COMMUNICATIONS TECHNOLOGY

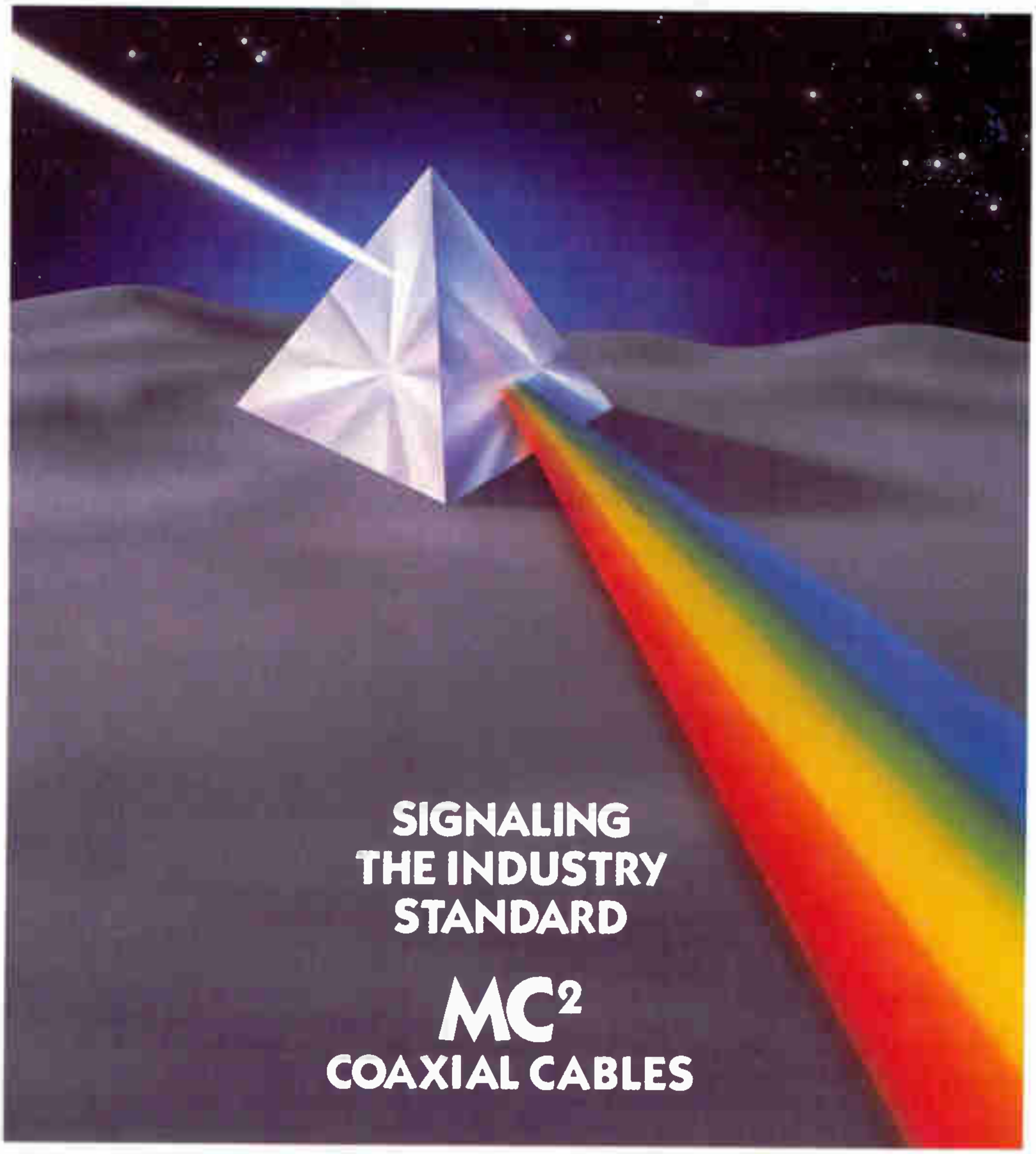
Official trade journal of the Society of Cable Television Engineers

An eye on status monitoring

Ushering in new SCTE headquarters

March 1987

GROWING STRONGER ALL THE TIME



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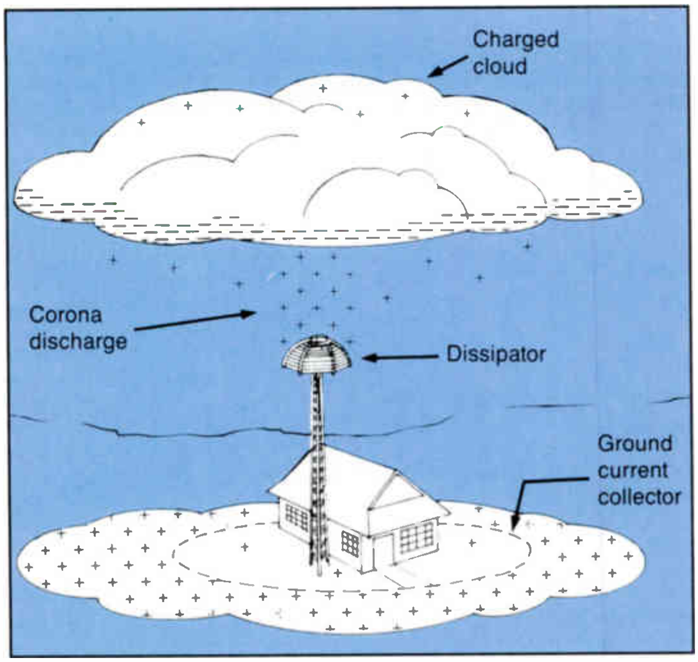
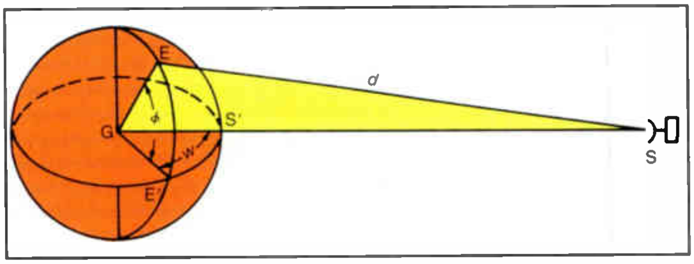
CONTENTS

Departments





Features

Cover
System monitoring via computer, courtesy Magnavox; photo of SCTE's ribbon-cutting ceremony by Howard Gordon.

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PUBLISHER'S LETTER

Howard Gordon

Off and running: A snip of the scissors and the SCTE begins a new chapter in its history.

A dream come true

For a long time, members of the Society of Cable Television Engineers dreamed of actually owning their national headquarters—lock, stock and plumbing. Well, they need dream no longer: On Jan. 14, the SCTE celebrated the grand opening of its new location at 669 Exton Commons in Exton, Pa.

I had the pleasure to be on hand for the event, which included a ribbon-cutting ceremony and speeches by SCTE board members in attendance. It was great to meet and speak with some old friends and make new ones. This is indeed a quantum leap for the Society to own its headquarters and have control of its own surroundings. Congratulations go to Bill Riker and his staff. (Read more about it in *The Interval*.)

Next month we will announce the winner of *CT* essay contest. Who will win the expenses-paid vacation for four to the Annual Engineering Conference and the Cable-Tec Expo? Stay tuned.

Two members of the SCTE who have contributed a great deal to its development and growth will be stepping down from the Society's board of directors this year—Tom Polis and Sally Kinsman.

Polis began his career in cable over 20 years ago as a bench technician for Jerrold; he then moved up to field engineer and later to product manager. Later, he became director of operations and director of international sales at Magnavox. Most recently he has been with Communications Construction Group as executive vice president.

Polis' contributions to the SCTE are legion. He has been on the board of directors since 1981 and was president for four terms. He was president during the first Cable-Tec Expo and the first BCT/E committee. Among his many accomplishments, he coordinated the guidelines for the chapter development committee (with John Kurpinski).

Sally Kinsman, president of Kinsman Design Associates, has been on the board since 1983 and was Western vice president for two years. In her first year she compiled a needs analysis of SCTE members, which spurred greater interest in chapter development, the Tele-Seminar Program and the Cable-Tec Expo. In other words, the survey gave the SCTE a direction to where it is today.

From a hospital bed, she coordinated the first live teleconference seminar, which took place in Denver; this program featured representatives from the FCC. Kinsman also chaired the restructuring committee, which proposed to expand the number of SCTE regions from seven to 12.

Both have been presented the Member-of-the-Year Award. And frankly, if people like Tom Polis and Sally Kinsman had not been around, there probably wouldn't be an SCTE today.

Paul R. Levine

COMMUNICATIONS TECHNOLOGY

Official trade journal of the Society of Cable Television Engineers

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Expo '87 workshops announced by SCTE

EXTON, Pa.—The Society of Cable Television Engineers has unveiled its technical seminars for the 1987 Annual Engineering Conference and Cable-Tec Expo, to be held April 2-5 at the Hyatt Hotel in Orlando, Fla.

Scheduled for the engineering conference April 2 is guest speaker Paul Weitz, NASA space shuttle commander. Also on the agenda will be the seminars "Lightning and grounding," "Consumer interface issues—Making cable compatible," "A technical evaluation of competing technologies—DBS, MMDS, SMATV, VCR" and "Developing a corporate training program."

At the expo itself, hands-on workshops include "Ku-band technology and TVRO calculations," "A working class on cable system design," "Headend antenna theory and EMI reduction," "Performing measurement on basic test equipment," "Baseband video test equipment measurements and modulator alignment," "A technical evaluation of pay TV security" and a question-and-answer session with FCC engineers Syd Bradfield and John Wong.

In addition, review courses will be held for the BCT/E Certification Program Categories I and VII; also, exams will be administered April 5 on Categories I, II, III, IV and VII. For more information, see this month's *Interval*; or circle #1 on the reader service card in this issue.

Favorable ruling protects MSO rights

BOSTON—A U.S. District Court judge ruled that a cable operator who receives pay satellite programming and transmits it to subscribers may sue when unauthorized earth stations intercept and use the programming for economic gain.

This decision resulted from American Cablesystems' satellite piracy case against three Quincy, Mass., bars. In an attempt to dismiss the suit, the bar owners had argued in court that only the programmer, New England Sports Network (NESN), could file the suit.

In his rejection of this argument, Judge Andrew Caffrey stated that the "defendants' unauthorized interception and use of NESN transmissions will likely deprive (American Cablesystems) of customers. . . In effect, (American) has a proprietary interest in the satellite transmissions."

Cable technology eases traffic jams

PATERSON, N.J.—Using its cable television plant here, U.S. Cable Corp. has taken over controlling some of the city's traffic signals (the system drops in on about 230 intersections). The cable system utilizes 550 MHz two-way Starline X-3000 feedforward distribution amplifiers and Quadrapower line extenders and bridgers from General Instrument's Jerrold Division, as well as coaxial cable from GI's CommScope Division.

The system's data transmission line feeds information by computer to traffic sensors at 153 MHz and returns at 15 MHz with data on traffic flow and amount of vehicles. After receiving the information, the computer decides how often and how long lights should be red or green. This improves flow and reduces vehicles idling at intersections, cutting down on pollution.

Traffic control via cable was required in the franchise agreement for the Paterson system.

- The 1985 lawsuit filed by Alpha Technologies Inc. against Data Transmission Devices Inc. and its president at the time, Thomas Hunter Jr., alleging false and misleading advertising on the part of Data Transmission, was settled recently by entry of a consented-to final judgment and the signing of a settlement agreement. The terms of the judgment and agreement are confidential; however, according to Alpha, Data Transmission has agreed not to make any unsupported statements that its products can double or triple battery life.
- Scientific-Atlanta reported an increase in sales, earnings and new orders for the second quarter ending Dec. 31, 1986. However, it cautioned that these results reflected a temporary upswing in the cable industry demand as some operators upgraded systems in preparing for industry deregulation, as well as by seasonality in some of its product lines.
- In response to a 400 percent subscriber growth for 1986, Empire Communications has moved to larger corporate offices at 5921 S. Middlefield Rd., Littleton, Colo. 80123. Its phone number, (303) 795-6500, remains the same.
- Tele-Wire Supply Corp. of East Farmingdale, N.Y., signed a contract to stock the VideoCipher II at all of its service locations and have the units available for immediate shipment.
- Rational Broadcast Systems, which designs turnkey automation systems for television, cable facilities and networks, has moved its national headquarters to 2306 Church Rd., Cherry Hill, N.J. 08002, (609) 667-7300.
- Hughes Aircraft Co.'s Microwave Products Division has received a $3 million contract for millimeter-wave power amplifiers for use in ground terminals of the military communications system Milstar. The contract calls for the design and manufacture of 17 preproduction units of the amplifiers, with delivery scheduled to begin in the fall of 1987.
- Anixter Bros. Inc. of Skokie, Ill., has acquired Colonial Wire & Cable of Lowell, Mass., a distributor of electronic and military-specification wire to OEM, computer and defense markets. The company will operate under the name of Anixter-Colonial.
- Pirelli Cable Corp. of Union, N.J. has acquired Jacobson Brothers Inc. of Seattle, Wash., a company involved in underwater cable laying and marine support work. As a supplier of underwater cable systems, Pirelli plans to operate Jacobson as a separate business headed by its existing management serving oil companies, power and communication utilities, and federal and state governments.
- The Jerrold Division of General Instrument Corp. (GI) announced that Heritage Communications has agreed to buy $2 million of distribution and headend equipment for its 600-mile system in suburban Philadelphia. GI's TOCOM Division will supply the MSO with $2.5 million of converters, addressable controls and related headend equipment for the Philadelphia build. Jerrold also announced a $2.2 million purchase of subscriber equipment by American Television and Communications Corp. Finally, TOCOM will supply nearly $3 million of addressable equipment to Cox Cable Communications in Virginia and Illinois systems.

Correction

In the February issue's "Back to Basics" column, the fourth paragraph under the subhead "Computing amplifier C/N," should have read: "Although the noise figure is worse in the *line extender* than in the *trunk amp*, the C/N is better. This simply is due to a higher input level."

Lipp

Cable pioneer Allen Lipp dies

TORRANCE, Calif.—Main Line Equipment Co. announced the death of Allen Lipp, its founder and president, on Jan. 18 at age 58.

Lipp began his 35-year career in the cable industry in 1946 at Rego Wire, which later became Viking. In 1977, he worked at Magnavox CATV Systems, where he served as general manager of sales and marketing for five years. Later he became vice president and general manager of Western CATV Distributors Inc. in California. In July 1986, Lipp founded, started and became president of Main Line Equipment Co. and Main Line Engineering Co.

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In every industry there are leaders who are innovative and dedicated to producing the highest quality product. The vision of these leaders fuels progress; they forge ahead and bring new solutions to the marketplace. Most of all, these leaders listen to their customers and translate their needs into products and services of the highest standard.

In CATV, Alpha has set the standard in Standby Power technology. This leadership is based on a long list of 'firsts' in powering concepts and product capabilities. Implementation of Alpha's single ferro-resonant power supply design revolutionized the industry and gave new meaning to cable system reliability and customer satisfaction.

Direct cost reductions through improved battery performance and

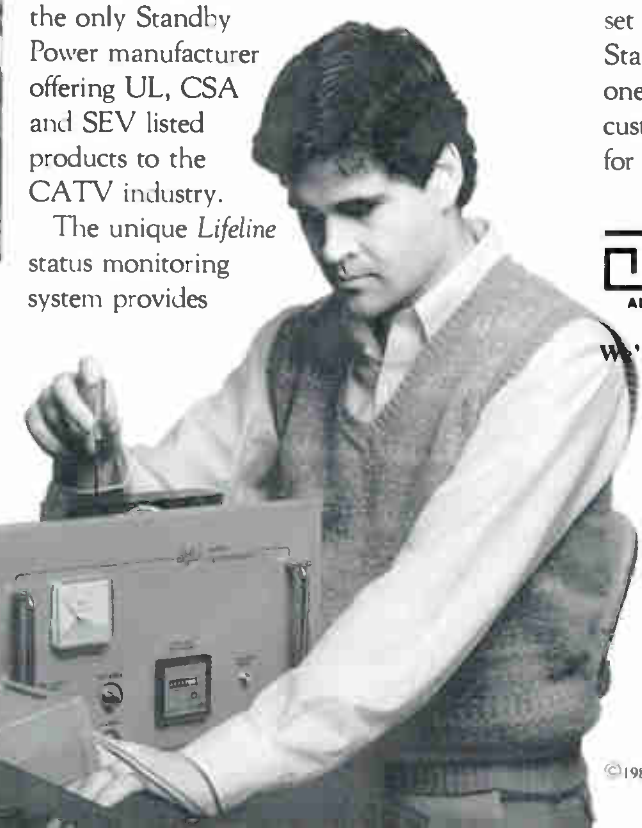
simplified system maintenance were brought about by Alpha's temperature compensating and performance monitoring circuit designs. In addition to these technological contributions, Alpha has

established the highest quality and safety standards. To date Alpha remains the only Standby Power manufacturer offering UL, CSA and SEV listed products to the CATV industry.

The unique *Lifeline* status monitoring system provides diagnostic information and remote control facilities on *one-way* and two-way cable systems. This pioneering development now enables operators to optimize service strategies and reduce overall system maintenance costs. *Lifeline* is Alpha's latest in a series of historic status monitoring milestones: the first and only stand-alone power-supply monitoring system, hardware interfaces

for the major amplifier monitoring systems, and complete monitoring software have all preceded the *Lifeline* introduction.

Alpha Technologies set the standards in Standby Power for one reason: Alpha's customers won't settle for second best.



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Reader Service Number 9.

A primer on R&D for the uninitiated

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

On a recent C-SPAN II program, our august body, the U.S. Senate, carried on a lengthy debate concerning the negative balance of payment dilemma and the accompanying loss of manufacturing jobs—about 3 million since 1981. The senators' staffs must have supplied the statistics, but it was painfully obvious from listening to those scientifically illiterate gentlemen that, while they had memorized the facts, they were incapable of either understanding or legislatively applying their knowledge to heal our wounded economy.

Research and development (R&D) is the foundation of a competitive industrial economy, leading to inventions and products that can be sold at a profit, enriching both the private and public purses. But R&D is indeed an ethereal animal, perhaps only visible to the R&D staff itself. The following highlights come from my 40 years of experience as a director of engineering, inventor and businessman.

Inventors are born, not made, and often the jewel in the rough is revealed only by the opportunity to engage in research. Education up to any level is helpful but not vital to inventors. Researchers should be afforded the utmost freedom in their pursuit; what they desire is the flash of lightning, not the finished product—neither time nor budget should obfuscate their ingenuity. Developers, while assigned a more mundane role in designing a salable, cost-effective product, also must take on the guise of inventors as needed; they may have to meet a budget and time target but not on too short a leash.

Doesn't seem very efficient, or perhaps even non-productive? Unfortunately, R&D is not a budgetable beast. Years can pass without a Nobel winner and do. But a business cannot function without R&D unless it is operated as a short-lived copycat company. Most organizations are built around a single invention or industrial process and polish that one apple indefinitely. The dollars spent per invention are usually directly proportional to the size of the company.

Now, to return to the Senate and its bumbling bombasts. A favorite target for legislative remedies is the corporate raider who is depicted as a greedy robber baron devouring major industries, sucking in the surplus funds and spitting out the pitiful remnants unable to represent the United States in world competition. What I see are moribund giants, ruled by self-indulgent officers holding minute quantities of their own stocks, armed with golden parachutes at the expense of the stockholders, shorn of any R&D effort, plagued by inefficient management and complacent workers, for all the world like a fat caterpillar being devoured by the wasps within. The raiders will become majority stockholders in lean companies, eagerly pursuing new products and opportunities, and financing the inventors heretofore unsupported by big business.

Next on the list of inferior institutions (as exposed by the brilliant insight of the Senate) is our education establishment. Why do we turn out so few scientists and how do so many pass through our schools, not even learning the three R's? More money is always the solemn answer by the scholarly appearing senator. Senator, shed your political clothing, tell the truth, abandon the concept of equality among the students, abolish taxpayer-supported athletics, eliminate liberal arts as a government-supported major, and pay only for science schools populated by students on competitive scholarships. I would bet that in one generation America could regain the leadership we have lost in the present generation and at a price half of what we spend today on education.

Finally, our senators have agreed on the easiest target for politicians to attack—the businessman. They ask, "Why doesn't he go after exports?" Gentlemen, *you* try to be an export salesman before you shoot off your mouths! The rest of the world doesn't have the open borders we do! Wake up, gentlemen, wake up! "Why doesn't the businessman modernize his plants?" Why, indeed? With what? Our capital investment now is taxed more than ever while the *foreign* businessman is gifted with land and buildings and machinery.

And then the cruelest blow of all—"Why is American business so uncreative? Why are the new products flooding U.S. markets designed and produced abroad? Why, oh, why, is the businessman so stupid?" The answer lies in the R&D budgets we American businessmen, for reasons too long to fit in one page, have been unable to finance. R&D, the vital heart of our corporate body, has been misunderstood and undermined by our legislators.

Let us sum it all by examining the progress of HDTV research in the United States vs. that of the foreigners. We are chock full of publicity releases, antitrust laws, standards committees, but not a dollar for R&D! Europe has raised 160 million for genuine HDTV R&D, Japan may have spent 1 billion to date. One guess who will win the high-tech battle!

Our senators someday may be presiding over colony America instead of the free United States of America. Even then, they will not understand the heart and soul of R&D.

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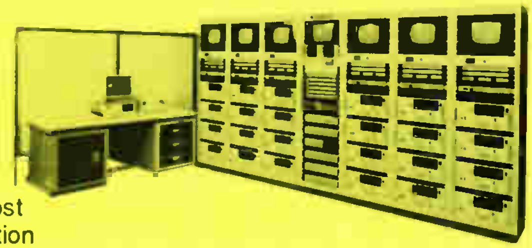

This is the system everyone thinks of when someone asks, "What is the most widely used random access ad insertion system?"

The fact is that there are more SPOTMATIC systems in use today than any other type of ad insertion system. The reasons are simple: high quality, proven reliability, unparalleled factory support, and an unmatched array of features.

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- Full random access or random pod operation
- Front-panel keyboard or optional personal computer control
- Complete turnkey packages available
- Quick delivery
- Broadcast quality vertical interval switching
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Complete product line listing with photos, block diagrams, and comprehensive descriptions and specifications. Enough detail to spec out your own custom system. Catalog will become a valuable reference. And it's yours just for the asking. Write, call, or circle the bingo number. But do it soon.

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ARE YOU THROWING MONEY AWAY?

Losing verification data is just the same as throwing money away, and who in their right mind would do that. Make sure when you run somebody's ad you get paid for it. The LOGMATIC™ and LOGMATIC JR.™ logging and verification systems always get their data when used in a system with SPOTMATIC JR. and LI'L MONEYMAKER low-cost ad insertion systems.

LOGMATIC

LOGMATIC JR.

The LOGMATIC contains a 4000-event memory and interfaces to an 80-column printer or to a PC for data retrieval. The LOGMATIC JR. has a built-in 20-column printer and real-time clock. It prints the event record as the event occurs. Both loggers feature automatic operation, and they record insertions on four channels.

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Reader Service Number 61.

LIKE GETTING YOUR MONEY FOR NOTHING AND YOUR CHECKS FOR FREE

Make Money the Easy Way — Put either SPOTMATIC JR.™ or LI'L MONEYMAKER™ to work for you now. They are the lowest-cost tools you can use to automatically insert local ads into cable TV programming. You have one unit controlling one VCR to put ads on one channel. Equipment overhead is very low.

Switching occurs during the vertical interval for broadcast quality transitions. Once the system is programmed by the operator, it operates automatically.

The SPOTMATIC JR. has a built-in printer for verification records; however, both the LI'L MONEYMAKER and SPOTMATIC JR. inserters connect easily to a LOGMATIC™ logging and verification system. With optional software, this enables computerized data retrieval and automated billing and report generation. Write now to see just how little it takes to get into automatic ad insertion.

