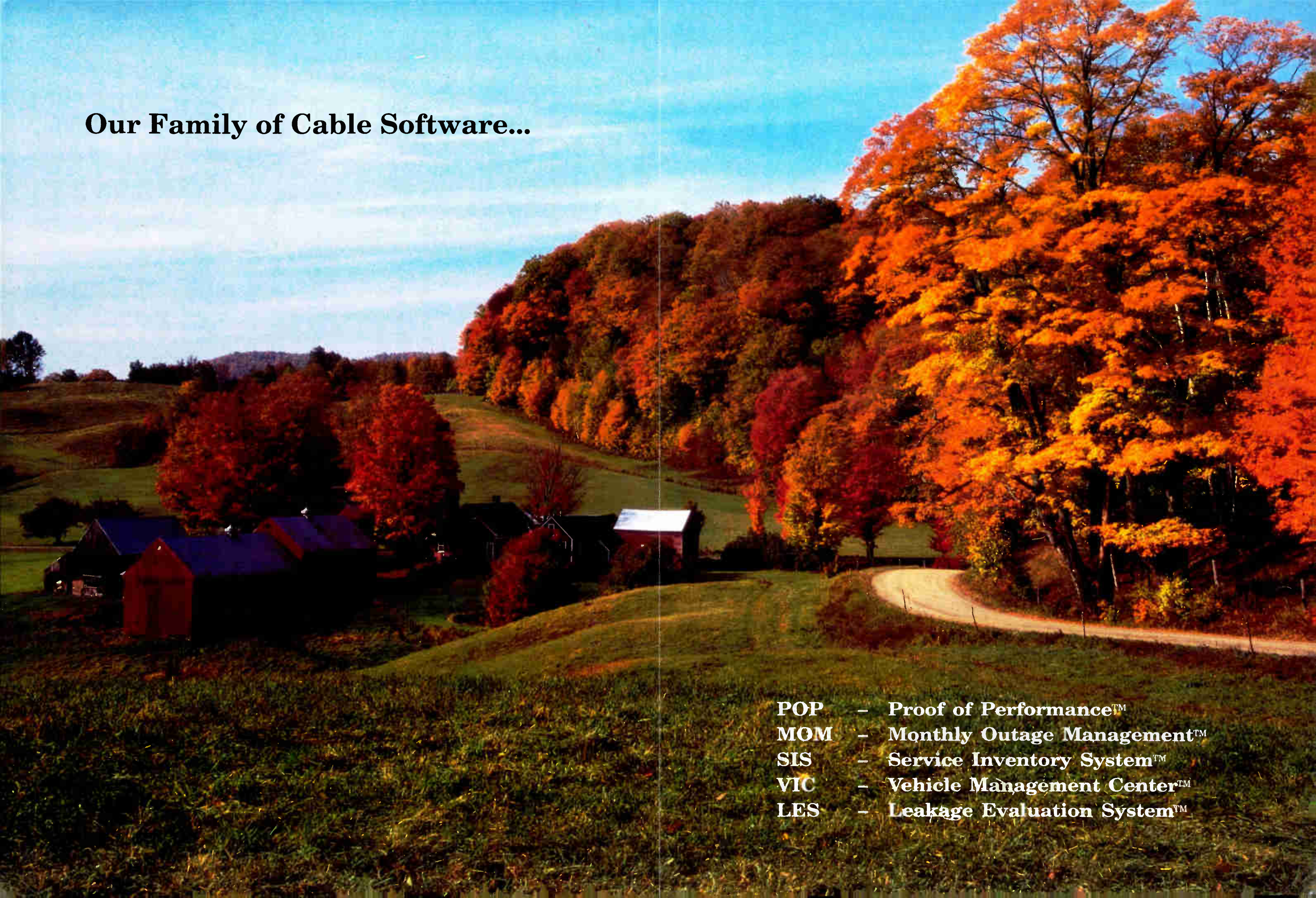
Once connected, the 2714's in-channel response measurement is accessed by pressing the CATV/APPL key and selecting Item 7, "in-channel response," from the second page of the applications menu. Select the automatic mode from the in-channel response setup menu. Then start the measurement by selecting "run in-chan resp" — press O on the keypad. The analyzer then measures the amplitude at each packet frequency listed in the in-channel response setup table, Item 5 on the "in-chan resp" menu. The difference between the highest and lowest measurements taken is divided by two, and the quotient displayed as the in-channel response measurement result.

Two warnings: First, do not enter the 4.2 MHz packet frequency in the setup table. That packet is outside the frequency band specified by the FCC, and is likely to put you outside the ±2 dB limit. Second, all multiburst signals are not created equal! Viewing the multiburst signal in the frequency domain can lead to confusion. Since the packets are the same amplitude at baseband, many technicians expect each packet to have the same RF power level. But due to differing packet widths in some versions of multiburst, FCC multiburst being one example, RF power levels can vary significantly from packet to packet. Measuring such a signal at RF gives erroneous results. Make sure the multiburst test signal you use has equal width packets and then verify they have equal power by viewing the baseband multiburst test signal on a spectrum analyzer. The multiburst signal generated by the Tektronix TSG100 NTSC TV generator is essentially flat over the applicable frequency range.

If you do note some minor spectral unflatness in the response of the baseband multiburst signal, it can be compensated for. Simply note the direction and amount of unflatness on the signal. Then run the 2714's in-channel response measurement in interactive mode, and subtract out (or add in) the unflatness recorded between the two packets you measure from (to) the displayed result.

• *Wording.* The wording of the amplitude characteristic specification is "±2 ... dB referenced to the average of the highest and lowest amplitudes within these frequencies." This could be restated as "find the midpoint between the high and low amplitude points and measure ±2 dB from the midpoint." Or, more simply, "the difference between the high and low points in the given frequency band can differ by no more than 4 dB." (I vote for the latter.) The result given by the 2714 corresponds to the official FCC wording and must be no more than 2 dB.

• *Multiburst at baseband.* The other, more popular, method of measuring amplitude characteristic involves characterizing the response of a multiburst test signal at baseband frequencies on



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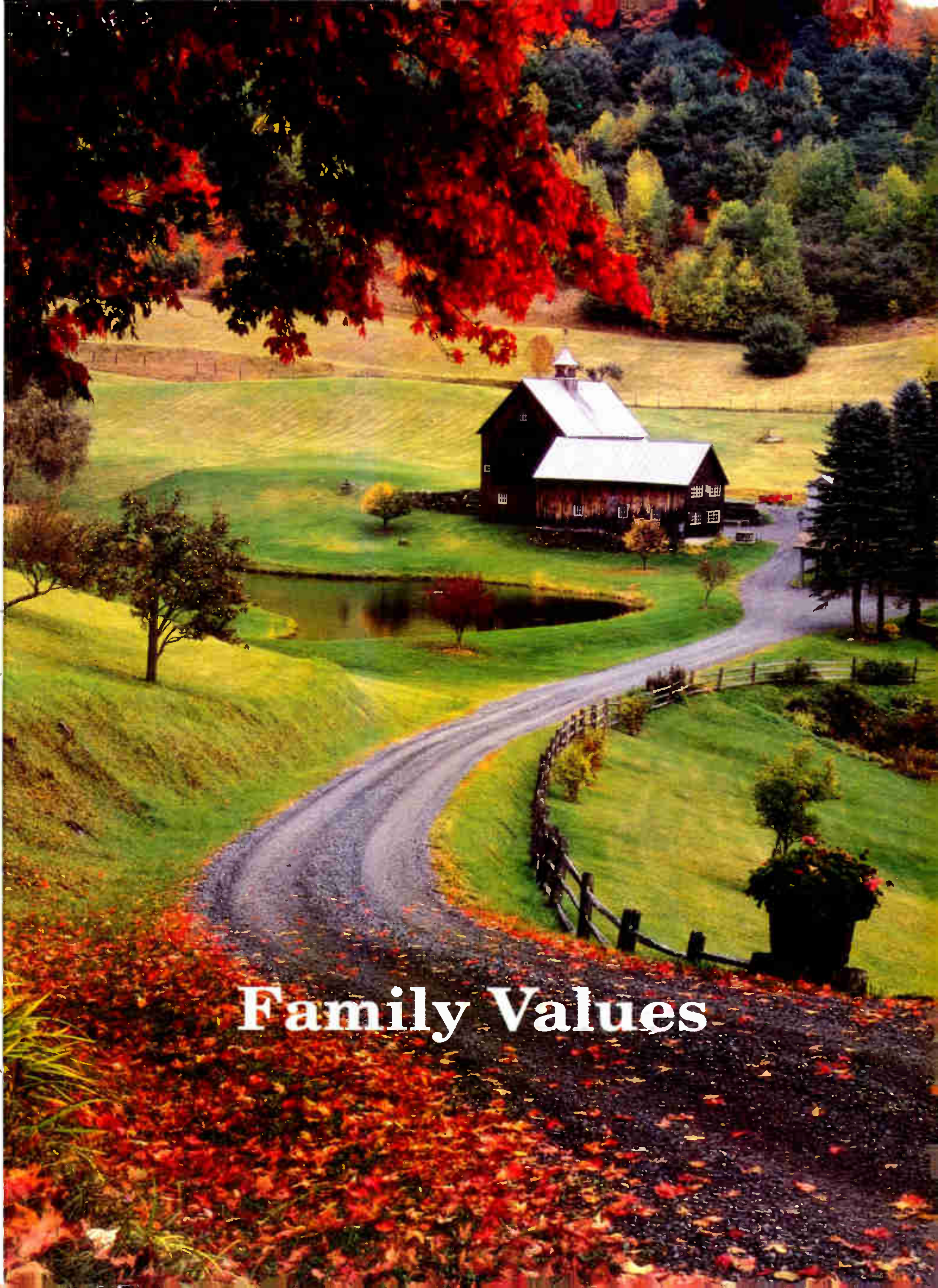

Family Values

a waveform monitor or automated video measurement set — on-line. Since either of these devices can easily make measurements on a single line of video, the multiburst signal can be transmitted along with regular programming as a VITS. The drawback to this method is that you have to lug more test gear out into the field. It is, however, the method suggested by the FCC.

To make the measurement at baseband, connect the cable feed, at the subscriber terminal, to a precision demodulator. But beware, not any old demodulator will do. Using a standard cable demodulator or a set-top converter to extract the baseband signal will add distortions and make any measurement data useless. In contrast, a measurement-quality demodulator introduces virtually no distortion.

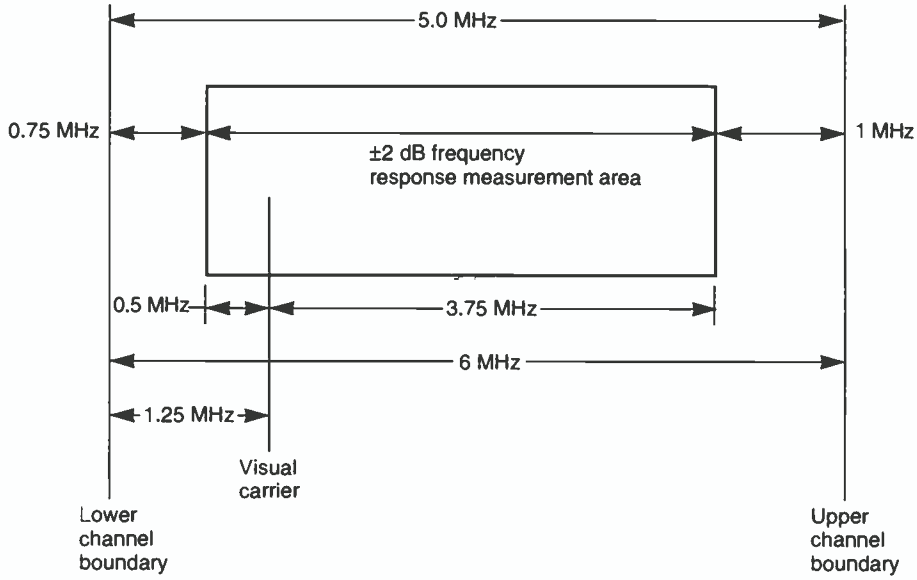
Video out from the precision demodulator drives a waveform monitor or oscilloscope with a line select function. This feature singles out the video line containing multiburst and displays it for measurement — and this all happens with the channel on-line. If the scope or waveform monitor you employ has voltage cursors, they can further simplify the measurement. Simply plug the amplitudes of the largest and smallest multiburst packets, excluding the last (4.2 MHz) packet, into the voltage difference-to-dB conversion formula: dB value = 20log (largest packet/smallest packet). The result should be 4 dB or less; or you can divide your result by two to get an FCC compatible (±2 dB) result.

Another drawback to this method is that viewing multiburst at baseband doesn't provide a direct look at the part of the spectrum that must be measured that is below the visual carrier (lower sideband). If the 500 kHz packet of the multiburst signal is low (or high), you can't tell from the baseband display whether the response error is at frequencies above or below the visual carrier.

Also, the closer to the bottom of the specified frequency band you get, the less impact amplitude errors have on the baseband signal. This effect is caused by the Nyquist slope used in TV receivers. The only way to know for sure what's happening with the lower sideband is to view the multiburst signal at RF on a spectrum analyzer, but this requires transmitting a full-field multiburst signal.

If you have a microprocessor-based video measurement set, such as the Tektronix VM700A, you can characterize frequency response using either the (sinx)/x test signal or multiburst. The (sinx)/x signal could be used in place of multiburst as VITS. Either signal, at baseband, can be measured automatically by the VM700A.

Frequency response measurement area for a cable TV channel



There is one last point to consider on this measurement. As this column is written, petitions have been filed with and are under review by the FCC regarding the amplitude characteristic specifications. Both the upper frequency limit and amplitude tolerance are under reconsideration. (Editor's note: On Nov. 10, 1992, the FCC adopted a Memorandum Opinion and Order clarifying these and other issues. Specifically regarding in-channel frequency response, the commission has declined to reconsider its decision concerning this standard. However, the rules will be modified to permit cable operators to measure in-channel response prior to the converter for no more than a seven-year period that began Dec. 30, 1992. After that time, in-channel response will have to be measured after the converter. Upper frequency limit and amplitude tollerance remain unchanged.)

Carrier-to-noise ratio

Carrier-to-noise ratio is a measurement familiar to cable operators. It's an easy measurement to make, it can be done on-line, and it's a good indicator of signal quality and system performance. A channel with a low RF C/N will translate to a baseband signal with a low video signal-to-noise ratio. The ultimate result is a snowy picture on your subs' TV sets.

The 2714 offers three methods — one fully automatic and two interactive — to perform the measurement. Each mode first measures and records the visual carrier level of the currently selected channel. The fully automatic mode then positions the low end of the channel in the first (horizontal) division of the display with a 30 kHz resolution bandwidth and video filtering. The analyzer then searches for the minimum point in the first division and makes the noise floor measurement at that point. The result returned is the difference between the visual carrier level and the noise floor measurement.

The Automatic with Pause mode uses the same equipment settings, but pauses after measuring the visual carrier, and prompts you to turn off modulation for that channel and to press "W" to continue. With modulation off, the 2714 searches for a minimum near the center of the channel and makes the noise floor measurement at that point. Once the result is returned, you are prompted to turn modulation back on.

Interactive mode allows you to place a marker at the precise location where you wish to measure the noise floor. It also gives you the opportunity to turn off modulation, or the carrier for that matter, if you need to.

In making the noise floor measurement, the analyzer utilizes a built-in noise measurement routine. The routine applies corrections for noise filter bandwidth, log and detector errors, and

(Continued on page 75)

Satellite look angles made easy

By James A. Goins
Plant Manager, TCI Cablevision

Several published computer programs have been written to calculate the elevation and azimuth look angles for earth stations. Typically, these programs have calculated one satellite location at a time. This requires re-entering the pertinent data each time you want to get the angles for a different satellite.

After experiencing the frustrations of using hand-held calculators and single-calculation satellite programs, the accompanying Lotus template was written. The advantages of this program are:

1) It needs only the earth station coordinates and the magnetic declination. A full chart in 1° increments is generated. The coordinates may already be

(Continued on page 70)

Partial replica of spreadsheet printout

GROUND LOCATION NAME: Ft. Pierce, Fl

North Latitude:

Degrees 27 Minutes 36 Seconds 37

DECIMAL DEGREES: 27.61

LATITUDE IN RADIANS: 0.481890

West Longitude:

Degrees 80 Minutes 27 Seconds 36

DECIMAL DEGREES: 80.46

LONG. IN RADIANS: 1.404291

Magnetic North Declination in Degrees: 1.00

SATELLITE POSITION IN DEGREES	TRUE AZIMUTH	MAGNETIC AZIMUTH	ELEV.	PATH LENGTH IN KM	PATH LENGTH IN MILES
60	141.17	142.17	50.62	37036.3	23013.3
61	142.68	143.68	51.24	36998.0	22989.5
62	144.24	145.24	51.84	36961.5	22966.8
63	145.84	146.84	52.41	36926.9	22945.2

Lotus 1-2-3 program to find satellite look angles

```
B1: [W3] 'SATELLITE AZIMUTH AND ELEVATION HEADINGS
K1: ' R= Earth's Radius in km
N1: 6371
K2: ' H= Height of GSO above earth's surface at equator,km
Q2: [W11] 35784
A3: [W8] 'THIS PROGRAM WILL CALCULATE THE AZIMUTH
  HEADING AND ELEVATION
A4: [W8] 'ANGLE FROM ANY GROUND STATION LOCATION TO
  MOST CATV SATELLITES
A5: [W8] 'IN THE GSO. THIS PROGRAM CAN BE EASILY
  MODIFIED TO ACCOMMODATE
A6: [W8] 'OTHER SATELLITE POSITIONS.
A8: [W8] 'GROUND LOCATION NAME:
D8: U [W9] 'Ft. Pierce, Fl
A9: [W8] ' North Latitude:
A10: [W8] ' Degrees
C10: U [W10] 27
D10: [W9] 'Minutes
E10: U [W9] 36
F10: [W9] 'Seconds
G10: U [W10] 37
A11: [W8] '
C11: [W10] 'DECIMAL DEGREES:
F11: (F2) [W9] ($C$10+($E$10/60)+($G$10/3600))
C12: [W10] 'LATITUDE IN RADIANS:
F12: [W9] (@PI/180)*($C$10+($E$10/60)+($G$10/3600))
A14: [W8] ' West Longitude:
A15: [W8] ' Degrees
C15: U [W10] 80
D15: [W9] 'Minutes
E15: U [W9] 27
F15: [W9] 'Seconds
G15: U [W10] 36
C16: [W10] 'DECIMAL DEGREES:
F16: (F2) [W9] ($C$15+($E$15/60)+($G$15/3600))
C17: [W10] 'LONG. IN RADIANS:
F17: [W9] (@PI/180)*($C$15+($E$15/60)+($G$15/3600))
A20: [W8] ' Magnetic North Declination in Degrees:
F20: (F2) U [W9] 1
A24: [W8] ' SATELLITE
F24: [W9] ' PATH
G24: [W10] ' PATH
A25: [W8] ' POSITION
F25: [W9] ' LENGTH
G25: [W10] ' LENGTH
A26: [W8] ' IN
C26: [W10] ' TRUE
D26: [W9] ' MAGNETIC
F26: [W9] ' IN
G26: [W10] ' IN
A27: [W8] ' DEGREES
C27: [W10] ' AZIMUTH
D27: [W9] ' AZIMUTH
E27: [W9] ' ELEV.
F27: [W9] ' KM
G27: [W10] ' MILES
A29: [W8] 60
C29: (F2)[W10]180+(@ATAN(@TAN(@PI/180*A29-$F$17)/@SIN($F$12)))*
  (180/@PI)
D29: (F2) [W9] +C29+$F$20
E29: (F2) [W9]@ATAN((@COS(@PI/180*A29-$F$17)*@COS($F$12)-$N$1/
  ($N$1+$Q$2))/@SQRT(((@SIN(@PI/180*A29-$F$17))^2+
  ((@COS(@PI/180*A29-$F$17))^2*(@SIN($F$12))^2))))*(180/@PI)
F29: (F1) [W9]((($N$1^2)+(($N$1+$Q$2)^2))-(2*$N$1)*($N$1+$Q$2)*
  (@COS(@PI/180*A29-$F$17))*(@COS($F$12)))^(1/2)
G29: (F1) [W10] +F29*0.6213699495
A30: [W8] +A29+1
C30: (F2) [W10]180+(@ATAN(@TAN(@PI/180*A30-$F$17)/
  @SIN($F$12)))*(180/@PI)
D30: (F2) [W9] +C30+$F$20
E30: (F2) [W9] @ATAN((@COS(@PI/180*A30-$F$17)*@COS($F$12)-$N$1/
  ($N$1+$Q$2))/@SQRT(((@SIN(@PI/180*A30-$F$17))^2+
  ((@COS(@PI/180*A30-$F$17))^2*(@SIN($F$12))^2))))*(180/@PI)
F30: (F1) [W9]((($N$1^2)+(($N$1+$Q$2)^2))-(2*$N$1)*($N$1+$Q$2)*
  (@COS(@PI/180*A30-$F$17))*(@COS($F$12)))^(1/2)
G30: (F1) [W10] +F30*0.6213699495
```

After entering all the formulas, edit the cells as indicated below:

1) Enter your city in Cell D8.
2) Enter your latitude in degrees, minutes and seconds in Cells C10, E10 and G10.
3) Enter your longitude in degrees, minutes and seconds in Cells C15, E15 and G15.
4) Enter the degrees of magnetic declination of your location in Cell F20.
5) Copy the 30 row down the worksheet until you have all the satellite locations of interest to you (usually to 140°).
6) If increments other than 1° are important, such as 0.5°, edit Cell A30 to read A29+.5 (in place of A29+1).
7) If this program is to be used in the Southern Hemisphere, enter the latitude with a minus sign in front of the degrees, minutes and seconds. Also, delete the number 180 from the beginning of Cells C29 and C30. Corrections to the azimuth also will have to be made if these formulas are used to calculate a chart for use east of the prime meridian.

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Fiber-optic test equipment

(Continued from page 17)

The most important OPM selection criteria is matching the appropriate optical detector type with the expected range of operating wavelengths. The accompanying table on page 17 summarizes the basic choices. It is important to note that InGaAs is best overall choice for making measurement in all three transmission windows. The overall preference for InGaAs over Ge include InGaAs's superior spectral flatness (uniformity) across all three windows, superior measurement accuracy within the 1,550 nm transmission window as well as its temperature stability and low noise characteristics.

The next factor concerns calibration accuracy. Is the power meter calibrated in a manner consistent with your application? That is, are calibrations performed with a fiber and connector combination consistent with your system requirements? What is the measurement uncertainty of using different connector adapters? Although the National Institute of Standards and Technology (in Boulder, CO) has established a national standard, it is important to consider other potential sources of error, such as the spectral uncertainty of the source, optical detector type, errors due to similar connectors from different manufacturers, etc.

The third step is to identify models that meet your measurement range requirements. Expressed in dBm units, measurement range is a comprehensive parameter that identifies the minimum/maximum range of input signal for which the OPM can guarantee sufficient overall accuracy and linearity (+0.8 dB, as defined by Bellcore). Is the resolution (usually or 0.01 dB) sufficient for the application?

Fourth, a basic feature found in most (but not all) OPMs is the relative dB function for direct optical loss measurements. Lower cost OPMs do not usually offer this function. Without the dB function, the technician must write down individual reference and test values and then calculate the difference. Thus, the dB function will assist the user in all relative loss measurements, thus improving productivity and reducing manual calculation errors. The user must fully evaluate the need for this useful function.

By now, the user has reduced his choices to those offering the basic features and functionality. From here, the user should evaluate the need for special features — including data logging, external interfaces for computer hookups, etc.

Stabilized light sources

During the loss measurement process, a stabilized optical source (SLS) launches light of known power and wavelength into the optical system. A power meter/optical detector calibrated for use at the wavelength of the SLS, receives light from the fiber-optic network and converts it into an electrical signal. To ensure accuracy in the loss measurement, the SLS should simulate, as much as possible, the operating characteristics of the transmission equipment that will be used. It should have the following characteristics:

- Operate at the same nominal wavelength and preferably of same type (LED, laser).
- Be stable with respect to time and temperature in output power and spectral characteristics over the duration of the measurement. →

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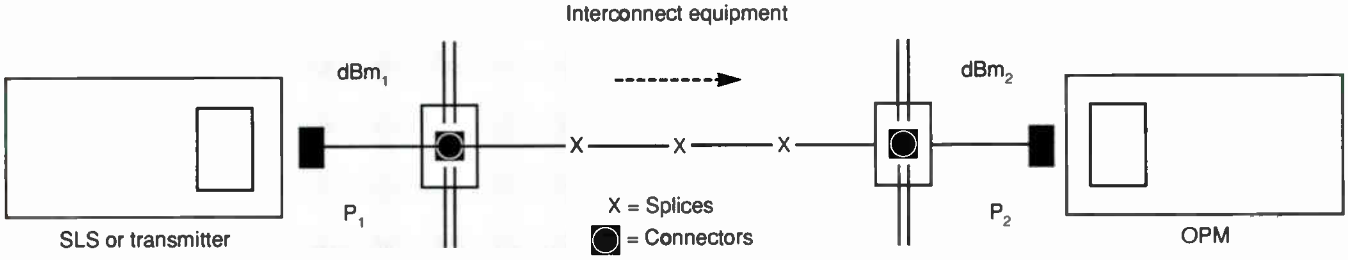
Figure 2: Typical system configuration for optical power and loss measurements



$$\text{System loss (dB)} = 10\log(P_1/P_2) = dBm_1 - dBm_2$$

Where:
P_1 = the power launched from the SLS or XMTR (in mW units) $dBm_1 = 10\log P_1$ (in dBm units)
P_2 = the power to be received by the RCVR (in mW units) $dBm_2 = 10\log P_2$ (in dBm units)

• Offer the same connector interface and fiber launch characteristics.

• Magnitude of its output power sufficient to measure worst-case system loss.

When a separate SLS is needed independent of the transmission system, the optimum selection of source should simulate the system's optical transmitter characteristics and measurement requirements at an affordable cost. Consider the following choices in light sources:

1) *Laser diode (LD).* Light emitted from an LD has a narrow band of wavelengths. It is nearly monochromatic. That is, of a single wavelength. In contrast to the LED, laser light is not continuous across the band of its spectral width (less than 5 nm). Several distinct wavelengths are emitted on either side of the central wavelength. Although a laser provides more power than an LED, it is more expensive. Laser diodes are most often used to characterize long-haul SM data links with system losses exceeding 10 dB. In general, try avoiding measuring multimode fiber with a laser source.

2) *Light-emitting diode (LED).* An LED has a much wider spectral width than an LD, usually in the range of 50-200 nm. In addition, LED output is noncoherent and more stable in power. LED sources are much less expensive than LD devices, but may lack the output power to measure worst-case losses. LEDs are typically used in short-haul network and LAN applications with multimode fiber. LED sources can be used to make accurate loss measurements of LD-based SM fiber systems as long as sufficient output power can be launched into the fiber network.

3) *White light.* A tungsten lamp can be used as an alternate, inexpensive

source. In applications where expected losses are moderate, the tungsten source is equivalent to a 850 nm source when used with a Si-based OPM. In combination with an InGaAs OPM, the superposition of the detector's spectral response curve over the lamp's spectral output curve produces a center wavelength at 1,300 nm. Consequently, these devices can be used as inexpensive substitutes for LED or LD sources at 850 nm and 1,300 nm. The white light source also can double as a visual fiber tracer for quick checks of continuity and fiber identification, without the hazards of laser-based systems.

Optical loss test sets

The combination of an OPM and SLS is called an optical loss test set. OLTSs are used to measure optical power loss over a fiber-optic path. These instruments can either be two individual component devices or a single, integrated unit. Overall, both types of OLTSs can perform the same measurements to the same accuracy. The differences usually extend to cost and features. The integrated OLTS is usually much more expensive, sophisticated and laden with additional features. Figure 2 is a typical system configuration for optical power and loss measurements.

