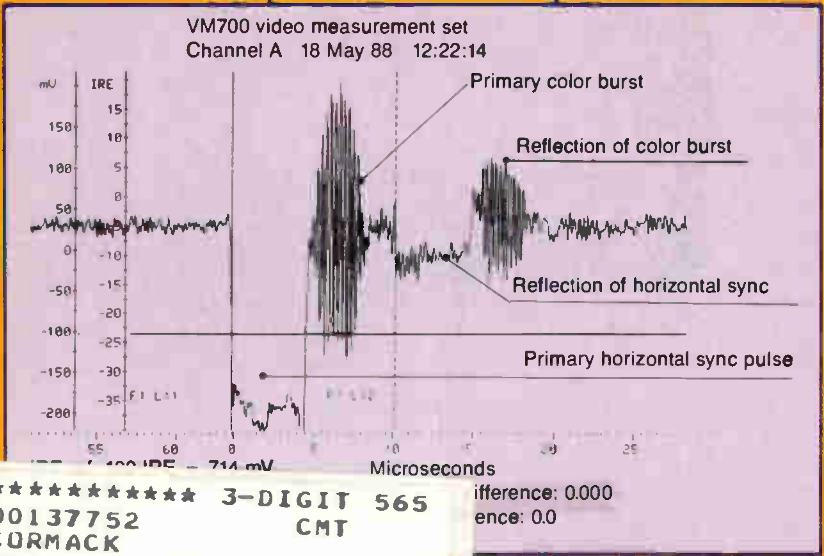
COMMUNICATIONS TECHNOLOGY

Official trade journal of the Society of Cable Television Engineers

Toward a leak-free air space

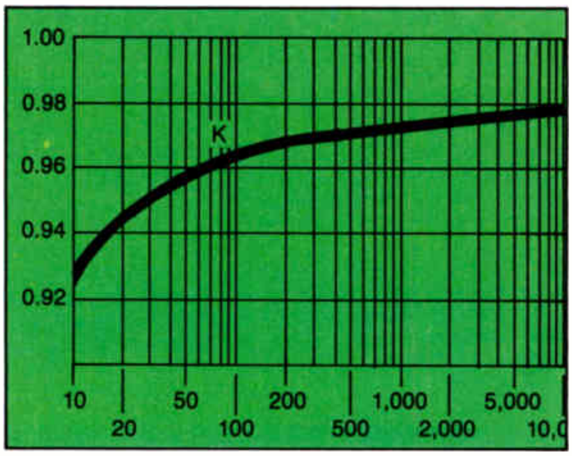


Eliminating multipath interference

July 1988

CONTENTS

Departments



Features

Communications Technology™ (ISSN 0884-2272) is published monthly by Communications Technology Publications Corp., 12200 E. Briarwood Ave., Suite 250, Englewood, Colo. 80112 — or — P.O. Box 3208, Englewood, Colo. 80155, (303) 792-0023. July 1988, Volume 5, Number 5. Office of publication is 12200 E. Briarwood Ave., Suite 250, Englewood, Colo. 80112. Change of address notices should be sent promptly; provide old (or copied) mailing label as well as new address, including ZIP code; allow 6 to 8 weeks for change. Second-class postage paid at Englewood and Denver, Colo. POSTMASTER: Please send address changes to Communications Technology, Box 3208, Englewood, Colo. 80155.

The name says it all: Jerrold IMPULSE 7000—tomorrow's addressable converter available today.

That's because our field-proven store-and-forward technology has been placed inside a new, sleek design that is 33% smaller than its impulse predecessors. In fact, with its tiny footprint and hi-tech look, this new converter will sit smartly atop a portable TV or blend attractively into any home entertainment system.

And, with features like volume control, last channel recall, plus, of course, push-button impulse ordering, the IMPULSE 7000 is the new star of the home entertainment scene.

To learn more about this exciting new series of converters—which are available in standard RF, volume control and baseband—contact your Jerrold account representative or call or write Jerrold Division, General Instrument Corporation, 2200 Byberry Road, Hatboro, PA 19040. (215) 674-4800.

JERROLD

. . . where innovation is a tradition

GENERAL INSTRUMENT

Reader Service Number 4.

Scientific Atlanta

Our Customers Are The Winners

W

fi

wa

Scientific-Atlanta introduces five new products to give you the winning edge. Our value-added, user-friendly solutions help generate revenue, improve penetration and retention, and operate your system more efficiently. We want you to be a winner.

WIN THROUGH VOLUME CONTROL

Our new 8590 is the friendliest and fullest featured volume control addressable in the industry. A unique display lets your subscribers *see* sound on a volume level indicator. And it guides them easily through the VCR programming process. The 8590 keeps a secret better, too. With a choice of 50 security modes, utilizing three advanced security technologies: dynamic sync suppression, dropped field, and video and sync inversion. It includes easy-to-implement, plug-in IPPV. It's compatible with the rest of the set-top family. And, since it's also compatible with Oak and a long list of others, the 8590 can help you out with the old and in with the new.

WIN THROUGH VALUE

The new 8570 addressable set-top is the value packed younger brother of the industry standard 8580. It comes with all the subscriber features of its older brother. And then some. It shares the same new advanced VCR timer with the 8580 and 8590, taping twice as many events as before. It simplifies impulse like the 8590, with a one-touch buy key on both the remote and the set-top.

in

ve

ys.

WIN THROUGH FRIENDLINESS

Our Complete Remote Control is so smart it generates revenue while solving problems. Ninety percent of subscribers with set-tops have two or more remotes per set; thirty percent have three or more. That's a problem! The CRC eliminates multiple remotes by quickly and easily learning their functions, without the obsolescence risk of preprogramming. And, if your subscriber has a remote control TV–it can provide volume control *without* a volume control set-top. That's friendliness your subscriber will pay for.

WIN THROUGH EFFICIENCY

Our new 9650 IRD beats today's rack space squeeze by cutting space needs in half. The 9650 integrates the leading CATV receiver–the 9640–with a satellite descrambler in one package the size of the receiver alone. Result: You get twice as many channels in the same rack–with perfect compatibility.

WIN THROUGH AGILITY

Our new Frequency Agile Drawer gives you agility when you need it. And only when you need it. One drawer that backs-up an entire headend, eliminating costly spare parts inventories. It provides quick and dependable slide-in convenience for the industry standards, the 6350 modulator and 6150 processor. Its 550 MHz range makes it compatible with every cable system.

Add these five new products to our proven line-up of winning solutions. You'll have a winning combination no one else can provide. That's because at Scientific-Atlanta we're committed. Committed to making sure that... "Our customers are the winners."

For more information, call: 1-800-722-2009. Or, write us at: Scientific-Atlanta, Dept. AR, P.O. Box 105027, Atlanta, GA 30348.

Reader Service Number 5.

Understanding HDTV

One lazy Saturday afternoon, I heard a knock at the door. As I opened it, a salesman began his pitch about a new product he was selling—a "high-definition TV kit." This was my lucky day. This simple device was easy to apply to any size, brand or model TV set. Guaranteed to clear up and brighten any screen. Only $19.95 (five for $75)—cash only.

But I was no fool; I only bought four, one for each of my cable hookups. Salesman and money parted. I opened the box and gingerly removed the high-tech product. It was a cleaning rag.

About a year ago, it was difficult to find much information on the emerging technology of high-definition television. Then all of sudden, it's becoming hard *not* to learn about HDTV. It seems practically every magazine in existence during the past year has had at least one article on the topic. Most state, regional and national cable TV gatherings have at least one technical session on it; the 1988 National Show had three seminars devoted to HDTV.

Adding more impetus to the upwardly mobile HDTV learning curve is a seminar being presented by the Society of Cable Television Engineers and its Rocky Mountain Chapter. This tutorial conference on advanced television systems, entitled "HDTV and Beyond," is scheduled for Oct. 28-30 at the Sheraton Denver Tech Center in Denver.

Similar to the SCTE's seminar on fiber optics (the *other* hot topic of the late '80s) last January, the HDTV conference is likely to generate a lot of interest and, accordingly, high attendance numbers—so register soon. Planned for the seminar will be live demonstrations of various formats by the leading proponents, panel discussions, technical papers, breakout sessions, reference materials and the opportunity to meet with industry leaders. And what industry function would be complete without BCT/E Certification examinations? These, too, are planned for the event.

For more information or to register, contact Jan Vicalvi at Executive Conference and Convention Services Inc., (303) 691-8380. Be sure to check the pages in forthcoming issues of *CT* and *The Interval* for the latest on the conference.

Talk to the engineers

This brings up an interesting question: Why learn about HDTV now? This technology probably won't take effect until the middle of the next decade. Manufacturers aren't producing affordable HDTV sets, local retailers aren't offering them and subscribers aren't asking for them. So why not narrow our focus to the current needs of good signal quality, leakage and training for installers? I asked several engineers what they thought.

Ron Hranac, senior staff engineer at Jones Intercable, said, "HDTV is a developing technology that has no one standard format at the present time. And that's why we should be generating interest, so that a standard can finally be chosen."

Replied a spokesperson from Magnavox CATV, "You have to think in terms of current capital investment. Even though HDTV won't happen in five or 10 years, the decision to invest the millions of dollars by manufacturers and cable operators has to happen very soon. We must be prepared for the future."

Dr. Walt Ciciora, vice president of technology at American Television and Communications Corp., said, "Why start now? Because it's going to take at least five years to implement the technology. And another thing—HDTV will probably be the biggest thing to impact the cable industry, especially when prerecorded materials (such as videotapes) in higher-definition formats become available."