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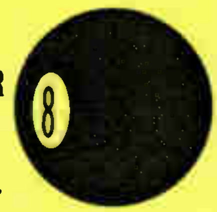
Does the high cost of monitor switchers have you behind the eightball? Then you need to

PUT AN EIGHTBALL™ UNDER YOUR MONITOR— 8x1 Very Low Cost Switcher



It is an integrated circuit-based monitor switcher featuring broadcast quality stereo audio and video switching. Lighted momentary contact pushbuttons are field-legendable. Its cost is far less than any other comparable unit on the market. Write or call for information today.

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Reader Service Number 63.

See us at the CAB Show, Booth #214.

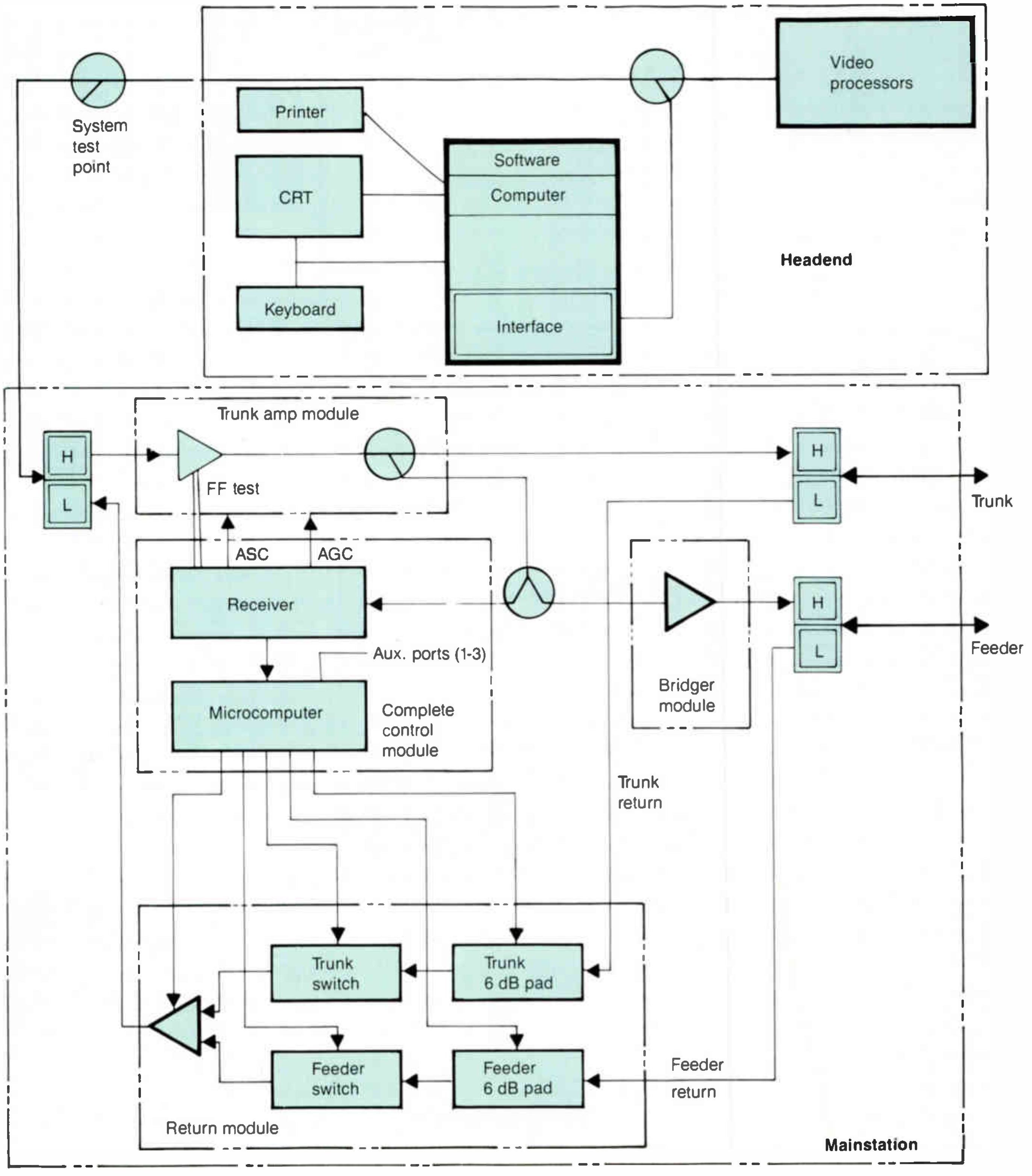
Monitoring with digital system sentry

By Tim Voorheis
Magnavox CATV Systems Inc

The digital system sentry with analog functions (DSSA) used by Magnavox CATV is a comprehensive monitoring and management system that helps broadband network operators spot actual and potential problems in a system before service is disrupted. It monitors three ways: First, it tells how the outbound and inbound amplifiers are operating in the field. Second, it controls and monitors remotely located disconnect switches in the inbound trunk and feeder lines. Third, it can monitor the status of the standby AC line power supply or other devices connected to auxiliary ports.

The DSSA uses both headend and field components. System software,

Figure 1: DSSA functional block diagram



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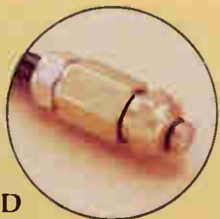

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*Linear Low Density Polyethylene is an extra-tough polymer that still can be readily cut for cold weather connectorization.

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For a sample of this remarkable new cable, contact TFC today at P.O. Box 384, Wallingford, CT 06492, (203) 265-8482 or (800) 243-6904.

TFC

TIMES FIBER COMMUNICATIONS, INC.
CABLE TELEVISION DIVISION

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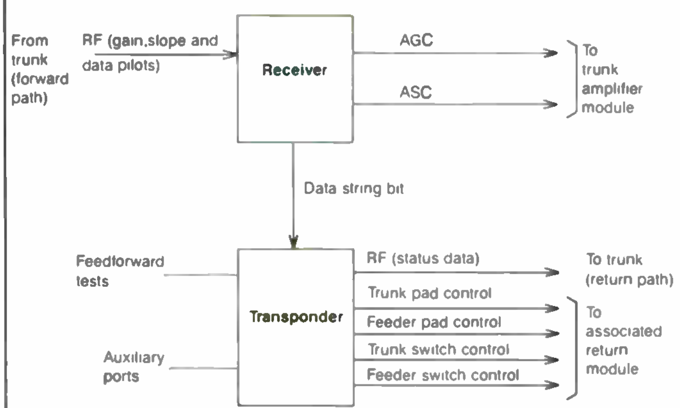
Reader Service Number 12.

Figure 2: DSSA complete control module functional circuits



System status screen.

the interface unit and field modules are supplied by Magnavox. Independent suppliers are the source for computers and printers used in DSSA.

During status monitoring, technicians receive information that the computer has collected from the entire cable network. Using the system software, technicians can interact with the network to gather other troubleshooting information and to issue commands to the microprocessor in the complete control module.

The computer and equipment modules in DSSA create a communications loop between the headend and the mainstations (Figure 1). Once initialized, the computer and software control the network through the interface unit. During status monitoring, the computer automatically requests information from DSSA-equipped mainstations. The microprocessor in the complete control module, which has been sampling data on the system's operations, processes it for return to the computer. The computer then stores all the data. When a major problem is reported, the computer can notify the operator with an audio alarm or visual indication on the computer terminal. Faults are identified when the computer compares current system data with the parameters for optimum performance stored in the database.

At the headend

The system requires several headend products; the combination of products needed here depends on the monitoring capability desired. Every setup needs a DSSI/A interface unit. In a basic system, the interface is an intelligent device, needing only a CRT to monitor and control the network. In a more sophisticated configuration, which will be described here, the interface acts as a computer-to-cable interface, working together with controlling system software, an IBM-compatible computer and a printer.

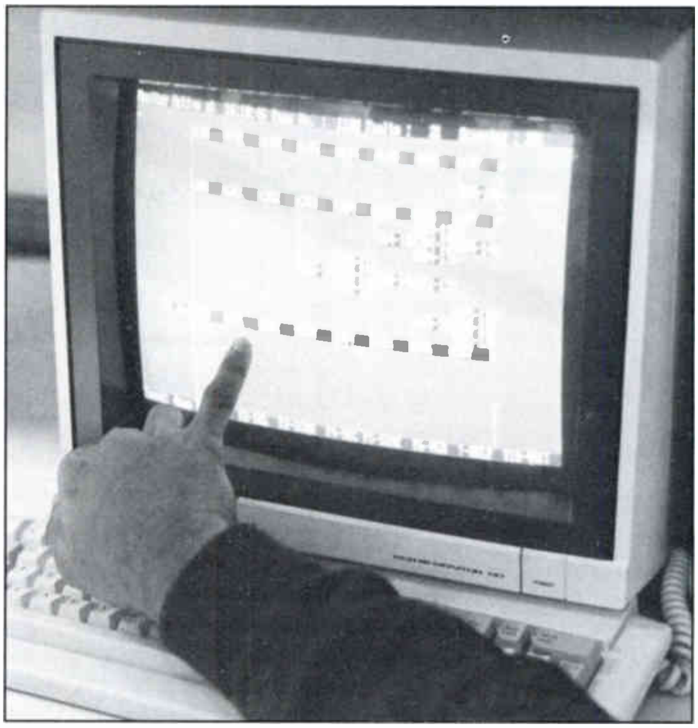
The *software* performs administrative and monitoring activities from the headend or office. SOFT/DSS-IBM is the software that runs DSSA and allows operators to perform functions from the keyboard. This menu-driven software helps operators to create a data base of information on every amplifier in the system; set default data, listing the acceptable operating parameters for each individual system amplifier; view amplifiers in schematic-type displays, showing signal paths and relationships between amplifiers; monitor individual mainstations, cascades or an entire system; isolate faults; perform trend analysis; and generate various reports. Let's look at two examples of how this software can help attack problems.

Example 1: Correct an immediate problem: In your office, an alarm sounds, indicating a major fault somewhere in the system. SOFT/DSS-IBM can help quickly isolate the source of the problem. The red bar in the band running across the top of the screen indicates that a major fault has occurred. Examining the block of module identification numbers in the center of the screen, the operator can quickly see that 20 of these identifier numbers have changed from blue to red. Each red identifier indicates a mainstation with a major fault.

To more easily determine if these faults all share a common cause, the operator calls up the system map screen. This screen also displays module identifier numbers, but this time the identifiers are laid out in a schematic map that accurately shows their position in the system and the signal's path.

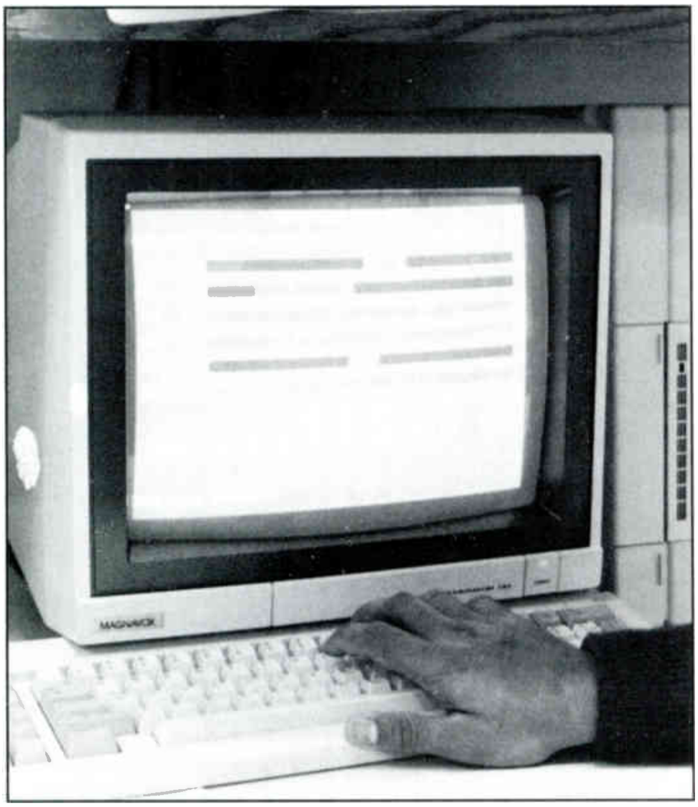
Next, the operator examines all information on a particular mainstation in the data base by calling up the single station status report screen. This display shows all parameters of a single station's status. Color-coded bar graphs show actual analog measurements from each amplifier, with color indicating status: green indicates good, yellow indicates a minor fault, and red indicates a major fault. Parameters reported include the outbound level of the command frequency, the level of the inbound response carrier, the AGC/ASC control voltages, output voltage of the 24 VDC regulated power supply and the temperature inside the mainstation. Once the parameters that have been exceeded are known, the operator can dispatch a technician to correct a specific problem in a specific location.

Example 2: Study trends to locate problem source: The trend analysis screen provides a way of linking and solving certain time-related problems.



System map screen.

If, for instance, you regularly experience faults around 7:30 p.m. in certain mainstations, you can use the trend analysis screen to review history files on each troubled amplifier to see if the cause of their faults is the same. Like the single station status report screen, the trend analysis screen reports on outbound and inbound system levels, AGC, ASC and temperature levels. In the trend analysis screen, the operator examines the readings taken



Single station status report screen.

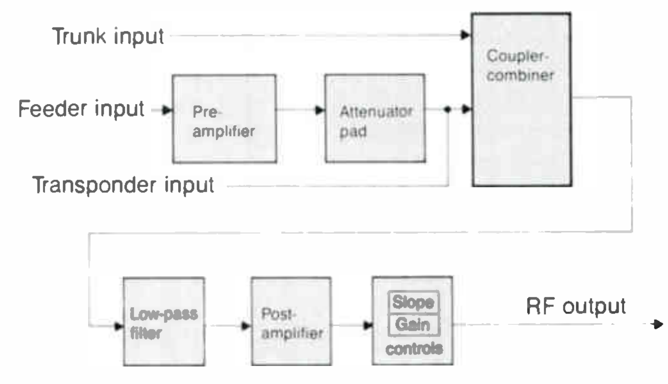
at 7:26 p.m. on Nov. 25, as indicated in the top row of text on the screen. To look at readings taken at other times on other days, the operator steps a small arrow across the screen, moving ahead in time as the arrow moves to the right. Using the trend analysis screen may help spot a single cause and solution to several seemingly unrelated faults.

The 6-DSSI/A *interface unit* is a computer-to-cable interface for the digital system sentry. In basic DSSA systems the interface acts as an intelligent device, interrogating up to 1,023 amplifiers and interpreting their responses. Typically, it is connected to a simple printer/terminal to allow viewing of reports and input of data.

In more sophisticated configurations, a computer and SOFT/DSS-IBM perform all intelligent actions to monitor up to 3,000 amplifiers. The main purpose of the interface in these systems is to modulate/demodulate the digital information for launch onto the cable system trunk network. It also interpolates received signal strength and reports to the computer system.

An RF output and an RF input port connect the interface to the CATV

Figure 3: DSSA inbound amplifier circuit



trunk network's outbound and inbound tap/insertion points. An RS-232C port connects the interface and controlling computer. An auxiliary input port allows injection of a 60 dBmV phase-locked CW (continuous wave) carrier for HRC and IRC systems. For audio fault alarm, an 8-ohm speaker connects to the interface. Some systems use the audio output port to trigger an autodial system to notify engineers at remote locations.

In the field

The DSSA requires two field modules: a *complete control module* and a *return amplifier module*. Both plug into any compatible sub-split, mid-split or high-split two-way interconnection chassis, making it easy to add status monitoring to existing cable plant.

The DSSA-equipped complete control module (CC/DSSA) is a monitoring, controlling and communicating device that plugs into each mainstation to be monitored by the DSSA. Like standard complete control modules, the CC/DSSA automatically controls the gain and slope of the outbound or inbound bandwidth signal. In addition, it also receives instructions from the headend, controls and monitors switching functions, monitors the relative levels of the amplifier modules, and encodes and controls the inbound transponder. Optionally, this module can monitor the external standby power supply and the TTL (transistor-transistor logic) control of the switchable functions, if needed. The transponder also can, on command, verify automatically the performance of a feedforward amplifier module.

A 10-pin DIP switch makes it possible to assign each unit a unique address used in conjunction with the software identifier number to identify and communicate with individual amplifiers.

The DSSA-equipped complete control modules have two functional circuits, a receiver and a transponder (Figure 2). The receiver generates the automatic gain control/automatic slope control (AGC/ASC) voltages and provides a data channel path to the transponder. The transponder accumulates the mainstation's status data and, when commanded, operates the trunk and distribution attenuator pads and the trunk and distribution disconnect switches. It then passes this data along to the computer in the headend.

The return amplifier performs standard inbound functions plus remote switching. Like complete control modules, these return amp modules also plug into the interconnection chassis of the mainstation to be monitored. DSSA return amplifiers have two functional circuits: a standard inbound amplifier and a trunk and distribution switching system.

The inbound amplifier circuit (Figure 3) accepts inbound signals, provides amplification, and controls gain and slope. It receives three independent inbound signals. Input from the inbound trunk cable and the complete control module's transponder feed directly into the coupler-combiner. Input from the distribution line goes through a pre-amplifier and attenuator to make it match the other two inputs before it feeds into the coupler-combiner. The combined signals then pass through a low-pass filter. A push-pull post-amplifier provides 22 dB of gain to the combined input signal levels. Finally, gain and slope adjustments—made manually or automatically, depending on the model used—control the circuit's output level.

The trunk and feeder switching system (Figure 4) consists of two identical, independent, three-position toggle switches. One switch controls the inbound trunk signal; the other controls the inbound distribution signal.

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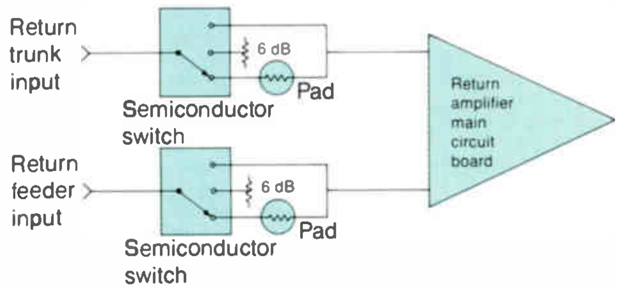
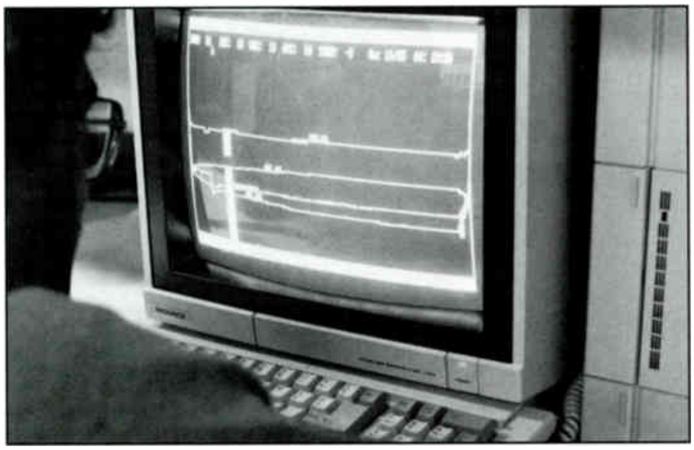
Figure 4: Return amplifier trunk and switching system





Trend analysis screen.

Both help locate RFI and minimize noise funneling. The toggle allows system operators to select either manual or automatic connection, disconnection and insertion of 6 dB pads to both the inbound trunk and distribution lines.

The 6 dB switching pads make it easy to locate RFI. To troubleshoot a specific RFI problem, the technician works on the fault isolation screen of the system software to perform ingress localization. From the terminal, you can systematically call up a specific mainstation, activate the 6 dB pad in that mainstation, and get a reading on interference amplitude on an attached spectrum analyzer. If there is a 6 dB shift in amplitude of interference, that is likely the source of ingress. Once identified, the mainstation's inbound path can be disconnected from the controlling computer until the problem is corrected.

The switching system also helps minimize noise funneling with its connect/disconnect capability. In the outbound path, noise accumulates only from the amplifiers in a direct line between the headend and the subscriber. In the inbound path, however, *all* amplifiers contribute to noise. The noise of every return distribution-line amplifier accumulates on the inbound trunk line and eventually funnels back to the headend.

Activating the disconnect switch eliminates the noise of every line extender on a particular distribution leg. Using the connect/disconnect switch, the operator can disconnect a noisy distribution leg and immediately dispatch a technician to correct the problem. The temporary disconnection of one leg is better than having the entire system inoperable because of one source of noise interference.

Efficient use of staff

The digital system sentry is a tool intended to help those responsible for the maintenance of broadband networks. Proper use of the headend and field products that make up DSSA can lead to more efficient use of maintenance staff and an increase in system reliability because degradations are noticed before actual downtime occurs. When problems are visible, maintenance can be scheduled, problems solved, and some future failures averted.

Automatic test equipment monitoring for broadband systems

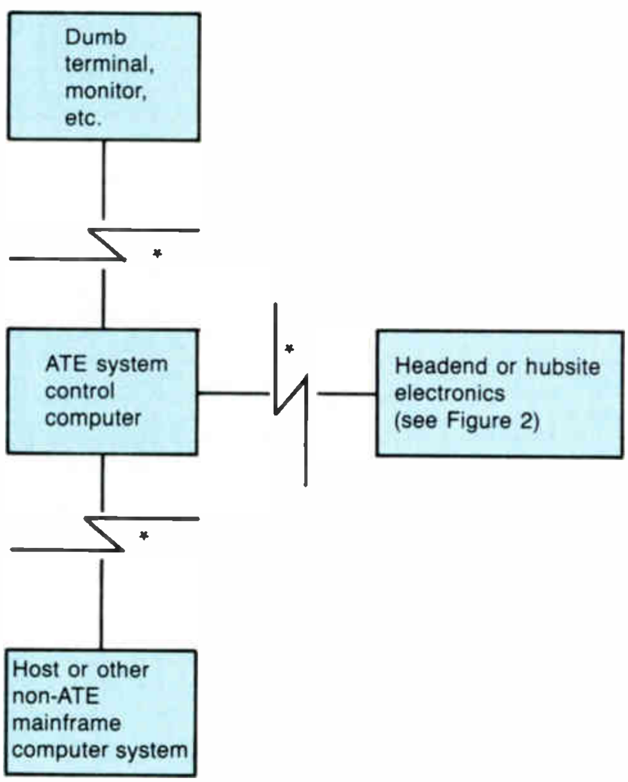
By Daniel M. O'Connor
Sales Group Manager, Status Monitor/LAN Systems, Texscan Instruments

If you're analyzing operating profits, system reliability and quality of delivered services for a broadband distribution system, don't overlook the obvious. The emphasis placed on profits and reliability often can deceive us into working harder instead of inspiring us to work *smarter.*

Regardless of whether your broadband system is used for transportation of data, videoconferencing, telephone, security, entertainment video or any combination of these services, neither you nor your users/subscribers can afford the luxury of outages or system downtime. Because of this, it is imperative that you respond to system outages as a matter of highest priority. Additionally, preventive maintenance (PM) is required to reduce the probability of system failure. As a result, your annual expenditures for plant maintenance probably are excessive in comparison to what they should be.

There are numerous tools and instruments required in order to maintain and troubleshoot a broadband system. A status monitor is one of them, although it is not generally recognized as such. Status monitoring systems have been available for cost-effective implementation in broadband transmission systems since 1981. There probably is not a broadband system (LAN, I-Net, CATV, etc.) that couldn't benefit from the enhancements a full featured status monitoring or diagnostics system can lend to troubleshooting and PM.

Figure 1: ATE control system



* — Denotes communication link. This is any RS232 interconnect. May be direct cable, telephone modem, RF, microwave.

Electronic subscriber

The term *status monitor* is misleading. It stems from an early concept of an electronic, computer-controlled monitoring system that most easily could be described as an "electronic subscriber." It was envisioned as a means to detect a system outage and possibly help in localization of the problem. Not only would the switchboard light up, so would the computer screen. The only advantage was that the screen would (hopefully) light up first. This form of status monitoring did not hold the solution to system maintenance woes. Since that time, the concept of status monitoring has been significantly expanded.