To technically evaluate various OLTS configurations, the basic OPM and SLS criteria still apply. It is important to match the transmitter and detector for operation at the same wavelength and to have sufficient power and sensitivity to provide the required dynamic range to measure the optical system in question. The unifying parameter is the measurement range capability of the resultant OLTS system. Measurement range is expressed in dB and reflects the difference between the maximum output power of the SLS and the minimum measurement power of the OPM. The resultant OLTS measurement range specification must equal or exceed the expected link loss.

Integrated OLTS systems are generally more expensive but usually offer high levels of sophistication and functionality than their component counterparts. For instance, integrated SM dual-wavelength units are available that can simultaneously measure link loss at both 1,300 nm and 1,550 nm. Component systems would not be able to perform this measurement as easily, but this additional sophistication comes at a higher price.

Variable optical attenuators

VOAs are essential for testing optical receivers. When a system is installed, the system engineer uses an attenuator to determine if the system will work over the specified range. With a BER generator hooked up to the electrical input of the optical transmitter, the VOA is used to reduce power (measured and verified with an OPM) and verify acceptable BER performance down to the minimum signal requirements of the optical receiver. In AM systems, receiver output is measured over a range of optical input levels.

Attenuator evaluation requires focusing on the following performance parameters: 1) operating wavelength, fiber type/size and connector interface; 2) residual loss and attenuation range; 3) accuracy and resolution; and 4) reflectance.

We have already observed that identifying the key system parameters and matching them to available models is fundamentally important when evaluating fiber-optic instrumentation. Various VOA configurations are available. Some are calibrated and feature calibrated readouts or dials, others are uncalibrated (where an OPM is employed to set the level). With regard to the optical interface, the user can select between the inflexibility of a fixed connector or the versatility of a universal connector interface (UCI). The UCI system offers two advantages: 1) accessibility to the ferrule end for routine cleaning and maintenance (critical to all fiber-optic measurements); and 2) the ability to accommodate all industry-standard connectors via simple screw-on/screw-off adapters.

The second factor focuses on the loss characteristics of the VOA. Residual loss (or insertion loss) is the loss of the attenuator at the 0 dB setting. Residual loss is in excess of the expected connector mating loss, which is dependent on the connector type. High residual losses (coupled with poor mating losses of particular connector types) limit the users ability to measure performance at higher power levels at the 0 dB starting point. The attenuation range is defined as the full range of losses over which the attenuator can be set.

Third, attenuation accuracy is defined as the correctness of the optical loss setting (i.e., the difference between the display setting and the true value of the optical attenuation) that should be taken together with the VOA's resolution (ability to incrementally set the attenuator to a specified setting). Actually, attenuators can be of the following three types: 1) continuous, 2) step or 3) combinational step/continuous configuration (whereby the stepping function momentarily blocks the optical signal). When BER measurements are being performed, both pure step and combinational models are undesirable due to the momentary blocking of the optical path between attenuation settings.

Another important performance factor is optical reflectance (OR), which is a critical performance factor in analog/video transmission systems as well as digital systems as bit rates reach beyond 1 Gb/s. OR, expressed in dB, is a measurement of the amount of forward power that is reflected back when the optical signal encounters reflective events (splices, connectors, etc.) within the fiber link. Reflectance always is expressed in negative dB units. Some people prefer the alternate terminology of optical return loss (RL), which is the negative of reflectance and thus, the numbers always are expressed as positive values. It is desirable to have either smaller OR values or higher RL. Different transmission technologies (analog vs. digital) have different RL requirements. For instance, digital and low bandwidth video systems with super physical contact (SPC) connectors are specified with OR<-40 dB (or RL>40 dB). High bandwidth CATV and analog transmission systems are utilizing angled physical contact (APC) connectors that require OR<-55 dB (or RL>55 dB).

OTDRs and fault locators

OTDRs are the most sophisticated form of fiber-optic instrumentation and provide the most information regarding the fiber-optic link under test. An OTDR is essentially a one-dimensional, closed-circuit optical radar, requiring the use of only one end of a fiber to make measurements. A high-intensity, short-duration light pulse is launched into the fiber while the high-speed optical detector records the returned signal (backscattered light). This light results from two principal

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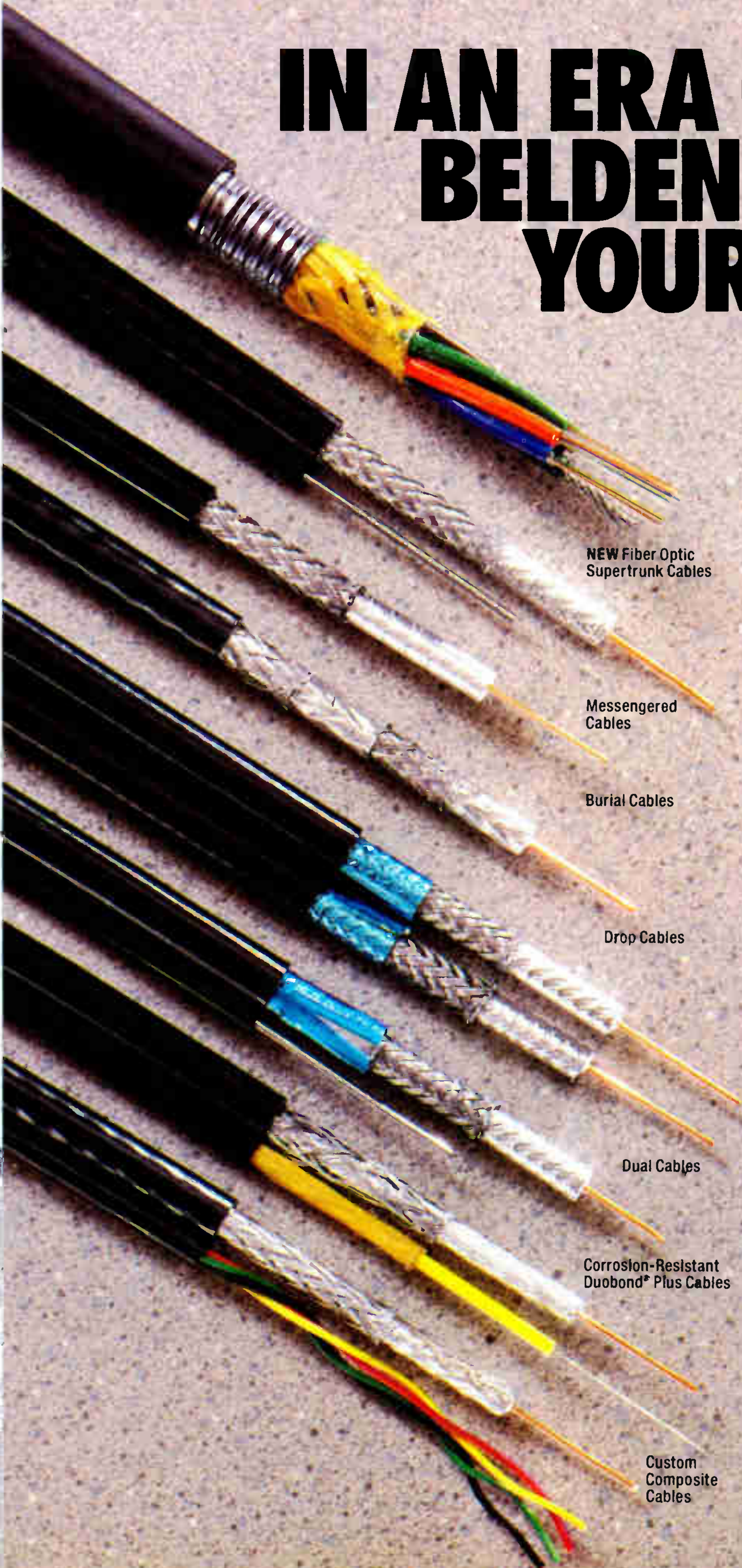

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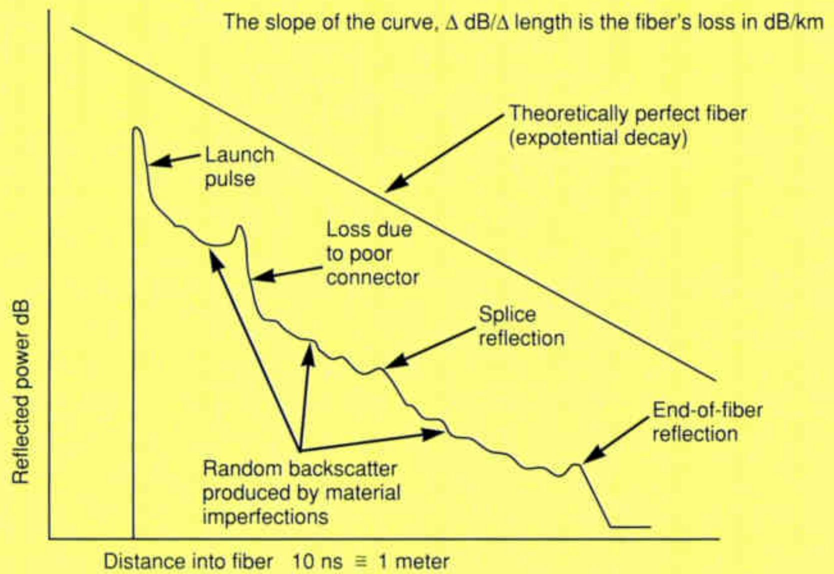
Figure 3: Identifying magnitude and distance from operator



sources: Fresnel reflections at the fiber ends and breaks and connectors; and Rayleigh scattering from fiber imperfections. The instrument provides a visual interpretation of the optical link. Splices, connectors and faults may be identified in both magnitude (dB loss) and in distance away from the operator, as in Figure 3.

The OTDR evaluation process shares many similarities to the requirements of the OLTS. In fact, an OTDR can be considered a very specialized test set comprising a stable, high-speed pulsed source and a high speed optical detector. The selection process should focus on the following attributes:

1) Identify operating wavelength, fiber type and connector interface.

2) Expected link loss and required backscatter range.

3) Spatial resolution.

For optimum performance, the operating wavelength, fiber type/size and connector interface must match the same characteristics of the optical link. With MM systems, an OTDR of mismatched fiber size could be used for most MM link applications (such as 50/125 used for both 50/125 and 62.6/125) but the user should be cautioned that the measurement range will be reduced. Until recently, potential buyers had to select a particular connector interface thus leading to hybrid patch cables for interfacing to other connector types. In some cases, the mix of connectors even required purchasing separate (expensive) plug-in modules dedicated to different connectors. Today, the user can simply select the Diamond UCI that offers precision, screw-on/screw-off adapters accommodating a full range of industry-standard connectors. The UCI can be used on both SM and MM systems without any degradation in optical mating performance.

The second most important factor is matching the backscatter range of the prospective OTDR (module) to the expected link loss. The range is expressed in dB and represents the useful range over which loss measurements can be made of the fiber backscatter signal. This range must exceed the expected link loss in order characterize the entire fiber span, especially for long haul SM systems where system spans can easily exceed 10 km. As a rule-of-thumb, the maximum distance (expressed in meters and/or feet) should be greater than twice the fiber length.

The third critical factor is the event dead zone expressed in meters. Two subfactors evaluate the spatial resolution performance of the OTDR with regard to interpreting features in the link. EDZ to the first connector specifies the minimum distance required to distinguish between two reflected connectors (based on the Fresnel reflections). Furthermore, EDZ to the first fusion splice characterizes the OTDRs ability to distinguish between

"No one OTDR can do all things. There always is a tradeoff between backscatter range, distance and resolution."

one reflective and one nonreflective fusion splice.

The industry divides OTDRs into two groups based on their spatial resolution performance (high-resolution and long-haul). Based on an instrument's ability to distinguish two connector events, a high-resolution OTDR can resolve two connectors separated by 10 m, whereas the event dead zones for long-haul OTDRs well exceeds 10 m. In general, if the expected distance of the fiber segments (i.e., distance between connectors) are expected to be short (<100m), you must select a short-haul, high-resolution type OTDR.

No one OTDR can do all things. There always is a tradeoff between backscatter range, distance and resolution.

Instrument maintenance

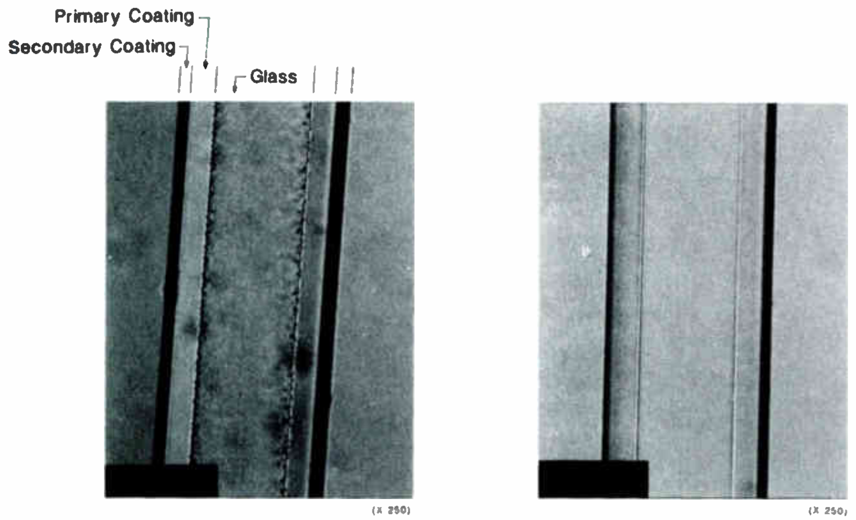
The issue of maintenance is a serious issue with fiber-optic instrumentation. It is obvious that optical systems will not perform if their interfaces are not clean. As a rule-of-thumb, the technician should clean the optical interface (particularly, connectors) before any measurement. Even a 1-2 µm dust particle can raise havoc in SM system performance. The user should evaluate instruments based on the accessibility of both ends of a mating interface. The typical fixed connector setup leaves little to be desired since the internal connector is inaccessible between a fixed bulkhead. Fortunately, new technology is now available in the form of the UCI, which features a male-type connector mounted on the front panel for direct access to the ferrule end for routine cleaning and maintenance. As an additional feature, the UCI offers compatibility with all industry-standard connectors via precision but simple screw-on/screw-off adapters.

The user also should consider the calibration requirements of different models. How often does the instrument have to be recalibrated? What is the cost for a routine calibration and turnaround time? Can the maintenance/recalibration be performed by the user or must the equipment be returned to the manufacturer? Can nonmanufacturer calibration labs do the same work? Consequently, the user should closely evaluate the manufacturer and the performance of his service operation. All of these factors should be taken as seriously as the direct performance characteristics of the particular instrument.

Conclusion

Selecting the appropriate test equipment is not a trivial matter. Many features and options are available. Indeed, manufacturers may prescribe different meanings to similar terms. With the help of these guidelines, the potential customer will better understand the basic characteristics of these important instruments so as to make the most informed decision. **CT**

Figure 8: A comparison of coating-to-glass interface quality after elevated temperature/humidity exposure



BASE COATINGS/ADHESION PROMOTER #2
AGED 10 DAYS, 85°C/85%RH

BASE COATINGS/ADHESION PROMOTER #1
AGED 24 DAYS, 90°C/95%RH

Fiber design

(Continued from page 22)

are even more evident in fibers Y and Z where a potentially corrosive ingredient has been added. The effects of the corrosive ingredient are not eliminated by a high quality interface but the effects are reduced by approximately 50%. AFM was performed on the glass surface of fiber Z and is shown in Figure 10. The surface is rough, but in addition to the roughness there are pitted regions that match the size of the microscopic pockets that have formed at the coating/glass interface. In this region the glass is more highly corroded, reflecting the tendency to collect moisture and corrosive components in delaminated regions.

The results shown in Figure 9 illustrate the need to maintain high quality coatings for good strength retention, which includes maintaining high purity levels to avoid potentially corrosive contaminants and maintaining good coating adhesion.

Solvent and solution resistance

As new optical fiber applications evolve in the subscriber loop, the fibers may be exposed to a wider variety of solvents and solutions including petroleum distillates in wasp sprays, chlorinated solvents, alcohols, bleach and ammonia. An assessment must be made of the likelihood of fiber contact with a solvent and the coated fiber must be tested for resistance to these materials using procedures that duplicate field use (e.g., spraying with a wasp spray and cleaning fibers with alcohol). One approach to defining the solvent resistance of coating materials is to evaluate polymer/solvent interactions through the determination of polymer swelling over a wide range of solvents.

Sheets of both a primary and a secondary coating material, approximately 8 mils thick, were fully cured using a Fusion Systems "D" Lamp. Samples were die cut from the sheets, length was measured using a vernier accurate to .01 mm, then placed in a petri dish, and covered with solvent. The cover was placed on the petri dish and the dish wrapped in aluminum foil to retard solvent evaporation. Since volatile solvents can rapidly escape from the sheet samples if they are removed for weighing or measuring, sample lengths were measured at various times in the petri dish. Solvent was added if necessary following each measurement and the dishes rewrapped in foil. Volume changes were calculated from length changes assuming isotropic swelling of the coating.

The volume increase as a result of swelling of the pri-

Figure 9: Strength reductions for fibers aged at 85°C and 85% RH (coating designations indicated in Table 1 on page 21)

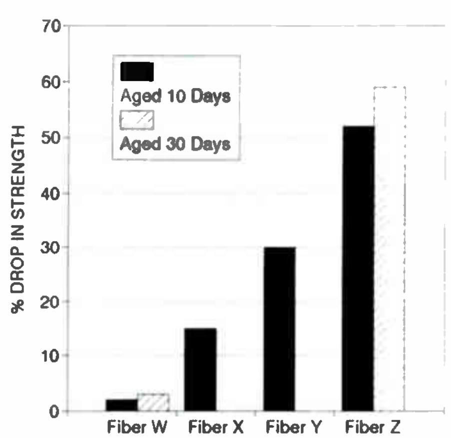


Figure 10: AFM of glass surface — fiber Z (aged 10 days at 85°/85% RH)

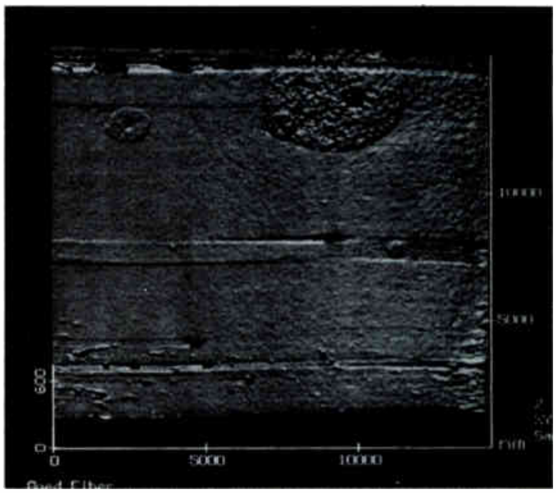


Figure 11: Effect of solubility parameter on swelling of primary coating sheets

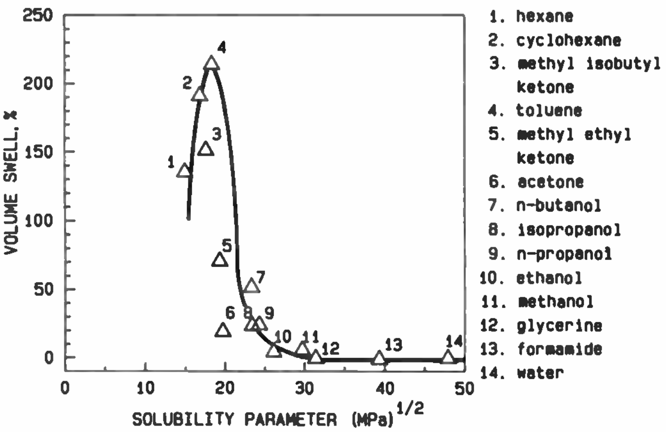
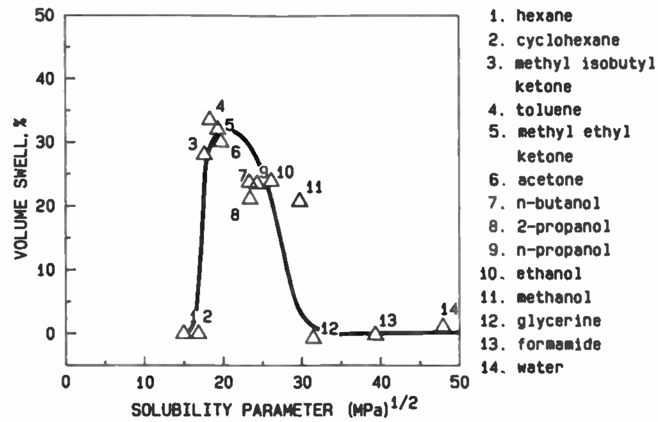


Figure 12: Effect of solubility parameter on swelling of secondary coating sheets



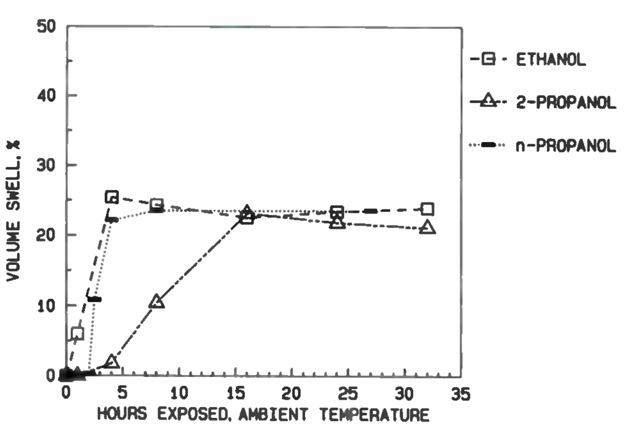
mary coating as a function of solubility parameter, δ (which is a measure of the solvent polarity), is shown in Figure 11 and for the secondary coating in Figure 12. The shapes of the curves reveal a maximum that can be shown to correspond to the point where the solvent solubility parameter matches that of the coating. The general shape of the curves can be derived from the Flory-Huggins equation and is expressed by the following equation[13]:

$$\ln(1-\phi_2)+\phi_2+\chi\phi_2^2+\frac{\rho V_1}{M_c}\phi_2^{1/3}=0 \quad \textbf{(1)}$$

Where:
ϕ_2 = the volume fraction of crosslinked polymer
ρ = the polymer density
V_1 = the molar volume of the solvent
M_c = the molecular weight between crosslinks
χ = the well-known polymer-solvent interaction parameter that depends on the molecular properties of the polymer-solvent combination.

For the primary coating in the region of high swelling and neglecting contributions from chain free ends, Equation 1 can be simplified by expanding the logarithm and neglecting second order terms to yield:

Figure 13: Sheet swelling of a secondary coating in 2-propanol, n-propanol and ethanol (95%)



$$\frac{\rho V_1}{M_c}\cong\left(\frac{1}{2}-\chi\right)\phi_2^{5/3} \quad \textbf{(2)}$$

The interaction parameter can be calculated from solubility parameters by the following semiempirical equation:

$$\chi=\frac{V_1}{RT}(\delta_1-\delta_2)^2+\chi_s \quad \textbf{(3)}$$

Where:
δ_1 and δ_2 = the solubility parameters for solvent and polymer, respectively
χ_s = the entropy contribution, which roughly = 0.34

From Equations 2 and 3, the volume swelling ratio (SR) of a crosslinked polymer by a solvent can be calculated as:

$$SR=\frac{V}{V_o}=\frac{1}{\phi_2}\cong\left(\frac{M_c}{\rho RT}\left[\frac{0.16RT}{V_1}-(\delta_1-\delta_2)^2\right]\right)^{3/5} \quad \textbf{(4)}$$

Where:
V_o = the original volume of the coating
V = the swollen volume.

From this equation, the maximum in swelling ratio can be seen to occur when:

δ_1 (solvent) = δ_2 (coating) **(5)**

The amount of swelling that occurs at the maximum point is determined by the crosslink density of the primary coating as measured by the molecular weight between crosslinks, M_c. The maximum for the primary coating is seen to occur at the value of δ for toluene, which has δ = 18 and molar volume of 106 cm³/mole. From Equation 4 we calculate M_c = 4,700 g/mole. This can be compared to mechanical data through an equation (also neglecting chain free ends) that relates shear modulus of the primary coating to M_c by:

$G = (\rho RT/M_c)$ **(6)**

The shear modulus as measured by dynamic mechanical methods for the primary coating in Figure 11 is 4.0 x 10^6 dynes/cm² and ρ = 1.0, which yields an M_c of 6,200 g/mole in fairly good agreement with the M_c obtained from swelling. A similar calculation is not done for the secondary coating be-

Figure 14: Effect of aging at 95°C/95% RH on color of optical fiber coatings

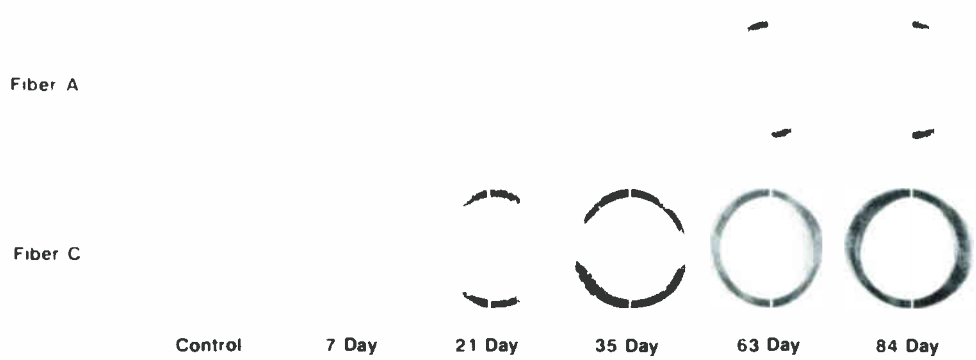


Figure 15: Effect of aging at 125°C on color of optical fiber coatings

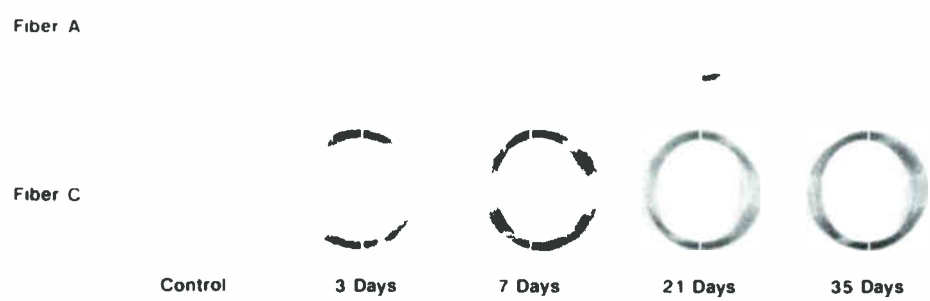


Table 2

	Effective molecular Shape	Molecular Cross-section for penetration Angstrom^2
Ethanol	Cylindrical	42.4
n-Propanol	Cylindrical	45.9
Isopropanol	Spherical	54.5

cause it is densely crosslinked and the approximate equations used previously do not apply. The positions and magnitudes of the points of maximum swelling of the primary and secondary coatings on the solubility parameter curves will determine whether and how much the coating will interact with various solvents. Referring to Figures 11 and 12 (page 52) we can assess the general behavior of these coatings in solvents, some of which may be encountered in the field. For example, gasoline and petroleum distillates, essentially hydrocarbon materials, would be expected to swell the primary coating significantly while the isopropanol used to clean fi-bers would have a much smaller effect. For the secondary coating the results are somewhat different with aliphatic hydrocarbons having no swelling effect while alcohol gives substantial swelling. The results in Figures 11 and 12 (page 52) form the basis for understanding the behavior of coated fiber in various solvents or solutions. Since all polymer coatings will absorb solvents in some region of the solubility parameter spectrum, the challenge is to design primary/secondary coating composites that work together to provide the required level of solvent/solution resistance.