Dan Pike, vice president of engineering at Prime Cable, took a more historical view. "Twenty years ago," he said, "this industry was involved in better ways to transmit signals for people to see off-air programming. So we spent our time with the technology of high-gain antennas and microwave towers.

"Ten to 12 years ago, the technology was earth stations to bring new programming to our subscribers. We jumped on the bandwagon as soon as we could, just to be part of the action before people built their backyard dishes."

Pike continued, "Today, if we're to continue to be a major part of the entertainment business, we've got to keep ahead of the HDTV skeptics, who say, 'What do you want that Buck Rogers stuff for?' On the other hand, we can't predict that HDTV will become that popular. So it's good to have a healthy skepticism but move forward with the same dispatch as before. We really ought to spend this time learning about HDTV because if we wait five years, we'll be left behind."

Thanks to everyone who participated in this roundtable discussion. And just so you won't be left behind, you'll read more about HDTV in upcoming issues. In the meantime, however, please be sure to catch the August issue of *CT* for a detailed report on last month's Cable-Tec Expo '88.

Home at last

We're glad to report that Sally Kinsman of Kinsman Design Associates Inc. has moved her business and settled in. She can be contacted at P.O. Box 2905, Redmond, Wash. 98073-2905, (206) 867-1433. Welcome home, Sally!

Rikki T. Lee

COMMUNICATIONS TECHNOLOGY

Paul R. Levine
President/Publisher

Robert C. Stuehrk
Associate Publisher

Lu Ann Curtis
Account Executive

Karen A. Gray
Account Executive

Neil Anderson
Account Executive

Marla Sullivan
Production Coordinator

Mary L. Sharkey
Circulation/Data Manager

Kenny Edwards
Controller

Geneva Hobza
Assistant to the Publisher

Toni I. Barnett
VP of Editorial

Wayne H. Lasley
Editor in Chief

Rikki T. Lee
Managing Editor

Karen L. Naiman
Assistant Editor

Shelley Bolin
Editorial Assistant

Lawrence W. Lockwood
East Coast Correspondent

Sharon F. Lasley
Art Director

Brad Hamilton
Assistant Art Director

Carroll A. Barnes
Production Assistant

Office: Communications Technology Publications Corp., 12200 E. Briarwood Ave., Suite 250, Englewood, Colo. 80112, (303) 792-0023 **Mailing Address:** PO Box 3208, Englewood, Colo. 80155

New CATV software unveiled at Expo '88

SAN FRANCISCO—The Society of Cable Television Engineers introduced its new software product, CATV Wizard, at Cable-Tec Expo '88 here June 16-19. CATV Wizard is a computer disk containing 30 computer programs that run mathematical formulas used in technical calculations.

Developed by the Society to provide well-tested and thoroughly researched formulas to the industry at a low cost, the programming deals with such topics as CATV systems, earth stations, attenuators and Ohm's and Watt's laws. It is designed to run on IBM PCs and compatible computer systems and is available in the June issue of the Society's newsletter, *The Interval*.

Royalties earned from the sales of CATV Wizard will be donated to the SCTE Scholarship Fund in the name of those who contributed to the project's development.

1988 technical papers available from NCTA

WASHINGTON, D.C.—The 1988 volume of the National Cable Television Association's engineering/technical papers, on which this year's National Show technical session oral presentations were based, is available for sale. The 319-page text is a source of original, non-commercial technical research and commentary. Sixty-four authors—including cable operators, equipment manufacturers, designers and consultants—address current issues such as fiber optics, high-definition television and impulse-ordering technology.

Copies can be purchased from NCTA's Science and Technology Department, 1724 Massachusetts Ave., N.W., Washington, D.C. 20036. Cost is $30 (members) and $40 (non-members), prepaid by check only.

U.S. Supreme Court affirms FCC authority

WASHINGTON, D.C.—On May 16, the U.S. Supreme Court unanimously upheld the FCC's authority to pre-empt state and local regulation of cable TV standards. The unanimous decision in *City of New York v. FCC* affirms an earlier ruling by the U.S. Court of Appeals for the D.C. Circuit.

The Supreme Court stated that the 1984 Cable Act clearly confers authority on the FCC to adopt technical standards. It was highly unlikely that Congress meant to limit the FCC's authority without some express indication that it intended to do so. This conclusion was based on the fact that the Cable Act was adopted against a 10-year background of pre-emption. Also a factor were the difficulties the FCC experienced in the early 1970s when it permitted state and local governments to adopt their own technical standards.

SCTE and chapter to host seminar

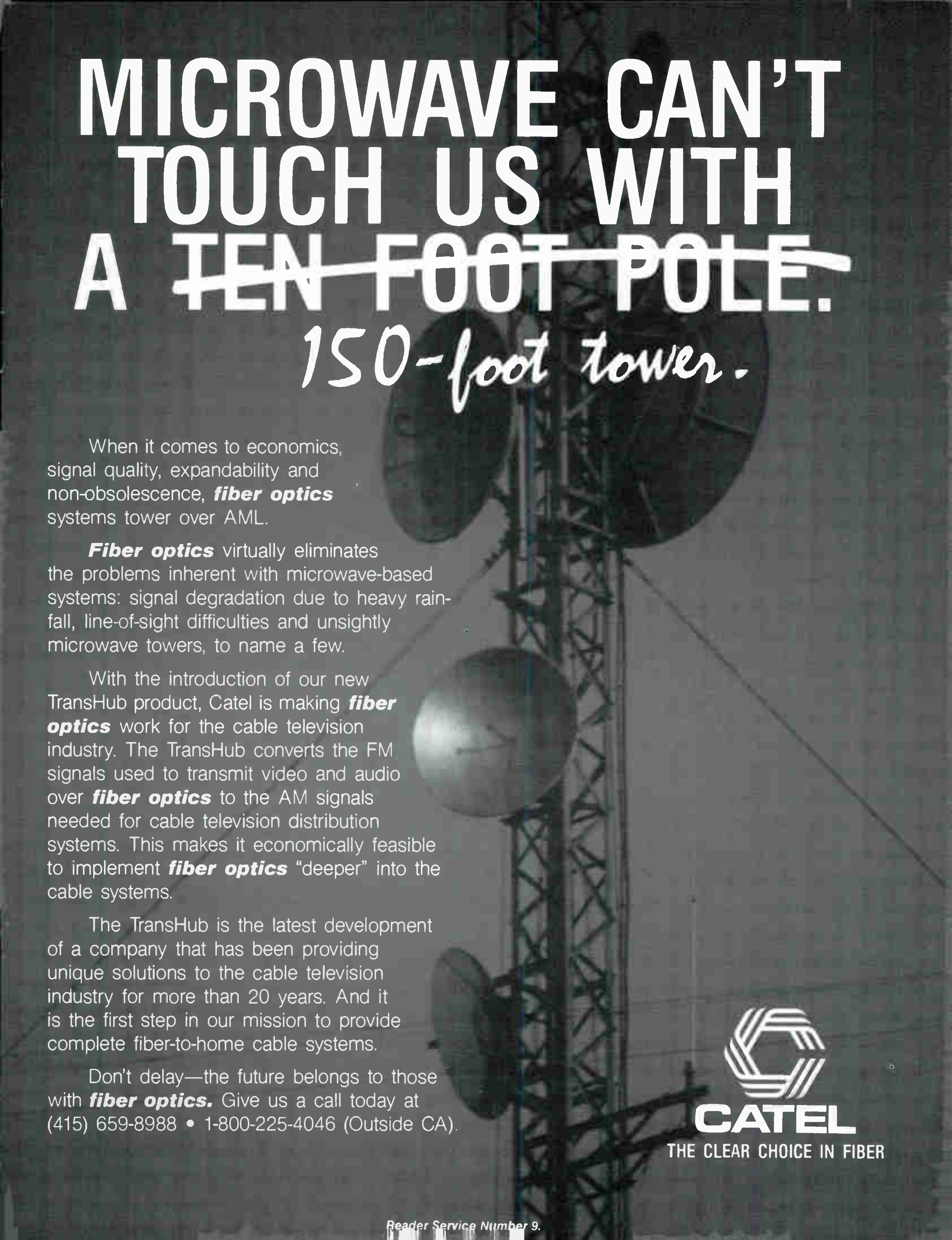
DENVER—The Society of Cable Television Engineers and its Rocky Mountain Chapter will host a three-day conference on high-definition television at the Sheraton Tech Center here Oct. 28, 29 and 30. The conference, titled "HDTV and Beyond," will be tutorial in nature. It will include live demonstrations of HDTV and various advanced television formats, as well as the opportunity for questions and answers.

The speakers and demonstrators will be representatives from American Television and Communications, HBO, Jerrold, Magnavox, the National Cable Television Association, the SCTE, Zenith and others. Attendance and participation from the broadcast industry is being encouraged as well. For more information and registration material, contact Jan Vicalvi at Executive and Convention Services, (303) 691-8380.

- Trilogy Communications signed an agreement to supply its MC² coaxial cable line to Cablevision of New York City for its new-build in Bronx and Brooklyn. Approximately 2,000 miles of cable will be used for the project, scheduled to begin during the second quarter of 1988.
- Microwave Filter announced a 4.3 percent increase in net sales from $1.16 million to $1.21 million during the second quarter ending March 31, compared to the second quarter of 1987.
- Atlanta-based FM Associates Ltd. is now serving as manufacturer's representative for Lightning Master's line of static dissipator products in Florida, Georgia, Alabama, Tennessee, Mississippi, North Carolina and South Carolina.
- CaLan announced that California-based Century Communications recently purchased its 14th Model 1776/77 integrated sweep receiver system from the manufacturer's local representative, ISS Communications.
- LPL Investment Group increased its equity interest in American Lightwave Systems, a fiber-optic designer and manufacturer, to 65 percent. Both are based in Wallingford, Conn.