The status monitor should detect any trend toward degradation of performance or impending failure. In this way, outages can be averted prior to their occurrence. It also should provide the capacity to exercise controls. The ability to remotely operate controls allows the performance of PM such as standby power supply testing. It also aids in performing diagnostics related to reverse path performance.

Not all status monitoring systems manufactured today provide these capabilities. However, if we were to define the desired performance characteristics of a status monitor, it might be: "A status monitor is a diagnostics system that provides the capability to monitor, track, document and control the performance of a broadband distribution system while adding the ability to localize and diagnose disturbances in system performance."

Today, some status monitoring systems incorporate techniques utilized in automatic test equipment (ATE) systems. (The terms *ATE* and *status monitor* will be used interchangeably in this article.) ATE has been around for many years; it is appropriate that we capitalize on this technology and reap the benefits provided by inexpensive but powerfully flexible testing devices.

We will take a look at the testing, control and interface flexibilities an ATE system offers. It can be utilized to improve the reliability of a broadband system and also can provide a means to reduce substantially the expenses associated with plant maintenance.

Periodic visits

In the normal day-to-day operation and maintenance of a broadband system, certain tasks must be performed either periodically or on demand. Sweeping and balancing, as well as standby power supply testing, are some examples of periodic tasks. In order to perform these tests and/or adjustments, a technician must schedule visits to each active device (an amplifier station or standby power supply). The frequency of these periodic visits is dependent upon plant size, environment, desired system reliability and type of testing and/or adjustments required. Typically, two or more annual visits to these locations are required in order to satisfy PM criteria.

On-demand maintenance is generated as a result of system failure, degradation of system performance, system expansion and installation or removal of services for a user or customer. These are essential to maintain the system's capability to deliver the services it was designed to provide. Therefore, it is reasonable to expect that the ATE system either should perform these tasks or, at a minimum, efficiently and cost-effectively assist in their performance. This is exactly how a status monitor can help you.

The following is a list of the features and capabilities you should look for in any status monitoring system. All five of these key areas must be properly addressed in order for the system to pay for itself.

I. Forward plant measurements
   A. Forward RF signal levels at any point in the plant (trunk/line extender input/output, end of line, headend, hubsite, subscriber locations, etc.)
   B. Transponder forward data carrier level
   C. DC voltages
   D. AGC/ASC performance
   E. Temperature
   F. Housing closures
   G. Redundant module status
   H. RF bypass switch status
II. Reverse plant measurements
   A. Return RF signal levels at any point in the plant (trunk/line extender input/output, headend, hubsite)
   B. Transponder return data carrier level
   C. RF bypass switch status
   D. Bridger return path status (closed, opened, attenuated)
   E. Redundant module status
III. Powering system measurements
   A. AC voltage
   B. AC current
   C. Battery terminal voltage
   D. Charger operation
   E. Temperature
   F. Utility input voltage
   G. Test standby status (standby or utility mode)
   H. Cabinet tamper
IV. Plant maintenance controls
   A. Force standby operation of standby power supplies
   B. Reset standby power supplies to utility mode
   C Automatic or manual (through computer keyboard) RF bypass switch operation
   D. Connect, disconnect or attenuate bridger return path
   E. Alter forward or return signal levels
V. System flexibilities
   A. Multi-tasking/multi-user capability
   B. User access through password control
   C. Local or remote access by dumb terminals
   D. Local or remote access by microcomputers
   E. Communication to local or remote headends/hubsites
   F. Ability to network multiple control systems
   G. Ability to communicate and interact with security, addressable converter or other mainframe computers
   H. Ability to communicate and interact with test instruments
   I. Ability to support an adequate volume of measurement devices (transponders)
   J. Flexible transponders that will operate in a system with any manufacturer's transmission and powering equipment

(Note: The one link frequently omitted in discussion of ATE system capabilities is the control system or computer and its software. They represent the central nervous system of the status monitor and can make or break the system capabilities.)

Now, let's look at a few specific examples of how various combinations of these measurements and controls can be utilized to enhance plant diagnostics.

On-demand service calls

Your customer calls; the system is down. Where do you start? First, you compile a list of information: the customer location and some specific details relating to the symptoms the customer has observed. Next, you take out the system maps, right? Wrong! The advent of ATE systems has redefined diagnostics and troubleshooting methodology.

Figure 1 is a block diagram that illustrates the flexibilities of the control

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Panasonic CATV.
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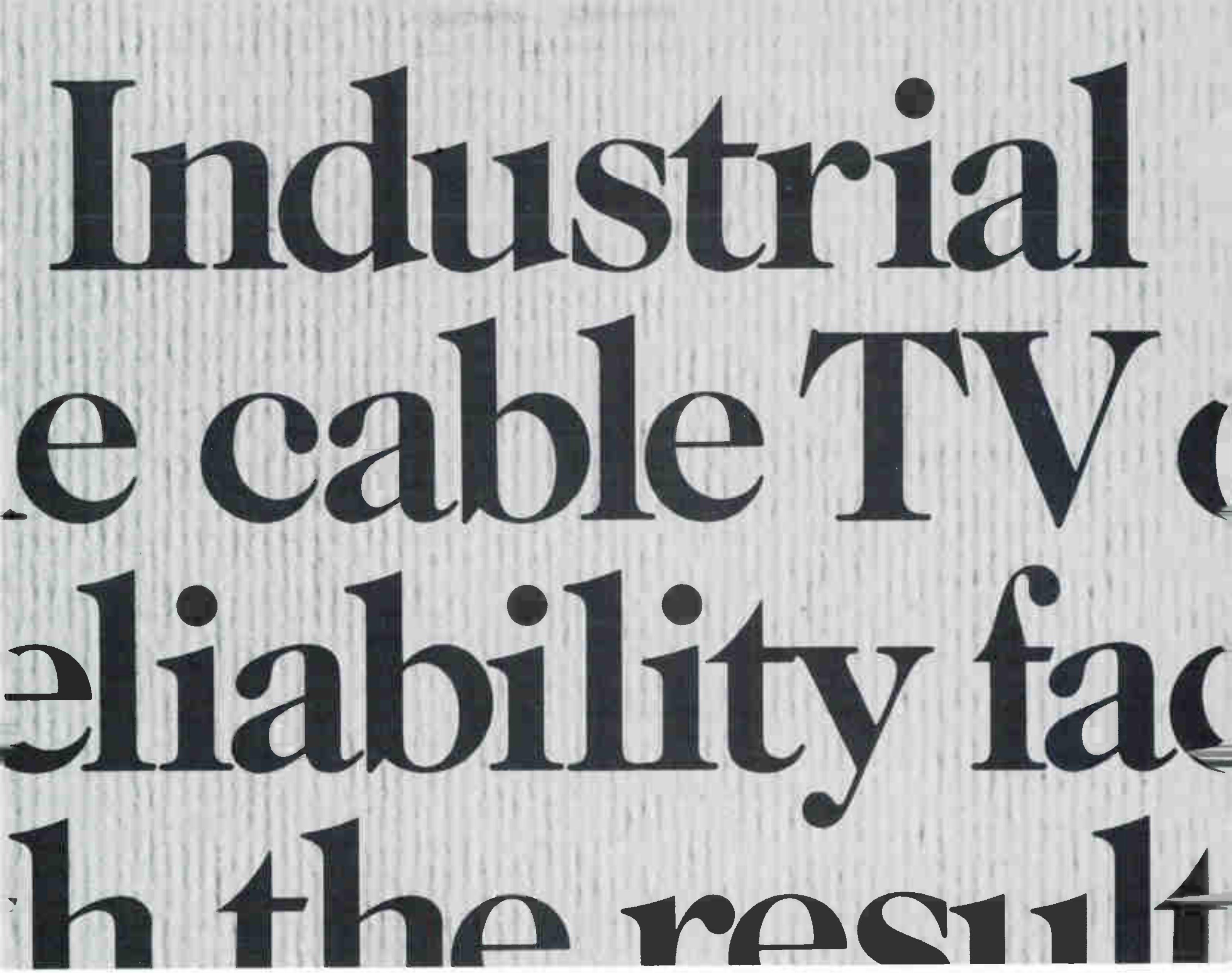
68-channel capability. Each channel is precisely controlled by phase-locked synthesized tuning, switchable between HRC and Standard/IRC offsets.

We didn't forget the favorite-channel memory. In fact, the TZ-PC120 can store up to 68 channels. It also features direct-access tuning, two-speed all-channel scan and last-channel recall. All this without an "Enter" button.

When it comes to our optional



parental control, the TZ-PC120 lets your subscribers lock out the sensitive channels they don't want their children to see, without affecting the remaining channels. And thanks to our innovative *Stored Charge Non-Volatile Memory*, parental control channels and other memory functions will not be affected by a power outage. There's also an 18-button infrared remote control. It's compact, controls every function and comes complete with Panasonic batteries.

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The new addressable PC-200 converter.

When it comes to your headend, the new PC-200 addressable converter

can help give you a head start. Downloadable features include channel map, channel authorization, clear parental control, initial activation and emergency alert.

The PC-200 also features 68 channels, a full-function infrared remote control, electronic parental control, favorite-channel recall and two-speed scan.

Pay-per-view capabilities include simultaneous events, multi-episode events and both inclusive and exclusive events.

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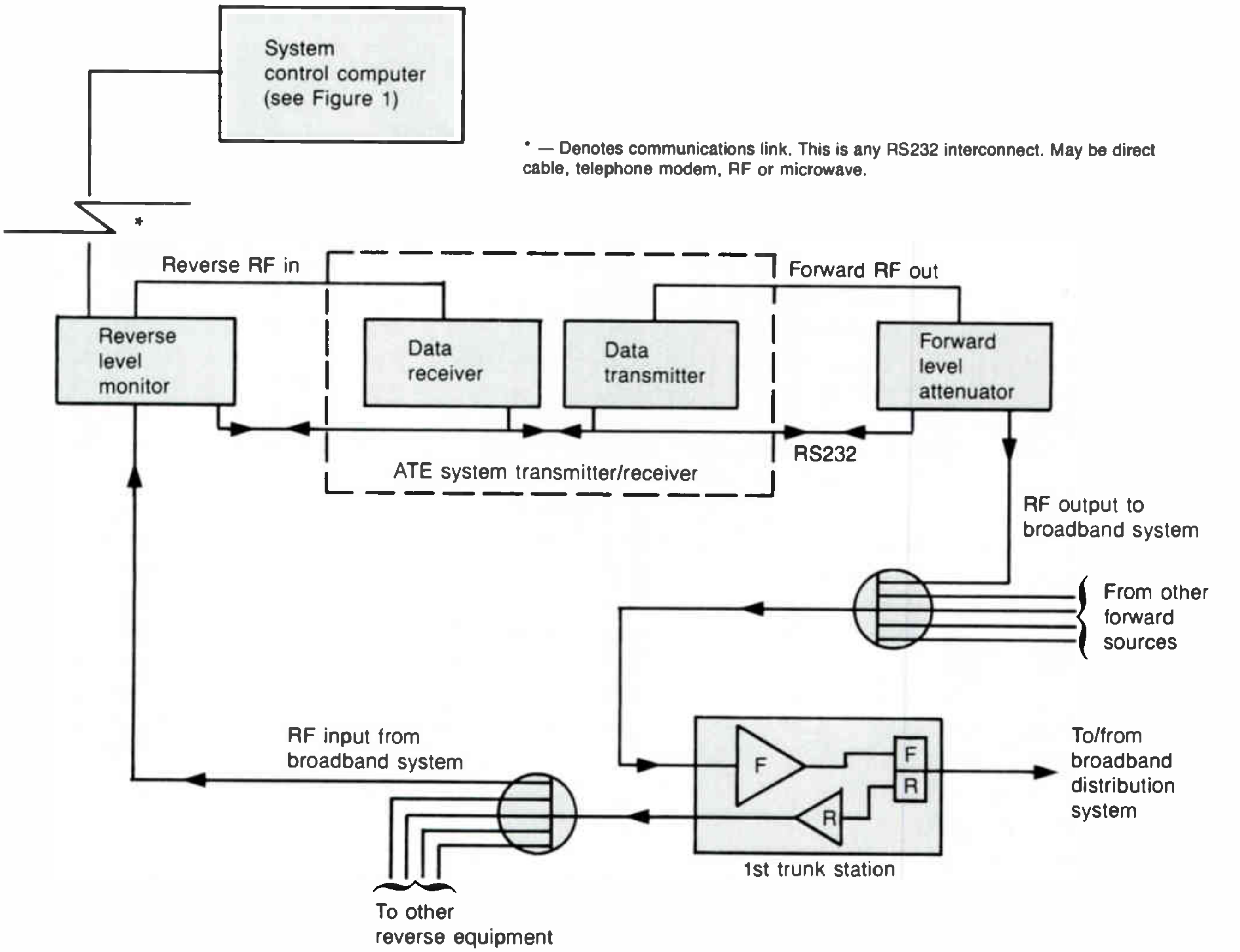
Figure 2: Headend for ATE monitoring system



system. Figure 2 shows the headend installation. The control system can communicate with several configurations of the variety shown in Figure 2. With the basic requirements for control and communication out of the way, it is easy to understand how this system can provide tremendous functionality.

The only missing link is a transponder, an addressable device that can make measurements, provide control signals and communicate with the control computer through the headend. The transponder is a dumb device; it needs no onboard intelligence since the control system wants it to think it is one of many different devices (thermometer, signal level meter, digital voltmeter, switch sensor, AC voltmeter, ammeter, TTL control, etc.). The list is nearly endless.

Transponders are placed at any location in the broadband system where control and/or measurement is useful. These locations include trunk amplifier stations, standby power supplies, line extender locations, ends of distribution runs, computer terminal locations, headends, hub-sites, etc. This makes it possible to maintain continuous measurements and operate controls at any location served by the plant, without the need to dispatch a technician to the location. In fact, it is possible to make over 130,000 tests in less than 34 minutes!

No reason to call

Consider the previous scenario: Your customer hasn't called yet. In fact, there is no reason to call. Before your customer even has an inkling that there may be a problem with the system, you are alerted by the computer that there is a problem on its way.

Standby power supply Number 1 (the first one outside the headend) is in standby. Its battery voltage indicates that there are approximately four hours left before it dies. In seconds, you have descriptive information about the supply, including its exact location, and have dispatched a technician to correct the problem or connect a backup AC generator, if necessary. Nearly any situation you could imagine that may call for on-demand maintenance can be resolved expediently with the aid of a status monitor or ATE system.

What if that power supply had not been properly serviced? The system would have died when it tried to go standby. It is common practice to make periodic visits to each standby power supply in the system and cycle it into the standby mode. This is done in an attempt to determine if the unit is functioning properly and is capable of withstanding standby operation for the duration intended by the system designer. Don't waste your time with this; that's why we have ATE systems.

Similarly, you can determine what sections of the RF plant require PM attention. Suppose a cable is damaged or a connector loosens. How do you currently determine that this has happened — wait for a complaint? Or perhaps the trunk maintenance tech might discover it during a scheduled pass through the system for sweep and balance activity. Never again. I could continue giving you these examples until you fall asleep, but I think you get the point.

Working smarter

As indicated at the beginning of this article, there probably is not a single broadband distribution system in existence that couldn't benefit from an ATE system. The goal today is to increase profits, and working smarter is the means to that end.

Remote monitoring in one-way plant

By The Engineering Staff
Alpha Technologies Inc

During the past year, we have seen a marked increase in the use or projected use of remote status monitoring systems. Older plant in upgrade or rebuild planning and new construction in the larger urban builds initiated in 1986 all evidence a strong trend toward increasing system reliability through the introduction of methods to improve effectiveness in maintenance. Although it is a relatively straightforward process for systems designed to include return capability, the option to remotely monitor or control AC powering hardware or signal handling equipment has not been available to cable systems limited to one-way plant.

A usable technology for one-way plant, providing the two-way communications capability needed to implement remote monitoring, would give the majority of today's systems the option to add a vital tool to their maintenance arsenals.

The transmission of data-modulated signals upstream on cable plant not equipped with typical HF (high-frequency) return limits the choices of return media usable for remote monitoring rather severely: telephone, radio or other "outboard" links suggest themselves, but a system utilizing existing CATV plant has obvious merits.

An RF industry

The perspective of AC power supply designers in CATV is substantially different from that of our counterparts in what is essentially an RF (radio

Figure 1: Typical passive device losses

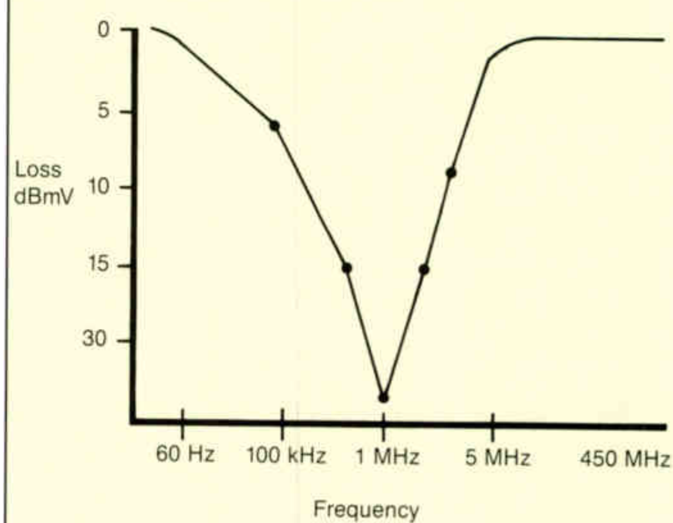
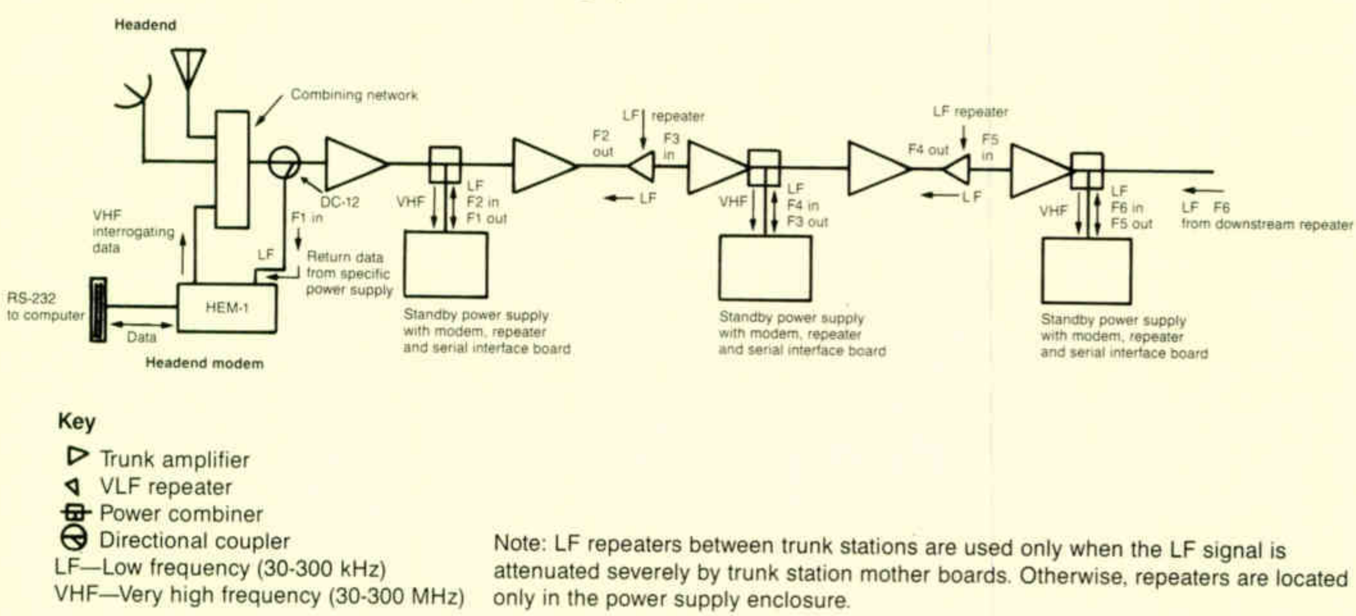


Figure 2: Multiple-frequency monitoring system



Note: LF repeaters between trunk stations are used only when the LF signal is attenuated severely by trunk station mother boards. Otherwise, repeaters are located only in the power supply enclosure.

frequency) industry: We see the cable system as a second network, running at 60 Hz (and 50 Hz) embedded in the RF plant. Our coaxial network is populated by lengths of cable interspersed with taps, splitters and amplifier networks, and is bidirectional to signals at frequencies significantly below the bandpass of the conventional downstream signal (Figure 1).

As in the case of power-line carrier technology commonly used in the power transmission industry, the use of the power path as a medium to support transmission of two-way data links is feasible and practical. In CATV, frequencies in the 100 kHz range are a reasonable choice for an end-to-end upstream communications channel on the power path, if the accumulated attenuations, particularly in long cascades, are low enough. Reducing net attenuation through the addition of specific bandpass coupling networks and increasing return signal amplitude periodically uses a repeater system, when required, to guarantee usable signal levels. However, the problems of isolation between transmitters and receivers in the repeater subsystem and of coupling the LF (low-frequency) carrier into the cable plant at power insertion points limit this approach.

A reliable and straightforward approach lending itself to economic transponder manufacture and a minimum of alterations to existing plant would utilize a multiple-frequency system enabling the use of a series of repeaters without the possibility of crosstalk and without expensive filtering networks or special power inserters (see Figure 2).

Modems designed for installation in AC standby power supplies or other instrumentation, such as signal monitors, may be equipped with adjacent-channel transmitter/receiver pairs in the frequency range of 20 to 200 kHz. Modems with up to six pairs of adjacent data channels (1-2, 2-3, 3-4, 4-5, 5-6, 6-1, etc.) would allow adequate separation of reused frequencies, in cascades lengthy enough to require more than one group of the five or six frequency pairs used in a given system. Installation and maintenance of a multiple-frequency repeater system is simplified if a minimum number of frequency pairs is used. Up to 12 channels for repeater use can be assigned if required in the usable band (Figure 3).

Modems are full-duplex, handling the downstream VHF carrier from the headend modem and the upstream LF carrier. Each modem downstream from the headend unit also incorporates an on-board LF repeater similar to stand-alone repeaters, which may be coupled directly into the cable as needed (Figure 4). Modems polled by the headend computer first are initialized by receiver carrier-detect circuitry prior to data transmission upstream. The addressable status monitor interface, integral with the monitored power supply or signal meter, transfers a serial bit stream to the active modem where it is FSK (frequency shift key) encoded on the LF carrier. The carriers are frequency synthesized from a crystal reference. Data speeds are determined by best bit-error performance, with 1,200 BPS typical.

Modems are interfaced with the cable by way of a multiplexed coupling network designed to combine power at 60 Hz, the LF carriers and the conventional VHF carriers. Data processing upstream from a given modem is transmitted at a carrier frequency equal to the receive frequency of the next repeater, or that of the headend modem in the case of the nearest downstream monitor.