A particularly important area for solvent resistance performance of coatings is that of cleaning fluids used to remove cable filling compounds during splicing/connectorization operations and in some cases to enter ribbons. For these applications the rate of penetration of the cleaning solvent into the secondary coating plays a key role in coating design and solvent selection. Isopropanol is typically used as a general cleaning solvent and ethanol is used for special applications. The rate of swelling of the secondary coating in three alcohols is shown in Figure 13 (page 52).

Ethanol begins to swell the material very rapidly while n-propanol shows little effect for approximately two hours and then rapidly swells. Isopropanol shows no initial swelling and then swells at a much lower rate than the linear alcohols. The final swollen volume of the coating is essentially the same for all three alcohols. In previous work on swelling of poly (methyl methacrylate) (PMMA) films, the effective cross-section of a molecule was more significant in determining penetration rates than the molecular volume.[14] The difference in the behavior of the materials is related to molecular size and shape of the solvent molecules. Table 2 shows the size characteristics of the alcohol molecules.

Since isopropanol is an almost spherical molecule while ethanol and n-propanol are more elliptical in shape, the effective comparison is the spherical cross-section of isopropanol (54.5) vs. the cylindrical cross sections of ethanol (42.4) and n-propanol (45.9). Based on this, the anticipated rate of swelling should be ethanol>n- propanol>isopropanol, as observed.

These results indicate that isopropanol is the preferred cleaning solvent for this set of coating materials since it will not penetrate the secondary coating during cleaning operations. Ethanol can be used but procedures should require a one hour time limit on exposure. None of these solvents should be used when they will remain in contact with the fiber for many hours.

Aging and reliability

Many of the new evolving applications for optical fibers involve exposure in outdoor equipment where the fibers will be subjected to elevated temperatures and/or humidity for long time periods. Temperatures inside telecommunications equipment can be as high as 68°C in Yuma, AZ, while temperatures of 40°C at relative humidities over 70% are seen in Miami. Under these conditions the urethane/acrylate systems used in fiber-optic coatings can degrade thermally

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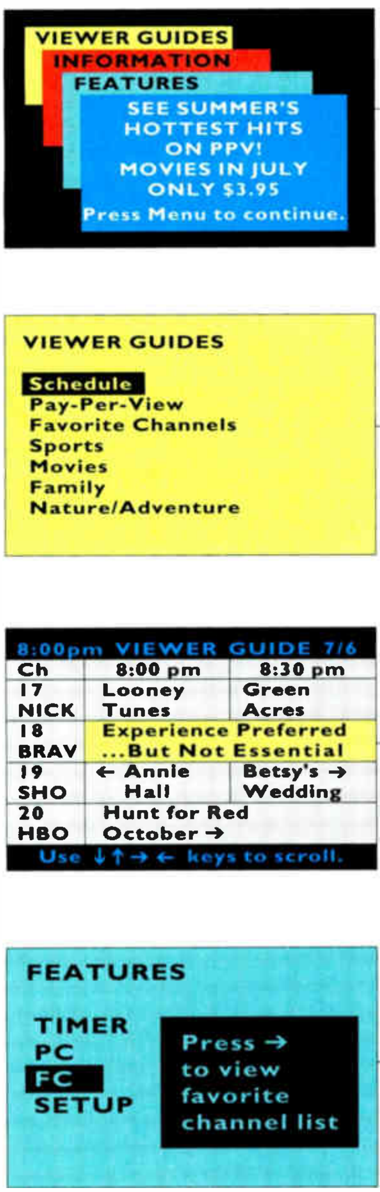

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Figure 16: Effect of aging on mechanical strip force for dual-coated fiber aged at 95°C/95% RH

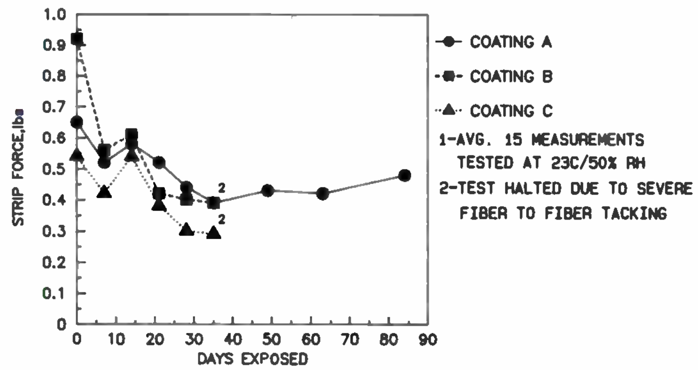


Figure 17: Effect of aging on pullout force for dual-coated fiber aged at 95°C/95% RH

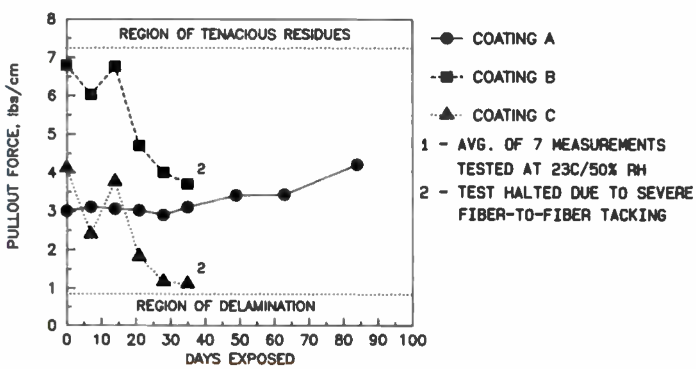
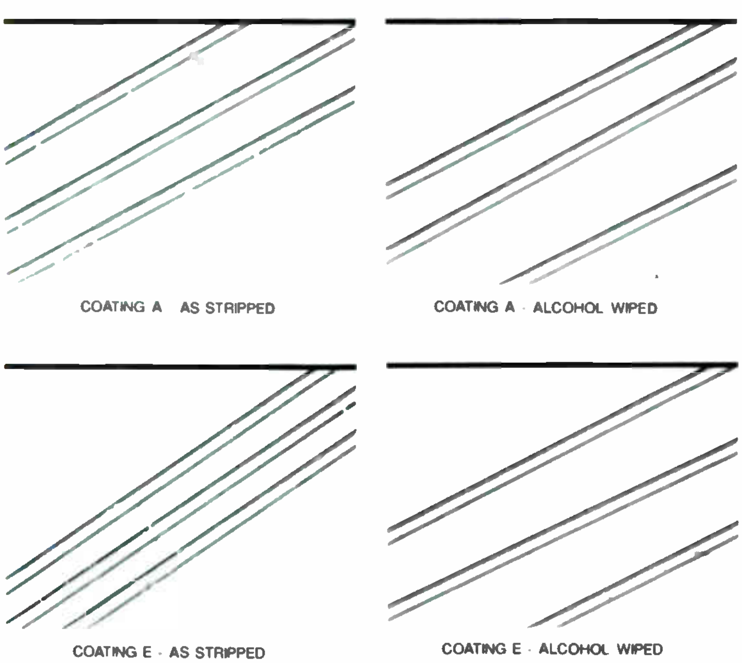


Figure 18: Strippng residues — hydrolytically stable fibers 84 days at 95°C/95% RH



(oxidation) or through attack by water (hydrolysis).

The degradation of the coating materials can effect fiber performance in several ways:

1) Yellowing/darkening — Changes in the coating color on aging can result in the loss of color-code identification of the fibers.

2) Loss of physical properties — Coating degradation can result in lowered strip force and tenacious residues after coating removal, added susceptibility to microbending loss and less resistance to damage from handling.

3) Loss of adhesion — The coating can delaminate from the fiber resulting in handling problems and exposure of the glass surface to attack by water.

In order to design coatings for resistance to oxidation, we utilize accelerated testing at a temperature of 125°C. We have based this choice on a typical activation energy of 70 kJ/mole for urethane/ acrylate materials. Based on the Arrhenius function,

$$\ln(t_2 / t_3) = \frac{E_a}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right) \quad (7)$$

where t_2 and t_1 are aging times at temperatures T_2 and T_1 in °Kelvin, respectively, E_a is the activation energy, and R is the gas constant, we can calculate that 35 days at 125°C roughly simulates 30 years at 40°C. Although this test does not give an accurate determination of lifetime, it has been very useful in comparing candidate coating materials for oxidative stability.

In the case of hydrolytic aging, both temperature and humidity must be considered. Typically, the time to degradation can be expressed as:

$$t \propto \frac{\exp-(E_a / RT)}{[H_2O]} \quad (8)$$

Which can be expressed as:

$$\ln t = -E_a/RT - \ln[H_2O] + C \quad (9)$$

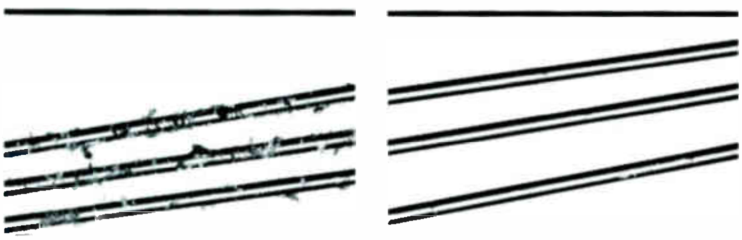
Where:
E_a = the activation energy for hydrolysis
C = a constant
$[H_2O]$ = the water concentration.

Equations of this form have been previously used to describe the time/temperature dependence of degradation of polybutylene terephthalate.[15,16] Using a typical activation energy of ~40 kJ/mole to describe the behavior of urethane/ acrylate systems in hydrolysis, we calculate that 77 days of aging at 95°C/95% RH roughly simulates 30 years at 40°C and 70% RH. As with the oxidative test described previously, this test method is very useful for comparative coating design.

Using these accelerated tests, we compared the color changes of two coatings exposed to these conditions as shown in Figures 14 and 15 (page 54). Coating C shows much more severe color changes than Coating A. Significant problems in fiber identification may occur with Coating C in outdoor applications. →

Reader Service Number 36

Figure 19: Stripping residues — hydrolytically stable fibers aged 84 days at 95°C/95% RH



The effect on physical properties under these same exposure conditions is shown in Figures 16 and 17 (page 56). Coatings B and C show major changes in both strip force and adhesion after aging at 95°C/95% RH. In fact, degradation is so severe after ~35 days that adjacent coils of Fiber B stuck to each other and could not be separated for testing. The same occurred with Fiber C. Evaluation of the strippability of several fibers after aging showed that no problem exists in the formation of tenacious residues after aging at 125°C for all coatings tested (Coatings A, C and E) exhibiting no problems on ferrule insertion. After aging at 95°C/95% RH, Coatings A and E stripped easily (Figure 18, page 56). However, Coating C had severe residues after stripping and small tenacious residue areas after wiping (Figure 19) such that ferrule insertion was no longer possible.

Delamination behavior of the coatings was examined by exposing fibers at 95% RH and temperatures ranging from RT to 95°C (Figure 20, page 60). A wide range of behavior was observed. Coating A exhibited no delamination even after 200 days at 95°C/95% RH. Coating F delaminated within 30 days at 60°C/95% RH, and Coating D delaminated in three days at RT/95% RH. Delamination as observed in Fibers D and F can result in glass strength degradation and handling problems since the coating comes off the fiber easily.

Degradation of optical fiber coatings in installations where elevated temperatures and humidity are encountered can result in loss of colored fiber identification, coating removal problems and delamination of the coating from the glass. Accelerated aging tests can be used to design coatings that age well and minimize the chances of problems occurring.

Summary

As fiber-optic applications continue to evolve, fibers are subjected to ever increasing performance demands. Coated fibers are required to provide uninterrupted low transmission loss while being exposed to elevated temperatures and humidity, increased solvent exposure and increased handling during installation and rearrangement. The fibers must remain identifiable, retain strength, maintain adhesion of the coating to the glass, and resist the solvents and solutions that are used. To design coatings for this level of performance, we utilize results from accelerated tests to select the coating candidates that will give the desired performance. We have presented techniques for evaluation of coating performance in the critical areas of strippability, strength retention, solvent and solution resistance, and aging and reliability.

Acknowledgment

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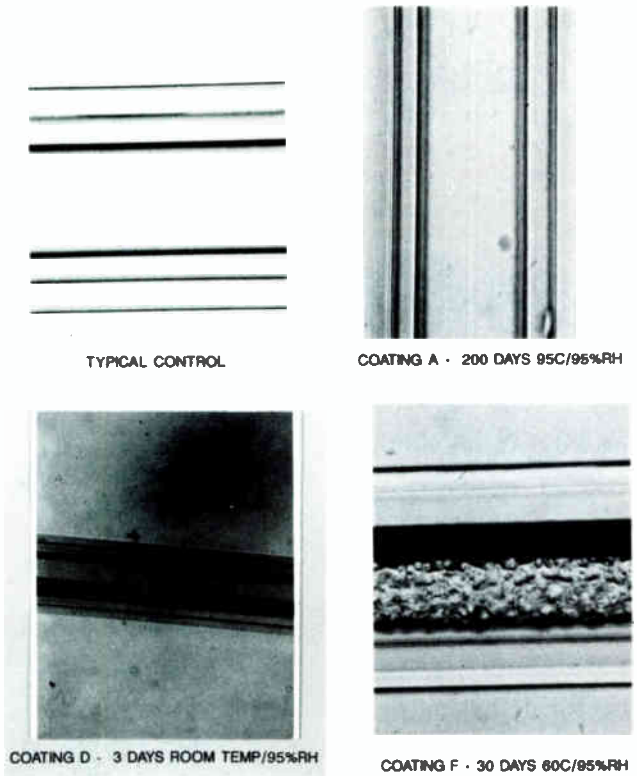
Figure 20: Relative delamination behavior of three optical fibers



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Outage management

(Continued from page 26)

liability is failure rate (λ). Because of the way cable systems are built and maintained (components are usually burned in on the bench before installation and are removed from service before wear-out), we can assume that the failure rate is constant over time. As a consequence of this assumption, μ and λ have the following simple relationship:

$$\mu = 1/\lambda$$

The reliability function describes what percentage of devices are working after time (t). For constant failure rates, the function is defined as:

$$R(t) = e^{-\lambda t}$$

When a system is composed of several devices in cascade, the failure rate of the system is equal to the sum of the failure rates of the individual components making up the system or:

$$\lambda_{system} = \lambda_1 + \lambda_2 + \lambda_3 + \ldots + \lambda_n$$

and:

$$\mu_{system} = 1/\lambda_{system}$$

With these basic concepts, we can construct a cable TV reliability model. A customer in the system is fed by a series of trunk amplifiers, power supplies, line extenders, cables, connectors and headend equipment including processors, modulators, descramblers, etc.

While the power supply is usually located in the middle of the group of amplifiers it powers, from a reliability perspective, it is the first device in series of a powered group. The model developed by CableLabs does not include the drop or the converter. Instead it focuses on multicustomer outages as opposed to single-customer service interruptions.

The model is based on a Lotus 1-2-3 worksheet that takes a basic network architecture (like cascade, channel capacity and number of amplifiers per power supply) and determines the performance at various iso-cascade points in the system. The CableLabs' model takes user input data and calculates system reliability at successive points in the system. In addition, the model can substitute a device's calculated MTBF with other values to perform "what-if" analysis.

Model validation

The model was tested using data from Warner Cable systems located in Houston; Columbus, OH; Nashua, NH; and Pittsfield, MA. The results showed a high degree of correlation between what the model predicts and the system results. The model identified differences that lead to variations in reliability performance.

Cable TV system reliability

The key factors involved in meeting acceptable outage performance are: trunk amplifier cascade, power supply cascade, the frequency of commercial power outages and equipment failure rate. As has been mentioned, the target is 0.6 outages/month. Using a cross-section of data that represents a hypothetical average system, a cable system can achieve 0.6 outages/month.

In order to conclude what effects the key factors produce, it was necessary to develop several test cases, which hold one or more of the key factors constant while varying the failure rate of a particular factor under test. The average CATV system's failure rates, which follow, were used as a Base Case, which resulted in 0.61 outages/month. Various test cases' outages/month were compared to the Base Case. A percent variance from the Base Case was calculated and is shown in the table on page 26.

Average CATV system:
Case 1 or Base Case
20% Modulator/processor failure rate
30% VideoCipher failure rate
33% failure in TVRO components
10% trunk amplifier failure rate
2% line extender failure rate
3% power supply failure rate
30% commercial power failure rate
3% failure of cable spans

The sample system used in the model was a 300-mile one with 300 trunk amplifiers, 1,000 line extenders, 90 power supplies and a 62-channel headend. Some estimates were made for the number of pieces installed in the headend: 62 modulators/processors, 30 VideoCiphers, 12 LNA/LNBs.

The following is an examination of the case results and points out the conclusions. The first key factor to be examined is trunk amplifier cascade.

Cable TV system structural reliability and customer expectations

By reducing trunk amplifier cascades, outages/month were reduced by 25 to 50%. Cases 2, 3 and 4 are the test cases involved. It was assumed that a proportional change in the power supply cascade occurs with changes in trunk amplifier cascade. The power supply cascades that were used are shown in two columns in the table (*# of reg PS* and *# of standby*).

Case 2 represents a 25% reduction in cascade from the Base Case, which resulted in a 27% reduction in outages. Case 3 is a 50% cascade reduction with a 47% reduction in outages. Case 4 represents a 50% longer cascade than the Base Case, which resulted in a 55% increase in outages.

The model showed that with all other factors being equal, 40-amplifier cascades will probably not meet an acceptable level of outage performance. Cascades equal to or shorter than the Base Case of 25 will meet 0.6 outages/month as long as average failure rates are experienced in the other key factors. If 40-amplifier cascades are to meet 0.6 outages/month, then improvements in the other key factors will be needed. The effects of the remaining key factors will now be examined.

System sensitivity analysis

Power supply cascades and the subsequent effects of commercial power outages were reduced through two methods: use of standby power and elimination of power supplies through redesign. The 11 power supplies in the Base Case represent the number seen in standard designs for this length of trunk amplifier cascade. In comparison to Case 1, Cases 5 through 11 are the test cases. Trunk amplifier failure rates and commercial power failure rates were held constant.

Case 5 shows the use of standby power at 5 of the 11 power supply locations. This reduced outages by 20%. The mixing of regular and standby power supplies has been the traditional approach with the standby units being used in the first few power supply locations.

Cases 6, 7 and 8 show 50% decreases in power supplies from Cases 4, 1 and 2. For these three cases, the results of decreasing the power supply cascade by 50% is a 25% reduction in outages.

Case 9 shows the Base Case with

all 11 power supplies converted to standby. Approximately 50% of the outages were eliminated as compared to the Base Case.

Case 10 shows a 50% reduction in the power supply cascade coupled with a 33% use of standby power. This resulted in a 32% reduction in outages.

Reductions of 50% in the power supply cascade consistently reduced outages by 25%, while the 50% use of standby power reduced outages by only 20%. A mixing of the two methods further reduced outages by 30%.

Regarding the use of standby power, the cable industry's experience with standby power supply is that we don't see a 100% elimination of commercial power outages. There are issues with batteries, outage length and corresponding battery capacity, electronic complexity of the standby power supply and maintenance. In order for us to see the elimination of commercial power outages, we may need standby powering. However, the issues regarding standby powering will have to be dealt with.

Commercial power reliability

The frequency of commercial power outages, or commercial power failure rate, is the percentage of power supplies that experience a commercial power failure in one year. A 40% failure rate indicates that 40% of the power supplies experienced a commercial power outage. The test cases examine results for 40-, 25- and 12-trunk amp cascades with varying commercial power failure rates. The cases are 1, 3, 4 and 11 through 19.

Cases 1 and 11-13 show that in a 25-trunk amplifier cascade, 10% drops in commercial power failure rates result in a corresponding 16% (or 0.1) reduction in outages per month.

Cases 3 and 14-16 show that in a 12-trunk amp cascade similar reductions of 8% (or 0.05 outages per month) occur with 10% reductions in commercial power failure rates.

Cases 4 and 17-19 show that in a 40-trunk amplifier cascade, 22% reductions outages/month occur with each 10% drop in the commercial power failure rate. Even with a fairly low commercial power failure rate of 10%, the 40-trunk amplifier cascade did not meet the outage performance standard of 0.6 outages per month.

Decreases of greater than 10% (but probably less than 20%) of outages/month can be seen when decreasing the commercial power failure rate by 10%. The best performance for commercial power failure rate may be somewhere near 20%. And 40-amplifier cascades, with the other factors being at average failure rates, will not meet the standard of 0.6 outages/month.

Even though the loss of commercial power is generally out of our control, we still should take steps to reduce the number of occurrences. Knowing when the power company plans their maintenance allows us to activate backup generators and isolate ourselves from the outage.

Trunk amplifier failure rates

Trunk amplifier failure rates were examined for 40-, 25- and 12-amplifier cascades with failure rates of 15, 10, 7 and 5%. The results indicate that some substantial decreases in outages can be achieved with reductions in failure rates and that the reduction is tied to the cascade.

Cases 4 and 20-22 show the effects of failure rates in a 40-amplifier cascade. For every 5% reduction in the failure rate from 15% down to 5%, outages per month are reduced by 30% (or 0.2 outages/month).

Cases 1 and 23-25 show the effects for a 25-amplifier cascade. Outages per month are reduced by 16% (or 0.1 outages per month) for every 5% drop in the failure rate.

Cases 3 and 26-28 show the effects for a 12-amplifier cascade. Outages per month are reduced by 8% (or 0.05 outages/month) for every 5% drop in the failure rate.

The effect of trunk amplifier failure rates is directly tied to cascade length. Case 24, which is for a 12-amplifier cascade, indicates that we can tolerate a fairly high trunk amplifier failure rate if the cascade is shortened (0.37 outages/month) and still have some headroom. But, also built into the shorter trunk amp cascade is a shorter power supply cascade with a 30% commercial power failure rate.

Overall failure rate

For the average system with 40-amplifier cascades, the outage performance does not meet the 0.6 outages per month standard. And even with 5 to 10% changes in both trunk amplifier failure rates and commercial power failure rates, the 40-amplifier cascade still fails to meet the standard. The alternative is to reduce the power supply cascade and to totally isolate the system from commercial power outages. Cascades of 25 amplifiers can pass the standard with average performance on all of the key factors. Amplifier cascades of 12 have a distinct advantage because 10% changes in failure rates show smaller results, typically on the order of 0.1 outages/month. If 12-amplifier cascades do not presently meet the standard, then getting below 0.6 outages/month could be challenging.

The larger reductions in outages per month were obtained by reducing power supply cascades. An action item should be to review the current method for designing the cable TV power system and make changes to get the 50% reductions. The rule-of-thumb would be to average no less than four trunk amps/power supply for any cascade. In comparison, current designs are showing two trunk amplifiers per power supply. (This will be covered in more detail in Part 3 next month.)

The dynamics of the reliability model

As mentioned before, the reliability model is a Lotus 1-2-3 worksheet that allows the user to input certain system operating parameters, quantities of various components used in the system, and the numbers of failures of these components over a specified period of time. The worksheet, called FAILURE.WK1, will then calculate the predicted reliability performance of the system. The model is included on diskettes provided with the Outage Reduction document that was sent to CableLabs members last September.

With the use of "Assigned MTBF," what-if scenarios can be evaluated. One of several available results sections in the worksheet will indicate the calculated outages/month for a given cascade. What-if scenarios also can be performed by changing cascade parameters, again indicating calculated outages/month.

The reliability model has four major parts: Estimation Section, Calculation Section I, Calculation Section II and Calculation Section III.

• *The Estimation Section* is the primary data entry area. In it the user enters the quantities of specified parameters and components in the system, such as the number of channels, amplifiers, power supplies, etc. Failure information from actual system performance data also is entered, and the worksheet will show predicted MTBF

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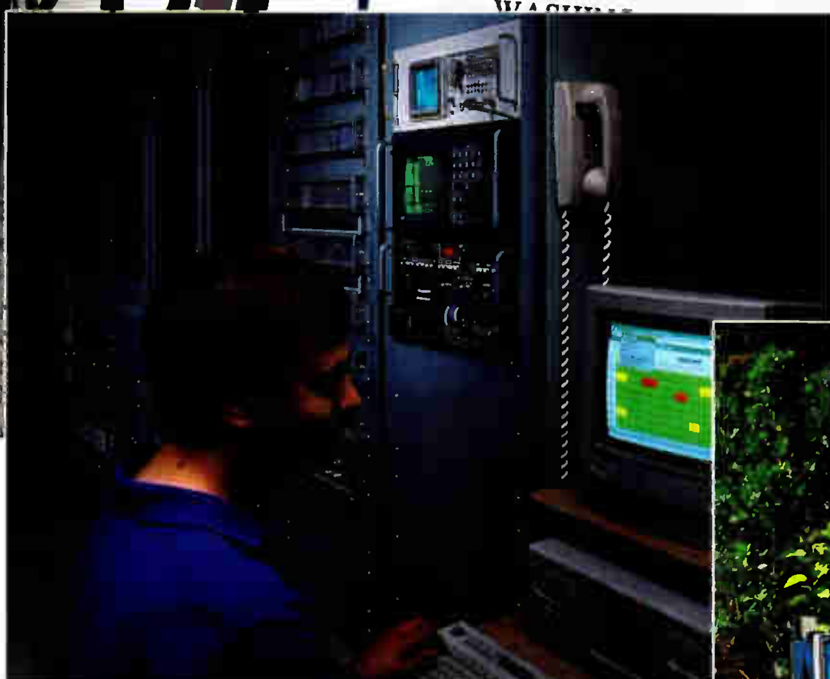

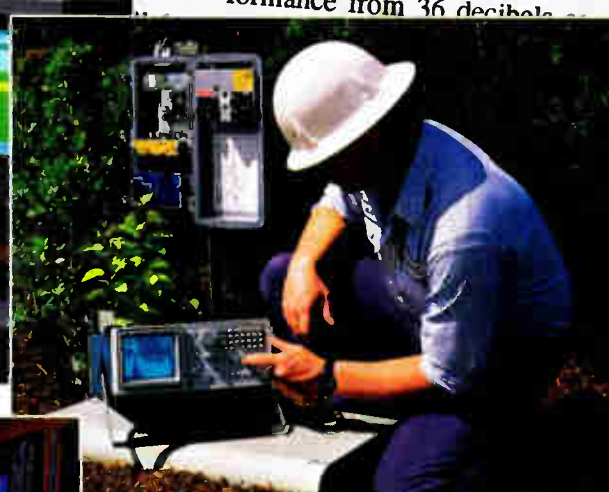

(ABOVE) THE CMP500 CABLE TELEVISION MEASUREMENT PACKAGE — COMPLETE BASEBAND VIDEO AND RF MEASUREMENT CAPABILITY, INCLUDING ALL FCC PROOF-OF-PERFORMANCE REQUIREMENTS.

(RIGHT) A WAVEFORM MONITOR, VECTORSCOPE AND NTSC GENERATOR CONSTITUTE A LOW-COST SYSTEM FOR EFFECTIVE BASEBAND MONITORING.

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to comply with the new set of standards, operators will be required to conduct baseband video proof-of-performance tests. Specifically, these will include chrominance-luminance delay inequality, differential gain and differential phase measurements.

In order to create a uniform, nationwide scheme, the FCC said its standards will preempt local standards. However

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for system components. This same section includes an "Assigned MTBF" column, where the user can perform what-if evaluations by entering target MTBF data.