Correction

In the May issue, page 92 ("Tech Tips"), the first paragraph should end "...reconfigured into a unified 9.6 kbps asynchronous data stream," not 6.9 kbps. We regret any confusion caused by this error.


MICROWAVE CAN'T TOUCH US WITH A ~~TEN FOOT POLE.~~
150-foot tower.
When it comes to economics, signal quality, expandability and non-obsolescence, ***fiber optics*** systems tower over AML.
Fiber optics virtually eliminates the problems inherent with microwave-based systems: signal degradation due to heavy rainfall, line-of-sight difficulties and unsightly microwave towers, to name a few.
With the introduction of our new TransHub product, Catel is making ***fiber optics*** work for the cable television industry. The TransHub converts the FM signals used to transmit video and audio over ***fiber optics*** to the AM signals needed for cable television distribution systems. This makes it economically feasible to implement ***fiber optics*** "deeper" into the cable systems.
The TransHub is the latest development of a company that has been providing unique solutions to the cable television industry for more than 20 years. And it is the first step in our mission to provide complete fiber-to-home cable systems.
Don't delay—the future belongs to those with ***fiber optics.*** Give us a call today at (415) 659-8988 • 1-800-225-4046 (Outside CA).
CATEL
THE CLEAR CHOICE IN FIBER
Reader Service Number 9.

Child labor—Can it work?

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

A rather typical definition of *child labor* is this example from an encyclopedia: "Child labor is work performed by children that either endangers their health or safety, interferes with or prevents their education or keeps them from play and other activities important to their development...Child labor as a social problem is associated with the rise of industrial production and the appearance of capitalism."

Certainly, the early history of the post-medieval world is replete with Dickensian tales of woe the mines, mills and the machine-powered industries. We read about half-naked children as young as 6 working in mines carrying coal to the surface on their backs for as long as 16 hours a day. "Pauper children," either without parents or whose parents could not support them, were "apprenticed" to mill owners under the English Poor Law and were treated little better than slaves. Many working children were "indentured" by their parents for a sum of money to employers who felt they were doing the poor a favor by providing them with useful work; otherwise the child might perish from lack of food or shelter.

Probably most of my gentle readers will have uncritically agreed with the historians who unanimously condemn capitalism and paint the emerging Industrial Revolution as the epitome of mad shylocks feasting upon the riches arising from the employment of helpless children. And they all agree, no doubt, that concerned citizens, together with enlightened legislators, bulldozed into law many a worthy decree to free the child from slavery and punish the wicked factory slavedrivers.

The United States followed the English custom regarding working children and it was not until 1842 that Massachusetts and Connecticut limited the work of children in textile factories to 10 hours a day. Pennsylvania in 1848 outlawed the hiring of children under 12 in the mills. Free compulsory education was promoted as a campaign against excessive child labor. However, progress in regulating child labor was sporadic and ineffective right up to World War I. Young boys labored in 12-hour shifts in front of fiery furnaces. Children under 10 made cigars and cigarettes. Age was not a barrier to employment in poisonous atmospheres, tending hazardous machinery and working long hours for uncaring employers.

President Wilson in 1916 signed the Keating-Owen Act, which barred from interstate commerce articles produced by child labor. The Supreme Court soon declared the act unconstitutional on the grounds that it violated states' rights and denied children the freedom to contract to work. A proposed constitutional amendment in 1924 was sent to the states for ratification and soundly defeated. Finally, under Roosevelt, in 1938 the Wages and Hour Act became the basic child labor law for the United States. It banned employers in interstate commerce from employing workers under 16 in hazardous occupations. Some children are allowed to work after school hours. Farm children are exempt from the age restrictions.

Compulsory education

Let us return to the concept that compulsory education was an antidote to the evil of child labor. Colonial America passed laws requiring townships to teach the three R's, build elementary schools and establish high schools. Local elementary schools were common by 1850 and by 1870 free public high schools were generally available. America led the world in free nonsectarian education, primarily to provide a common background for the young Americans whose parents came from many different national and social backgrounds. Along with the growth of a free school system, there arose the concept of compulsory attendance. The American child is now legally compelled to attend school through the secondary level.

This history lesson tells us how we got here, but where are we? In my school years, the parents, teachers and society were united: Beat the kid into submission to authority! Every teacher had the right to physically punish for poor performance and parents added blows as required. Not anymore. Our society is now in a moral shambles for the most part and the stern, caring parents are a vanished dream. Schools have become jails—the largest such institutions of confinement the world has seen. Children are compelled to attend school, rounded up by truant officers and forced to sit in one place for hours, bored and rebellious, turning to drugs and gang warfare against those they see as tormentors. If they do drop out and escape the attention of the truant officer, what alternative occupation of their time is available? Gainful employment? The law says no. We are gored on the horns of our good intentions, paralyzed with humanitarian impulses that no longer relate to current social problems.

Perhaps we should cast off our emotional chains and attack the problem with intellect, not passion, and revisit the subject of child labor. I was raised in a garage where, from the age of 6 (maybe earlier), I worked to help my father in every conceivable task a garage could offer, soaked in kerosene, oil or gasoline, operating with electric tools and a blacksmith's forge. Children can do such work with safety, as you can observe on any American farm. Why do we deny other children their right to work, earn money and be proud of their contribution to their families' well-being?

Therefore, I propose a new direction for the farsighted social reformers (do they exist?) based on three principles: 1) Compulsory schooling stops at puberty—no later than age 12. 2) Child labor is permitted at any age at any hourly pay the employer offers until the age of 18, at which time present rules apply. Reasonable hours and safety rules will prevail. 3) Progress through the school system is based solely on scholastic achievement. It is probably useless to speculate on the societal changes these reforms might encourage, but I would venture a hope that the schools would become havens of refuge for the scholar, safe for the teachers and free of drugs and defiance. Perhaps my greatest dream would materialize—every student would study science with the majority majoring in technology-driven degrees, thereby reviving our vanishing industrial complex and assuring the survival of a free America as envisioned by our founding fathers.

Signal leakage compliance

By Robert Saunders
Director of Engineering, Sammons Communications

Although much has been written about the events leading to the incorporation of Docket 21006 into Part 76 of the FCC Rules, a brief overview of the potential risks may help justify all the time, effort and expense required to assure compliance.

Most of the mid-band, super-band and hyper-band channels are used by aircraft for navigation and communication, amateur radio operators (hams), business and municipal two-way radios, pagers and military. The most important point to remember is that CATV systems do not have over-the-air authorization for any frequency typically used within a coaxial cable system. The additions to the rules are intended to protect aeronautical frequencies between 108-137 MHz and 225-400 MHz.

Tasks required for compliance can be divided into three areas: channel standardization, quarterly monitoring and an annual cumulative leakage index (CLI) filing.

Systems may operate under grandfathered rules until July 1, 1990; however, a channel that would not clear under the old rules can be used under the new rules as long as proper notification is sent to the FCC, correct frequency offsets are maintained and quarterly monitoring is immediately started. Everyone must use the new frequencies, record quarterly monitoring activities and file an annual CLI after July 1, 1990. Since the following procedures take some time and effort to develop, *don't wait* to begin.

Channel standardization

The intent of channel standardization is to place cable TV frequencies, which operate above +38.75 dBmV at any point in the cable plant, exactly between aeronautical carriers. Standard video carriers operating between 108-118 MHz and 328.6-335.4 MHz (Channels A-2, A-1 and FF) require a ±25 kHz offset for this placement (e.g., Channel A-2 = 109.250 MHz + .025 MHz = 109.275 MHz). Those standard video carriers that fall be-

Figure 1: Comparison of field strengths vs. signals (measured at 150 MHz)