Figure 3: Repeater system with 12 channels

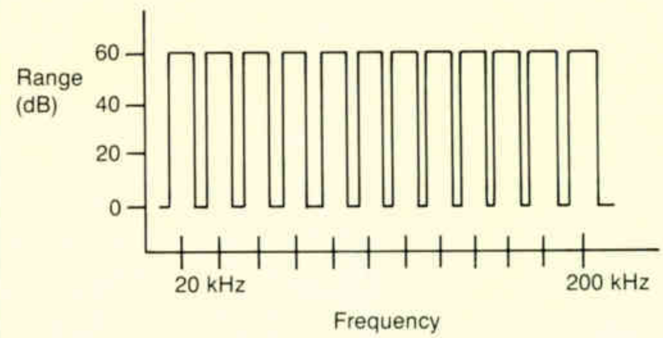


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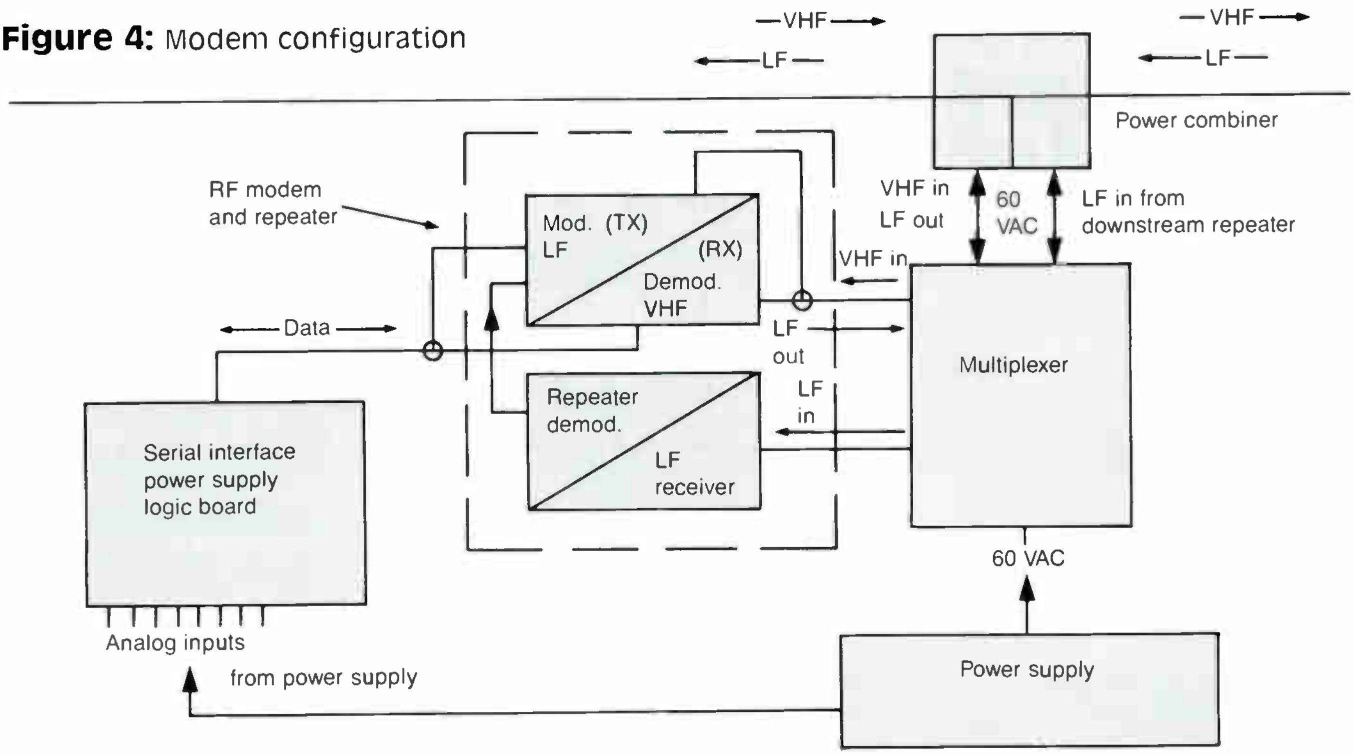
Figure 4: Modem configuration



No longer power hungry

Once the repeater structure is installed in a CATV or any broadband trunk, a "party-line" system may be added to extend the repeater pairs into system branches throughout the plant. Such a system now may be used to economically implement complete system monitoring, without the expense of much rebuild and the consequent use of power-hungry return electronics.

Thanks to R. Bridge, B. Gilbert, B. Kennedy and J. Geer.

Lightning—Target Earth

By Ralph A. Haimowitz
Director of Technical Training, American Cablesystems Corp.

Almost everyone in cable television has experienced one or more problems with outages, equipment failures and sometimes damage that has been caused by surges of electrical current during electrical disturbances in the atmosphere. We probably know less about the cause and effects of lightning than any other type of problem that we encounter in the operation of a cable system.

The frequency of thunderstorm activity around the Earth is exceedingly high, resulting in heavy lightning activity—about 100 flashes hitting the ground each second. Lightning activity has been seen in various types of clouds, but most of the lightning and thunder activity seems to occur in the cumulonimbus cloud formations. These are the type commonly called *thunderclouds*, and they can vary in size. Those that form independently and are of a short duration of up to an hour or so are referred to as local thunderstorms.

In southern Florida during the summer months, we experience these local thunderstorms one or more times per day, usually in the late afternoon or early evening hours. Besides being of rather short duration, local thunderstorms usually produce moderate amounts of lightning, wind, rain and perhaps some light hail (although there are a number of people who would argue the reference to moderate). The vast majority of thunderstrom activity is the local-type storm.

The second type of thunderstorm is large in size, with severe lightning activity, high winds, heavy rain and may have large hailstone activity. This type of storm is usually referred to as an organized or frontal thunderstorm, and often is associated with cold weather fronts.

Figure 1 shows the average number of annual thunderstorm days for the United States. This data is fairly accurate as it has been based upon collected statistics for many years, and these maps have been issued by the U.S. Weather Bureau since the turn of the century. A thunderstorm day for a given area is any calendar day that a thunderstorm is heard. If more than one is heard in any given day it still only counts as one thunderstorm day.

The most common lightning occurrences are cloud-to-cloud discharges of electrical current but, for obvious reasons, most research efforts have been directed toward cloud-to-ground lightning discharges (Figure 2). The normal cloud-to-ground activity occurs at the base of a thundercloud where a heavy electrical charge builds up from the electrostatic fields that generate a flow of electrons between the tops and bottoms of the clouds. Normally this develops a large negative charge at the base of the cloud. Continued inter-cloud activity produces corona leaders (commonly called *stepped leaders*) that extend downward from the base of the clouds toward the ground. The area of the base cloud where the electrical charge is formed is at an altitude of about three miles, in the region of the cloud where water droplets freeze.

The stepped leaders continue to extend below the base of the cloud toward the ground, and the large negative charge in this leader induces a more positive charge potential on the ground below the cloud, particularly on objects that stick up above the Earth's surface, such as trees, powerline poles and communications towers. This buildup of the positive ground charge potential further attracts the clouds stepped leader toward the ground, and creates a phenomena known as *streamer corona* up toward the cloud from the ground objects. When the two coronas (stepped leaders and streamers) become close enough to each other, a discharge path forms along the original leader path allowing a very large discharge current flow from ground-to-cloud. This ground-to-cloud flow of current is called the *return stroke* and is responsible for the majority of the damages that occur.

In a cloud-to-ground lightning discharge, called a *flash*, there are one or more intermittent partial discharges called *strokes*. The length of a lightning flash and how long it will last varies. The length of the average lightning stroke is about 10,000 feet, or just under two miles. The average lightning flash is composed of four strokes, with an average of 30 microseconds per

Figure 1: Annual thunderstorm days

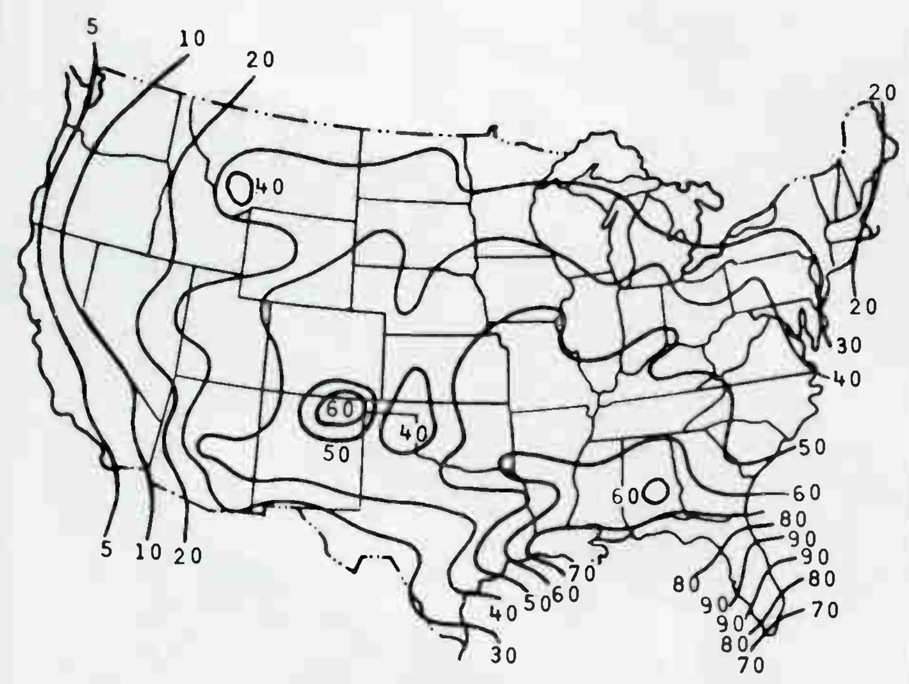
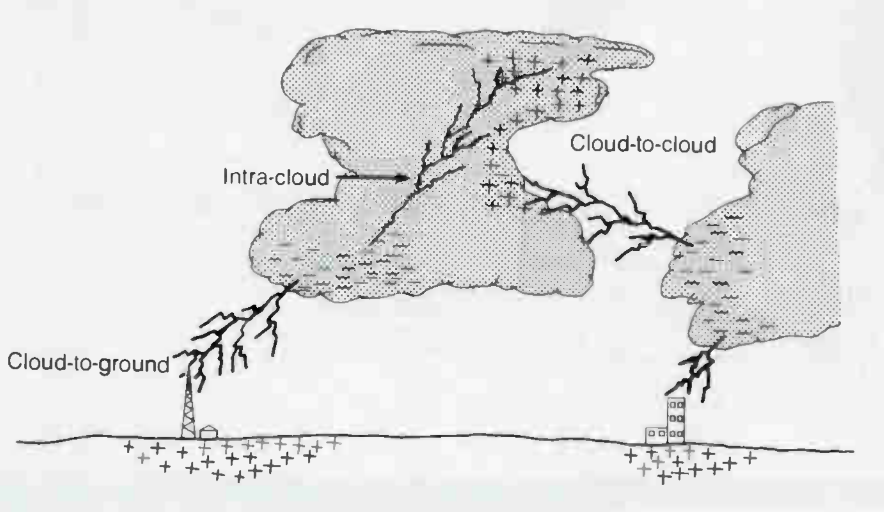


Figure 2: Common lightning occurrences



'The frequency of thunderstorm activity around the Earth is exceedingly high. . .about 100 flashes hitting the ground each second'

stroke over an average total flash time of 0.2 to 0.5 seconds. It is the separation of the highly luminous individual strokes over the total flash time that causes lightning to flicker to the human eye. Maximum current flow in the lightning stroke occurs in less that one microsecond and lasts about 20 microseconds in duration. A sharp reduction in current flow then occurs where only a small amount of current flow remains in the stroke path for a period of time that may extend to longer than 100 microseconds.

Certain collected experimental data has shown the following probability ratings for direct lightning strikes:

- There is a 90 percent probability that the current flow will be less than 10,000 amperes.
- There is a 10 percent probability that the current flow can be as high as 60,000 amperes.
- There is a 2 percent probability that the current flow can be as high as 150,000 amperes.

The average lightning stroke has an energy dissipation of 10^5 joules per meter (one watt per second equates to one joule) over the average distance of three meters in the average stroke length, which equates to about one-tenth of a ton of trinitrotoluene (TNT) per lightning stroke channel. In the simplest of terms, a direct strike of cloud-to-ground lightning can be described as a blinding flash and deafening boom—with the probability of serious damage or destruction to communications equipment.

When the strike hits

Let's examine what happens in a non-protected building that receives a direct strike. The stroke current is seeking the path of least resistance to ground, and that usually means it follows metallic water pipes or electrical wiring. Lightning current frequently enters the home through the power lines, telephone lines or a TV or FM radio antenna mast. When the conductor that the current is travelling through does not have the best ground potential, the lightning current will probably arc over to another path that has a better ground potential. If you are home during a thunderstorm you should avoid using the telephone, touching any electrical appliance that is plugged into the electrical circuits, and stay away from sinks, showers and bathtubs.

Aerial cable installed between poles or towers is susceptible to direct lightning hits unless that cable is mounted below a periodically grounded static line. Where the grounded static line technique is used (Figure 3), the problem of direct strikes to the cable is eliminated. Damages that occur to the cable with ground static lines occur from arc over or flash over of current from the direct ground path to the cable due to poor grounding techniques or the close proximity of the two paths to each other reacting to a difference in potential.

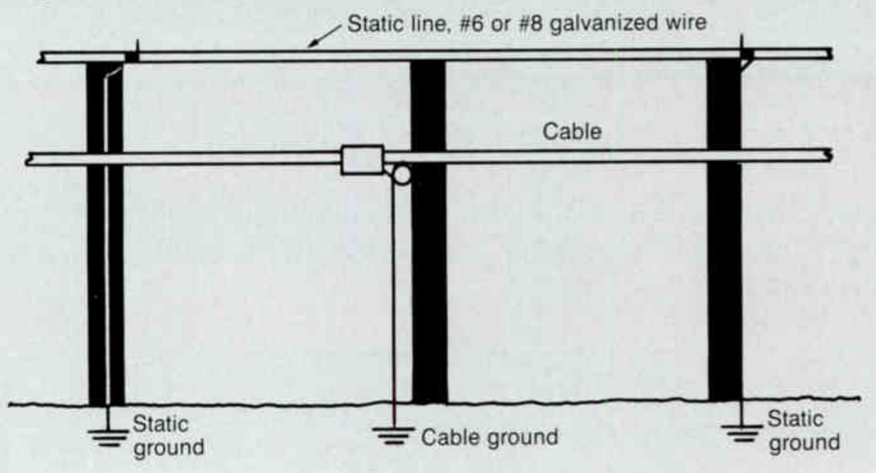
Damages to underground cables are the result of flash or arc over. Contributing factors are length of buried cable between shield ground, depth underground, soil resistance, distance from direct stroke object and the strength of the lightning stroke.

There are many variables associated with lightning and thunderstorm activity. There are some occasions where the cloud base potential is positive with respect to the ground potential. A discharge still will occur if the potential difference and the physical separation of the two results in a corona path and breakdown.

References

"Lightning and CATV Systems," Hansel Mead, Q-bit Corp.
"Lightning and Its Behavior," Dr. Rodney Bent, Atlantic Scientific Corp.
"Lightning and Lightning Protection," William C. Hart and Edgar W. Malone.

Figure 3: Grounded static line



Lightning strike prevention: A 15-year historical analysis

By Roy B. Carpenter Jr.
President, Lightning Eliminators and Consultants Inc

And Mark D. Drabkin, Ph.D.

Ever since the days of Benjamin Franklin, a few scientists and engineers believed that lightning strikes could be prevented from terminating within any area of concern. Franklin himself made that assertion after observing the corona emitted from his sharpened lightning rods. Recently, Professor Charles Moore, a well-known atmospheric physicist at the New Mexico Institute of Mining and Technology, indicated that his research demonstrated that sharp points tended to "protect themselves" and reduce their effectiveness as a lightning rod. A lightning rod is intended to attract the stroke to it and divert the energy flow away from the areas of concern. Moore contended that the blunt rod is a more effective diverter since it does not protect itself.

In early 1971, we became interested in lightning protection technology as the result of the Apollo 12 lightning problems. Later that year, a new concept for lightning protection called the dissipation array system (DAS) was introduced. It was based on the premise that sharp points do tend to protect themselves, and when enough of them are properly deployed, they will protect any form of facility, regardless of its size or configuration.

The DAS as a lightning strike prevention concept has been in use since 1971. Today there are about 610 systems installed in many parts of the world, protecting a wide variety of facilities. These systems provide over 3,000 system-years of operational data. The statistics support a reliability assessment in excess of 99 percent. The few failures were related to early design errors or customer-imposed constraints.

The data collected to date has presented a reasonably clear picture as to the capabilities of the DAS concept:

1) It prevents the direct strike to the protected facility.
2) It reduces the electrostatic field within its sphere of influence by several orders of magnitude.
3) It reduces the "bound charge" usually induced on petrochemicals, other flammables and explosives.
4) It provides an area free of the lightning-related EMP (electomagnetic pulse).

Since lightning serves the function of neutralizing the charge differential between the base of a storm cloud and its image charge on the Earth surface below, it should be obvious that the same function could be accomplished slowly by making the intervening air space a leaky dielectric. Since scientists tell us that about 90 percent of the storm's energy is dissipated naturally over land, it is evident that an efficient dissipator should be able to improve on nature. A lightning strike passes an average of 18 to 20 coulombs at 20,000 amperes peak current. That equates to only 333 milliamperes for one minute. Given these parameters, it follows that if a DAS can

Figure 1: Dissipation array system

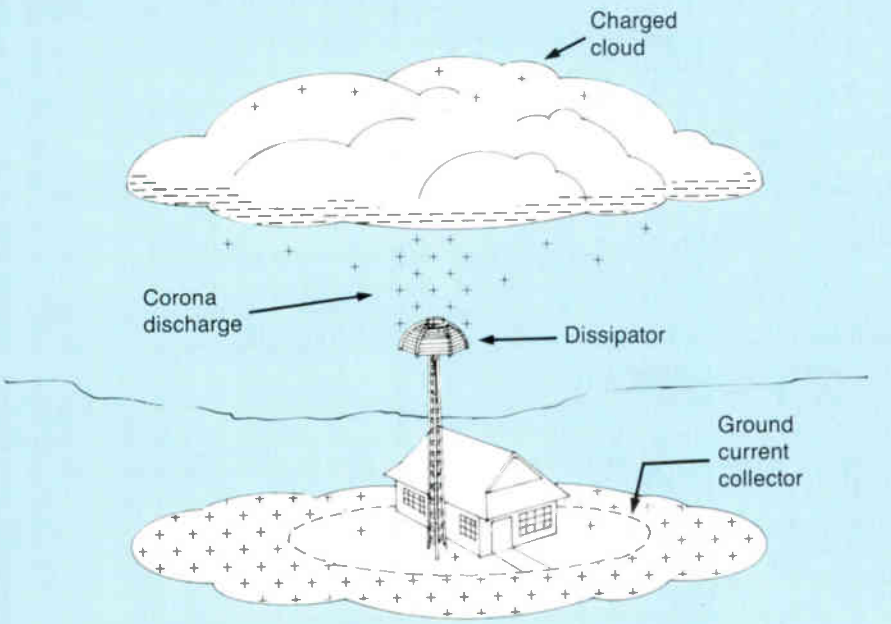
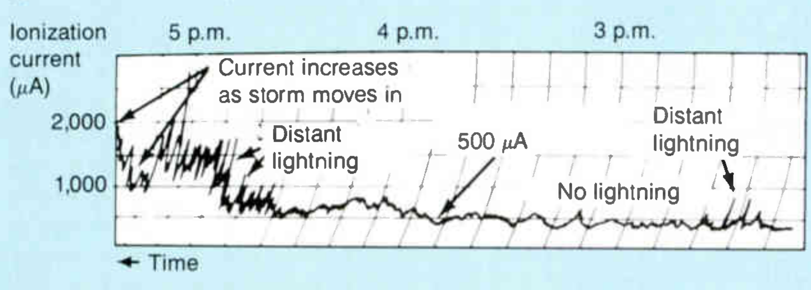


Figure 2: Slow-speed recording on a 20-meter pole



dissipate the equivalent charge, it will accomplish the same objective as a direct stroke.

Operational concept

The function of a lightning stroke is to neutralize the charge developed between two surfaces of conductive elements (the Earth and the cloud base), separated by an insulator (the air). This movement of charge can take place via a deluge of electrons (lightning) or via a trickle (natural or forced dissipation). The dissipation array system encourages trickle discharge through use of "point discharge," a phenomenon discussed later on.

The DAS consists of thousands of sharpened points, enhanced by the electrostatic field always present in any weather condition. Figure 1 presents a conceptual example. In fair weather conditions, the DAS as well as the ground is charged negatively with respect to the ionosphere and produces a very small (tens of nanoamperes) negative charge flow into the air surrounding the DAS, particularly from tall structures.

Under the influence of the thundercloud's dipole, which in most cases has a negative charge near the base of the cloud and a positive charge in the upper part of the cloud, the DAS becomes a positively charged system, as does the surrounding earth. The charge is accumulated in the DAS by means of the ground current collector system. This building up of the positive charge on the DAS creates a local corona when ionization of air by collision occurs around all of the thousands of sharpened points of the DAS. This is commonly referred to as *point discharge*.

As a result, the positive charges stream from the DAS into the surrounding air, creating a positive space charge. This is carried away from the DAS by the thundercloud field and wind and changes the resulting electrostatic field so that the potential gradient at ground level (DAS has the same potential as ground) decreases substantially. This prevents any further development of ionization by collisions that would develop into the stepped streamer, etc. Thus, the likelihood of the direct lightning stroke to the DAS and the protected facility is eliminated because the conditions conducive to the stroke are eliminated.

A detailed analysis of the operational concept and its theoretical derivation will be presented later on. Factors such as ionizer shape, size, height, point separation and environment all must be considered in concert to assure a successful system.

Performance assessment criteria

Assessing the performance of any form of lightning strike prevention system is not an exact science. There are only two parameters that can be evaluated, the dissipation current and the site statistical history.

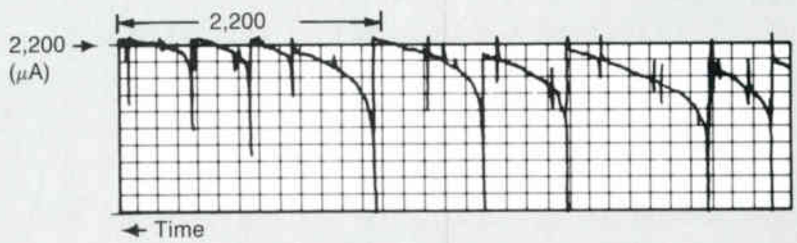
Figures 2 and 3 are copies of segments of dissipation current recordings made for two separate sites. Figure 2 is a slow-speed recording, about 1 cm per minute. Figure 3 is a high-speed recording of about 1 cm per second on a fast-reacting chart recorder. In both cases, the displacement from the baseline is proportional to the dissipation current. Its full scale is 2 milliamperes. These data present a histogram of the storm motivated dissipation current. Time progresses from right to left.

Note in Figure 2 that the dissipation current starts long before the storm matures; it builds up slowly until maturity or until it is above the array system. At that time the current maximizes. From Figure 3, we see that the current rises along a decaying exponential, approaching a point of equilibrium where the potential on the array is well below strike potential, but high enough to maintain the required ionization. A nearby discharge (up to as much as a mile away) causes the cloud overhead to discharge, thus the sharp return to zero. From there is an immediate return to ionization and then to the equilibrium potential. The integral of these over a minute or so is equal to an average stroke.

Of the over 610 systems installed to date, some typical examples were selected to demonstrate DAS effectiveness. History is important, as it contributes to the statistical evidence as well as contrasting information with respect to the before and after status. The following are of particular interest because of the extended history and contrast.

1) *Radio station CKLW, Windsor, Ontario, Canada*. The antenna system is composed of five well-grounded towers 92 meters high. For over 20 years, the station log recorded an average of 25 outages per year due to direct lightning strikes. In 1972, a disk-type DAS was installed. Since then there have been no strikes in over 14 years to these towers or the site.

Figure 3: High-speed recording on a 365-meter pole



2) *Television station WBBH, Fort Myers, Fla.*, is in a keraunic level area of 100 lightning days per year. The antenna is mounted on a tower over 300 meters in height. The records indicated over 48 outages per year due to direct strikes to the antenna. In 1975 a trapezoidal-shaped DAS was installed. No strikes have been recorded since then.

3) *Philadelphia Electric* has a nuclear generating plant at Peachbottom, Pa. The plant occupies over 100 hectares along the banks of the Susquehanna River. The "off gas" stack rises to 720 feet above the plant. Plant history records between two and five lightning related incidents per year. In 1976, a hemispheric-shaped dissipator was installed. Since then no further outages were recorded due to lightning activity.