- *Calculation Section I* will estimate system MTBF, outages per month and outages per year for a defined location in the system. This would normally be at the end of the longest cascade. This part of the worksheet allows the user to evaluate changes in a variety of system parameters, such as different cascade lengths or the use of standby powering compared to conventional powering. A detailed cascade analysis also can be performed, with MTBF results for various points along the cascade.
- *Calculation Section II* will estimate system reliability for a given cascade based upon MTBF data generated in the previous section. Three sets of monthly estimates for cascade performance are provided. These include reliability (shown as a percentage), outages per month and probability that an outage will occur. All of these estimates are shown for each point along the cascade.
- The last part, *Calculation Section III*, provides average reliability and MTBF figures for the overall system, based on an iso-cascade approach. This is an analytical tool that can characterize the system based on the total numbers of amplifiers at each cascade depth. For example, if four trunk cables originate at the headend (assume no splits in any of the trunks), there would be a total of four amplifiers at a cascade depth of two, four amplifiers at a cascade depth of three, and so on.

Does the model work?

After working with the model, there should be some consensus that the model-based results compare to some measure of customer satisfaction. In trying to achieve some comparison, several points need to be considered. These include:

1) Does the model behave like a cable system?

2) Can a cable TV system get to the acceptable level of outage performance?

3) What actual results are shown for systems?

4) Are the solutions achievable?

5) Do typical MTBFs achieve this level of outages/month?

6) Are any other plant issues involved?

7) What about headend issues and single channel outages?

The model does behave like a real cable TV system. You would expect that outages increase with longer amplifier cascades and higher failure rates and the model shows this to be the case. One of Warner's systems has collected data for subs out per outage, and the resulting calculation is very close to the model. Overall, the data collected from these systems and run through the model suggests that there is distinct difference in the level of outages between each system, and the respective customer surveys concur.

Summary

The Lotus 1-2-3 reliability model was developed by the task force to be a useful tool for evaluating the predicted reliability performance of various cable system configurations. Given its correlation with actual system performance, engineers and designers can quickly determine whether or not a system will be within CableLabs' recommended reliability threshold. The availability of this model also will allow system reliability to be evaluated along with the more familiar performance criteria of end-of-line noise and distortion calculations. **CT**

Technical service

(Continued from page 25)

shown significant improvement in the following areas:

1) Reduced abandonment rate. It dropped from 23.2% in 1988 to 3.5% for year-end 1990. Currently, the number is 1.6%.

2) Report rate dropped from 9 per 100 customers to 1.75 per 100 customers.

3) Average time to answer phone dropped from 108 seconds in 1988 to 28 seconds in 1990. Currently, this is running at 15 seconds.

4) A decrease in staff from 26 to 20. (This is despite the fact the number of customers in the system has increased.)

5) Improved overall customer satisfaction, responsiveness, etc.

As the ability to handle the number of customer phone calls began to show improvement, the number of people required to perform the work was reduced. It did not make sense to allow the same number of employees to perform a reduced work load. Therefore, price was controlled by reducing the number of employees handling the work. A base number of employees required to perform the work was determined and additional tasks were assigned to the group in order to fulfill other requirements within the corporation (such as the management of the PPV, the preparation of all work related with installation work orders, various nighttime calling activities, etc.)

The Wilmington system was one of the first systems in the U.S. to receive the National Cable Television Association's Seal of Good Customer Service. Much credit needs to be given to those past, present and future members of the now TCI of New Castle County Cablevision's Technical Operations Center for an outstanding job. **CT**

Competitive access

(Continued from page 28)

into increasing their quality of service as well.

CAPs like MFS are able to claim market share because they can do what the RBOCs do better and cheaper, which keeps the RBOCs on their toes. Before competition, Pac Bell could have a new leased T1 line in service in four to six weeks. Now it takes one day.

Kozak said, "As MFS expands and we become stronger in the marketplace, the customers will see a much more responsive Pac Bell over the coming years. They need to do that in order to remain competitive."

Network downtime can be a trillion dollar bottleneck for business. The New York City Partnership noted in 1990, that over $1 trillion in financial transactions are conducted daily in New York City. The business community is dependent on these financial transactions in order to operate.

In 1991 Nynex maintained a reliability standard that permitted downtime of up to 26.28 hours — which translates to over three and a quarter business days and $3.25 trillion in potentially lost transactions, representing billions of dollars in lost profits. MFS on the other hand guaranteed maximum downtime of only 53 minutes a year, and was only down for five minutes.

MFS has been pushing to improve standards across the board, by submitting its standards and records to the House of Representatives and FCC, as an impetus for pushing all carriers to adopt higher performance levels. Kozak said, "I would like to characterize MFS as the Nordstrom's approach to service for the feeling of comfort of certainty that we will be there if the customer needs us."

The LECs have been beefing up their networks in an effort to meet these higher standards. Traditional telco networks have been built using a tree architecture. If there is a break somewhere, then service is lost lower down on the branch.

"The opportunities for cable TV companies in competitive access could spawn a whole new set of alliances as the local loop is redefined."

Pac Bell, for example, has initiated an aggressive $100 million strategy for upgrading its aging Los Angeles network — 30 years old in some places — to a fully digital network incorporating SONET-based fiber-optic rings that can instantly reroute traffic in the event of a break somewhere. Gary Cuccio, product marketing president at Pac Bell said the recent FCC decision to force the LECs to interconnect "will motivate us to put in fiber faster."

Overcoming the barriers to competition

Realizing the high stakes up for grabs, MFS has been a trailblazer in opening the central offices to competition. In September 1989 it launched the "Local Equal Access Initiative," which asked the FCC and the Department of Justice to force the RBOCs into competition in several different areas. Actions requested included:

• Requiring RBOC interconnection

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of special access lines on a competitive basis.

• RBOC unbundling of interstate switched access traffic into component parts.

• Allowing phone number portability between service providers.

• Allowing equal access to Signaling System 7 (SS7) data bases.

• Regulatory scrutiny of RBOC services, particularly prohibition of anti-competitive cross-subsidization to competitive services.

• A system of careful auditing of LEC cost data to ensure that costs are not shifted to service elements that will be resold as part of interconnection offerings.

For many of these issues, the states have the power to get involved, but have taken a "wait-and-see" approach. A few progressive states, like New York, have gone ahead on their own to accommodate these changes, and speed the development of competition within their regions of coverage.

In May 1991, the New York Public Service Commission issued an order for interconnection that approved a New York Telephone (NYT) physical collocation tariff for the provisioning of intrastate traffic. Now Teleport is collocating with NYT, enabling Teleport to offer ISDN and Centrex services (27,000 Centrex lines had been installed as of February of last year).

MFS has signed agreements to interconnect with central offices (COs) in New York and four in Boston. This enables them to attract customers interested in connecting large networks with some nodes that are outside of the MFS range of coverage, using the CO as an extension of the MFS network.

Last September, the FCC mandated that all LECs with annual revenues in excess of $100 million would be required to interconnect with whoever requested it for special access connections. They are required to file interconnection tariffs by mid-February. This paves the way for CAPs to begin offering interstate services whereas before, only intrastate connections were possible.

As part of this ruling, the FCC required that LECs permit physical collocation of equipment of those requesting it. Some feel that this goes too far, including the chairman of the FCC, Alfred Sikes, who said, "It's not clear to me what problems we are attempting to resolve by requiring the local exchange carriers to provide physical collocation to all interconnectors that request it.

"Often such a highly regulatory approach will create more real problems than the illusory ones it seeks to resolve. This constitutes a 'taking' or confiscation of local exchange carrier property ... I have serious concerns about the local exchange carriers' ability to control access to their facilities and thus the impact of such a mandate on network reliability."

The commission has left the door open for "virtual collocation," which allows a CAP to run a fiber-optic line or other connection between its office and the LEC's. Virtual collocation is an option if the LEC can demonstrate its office is packed full, it is mutually agreed upon between the CAP and the LEC, or the state has a specific policy of requiring virtual collocation. With virtual collocation, the CAP can designate what LEC equipment it will interface to.

In light of these changes, the FCC has stated that LEC customers, bound by existing special access contracts with three or more years remaining, have 90 days after expanded interconnection becomes available to consider new options. If they do switch service providers, the LEC is permitted to charge a non-discriminatory one-time reconfiguration fee.

So as not to hamstring the LECs out between these new services, they have been given a reprieve to begin replacing the current pricing system meted out by the Modified Final Judgment, which required the LECs to offer equal pricing for all IXCs per unit of traffic. By November 1993, they must have the new system in place consisting of four types of charges:

1) A flat rate entrance facility charge to be assessed for transporting IXC traffic between the IXC and the LEC serving wire center.

2) A flat trunk charge to be assessed for service not requiring use of the LEC's switches.

3) A usage charge based on the volume of traffic used by the LEC's switches.

4) An interconnection charge based on the volume of traffic generated.

By unbundling usage fees, from a straight per unit traffic fee, the FCC hopes to encourage more efficient use of the transport facilities with a pricing strategy that reflects cost and facilitates the development of interstate access competition.

FCC Commissioner Ervin Duggan said, "The future success of local competition, the ability of the local telephone companies to compete, the preservation of vigorous interexchange competition, even the protection of interexchange service — all these depend on our ability to reach a sound conclusion on the rate structure and rate level issues in this proceeding."

Supplementing this new pricing structure, the FCC is considering requiring the LECs to interconnect to CAPs for switched access services, similar to that established for special access. In addition, it is looking at requiring the LECs to give SS7 to CAPs.

From the congressional side, Rep. Jim Cooper has been pushing for H.R. 3515, which would require a new tariff structure for facilitating increased CAP penetration, similar to that being considered by the FCC. In addition it would mandate number portability, so that a customer switching service providers would not be forced to switch telephone numbers as well.

Who can play the CAP game?

Many call the CAPs cream skimmers, because they are focusing on the highly profitable business of business, and are leaving residential users to the LECs.

As the LECs begin to build fiber, the CAP advantage erodes and they need to find new niches to fill. While the IXCs have been rolling out new data services like Frame Relay, the LECs have fallen behind in getting the technology on the road. This could prove a point of assault to the CAPs. The Yankee Group believes a key to CAP market growth will involve moving away from providers of special access circuits toward application-specific offerings their customers require from access providers.

The CAPs have begun offering customers the ability to monitor their networks and reconfigure them to optimize the cost, which is something that LECs have avoided. Some CAPs even offer E1 circuits, the European equivalent of at T1, which is not compatible. This lets customers interface networks directly with Europe.

The cable companies are attracted to the CAP game by the notion that they can expand the use of their network. Some estimate that 80% of all cable companies have some fiber, so they are uniquely positioned to offer data and networking to both residential and business customers. New technologies, like American Lightwave's Soneplex are enabling these networks to carry every kind of data imaginable.

That 60% of all CAPs are related to cable companies may be due to the strengths they bring to the table, maintains The Yankee Group. These include substantial capital, a long-term view, right-of-way, existing customers and the plant and plans for fiber. CAP networks are by their nature, capital intensive, as they are often based on the state-of-the-art in fiber-optic technology. The Yankee Group estimates that $1 billion will have been invested in CAP fiber-optic networks by the end of 1993.

Many cable companies are already in the process of converting their cable plants to fiber. This same network could be adapted to support voice and data services as well. However, Lowenstein believes that it will be a few years before we begin to see CAP networks completely integrated with cable TV networks.

John Holobinko, at American Lightwave, in Wallingford, CT, said that many cable companies are moving into the business of providing bypass services for video services. Now instead of satellite broadcasts, which can be uplinked from anywhere, events are relayed using nationwide video distribution networks, such as Vyvx, a Willtell subsidiary based in Oklahoma. Holobinko said, "When ABC wants to carry Monday night football, Vyvx does not need a point-of-presence in Minneapolis and at ABC headquarters, it uses a bypass carrier on both ends."

Holobinko believes cable TV companies are looking more at bypass operations now that they have fiber in the local loop. He said that traditional telephone T1 line equipment can easily exceed $10,000 per end, because they must subsidize expensive equipment across a few users. Note that 80% of all high capacity operations use four T1s or less. Using a line of equipment developed by American Lightwave (called Soneplex) operators can price a T1 service for about $2,000 an end.

"The FCC mandated that all LECs with annual revenues in excess of $100 million would be required to interconnect with whoever requested it."

New technologies are enabling cable operators to interconnect LANs over existing coax, which could enable them to leverage their existing base for CAP services, without having to build fiber. Zenith Data Systems has developed a way of splitting radio frequencies over coax for data. DEC's Ethernet on television serves the same purpose.

Cable companies right-of-way enables them to subsidize network growth with existing conduits, which could otherwise weigh in at a hefty price tag. Many utility companies are taking advantage of this asset as well. Baltimore Utilities operates a Baltimore-based CAP network owned by BG&E. Electric Lightwave in Seattle and Portland, OR, is backed by Citizens Utilities Capital Corp. Houston lighting and power operates a CAP network as a division of the company. MWR Telecom in Des Moines is a part of Iowa Power. Tulsa Metrolink, is part of Oklahoma Public Service Co. All of these utilities are able to leverage their existing infrastructure of conduit for these new CAP services.

How will these CAPs be able to undercut the LECs that have already spent so much capital and time in providing these services? Kozak said, "Our network is not carrying all of the people overhead." While the LECs are stuck with an existing bureaucracy, the CAPs can start from ground zero designing their organization for optimum efficiency. Also, many of the CAPs are using the latest in modern technology, which can be cheaper to install and maintain. American Lightwave's Soneplex is a good example. Another factor is that the CAPs have been focusing on the business market of customers that are really profitable. This leaves low return on investment universal service to the LECs, which they are required to maintain.

The future of competitive access

The opportunities for cable TV companies in competitive access could spawn a whole new set of alliances as the local loop is redefined. They already have the networks that reach the customer. Kozak said some are thinking about going into the telephone business themselves.

There is nothing preventing them from doing this for interstate traffic, if they bypass the LECs completely. However, within each state, the rules may be different. Kozak cautions that there is a different set of economics involved in telephone service than entertainment. He said that they may be better off aligning themselves with someone who already knows the business.

The technology for voice over coaxial cable exists and is being used for the delivery of a one cable to the home solution for voice and video in England. Denver-based ONI produces a product called CLC-500 used in these networks. But many believe that the margins would be too low to justify cable companies getting into the voice business. However, as the bandwidth of interactivity demanded by consumers begins to expand, this may change. Cable companies may be able to charge a premium for videophones or interactive virtual reality to the home. **CT**

Satellite look angles

(Continued from page 34)

known or may be computed from a U.S. Coast & Geodetic Survey 7.5 topo map. The declination also may be read from the same topo map. The program is easily modified to read in less than 1° increments if desired.

2) It is written as a Lotus 1-2-3 template. Lotus 1-2-3 is widely used throughout the cable industry. Other 1-2-3 compatible programs such as Quattro Pro also may be used to run the template.

3) The template can be modified for use in the Southern Hemisphere.

It has been designed with the idea that a complete chart is printed out and posted in the headend. (A partial replica of the spreadsheet printout is shown in the accompanying table on page 34. This example spreadsheet only shows from 60 to 63°. See Item 5 following the program for directions to expand it to cover your required arc.) It can be used as needed without further calculations. A clinometer, a common magnetic compass and this chart are the only resources needed to find a satellite in the sky. With the relocation of satellites, a chart printout of look angles will be beneficial. **CT**

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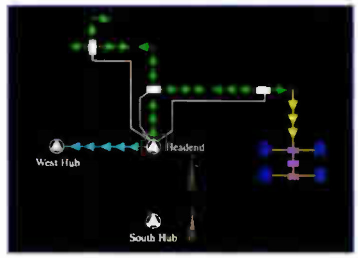

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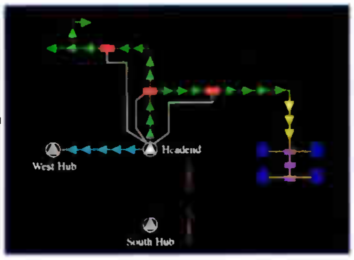
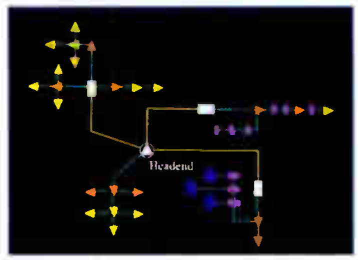


C.A.N. Rebuild, Upgrade

OR THE KNOW-HOW

TO BUILD, REBUILD OR UPGRADE



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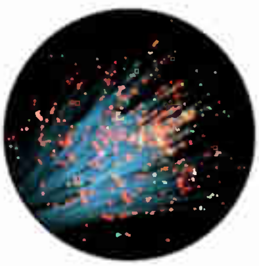
YOUR



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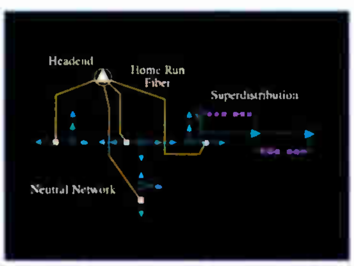

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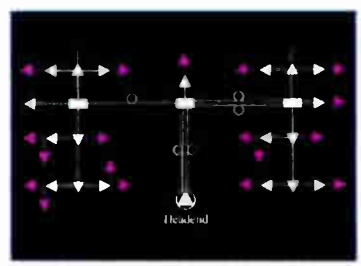

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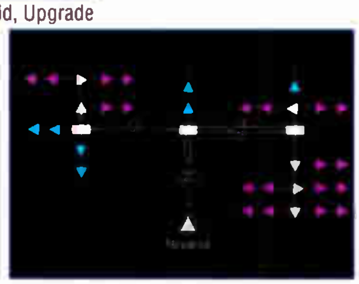

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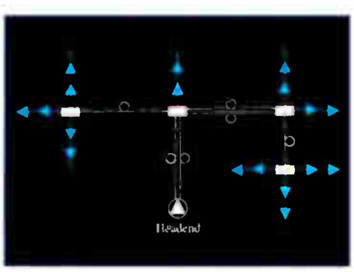

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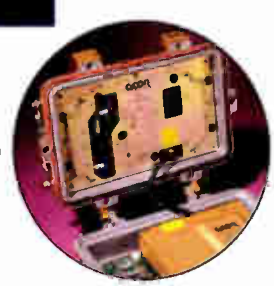

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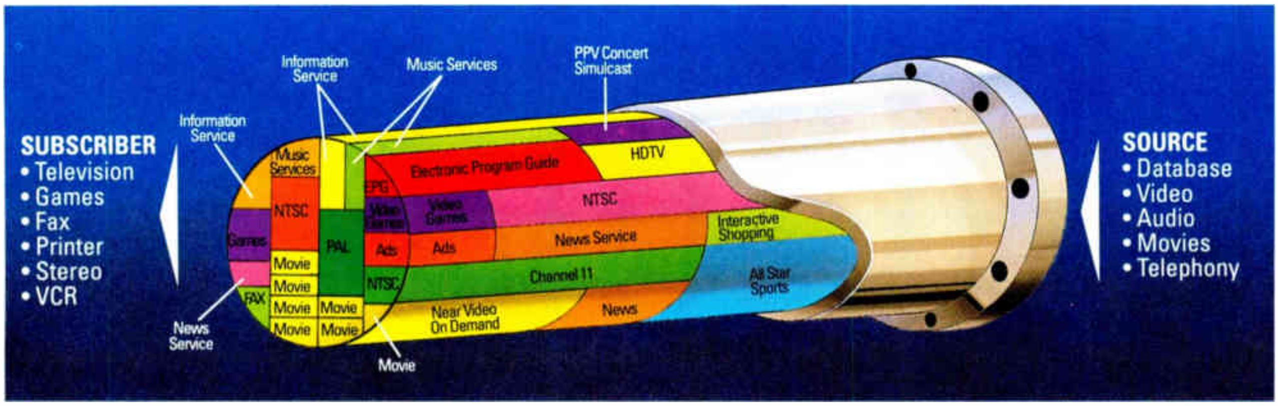

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FCC-required measurements

(Continued from page 33)

proximity to the analyzer noise floor to provide an accurate measurement result.

The FCC specifies a normalized noise bandwidth of 4 MHz for this measurement, which is the 2714's default setting. Also, the 2714's accuracy can be enhanced under certain conditions by utilizing an external preselector and/or an internal preamp.

A 36 dB C/N is the immediate requirement, with the mandated goal in three years being 43 dB. One year plus 90 days from adoption of the regulations, they tighten a little to 40 dB.

The final twist on C/N is the types of signals to which the specifications apply. Class I and II signals (anything resembling NTSC video) are broadly specified in the regulations. With C/N, however, the FCC realizes that some signals received at the headend may already exceed the given limits. So the specifications for C/N apply to the following classifications of signals:

- All public access and local origination channels (Class II),
- All Class I signals first received via direct feed from a traditional broadcast station, an LPTV station or TV translator,
- All Class I signals picked up over-the-air within their predicted Grade B contour, and
- All Class I signals delivered to subscribers within the signal's predicted Grade B contour.

Hum

Hum bars rolling through your TV picture are among the most annoying of all distortions. Just when that slow moving, horizontal bar rolls off the top or bottom of the screen and you think you're rid of it, there it is again, at the other end of the display.

Hum occurs when 60 Hz power line energy, or its 120 Hz harmonic, modulates the visual carrier. Expressed as a percentage of the visual carrier, peak-to-peak hum is measured with no modulation on the channel in question. Since modulation must be shut off to perform the measurement, automating the process is highly desirable.

The 2714 can measure hum on-line, provided that sync-suppressed scrambling is not used on the selected channel. If it is, you'll have to shut off modulation or scrambling to get accurate results. This is because the measurement looks for hum at sync tip, and if horizontal sync is suppressed, the 60 Hz signal component due to vertical sync will be measured instead. Misinterpreting vertical sync as hum would yield a very large, inaccurate result.

The analyzer's hum routine first records the visual carrier level. Then the instrument switches to zero span and acquires portions of the time domain waveform. A Fast Fourier transform (FFT) moves the time domain data back to the frequency domain to simplify measurements of the 60 Hz and 120 Hz components. Three results, each expressed as a percent of visual carrier, are then displayed: 60 Hz hum, 120 Hz hum and total hum (root-sum-square of 60 Hz and 120 Hz hum). The entire process takes only a few seconds.

This concludes the series on the recent FCC technical regulations. With this information, you'll be better equipped to deal with the specific measurement issues surrounding them. While they may still seem like a big hassle, these requirements are likely to improve the technical quality of the product you deliver — and that can only be good for your business. **CT**

"Time" compressed TV?

By Lawrence W. Lockwood
President, TeleResources
East Coast Correspondent

"It seems that ... the mass use of time compression faces enough difficult hurdles to question how soon or in what manner it may be realized."

The idea, according to proponents of time compressed TV, is to deliver a 90-minute movie in just a few minutes to a digital storage device in subscribers' homes. Playback could take place either immediately after the signal was received or at some later point in time.

In Europe, an entrepreneur named William Graven has been promoting this approach and a digital VCR technology developed by his company, EMC2. A U.S. company, Instant Video Technologies (IVT), showed its time compressed TV technology at the 1991 Consumer Electronics show. IVT President Richard Lang says that the core of its technology is a patented system that he claims can achieve a 100 to 200:1 time compression. Lang predicts IVT will introduce a product for the commercial market within 12 months, with a price probably in the $5,000 range. He believes it may be three years before storage prices fall enough to allow the company to offer a consumer product — in the $400 to $500 range. Incidentally Lang was a principle and co-founder of Go-Video, a U.S. company that developed a dual-deck consumer VCR. The company achieved widespread attention by suing a number of Japanese VCR suppliers on antitrust grounds.

Unlike EMC2, Lang believes VCRs are not an appropriate storage technology for a time compression delivery system. Yet other storage approaches have problems. At present, the read-write times for hard disk drives are too slow for full-motion video playback and RAM devices used as buffers are currently very costly. However, he is counting on the rapid decline of memory costs to continue. Lang also says that the cost of consumer memory can be cut by delivering video programs in short segments, say five minutes long, then sending a follow-up burst sometime before the first segment is completely played back. He also suggests, for example, that some memory could be located at an intermediate point in the network; e.g., fiber-optic nodes serving 500 homes.

At least one more U.S. company has entered the fray — USA Video Inc., which has been granted two patents for systems architectures for time compressed video-on-demand services. USA Video (which is headquartered in Beverly Hills, CA, and has research facilities in Dallas) originally targeted the telephone industry for application of its technology, but because of the slowness of telco fiber-in-the-loop (FITL) deployment it has shifted its efforts to the cable industry. However, both cable and telephone industry officials that have been approached by USA Video have indicated that the company still has a lot to learn about the industries it hopes to do business with. USA Video President Gordon Less is currently pursuing an alliance with computer maker Digital Equipment Corp. (DEC).

Uncompressed digitized video

To get an overall view of how a time compression system works technically, a few steps in the digital processing must be reviewed. First the video is digitized, then the digitized video is compressed and stored, and finally the resultant compressed digitized video is transmitted at a high data rate to a reception point where it is stored for later playback at a slower rate (a time *uncompressed* rate).

Table 1 shows some digital rates for several video standards[1]. The first two systems in the table (NTSC) are composite video systems and the second two systems (CCIR 601 and SMPTE 240M) are component video systems[2].

- Composite NTSC video is the familiar NTSC signal with the two chrominance signals modulated on the subcarrier, which is multiplexed with the luminance signal and the combination is a single output signal.
- Component video keeps the luminance signal (Y) and the two chrominance signals (R-Y and B-Y) separate, and therefore component video has three signal outputs.

CCIR (Consultive Committee International Radio) 601 is an international standard adopted by the NTSC, PAL and SECAM countries for digitizing any of those video signals. SMPTE 240M is a standard adopted by the Society of Motion Picture and Television Engineers

Table 1: Digital data rates (uncompressed) for several video standards

System	Sample rate	8-bit data rate	10-bit data rate
NTSC	10.74 MHz = $3f_{sc}$	85.92 Mbit/s	107.4 Mbit/s
NTSC	14.32 MHz = $4f_{sc}$	114.5 Mbit/s	143.2 Mbit/s
CCIR 601	13.5 MHz	216 Mbit/s	270 Mbit/s
SMPTE 240M	74.25 MHz	1,188 Mbit/s	1,485 Mbit/s

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Table 2: Image and video compression standards

Features	JPEG	MPEG-I	MPEG-II	Px64
Full-color still images	Yes			
Full-motion video	Yes	Yes	Yes	Yes
Broadcast-quality full-motion video	Yes		Yes	
Image size	64Kx64K (max.)	306x240	640x480	360x288
Compression ratios	10 to 80:1	200:1 (max.)	100:1 (max.)	100:1 to 2,000:1
Data rates (compressed)		1.5 Mbps	5-10 Mbps	64 kbps-2 Mbps

(SMPTE) while the Japanese MUSE HDTV system was being considered very strongly as an HDTV standard. All four of the current digital HDTV standards under current consideration use component digitization but the sampling rates are different for each of them.

Since composite video is a single signal, the digital sampling rate is of a single value — usually either three or four times the 3.58 MHz color subcarrier frequency. However, since component video is a three-signal (Y, R-Y, B-Y) system, three separate digital sampling rates are specified. In CCIR 601 the 13.5 MHz sample rate is applied to the luminance (Y) signal. Since lower spatial resolution is required in color, the two chrominance signals are each sampled at one-half the luminance rate; i.e., 6.75 MHz.

Compressed digitized video

As shown in Table 2, image and video compression standards fall into four classes: JPEG (Joint Photographic Experts Group), MPEG-I, MPEG-II (Motion Picture Experts Group) and Px64 (CCITT H.261). The JPEG standard was developed for still images, but some commercially available chips[3] can operate at 30 frames/s.

MPEG-I applies to full-motion video and was originally intended for CD-ROM applications (about 1.5 Mbps) yielding VHS-quality decompressed video, while the intent of MPEG-II is to offer improved video quality suitable for broadcast operations. MPEG-II has not yet been formally ratified but a Working Draft is scheduled to be "frozen" by a scheduled March 1993 meeting of the MPEG in Australia. The Px64 (CCITT H.261) standard is intended for video teleconferencing.