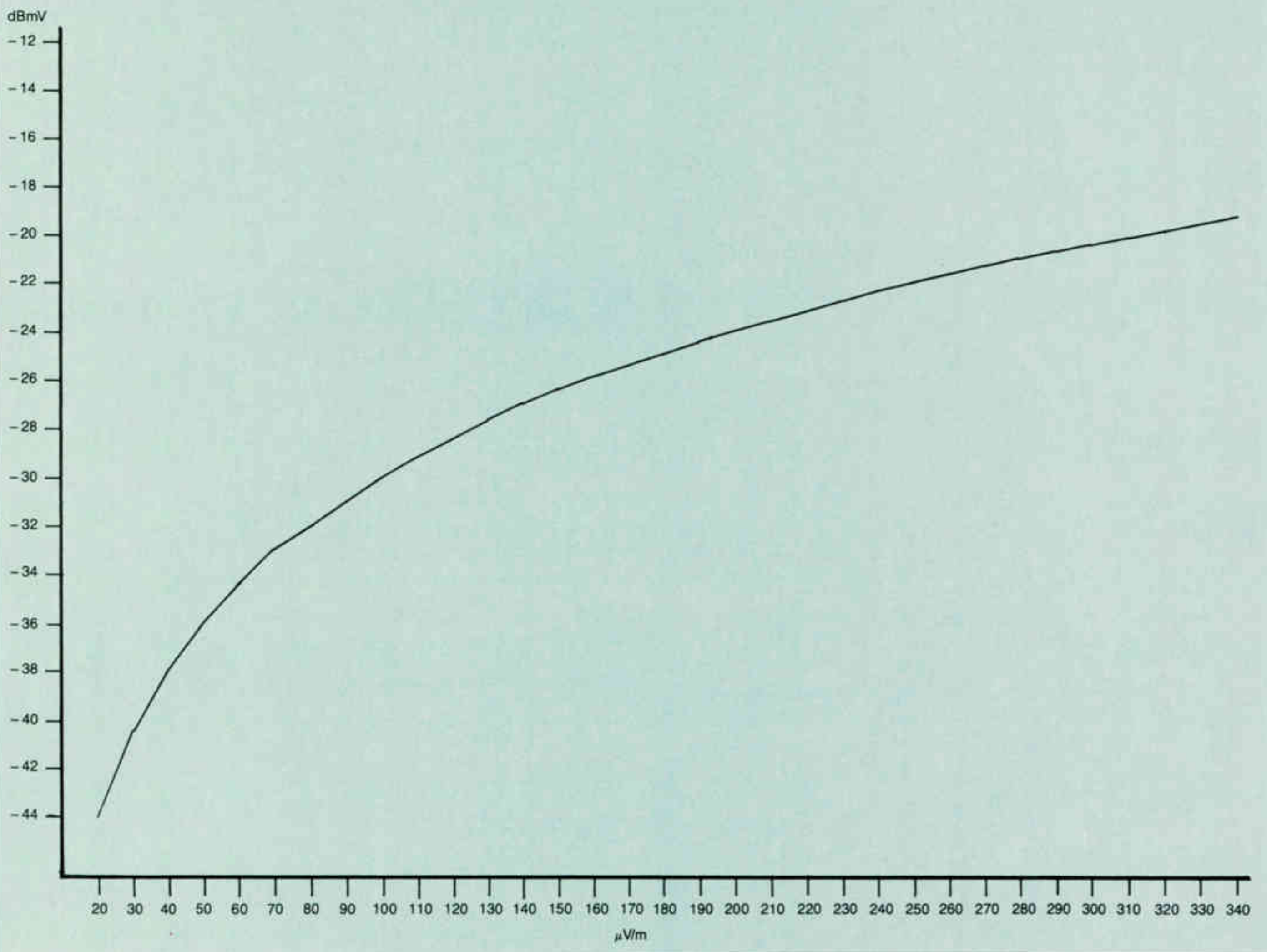


Table 1: Offset formulas for carriers exceeding +38.75 dBmV

Bands	Formula
108-118 MHz and 328.6-335.4 MHz	Closest standard video carrier frequency ±25 kHz + 2N(25 kHz) = clear frequency
118-137 MHz, 225-328.6 MHz and 335.4-400 MHz	Closest standard video carrier frequency ±12.5 kHz + 2N(12.5 kHz) = clear frequency

where: N is any whole number

Example:
109.250 MHz + .025 MHz + 2(5) × .025 MHz
= 109.275 + 10(.025 MHz)
= 109.275 MHz + .25 MHz
= 109.525 MHz

tween 118-137 MHz, 225-328.6 MHz and 335.4-400 MHz must be offset by ±12.5 kHz (e.g., Channel A = 121.250 MHz + .0125 MHz = 121.2625 MHz).

Headends using harmonically related carrier (HRC) frequencies must retune the fundamental carrier frequency of the comb generator to 6.0003 MHz with a tolerance of ±1 Hz to achieve proper channel placement. This will likely require a new comb generator to achieve that frequency stability.

Incrementally related carrier (IRC) systems must move the fundamental reference frequency to an odd multiple equal to or greater than three times the 12.5 kHz offset in order to also meet the 25 kHz offset requirement in the aeronavigational band. Multiple comb generators may be required in IRC headends to properly offset all channels.

Other carriers that exceed +38.75 dBmV, such as data and control carriers, will be properly offset by using the formulas in Table 1.

Frequency tolerances for all standard carriers offset by this plan must be held at ±5 kHz. Beware of using *off*-channel headend processors that have output channels within the aeronautical bands. Since two local oscillators are used, this tolerance is difficult to maintain. If the processor is fed by an off-air channel, the problem is compounded, since ±10 kHz offsets are often assigned to broadcaster's licenses. Moving the processor to a non-aeronautical channel assignment or converting the frequency with a demodulator/modulator scheme (meeting proper output frequency offset specs) will resolve the problem.

On-channel processors used to reprocess signals from an interconnected remote site do not present this problem, since only one local oscillator is used. It is a good practice to check the output frequencies of all your headend equipment regularly to ensure operation within tolerance.

Quarterly monitoring

Quarterly monitoring actually means locating, logging and repairing all leaks that exceed 20 µV/m at a distance of 3 meters (10 feet). Notification to the FCC of an intention to use a channel under the new rules must include information outlining the procedures and equipment that will be used to monitor leakage.

The receiving equipment must have sufficient sensitivity to detect leaks at a distance that may be reasonably reached while driving your cable plant. Typically, restricted easements are about 100-150 feet from the street. Receivers must be calibrated at a specific frequency and the gain/loss characteristics of the antenna used when compared to a half-wave dipole. A meter such as an analog meter, multiple LCD/LED displays or a digital display is important. This allows recording of various levels and makes the locating process much easier. Receiver squelch is also very important. If your operator loses interest and/or sanity after an hour or so, the battle is lost.

Dash-mounted or fixed large-scale 110 VAC powered receivers are very

Figure 2: Test setup to determine signal level

limiting. A portable, battery-operated hand-held device produces very good results while driving the area and speeds the final localizing process exponentially. Finally, the receiver should be durable and easy to operate. If your program is to be successful, it should be used daily with confidence.

The initial phases of a monitoring and repair program are crucial to its success. Equip a sufficient number of employees to cover 100 percent of your system every three months.

Establish a calibrated leak location at 20 μV/m tuned to your test frequency to serve as a routine checkpoint for the receivers. An appropriate signal delivered to a half-wave horizontal dipole mounted on a pole or building near the gas pump or a specific spot in the parking lot is a good example. Keep in mind this is a very inexact science since reflections of your calibrated leak signal from nearby objects will affect the level and accuracy at the receiver. The field strength of the leak is also a moving target changing with the elements (temperature, humidity, wind, etc.).

Each receiver should initially be calibrated on the bench. Be sure the meter has sufficient range to measure leaks from 20 to at least 150 μV/m. A wider range may limit the reading's accuracy since only a portion of the meter is used. In-line attenuators in the antenna lead will increase the upper range without adversely affecting accuracy.

The following formula will convert a specific field strength (E) in microvolts/meter to dBmV at a specific frequency. The receiver must be fed by a half-wave horizontal dipole to calibrate with the levels derived.

$$\text{dBmV} = 20\log_{10}\left(\frac{E\ (\mu V/m)}{.021 \times f} \div 1{,}000\right)$$

where: f = frequency being measured in MHz

Example:

$$\text{dBmV} = 20\log_{10}\left(\frac{20\ \mu V/m}{.021 \times 150} \div 1{,}000\right) = -43.95\ \text{dBmV}$$

The example demonstrates that a 20 μV/m leak at a frequency of 150 MHz measured with a half-wave horizontal dipole can be simulated by feeding the receiver being calibrated with a −43.95 dBmV signal. An X/Y graph comparing various field strengths in microvolts/meter vs. signals in dBmV can be produced for the frequencies being monitored. Figure 1 is a graph for a 150 MHz receiver.

A signal generator can be used with the test setup shown in Figure 2 to determine the signal level measured in dBmV at each mark of the receiver's meter. These levels are then converted to field strengths in microvolts/meter using the previous formula. Remember, if a horizontal dipole is not being used, the effects of gain/loss must be determined for your antenna.

Employee training is the next critical step. The proper use of receivers, as well as demonstrating efficient leak localizing techniques, will speed the process and limit the initial fear of a new skill. Describe probable causes of leaks, their locations and how they can be avoided.

Our reports indicate that loose and/or poorly constructed F fittings in house drops, primarily at the pole or ground block/splitter, are the prime producers of leaks. Extra time spent attaching F fittings to drop cable and ensuring they are securely tightened to each device will go a long way in preventing leaks.

Other probable causes are non-sleeved aluminum cable connectors, breaks in trunk and feeder cables, poorly shielded older drops, poorly shielded customer equipment (especially FM receivers) and illegal outlets. Customers typically use poorer grades of fittings, passives and cable (even 300-ohm twinlead). Be on the lookout for roof antennas with downleads connected parallel to the cable system's matching transformer at the television's VHF terminals. This produces a very efficient transmitter.

When each leak is located, log its location and relative field strength at a distance of 10 feet. Even if the repair is made immediately, which is the ultimate goal, the record of this procedure is very important. This FCC file will be proof that an active monitoring program is in place. I recommend that this information be forwarded to a dispatcher or office clerk immediately via two-way radio or telephone.

A good log should include the date and time the leak is discovered, the employee who found it, the approximate level in microvolts/meter, its location, the corrective action, the date and time the repair is made, and the name of the employee who made them. Our company consolidates daily logs and reports leaks to various supervisors on weekly, monthly and quarterly intervals.

Annual CLI

Reporting an annual CLI and quarterly monitoring are two very different procedures. CLI is best defined as *one* intentional pass of your cable system to determine the cumulative field strength from the addition of all the leaks located. Quarterly monitoring is random in nature and is integrated into normal daily activities.

The formula in the FCC Rules is:

$$I_{\infty} = \frac{1}{0}\sum_{i=1}^{n} E_i^2$$

More simply put:

$$\text{CLI} = 10\log_{10}\left[\left(\frac{\text{plant miles}}{\text{miles monitored}}\right) \times (\text{sum of leaks}^2)\right]$$

A CLI of 64 or less is passing, as long as at least 75 percent of the plant is monitored and all leaks detected above 50 μV/m are used in the calculation. The plant miles over miles monitored portion of the formula is an adjustment for partial ride-outs. It presumes that the unmonitored portion of the plant contains the same leakage contribution as the portion inspected and produces a systemwide CLI. Be sure to square the leaks detected before they are summed. Adding up all the leaks and squaring the sum will produce a failing CLI very quickly.