4) In Memphis, Tenn., *Federal Express* Co. (FEC) occupies over a square kilometer of the airport facility. Each night between 11 p.m. and 3 a.m., up to 100 aircraft come into the hub to discharge and pick up packages. Time is critical, and lightning was a problem to the whole operation. No records of the number of strikes were available. The keraunic number is 65, which indicates that up to 10 strikes per year could be expected in the area. The results of the DAS installation were dramatic. No further lightning activity was noted in or near the area. At first the corona disturbed the FEC personnel. Subsequently, the Federal Aviation Administration (FAA) control tower personnel noted that there was no lightning at the FEC end of the field and much less even at the far end. An unsolicited report was filed in Washington, D.C., with a recommendation that the FAA make use of the DAS.

5) *PPG Chemical* also occupies several hundred hectares of land on the southern coast of Louisiana, with a keraunic number of 70, indicating a stroke potential of about 17 to the plant each year. Lightning was creating a problem in the chlorine-generating cells. A DAS was installed over two cells, and several years later over two more. Later, more of the plant was protected, not so much because of direct lightning but because it was observed that the hydrogen flare stacks under the arrays were not set on fire by nearby strikes; the ones outside the DAS were. The DAS had reduced the electrostatic field to below the secondary arcing level, as well as preventing the direct strike.

6) *Phillips Petroleum, Freeport, Texas*. This facility includes 26 petroleum storage tanks of sizes varying from about 5,000 to 500,000 barrels wherein a variety of hydrocarbons are stored. Often during the thunderstorms, a nearby lightning strike causes the vapors around the seal of floating roof tanks to ignite. This phenomenon, known as *secondary effects* or *back flash*, is responsible for innumerable fires of this type. In mid-1980, we installed the DAS to protect all the tanks. Subsequent to that installation, there were no lightning strikes to the area and no seal fires, in spite of the fact that the facility was in a very vulnerable location in a high isokeraunic area. This proves that the DAS reduces the electrostatic field to below the flash point of light hydrocarbons.

Statistics

There are many other success stories; there have been very few failures. *Failures* are herein defined as not preventing the strike to the protected area. The most convincing data is the cumulative records of successes. In late 1985, a second survey of all known DAS installations was made as to their state and performance. The results were:

- Over 99 percent reported complete success, i.e., no strikes subsequent to the installation.
- 0.7 percent reported at least a 90 percent reduction in the recorded strikes.
- Less than 0.3 percent reported little or no perceptible change.

An assessment of those sites having problems before corrective action was implemented indicated the following problems:

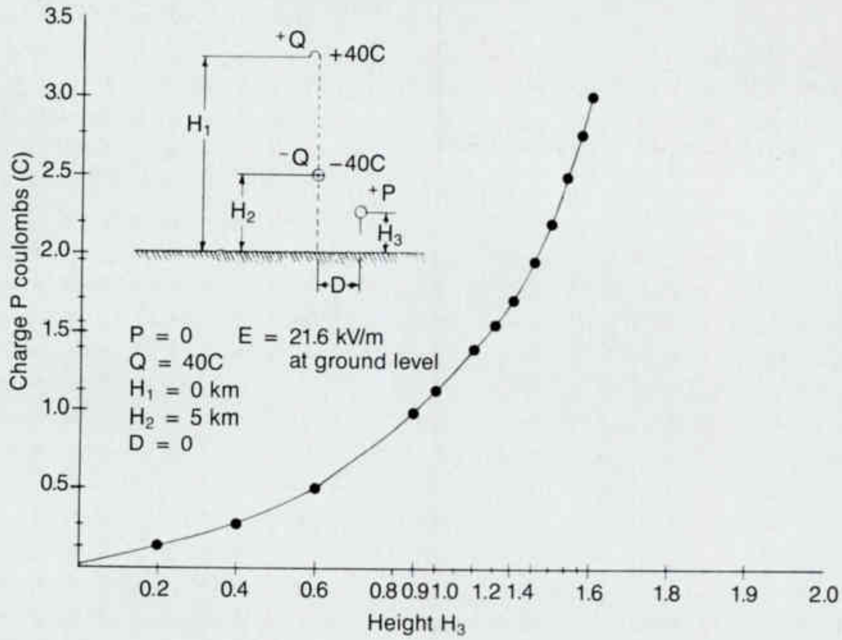
1) Constraints established by the customer, the system or finances prevented a proper or optimum system design or installation.
2) Poor design (systems designed prior to 1978).
3) Losses caused by power main surges, not strikes to the tower.
4) Poor installation technique.

Most of the problem installations have been reworked and now are functioning satisfactorily. The few that were not reworked are due to customer- or site-imposed constraints.

From the past 15 years there is an abundance of evidence available that substantiates the premise that lightning can be eliminated from the area of concern. As in all R&D programs, some failures did happen in the early years. However, the preponderance of data is overwhelming in favor of the dissipation array system for lightning prevention. The study results are conclusive:

- Lightning strikes can be prevented.
- The designer must pay careful attention to the site and facility character, as well as the array configuration itself.

Figure 4: Positive space charge at thundercloud



Zero electrostatic field at ground level due to lower positive charge situated underneath the thundercloud dipole

- Early design weaknesses were clarified, and now permit achievement of a 100 percent successful system design every time.
- A secondary benefit was discovered that may prove even more profound than strike prevention—the "secondary effects" were eliminated as well. This is the direct result of draining the charge from the protected facility, and thus lowering its potential (in relationship to true Earth) to a level below that required to ignite even hydrogen. This then infers that the DAS concept creates a safe environment for the storage of explosives and flammables. Whereas the lightning rod brings strokes into the area of concern, the DAS eliminates the stroke potential from its protected areas.

Three basic elements

The dissipation array system is composed of three basic elements: the array of many discharge points (the dissipator), the ground current collector and the service wires connecting the two. The operational concept is based upon the point discharge phenomenon both in natural and laboratory conditions.

It is a proven fact that an electrostatic field near a pointed conductor tends to concentrate at the point, enhancing the electric field. An electric field exists over the entire fine weather areas of the Earth. At an altitude above 50 km, the air has such a high conductivity that it may be considered to be the equivalent of a good conductor. Any electrical charge reaching a point at this altitude soon will become uniformly distributed around the whole Earth.

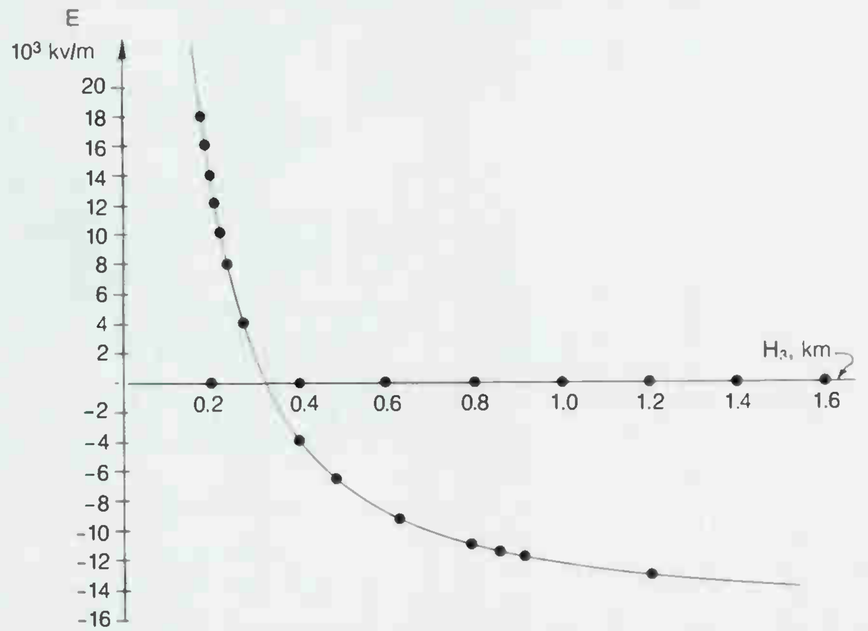
So the atmosphere above 50 km and the surface of the Earth, which is also a good conductor, in effect constitutes the plates of a concentric spherical capacitor, having at fair weather conditions the negatively charged earth and the positively charged ionosphere. Because of its ionization, the air is not a perfect dielectric, the plates of the capacitor are not completely insulated from each other and electric currents will flow between them when they are charged to different potentials. The average value of the fair weather positive field at ground level is about 130 v/m.

The lines of the electric-field cloud to Earth will be deflected from their generally vertical direction near any elevated pointed conductor. And, if the electric field enhanced by the concentration of its lines of force ending on the conductor's point is sufficiently strong, there is a possibility of ionization by collision confined to the very small volume near the point. An electric current starts to flow from the tip of the conductor to the air. Current flow from the point is normally a quiet, invisible process, but if the electric field becomes sufficiently great, ion collisions yield enough energy to excite particles of the air and make them luminous and audible. The visible ionization is termed *corona* (also known as *St. Elmo's fire*) and can be seen in darkness as a bluish glow.

The likelihood of producing corona on the tip of a conductor depends upon three major factors: the height of the conductor, the radius of curvature or the sharpness of the point, and the electric field. When the conductor is connected to the ground, it has the same potential as the Earth, but the air is at different potentials at different heights. So the tip of the conductor and the air around it have a potential difference. This difference is increased as the conductor is made taller and a lower initial electric field is required to initiate corona

The point-discharge current will start to flow from the tip of an earthed vertical conductor as soon as an electrical field exceeds the critical value required to initiate the ionization by colli-

Figure 5: Positive space charge for zero electric field



The electric field at ground level as function of the height of the charge P at 2 km horizontal distance from thundercloud dipole 40C

sion. The current may be quantitively evaluated by Equation 1.

$$I = 2(E^2 - E_{cr}^2) \quad (1)$$

where:
- I = current flowing from the tip
- E = the electric field at the height of the tip
- E_{cr} = the minimum electric field required to initiate discharge

E_{cr} depends on the shape of the conductor and on the weather conditions. An experimentally received relationship between E_{cr} and the radius r of the cylindrical conductor at given weather conditions may be described for example by Equation 2

$$E_{cr} = 24\varsigma\left(1 + \frac{0.638}{r^{[illegible]} \times \varsigma^{[illegible]}}\right) \quad (2)$$

where:
- ς is a factor determined by weather conditions.

Under disturbed weather conditions, when thunderclouds are formed, the base of a thundercloud has in most cases a negative charge concentration and the upper part of the thundercloud is charged positively. The negatively charged base of the thundercloud attracts positive charges from the under-cloud Earth surface, thus while negatively charged at fair weather the elevated pointed conductor or array of such conductors will change the sign of the charge and become positively charged as a result of the presence of the thunderclouds. The point-discharge current from the array of the pointed conductors will carry away positively charged ions. Moving away from the array, these ions will form a space charge that reduces the electric field near the points, since lines of force will end on these ions instead of on the points. This process will progress until the electric field will be reduced so much that it prevents further ionization and the corona ceases. Then, as the space charge is carried away by wind, the electric field near the points again increases and the new corona discharge starts. Thus, the point-discharge currents have a pulsed nature, which has been proven by measurements of point-discharge currents both in natural and laboratory conditions. It was found that wind velocity has a great influence on the current flow, increasing both the interval between pulses and the charge per pulse.

Figure 4 shows a simplified model of thundercloud and the positive space charge situated at some horizontal distance from the thundercloud dipole. The electrostatic field at ground level, at the given moment, can be calculated from Equation 3

$$E_0 = 2Q\left[\frac{H_1}{(H_1^2 + D^2)^{3/2}} - \frac{H_2}{(H_2^2 + D^2)^{3/2}}\right] + \frac{2P}{H_3^2} \quad (3)$$

where:
- H_1 and H_2 = heights of the centers of the positive and negative charge (Q) in the thundercloud.
- H_3 = height of the positive space charge P situated horizontally at distance D from the thundercloud dipole.

Although in fact it is known that the charge distribution is not strictly uniform, the actual distribution is so variable that it is difficult to justify more precise calculations.

Figure 5 presents the calculated size of the positive space charge required to produce zero electric field at ground level when D = 0. Based on such calculation, the 0.1 C (0.1 coulomb charge) at a height of 300 m above the earth will be sufficient to neutralize the negative field of thundercloud at ground level. Assuming a total point-discharge current of about 100 microamperes, it will take about 17 minutes to constitute such charge. The curve shown in Figure 5 represents the calculated electric field at ground level as a function of the height of the positive space charge of 0.1 C situated at 2 km from thundercloud dipole. As may be seen from this figure, the electric field decreases with an increase of the height of the space charge, becomes zero at about 330 m and changes sign from positive to negative with a progressive increase of the space charge's height.

The lightning discharge initiated by upward leaders goes through the state from point discharge to streamer, due to a glow to arc transition when the current exceeds some critical value.

To reduce the likelihood of the transition from a glow to arc discharge, which would initiate an upward directed leader, a multitude of the points have to be arranged and placed on the large electrode with a shape designed as the uniform electric field electrode used in high voltage apparatus to suppress the corona. It is conceivable that no single point of such array will discharge current enough for the transition to the arc regime. As a result, the initiation of an upward leader would not take place under the conditions found during normal storm situations. In such circumstances the lightning strikes to the DAS and object protected by the DAS (site of concern) would in practice be eliminated.

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Reader Service Number 34.

Program for satellite earth station antenna look angles

By Lawrence W. Lockwood
President TeleResources

Since most systems either own or have access to a personal computer, the program for satellite earth station antenna look angles should be a welcome addition to the collection of engineering tools. The program (in IBM PC BASIC A) will determine the pointing angles of the antenna at any earth station location to any satellite. There are programs in the public domain that will provide the earth station's antenna pointing angles, however, after requiring the station coordinates, most programs provide a menu of satellites to choose from. The program in this article, of course, requires the earth station's location (longitude and latitude) but asks for the satellite's longitude rather than providing a menu of satellite names.

There are a number of advantages to this approach—not the least of which is the fact that satellites are added and gradually some are phased out—and at times programming changes from one satellite to another. In addition the FCC-mandated reduction of satellite spacing of 4° to 2° is not yet complete and will provide further applications for this program. All these factors make this program universally useful *ad infinitum*. The directions for its use are built into the program.

Derivation of look angle formulas

In Figure 1 the geostationary satellite S is shown at longitude L_S and the earth station E is at latitude ϕ and longitude L_E. The distance between the earth station and the satellite is d. To find θ, the antenna elevation angle, assume the following:

- Earth's radius R_O (R_O = GE)
- Satellite distance from center of earth R (R = GS)
- Earth station relative longitude w with respect to the satellite, where $w = (L_E - L_S)$

As seen in Figure 1, S′ is the subsatellite point on the equator and E′ is the substation point on the equator where it is intersected by the plane of the great circle passing through the earth station E.

The spherical triangle EE′S′ is orthogonal at E′ since the equatorial plane and the great circle plane are orthogonal. Consequently, cos

Figure 1: Earth station E with latitude ϕ and relative longitude w

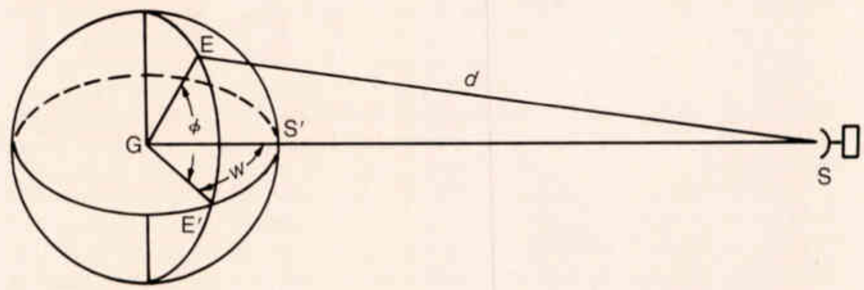


Figure 2: Earth station E and local horizon (elevation angle θ)

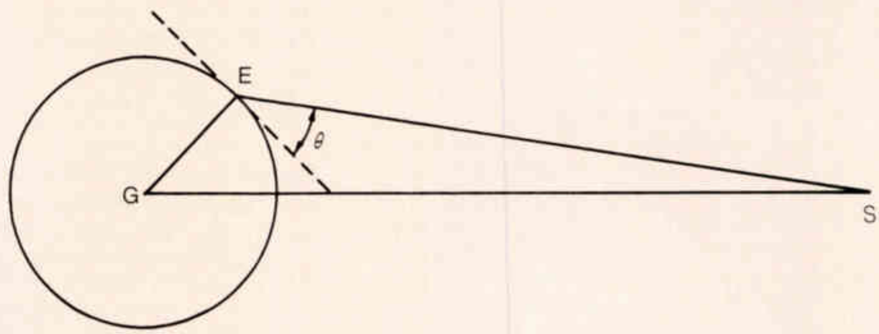
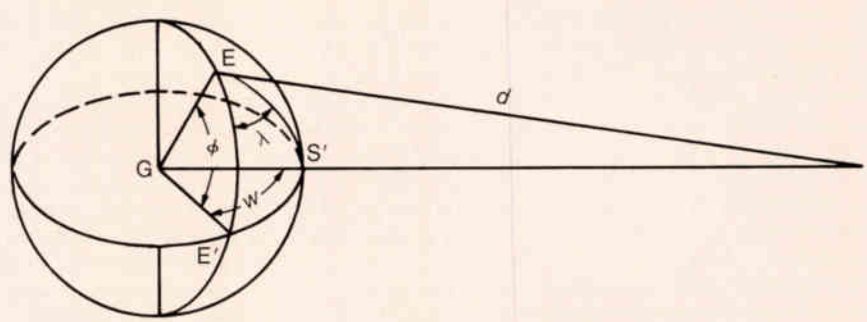


Figure 3: Computing antenna azimuth angle



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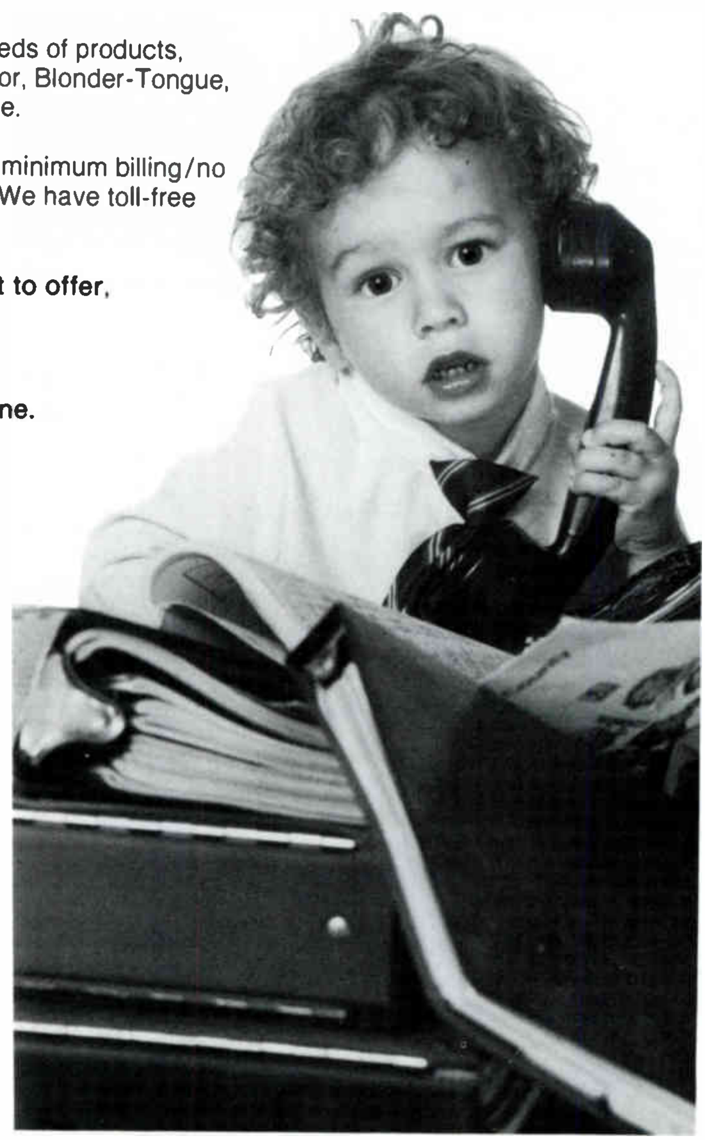

Toner
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Reader Service Number 47.

Table 1: True azimuth relationships

True azimuth	Earth station quadrant
$180-\lambda$	NW
$180+\lambda$	NE
λ	SW
$360-\lambda$	SE

EGS = $\cos\phi \cos w$. But from the planar triangle EGS we have

$$d^2 = R^2 + R_O^2 - 2RR_O \cos EGS$$
$$\text{so } d^2 = R^2 + R_O^2 - 2RR_O \cos\phi \cos w$$

Figure 2 represents the plane of the triangle EGS and its great circle intersection with the Earth's surface.

By drawing the local horizontal (dashed line), we obtain from the triangle GSE:

$$(GS)^2 = (GE)^2 + (ES)^2 - 2(GE)(ES)\cos(90° + \theta)$$
$$\text{or } R^2 = R_O^2 + d^2 + 2R_O d \sin\theta$$
$$\text{so } \theta = \sin^{-1}[(R^2 - R_O^2 - d^2)/(2R_O d)]$$

The antenna azimuth angle is shown in Figure 3 as λ. Again from the spherical triangle EE'S' we have

$$\lambda = \cos^{-1}(\tan\theta \cot EGS),$$

which provides the angle at E. The true azimuth then is obtained from Table 1. The earth station quadrant is identified with respect to the meridian passing through the subsatellite point and the equator.

The values of Earth radius, R_O = 6371 km, and satellite altitude, $(R - R_O)$ = 35,784 km, are used in these formulas that the program (in BASIC A) calculates when the required information is entered (Figure 4). This information is the earth station's latitude and longitude and the satellite's longitude. The program is so written that its operation is self-explanatory—the required information is asked for by the program

Table 2: Longitude of satellites

ANIK C3	117.5
SATCOM III-R	131.0
TELSTAR 303	125.0
ANIK D1	104.5
SATCOM IV	83.0
WESTAR IV	99.0
GALAXY I	134.0
SPACENET I	120.0
WESTAR V	123.0

Table 3: Latitude and longitude of selected cities

		Latitude	Longitude
AK	Anchorage	61.17	149.92
AK	Juneau	58.30	134.58
AL	Birmingham	33.52	86.82
AL	Mobile	30.42	88.03
AR	Clarksville	33.42	94.03
AR	Little Rock	32.75	92.27
AZ	Flagstaff	31.15	111.40
AZ	Tucson	33.23	110.98
CA	Los Angeles	34.05	118.25
CA	San Francisco	37.78	122.43
CO	Denver	39.75	104.98
CO	Grand Junction	39.07	108.57
CT	Hartford	41.77	72.68
CT	New London	41.35	72.10
DE	Dover	39.15	75.53
DE	Wilmington	39.75	75.55
FL	Miami	25.78	80.18
FL	Tampa	27.95	82.45
GA	Atlanta	33.77	84.38
GA	Columbus	32.47	85.00
HI	Hilo	19.73	155.08
HI	Honolulu	21.32	157.87
IA	Cedar Rapids	41.98	91.67
IA	Des Moines	41.60	93.63
ID	Idaho Falls	43.50	112.03
ID	Boise	43.62	116.20
IL	Chicago	41.87	87.65
IL	Peoria	40.45	89.35
IN	Fort Wayne	41.07	85.15
IN	Indianapolis	39.77	86.17
KS	Topeka	39.05	95.68
KS	Wichita	37.70	97.33
KY	Lexington	38.05	84.50
KY	Louisville	38.25	85.75
LA	Baton Rouge	30.43	91.18
LA	New Orleans	29.95	90.07
MA	Boston	42.37	71.07
MA	Springfield	42.10	72.60
MD	Baltimore	39.32	76.62
MD	Hagerstown	39.65	77.72
ME	Bar Harbor	44.33	68.20
ME	Portland	43.65	70.27
MI	Detroit	42.33	83.05
MI	Grand Rapids	42.97	85.67
MN	Duluth	46.78	92.10
MN	Minneapolis	44.95	93.27
MO	Kansas City	39.10	94.60
MO	St. Louis	38.63	90.20
MS	Biloxi	30.40	88.88
MS	Jackson	32.30	90.18
MT	Billings	45.78	108.50
MT	Helena	46.58	112.03
NC	Charlotte	35.23	80.85
NC	Raleigh	35.78	78.63
ND	Bismarck	46.82	100.78
ND	Grand Forks	47.92	97.05
NE	Lincoln	40.82	96.70
NE	Omaha	41.25	95.95
NH	Concord	43.22	71.53
NH	Portsmouth	43.07	70.77
NJ	Camden	39.95	75.12
NJ	Newark	40.73	74.18
NM	Albuquerque	35.07	106.67
NM	Santa Fe	35.68	105.95
NV	Las Vegas	36.17	115.13
NV	Reno	39.53	119.80
NY	Albany	42.65	73.78
NY	New York City	40.75	73.95
OH	Cincinnati	39.10	84.52
OH	Columbus	39.63	83.02
OK	Oklahoma City	35.47	97.52
OK	Tulsa	36.15	96.00
OR	Portland	45.52	122.68
OR	Eugene	44.08	123.00
PA	Philadelphia	39.95	75.18
PA	Pittsburgh	40.45	80.00
RI	Newport	41.32	71.28
RI	Providence	41.82	71.42
SC	Columbia	34.00	81.03
SC	Greenville	34.87	82.40
SD	Rapid City	44.08	103.22
TN	Nashville	36.17	88.78
TX	Dallas	32.78	96.78
TX	Houston	29.75	95.38
UT	Salt Lake City	40.77	111.90
VA	Alexandria	38.80	77.05
VA	Richmond	37.53	77.43
VT	Montpelier	44.27	72.58
WA	Seattle	47.62	122.33
WA	Spokane	47.67	117.42
WV	Charleston	38.35	81.63
WI	Milwaukee	43.03	87.92
WY	Casper	42.85	106.30

and then the calculations are made. This program can be used with a printer for a written record by changing each PRINT statement to an LPRINT statement.