Time compressed TV

If a 60:1 compression ratio is applied to the composite NTSC signal of 85.92 Mbps the resultant compressed signal is about 1.5 Mbps. A compression ratio of 120:1 produces a signal of about 750 kbps — in the neighborhood of very high quality video teleconferencing. Compression of 60:1 is close to that used in all four HDTV digital schemes. Their sampling rates vary from about 50 to 75 MHz yielding data rates varying from about 14 to 18 Mbps. The compressed 1.5 Mbps signal can be transmitted in a 6 MHz channel at four times that rate. Therefore a 60-minute program can be transmitted in 15 minutes in a 6 MHz channel. The values in Table 3 are derived in that manner. The compression of HDTV is applied to component digital signals. In compressing the NTSC composite digital signal using a much more conservative compression ratio of 30:1 would merely double the values in Table 3.

Conclusions

IVT's Lang argues that time compression is the most cost-effective way to achieve a true video-on-demand capability. He claims that by using just six video channels on a cable system IVT can download a full-length movie in just two minutes. Lang notes another advantage of a time compression system: By downloading to a digital storage device in the home it allows viewers to enjoy VCR-like features (e.g., pause, rewind, fast forward) that real-time transmission schemes cannot readily offer.

However the price of that home device presents one of the significant obstacles in the path to mass implementation of time compression TV. Cable operators are going to be more than a little reluctant to foot the bill for every subscriber at $400 to $500 each. Lang, however, proposes that it may be possible that others (i.e., pay-per-view programmers) may pay for them.

It seems that, although certainly technically feasible, the mass use of time compression faces enough difficult hurdles to question how soon or in what manner it may be realized. The proposers, of course, will continue to promote and hope. But if they are occasionally disheartened with their progress they might well keep in mind an encouraging definition of hope by the playwright Jean Kerr — "Hope is the feeling you have that the feeling you have isn't permanent." **CT**

References

1 *Video Engineering*, A. Inglis, McGraw-Hill, 1993.

2 *HDTV Advanced Television for the 1990s*, K. Benson and D. Fink, McGraw-Hill, 1991.

3 "Monolithic Architectures for Image Processing and Compression," K. Konstantinides and V. Bhaskaran, *IEEE Computer Graphics and Applications*, November 1992.

Table 3: Examples of transmission times

Program length (min.)	Transmission time in minutes and seconds					Video compression
5	75s	12.5s	6.3s	1.3s	0.4	60:1
	37.5s	6.3s	3.2s	0.6s	0.2s	120:1
30	7.5m	1.25m	38s	7.5s	2.25s	60:1
	3.75m	38s	19s	3.8s	1.13s	120:1
60	15m	2.5m	1.25m	15s	4.5s	60:1
	7.5m	1.25m	37.5s	7.5s	2.25s	120:1
120	30m	5m	2.5m	30s	9s	60:1
	15m	2.5m	1.25m	15s	4.5s	120:1
Transmission bandwidth (MHz)	6	36	72	360	1,200	

January 1993

BACK TO BASICS

Calibrating leakage equipment

The training and educational supplement to Communications Technology magazine.

Table of Contents

Signal leakage calibration, etc.

By Dick Shimp
Manager of Technical Support
ComSonics Inc.

Hardware used to measure signal leakage escaping from a CATV coaxial environment hasn't changed very much over the years. This is a true statement probably for the same reason a few pieces of properly formed wire strategically placed on a small board makes the best mouse trap (so far). Both devices aid in simple elimination tasks that involve far more complex physical properties during execution. This article addresses some of the questions that, on a daily basis, plague those required to perform this most important function.

Leakage basics

Fundamental leakage quantification device requirements are:

- Select or insert a test carrier for leakage control.
- Selectively intercept energy inadvertently emitted from the cable.
- Interpret and display its root mean square (RMS) amplitude.

Let's expand a bit on this listing. First, among all the other channels carried, one signal (or perhaps more) acts specifically as a signal leakage indicator. It may be a discrete and dedicated carrier used only for this purpose. It also may be a normal picture delivering TV carrier, doubling as designated signal leakage channel and perhaps even serving triple duty as one of the system pilot carriers.

With a test signal inside the coaxial system, causes of integrity loss create microscopic means to quite visible means of signal escape. The years have seen many changes as the importance of signal containment became focused. As examples, consider the near extinction of two-piece F-connectors, braid-only drop cables and sleeveless hardline connectors. Even given all the improvements, some degree of integrity loss is a fact of life because of harsh environmental exposure. Temperature presents an ever-changing challenge because of the expansion and contraction of the metals comprising the system. Wind and ice wreak havoc in their selective geographic areas accompanied by rodent damage.

Energy hurls from within the coaxial system opening at the speed of light. Some escaping energy passes onto a thin surface layer of the cable sheath and eventually dissipates as heat. Some energy breaks free from the near-field coherent bond at the leakage point as well as from the surface of the outer conductor and launches into the surrounding far-field space. It is the latter that generates signal leakage and causes concern.

Signal leakage is present in the free-space surrounding coaxial systems. The magnitude is proportional to the amount originally launched into the system modified by the degree of system shielding integrity and the distance from the launch mechanism. Its amplitude is never zero, but, governed by our choice of detection equipment, may be below our ability to quantify.

To determine the amplitude of a given leak, expose an antenna to space and systematically search for one (or more) of the previously mentioned test carriers. The antenna continuously intercepts electromagnetic fields that get routed through a short interconnecting cable to the receiving device. It is up to the receiver to isolate the lone signal that reflects the leakage state within the system and determines the absolute field strength of the intercepted power. The accuracy of the answer is totally dependent upon the cumulative calibration of the system.

Legal references

The Federal Communications Commission controls radiated signal traffic to make the most efficient use of free-space signaling. There may seem to exist an unlimited number of frequency allocations to propagate radiated information. Endless demand dispels this premise. With present coaxial technology, spectrum reuse makes delivery of cable TV signals possible. This philosophy is achievable only so long as conflict does not exist. An adequate amount of shielding integrity, maintained within the coaxial environment, minimizes the signal leakage conflict.

Part 47 of the Federal Code of Regulations, paragraphs 76.605 (11), 76.611, 76.612, 76.614, 76.615 and 76.616, provides the operator with specific level limitations for various portions of signal leakage containment efforts. By far, however, by describing the maximum allowable leakage for every 24-hour period, 365 days each year, the first paragraph, 76.605(11), contains the controlling specification.

Stated leakage specification limits, whether 20, 50 or 100 µV/m, give absolute ceiling levels. Perfecting monitoring techniques and maintaining hardware calibration improves confidence in the ability to maintain the leakage levels below the legal threshold.

A frequency-selective shielding integrity loss is not typical. Honoring the most stringent leakage limits allows using any signal carried on the system to accomplish control across the occupied CATV spectrum. Keep in mind that the FCC expects obtaining cumulative leakage index (CLI) samples at a frequency location within the commercial aircraft navigation and communication signaling frequencies, i.e., between 108 and 137 MHz, or adjusted to be equivalent.

Leakage signal source

- *Frequency discussion.* Regardless of the channel or carrier selected for monitoring, it is vitally important that the test signal frequency matches the tuned detector center frequency within the tolerance allowed by the bandwidth of the latter and its temperature dependence. A detector with 2 kHz bandwidth used in conjunction with a modulator specified to deliver a given center frequency ± 5 kHz invites error.
- *Amplitude discussion.* Quantifying signal leakage is the equivalent of determining the interference potential experienced by allowing normal signal carriage to escape the confines of the coaxial environment. Making the evaluation

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delivered to the terminals of an antenna: the strength of the surrounding field, the tuned impedance, and the directivity. The field strength value represents the unknown variable in this trio affected primarily by the size of the shielding flaw or flaws present within the immediate area. Tuned antenna impedance varies somewhat with mounting position, but very little affects the nominal value achieved by proper element length adjustment.

Antenna directivity determines terminal voltage gain. Directivity refers to the field pattern difference exhibited by a particular antenna when compared to a theoretical antenna. The latter isotropic antenna assumes a spherical pattern with signal gain equal to one. Practical antenna patterns, on the other hand, reduce the sensitivity in certain portions of the pick-up sphere while realizing improvement in the areas remaining. Signals received with the antenna in the direction of the improved sensitivity will produce higher terminal voltage than those theoretically available from the isotropic device.

The sensitivity pattern of a tuned dipole resembles an infinitely large donut with the antenna elements spearing the donut hole. With elements parallel to the earth, the horizontally positioned dipole donut pattern rolls the surface of the earth. Vertical orientation flips the donut on its side and the antenna elements are perpendicular to the earth. In free-space, both positions demonstrate a maximum gain, perpendicular to the elements' center, equal to 1.64 times that of the isotropic receptor or about 2.14 dB.

Removing one element from a half-wave dipole and adding an RF ground to one end constructs a quarter-wave monopole. The antenna exhibits much the same sensitivity as its dipole counterpart with a radiation pattern resembling the upper half of a donut lying on its side. A single element mounted to an ideal ground plane exhibits the same gain potential as a twin-element tuned dipole.

Calibration techniques

Locating and quantifying signal leakage requires a relatively simple set of hardware: a test signal transmitter, a test signal detector and an antenna (along with considerable patience). The following concentrates on indirect and direct methods of confirming the accuracy of these devices.

• *Test source calibration.* Meaningful signal leakage testing requires identical peak amplitudes from both the test signal source and the nearest adjacent active channel. If a separate device, dedicated to signal leakage, the test source likely contains symmetrical amplitude modulation. Remove such modulation from the carrier before adjusting its peak amplitude.

Test source frequency drifts somewhat with reference crystal aging. Periodic use of a frequency counter ensures that the transmitter carrier remains close to the center of the

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detector's narrow passband. Use a frequency counter capable of at least 1,000 Hz resolution and remove the test signal modulation from the carrier before deciding the correct frequency.

Adjust the amplitude of a video modulator doubling as a leakage test source with or without modulation applied since the peak carrier amplitude is identical in both cases. Amplitude calibration requires setting the test signal level equal to the peak level of the nearest adjacent channel. Long-term frequency stability causes a calibration concern when using video-sensing detection methods. A modulator normally serves as the device for video sensing leakage testing besides its primary duty of delivering pictures. Modulators perform their primary function without compromise while exhibiting a center frequency error of ±5,000 Hz. Yet, the same frequency skews can place the carrier outside the passband of a signal leakage detector. Periodic checks of the center frequency reward you well by reducing the probability of searching for an out-of-touch carrier.

Use a frequency counter to compare the modulator's center frequency with the detector manufacturer's specified center frequency. A difference of 1,000 Hz may cause sensitivity loss symptoms when operating leakage detectors at temperature extremes. The modulator holds its center frequency more closely when operated within a controlled environment allowing no more than a few degrees of temperature fluctuation.

- *Test detector calibration.* Indirect calibration depends on manufacturer supplied transfer standards built into the hardware in concert with an occasional test to confirm the standard's accuracy. Some signal leakage detectors have no internal provisions for calibration confirmation. Those require checking with more direct methods discussed later. Others contain an internal temperature independent source for providing received signal amplitude confidence. The typical calibration source provides a signal that is equivalent to 20 µV/m at the input connector assuming use of a tuned dipole. During equipment use, follow the manufacturer's instructions for calibration checks often since the accuracy of all measurements depend upon this setting.

It's relatively easy to directly couple the transmitter signal into the detector to test the calibration accuracy and, if present, the accuracy of the internal calibration source. Because of the typical detector's sensitivity, perform the test remotely from the transmitter, using the test signal available at a subscriber tap or the equivalent.

The trick is lowering the test signal until it is equivalent to 20 µV/m. Since the signal leakage detector is being calibrated, establishing this quantity requires use of another tool. Measure the value of the leakage test signal with a signal level meter or spectrum analyzer[1]. (Check the calibration date on both.) Armed with the starting value, reduce the amplitude with in-line pads or, if available, a step attenuator to the equivalent of 20 µV/m.

Part 1A: Determine the decibel voltage equivalent of 20 µV/m using:

$$\text{dBmV} = 20\log E - 20\log(20.7F)$$

Where:
E = µV/m

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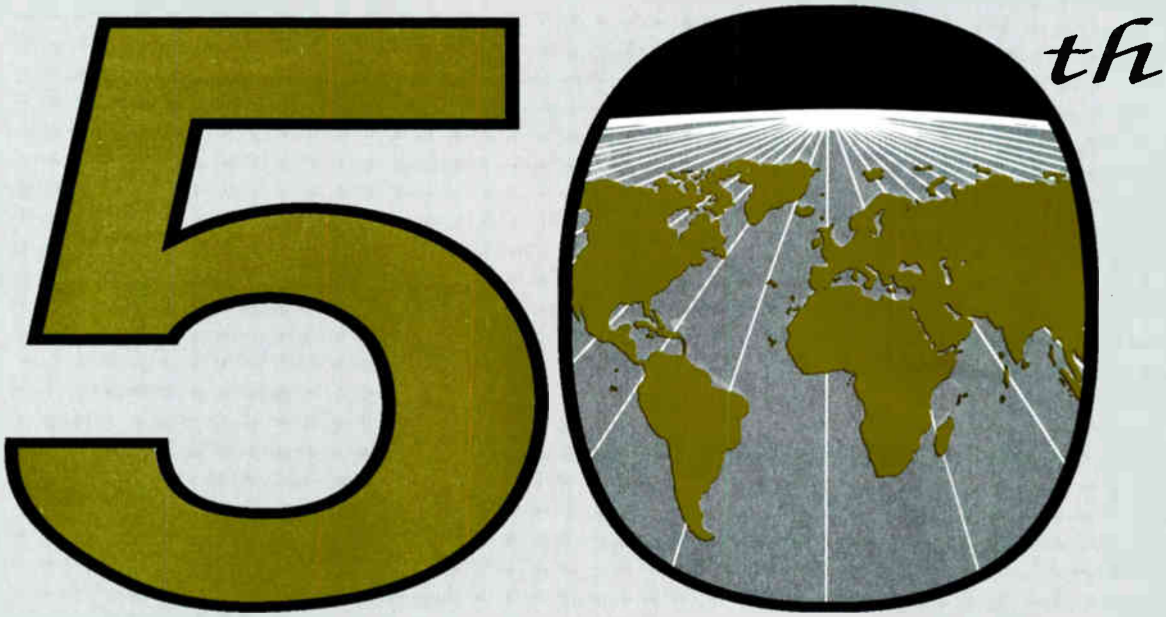

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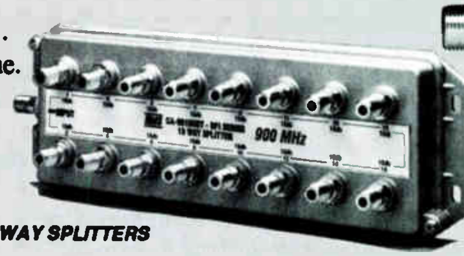

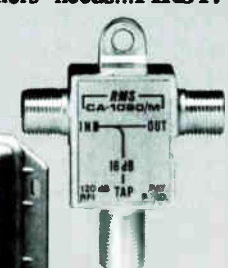

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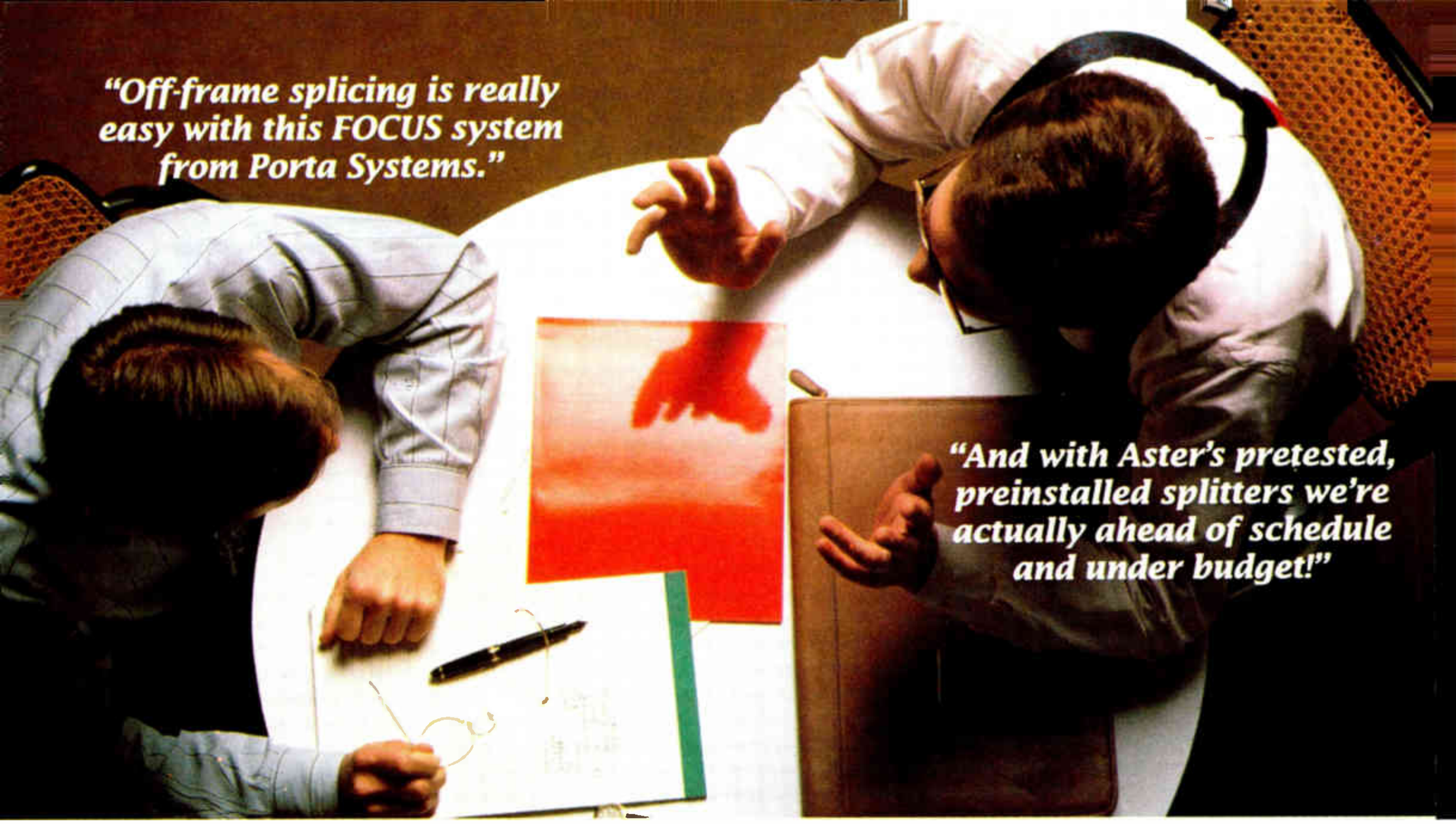

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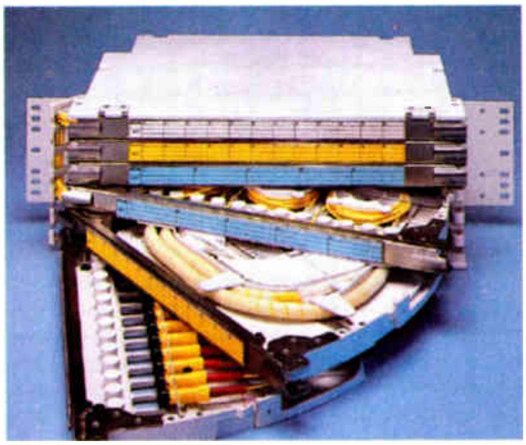

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Reader Service Number 61

F = Frequency in MHz

Example: For 108.6250 MHz then:

$dBmV_{(20\ \mu V/m)} = 20\log(20) - 20\log(20.7 \times 108.625)$

$= -41.017$

Part 1B: Then compute the attenuation value necessary using:

Attenuator value = input level - $dBmV_{(20\ \mu V/m)}$

Given an unmodulated input signal level of +5 dBmV:

Attenuation $value_{(dB)} = 5 - (-41.017) = 46.017$ dB

Finally, connect the +5 dBmV test signal source to the detector through the computed attenuator value. Be sure that the connections are tight to avoid creating leakage around the pads; otherwise the level may be higher than expected. An absolute measuring detector[2] should indicate 20 µV/m. Set the indicator of those detectors with variable gain to the proper 20 µV/m scale mark. Engage the calibration source and note that the indicator does not move significantly. Little movement signifies that the calibration source and the input signal are nearly the same amplitude at the input connector and that the amplitude of both is equivalent to 20 µV/m.

• *Radiated field calibration.* It may be desirable to dynamically calibrate the entire signal leakage system, as used, rather than as discrete devices. This also is possible, but set-up is a bit more time consuming. With direct-connection methods, only two parameters need controlling to ensure accurate calibration: test signal amplitude and frequency. These items retain their importance when using a controlled, radiated field with a couple of variables added to the list: antenna orientation and antenna type.

To establish a reasonably accurate radiated field strength of any value, pump a signal into an antenna, properly tuned for the frequency chosen, while monitoring the field strength with a calibrated field strength meter and an appropriately tuned and oriented half-wave dipole located five or more wavelengths from the transmitting antenna. The area surrounding both antennas should be obstacle-free for a diameter of 10 or more wavelengths. As a starting point, consider the following theoretical study.

Part 2A: Determine the equivalent power level of a 20E-6 volts per meter (20 µV/m) field strength:

$20E\text{-}6^2/377 = P = 1.061E\text{-}12$ watts per meter

Part 2B: Given that:
f = 108.6250 MHz
$\lambda = 2.76$ meters
A = 3 meters
$Gt_{(monopole)} = 2.14$ dB = 1.64
$Gt_{(dipole)} = 2.14$ dB = 1.64
$Gr_{(monopole)}{}^3 = -1.0$ dB = 0.794
$Gt_{(dipole)}{}^4 = 2.14$ dB = 1.64

Where:
f = Test frequency
λ = Test frequency wavelength
A = Transmission path length
Gt = Transmitting antenna gain
Gr = Receiving antenna gain

Part 2C: Find power (and equivalent dBmV level) needed at the transmitting antenna terminals to establish a field density of 1.061E-12 watts per meter at a distance of 10 feet from the antenna with a properly grounded quarter-wave monopole and with a free-space suspended half-wave dipole using:

$(4\pi A^2 Pr)/Gt = (4\pi \times 3^2 \times 1.061E\text{-}12)/1.64$

$= 73.17E\text{-}12$ watts

$= \sqrt{73.17E\text{-}12 \times 75}$

$= 74.08E\text{-}6$ volts

$= 20\log(74.08E\text{-}6/1E\text{-}3)$

$= -22.61$ dBmV

Part 2D: Alternately, buy a calibrated leakage source from those available for this purpose and follow the manufacturer's recipe for accurate field generation.

Part 2E: Determine the receiver voltage developed by inserting a vertical quarter-wave monopole into a 20 µV/m vertically polarized field using:

$P(\lambda^2 Gr/4\pi) = 1.061E\text{-}12 \times ([2.761^2 \times 0.794]/4\pi)$

$= 511.0E\text{-}15$ watts

$= \sqrt{511.0E\text{-}15 \times 75}$

$= 6.191E\text{-}6$ volts

$= 20\log(6.191E\text{-}6/1E\text{-}3)$

$= -44.16$ dBmV

Part 2F: The difference noted using a receiving dipole with matching transmitting antenna polarization is obtained by:

$P(\lambda^2 Gr/4\pi) = 1.061E\text{-}12 \times ([2.761^2 \times 1.64]/4\pi)$

$= 1.056E\text{-}12$ watts

$= \sqrt{1.056.0E\text{-}12 \times 75}$

$= 8.898E\text{-}6$ volts

$= 20\log(8.898E\text{-}6/1E\text{-}3)$

$= -41.01$ dBmV

• *Antenna calibration.* Element length and antenna mounting contribute to overall signal reception calibration. Tuned elements of a dipole and a monopole have a direct relationship with the wavelength of the test signal and are expressed by the following: →

Leakage measurements: Calibrating your dipole and field strength meter

By Jack Webb
Applications Engineering Production Manager
Sencore

Most commercial dipole antennas come with an antenna factor chart or a table for correlating signal level readings to field strength. With these tools and properly functioning test equipment, you can be relatively sure of accurate leakage measurements by simply following good engineering practices. (See Figure 1 for the measurement system setup.)

If you are not sure of your equipment or have constructed your own dipole antenna you can use the following procedure to check or calibrate your instruments. This procedure also can be applied to any of your leakage patrolling and measurement systems, and is especially useful on systems that are vehicular-mounted, since the antenna pattern may be significantly altered when mounted on the vehicle or when used in the proximity of other antennas, ladders, booms, etc., common to service vehicles.

The signal level meter is the easiest part of the system to check and calibrate. Follow your established procedure for this as you would normally or consult the manufacturer's operating manual. In brief this can be done by simply applying a signal of known amplitude to the input, tuning the meter to the signal and making sure the proper level is displayed on the meter. Be sure to use a known good source and to check the lower input ranges of -20 to -40 dBmV, where you will be making most leakage measurements.

Your dipole antenna may include a preamp in order to improve the sensitivity of your signal level meter. If this is the case you should be sure that it is operating properly and providing the expected amount of gain at the proper frequencies. If a bench sweep is available, test the amplifier as you would any other used in your system, referring to the manufacturer's specifications. If a bench sweep is not available, use the same source that your used to check your meter's proper operation, tuning to several frequencies in the band where you will be making your leakage measurements. The gain of the amplifier will be the difference between the level of your source and the level read on your meter. The gain should be within 1 dB of the manufacturer's spec. Typically 15 to 20 dB of gain is required to provide sufficient meter sensitivity. The gain of this amplifier will either be included in the tables provided by the dipole manufacturer or used in your calculations to convert your meter reading to field strength.

One precaution should be observed when using a preamp to extend the sensitivity of a signal level meter: the preamp is generally a broadband amplifier that is susceptible to overload by strong local over-the-air broadcast signals. Broadcast signals can easily be 100 dB stronger than the leakage signals that we are trying to measure. For this reason a bandpass filter is often used between the dipole elements and the preamp, thus preventing the stronger signals from overloading our preamp causing erroneous readings. Naturally the filter will have an insertion loss that may affect the level measurement. This loss will have to be measured and used in our calculation of field strength. You can easily measure this insertion loss using the same method that you used to test the preamp. Remember, a typical bench sweep system cannot be used to accurately test the rejection or shape factor of a filter, but will give a good measurement of the insertion loss.