When you calculate your first CLI, it will immediately demonstrate the importance of repairing the most severe leaks first. The following demonstrates that point:

1,000 leaks at 50 μV/m = a CLI of 63.98
250 leaks at 100 μV/m = a CLI of 63.98
100 leaks at 150 μV/m = a CLI of 63.52
1 leak at 1,600 μV/m = a CLI of 64.08 (failure)

Correction charts can and should be developed to adjust leak levels measured at distance greater than 10 feet. Our experience indicates, however, that pinpointing leak locations from greater distances is difficult, since leaks can travel along the strand and cable. In addition, one large leak may falsely produce several weaker leak points in its proximity. This false contribution to the CLI may mean the difference between passing and failing. Yagi antennas improve the directivity of receivers in these cases and will help sort out the real leak location. This emphasizes the need to repair large leaks first.

If we do not comply, fines may be imposed and the loss of channels could extend beyond the aeronautical frequencies. The American Radio Relay League (ARRL), municipalities, government and business users could reduce the available frequencies to the old 12-channel system. How long could we survive in that environment?

If we do comply, our systems will operate better. Our existing services will present themselves in a more saleable fashion and the introduction of future technologies—such as high-definition TV—will be easier.

References

Jerrold CATV Reference Guide RD-15.
Part 76 of the FCC Rules.

Leakage detection program

By Jim Bishop
Line Service Manager, United Cable of Colorado

As the July 1, 1990, deadline for cumulative leakage index (CLI) compliance and quarterly leakage testing draws near, United Cable of Colorado has begun its program. Our system utilizes two AML (amplitude-modulated link) microwave systems consisting of 21 hub sites and approximately 3,200 miles of cable plant. Operationally, the system is divided into north, south, east and west areas with a supervisor responsible for the technical operation of about 800 miles of plant in each area. There are field line techs assigned to each supervisor; their maintenance responsibilities include maintaining all cable plant from the hub site to the subscriber's set. These responsibilities have been expanded to include a leakage detection program.

This program started with a series of meetings that included personnel from our operations and engineering staff. The primary objective of these meetings was to determine what methods should be used to establish the necessary guidelines for a comprehensive detection program best suited for our needs. The program we established consists of two separate parts, both of which are designed to actively seek, identify and repair leakage on a continual and accountable basis.

The first part was established by issuing Sniffer Jr., which operates on a Channel D video carrier frequency, to all service techs, based on the theory that a high percentage of leaks are found at subscriber drops. Considering the number of service calls worked each month, it was felt that this method of detection would be an effective and accountable addition to the plant drive-out.

The service tech is required to use the leakage detector after completion of every call to ensure that the subscriber's drop is free of leaks. While it cannot give precise measurements of leakage, the detector does have the capability of indicating leakage greater than 10 μV/m at a distance of 10 feet. Any leakage greater than this is logged by the tech. If the leak is found to be within the subscriber's drop, the tech is required to repair the source of leakage and go over the area again with the detector to ensure the leak has been repaired. If the leak is determined to be coming from the distribution or trunk line, the tech records this indication on the leakage log.

After receiving the tech's log sheet at the end of the work day, the area supervisor assigns a leakage work order to a line technician. In turn, the line tech responds to the area of the leakage, makes the necessary repairs and returns the completed form to the supervisor. The area supervisor then completes the second half of the leakage log and attaches the completed work order for filing. While this part of the program was of great benefit in leakage detection, it wasn't enough by itself. Thus, the drive-out program was developed.

Drive-out program

Part two, the actual plant drive-out, was established after a 30-day study to determine among other things, the number of personnel needed to cover the required plant mileage in the specified time frame, according to Federal Communications Commission regulations. The vehicles were equipped with Sniffer IIs and calibrated to detect leakage at 100 feet.

During the test period, detailed information was kept each day as to driving time, leaks detected and mileage driven. All drive-out and repair times were actual and mileage was taken

Leakage work order

Leakage form control # ______ Line # ______ W/O # ______

Date reported ______ Date of fix ______ Elapsed time ______

Plant type: Aerial ______ Underground ______ Hub # ______

Address/location: ______

Problem found: ______

Corrective action: ______

Completed by technician # ______

Special comments: ______

Leakage log

TECH ______ HUB ______ LOCATE # ______ LEAKAGE FORM CONTROL # ______

THIS SECTION TO BE COMPLETED BY TECHNICIAN / THIS SECTION TO BE COMPLETED BY AREA SUPERVISOR

DATE	TIME	ADDRESS	LEVEL 10 to 40	+40	W/O #	PROBLEM	DATE OF FIX	TECH #	LEVEL AFTER REPAIR
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									

110%

That's the kind of effort we put out. Because that's what it takes to become the leading CATV standby power system manufacturer in North America. That's what it takes to design the technology that sets the standards in the industry. And that's what it takes to beat the competition.

Efficiency. Alpha has developed standby power supply transformers rated at 94% efficiency – the highest in the industry. And this without sacrificing quality, thanks to superior engineering.

Cost of Ownership. Alpha systems cost less because our efficiency, reliability and performance monitoring result in lower maintenance and operating costs.

Modularity. Alpha pioneered functional modularity. Just add simple plug-in components and your standby power system is updated with the latest innovations from Alpha's R&D labs.

Uninterrupted Power. Alpha's transfer time is so immediate that we offer standby power with the advantages of uninterruptible power. Uninterrupted power means uninterrupted service to your subscribers.

Innovation. We're never content. We're always looking for ways to improve. That's why the industry looks to Alpha for innovations in standby power. Single ferro-resonant design. Temperature compensation. "Smart" battery charging. Performance monitoring. Status monitoring. Major innovations resulting in real benefits – and all introduced by Alpha Technologies.

And have we finished yet? Don't bet on it.

ALPHA TECHNOLOGIES

We're Here to Back You Up.

3767 Alpha Way Bellingham, WA 98225
206-647-2360 FAX: 206-671-4936

7033 Antrim Ave. Burnaby, B.C. V5J 4M5
TELEX [illegible] FAX [illegible]

Reader Service Number 14.

Drive-out leakage test form

HUB NO: ____________

DATE OF DRIVE-OUT: ____________ MAP NO: ____________ MAP MILEAGE: ____________

TIME START: ________ DRIVE-OUT TECH ________ TIME STOP: ________ | REPAIR TECH |

LOCATION	LEVEL	DATE	CAUSE	REPAIR	TECH #	NON-VR REPAIR

from design maps as actual plant miles covered (not actual miles driven). As a result of the test period, it was determined that only two additional techs would be required in order for us to cover a substantial portion of our plant on a quarterly basis.

The two additional employees were hired at the service tech level and trained as qualified service techs. One was assigned to our north area and one to our south area. The north area drive-out tech was responsible for approximately 50 percent of plant in the north and west areas, while the south area drive-out tech was responsible for the other half—the south and east portions.

One thing discovered as a result of the 30-day test period was that, because of the slow pace of the actual drive-out, boredom became a big factor with the participating techs. It was decided after the test phase that the personnel performing the drive-out should rotate functions at least every 30 days, which was accomplished by distributing the plant drive-out duties among all the service techs.

Each area supervisor was given instructions not to pull the drive-out technicians away from their duties. It was explained that the tech doing the plant drive-out must be dedicated solely to the drive-out and normally would not have time to participate in the repair side of the program if we were to meet our quarterly monitoring requirements. The drive-out tech documenting as closely as possible the exact location of all detected leaks and completing the entire system grid map before going on to another ensures we have continuity in our program. The drive-out tech completes the leakage test form and gives it to the supervisor at the end of the scheduled shift. The supervisor then assigns a repair technician, generally a line tech, to complete the leakage repair. The leakage form is then forwarded to our central office to be filed by hub and date. At the end of the month a monthly drive-out report is calculated from these completed forms and forwarded to the engineering department for review.

In addition to the service tech's Sniffer Jr. and the techs who are dedicated solely to the plant drive-out, all line trucks are equipped with Sniffer IIs. The trucks are used in system travel from one job to another during routine maintenance but are primarily used for identifying leaks at the time of repair.

With these combined programs in place, we are on the right road to compliance with the FCC signal leakage requirements. However, it is important to continue fine-tuning the established program to obtain the most effective and efficient program possible.

Monthly drive-out report

Area ____________ Drive-out tech # ____________

Month ____________

Hub numbers ____________

Map numbers ____________

Aerial plant miles driven ____________

Underground plant miles driven ____________

Total plant miles driven ____________

Number of aerial leaks found ____________

Number of underground leaks found ____________

Total number of leaks found ____________

Number of leaks drop-related ____________

Number of leaks trunk/feeder-related ____________

Additional comments/details regarding area driven out: ____________

Procedures for conducting a flyover

By Robert V.C. Dickinson
President

And Edwin L. Dickinson
Vice President, Dovetail Systems Corp.

A great deal of interest has been generated in measurement of CLI (cumulative leakage index) by flyover techniques. Due to the Federal Communications Commission Rules requiring annual qualification of cable systems (after July 1990) to the leakage specifications of Part 76.611, many are evaluating the state of their plant and planning for periodic measurements.

Flyover techniques are often chosen in order to reduce the time necessary for the measurements and thereby produce a virtual "snapshot." Other systems containing large amounts of vertical plant and/or easement sections find this to be the only technique suitable for their system topography.