For additional convenience Table 2 lists the longitudes of satellites commonly used in CATV; the latitudes and longitudes of selected U.S. cities are listed in Table 3.

An example of the program as it is printed out is shown in Figure 5.

References

Manual of Satellite Communications, Emanuel Fthenakis, McGraw-Hill, 1984.

Reference Data for Engineers: Radio, Electronics, Computer and Communications, Seventh Edition, Howard W. Sams & Co.

Figure 4: Computer program for antenna look angles

```
10 PRINT TAB(15) "SATELLITE EARTH STATION ANTENNA LOOK ANGLES"
20 PRINT TAB(25) "LAWRENCE W. LOCKWOOD"
30 PRINT TAB(30) "(C) 1987"
40 PRINT
50 REM IF FOLLOWING ANGLES ARE IN DEGREES ONLY, ENTER AS DEGREES,0,0
60 INPUT "LATITUDE OF EARTH STATION IN DEGREES, MINUTES, SECONDS";A,B,C
70 INPUT "LONGITUDE OF EARTH STATION IN DEGREES, MINUTES, SECONDS";D,E,F
80 R=A+B/60+C/3600
90 Q=D+E/60+F/3600
100 PRINT "LATITUDE OF EARTH STATION =";R;"DEGREES
110 PRINT
120 PRINT "LONGITUDE OF EARTH STATION =";Q;"DEGREES"
130 PRINT
140 PRINT
150 N=R*3.141593/180
160 P=Q*3.141593/180
170 INPUT "LONGITUDE OF SATELLITE IN DEGREES, MINUTES, SECONDS";V,W,Z
180 F=V+W/60+Z/3600
190 G=F*3.141593/180
200 PRINT "LONGITUDE OF SATELLITE =";F;"DEGREES"
210 PRINT
220 PRINT
230 PRINT
240 W=ABS(G-P)
250 X=COS(N)*COS(W)
260 D=(42155!*42155!+6371*6371-2*42155!*6371*X)^.5
270 S=(42155!*42155!-6371*6371-D*D)/(2*6371*D)
280 L=ATN(S/(1-S*S)^.5)
290 T=L*180/3.141593
300 K=ATN(SQR(1-X*X)/X)
310 Z=COS(K)/SIN(K)
320 J=Z*TAN(N)
330 H=X*TAN(N)
340 K=ATN(SQR(1-J*J)/J)
350 M=K*180/3.141593
360 PRINT "SATELLITE EARTH STATION ANTENNA ELEVATION ANGLE =";T;"DEGREES"
370 PRINT
380 PRINT "SATELLITE EARTH STATION ANTENNA AZIMUTH ANGLE =";M;"DEGREES"
390 PRINT
400 W=G-P
410 IF N<0 GOTO 430
420 IF N>0 GOTO 450
430 IF W>0 GOTO 510
440 IF W<0 GOTO 530
450 IF W>0 GOTO 470
460 IF W<0 GOTO 490
470 M=180+M
480 GOTO 550
490 M=180-M
500 GOTO 550
510 M=360-M
520 GOTO 550
530 M
540 GOTO 550
550 PRINT "SATELLITE EARTH STATION ANTENNA TRUE AZIMUTH =";M;"DEGREES"
```

Figure 5: Example of program printout. Earth station at Washington, D.C., and satellite III-R.

LATITUDE OF EARTH STATION = 38.8 DEGREES

LONGITUDE OF EARTH STATION = 77.05 DEGREES

LONGITUDE OF SATELLITE = 131 DEGREES

SATELLITE EARTH STATION ANTENNA ELEVATION ANGLE = 19.08762 DEGREES

SATELLITE EARTH STATION ANTENNA AZIMUTH ANGLE = 65.48274 DEGREES

SATELLITE EARTH STATION ANTENNA TRUE AZIMUTH = 245.4827 DEGREES

SCTE TECHNICAL TUITION ASSISTANCE APPLICATION

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669 Exton Commons
Exton, PA 19341
(215) 363-6888

Name: Mr. / Mrs. / Ms. ______________________ (Last) (First) (Middle)

Telephone Numbers:

Mailing Address: ______________________

Home: ( ) ______

Work: ( ) ______

Date of Birth: ___ / ___ / ___ (mo. day yr.)

Social Security No. ___ - ___ - ___

SCTE STATUS:

Chapter or Meeting Group Member? _____ Yes _____ No

Chapter or Meeting Group Name: ______________________

Nat'l Member? _____ Yes _____ No

Member Number: ______________________

CURRENT EMPLOYMENT INFORMATION: Total No. of Years in the Cable Industry: ______

Company Name: ______________________

Telephone Number: ( ) ______

Address: ______________________

Present Supervisor: ______________________

Title/Position: ______________________

Duties: ______________________

Employment period: from ______ to ______

EMPLOYMENT HISTORY:

Employer: ______________________

Address: ______________________

Phone Number: ( ) ______

Title/Position: ______________________

Duties: ______________________

Immediate Supervisor: ______________________

Employed from: ______ to ______

Employer: ______________________

Address: ______________________

Phone Number: ( ) ______

Title/Position: ______________________

Duties: ______________________

Immediate Supervisor: ______________________

Employed from: ______ to ______

Professional Activities & Memberships:

Activity or membership: ______________________

Your most significant contribution: ______________________

Activity or membership: ______________________

Your most significant contribution: ______________________

Activity or membership: ______________________

Your most significant contribution: ______________________

Current SCTE BCT/E Certifications: ______________________

EDUCATIONAL HISTORY: (Attach all appropriate transcripts)

High School Level Completed: ☐ 9 ☐ 10 ☐ 11 ☐ 12

Names & Locations of Schools: (Attach additional page if necessary.)

Diploma Granted: ______ Yes ______ No ____________ Date

Course of Study: ____________

GPA ________ Dates of Attendance: ____________

Diploma Granted: ______ Yes ______ No ____________ Date

Course of Study: ____________

GPA ________ Dates of Attendance: ____________

College Level Completed: ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6

Names & Locations of Schools: (Attach additional page if necessary.)

Degree Granted: ____________ Date: ____________

Major: ____________ GPA: ____________

Dates of Attendance: ____________ to ____________

Degree Granted: ____________ Date: ____________

Major: ____________ GPA: ____________

Dates of Attendance: ____________ to ____________

Vocational/Military School:

Name & Location of School:

Graduated: ______ Yes ______ No ____________ Date

Course of Study: ____________

Dates of Attendance: ____________ to ____________

Grade Point Average (4.0 scale): ____________

Correspondence Courses:

Name and Location of Institution:

Diploma Granted: ______ Yes ______ No ____________ Date

Course of Study: ____________

Dates of Attendance: ____________ to ____________

Grade Point Average (4.0 scale): ____________

PERSONAL REFERENCES: (Industry-Related)

Name: ____________

Title/Position: ____________

Company: ____________

Address: ____________

Telephone Number: (   ) ____________

Name: ____________

Title/Position: ____________

Company: ____________

Address: ____________

Telephone Number: (   ) ____________

CONFIDENTIAL FINANCIAL DATA:

Gross Annual Income:* $ ____________

Net Taxable Income:* $ ____________

Number of Dependents: ____________

*As reported to the IRS in last tax year; for married couples filing separately, include both incomes.

Explain why you should receive an SCTE Technical Tuition Assistance Grant and how it will benefit you (use additional page if necessary):

Please return completed form to:
Society of Cable Television Engineers
669 Exton Commons
Exton, PA 19341

Signature: ____________

Date: ____________

Reader Service Number 38.

Baseband video performance testing

The final installment of this three-part series discusses video waveform analysis.

By Jim Schmeiser
Staff Engineer

And Terry Snyder
District Field Engineer, Group W Cable Inc

This article will give a brief description of how to perform a few video tests, as well as describe the results if certain parameters are not met.

1. *Line-time waveform distortion:*

The signal we will use is the bar portion of the composite test signal. The purpose of this measurement is to recognize distortions occurring at and below frequencies of a few hundred kHz. The measurement is made by placing the center of the bar on the 100 IRE line and noting the peak-to-peak amplitude change in IRE of the bar tilt. The peak-to-peak excursions should not be more than 4 IRE (Figure 1).

Horizontal streaking, smearing, and shading are typical picture distortions for such a parameter.

2. *Short-time waveform distortions:*

Short-time waveform distortions affect horizontal resolution, crispness and fine details. Ringing or smearing may be in the reproduced picture. Make sure the bar edge is adjusted to 100 IRE units. Measure the amplitude of the 2T pulse. The parameter is 100 IRE units ±6 IRE. Next, measure the bar edge peak-to-peak variations. These are not to exceed 10 IRE (Figure 2).

3. *Chrominance-luminance gain inequality:*

To ensure proper saturation of color, it is important that transmission of the color signal does not affect the correct gain relationship between the luminance and chrominance components of the picture. If the chrominance component is enhanced or attenuated relative to the luminance component, picture colors are more vividly or palely reproduced when compared to the original picture.

Still using the composite test signal, measure the amplitude of the chrominance pulse (12.5 T pulse). The parameter is 100 IRE ±3 IRE (Figure 3).

4. *Chrominance luminance delay inequality (CLDI):*

To ensure proper registration of the color signal with the luminance signal, it is important that the transmission path does not affect the time relationship between the luminance and chrominance components of the picture. When chroma is delayed or advanced with respect to luminance, the distortion in the reproduced picture is visible as lagging or leading colors respectively. It shows up as a color shift or misregistration.

Figure 1: Line-time distortion

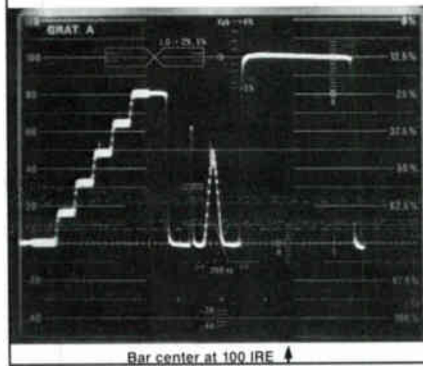
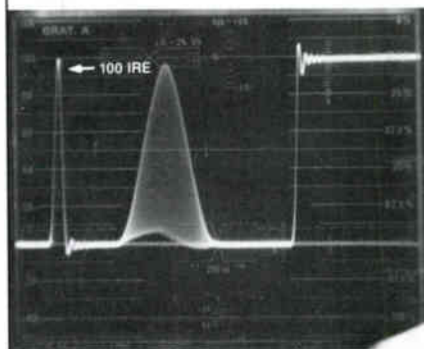


Figure 2: Short-time distortions



CC-1 Subscriber Terminal Entry Enclosures

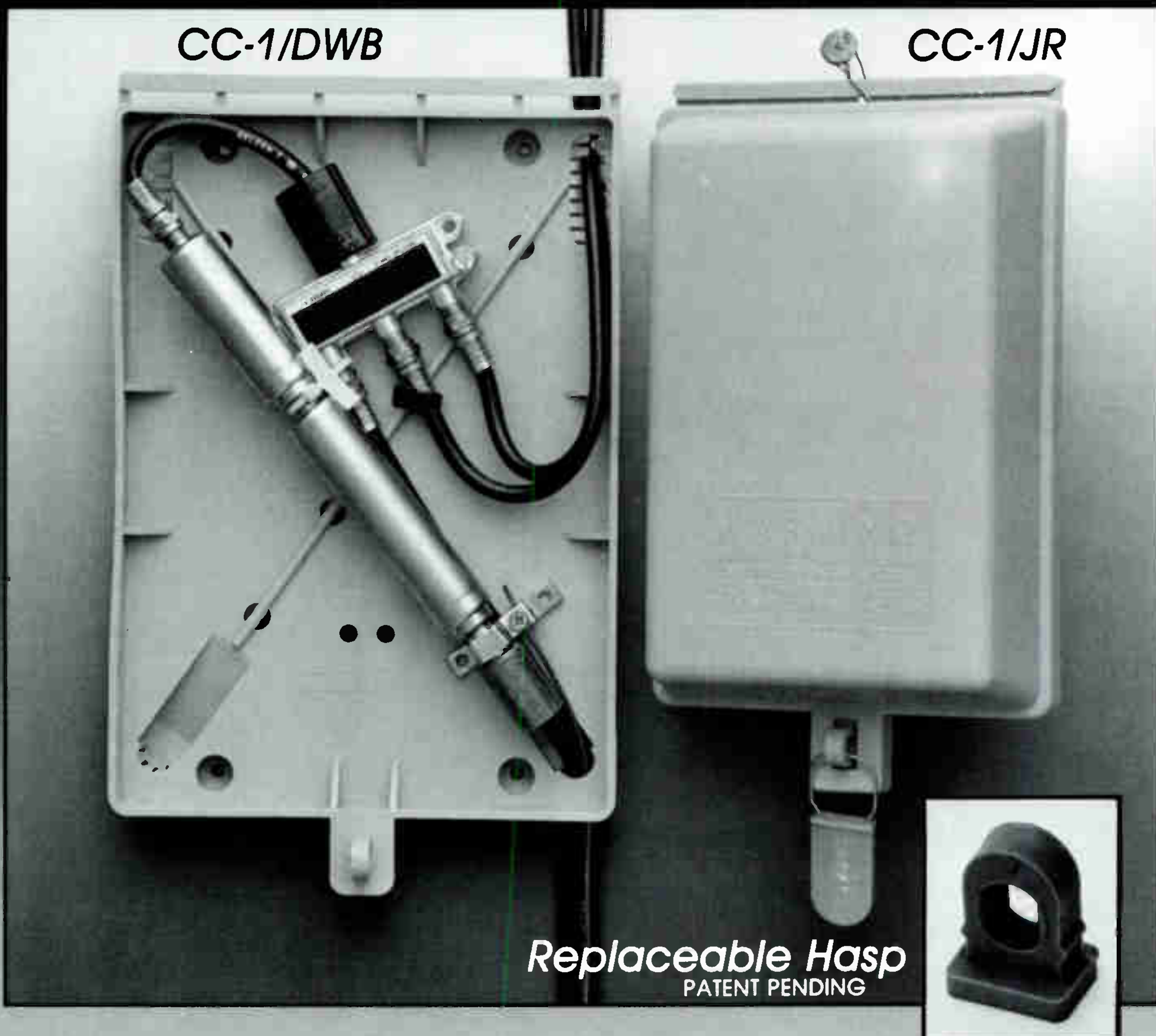


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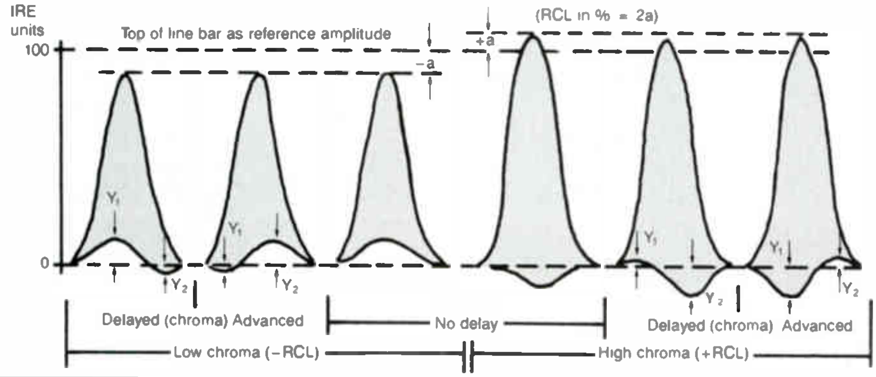
Figure 5: Chrominance-luminance gain measurement convention



Again, we use the chrominance pulse portion of the composite test signal. The chrominance pulse is set to exactly 100 IRE (Figure 4). A starting positive going lobe should be recorded as delayed chroma. Delay inequality can be computed by CLDI (in nanoseconds) $= 20\sqrt{Y_1 \times Y_2}$ (Figure 5), or use the nomogram (Figure 6).

5. Gain/frequency distortion:

This test signal is used for a check of the gain response at selected frequencies in the range from 500 kHz to 4.2 MHz. It consists of a burst of peak white (white flag) followed by six sine wave frequencies.

If the bandwidth is greater than 4.2 MHz, a noisy picture is present. If the bandwidth is less than 4.2 MHz, a loss of color and resolution is present. For this particular test, we use the multiburst test signal. The white flag is adjusted for 100 IRE then the peak-to-peak amplitude of each burst is measured. All frequency burst packets shall be +3 or −5 IRE of being flat (Figure 7).

6. Differential gain:

Differential gain is the change in amplitude of a high frequency signal as the luminance varies from blanking level to white level. It is caused by non-linear elements that compress or stretch black and/or white regions. The effect on the corresponding picture is a change in the saturation of colors with brightness.

The differential gain is measured by using the staircase of the composite test signal. Pass the signal through the chroma bandpass filter in the waveform monitor; you will get the presentation of Figure 8. Adjust the vertical sensitivity until the

Figure 3: Chrominance-luminance gain inequality

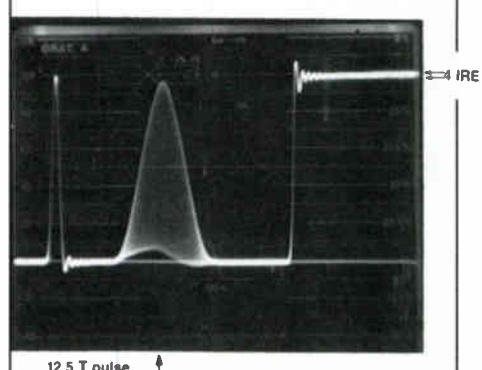


Figure 4: CLDI waveform

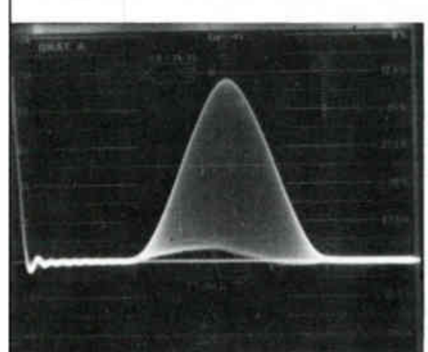


Figure 6: Chrominance-luminance delay nomogram with measurement convention

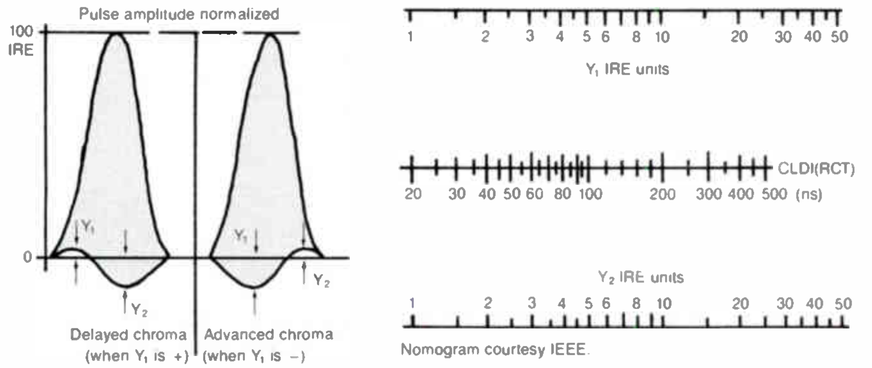


Figure 7: Multiburst test signal

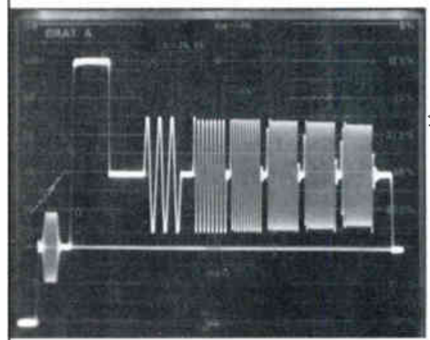
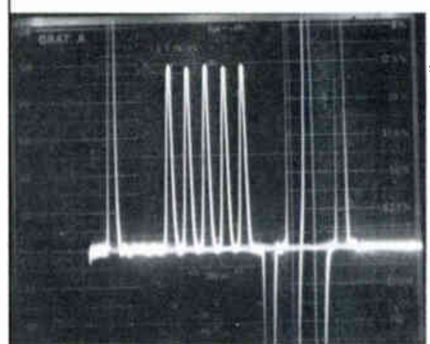


Figure 8: Differential gain



largest chroma envelope (spike) is 100 IRE. Measure the difference between the peak step and the smallest step. This is the differential gain. The parameter is not to exceed 15 IRE.

7. Signal-to-random noise (CCIR weighted):

Noise is classified into many different types, of which random noise is by far the most important. The visual effect of excessive random noise is a pronounced graininess or snow in the reproduced picture. The signal-to-weighted noise ratio of a TV signal is defined as the ratio expressed in decibels of the nominal amplitude of the luminance signal (100 IRE units) to the RMS amplitude of the noise measured at the receiving end after band limiting and weighting. Band limiting prevents the inclusion of the irrelevant out-of-band energy, and weighting converts the input signal so that the output measures the equivalent subjective picture impairment.

In service noise measurements can be made using the R147A NTSC generator or the 1430 random noise measurement set, both made by Tektronix.

All the previous measurements were taken in the flat mode, with the exception of Figure 1. All the photographs presented in this section have deliberate distortions introduced to the waveform.

A better quality product

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Keeping pace with technology

By Frank Cawley
ATC Corporate Affairs
And Alan Babcock
Technical Instructor, ATC National Training Center

For most ATC personnel, solving the problems caused by terrestrial interference with a TVRO satellite is not part of their job. Fortunately, however, a select group now can confront this and many other technical challenges, thanks to the new Chief Technician/Engineer course offered by ATC's National Training Center (NTC) in Denver. "Eight members of this group, as the first graduating class, can be especially proud of what they have accomplished," said Al Dawkins, NTC senior technical instructor and one of the course designers and teachers. "This new technical class is the most difficult course we offer."