Finally, the dipole antenna itself is the most often confusing part of any leakage measuring system. This confusion probably stems from the fact that our dipole has no input, no electronics or power supply — but pulls signals "right out of the air." This is not magic. It is in fact quite predicable and quantifiable. We will not go into complex antenna theory here, but I ask you to have faith (and, well, trust me). Simply stated, the electromagnetic waves traveling through the air set up a field that excites the electrons in the dipole antenna when the wavelength of the dipole matches the wavelength of the electromagnetic waves. The electron motion in the antenna produces a potential across its output terminals that we can measure with our signal level meter. Quantify-

Figure 1: Leakage measurement system

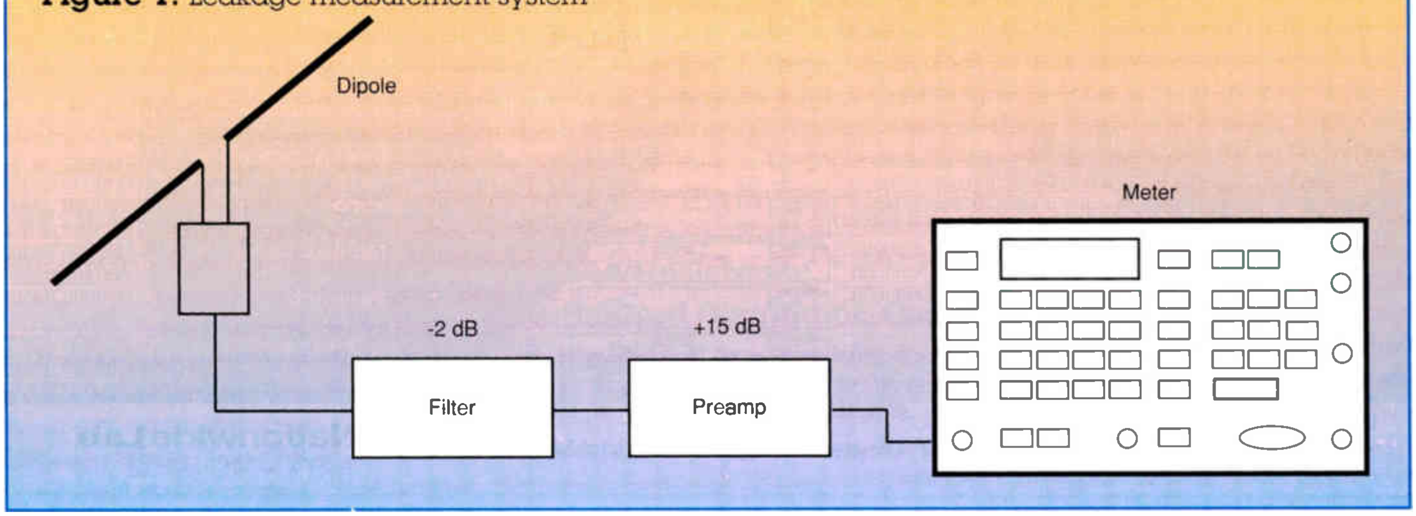
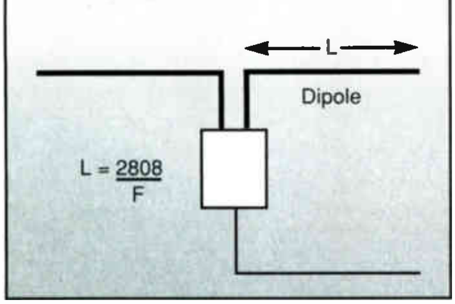


Figure 2: Dipole element length



ing these antenna characteristics is the last challenge we face in calibrating our leakage system.

One of the key parameters of adipole antenna is tuning it to the proper frequency or wavelength. Most manufactures provide a table for tunable dipoles or a fixed dipole for a specific frequency. If necessary you can easily calculate the proper element length (see Figure 2) with the following equation:

$L = 2{,}808/F$

Where:
L = the length of one side (one element) in inches
F = the frequency in MHz

The bandwidth of the dipole antenna also can be calculated, but is unnecessary since most dipoles are constructed of elements of sufficient diameter-to-length ratio to produce sufficient bandwidth that simple length adjustment, *to the nearest inch*, is sufficient to tune our dipole. Dipole tuning can be verified using a bench sweep system and a bridge. Setup is as though you were to measure the return loss of the antenna. The maximum return loss or best match will occur at the antenna's resonate frequency, which you can measure using the markers of the sweep system.

Setting up the calibration field

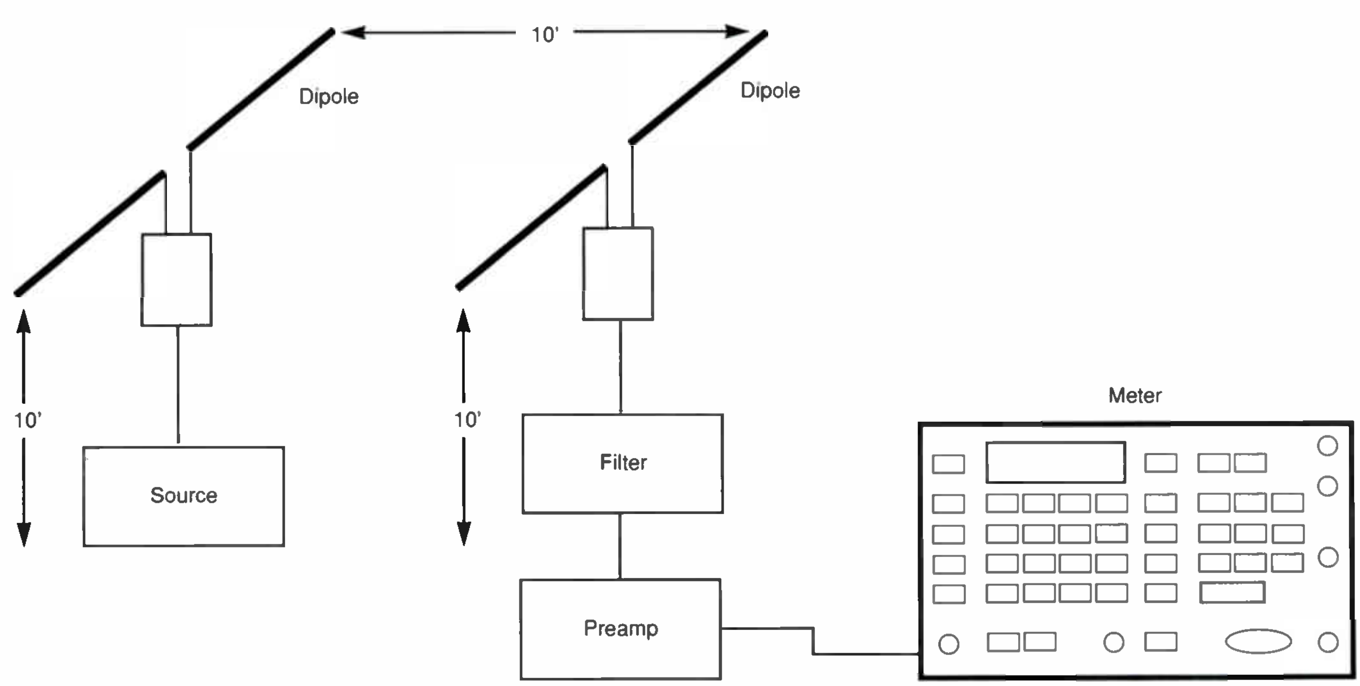
Measuring the actual gain or antenna factor of your dipole can be quite a technical challenge best left to later discussion. The best method to calibrate your leakage measurement system is to set up a known field in which you control the leakage field strength, the distance to the source antenna and the environment (clear of obstructions and reflectors that disturb your antenna pattern). This is done by using an area clear of any conductor or reflective objects within a minimum of 20 feet from your source antenna and 20 feet from your dipole to be calibrated. Twenty feet is an absolute minimum and 30 to 50 feet would provide a better calibration. Naturally, if your leakage measurement system is mounted to a vehicle you want to make the calibration with the antenna mounted on the vehicle as though the vehicle were in normal use.

To establish your calibrated field, a reference calibrated leakage measurement system must be used. (See Figure 3.) The signal source can be any source capable of long-term stability, such as an agile modulator or signal generator. A spare modulator modulated with a typical system signal is the best. Don't forget, when we build a leak for calibration purposes, that we are still responsible for this "leak" and the level should not exceed 20 µV/m. This signal should be fed to a dipole antenna similar to the one you will use for measurements. The source dipole must be mounted with a minimum of metal hardware to a mast or structure that will not modify the receiving antenna's pattern.

Using the output level control on the modulator and a fixed pad you should easily be able to achieve a leak of 19 µV/m at the frequency you will be testing (about +6 dBmV at Ch. 14 fed to the dipole). A helper may be required to adjust the source level while you measure the leakage. Recording the modulator output level, the placement of the source antenna and measurement antenna will allow you to reproduce the field whenever you need it. A permanently mounted source antenna on a wood mast and painted locator marks in the parking lot are common methods.

In making your measurements some calculations will be necessary. Your field strength meter measures in dBmV while leakage is measured in µV/m. You should already have a good understanding of the common term dBmV (decibels above 1 milli-

Figure 3: A calibrated leak



Conversion table for dBmV to µV/m

Channel: 14 at 121.25 MHz
Preamp: 15 dB gain
Filter: 2 dB loss

Meter level	Leakage level	Meter level	Leakage level
-40 dBmV	6 µV/m	-10 dBmV	177 µV/m
-39 dBmV	6 µV/m	-9 dBmV	199 µV/m
-38 dBmV	7 µV/m	-8 dBmV	223 µV/m
-37 dBmV	8 µV/m	-7 dBmV	250 µV/m
-36 dBmV	9 µV/m	-6 dBmV	281 µV/m
-35 dBmV	10 µV/m	-5 dBmV	315 µV/m
-34 dBmV	11 µV/m	-4 dBmV	354 µV/m
-33 dBmV	13 µV/m	-3 dBmV	397 µV/m
-32 dBmV	14 µV/m	-2 dBmV	445 µV/m
-31 dBmV	16 µV/m	-1 dBmV	500 µV/m
-30 dBmV	18 µV/m	0 dBmV	561 µV/m
-29 dBmV	20 µV/m	1 dBmV	629 µV/m
-28 dBmV	22 µV/m	2 dBmV	706 µV/m
-27 dBmV	25 µV/m	3 dBmV	792 µV/m
-26 dBmV	28 µV/m	4 dBmV	889 µV/m
-25 dBmV	32 µV/m	5 dBmV	997 µV/m
-24 dBmV	35 µV/m	6 dBmV	1,119 µV/m
-23 dBmV	40 µV/m	7 dBmV	1,255 µV/m
-22 dBmV	45 µV/m	8 dBmV	1,408 µV/m
-21 dBmV	50 µV/m	9 dBmV	1,580 µV/m
-20 dBmV	56 µV/m	10 dBmV	1,773 µV/m
-19 dBmV	63 µV/m	11 dBmV	1,989 µV/m
-18 dBmV	71 µV/m	12 dBmV	2,232 µV/m
-17 dBmV	79 µV/m	13 dBmV	2,504 µV/m
-16 dBmV	89 µV/m	14 dBmV	2,810 µV/m
-15 dBmV	100 µV/m	15 dBmV	3,153 µV/m
-14 dBmV	112 µV/m	16 dBmV	3,537 µV/m
-13 dBmV	126 µV/m	17 dBmV	3,969 µV/m
-12 dBmV	141 µV/m	18 dBmV	4,453 µV/m
-11 dBmV	158 µV/m	19 dBmV	4,997 µV/m

volt across a 75 ohm load). The term µV/m refers to the field intensity in microvolts per wavelength of the signal. Conversions require the following formulas:

$$E_{dBmV/m} = V_{dBmV} + 20\log F - 33.7\ dB - G + L$$

$$E_{\mu V/m} = .021 * V_{\mu V} * F_{MHz}$$

$$V_{\mu V} = E_{\mu V/m}/(.021 * F_{MHz})$$

$$V_{dBmV} = 20\log(V_{mV}/1\ mV)$$

$$V_{mV/m} = 10^{(EdBmV/20)}$$

$$V_{dB\mu V} = 20\log(V_{\mu V}/1\ \mu V)$$

$$V_{\mu V/m} = 10^{(EdB\mu V/20)}$$

Where:
E = field strength
V = voltage
F = frequency
G = gain of the preamp
L = loss of the filter

Example: When measuring a level with your signal level meter insert the proper criteria in the formula as indicated here. Our meter reads -25 dBmV at Ch. 2, we are using a standard dipole, a preamp with 15 dB of gain and a filter with 2 dB insertion loss.

$$E_{dBmV/m} = V_{dBmV} + 20\log F - 33.7\ dB - G + L$$ →

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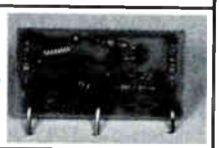

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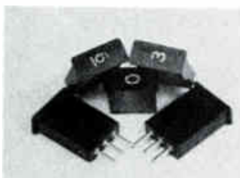

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$= -25\ \text{dBmV} + 20(\log 55.25\ \text{MHz}) - 33.7\ \text{dB} - 15\ \text{dB} + 2\ \text{dB}$

$= -36.5\ \text{dBmV/m}$

$E_{dB\mu V/m} = E_{dBmV/m} + 60\ \text{dB}\mu\text{V/m}$

$= -36.5\ \text{dBmV/m} + 60\ \text{dB}\mu\text{V/m}$

$= 23.5\ \text{dB}\mu\text{V/m}$

$V_{\mu V} = 10^{(VdB\mu V/20)}$

$= 10^{[(23.5\ dB\mu V/m)/20]}$

$= 10^{1.18}$

$= 15.0\ \mu\text{V/m}$

To simplify the mathematics of leakage measurement you should get or use the table provided with your dipole or create your own. Tables are not readily available since a different one must be used for each frequency. If you have access to a PC with a spreadsheet program the previous formulas can be consolidated to the following formula and used to produce a table like the accompanying one on page 97.

$V_{\mu V/m}$ = 10^((A7+60+20*log($C$4)-33.7-$B$5+$B$6)/20)

Where:
$A7\text{-}A_N$ = dBmV = meter level measured (from -40 to +20 dBmV)
C4 = MHz = frequency of leakage
B5 = G = preamp gain
B6 = L = filter loss

To make your table, simply insert the correct figures for your preamp, filter and frequency; take your measurement and look up the corresponding leakage. To work from µV/m to dBmV use the following:

$V_{dBmV} = 20 \cdot \log(\mu V/m) - 60 - 20 \cdot \log F + 33.7 + G - L$

If you are determined to test the accuracy of your dipole try this formula:

$P_r = [P_t \cdot G_t \cdot G_r \cdot X^2/(4\pi R)^2]$

Where:
P_r = power at the receive antenna
P_t = power at the transmit antenna
G_t = gain of the transmit antenna
G_r = gain of the receive antenna
X = wavelength of the signal
R = distance between the antennas

By setting up your distance between antennas at one wavelength and using the same type antenna for both the source and measurement you can simplify the equation to:

$G = 4\pi\sqrt{P_r}/P_t$

Thus, by measuring the input power to the source antenna and the output power of the measurement antenna you can calculate the gain of your particular antenna. **BTB**

Mesozoic droppings

By Isaac S. Blonder

Why do I qualify as a cable dinosaur? By age and experience, of course. I was born in New York City, June 24, 1916, and moved to rural Connecticut in 1922. I grew up at the same time as radio and television and always in the fringe reception areas.

Cutting teeth on radio

Crystal radios were the principal means of radio reception in the early 1920s, and almost every household possessed long wire antennas strung from the house to adjacent tress, which were able to receive the major market stations from across the nation. I remember sitting in a neighbor's parlor until the dawn, listening in turn to New York City, Pittsburgh, Chicago and Denver as the distant signals grew stronger as night fell in each city.

Battery-powered radios appeared in the mid-1920s, followed quickly by AC-powered home models in bewildering profusion. My father had a garage and I was a grease jockey until the end of my college career. The early automobiles had expensive radios with dry cell B-batteries for the voltage, and everyone envied the affluent drivers. Repairing the radios fell to the educated son. I had a great time with the car radios and neighbors' home models.

Breaking into television

By 1940, I had a master's degree in physics from Cornell and no high-level job. Finally, in 1941, the GE personnel department in Bridgeport, CT, from the depths of its generous heart, took me on as a troubleshooter in the radio factory ($40 weekly). Several months later, in the mail, came an equally generous letter from the United States offering me a commission in the army for one year to engage in research. Arriving at Fort Monmouth, before Pearl Harbor, I learned that the research was being a radar officer in the British Army in England!

Four years later, out of the army and strong on radar and weak on physics, I found a job at Panoramic Radio Corp. in New York City. There I met Ben Tongue, the company's very young and highly competent chief engineer. Still wanting to dabble in physics, I moved to City College as an instructor in engineering physics. After a couple of years of boring myself to despair by preaching the same old material to inattentive students, I joined the TeleKing Corp. in New York City. There I was an engineer building receivers for an exciting new field that many said could never displace radio — television!

At TeleKing came my first exposure to master antenna TV systems (MATV). The half-dozen engineers in the lab were constantly threatening to murder each other. It seems that the one antenna on the roof fed a twin-lead running from bench to bench and only one engineer at a time could get a usable signal. I scanned my textbooks and came up with matched two-set and four-set resistive splitters that calmed the murderers, but delivered a rather weak signal. The available tubes could not singly amplify the entire VHF band,

but, employed as a cathode follower, gave a few decibels extra. The factory manager soon grabbed me by the ears and demanded similar devices in his department. So, in 1948, it was MATV of sorts.

Back home, my parents (120 miles from New York) suggested that their learned son install television as a matter of utmost urgency. So I built a double Yagi and installed it on a tall mast above the garage. Presto! Especially at night, one could see cowboys galloping in and out of the snow and hear the firing of guns. I explained the lack of good reception due to distance and offered to remove the gear. The immediate reply was for me to stop talking so they could enjoy the show. Some months later, on a visit home, my mother was much clearer. Why couldn't her son be a better engineer? I replied, "Mom, if you will move to a house on the hill your son will have a higher skill level!"

The birth of B-T

In 1950, Ben Tongue and I left our good jobs and founded our own company in a storefront in Yonkers, NY, without a single product to sell. We would temporarily install high-quality TV systems for rich clients in the Westchester area until we could finish the design of some hotshot TV test gear for the engineering profession.

However, there was some excite-

ment the first week. Police cars came screaming up to our little store with guns showing to catch unaware the new bunch of Yonkers racetrack bookmakers like the last crowd that were in our location. They sure were disappointed to verify we were engineers.

In those days, the noise figure of the typical TV set was so poor that all fringe installations used tunable RF boosters. If you think the VCR is a consumer hazard, just watch your average citizen tune in the TV signal! To make our job easier and quicker, we jointly invented the first broadband amplifier. HA-1-L had four tubes with a better noise figure than the TV sets. I packaged the amplifier in a leatherette case, complete with an automatic power switch and bypass switch, and handed samples to some salesmen friends in the parts distributors field. Orders shot in, the fuses blew in our little store and a bank gained the courage to finance a larger factory.

Immediately, we started hearing stories that our unit was being sold for rudimentary master antenna systems in place of individual channel amplifier combinations. We came out in 1951 with a high-gain, higher power broadband amplifier, the CA-1-M. Of course our products and business grew along with the cable industry, since the typical cable customer took one year to pay his bills, and parts distributors paid within the month!

"In those days, the noise figure of the typical TV set was so poor that all fringe installations used tunable RF boosters."

Our CA-1-M was installed in some strange places. The service department reported that a couple were returned with bullet holes. Why? It seems that installations were being made out West using miles of fence wire nailed to trees as twin-lead with 110 volts fed on the wire to our amplifiers, which were nailed to the tree with a rain shelter of sheet metal included. "Target practice" was what we heard caused the bullet holes!

The MSO experience

In the '60s I was the president of a cable MSO with most of the systems in northern California. Times may be better today but in those days it never seemed possible to hire electronics technicians to climb poles and service the systems. I guess long-distance troubleshooting was no worse than serving as a radar officer.

One of the rural systems that we bought carried low-band VHF only at the bargain price of $3.50 monthly. The system was rebuilt to both high- and low-bands and the monthly charge raised to $5.50. At the request of the local authorities with the aid of band separators, the increased price was made a voluntary decision on the part of the customer. Guess what? The majority stayed with the lower price. It took a whole year to get the council to remove the option.

In another heavily rural system, we observed that one section did not enjoy the same subscription rate as the rest of the system. An audit by outsiders uncovered the reason. The installer was trading hookups for sex! Headquarters was not offered a share of the income. End of job. Perhaps if he had the skills of your average politician, he would have found a suitable compromise and kept his position!

Exit the dinosaur era and welcome big business. But some things never change.

Ike Blonder currently is president of Blonder Broadcasting Corp.

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.

☛ *Digital Compression: Expanding Channel Capacity While Enhancing Video and Audio Quality* — This tape features Thomas Elliot (moderator), H. Allen Ecker Ph.D., Richard Prodan Ph.D. and Geoff Roman. Cost-effective digital video compression is closer than ever and will provide new opportunities for services and revenue. This program deals with the realistic goals and benefits to be derived from digital video compression. It covers trade-offs such as pix quality vs. data rate vs. cost, data rate vs. ruggedness vs. cost and features vs. value vs. cost. Digital video compression architectures, performance of various digital techniques and DigiCipher and DigiCable products also are discussed. (80 min.) Order #T-1111, $45.

☛ *Technical Compliance: How FCC Re-Regulation Will Impact Your System Operations and Maintenance Practices* — This tape features Steve Ross (moderator), Wendell Bailey, Jonathan Kramer and John Wong. With FCC re-regulation a reality, this presentation seeks to provide an overview of the new regulations, as well as define key parameters including classes of signals covered, channel boundaries, aural standards, visual signal levels, signal-to-noise, signal-to-coherent disturbances ratio, hum modulations, color signals, testing requirements (including the number of test points required) and when tests are to be conducted. The federal/local relationship, as well as many other topics also are discussed. (85 min.) Order #T-1112, $45.

Note: All tapes listed this month were videotaped at Cable-Tec Expo '92 in San Antonio, Texas. They are available in color and 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 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 book or 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 complete listing of publications and videotapes is included in the March 1992 issue of the Society newsletter, "Interval."

AD INDEX

It's so simple! To obtain additional information from any of the display advertisers appearing in this issue of **Communications Technology,** please use one of the **Reader Service Cards** on the facing page (pass the others along). The ad index below has been expanded to include not only the page number of each advertiser, but also each corresponding reader service number to be circled on the Reader Service Card.

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CT 1/93

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- ☐ 3. Cable TV Program Network
- ☐ 4. SMATV or DBS Operator
- ☐ 5. MDS, STV or LPTV Operator
- ☐ 6. Microwave or Telephone Company
- ☐ 7. Commercial Television Broadcaster
- ☐ 8. Cable TV Component Manufacturer
- ☐ 9. Cable TV Investor
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5	24	43	62	81	100	119	138	157	176	195
6	25	44	63	82	101	120	139	158	177	196
7	26	45	64	83	102	121	140	159	178	197
8	27	46	65	84	103	122	141	160	179	198
9	28	47	66	85	104	123	142	161	180	199
10	29	48	67	86	105	124	143	162	181	200
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14	33	52	71	90	109	128	147	166	185	204
15	34	53	72	91	110	129	148	167	186	205
16	35	54	73	92	111	130	149	168	187	206
17	36	55	74	93	112	131	150	169	188	207
18	37	56	75	94	113	132	151	170	189	208

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4	23	42	61	80	99	118	137	156	175	194
5	24	43	62	81	100	119	138	157	176	195
6	25	44	63	82	101	120	139	158	177	196
7	26	45	64	83	102	121	140	159	178	197
8	27	46	65	84	103	122	141	160	179	198
9	28	47	66	85	104	123	142	161	180	199
10	29	48	67	86	105	124	143	162	181	200
11	30	49	68	87	106	125	144	163	182	201
12	31	50	69	88	107	126	145	164	183	202
13	32	51	70	89	108	127	146	165	184	203
14	33	52	71	90	109	128	147	166	185	204
15	34	53	72	91	110	129	148	167	186	205
16	35	54	73	92	111	130	149	168	187	206
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Reader Service Number 1

Electrical conductor safety (Part 1)

By Michael H Morris
President, Taylor, Morris & Associates

Every day we take for granted the impact that electricity has on our lives. Few things we know and appreciate would be the same without it— including cable TV.

How safe is electricity?

Ironically, of the sources used to generate electricity, many look upon nuclear fission as "bad." I suggest that concept began with the death and destruction in Japan in the last days of World War II. Paradoxically, we look upon electricity as good. In reality, I submit (not documented) that more people have died from electricity than all the nuclear-induced deaths.

Perhaps the questions we should ask ourselves is, "Why?" Perhaps the answer is because we take electricity for granted. We assume that it is safe because it's so much a part of our lives. Because we assume it is safe we don't observe proper safety measures when we use it, we are careless and frequently ignorant of the dangers involved. We all know that lightning kills, yet how many of us know that we can die from direct contact with a 30 volt cable TV power supply?

An overview of regs

The Occupational Safety and Health Administration through Title 29 Code of Federal Regulations Part 1926.400 (Subpart K) addresses the following:

1) Installation safety requirements are contained in 1926.402 through 1926.408. Included, but not necessarily limited to, in this section are minimum clearances, work space, grounding, vehicle-mounted generator, bonding, extension cords, communication networks, marking, poles, antenna lead in conductors, equipment locations and much more.

2) Safety-related work practices contained in 1926.417 address (but are not necessarily limited to) accidental contact, protection of employees, and lockout and tagging of circuits. As an example, lockout tagging would clearly indicate (by a tag and a lock) that a power supply has been disabled and/or backfed, and should not be returned to service until all employees working on that circuit are clearly accounted for. If a power supply is being fed from a generator or backfed through powering directors, powering can feed back into the utility power lines, thus creating a hazard to power linemen working on what they think are dead circuits. Lockout tagging is a serious concern with which your company should be knowledgeable and should be providing you training in respect to.

3) Safety-related maintenance and environmental considerations are contained in 1926.431 and 1926.432. These regulations address maintenance and environmental deterioration of equipment.

4) Safety requirements for special equipment are contained in 1926.441 and address batteries and battery charging.

5) Definitions are included in 1926.449.

The National Electrical Code, NPFA 70, the National Electrical Safety Code, Underwriters Laboratories, the Bell "Blue Book," local utility codes and other state or local codes also impact the procedures that your company must provide you training in respect to.

On the surface this sounds very confusing, but it's not. Quite simply each of us, by OSHA's mandate, must be properly trained in respect to the job functions that we normally perform while executing our work assignments. This includes training that addresses safety around electrical conductors for employees working in close proximity to electrical lines.

Benefits of the Blue Book

It would be a cumbersome and time-consuming procedure for each of us to be totally familiar with all of the nuances of the various codes mentioned in this article. One of the best references of these requirements (as defined for use by cable TV) is the Bell Blue Book. This document, developed by Bell Telephone, addresses to a large degree construction standards extracted from various federal and local codes. The book is generally referenced by utilities during the process of make-ready (the repositioning of telco, power and other conductors in order to make space available for cable TV lines).

Most cable linemen are aware of the "1240" rule. That is, cable should be placed no closer than 12 inches to phone and no closer than 40 inches to power. Minimum clearance specifications for power and communication conductors are derived from 1926.400, as well as other sections. They may vary given the specific application.

The Blue Book is clear, concise and generally easy to use. Although OSHA does not require that your company have a copy of the book, its content should be considered a must for your construction and your electrical safety training programs.

Accidents will happen

Accidents happen to the nonexperienced as well as the seasoned veteran. The rookie is generally injured because of improper training; the veteran due to assumption and carelessness. Electricity is not forgiving. If you are the shortest path to ground and contact an electrical line, you will tempt death. The best way to avoid electrical hazard is to be properly trained, to assume nothing and to use the proper safety equipment. **CT**

Product Wrap-Up

CT DAILY

From *Communications Technology* magazine — Western Show Edition

Alpha's Powering Solutions

Alpha Technologies featured its new power supply, the XP Series. Part of the CableUPS line, the XP Series is a high performance uninterruptible power supply for cable TV and broadband networks. Providing clean and reliable uninterruptible power, the 60 VAC XP 6012-24 is small and compact for easy installation, according to the company, and features a removable module that can be quickly and easily replaced or upgraded without interruption to the cable plant. In addition, the single ferroresonant design is said to provide fully regulated output voltage, battery backup, surge and short circuit protection, and complete line conditioning under all modes of operation and loading. The XP Series UPS allows cable technicians to determine the power supply status at a glance, with displays that give information about output current to the load, battery charging modes, line and standby operations, total outage time, number of standby events and automated maintenance procedures and power supply data retrieval. The XP's flexibility is enhanced by plug-in logic upgrades including Automatic Performance Monitor and Universal Status Monitor for remote monitoring applications. **Reader service #209**

AM Tackles FCC Compliance Tests

AM Communications debuted two products — the TMC-9040 headend automation controller and the TMC-9070 headend switch. Both components are used in conjunction with AM's TMC-9015 performance monitor to control the on/off state of individual modulators or processors while measuring hum, distortion or the in-band frequency characteristics now required by the FCC. The new AM system is said to reduce the burden of FCC compliance testing to a simple effortless project when controlled by AM's Taskmaster software.