It may seem obvious, but it is well to note that there is little value in flying over a system that is very leaky. It is a foregone conclusion that it will fail the test and, with many leaks present throughout the system, the flyover results will give little indication of the actual locations of individual leaks. Some, however, have employed flyovers on the basis that the results obtained would give them a measure of the trouble they were in. CLI flyovers done before 1990 will not have any validity with the FCC. On the other hand, periodic flyovers coupled with a consistent and rigorous monitoring and repair program can be of great value to the cable operator, giving current evaluation of the effectiveness of the ongoing leakage control program.

Prior to any flyover, check that all technical records required by the commission are in good order, because there is always the prospect of an inspector from the Field Operations Bureau dropping by and asking for this material. Remember that the requirements for demonstration of periodic monitoring and recording of leaks, locations, causes and repair dates are already in effect under the provisions of Part 76.

Flight preparation

This preparation may seem as simple as "add the test signal and fly!" However, preparation for the overflight is one of the most important phases of the test program and requires a good deal of information, effort and control.

First of all, determine the flyover area. In a flight test program, the duration of the flight is determined by the area encompassed by the cable system and not by the number of strand miles. Flight tests are flown at a fixed altitude (1,500 feet) above the average terrain and are usually performed by flying parallel passes spaced to assure good coverage of leaks as governed by the shape of the aircraft receiving antenna pattern. This spacing is nominally something less than one-half mile. Normally, orientation of a flight pattern is chosen that gives the longest uninterrupted parallel paths so that turnarounds are kept to a minimum. Cable systems are often irregularly shaped; therefore, it is not always possible to make a very efficient survey pattern.

Other things also affect the patterns and efficiency of the overflight. A major one is the presence of airports and air traffic control areas. Flying directly over an airport is somewhat less dangerous than flying directly across the takeoff and landing patterns, but when flying near an airport with moderate to high traffic density proper clearances must be obtained. Often it is impossible to obtain clearance during the most desirable daylight hours. It is important that the person planning the flyover be aware of these situations to make the proper contacts prior to the planned flight and develop alternatives that may be used in case of changes in the weather, traffic, etc.

It is also necessary to select a test frequency. This frequency should normally lie within the aeronautical bands and great care must be exercised in its selection. Cable system personnel should note frequencies within the region that are used by high-powered and/or nearby transmitters and select test frequencies that are well removed from these signals and/or their harmonics. Measurements to be taken in a flyover are generally of quite small signals (they must be small or the system will fail). For this reason, very small harmonic energies, etc., may confuse the results. It is advisable

An aircraft awaits its next CLI flyover. Arrow designates the dipole antenna.

to add a distinctive audio modulation to the test signal so that if interference is present, the modulation will no longer be heard and the data can be flagged as suspicious. This implies the use of headphones or a loudspeaker in the aircraft so that the modulation is continually audible. Detection of the modulation by ear is more sensitive than most automatic methods.

In addition, strong signals adjacent to the test frequency can confuse the results, while a very strong signal at any frequency can cause overload problems in the receiver. For these two reasons preselector filters are usually employed to reduce the possibility of these types of interference.

There is one last, but not insignificant, cause of concern when performing flyover tests—the presence of distant signals on the test frequency cannot be heard on the ground, but are of significant levels in the air. For this reason it is advisable not to select any frequencies in the FM broadcast band except in very isolated regions. In addition, take care to avoid aircraft navigation or communication signals from remote locations.

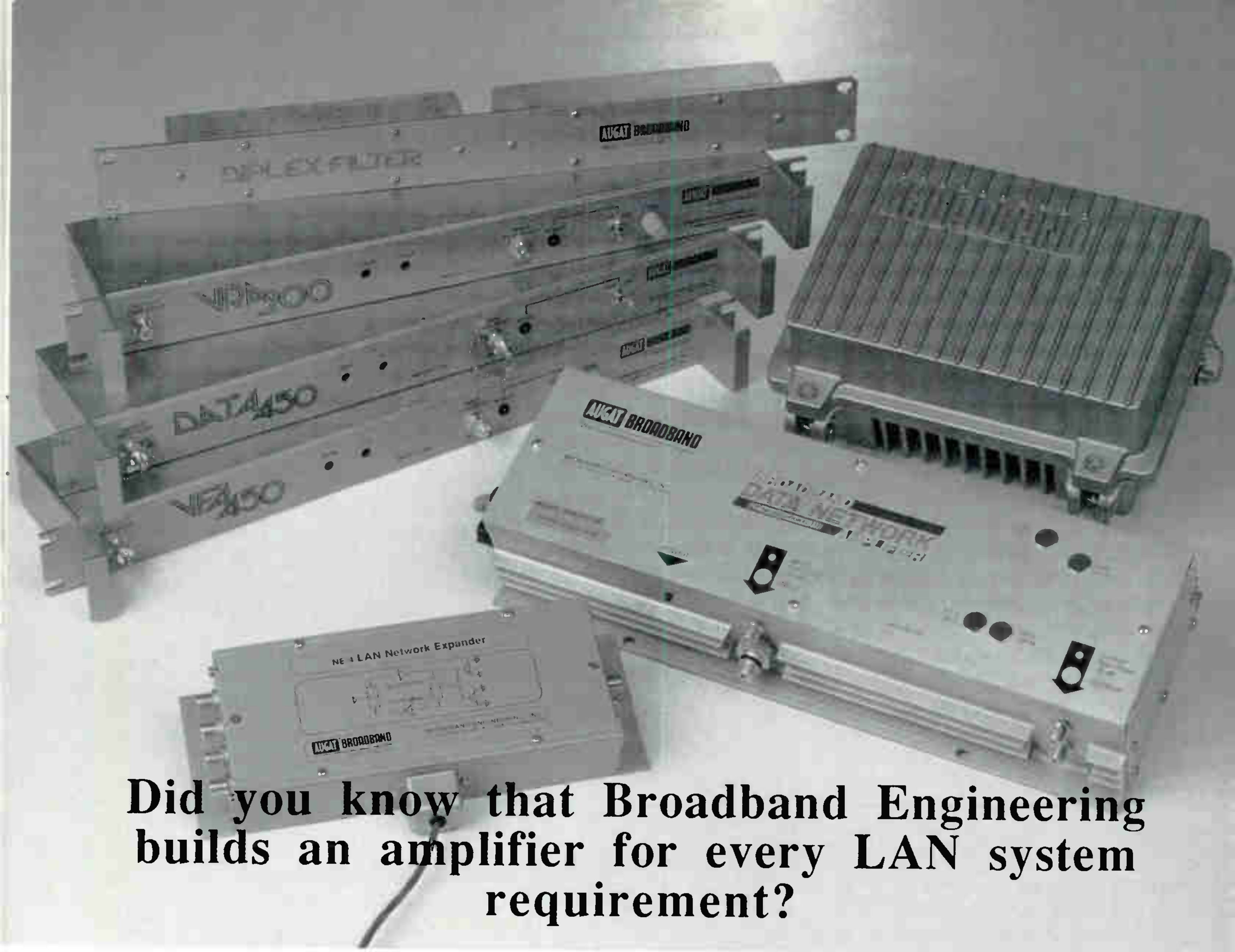
All of these frequency selection matters must be thoroughly investigated and noted by the cable operator prior to a flyover test. If interference is found once airborne, additional time must be used in reassigning and resetting the test frequency.

Prior to actual testing, another important area is to be sure that the test signal injected at one point reaches all portions of the cable system. This is generally not a problem unless there are amplitude-modulated link (AML) or microwave hubs or off-channel carriage on supertrunks that shift the frequency of the test signal. In some cases it is better to fly the system in sections, relocating the test generator in order to test the various parts. Obviously, it would be unwise to use a test signal that is similar and on the same frequency as that of an adjacent cable system. You probably have trouble enough with your own leaks and do not need the leakage of your neighbors to interfere.

Application of the test signal requires complete knowledge and understanding of the cable system design. The FCC Regulations Part 76.611(b)(2) requires that the signal be set equal to the level of the highest cable TV carrier on the system. Those concerned with signals on both trunk and distribution and where tilt is involved may find it necessary to insert the test signal at a considerably higher level than expected. The data taken for the test for submission to the FCC will require certification of the test signal level as well as the frequency and modulation.

During the flight

The cable operator's responsibility during the flight is simple but very important. The operator must control the test signal so it remains on and at the same level throughout the process. Again, in certification and submission of the data to the FCC this item is also the responsibility of the cable operator. As a precaution, it is well to equip the flyover vehicle with one of the cable company's hand-held radios in order to make constant



Did you know that Broadband Engineering builds an amplifier for every LAN system requirement?

It might surprise you to learn that we are the most innovative supplier of LAN amplifiers. That comes from listening to our customers and designing amplifiers that meet their requirements.

To meet our customers needs, we build rack mounted amplifiers for single and dual cable networks, a mid-split amplifier with a weatherproof housing and a highly efficient switchmode power supply. We also have mid-and high-split indoor distribution amplifiers.

Our rack mounted amplifiers are AC or DC powered. DC powered units are built for use with communications battery powering systems.

Another unique LAN product is our network expander for expansion from a single port to four ports. The network expander allows more terminals on an existing network without adding taps.

To find out about our full line of LAN products or for LAN application assistance, give us a call.