The course is a two-week, lecture/lab class that provides students with hands-on experience. Since the facilities at the NTC place state-of-the-art equipment at the students' disposal, the educational value of the class is enhanced. Due to the difficult subject matter, each class accommodates eight students to keep the instructor/student ratio low. The instructors, Alan Babcock, Dawkins and Gary Wesa, are key reasons for the success ATC enjoys as a front-runner in providing and servicing cable technology. "Reliable delivery of our product is essential to providing customer service." said Gary Bryson, executive vice president and office of the president. "That's why technicians comprise the greatest percentage of our people."

Age of high tech

"We live in an age of high tech, and the future of the cable business is built around an understanding of that technology," said Dawkins. The Chief Technician/Engineer class was designed to provide ATC personnel with a greater understanding of these rapid advancements. According to Dawkins, the knowledge gained from this class allows graduates to more efficiently identify and correct technical difficulties they face every day.

The NTC offers a sequence of courses designed to instruct how to better work with CATV technology. The sequence begins with Technician I and advances to Technician II and Technician III before culminating with Chief Technician/Engineer. In order to take the final class, one must satisfactorily complete the first three courses or an equivalent as judged by the NTC. The NTC has the right to say what previous education will be honored.

Although only eight individuals successfully finished the first course in December 1986, there have been and will be more in the future. "This class is scheduled twice annually, but will be offered a third time in 1987 due to the demand," said Dawkins. The second session was from Feb. 2 through 13, with the next two sessions beginning on June 15 and Oct. 26.

Bob Sullivan

The first eight graduates of the Chief Technician/Engineer course from ATC's National Training Center are Brian Hemmings, Kent Vermillion, Chuck Walters, Clarence Harvis, Donnie Taylor, Linda Chavez, Paul Borics and Bob Bailey.

'The future of the cable business is built around an understanding of . . . (high) technology'

The Fayetteville Division, the largest supplier of people to the class, provided three of the eight December graduates and sent four more to the NTC in February. Randall Fraley, vice president of business operations for Fayetteville, explained the reason for supporting the class: "We have supported the National Training Center since it was formed because it offers our installers and technicians the training they require. Without proper instruction, bad habits develop."

John Nicholas, vice president of engineering for Fayetteville, said, "The prime reason we encourage our people to attend the NTC is that trained technicians are a value to the business. Individuals who take NTC classes not only increase their own education, but they bring those new skills back to the division."

In addition to educational benefits, the new course eventually may generate revenue. Multi-Vision, Cox and Daniels are some of the MSOs that pay for their people to attend the lower-level technical classes at the NTC. Times Mirror, Warner, American Cablesystems and United Cable Systems of Hartford, Conn., are discussing the possibility of sending their people.

ATC, by expanding and developing educational efforts in cable technology, is helping the entire industry meet the expectations and needs of consumers, according to Bob Odland, manager of the NTC. "There have been 1,900 people completing classes at the NTC. We expect to train other MSO technicians in the installation instructor course, Technician I, and Technician II in 1987." Odland said, "ATC offers courses to other MSOs on a contract basis, but only after meeting internal needs generated by ATC and Paragon Communications systems."

Information on course offerings at the NTC may be obtained by contacting Bob Odland, ATC National Training Center, 2180 S. Hudson St. Denver, Colo. 80222, (303) 753-9711.

Reader Service Number 46.

Remote control

Pioneer has introduced its SmartRemote, a remote control that is said to program up to eight functions of a television, VCR or other home entertainment equipment. To operate the remote, a subscriber places it head-to-head with an existing remote and presses matching function keys on each; the new unit immediately learns and duplicates each designated function.

According to Pioneer, a cable system can use the remote to offer volume control without giving up the RF scrambling method or changing out to baseband converters.

For more information, contact Pioneer Communications of America, 600 E. Crescent Ave., Upper Saddle River, N.J. 07458, (800) 421-6450; or circle #89 on the reader service card.

DC power supply

Leader Instruments has introduced its Model LPS-2801 programmable DC power supply, designed for test applications where a variable voltage change is required. It is said to provide the user with the capability of instantaneously producing DC variations in the range of 0 to 32 VDC with a 10 millivolt maximum rate of voltage change during a 10 millisecond minimum time interval.

According to the company, the unit can be controlled manually or through a computer using a standard GPIB interface. The product provides 200 program channels, each of which can be programmed to produce a steady DC voltage or a ramp of user-specified delta. Switching time between and within channels also is programmable.

For more details, contact Leader Instruments Corp., 380 Oser Ave., Hauppauge, N.Y. 11788, (516) 231-6900; or circle #100 on the reader service card.

Directional coupler

LRC Electronics is offering the Accu-Tap broadband directional coupler. It allows 1 dB increment adjustment to select the desired values needed (14-45 dB for four-way and 17.5-48.5 dB for eight-way); this gives the flexibility to overcome variation in design and losses by components and cables.

According to LRC, the product incorporates an RF and AC bypass switch allowing for 24-hour maintenance without affecting the total system.

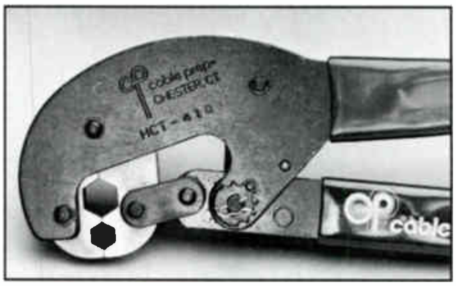
For more information, contact LRC Electronics Inc., 901 South Ave., Horseheads, N.Y. 14845, (607) 739-3844; or circle #88 on the reader service card.

Split-band taps

A line of split-band taps from Broadband Networks is said to improve the performance of single-cable broadband LANs used to figure MAP, TOP, and IEEE 802.4 and 802.7 systems. According to the company, the taps allow independent control of downstream and upstream tap loss values in 1 dB steps, minimizing path loss variations.

The mid-split taps have a return path frequency passband of 5 to 120 MHz and a forward passband of 150 to 450 MHz, while the high-split taps offer 5 to 186 MHz and 220 to 450 MHz, respectively.

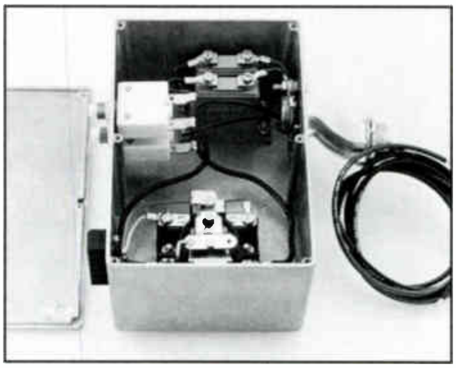
For more details, contact Broadband Networks Inc., P.O. Box 8071, State College, Pa. 16803, (814) 237-4073; or circle #85 on the reader service card.



Hex crimp tools

Ben Hughes has announced improvements in its Cable Prep adjustable hex crimp tools. The eccentric adjustment area now incorporates a cogged wheel, which makes adjusting the tool's compression simpler, and a simplified holding device for the adjusting wheel. A hitch pin slides through the cam shaft, locking the cog wheel in place.

For more details, contact Ben Hughes Communication Products Co., 207 Middlesex Ave., Chester, Conn. 06412-0373, (203) 526-4337; or circle #87 on the reader service card.



Surge protector

PolyPhaser has introduced its IS-PM240 series power main surge protector, available in single- and three-phase models. The product provides common mode protection via field replaceable MOV blocks and is rated at 30 kA per leg. The internal relay has dry single-pole contacts that can be used for local or remote status signaling.

For more information, contact PolyPhaser Corp., 1425 Industrial Way, Gardnerville, Nev. 89410, (800) 325-7170, or circle #96 on the reader service card.

Cable clip

Sachs Communications has introduced the 8 millimeter Saxxon clip, Model SC-18-3Q, for wider cables. According to the company, the clip's 100 percent Galvalume steel body offers excellent resistance against corrosion. Also, the clip is said not to break during installation or with time.

For more information, contact Sachs Communications Inc., 30 W. Service Rd., Champlain, N.Y. 12919-9703, (800) 361-3685; or circle #97 on the reader service card.

Stereo modulator

FM Systems has introduced its second-generation Model FMT633 MTS stereo multiplexer and modulator with built-in dynamic noise reduction system. The modulator is designed to be compatible with BTSC television stereo transmission and, according to the company, provides up to 14 dB improvement in signal-to-noise over other MTS modulators.

The FMT633 accepts stereo or mono signals from audio baseband sources or demodulated subcarriers and converts them to 4.5 or 41.25 MHz MTS-compatible stereo. A built-in synthesizer converts monaural audio to synthesized stereo. The output is connected into a cable TV modulator, providing MTS-compatible stereo on cable systems for all TV channels.

For more information. contact FM Systems Inc., 3877 S. Main St., Santa Ana, Calif. 92707, (714) 979-3355; or circle #86 on the reader service card.

Self-fusing tape

Tele-Wire Supply Corp. has announced its Polyflex self-fusing tape to its line of CATV construction equipment. According to the company, the tape is easy to install and requires no heat or open flame. It is said to provide permanent moisture and corrosion protection for outside plant connections and equipment.

For more information, contact Tele-Wire, 7 Michael Ave., C.S. #6025, E. Farmingdale, N.Y. 11735, (516) 293-7788; or circle #93 on the reader service card.

Set-tops, remotes

Upgraded set-top and remote converters based on units previously offered by Standard Components now are available from NSC Electronics. The Micro-Slim series is said to offer 300, 450, 500 or 550 MHz capacity. Its microcomputer control is said to lock in on the frequency and eliminate the need for fine tuning.

According to NSC, the converters have standard, HRC or IRC frequency configuration, a SAW resonator, inverted frequency capability and a convenience outlet. The 17-button infrared remote step-up option has random program access, program memory, parental control and an on/off switch that also controls the television.

For more details, contact NSC Electronics Inc., 2201 Landmeier Rd., Elk Grove Village, Ill. 60007, (312) 956-8000; or circle #95 on the reader service card.

UPS products

Alpha Technologies has announced its high-power uninterruptible power supply (UPS) 3000 Series for CATV and LANs. Offered in 1.5 kVA, 2 kVA and 3 kVA formats, the units can be supplied in racks or mobile cabinets. Various back-up times are available through battery packages and battery extender options.

For more information, contact Alpha Technologies Inc., 3767 Alpha Way, Bellingham, Wash. 98225, (206) 647-2360; or circle #99 on the reader service card.

Oscilloscope

Tektronix has announced its Model 2430A digital oscilloscope, designed to automate and simplify the measurement process from menus and front-panel controls. Its human-interface features include auto setup, waveform parameter extraction, AutoStep and Save on Delta.

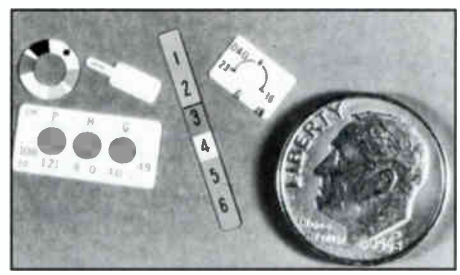
According to the company, the product's triggering capabilities allow users to find just the information they need. Dual-channel 100 megasamples per second digitizing combines eight-bit vertical display resolution, 1K record length per channel, portability and ruggedness. It also provides a full 150 MHz bandwidth for X and Y dimensions.

For more information, contact Tektronix Inc., P.O. Box 500, Beaverton, Ore. 97077, (503) 644-0161; or circle #91 on the reader service card.

Lowpass filter

Microwave Filter Co. recently introduced its lowpass filter Model 3322-W/CC, designed to prevent viewing of hyper-band premium channels by non-subscribers with cable-ready TV sets. According to the company, the filter passes Channels 2 through W with 3 dB maximum loss and provides 30 dB minimum rejection on hyper-band channels CC and above. Impedance is 75 ohms and connectors are type F male/female.

For more details, contact Microwave Filter, 6743 Kinne St., East Syracuse, N.Y. 13057, (800) 448-1666; or circle #92 on the reader service card.



Miniature labels

The Industrial Products Division of W.H. Brady is featuring microminiature labels for use on circuit boards, tiny components and parts, transistors, or any small products that need to be identified. The labels can be preprinted with date coding, serialization, part numbers and so on. They also may be custom designed in a wide range of colors, legends and die-cut shapes.

For more details, contact W.H. Brady Co., Industrial Products Division, P.O. Box 2131, Milwaukee, Wis. 53201, (414) 351-6630; or circle #94 on the reader service card.

Connectors

RF Industries is offering its RFM-1002SI type N and RFB-1101IS type BNC plugs for use on Belden 9913 and 9914 cables. Both connectors have a silver-plated brass body and pin and use Teflon insulation. Center pins are designed to accommodate 9.5- or 10-gauge center conductors. The connectors meet or exceed all applicable military specifications.

For more information, contact RF Industries, 690 W. 28th St., Hialeah, Fla. 33010-1293, (800) 233-1728; or circle #84 on the reader service card.

How much will it cost not to do it?

Figure 1: Outages per 100 plant miles

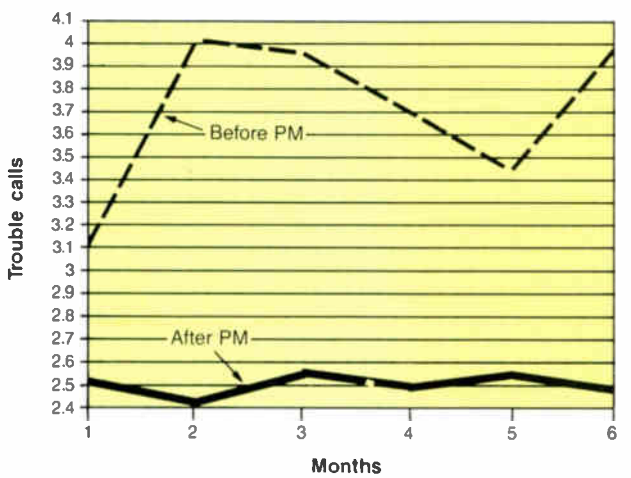
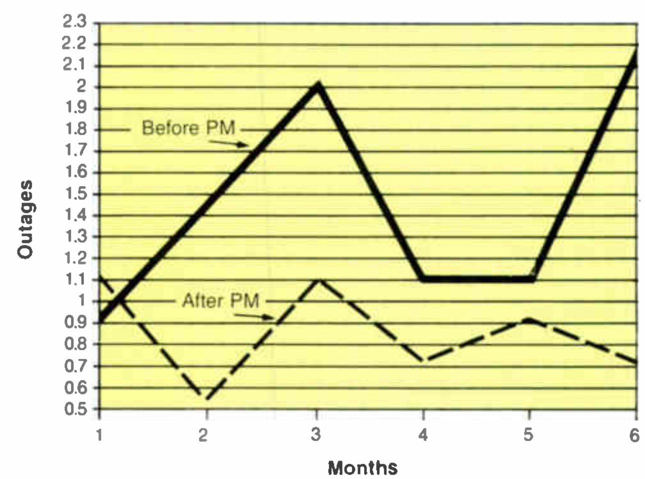


Figure 2: Trouble calls per 100 subs



By Garland R. Thomas

Every time preventive maintenance is discussed the main question seems to be. "How much will it cost?" But the question should be. "How much will it cost if we *don't*?" No one questions the need to perform PM on a new car or an airplane. Yet, PM is questioned on CATV systems that cost millions of dollars. The problem may be that, although everyone agrees that maintenance must be performed, no consensus has been reached in the industry as to how much and how often

Without considering the areas of customer satisfaction or better relations with the franchising authority, we will explore the true cost and problems of PM programs.

Usually the trouble call and emergency maintenance group handles the PM as well. Invariably the pressures of handling day-to-day problems take precedence over PM. Separating the functions by adding a PM group eventually decreases trouble calls and increases customer satisfaction. After a reasonable period of time (six months or more, depending on the condition of the CATV system), the results of the PM program will start to relieve the pressures that prevented it from being accomplished in the first place.

PM not only will reduce the number of technicians needed to service trouble calls but also will reduce the number of people needed to answer the telephone and schedule calls. These savings alone after one year of an extensive PM program should more than pay for its cost.

Electrical and mechanical PM

There are two distinct portions of any good PM program: electrical and mechanical. The electrical program includes sweeping the trunk, setting line extender levels, and maintaining standby power supplies and headends. Usually the improvements resulting from the electrical program can be accurately evaluated and assessed over a short time frame.

Immediate results from mechanical maintenance may be more difficult to assess accurately, but this may have more to do with the quality and life of the CATV plant than any other factor. A mechanical PM program will find loose fittings, cracks in the cable and deteriorating house drops. These do not cause outages or immediate trouble calls, but instead cause slow deterioration of signal quality and intermittent problems, resulting in a steady increase in trouble calls and outages.

Staffing levels of the PM department vary from system to system depending on plant age, quality at the time the program is started, size of the CATV plant and environmental conditions. Staffing levels should be sufficient to complete electrical PM every six months and mechanical PM every year on all portions of the plant. The staff needed should be monitored continually. After approximately one year, the goals will continue to be achieved with a reduction in staff.

The dramatic effects of implementation usually will not be seen until after one year, and then only if comparisons are made with statistics obtained prior to the start of the PM program. The following are the results of two systems that made the change to a separate department for PM. System A was the first to implement the program; System B, approximately two years later. It should be noted that both of these systems were using addressable converters for control of six and 10 pay channels, respectively.

System A: 1) Outages per month decreased from 1.5 to .8 per 100 miles of plant after one year. 2) Percentage of trouble calls vs. subs decreased from 3.6 percent to 2.5 percent per month after the first year.

These results are illustrated in Figures 1 and 2. Figure 1 shows the trouble call percentage per 100 subscribers in the six months prior to, and the six months after, the first year of the program. Figure 2 reflects the outages per 100 miles of plant in the six months prior to, and the six months after, the first year of the program. During this period the system increased its miles of plant from 475 to 555 and its subscriber base from 35,000 to 47,000. Trouble calls actually *decreased* while the subscriber base increased by 30 percent.

The PM staff dropped from seven to five members after the first year. If the program had not been implemented and the trouble call percentage had remained constant, an increase in the service technician and customer service staffs to handle more service calls would have been 30 percent.

If you carry these results one step further, at least five more technicians for trouble calls would be needed. At least four more people in the office would have to answer phones and schedule trouble calls. Also, since the number of outages decreased by .7 per 100 miles of plant per month, the overtime required to restore service decreased by 47 percent.

If considering wages, benefits, equipment and vehicles, the cost of a technician is $45,000 per

'The results of the PM program will start to relieve pressures that prevented it from being accomplished'

year and an office worker is $25,000 per year. The following then would be true:

- The cost of the PM program each year after the first would be $225,000 (five technicians).
- The increased cost if the program is not implemented would total $325,000 per year (five technicians plus four office workers).
- Added to this would have to be the overtime savings of 47 percent for outages.
- An item that will affect savings and cannot be quantified is the increase in subscribers due to increased customer satisfaction. This could prove to be the largest factor in the financial equation. As we all know, a customer who disconnects in anger probably is lost forever.

The cost savings between the first and second items alone will be $100,000 per year. There should be slight improvements in the savings for subsequent years as the training of the employees in the PM group is accomplished in the first year.

System B: 1) Outages per 100 miles of plant per month declined from an average of 2.6 to 1.8. 2) The percentage of trouble calls vs. subs declined from 3.8 percent to 2.5 percent.

These results refer to a system approximately three times the size of System A. The number of subscribers increased from 153,000 to 165,000, while miles of plant increased from 1,519 to 1,607.

Trouble calls actually declined from an average of 5,800 per month to 4,125 per month, even though the number of subscribers increased. The number of trouble calls expected without the program was 165,000 times 3.8 percent, or 6,270. This number represents a decrease of 34 percent in trouble calls.

Using the same cost figures applied to System A, the following financial results are obtained:

- The cost of the PM program each year after the first would be $360,000 (eight technicians).
- The increased cost if the program is not implemented would total $625,000 per year (33 percent increase in technicians and office workers in the repair dispatch department, and 10 technicians plus seven office workers).

The direct cost savings of $265,000 per year does not take into consideration the other costs and benefits previously discussed.

Subtle results

There were other results that were more subtle but also very important to the overall company. Customer satisfaction increased, which made everyone's job more enjoyable and improved employee morale. Also, employees became more quality oriented in all phases of the company operations. This can be traced directly to the company's commitment to preventive maintenance and quality assurance.

These results can be realized in any CATV system that has not already made this commitment. So the next time you are asked, "How much will PM cost?" Answer by telling them, "How much will it cost if you don't?"

Acknowledgements: I would like to thank Carol Sunahara, M.A., academic advisor and instructor of cooperative education and English at Hawaii Pacific College for her encouragement, advice and editing of this article.

Garland Thomas is a free-lance writer living in Hawaii.

HDTV, NAB, NHK, ATSC and the FCC

By Lawrence W. Lockwood
East Coast Correspondent

The first week of the year showed a great deal of activity at the Federal Communications Commission in Washington, D.C. The NAB (National Association of Broadcasters) in conjunction with NHK (Japan Broadcasting Corp.) gave a demonstration of HDTV (high-definition television) for and at the FCC. In addition, two tutorials related to the demonstration were presented. Robert Hopkins, the executive director of the ATSC (Advanced Television Systems Committee) gave a tutorial on "Advanced Television Systems." In this tutorial, he outlined proposed systems for

1) Improved NTSC
2) MAC systems
3) 1,125/60 high-definition TV system
4) Five systems for HDTV transmission

Representatives of NHK also gave a tutorial. Theirs was on the MUSE system of HDTV transmission, which was used in the demonstration.

The HDTV used in the MUSE demonstration has 1,125 scan lines per frame as opposed to the standard NTSC scan line value of 525. Both use an interlace of 2-to-1. Another difference is in the aspect ratio (i.e., ratio of picture width to picture height). In standard broadcast (NTSC) the ratio is 4-to-3, whereas the Japanese HDTV system has an aspect ratio of 16-to-9 or roughly 5.3-to-3. This aspect ratio is much closer to that of a standard motion picture than that of the current NTSC aspect ratio.

The NAB got special permission from the FCC to use Channels 58 and 59 for this demonstration of over-the-air HDTV. The broadcast equipment (HDTV videotape player, transmitter, etc.) was at television station WUSA (Channel 9), and with Channel 9's cooperation, the special broadcast antenna was placed on its tower. Later in the month the demonstration was moved to Capitol Hill to show Congress this new technology.

These demonstrations are intended to show the FCC and Congress that TV broadcasting can—and should be allowed to—deliver high-definition images. The broadcasters are seeking to head off proposed FCC regulations granting more space on the UHF spectrum to the operators of the two-way mobile radios, such as fire departments, police forces and delivery services.

Table 1: 1,125/60/2:1 studio system

1,125	lines per frame
60	hertz field frequency
2:1	interlace
16:9	aspect ratio
1,035	active lines
1,920	luminance samples/active line
960	color-difference samples/active line

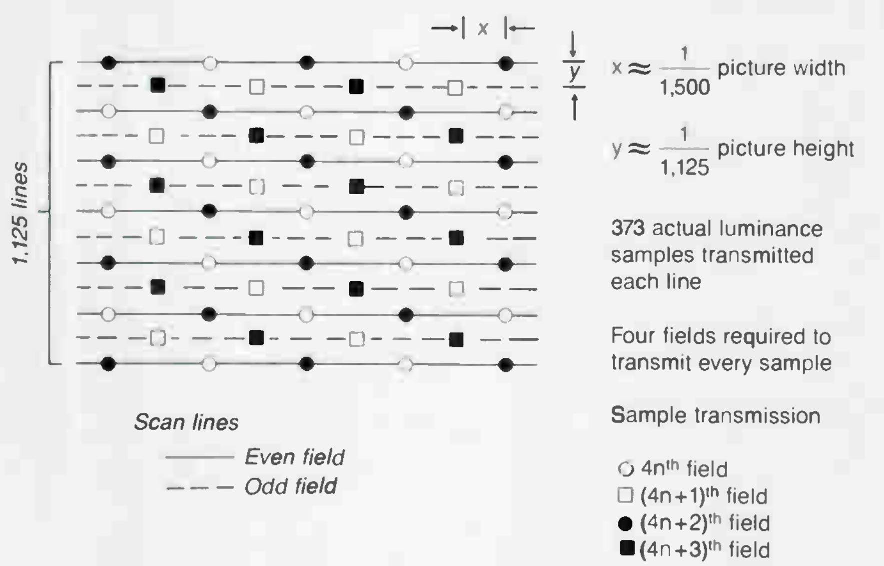
'These demonstrations are intended to show the FCC and Congress that TV broadcasting can . . . deliver high-definition images'

The NAB, which represents more than 4,800 radio stations and 900 television stations, argues that the regulations not only would interfere with current UHF broadcasts, but also would take up space needed for the future airing of HDTV signals.