AM also announced a number of new products to be released in 1993. The first of the products, scheduled for release in early '93, is a result of the joint partnership formed last July with Wavetek. The Lawman software recently introduced by Wavetek for both the LineSAM and LineSAM II units will soon include a feature that allows it also to communicate with AM's TMC-9015.

Other new products, scheduled to be introduced in mid-1993, include an improved headend sweep transmitter, the TMC-9030, that will work in conjunction with the Taskmaster software. It will perform remote, fully automated, noninterfering sweep measurements from a headend to any system test point equipped with a TMC-9015, and do so, the company says, with a 1 dB accuracy from 40-550 MHz. AM also is working on the TMC-9031 and TMC-9032 test signal generators that are designed to facilitate remote, automated measurement of the in-band frequency response for modulators and processors. The 9031 will drive up to 16 modulators, while the 9032 will drive an equal number of RF processors. Both units will be controlled through AM's new 9040 headend automation controller and Taskmaster software. **Reader service #202 (TMC-9040), #201 (TMC-9070)**

Budco Covers Drop Protection

Budco introduced a low-profile marking system — called Soilmark — to identify buried cables in areas where marker posts will not work. The Soilmark system, which is impact-resistant and can be driven over by mowers, features a warning message permanently imprinted on the 7-inch diameter, high visibility orange disc. Standard legends are available or you can have your own message imprinted.

Also being introduced by Budco is Spiral Wrap, a plastic tubing used for protecting underground cable from mowers, weed-eaters, etc., where the drop meets the structure. The split tube permits installation of the Spiral Wrap after the cable is placed. **Reader service #208 (Soilmark), #207 (tubing)**

Flexibility Of New Jerrold Line Extender, Modulator Highlighted

Jerrold Communications' new Starline JLX-750P line extender was on display for the first time. The company says the product allows cable TV systems the flexibility to employ various architectures when rebuilding, thus maintaining the possibility of meeting ever-expanding bandwidths. The company's Pat Harkins remarks that the goal of the unit is to continue the evolutionary growth of Jerrold's Starline series while providing expanded bandwidth channel capacity and minimal distortion contribution.

Also on display was Jerrold's new frequency agile integrated addressable data path modulator (DPM). The DPM is for one-way addressable systems and includes the frequency agility and the data splitter and data combiner functions in one unit. **Reader service #206 (line extender), #205 (DPM)**

DX Spotlights The Headend

DX Communications displayed its newest remote-controllable headend product — the DSM-180 modulator. The DSM-180 is a 550 MHz agile modulator that utilizes a contact-closure switching system or the available RS-232C computer interface for video/ audio/IF switching through its multiple inputs. Combined with the DIR-657 broadcast-quality (RS-250B) IRD, DX says these units can be configured to remotely control up to 100 channels in a headend. **Reader service #204**

C-COR Confronts Powering, Surge Protection

Among the new products announced by C-COR Electronics was a transformerless power supply, the H.E. (high efficiency), which will be available by the end of this year. Operating at efficiencies of 85 to 90%, according to C-COR, the H.E. consumes significantly less power than comparable linear or transformer-driven switch-mode power supplies, translating directly into ongoing reductions in operating costs, and may even result in a reduction in the quantity of system power supplies needed for the related section of cable plant. The power supply is intended for use with C-COR's SF, SP, UHF and 1 GHz product lines, and is compatible with any of its 2- or 4-port 1 GHz housings.

C-COR also announced the immediate availability of its new Surge Terminator, an AC crowbar device that is designed to dissipate surges associated with lightning, power line faults and overvoltages. **Reader service #198 (power supply), #197 (Surge Terminator)**

Contec Goes High Tech With Repair Info

Contec International demonstrated its expanded service of a "dial-up" electronic exchange of repair information by converter serial number, using optically scanned bar codes. Harold Petrie, a Contec vice president, said, "When defective equipment is sent to Contec for repair, the cable operator optically scans the serial numbers, as well as other pertinent data (like failure codes) into their computer using a software package developed by Contec. Then using standard PC-based software and hardware, the operator electronically transmits the data to the Contec location performing the repairs." Upon receipt, using a variety of processing equipment, including CCD-type bar code scanners and thermal printers, the repair center matches the serial number of the defective converter to the previously transmitted customer records, thus building a repair information data base. When equipment is ready to ship, Contec notifies the cable operator that the serial number file is ready. The operator once again dials into the Contec computer and downloads the repair information in their computer system. Contec says benefits to cable operators include: identification of equipment to be removed from service due to chronic breakdown, listing of parts used in repair, easier inventory reconciliation and improved repair file histories maintained by both Contec and operator. **Reader service #199**

Electroline Addresses Signal Control

Electroline Equipment's Multi-Tier Security system, designed for multiple dwelling unit and resort housing applications, has been upgraded to jam channels up to 600 MHz and now features addressable control of jamming frequencies, on a remote basis, from the headend. The system is said to provide significant operating cost savings and flexibility to operators. Providing a broadband feed of all authorized signals to the entire house, the MTS system is available in four jamming frequency ranges: 120-195 MHz, 175-280 MHz, 250-400 MHz and 400-600 MHz. Other system specifications include a tier alignment of two broadband tiers plus six jammed tiers (up to 12 channels); a tap-to-tap isolation of 55 dB; 16 dB return loss in-out; a 1 GHz bandwidth; about 11 VA of power consumption; with dimensions of 20 inches by 15 inches long. **Reader service #203**

Augat Amplifies Miniflex Line

Augat Communication Products offered two new additions to its Miniflex family of outdoor line extender and distribution amplifier products. The new Super Distribution Amplifier is available in mini-trunk/bridger and terminating bridger configurations. Each output port is independently driven by its own output hybrid amp, which Augat says allows for higher output levels while maintaining excellent noise and distortion performance, and offer exceptional design flexibility due to unique plug-in splitters and directional couplers that allow a multitude of signal level configurations on the amplifier's three output ports. The Miniflex line is designed for flexibility and ease of operation by offering plug-in AGC, plug-in return amps in discrete of hybrid technologies, and a 1 GHz platform. **Reader service #200**

A Glimpse Of Ortel's New Plans

Some of its current development plans with amplifiers, return path lasers and TVRO enhancements were spelled out by Ortel Corp. "Ortel is now developing a complete transmitter subsystem package to address the need for higher performance drive amplifiers. We also are developing a return path laser and transmitter circuit to accommodate the anticipated demand for interactive video networks, including personal communications network (PCN) services," said the company's Vice President Larry Stark.

The company says its DFB lasers' performance levels were "previously considered theoretically unattainable." With these lasers now approaching 25 mW power levels, the capability of standard drive amplifiers to handle the output has been exceeded. The company is developing a complete transmitter subsystem package consisting of a DFB laser, patented predistorter board, and a custom-designed drive amplifier that will meet this need.

The company is focusing attention on interactive video networks, including PCN services. It is developing a return path laser and transmitter circuit that is said will deliver the same level of quality as its higher performance downstream DFB laser circuits — suitably tailored for the reduced requirements of return path. This undertaking requires several advancements because of environmental demands. Since the return path lasers are installed in an outdoor housing, the laser module must operate over a significantly wider temperature range. Because the laser resides in a receiver housing, the cost has to be much less than for high-performance downstream lasers.

The company's Model 10005A TVRO fiber-optic product family has undergone a facelift. Earlier this year Ortel announced the availability of high-performance optically isolated DFB lasers for these products. Now, several new enhancements are available, including the fact that controls layout has been rearranged to simplify setup and installation of the equipment and the fact that installation of the equipment and the internal design of several circuits has been improved. **Reader service #179**

Comm/Scope Cables Fit Needs

Comm/Scope Inc. offered a new size coaxial cable, the QR 715, designed specifically for fiber-to-the-feeder applications and, says the company, to be the lowest cost solution to fiber-rich rebuilds. Employing patented QR technology, Comm/Scope reported it developed the 715 to best meet the needs of today's rebuilds and tomorrow's new technologies. **Reader service #196**

Panasonic Boosts Receiver Features

Panasonic Broadcast & Television Systems displayed its new PS-750EX, an integrated satellite receiver that is compatible with the VideoCipher VCRS module.

The receiver is said to have more features than any of the company's previous models. Among these features are a newly styled UHF remote, on-screen display, satellite graphics, Dolby and three audio/visual surround modes, and four built-in audio amplifiers. In addition, extensive software improvements include menu selection of all current programs and audio services (each listed in 12 categories), the capability of adding new programs as they are transmitted, and 27 user-programmable favorites channels and 27 audio services.

The company says that when two stereo and two surround sound speakers are connected to the receiver and a high quality TV set or projector is used, "a satellite home theater system audio environment is created that greatly increases the entertainment value of the satellite system."

The PS-750EX also provides input and output terminals for a Hi-Fi VCR so that prerecorded tapes also may be used. **Reader service #195**

Quality RF Jump Starts New Amps

Quality RF Services showcased its new Palm Beach series of indoor mains-powered amplifiers. This series encompasses headend/laser drivers, one- or two-way multidwelling, and push-pull house drop amplifiers.

Feedforward, quadra-power, power-double and push-pull to expanded bandwidths technologies have been incorporated into the amplifiers. **Reader service #194**

Philips Demos New Transmitter

The new Diamond Link DFB transmitters and the first production models of the Vector video echo canceler from Philips Broadband Networks were just some of the products displayed.

The DFB transmitters operate at bandwidths up to 860 MHz and contain a combination of performance enhancement circuitry and customized DFB lasers. As well, they offer significantly better noise and distortion performance than has previously been available and provide up to 51 dB carrier-to-noise performance over 14 dB, 80-channel, single fiber links without compromising composite triple beat or composite second order, according to the company.

The same technology used in the new line of enhanced output DFB transmitters also has been incorporated into Philips' standard transmitter product line. These transmitters offer traditional performance at a reduced price. **Reader service #193**

C-COR Amps Designed For Fiber's Growth

C-COR Electronics introduced two series of line extender amplifiers — the E600 and E700 — designed specifically for systems employing fiber optics. According to Steve Day, marketing director, "As fiber-optic distribution systems mature, the need for a low-cost RF line extender increases," which is what the E600, scheduled for production in early 1993, was developed for.

The E700 Series features a closed-loop automatic level control that C-COR says allows cascades of four line extenders to operate reliably under all conditions and ensures compensation for all changes in amplifier input levels. "This product line was developed to provide the tight control of amplifier output levels needed to meet the high performance requirements of today's fiber-optic systems," said Colin Horton, product manager. Two-way upgrades of the E700 are accomplished by installing plug-in diplex filter and a reverse upgrade kit.

Features in common with both the E600 and E700 include power-doubling and push-pull 550 MHz versions; dual hybrids with provision for a plug-in interstage equalizer (which C-COR says ensures a carrier-to-noise performance at the lowest channels consistent with the highest channels — a feature highly recommended in fiber-optic designs); installed in 1 GHz 2-port housings featuring -25 dB external test points, with an optional 4-port housing also available; compatibility with its SF7XX series ensuring that the system can be upgraded as needed with a module changeout to increase bandwidth or performance; and for surge protection, both incorporate C-COR's Surge Protection Module, plus an integral high pass surge protection filter (not offered on the E700 two-way version) and as an optional accessory the company's new Surge Terminator is available. **Reader service #173 (E600), #172 (E700)**

Standard's IRD Priced For Smaller Systems

Standard Communications displayed its new Agile IRD-I integrated receiver and VideoCipher II Plus descrambler, which offer the features and characteristics of the company's Agile IRD-II unit at a price that is said to make it affordable to small and medium CATV systems.

The IRD-I offers video specifications, 100 kHz PLL synthesized tuning and dual-converted 70 MHz final IF. Other features of the product include signal quality alarm, active loop-thru and +20 VDC LNBC power output.

With front panel controls that are factory calibrated for guaranteed performance, the IRD-I is designed for simple integration and operation. The VideoCipher II Plus module can slide into the rear panel, batteries can be changed, and a 70 MHz test point can be monitored without interrupting service. Because the IRD-I uses compact surface-mount components, it is only one rack high, freeing up to 50% more rack space. **Reader service #192**

Jerrold Focuses On Consumer Needs

Jerrold displayed a wide array of consumer interface products available to cable operators that want to provide the subscriber options requested by some consumers. These products included a single cable bypass switch and a dual source RF switch, both of which can be installed by the subscriber or a service representative without opening the converter. Since the switches are powered by the converter via the "cable in" port, no additional electrical connections are required. The A/B buttons on the set-top keypad or hand-held remote operate the switches.

The single cable bypass allows subscribers to watch a basic channel or trapped premium channel while using a VCR to record a scrambled premium channel. It also allows subscribers who want to continue using the remote control units they purchase with their cable-ready TV sets after they have a cable converter installed in their home to obtain a premium service. The dual source RF switch addresses the FCC "must carry" antenna input requirement. In its primary function the subscriber can switch back and forth between cable and antenna reception simply by pushing the A/B button. Some subscribers also can switch to their computer instead of the TV antenna so they can switch between use of the TV for normal video reception and as a computer monitor.

Jerrold also demonstrated cable TV's ability to provide data services at high speed with representatives from the Prodigy service, the popular on-line home computer network. Prodigy demonstrated as part of an entire multimedia environment; Jerrold is exploring all areas of multimedia applications with the goal of including such capability in the next generation of converters.

In another look ahead, Jerrold unveiled its concepts for its "converters of the future." The display was to gauge industry input into what features should be included in the next generation of addressable converters. Among the concepts being displayed were the ability to handle near video-on-demand ordering over multiple channels of programming, renewable security via a smart card that can be inserted into a unit, a 1 GHz tuning range and electronic program guide capabilities.

New converters that will be available from Jerrold include the Watch-'N'-Record addressable, which features two tuners and allows subscribers to watch one scrambled premium channel while taping another. It also allows subscribers with high-end TV sets to use their picture-in-picture capabilities.

As well, Jerrold and InSight Telecast have developed an addressable converter that incorporates Insight's electronic program guide and one-touch VCR recording system. The product provides viewers with a personalized on-screen program guide continuously updated with seven days ahead TV programming; once a program is selected from the TV screen, a touch of a button allows the selected program to be recorded in its entirety. **Reader service #165 (bypass switch), #164 (RF switch), #163 (converters)**

Hewlett-Packard CATV Analyzer Systems Measures New FCC Standards

Hewlett-Packard displayed a measurement personality card that customizes the HP 8590 Series portable spectrum analyzers for CATV measurements to meet newly revised FCC 76.6050 (A) standards. The HP 85711B adds dedicated cable TV test functions and measurements to any HP 8590 series analyzer with a memory-card reader. The card simplifies manual headend testing, FCC proof-of-performance testing, trunk maintenance and test-result data collection.

The CATV measurement personality allows engineers and technicians to make the following tests: automatic tuning of visual and aural carriers; visual and aural carrier levels and frequencies; system channel survey; depth of modulation; aural carrier deviation; carrier-to-noise ratio; in-channel frequency response hum/low-frequency disturbance; system frequency response; view of baseband TV line and field; aural carrier demodulation (listen); distortion (CSO/CTB); and cross-modulation. Numeric and trace results can be directly printed or plotted, or they can be stored in the CATV analyzer's nonvolatile memory.

HP also announced a companion 75-ohm preamplifier that is powered by the CATV analyzers and fits into the analyzer's front cover. It offers 45-1,000 MHz frequency range, 20 dB gain, ±1 dB gain flatness across the full frequency range and a 7 dB maximum noise figure. **Reader service #170 (card), #169 (preamp)**

Zenith Allows Double Digital With New Modulation

Zenith Electronics Corp. demonstrated a rugged new digital modulation technology that is said to double the amount of digital information that can be transmitted on CATV channels without additional video compression. The new 16-level digital transmission system would be able to send two digital high definition TV signals on a single 6 MHz cable channel. The system also would double the number of digitally compressed standard TV signals on a cable channel.

The system "would be able to deliver as many as 23 movie channels, nine live video channels or two full HDTV channels in each 6 MHz analog cable channel," says Zenith's Wayne Luplow. He adds that this can be done using current video compression techniques.

Zenith has extended the capabilities of the four-level vestigial sideband (VSB) modulation and transmission technology developed for the Zenith/AT&T Digital Spectrum Compatible (DSC-HDTV) system. By quadrupling the number of levels of digital data, Zenith reports it has increased the data rate to 43 megabits per second from 21.5 Mbps.

Other digital advantages of the new cable transmission technology include noise-free performance, noise-free digital audio and friendliness with computer, telephone and other digital communications systems that already process large amounts of digital information. **Reader service #174**

Air-Dielectric Coax Anyone? See Trilogy

The new 50-ohm version of MC^2 air-dielectric coaxial cable was introduced by Trilogy Communications. The new version has the same features and benefits of the old that will elevate coax performance in many other applications including broadcast antenna systems, voice/data transmission, cellular systems, mobile radio, various ham and for all UHF bands.

The air-dielectric consists of 100% bonded, hermetically sealed polyethylene chambers that eliminate any water ingress. By contrast, the most widely used 50-ohm air-dielectric coax has a completely open core, which provides no restrictions of water migration. The connectors lock right into the center conductor to eliminate pull-out, unlike other competitive cables that require a highly complex pressurized connector that must be soldered.

Electrically, the velocity of propagation of MC^2 50-ohm is 91%, like the open-core product, but with a lower attenuation. All other electrical characteristics are virtually the same. The product is available in .500, .750 and 1-inch versions. **Reader service #177**

Triple Crown Rolls Out New Transmitters, Amps

Triple Crown Electronics had two new products on display, the TOTX-120 reverse laser transmitters for Titan series amplifiers and the Minex series of ultra-small indoor and outdoor distribution amplifiers.

The transmitter accepts input signals, both standard RF TV channels and data, in the 5-120 MHz band and modulates these signals onto a 1,310 nm laser for reverse fiber transmission. The unit fits any Titan Series amplifier equipped with fiber housing. The complete package could include: 77-channel fiber receiver, reverse fiber transmitter, 550 MHz power-doubled trunk output and two 550 MHz power-doubled bridger outputs. This all can be contained in a single housing, which the company says makes it "the smallest package of its type in the world."

Triple Crown reports the new distribution amplifiers are not much larger than most line passives but offer features often not available in much larger units. Push-pull and power-doubled models, in bandwidths to 862 MHz, use full modularity, bidirectional operation and built-in controls. The Minex amplifiers can be cable-powered for outdoor applications, as well as indoor 117 VAC powered. **Reader service #176 (laser transmitter), #175 (amps)**

"Digital Future" Demoed By Philips

Philips Broadband Networks hosted a live demonstration of what it has dubbed its "home of the future" delivered via "compressed digital highway." Philips compressed digital highway is based on MPEG standards that are said to be designed to "future-proof" cable operators' investment in compressed digital technology.

Philips digital delivery system allows for faster data channels of multiple megabytes per second. Each 6 MHz channel can carry about 30 megabits per second and can support a variety of potential applications including telephony, video phone, CD-quality music channels and other data and transactional services. **Reader service #113**

New Upconverter At Nexus

Nexus Engineering Corp. showcased the UC-2000 IF to RF upconverter. It will take an existing IF from a digital optical device or scrambler and deliver on-channel frequencies with the UC-2000 dual-channel upconverter. The product is packaged two channels per rack unit with optional IRC or HRC frequencies and the company reports "many cable operators have found they also can create entirely new channel lineups in a space- and power-efficient manner." **Reader service #191**

New Siecor Heat-Shrink Oven Is "One-Step"

Siecor's one-step heat-shrink oven that mounts to the company's complete family of fusion splicers was on display. The new oven is smaller than traditional units and is used in providing heat-shrinkable fiber protection sleeves for fusion splices. It can be mounted directly to Siecor's M90, M91 and M92 splicers. Since the oven draws directly from the splicer, the need for long power cords or bulky adapters is eliminated. Also, less slack is necessary for splicing and protected splices can be individually accessed.

The product is said to be "craft-friendly" and easy-to-use, requiring about two minutes to complete the heating cycle. The heat-shrink part is placed over the fiber prior to splicing. Once the splice is completed, the heat-shrink is repositioned directly over the splice and then placed in the oven. Closing the oven lid will automatically activate the heating cycle. A visual indication is provided by an LED and when the LED indicator goes out, the process is completed. The protected splice is then placed in a splice tray and protected splices can be individually accessed from the tray if required. **Reader service #178**

Electroline Amp Boosts Drop Performance

Electroline Equipment introduced a 1 GHz subscriber drop amplifier offering 13 dB gain and 23 dBmV output per channel. The new amp is designed for use in wide bandwidth systems where high signal attenuation above 550 MHz often results in low signal levels inside the home. The amp, powered from the home, boosts levels to feed homes with numerous outlets, multiple TV sets, VCRs and other devices connected to the drop or for situations where an extra long drop is encountered. Available next February and enclosed in a zinc die-cast housing, the amp will offer -60 dB CTB, CSO and cross-mod, and an optional 5-30 MHz return path with the addition of one filter. The output of the amp (which is available with one, two, three or four outputs) is said to be flat across all 155 channels. It measures 4.5 x 4.5 x 1.25 inches, including F-ports. **Reader service #171**

Sag Saga Ends

Comm/Scope's Spanmaster2 is a PC program for determining sag and tension parameters required for construction of aerial plant that is user-friendly — but accurate, according to the company. It is a stand-alone program that runs on any IBM-compatible PC and provides the appropriate data for any area of the country. Plus, the printed output from the program is accepted by utilities as confirmation of calculating the requirements for your installations. **Reader service #168**

FM Makes Video Viewable

FM Systems introduced the VIP (video insertion processor), a video test signal generator for FCC-required video compliance testing by CATV companies. The VIP enables the system to insert video test signals into a TV channel without interfering with the ongoing program and also without momentarily interrupting the TV channel when connecting or disconnecting the test signal generator to that channel. This enables the cable system to perform FCC tests during the day and even prime time instead of having to schedule test in the middle of the night to avoid customer complaints.

FM also exhibited the VM771 Video Master, which automatically corrects video level to 1 volt peak-to-peak, corrects sync to 40 IRE units and peak white to 100 IRE units, removes 60 cycle interference, and also automatically compensates for lost picture detail caused by long cable runs. The unit automatically corrects video to standard levels even when the input level is as low as 0.5 volts or as high as 2 volts. **Reader service #167 (VIP), #166 (Video Master)**

Leaming Offers Stereo Decoder

Leaming Industries featured its new TSD TV stereo (and SAP) decoder. This demodulator/decoder can be used to monitor and test stereo TV audio in the headend or used in the field for service calls. The TSD accepts Ch. 3, Ch. 4, 41.25 MHz, 4.5MHz or composite baseband at its input. It demodulates and decodes to high quality left and right line level outputs as well as a headphone output. **Reader service #154**

Digital Commercial Insertion

Texscan MSI introduced its MPEG-based digital commercial insertion system. According to John Boland, Texscan's director of sales and marketing: "The real magic of this new system is its ability to perform the video compression and encoding function conveniently in the local office. We designed a sensible upgrade path to the new digital platform by engineering system compatibility with the new M-Series and with Texscan's widely used 190/290 family of Comserter commercial insertion products. This gives our customers a smooth upgrade path to full digital performance." **Reader service #157**

Transmission System From American Lightwave

American Lightwave Systems unveiled a 2.4 Gbit/s 16-channel video fiber transmission system, the DV6000, which it says is the first digital system for CATV and broadcast applications that uses newly available high speed programmable logic. According to ALS, this allows modular packaging of 16 channels in only 19 inches of vertical rack space with less than half the power consumption of other systems and no cooling fans. Each video channel is individually addressable and can be added, dropped or passed at each location, with spacings of up to 90 km between locations. As well, 8- and 10-bit video encoders can be supported simultaneously in the same system. **Reader service #153**

Siecor Expands Fiber Communicator Line

The new smallTALK fiber communicator product line from Siecor was expanded to include a unit used with single-mode fiber. This point-to-point voice communicator can be used in both single-mode and multimode environment with bidirectional operation over a single fiber at 1,300 nm. The newest model offers a 30-mile range for single-mode fiber and a 20-mile range for multimode. Dynamic range is 30 dB.

No headsets are required for the 850 nm and 1,300 nm smallTALK set. It is used like a walkie-talkie. A button is pressed to engage conversation and released to hear responses. The communicator is said to be low-cost and can be used with virtually any single-mode or multimode system operating at 1,300 nm by connecting a unit to each of a system. Compact and lightweight, the 6-ounce units operate on a 9V battery with up to 15 hours of operation.

Featuring ST-compatible or FC connectors, the products also can access other connector types with hybrid jumpers. To access unterminated fibers, a bare fiber adapter is used. **Reader service #162**

Zenith Decoders Compatible With Program Guides

The first addressable cable decoder with built-in capability to receive and display electronic program guide services from multiple program providers was unveiled by Zenith Cable Products. It's called the HT-2000 baseband decoder and is has on-screen display technology designed to work with electronic program guides from InSight Telecast Inc. and Prevue Networks Inc. The product's "Viewer Guide" display system provides up-to-the-minute guides with program titles, times and program content on the TV screen, according to the company.

For the InSight system, Zenith has developed an infrared (IR) controller for simplifying VCR programming. The IR controller is short cable that connects to the decoder box and is placed near the infrared signal receiver at the front of a VCR to activate recording through the cable box. The HT-200 also makes Prevue Guide's TV Trakker system available. The Trakker system lets viewers examine the listings of up to four hours at one time. Zenith also demonstrated Prevue Guide's Sports Trakker service. It delivers up-to-the minute scores and information from nearly every major sport from football to racing.

In addition to electronic program guides, the HT-200's on-screen display system allows cable operators to send local news and weather, stock market quotes and shopping information. **Reader service #161 (decoder), #160 (IR controller)**

Fresh Pioneer Product: BA-9000 Converters

Pioneer Communications of America exhibited its new BA-9000 Series converters. The product has extensive on-screen display capabilities and the company reports it offers "field-proven," second-generation near-video-on-demand for multiple pay-per-view applications.

Other features include an "extremely high security system" maintained through digital video scrambling and encrypted data communications between controller and addressable converters. The unit also has a platform to accommodate digital video compression as it becomes available.

Also highlighted by Pioneer was its PLUS (Pioneer Laserdisc Universal System) stand-alone pay-per-view technology, which the company says has "won the praise of at least three major cable systems and the interest of many others." The system is a combination of three Pioneer components — the LC-V330 autochanger (with a 72-disc capacity), the LD-V8000 laserdisc player and the PLUS controller. **Reader service #159 (converters), #158 (PLUS)**

Video Laser's IPPC Pays

Video Laser Systems, the new spin-off company from Video Data Systems, has completed NTSC and PAL versions of IPPC, the Integrated Playback Promotion Center. IPPC is designed for use by stand-alone pay TV operations and a wide range of pay-per-view applications from single channel to near video-on-demand (NVOD).

The heart of the IPPC is a multitasking 386DX computer and VLS proprietary program promotion and scheduling software that can control any combination of laser disc, S-VHS or other playback equipment designated by the domestic or international network/operator. The inclusion of at least one laser player in combination with a custom pressed laser disc allows for recurring highlight, logo, ordering, schedule and special offer material to be randomly accessed and constantly updated for always fresh interstitial and free-standing promotional channel programming.

IPPC hardware features include data routing, industrial laser players, add-on S-VHS flexibility, time base correction, sync generation and a matrix switcher for NVOD systems. IPPC software includes programming day scheduling, program database indexing, seamless disc switching, remote control and/or on-site access. **Reader service #151**

80-Channels from Augat

Augat Communications Products announced the availability of an 80-channel laser transmitter that features automatic RF level control and fully automatic operation. The transmitter mounts in a standard 14-inch rack, occupying 1-3/4 inches of rack space. **Reader service #155**

One Fiber, 80 Channels

ONI and AT&T have added another product to the Laser Link II line of transmission equipment. The Laser Link II Plus transmitter, designed and manufactured by AT&T to ONI specifications, features a highly linear, distributed feedback (DFB) laser that can transmit 80 channels on a single fiber over optical links of up to 26 km. Typical performance on a 10 dB loss budget is 50 C/N, 65 CTB, 60 CSO.