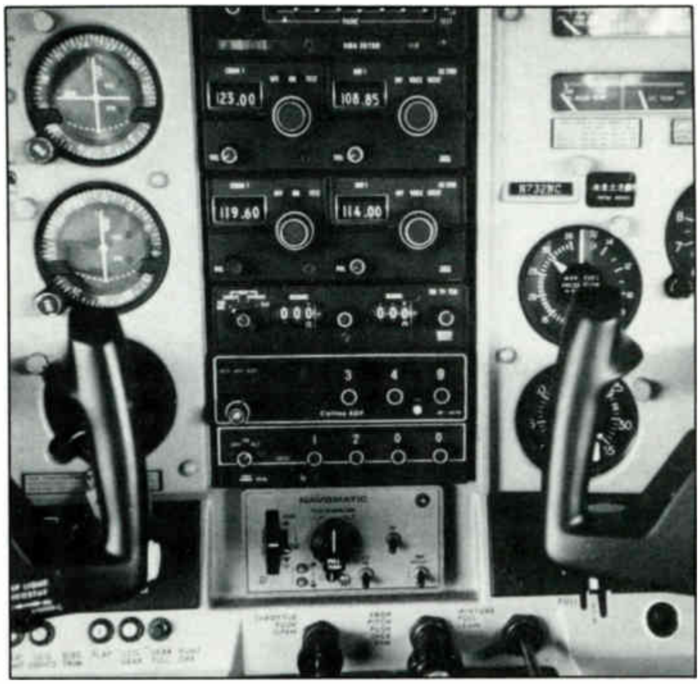
Call toll free at 800-327-6690. In Florida, call 305-747-5000 or write us at 1311 Commerce Lane, Jupiter FL 33458.

AUGAT® BROADBAND

Quality and Innovation

A part of the growing Augat Communications Group

Reader Service Number 17.



Courtesy Dovetail Systems

The test frequency selected should normally lie within the aeronautical bands. Audio modulation should be added to the test signal and made continually audible with headphones or loudspeaker.

communications available. If when becoming airborne it is found that there is some problem requiring frequency adjustments, etc., in-flight changes may be possible without aborting the flight and wasting expensive time.

One important factor in the flight is the calibration of the aircraft receiving system from a known source. FCC Part 76.611(a)(2) specifies the use of a particular antenna configuration and a signal designed to give a 10 μV/m signal strength at 1,500 feet above the antenna are normally made and the data recorded for later calibration of the remainder of the measurements in the data analysis phase. Although on-site calibration is specified by the FCC, it is likely that this requirement may be replaced by periodic calibration of the airborne measuring system.

After the flight

The first thing to do after the flight is to turn off the test signal and restore any changes that have been made in the system, such as turning off a channel or two. Depending upon the measurement system employed, some amount of preliminary data can usually be supplied prior to the formal data reduction phase. The real "proof of the pudding," however, is produced by relating the leakage measured to the geography of the system so that 1) areas of excessive leakage can be noted and 2) their locations determined for reparative action.

Ideally, a passing cable system will have no indications of leakage exceeding 10 μV/m at 1,500 feet above the average terrain. A very leaky system will show a "mound" of leakage over the cable system that will exceed the threshold by a substantial amount. A good system with a few substantial leaks will be somewhat of a "heart breaker" in that it almost passed. Such surveys make it plain that the leakage in the system is generally under control, but a few major leaks have developed to fault the leakage profile. In these cases technically the system has failed the test. It is likely that the FCC will consider additional engineering information showing that the system was brought into compliance and issue a "passing grade" without additional flyovers. In these areas of FCC discretion only time will tell as the treatment of many individual cases develops.

If anyone receives a sympathetic ear from the FCC, it is the one who demonstrates an ongoing and effective leakage reduction program that addresses the containment of CATV signals to within the system and thereby protects aeronautical and other over-the-air services from interference. So keep on monitoring. Keep on fixing. Let's make our goal "leak free" cable systems.

History of Docket 21006

By Cliff Paul
Consulting Engineer, RTK Corp.

The cable industry has had many technical problems to overcome in its history. However, Docket 21006, which governs cable systems in the use of aeronautical frequencies, could have a devastating effect.

Remember, the Federal Communications Commission is expecting cable systems to start performing cumulative leakage index (CLI) tests to check for leakage July 1, 1990. To put in perspective where this all started, I would like to give a history of what has occurred leading up to the present FCC requirements. Before starting, however, keep in mind that the band of frequencies 108-136 MHz and 225-400 MHz are Federal Aviation Administration frequencies and are controlled by the FAA, not the FCC. Also, the FAA is expanding the radio communications band to 137 MHz on Jan. 1, 1990.

The signal leakage problem has been around for a long time. As early as 1971, when the cable industry first began to use the mid-band, it drew the attention of the Office of Telecommunications Policy, the Department of Commerce, the FAA and the FCC. Since then these agencies have been aware of the potential danger of interference to licensed services posed by cable TV's use of aeronautical frequencies and began to monitor the performance of cable systems. The FAA was particularly concerned with cable's use of 108-136 MHz and later 225-400 MHz. During this time the FCC was content to monitor the progress of the channel expansion of cable systems.

The Harrisburg incident

It wasn't until 1976, when the first documented case of interference was discovered, that the agencies' growing concern turned into alarm. The first case is known as the "Harrisburg incident" and occurred in April 1976, when the FAA transferred a VHF omnidirectional radio range (VOR) frequency from upstate New York to the Harrisburg, Pa., area. The problem was found to be cable system pilot carriers operating on the same frequency as the VOR.

This incident was so serious in the eyes of certain people at the FAA that its director wrote the chairman of the FCC. It was requested that the FCC order cable systems using any of the FAA frequencies to stop operations until the FCC could assure the FAA that no system would leak signals.

Fortunately, there were some cooler heads at the FCC, FAA and in industry, allowing the commission to publish a Notice of Interest and a Notice of Proposed Rulemaking. The result was the First Report and Order, Docket 21006, adopted by the commission July 27, 1977, effective Jan. 1, 1978. This docket added Sections 76.610, 76.611 and 76.613 to Part 76 of the commission's Rules, adding frequency offsets, distance separation and power limitations to reduce the possibility of interference with aeronautical services.

Also, Section 76.610 of the Rules required cable systems wishing to use a frequency in the aeronautical bands to obtain FCC approval. However, if the applicant did not receive notification of approval within 60 days, the applicant could use the frequencies requested.

In addition to the technical aspects of Docket 21006, the FCC made three important points:

1) Waivers may be granted.
2) The Rules were interim.
3) Because the FCC was not sure the Rules promulgated were too restrictive, an advisory committee should be formed to study the subject of leakage and to make recommendations to the FCC on what changes, if any, should be made.

The Advisory Committee on Cable Signal Leakage was chartered Feb. 10, 1978. This research program was initiated to determine under what conditions, if any, cable systems could operate in the same geographical area with aeronautical radio services and not cause harmful interference. Participants in the program included representatives from the FCC, the FAA, the National Telecommunications and Information Administration, members of the cable industry and private aviation. The report titled "Final Report of the Advisory Committee on Cable Signal Leakage" was released Nov. 1, 1979. Rather than go into an exhaustive discussion of the work done by the committee, I suggest you purchase a copy of the report from the Society of Cable Television Engineers (Publication TR-2).

A brief summary of the committee's proposed regulatory approach is as follows:

1) The report is based on the fact that each cable system must have a routine monitoring program in place and perform a yearly cumulative leakage index (CLI) test to indicate the level of signal leakage at a specific time.

2) For aeronautical communications frequencies, allow use on any frequency if monitoring and CLI are performed. Exceptions are emergency frequencies 121.5, 243 and 156.8 MHz, where offsets are required.

3) For aeronautical navigation frequencies, offset 25 kHz ± 5 kHz.

4) For basic signal leakage at an altitude of 450 meters, power should be less than −100 dBm at the 90th percentile.

5) Acceptable evidence that leakage criteria is met includes:

a) CLI ($10\log I_{3000}$) is equal to or less than −7, or
b) $10\log I_{\infty}$ is equal to or less than 64, or
c) Airborne measurement indicates signal leakage power level at 450 meters is equal to or less than 10 μV/m.

6) The FCC retains authority to terminate use of frequencies, if necessary.

7) The FCC must be notified before the use of frequencies.

8) Threshold power level must be changed to 10^{-4} watts (38.75 dBmV). Reporting still should be at 10^{-5} watts (28.75 dBmV).

9) A routine monitoring program must be in operation.

10) Threshold for individual leaks is to be raised to 100 μV/m.

11) Cable systems should be allowed to continue present offset rules or meet new requirements. Grandfathering should be five or 10 years.

Remember, the Advisory Committee based its recommendations on: *"No offsets were needed from aeronautical communications frequencies provided there is a proper monitoring program in place to detect and repair signal leakage."*

Soon after the release of the advisory committee's report the FCC released "Further Notice of Proposed Rulemaking" in Docket 21006 on March 20, 1980. This second notice followed almost exactly the recommendations of the advisory committee. The initial and reply comment periods were at first April 25 and May 12, 1980, respectively, but by order on April 22, the dates were extended to June 25 and July 10, 1980, respectively. It was at this time that I was assigned the task of writing the draft of the forthcoming order. After the draft was completed and received tentative engineering approval, it was turned over to the legal department to be written in "legalese."