In a speech last month, Edward Fritts, NAB president, contended that the FCC regulations, if finally approved, would "preclude America's broadcasters from developing HDTV as a free over-the-air service to the nation."

Ben Crutchfield, the official from NAB who was in charge of the demonstration, said "in the next two or three years, HDTV consumer products (such as special VCRs) would start showing up" and he mused that it is conceivable that the local

Figure 1: MUSE sampling pattern



broadcaster could be an endangered species in the '90s, "if we are prevented by regulatory limitations from competing technologically" with high-definition VCRs, cable television or satellites. By 1990, NHK plans to offer two channels of high-definition programming by satellite.

While broadcasters and regulators debate how the high-definition system shoud be rendered unto the masses, Sony, which is in the forefront of marketing this new technology, is selling its equipment to filmmakers. Proponents say the extremely high-quality video system can drastically reduce production costs, particularly for special effects. Rebo Associates, a New York City production house, already has invested about $1.5 million in a Sony high-definition studio system and recently has shot a music video for the band Cameo, in which "every frame is a special effect," according to Dennis Bieber, a partner in the firm. The video was shot in three days, "and when the band went home the third night, they saw the completed video." There was no expensive postproduction work as is necessary for filmed special effects, said Bieber.

Table 2: Principal parameters of MUSE

System		Motion-compensated multiple subsampling system (multiplexing of C signal is TCI format)
Scanning		1,125/60 2:1
Bandwidth of transmission baseband signal		8.1 MHz (−6 dB)
Resampling clock rate		16.2 MHz
Horizontal bandwidth	(Y)	20-22 MHz (for stationary portion of the picture) 12.5 MHz (for moving portion of the picture)
	(C)	7.0 MHz (for stationary portion of the picture) 3.1 MHz (for moving portion of the picture)
Synchronization		Positive digital sync

For broadcast, the video will be converted to the NTSC 525-line format. The company plans this month to shoot a small-budget feature-length movie with the system, to be transferred to 35 mm film for theatrical release.

Broadcasters face a hurdle on the path to high-definition TV not faced by their competitors (CATV, MMDS, VCRs and DBS) and that is regulations restricting their transmission bandwidth. The baseband bandwidth of HDTV is about 30 MHz and the broadcast TV channel bandwidth is limited to 6 MHz. A key element in the demonstration is NHK's MUSE transmission system, which employs an innovative bandwidth compression technique to compress the 30 MHz HDTV signal to slightly more than 8 MHz or about 1½ standard broadcast channels.

HDTV standards

The standards of the system used in the demo and the one proposed by NHK are shown in Table 1.

The international standards organization CCIR (International Radio Consultative Committee) definition of HDTV has been that the signal should have about twice the resolution, both horizontal and vertical, of current television systems. The ATSC argued that CCIR Recommendation 601 specifies 720 samples for luminance during the active line, and half that number for each of the two color-difference signals. Twice the resolution then would imply twice 720 samples multiplied by the ratio of the aspect ratios (16:9 divided by 4:3) resulting in 1,920 samples per active line for the luminance and half that number for each of the two color-difference signals. The resulting bandwidths would be about 30 MHz for luminance and 15 MHz for each of the color-difference signals.

The ATSC agreed in March 1985 to recommend to the U.S. Department of State that the 1,125/60/2:1/16:9/1,920 parameters be proposed to the CCIR as a single worldwide standard for high-definition television studios (which was done at the CCIR Plenary Assembly meeting in Dubrovnik, Yugoslavia, in May 1986). Similar positions were submitted by Canada and Japan. However, at that meeting a decision on a studio standard was postponed until the next study period. Observers say that the Europeans do not want to yield the world market to Japan without a fight and have chosen instead to launch an expensive search for their own system. Hopkins of the ATSC said the ATSC feels that "activities around the world indicate that the 1,125/60 system will probably become a de facto standard for 60 hertz HDTV studios, but it is not clear whether or not the system will be accepted as a single worldwide standard."

In both the ATSC and NHK tutorials the MUSE transmission scheme was treated. The Multiple Sub-Nyquist Encoding system has been proposed by NHK as a DBS transmission format for HDTV. In this system the luminance and color-difference signals are band limited and then digitized. The resulting data stream then is "subsampled" —one of every four samples in each succeeding line for four consecutive fields (two frames) is transmitted and, after four fields, every sample will have been transmitted. This process, depicted in Figure 1, produces high-quality still pictures. The resolution of objects in motion is lower than the resolution of stationary objects.

Since adjacent samples arrive at the receiver out of sequence, a frame store is required at the receiver to put the picture together again. Motion detectors are used to fully compensate for some types of motion such as a camera pan. This information is transmitted to the receiver as a digital signal. The baseband is digitized as an eight-bit PCM encoded signal but MUSE transmits one bit (PAM) per sample (see Table 2 for the MUSE parameters).

Digital sound is transmitted, and luminance and color-difference signals are kept separate. The full signal requires a baseband bandwidth of 8.1 MHz.

Although the MUSE system was designed for FM transmission, the demonstration used the MUSE system with vestigial sideband AM transmission and occupies more than one NTSC channel. The two adjacent UHF channels (58 and 59) were allocated for the demonstration.

NHK says that "with the MUSE system, various associated equipment, such as VTRs, videodisc recorders and other consumer use electronic facilities are also feasible." NHK also feels that the MUSE system should prove useful for the transmission of HDTV on CATV systems.

Johnson

Scientific-Atlanta announced the appointment of **William Johnson** as vice chairman and CEO. Before joining the company, he was founder and president of William E. Johnson Associates, a consulting firm. Contact: 1 Technology Pkwy., Box 105600, Atlanta, Ga. 30348, (404) 441-4000.

John Johnson has joined **Anixter Bros.** as executive vice president of its manufacturing division. Prior to this, he served in sales management and engineering positions with Illinois Bell and AT&T.

Also, **Bill Millholland** has been named vice president of contractor sales. Previously, he was vice president of sales, computer and communications for Siecor Corp. Contact: 4711 Golf Rd., 1 Concourse Plaza, Skokie, Ill. 60076, (312) 677-2600.

Bruce Armstrong has been appointed chief executive officer of **Jones Spacelink Ltd.** Previously, he was group fund vice president of Jones Intercable Inc.

Also, **David Rhodes** has been appointed vice president of finance. He was formerly assistant vice president of finance for Jones International Ltd. Contact: 9697 E. Mineral Ave., Englewood, Colo. 80112, (303) 792-9191.

Texscan Corp. appointed **William Dawson** as vice president of engineering in its Communication Products Division. He was formerly vice president of corporate development for the company.

Bert Henscheid has been appointed as vice president of research and development. Prior to this, he was vice president and director of engineering. Contact: 10841 Pellicano Dr., El Paso, Texas 79935, (915) 594-3555.

United Artists Cablesystems Corp. (UACC) announced **Frank Baxter** as vice president of engineering. Previously, he served as vice president of UACC Midwest Inc. with overall engineering responsibility for the MSO's Midwest Division. Contact: 60 Craig Rd., Montvale, N.J. 07645.

Jay Vaughan and **Ronald Wolfe** have been named project engineers for **American Television and Communications**. Among other responsibilities, they will prepare and issue technical bulletins, conduct inspections through ATC systems, and coordinate FCC filings.

Prior to joining the MSO, Vaughan was chief engineer for Rogers Cablesystems; Wolfe was formerly materials manager for Warner Cable Communications' national headquarters. Contact: 160 Inverness Dr. West, Englewood, Colo. 80112, (303) 799-1200.

Dozier

Steven Dozier has been named Western regional sales manager for **Hughes Microwave Products Division**. Most recently, Dozier was a sales manager with Channel Master. Contact: P.O. Box 2940, Torrance, Calif. 90509-2940, (213) 568-6307.

NCS Industries announced the appointment of **Samuel Landis** as sales engineer. Previously, he held positions with Jerrold, Compass Service Inc., Storer Communications and Magnavox CATV.

Thomas Thorpe has been appointed sales engineer for northern New Jersey, Pennsylvania and part of West Virginia. Prior to this, he served in engineering and sales positions with Jerrold, Winegard and Amplifier Research Corp. Contact: 2255-E Wyandotte Rd., Willow Grove, Pa. 19090, (215) 657-4690.

Priebe

Frank Priebe has been named CATV area sales manager, Midwest territory, for **Reliable Electric/Utility Products**. Formerly with Anixter Communications, Priebe has more than seven years of sales experience. Contact: 11333 Addison St., Franklin Park, Ill. 60131, (312) 455-8010.

Patterson

Ralph Patterson has joined **Alpha Technologies Inc.** as Western regional sales manager. Previously with Data Transmission Devices, he will be based in Southern California, with responsibility for the Western states. Contact: 3767 Alpha Way, Bellingham, Wash. 98225, (206) 647-2360.

Gregory

Passive Devices Inc. appointed **Leonard Gregory** as Southeastern regional sales manager. Previously he was vice president and general manager of Access Cable of West Boynton, Fla. Contact: 5120 N.E. 12th Ave., Fort Lauderdale, Fla. 33334, (305) 493-5000.

MacAllister

Microdyne Corp. announced the promotion of **J. Thomas MacAllister** to sales manager of its Satellite Communications Division. Prior to this, he was a sales engineer for Microdyne since 1982. Contact: P.O. Box 7213, Ocala, Fla. 32672, (904) 687-4633.

Wegener Communications named **Ken Leffingwell** as a sales engineer. His responsibilities will include marketing the company's cable and broadcast products. Prior to this, Leffingwell was an applications engineer with Scientific-Atlanta. Contact: 150 Technology Park, Norcross, Ga. 30092, (404) 448-7288.

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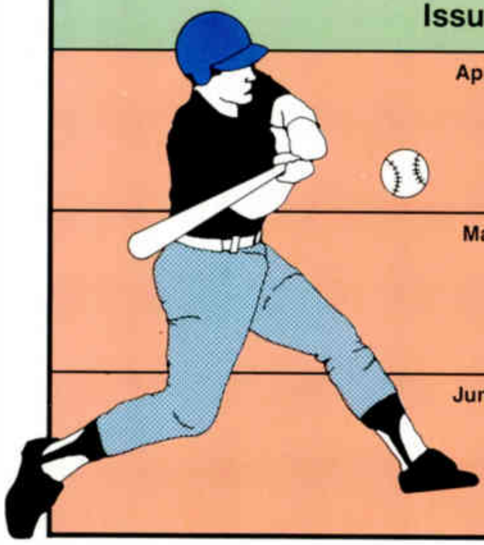

Issue	Editorial Focus	Bonus	Closing
April	Cable Construction: A complete look at what's happening in 1987; the big picture, not a snapshot.	Distribution within all official registration kits at the **Cable-Tec Expo**, April 2-5.	**March 9**
May	The interfacing of consumer electronics and CATV; the latest developments that give you the perfect pitch.	The largest distribution in our history at the **National Cable Show**, May 17-20.	**April 2**
June	Satellite Technology Update: VideoCipher, Ku- vs. C-band, computing satellite antenna gain. Technology that provides a clear path to the plate.	Special pull-out wall chart featuring C- and Ku-band transponder frequencies; expanded Tech Book section.	**May 4**

Special Opportunities	Bonus	Closing	Rates
Cable-Tec Expo Show Daily: Featuring breaking news of products and services and a complete rundown of all technical sessions, providing a working diary of expo events.	Distribution at the entrance to each and every technical session and the entrance to the Expo each day—April 2, 3, 4.	Space - March 9 Copy - March 16	Special rate packages are available for advertisers in conjunction with *Communications Technology* magazine. Your ad representative can furnish complete pricing details.
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Reader Service Number 52.

Cumulative leakage index

By Bruce Catter and Ron Hranac
Jones Intercable Inc.

Cumulative leakage index (CLI) is a method for assessing the signal leakage integrity of cable plant. The measure for CLI is "figure of merit." The formula described later is used to determine figure of merit; an example for using the formula is exhibited on the back of this page.

The FCC released the following formulas and indicated that compliance with CLI can be demonstrated if:

$$10 \log I_{3000} \leq -7$$

or:

$$10 \log I_{\infty} \leq 64$$

using either:

$$I_{3000} = \frac{1}{\phi} \sum_{i=1}^{n} \frac{E_i^2}{R_i^2}$$

or:

$$I_{\infty} = \frac{1}{\phi} \sum_{i=1}^{n} E_i^2$$

where:

$$R_i^2 = r_i^2 + (3{,}000)^2 \text{ and}$$

r = the distance in meters between the leakage source and the center of the cable system;
ϕ = the fraction of the system cable length actually examined for leakage sources and is equal to strand miles tested divided by total strand miles;
R = the slant height distance in meters from leakage source *i* to a point 3,000 meters above the center of the cable system;
E = the electric field strength in microvolts per meter measured three meters from leak *i*; and
n = the number of leaks found of field strength equal to or greater than 50 μV/m.

These are summation formulas and many cable television engineers may not be familiar with their use. The following formula is easier to understand and can be used to determine CLI figure of merit:

$$\text{CLI} = 10 \log \left[(\text{plant miles/miles driven}) \times (\text{sum of each leak}^2) \right]$$

Compliance is indicated if the formula yields a figure of merit of 64 or less.

Example:

$$CLI = 10\log\left[(\text{plant miles/miles driven}) \times (\text{sum of each leak}^2)\right]$$

CLI to be 64 or less

Required information	**Sample information**
Total plant miles:	1,000
Plant miles driven:	750
Level of each leak in μV/m:	Found:
	300 leaks @ 50 μV/m
	30 leaks @ 150 μV/m
	3 leaks @ 450 μV/m

Sum of each leak² =

$(300 \times 50 \times 50) + (30 \times 150 \times 150) + (3 \times 450 \times 450) =$

$750{,}000 + 675{,}000 + 607{,}500 = 2{,}032{,}500$

Plant miles/miles driven = 1,000/750 = 1.33

CLI = 10log (1.33 × 2,032,500)

= 10log (2,710,000)

= 64.33

If the 3 large leaks in the example above were repaired, the new figure of merit would be:

Sum of each leak² =

$(300 \times 50 \times 50) + (30 \times 150 \times 150) =$

$750{,}000 + 675{,}000 = 1{,}425{,}000$

Plant miles/miles driven = 1,000/750 = 1.33

CLI = 10log (1.33 × 1,425,000)

= 10log (1,895,250)

= 62.78

Note that in the example above, large numbers of leaks at the same level were used for simplicity sake. In reality, each leak would have to be dealt with individually at its measured level. Only those leaks of 50 μV/m or greater are to be included in the calculation.

March

March 4: SCTE Cascade Range Meeting Group seminar on digital spectrum analysis, Tektronix facility, Beaverton, Ore. Contact Dave McNamara, (503) 667-9390.

March 4-6: Magnavox CATV training seminar, New Orleans. Contact Amy Costello, (800) 448-5171.

March 9-11: Center for Personal Development seminar on fiber-optic communications, Arizona State University, Tempe, Ariz. Contact (602) 965-1740.

March 10-12: Jerrold technical seminar on applying problem-solving technology, Sheraton Fredericksburg Resort & Conference Center, Fredericksburg, Va. Contact Jerry McGlinchey, (215) 674-4800.

March 11: SCTE Shenandoah Valley Meeting Group review on BCT/E Category II—video and audio signals and systems, Blue Ridge Community College, Verona, Va. Contact David Lisco, (703) 248-3400.

March 11: SCTE Gateway Meeting Group organizational meeting, Ramada Inn Westport, St. Louis. Contact Larry Lehman, (314) 576-4446.

March 13: Wavetek system sweeping seminar, the Wavetek factory, Beech Grove, Ind. Contact Steve Windle, (317) 788-5980.

March 14: SCTE Iowa Heartland Meeting Group seminar on BTSC stereo, Holiday Inn of the Amanas, Amana, Iowa. Contact Dan Passick, (515) 266-2979.

March 16: Hughes Microwave Products training seminar on AML equipment, Torrance, Calif. Contact Seminar Registrar, (213) 517-6244.

March 16-19: Military Fiber Optic Conference (MFOC '87), Hyatt Regency Crystal City, Washington, D.C. Contact Information Gatekeepers, (617) 232-3111.

March 17: Ohio Cable Television Association annual meeting, The Hyatt on Capitol Square, Columbus, Ohio. Contact Dan Helmick, (614) 461-4104.

March 23-25: North Central Cable Television Association annual convention and trade show, Radisson St. Paul Hotel, St. Paul, Minn. Contact Mike Martin, (612) 641-0268.

March 23-27: George Washington University course on optical fiber communications, Hilton Inn Florida Center, Orlando, Fla. Contact (202) 676-6106.

March 24-26: C-COR Electronics technical seminar, Portland, Ore. Contact Tammy Kauffman, (800) 233-2267 or (814) 238-2461.

March 25-27: Virginia Cable Television Association annual convention, The Homestead Resort, Hot Springs, Va. Contact Lorraine Whitmore, (804) 780-1776.

March 25-27: Institute for Advanced Technology seminar on local area networks, IAT Training Center, Washington, D.C. Contact (800) 638-6590.

March 26: SCTE Central Indiana Meeting Group seminar on spectrum analysis, Holiday Inn East, Indianapolis. Contact Rick Cole, (317) 841-3692, or Lou Zimmerman, (317) 632-2288.

March 31: SCTE Satellite Tele-Seminar Program, "Video and Audio Signals and Systems," Part II, 1-2 p.m. EST on Transponder 7 of Satcom IIIR. Contact (215) 363-6888.

Planning ahead

April 2-5: SCTE Cable-Tec Expo '87, Hyatt Hotel, Orlando, Fla.

May 17-20: NCTA annual convention, Convention Center, Las Vegas, Nev.

July 20-22: New England Show, Dunfey's Hyannis Hotel, Hyannis, Mass.

Aug. 30-Sept. 1: Eastern Show, Merchandise Mart, Atlanta.

Sept. 21-23: Great Lakes Expo, Indianapolis Convention Center/ Hoosier Dome, Indianapolis.

Oct. 6-8: Atlantic Show, Convention Center, Atlantic City, N.J.

Oct. 18-22: Mid-America CATV Show, Hyatt Regency at Crown Center, Kansas City, Mo.

Dec. 14-16: Western Show, Convention Center, Anaheim, Calif.

AD INDEX

An 'automated' tap audit verification system

By Tom Foster
Director of Engineering
Greater Rochester Cablevision

After perusing a number of articles and reviewing the results of several (if only short-lived) tap audits in the ATC Rochester Division, it became obvious that a cost-effective program to monitor who was connected to the cable plant had to be implemented. However, we were faced with the same problems as many other operators: an already busy field staff and a business office staff that needed to be dedicated to answering customer calls rather than spending hours at a terminal verifying audit information. Other problems existed that included a data base in need of a little house cleaning, and our philosophy that the best time to approach the illegal customers to convert them into paying ones was not necessarily right after the discovery.

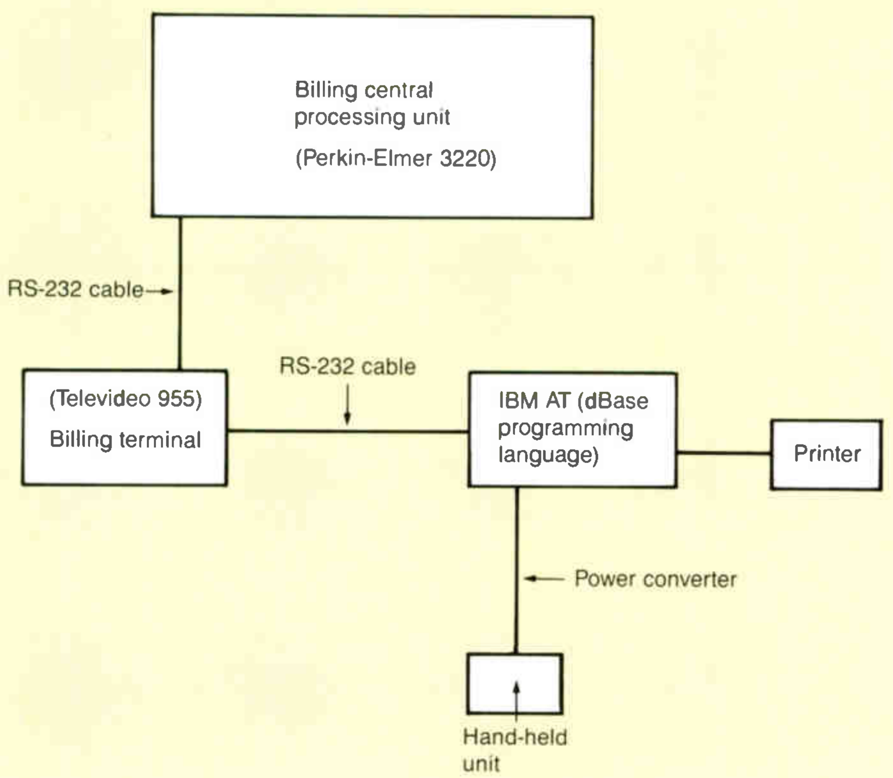
So the objectives were simple: Develop a program that did not have a major impact on the field operation, reduce the verification process so the customer service representatives could do what they do best, provide updated information to help clean up the data base and track illegals regardless of when they were converted to paying customers.

With these objectives in mind, we began helping to develop an "automated" tap audit system with Diversified Control, a vendor we have been using for locking devices for apartment boxes and pedestals. From that association, the Auditrol system was developed. Now, with the use of hand-held computer technology, a personal computer and our own billing system, we are able to significantly reduce the time necessary to verify our audited passings, print out discrepancy lists needed to clean up our data base, disconnect actual illegals and track over time the history of each illegal.

The process involved developing software for a personal computer (we use an IBM AT already on site) to act as a billing system terminal and operator (emulator). The emulator pulls passings information with services being received from the existing data base, then stores that information while it downloads the address information to a hand-held computer that the auditor carries in the field. The hand-held, which is no larger than an ordinary calculator, was developed to be easy to use and nearly foolproof.

'Automating . . . can improve the timeliness of the field audit results (and) . . . reduce operational costs'

Auditrol functional block diagram



The auditor proceeds to the selected addresses and is queried by the hand-held unit through a list of questions concerning the services being received at each address. The auditor has the ability to amend the address information (no such address, missed address, misspelled street name, etc.) for later use. At the end of each day, the hand-held is plugged back in and all information is then uploaded to the PC. The PC compares the audited information with the information in the data base and a discrepancy list is then printed. All discrepancies are stored for tracking purposes unless deliberately deleted (if that error was in the data base). At any time in the future, a report can be run to determine the status of any previous illegal.

Because the types and number of questions that system management may ask are different, optional reports could include:

- Auditor's field performance report
- Quality control on construction/installs
- Conversion rate
- Disconnect report
- Sales leads
- Penetration report
- Maintenance reports (physical condition of plant/leakage)
- "Coffee shop" disconnects

Automating the audit verification procedure not only can improve the timeliness of the field audit results, but it also can reduce operational costs by eliminating the need for a verification clerk, a savings of $20,000-$30,000 per year (more if a large scale audit is being conducted). As well, verification can be done off-hours, thereby not slowing down computer response time.