Like the Laser Link II transmitter, the Laser Link II Plus contains power and laser status LEDs as well as an RF modulation adjustment and -30 dB test point. It also features laser temperature control and bias control and protection. The Laser Link II, predecessor to the Laser Link II Plus, transmits 60 channels on a single fiber over optical links of up to 30 km.

Five new modules added to the Laser Link II line of transmission equipment include: a feedforward drive amp that features 18 to 20 dBmV input, 22 dB gain and a single output; a return data laser that uses a Fabry Perot laser to send data on a single fiber in the 5 to 33 MHz spectrum; a return video laser that uses a high-quality Fabry Perot laser to transmit four video channels and data; a return data receiver that uses 5 to 33 MHz bandwidth to receive optical signals and provide RF output for data applications; and a return video receiver that uses 5 to 200 MHz bandwidth for applications requiring a high quality output for video return paths. All the new modules are designed to be incorporated in the Laser Link II shelf assembly.

Also introduced was the Cable Loop Carrier-500 (CLC-500), the first interactive application for the Cable Integrated Services Network (CISN) according to the company, a spectrum utilization plan that accommodates video compression, analog and digital transmission techniques in a 1 GHz spectrum.

The CLC-500 allows cable operators to use existing fiber/coax hybrid networks to provide both entertainment video and voice services via one provider. The CLC network consists of a headend unit that provides a standard interface to the public switched telephone network (PSTN), a hub divider and a subscriber unit. The headend device transmits digital telephony signals via fiber-optic cable to the hub divider, where they are combined with broadband entertainment signals. The converted optical signals are then carried on coaxial cable to serve an area of 500 homes. At the home, the headend device interfaces with a CLC-500 subscriber unit that, in turn, interfaces with a telephone. The CLC unit uses existing home wiring for multiple telephone outlets.

ONI also introduced the MS-TK-3 precision fiber-optic stripping kit, specifically designed to handle telecommunications applications. The company says that the kit's sequential set of three stripping tools allows technicians with limited fiber experience to properly strip 125-micron fiber-optic cable.

The kit includes a jacket stripper for 3 mm and 2.5 mm jacket removal; two buffer strippers (one for 250/900-micron tight or loose buffer removal and one for 125/250-micron acrylate coating removal); and Kevlar cutters. Blade inserts are mounted in the handles of the preassembled stripping tools. **Reader service #131 (transmitter), #130 (drive amp), #129 (return data laser), #128 (return video laser), #127 (return data receiver), #126 (return video receiver), #125 (CLC-500), #124 (MS-TK-3)**

Get More With New S-A Subscriber Terminal, Compression

One of the highlights of Scientific-Atlanta's exhibit was its next member of a new generation of subscriber terminals that builds upon the on-screen and communications capabilities of the Model 8600. S-A says the new Model 8600^X has the intelligence and upgradeability needed to provide a platform for generating alternative revenue streams for cable TV operators from the growing home entertainment and information services business.

Features of the 8600^X (scheduled to be available in mid-1993) include: the ability to accept and display program data from virtually any electronic program guide (Insight Telecast and S-A recently signed an agreement allowing S-A to provide Insight's guide format); advanced messaging services for "easy" recall of various preselected categories of news, information and other stored messages; VCR Commander controller for one-step VCR recording; high resolution on-screen graphics or bit-mapped ones that provide more information per screen; near-movie-on-demand capability; virtual channels that require no video bandwidth for information services; expanded tuning bandwidth with 550 MHz standard (750 MHz and 1 GHz are optional); optional audio and video baseband outputs; downloadable software to update feature set addressably; Genius cards for extending current capabilities as well as adding future services and providing for renewable security upgrades; dual tune/descramble for picture-in-picture and to watch and record scrambled channels simultaneously; digital upgradeability through a serial port; and a serial data port for connection of a PC terminal, printer, etc.

S-A also demonstrated its MPEG-based digital video compression system, which is now in production. **Reader service #150 (8600^X), #149 (video compression)**

LRC's Drop Connector

LRC Electronics' Push-N-Lock drop connector features a unique locking mechanism that the company says makes it dependable and easy to install, and with one push gives the installer (or subscriber) a positive RF seal on any mating F-port. It uses a standard 1/4"-1/4" preparation and is compatible with 59 and 6 Series cables. **Reader service #152**

Riser-Bond Finds Faults

Riser-Bond Instruments showed the Model 3000 multipurpose digital metallic TDR, medium range cable fault locator used to locate opens, shorts, bad splices, cut and crimped cable, loose connections, water damage and other major cable problems. It can be used to test both aerial and underground cables of all sizes. It features multiple range settings and variable sensitivity control for troubleshooting virtually all types of metallic paired cables. According to the company, the unit has readability to 19,990 feet (1999 meters), high precision accuracy and simple one-button operation. An oscilloscope output feature allows the operator to view the waveform of the cable under test. **Reader service #142**

Synchronous Shows Fiber-Optic Video Link

Synchronous Communications showed its multichannel fiber-optic link, which is composed of: an FMVT-4004-40 wideband FM modulator, FMVR-4004-40 wideband FM demodulator, AC-16 sixteen-channel active combiner, SMLT-1300 single-mode laser transmitter and SMOR-1300S single-mode optical receiver.

The FM modems utilize extremely linear PLL VCOs using the latest microwave stripline techniques, according to the company. All of the video amplifiers are integrated circuit high speed operational amplifiers, as opposed to discrete transistor circuits. The video pre-emphasis and de-emphasis filters are composed of IC high speed operational amplifiers with fixed feedback components. The company says the microwave circuit-type monolithic amplifiers are used throughout the RF circuits to reduce the parts count and reduce the total current consumption as well as to ensure constant circuit performance over the required temperature range.

Also on display were: the AMLT-1310 laser transmitter, AMLT-1550 laser transmitter, AMPR-1550 optical receiver and EDFA-1550 erbium-doped fiber amplifier. **Reader service #147 (fiber-optic link), #146 (AMLT-1310), #145 (AMLT-1550), #144 (receiver), #143 (amp)**

Antec's Monitor System Alerts Your Subs on Weather and Public Safety

You've probably heard that the Cable Television Consumer Protection and Competition Act directs the FCC to extend the Emergency Broadcast System to include cable TV networks. There's a product that Antec says allows operators to offer subscribers security and safety today.

Antec Network Systems and HollyAnne Corp. teamed up to market a safety alert system that is said to make "the world a safer place for cable TV subscribers who use it." The Safety Alert Monitor (SAM) system allows the National Weather Service and public safety officials to instantly warn the public of life-threatening emergencies via cable TV whether their TV sets are on or off. It also can alert subs of less threatening community concerns such as school closings.

The system is comprised of a controller device at the headend, which is linked via the cable TV network to safety alert monitors in subs' homes. Each monitor has an alarm, red warning light and speaker. In an emergency, agencies with warning responsibilities can easily access the headend device and activate monitor alarms and announce emergency information. **Reader service #148**

Lectro Unveils Standby Power Supplies

Lectro Products' Uni-Max II is an efficient, common ferro standby power supply designed for ease of installation and service, according to the company. Features include 91% efficiency at full load, heat sink cooling for longer transformer life, LED status indicators, synchronized transfer between operating modes, limited FR foldback, key locked door, dual output option, all-aluminum housing and temperature range from -40° to +55°C.

Also being shown by Lectro was its Sentry II standby line, which is totally modular, with faceplates that are color-coded by amperage. The line is compatible with both conventional powering and fiber optics.

In addition, the company's CLPS-35 was on display. This 35-amp cable line power suppresser eliminates 80% or better of outages due to surges, transients, spikes and lightning. **Reader service #136 (power supply), #135 (standby), #134 (power suppresser)**

Harmonic Lightwaves Ups YAGLink Output Power

Harmonic Lightwaves and Optical Networks International announced the availability of the HLT 6020 transmitter, a high-power version of its HLT 6000 and part of the YAGLink system, designed specifically for delivering multichannel video over fiber in cable TV plants.

The company says the unit's increased power and ability to run links of different lengths gives operators a wide number of options when planning their fiber network architectures. For instance, the product's 40 mW output, half delivered on each of two output fibers, can be split to cost-effectively handle 20 nodes of 500 subscribers per node.

Also, the enhancement of its SMS 5000 network management system to provide remote monitoring and control capabilities was announced. The system is designed to operate in conjunction with all components of the company's YAGLink system. **Reader service #139 (transmitter), #138 (management system)**

C-COR's CNM Software

CNM (Cable Network Manager) is a new generation of control and monitoring software product introduced by C-COR Electronics. It provides quick detection, location and correction of outages that are important for monitoring total communication systems, including fiber and RF networks. The Windows-based program integrates multifunctional network alarm system in all three elements of the network: digital fiber optics, analog fiber optics and RF coaxial plant. **Reader service #137**

Cheetah Addition Prowling at Superior

Superior Electronics Group announced the addition of CellPack to the Cheetah system of test equipment. It has been developed to allow portable communications for automated compliance testing with the Cheetah system.

The CellPack can be purchased as a backpack device mounted to any PC4650 series system measurement device or as a portable independent package. As a backpack device, the operator can remotely program a test site, then move the CellPack to a second location, repeating the process until all sites have been programmed. Used as a portable package, CEL4650, the unit can be used as a troubleshooting and diagnostic tool. **Reader service #122**

Legal Software from etrok

Los Angeles-based etrok has a cable TV edition of its LawManager for Microsoft Windows 3.1 that features the new FCC rules for cable TV and the Cable TV Consumer Protection and Competition Act of 1992, all in a "unique" hypertex format. It's designed for anyone who needs to understand the new federal laws. **Reader service #156**

Triple Crown Solves Rebuild Respacing

The new Minex series of ultra-small line amplifiers by Triple Crown Electronics includes two specialized versions, the MX 5309 and MX 5209, designed for rebuild and bandwidth upgrade applications. They are intended to be installed mid-span, between existing trunk/bridger locations.

Because of the low gain, the products can be operated with high input and low output levels. This, according to Triple Crown, effectively reduces the cable length by 9 dB, while contributing minimal noise and distortion. The 10 ampere power passing capability and bidirectional operation are said to assure that the amplifier is essentially transparent in the overall trunk. When used in conjunction with the company's Titan series or equivalent power doubled trunk amplifiers, the MX5209 (push-pull) and MX5309 (power doubled) units will allow a 350 MHz system to be upgraded to 550MHz without relocating trunk/bridger locations. **Reader service #115 (MX 5309), #114 (MX 5209)**

New Modulator from Standard

Standard Communications says that its new TVM450L CATV modulator provides the quality of fixed-channel modulators with the flexibility of frequency agility. According to the company, PLL tuning ensures compliance with all FCC stability requirements; and high quality, low noise amplifiers, mixing techniques and six levels of filtering provide exceptional spurious response and broadband noise performance.

The unit features factory calibrated front panel controls with full metering. The front panel LED display shows a real life channel number. Both visual and aural I.F. loop-throughs are offered, compatible with all scrambling formats, as well as BTSC integration. **Reader service #141**

Sweep/Analyzer System From Avantron

Avantron introduced the 600 MHz version of its noninterfacing system sweep/ spectrum analyzer Model AT85R/G, designed to facilitate the FCC's new 24-hour test. The microprocessor controlled system uses the company's patented low-level sweep technology that allows true continuous sweeping with real-time display.

A built-in frequency counter allows the measurement of modulated video and audio carriers, and 4.5 MHz intercarrier spacing. Microprocessor power adds storage capabilities for up to 100 traces and measurements recorded in nonvolatile memory for later viewing, printing or transferring to a PC. An additional 64 instrument settings can be preset and stored. **Reader service #140**

Regal Converter Leaves Small Footprint

Regal Technologies unveiled a new 550 MHz basic converter, the RR-92, the smallest full-bandwidth converter in the industry, according to the company. It is an 83-channel unit that passes separate audio program signals and is fully BTSC stereo compatible. It is IR programmable and can be tuned to HRC, IRC or EIA standard frequency allocations. Features include self-test diagnostics, parental guidance and a switched AC convenience outlet.

The company also introduced the CRP-10 hand-held remote that features user-friendly buttons, differentiated for individual tasks. It is backward compatible, enabling Regal RC-83 converter users to choose an alternative remote control. **Reader service #133 (converter), #132 (remote)**

Stop Thief! NCA Microelectronics Intros Encryption System

The research and development division of Fundy Cable Ltd./Lteé, NCA Microelectronics, rolled out its new Chameleon pay TV encryption system. It's said to be a cost-effective solution that prevents pay TV theft by digitally encrypting the video timing information of sync suppression systems. The company says the technology has been proven effective against pirate boxes and tampered decoders.

NCA also reported that upgrading existing decoders to Chameleon technology with a low-cost add-in circuit card retains capital investment. The card's sealed custom computer chip, developed by NCA, is said to defy copying. **Reader service #116**

Viewsonics Unlocks New Locking Terminator

On display at Viewsonics was the new Gilbert equivalent locking terminator. Two models are available: TR75GTL with resistor and TRWGTL without resistor. The unit uses the same Gilbert security tool.

Also displayed was the Model VSTWE-30-6 two-way expander. It's designed so that existing one-way distribution apartment amps can still be used if the system is changed to two-way. Several amplifier models were highlighted at the booth as well. The Platinum Plus amplifiers are 45 MHz-1 GHz and 130 RFI. Housings are tin-plated and solder-sealed, producing a high degree of anti-corrosive protection along with superior conductivity, according to the company. **Reader service #119 (terminator), #118 (expander), #117 (amps)**

Where's the 4-in-1 Remote? US Electronics

US Electronics displayed its new 4-in-1 universal remote control that operates all TV sets, VCRs, cable boxes and digital music terminals.

Also displayed was the new UTV 2000 multifunction remote to operate the on-screen converter from GI. It also features the option to control the subscriber's TV set as well as the cable box. **Reader service #121 (4-in-1 remote), #120 (UTV 2000)**

Tektronix Sweep System Goes Lightweight

Tektronix announced its new 2721A/ 2722A cable TV sweep system, which consists of the 2721A transmitter and the 2722A receiver. It features a compact, lightweight package, with the 2722A weighing in at 17 pounds and the 2721A at 11 pounds. Noninterfering transmission means techs can make amplifier adjustments without affecting closed captioning or other VBI services. The receiver includes a built-in SLM and high contrast LCD, and can store 63 archive records all downloadable to a PC or printers. The system is compatible with LAN and with NTSC, PAL and most SECAM cable TV systems. **Reader service #180**

ComSonics Carts Out Innovative Modularity

ComSonics announced its new WindowLitePLUS. Field techs can simply add a choice of snap-in-place modules, thereby expanding the test capability of the signal level meter to carry out other test functions.

The product weighs just 40 ounces and has automated time interval sampling that wakes up on the user's programmed schedule, takes and stores readings (including ambient temperature), then shuts down. It also features expanded memory and downloading capacity. **Reader service #123**

CALENDAR

January

4: SCTE Penn/Ohio Chapter, Installer exams to be administered, Pittsburgh. Contact Marianne McClain, (412) 531-5710.

6: SCTE Golden Gate Chapter seminar, Viacom, San Francisco. Contact Mark Harrigan, (415) 358-6950.

6: SCTE New Jersey Chapter, Installer exams to be administered, Tintonfall, NJ. Contact Jim Miller, (908) 446-3612.

6: SCTE Ozark Mountain Meeting Group seminar and Installer and BCT/E exams to be administered in all categories at both levels, Springdale, AR. Contact Bob Griffith, (501) 648-1966.

6-7: SCTE Annual Conference on Emerging Technologies, Hilton Riverside, New Orleans. Contact (215) 363-6888.

12: SCTE Bluegrass Chapter, BCT/E exams to be administered in all categories at both levels, Elizabethtown, KY. Contact Alan Reed, (502) 389-1818.

12: SCTE Cascade Range Chapter seminar. Contact Cynthia Stokes, (503) 230-2099.

12: SCTE Wheat State Chapter seminar, basic troubleshooting. Contact Lisa Hewitt, (316) 262-4270, ext. 191.

12: SCTE Delmarva Meeting Group seminar, testing and measuring for new FCC rules, digital architectures for CATV, Dover, DE. Contact Linc Reed-Nickerson, (215) 825-6400.

13: SCTE Bluegrass Chapter seminar, proof-of-performance procedures and testing, Prichard Community Center, Elizabethtown, KY. Contact Alan Reed, (502) 389-1818.

13: SCTE Heart of America Chapter seminar. Contact Don Gall, (816) 358-5360.

13: SCTE North Country Chapter seminar, Sheraton Midway Hotel, St. Paul, MN. Contact Bill Davis, (612) 646-8755.

13: SCTE Oklahoma Chapter seminar, proof-of-performance standards. Contact Arturo Amaton, (405) 353-2250.

13: Tektronix seminar, how to evaluate your system, Northwest Marriott, Atlanta. Contact Kathy Richards, (503) 627-1555.

13-15: Scientific-Atlanta seminar, fiber optics, Orlando, FL. Contact Bridget Lanham (404) 903-5516.

14: SCTE Satellite Tele-Seminar Program, to air on Galaxy I, Transponder 14. Contact (215) 363-6888.

14: SCTE Gateway Chapter seminar. Contact Chris Kramer, (314) 949-9223.

14: SCTE New Jersey Chap-ter, Installer exams to be administered, New Providence, NJ. Contact Jim Miller, (908) 446-3612.

14: SCTE Ohio Valley Chapter seminar, fiber optics. Contact Jon Ludi, (513) 435-2092.

14: SCTE Penn-Ohio Chapter seminar. Contact Marianne McClain, (412) 531-5710.

15: Tektronix seminar, how to evaluate your system, International Drive Marriott, Orlando, FL. Contact Kathy Richards, (503) 627-1555.

16: SCTE Cascade Range Chapter, BCT/E exams to be administered in all categories, Paragon Cable, Portland, OR. Contact Cynthia Stokes, (503) 230-2099.

16: SCTE Golden Gate Chapter, Installer and BCT/E exams to be administered in all categories at both levels, TCI Cablevision, San Jose, CA. Contact Mark Harrigan, (415) 358-6950.

18-19: SCTE Wheat State Chapter, BCT/E exams to be

administered in all categories at both levels, Wichita, KS. Contact: Lisa Hewitt, (316) 262-4270, ext. 191.
19: SCTE Pocono Mountain Meeting Group seminar, fiber optics, Hazleton, PA. Contact Anthony Brophy, (717) 462-1911.
20: SCTE Golden Gate Chapter seminar, CLI, TCI Cablevision, Hayward, CA. Contact Mark Harrigan, (415) 358-6950.
20: SCTE Great Plains Chapter seminar, fiber construction, installation and maintenance, Quality Inn Crown Court, Bellvue, NE. Contact Jennifer Hayes, (402) 334-2336.
20: SCTE Michiana Chapter seminar, Midwest CATV, Mishawaka, IN. Contact Russ Stickney, (219) 259-8015.
20: SCTE Piedmont Chapter seminar. Contact Tod Dean, (919) 662-1489.
20: SCTE South Jersey Chapter seminar, SCTE overview, basic CATV for the CSR, customer relations, hands-on training (VCR and TV hook-up lab) and BCT/E exams to be administered in all categories at both levels, Vineland, NJ. Contact Kevin Hewitt, (914) 425-6084.
21: SCTE Central Indiana Chapter seminar. Contact Gregg Nydegger, (219) 583-6467.
21: SCTE Dakota Territories Chapter seminar, Aberdeen, SD. Contact Kent Binkerd, (605) 339-3339.
21: SCTE Iowa Heartland Chapter seminar, OSHA rules and regulations, Newton, IA. Contact Mitch Carlson, (309) 797-2580, ext. 3700.
21: SCTE Lake Michigan Chapter seminar, technical standards. Contact Karen Briggs, (616) 947-1491.
21: SCTE Mount Ranier Chapter seminar, test gear and FCC compliance, Silverdale, WA. Contact Gene Frye, (206) 747-4600, ext. 107.
21: SCTE Ohio Valley Chapter, Installer and BCT/E exams to be administered in all categories at both levels. Contact Jon Ludi, (513) 435-2092.
23: SCTE Chaparral Chapter seminar, back to basics, Installer and BCT/E exams to be administered in all categories at both levels. Contact Rita Erickson, (505) 761-6206.
26: SCTE Appalachian Mid-Atlantic Chapter, BCT/E exams to be administered in all categories at both levels, Harrisburg, PA. Contact Richard Ginter, (814) 672-5393.
26: SCTE Magnolia Chapter seminar, installer training, Ramada Coliseum, Jackson, MS. Contact Steven Christopher, (601) 824-0200.
26: SCTE Palmetto Chapter, Installer and BCT/E exams to be administered in all categories at both levels. Contact John Frierson, (808) 777-5846.
27: SCTE Smokey Mountain Chapter seminar, FCC testing, locations and liabilities and underground construction practices, Days Inn, Kingsport, TN. Contact Roy Tester, (615) 878-5502.
28: SCTE Shasta Rogue Meeting Group seminar, CSR training, Redding, CA. Contact Dan Barger, (916) 547-5438.
29: SCTE Wheat State Chapter, BCT/E exams to be administered in all categories at both levels. Contact Lisa Hewitt, (316) 262-4270, ext. 191.
31: SCTE Old Dominion Chapter, Installer and BCT/E exams to be administered in all categories at both levels, Holiday Inn, Richmond, VA. Contact Margaret Davison, (703) 248-3400.

Planning ahead

Feb. 2-4: SCTE Technology for Technicians II seminar, Holiday Inn, New Orleans. Contact (215) 363-6888.
Feb. 21-26: OFC/IOOC '93 conference, San Jose, CA. Contact (202) 223-8130.
Feb. 24-26: Texas Cable Show, San Antonio. Contact (512) 474-2082.
April 21-24: SCTE Cable-Tec Expo, Orlando, FL. Contact (215) 363-6888.
June 6-9: National Show, San Francisco. Contact (202) 775-3669.

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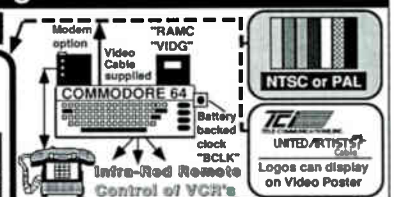

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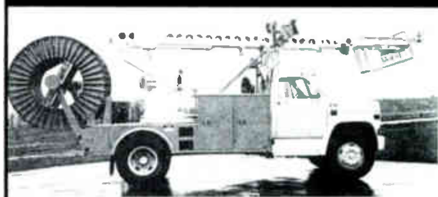

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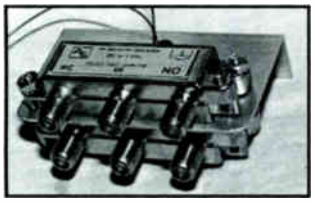

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The history of chapter development

By Bill Riker
President, Society of Cable Television Engineers

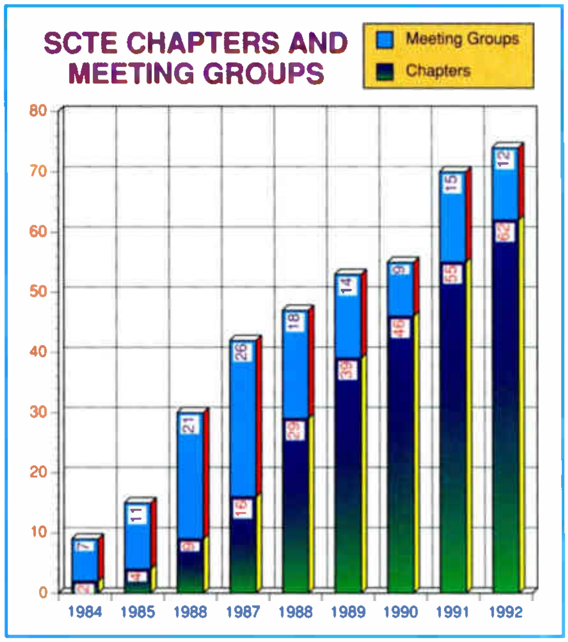
The development and evolution of the Society's Chapter Development Program, which promotes the establishment of local SCTE meeting groups and their advancement to chapter status, is closely entwined with the history of the Society of Cable Television Engineers itself.

In 1970, just one year after its formation, the Society first began to organize local chapters to provide a forum for the exchange of ideas and solutions regarding cable TV technology. However, this development was delayed by problems the young organization was experiencing with correspondence, dues and miscommunication.

The program evolved slowly over the years, and by 1975, SCTE had 15 chapters in the U.S., as well as four chapters in Canada and chapters in Argentina, Australia, Brazil, England, France, Holland, Italy and Mexico.

The Chapter Development Program continued to grow steadily in the late 1970s, but the Society fell upon hard times during the early 1980s and all local chapters ceased to exist. When I joined the SCTE staff as executive vice president in 1984, one of my first priorities was to revitalize the program in order to bring high-quality, low-cost technical training opportunities to industry technicians and engineers who could not otherwise attend seminars to receive their training. With only one chapter and two meeting groups (chapters under development) in existence at this time, members were organized through the assistance of their regional directors and national headquarters staff to form new local chapters. John Kurpinski chaired a committee to establish new rules for chapter organization and development. The first chapters to organize under this new launch were the Appalachian Mid-Atlantic, Delaware Valley and Golden Gate. Their vitality and enthusiasm were contagious, as they inspired the sprouting of a variety of new chapters in the years to come.

Chapter development has grown to be one of the Society's most successful "grass roots" programs, which is evidenced by the growth of SCTE chapters and meeting groups nationwide. By 1985, the Society had four chapters and 11 meeting groups. Each successive year brought more growth, with nine chapters and 21 meeting groups in 1986, 29 chapters and 18 meeting groups in 1988, 46 chapters and nine meeting groups in 1990 and, as we entered 1992, 62 chapters and 12 meeting groups for a total of 74 training groups operating under the auspices of SCTE. This means that the Society now presents over 300 local technical training meetings each year for the benefit of its membership.



The chapter program could not have grown as it has without the support of the Society's board of directors and national headquarters staff. The program has become so important to the Society's effectiveness that in 1988, Ralph Haimowitz was hired as director of chapter development and training. The position combined a focus on chapter visitation and support with an area in which Ralph is an acknowledged master: the training of industry personnel. But by 1991, with the continued growth of the chapter program and Ralph's increased training responsibilities, it became necessary to modify his position, effectively splitting it into two: director of chapter development and director of training. Ralph would continue his educational duties in the latter position, and Marvin Nelson, a 13-year veteran of the industry with a strong technical background, certification in the BCT/E Program at the Engineer level and an impressive array of experience with the Great Lakes Chapter, was named director of chapter development.

With the support of Marvin and the national staff, our 74 chapters and meeting groups currently offer a wide variety of highly beneficial educational opportunities to the industry. Testing in SCTE's Broadband Communications Technician/Engineer (BCT/E) and Installer Certification Programs is a regular feature of many local meetings, as are hands-on demonstrations of important hardware and technologies, and tours of manufacturing facilities and CATV systems. Local group meetings attract knowledgeable speakers from top manufacturers, suppliers and MSOs, as well as speakers from outside the industry, such as local and national government officials who offer different viewpoints on topics of vital interest to our industry.

Throughout the history of the program, the SCTE national board of directors has been instrumental in promoting participation in local groups among the Society's national membership. Most regional directors visit the chapters and meeting groups in their region at least once each year, informing them of national activities and conveying the importance of their local training efforts.

Of course, our 74 chapters and meeting groups would be nothing without the over 600 volunteers who serve as their officers and board members, supervising and planning group events, securing speakers and acting as liaisons between the local organizations and the national Society to ensure their efficient and legitimate operation.

Last but not least, we can't forget the SCTE members who attend group meetings and participate in their worthy activities. To everyone who has contributed to the success of the SCTE Chapter Development Program, you have our thanks and our pledge to continue to support your training efforts every way we can. **CT**

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