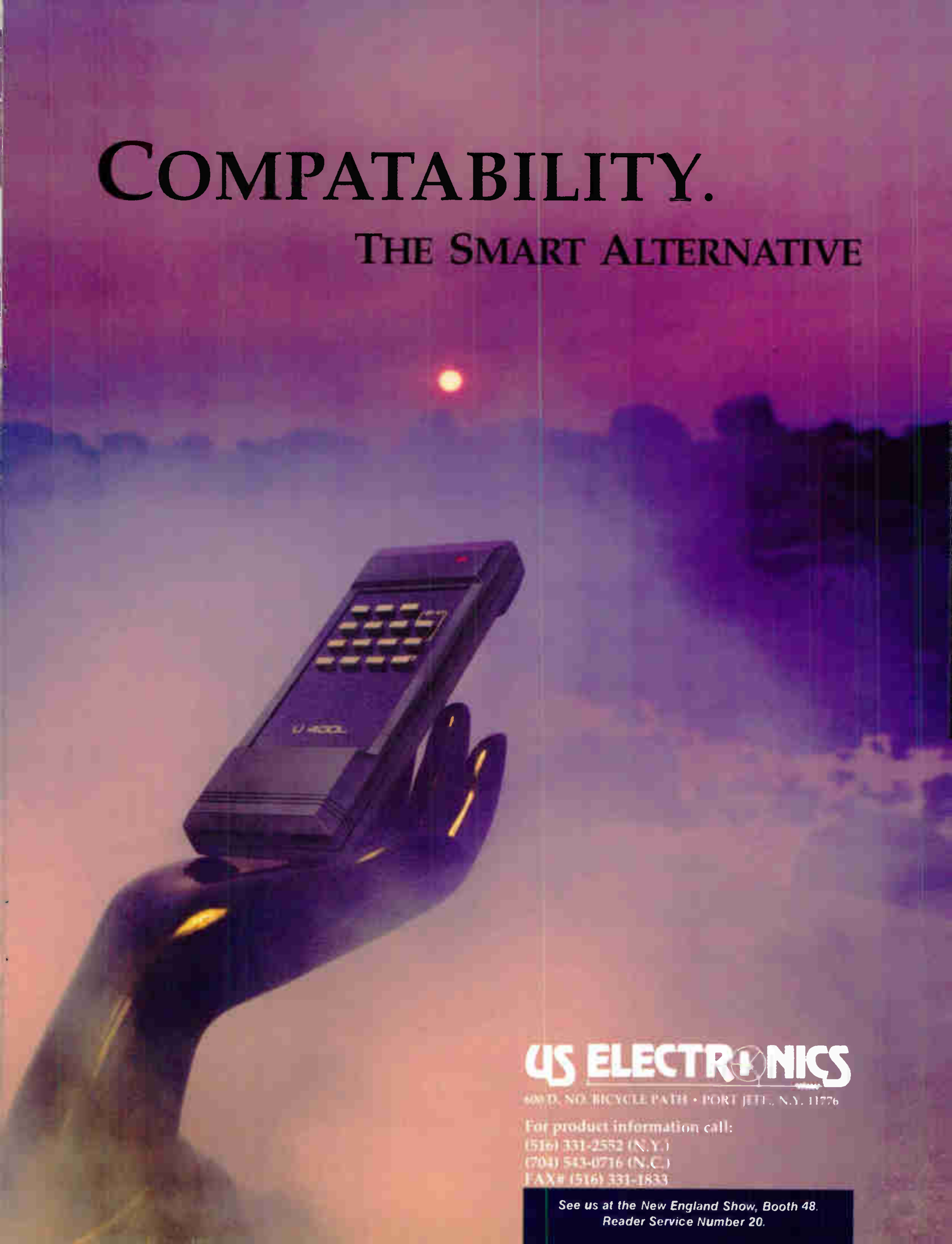
The Flint incident

However, in August and September 1980, an event occurred that changed the direction of the "Second Report and Order"; this was the "Flint incident." Up to this incident, only three cases of interference had been documented since the Harrisburg incident in 1976. These occurred in Oxnard, Calif. (pilot carrier); Wilmington, N.C. (pilot carrier); and Hagerstown, Md. (pilot carrier, during advisory committee flyover).

In the Flint incident, two commercial aircraft flying over Flint, Mich., at altitudes of 25,000 and 27,000 feet experienced interference when communicating with their air traffic controller in Oberlin, Ohio. The FAA reported this to the FCC field office in Detroit; within hours, the field inspector traced the interfering signal to one leak in the cable plant in Flint. After this leak was repaired, the aircraft reported no interference at its altitudes when flying over Flint. A closer inspection by the FCC field operations personnel found the system leaking very badly. The system was ultimately fined $20,000. (It should be noted that the cable system spent thousands of dollars, much more than the $20,000 fine, to clean up its plant.)

This incident had a two-fold effect on the FCC. First, it decided that to err on the side of safety, offsets must be included in the Rules for both communication and navigation frequencies. Second, the FCC for some time had suspected

"Each cable system must have a routine monitoring program in place and perform a yearly cumulative leakage index (CLI) test."


COMPATABILITY.
THE SMART ALTERNATIVE
U 4000
US ELECTRONICS
600 D. NO. BICYCLE PATH • PORT JEFF., N.Y. 11776
For product information call:
(516) 331-2552 (N.Y.)
(704) 543-0716 (N.C.)
FAX# (516) 331-1833
See us at the New England Show, Booth 48.
Reader Service Number 20.

You Can Tell How People Feel About

Let's get one thing straight. The C-COR you may have known in the past is history.

In its place we've built a new organization. With new management. New ideas. And a new sense of mission.

You might say we're the only new company in the industry with 34 years' worth of experience. A reputation for reliable products. And a track record in technological innovation as long as your shirt sleeve.

Appropriately enough, C-COR is a shirt sleeve operation, with dedicated, determined people from the president on down eager to roll up their sleeves and work with you on any size build, rebuild or upgrade project you can name.

Customer service? We're flat-out fanatic about it. This means having a C-COR engineer on your job site, training your own people at your location, so they know the system as well as you do.

You By The Kind Of Reception You Get.

It means an array of unique, computer-aided design services that let you test a new system before it's even built, or generate more revenue by squeezing as many channels as possible out of your current plant.

And it means a 24-hour hotline, so you don't have to wait a week for the answers you need today.

It comes down to this. The industry is starting to shake out. When it does, we intend to come out on top.

So from now on, whatever your needs, call us at 1-800-233-2267. Or write us at 60 Decibel Road, State College, Pennsylvania 16801. We're out to give you the best reception in the business.

C-COR® ELECTRONICS INC We're Out To Give You The Best Reception In The Industry.

See us at the New England Show, Booth #44. Reader Service Number 21.

that many cable systems using aeronautical frequencies had never reported them as required under Section 76.610 of the FCC Rules and Regulations.

Until the Flint incident the commission was receiving three to four applications per month. However, immediately after the incident, it began receiving many more, until the average number of applications peaked around 20 per day. Each application in most cases wasn't for just one frequency, but 20 or 30.

At this time a number of other events took place:

1) Up to this time all applications had to be processed by hand. Even with five people working on them, the backlog climbed to over 600. It became evident that a computer program was required. This program was created in record time, due mainly to the efforts of John Wong (of my staff and the Office of Science and Technology), who wrote the program. It was put in place in August 1981 and the backlog was quickly reduced to manageable levels.

2) The Rules had to be changed, since there was no way applications could be processed in 60 days as set forth in Section 76.610. This was done by order—85 FCC 2d 397 (1981)—which modified the notification procedure so cable systems could not operate in the aeronautical bands until the FCC gave approval to their applications.

3) At the same time this program was being established, the FCC determined that the field enforcement efforts should be stepped up and a concerted program of inspection began. This program was developed to determine how many systems were still using aeronautical frequencies and had not reported them, and to make cable operators aware of the problem of leakage.

4) A system of forfeitures (fines) was instituted, giving the field inspectors authority to levy fines on the spot.

5) Many other licensed services, such as amateur radio operators, police, ambulances, mobile radio and forestry, took a look at what leakage from cable systems might do to their services. For example, action was taken by the American Radio Relay League (ARRL), resulting in RM 4040.

As indicated earlier, the FCC decided to have the Second Order and Report rewritten due primarily to the Flint incident. The main revision was the addition of offsets. The offset for standard channel alignment was 12.5 kHz with a tolerance of ±5 kHz. For HRC it required a 6.0003 MHz comb generator with a tolerance of ±1 Hz. This precipitated Public Notice 07947, which invited all interested parties the opportunity to submit additional comments; by Public Notice 3310, the FCC notified all interested parties the final comment date was Sept. 11, 1981.

Docket 21006, however, was not presented to the FCC by its Cable Bureau. It wasn't until April 30, 1983, when the Cable Bureau and Broadcast Bureau were reorganized into the Mass Media Bureau, that work began again on Docket 21006. It was subsequently adopted by the FCC Oct. 26, 1984, and released Nov. 9.

On Nov. 16, seven parties petitioned for reconsideration, including ARRL, Archer Taylor, Capital Cities Cable, Heritage Communications, Jones Intercable and the National Cable Television Association. The issues raised by the petitioners for reconsideration concerned uniform frequency offsets, basic signal leakage, routine monitoring requirements, grandfathering, cable signal threshold power levels, notification requirements and leakage limits.

The commission on Jan. 30, 1985, issued Public Notice 2275, which clarified many of the issues. However, the Office of Management and Budget (OMB) had to review and approve the Rules before they became effective. This put many operators in a bind because they did not know whether to file an application under the old or new Rules. The FCC therefore conditionally approved applications filed between Jan. 30 and March 11, 1985, to use the aeronautical frequencies under the criteria in the Second Report.

On March 11, the OMB gave the FCC approval to use the new Rules, except for the annual basic CLI performance tests required of the cable operators. This requirement for CLI measurement by cable systems using aeronautical frequencies would commence July 1, 1990. All of these actions were covered in the FCC's Memorandum Opinion and Order released July 1, 1985.

So here we are just two years from July 1, 1990. It is suggested that the reader get out the latest copy of Part 76 Subpart K and review the Rules now.

Results of the rulemaking

Under the new Rules the FCC retained the frequency offset notification requirement, monitoring and logging requirements, CLI (effective July 1, 1990) and protection of emergency frequencies. It also retained the right to suspend any cable system's use of any frequency if there is harmful interference to radio communications involving the safety of life and protection of property if the interfering signal cannot be promptly eliminated.

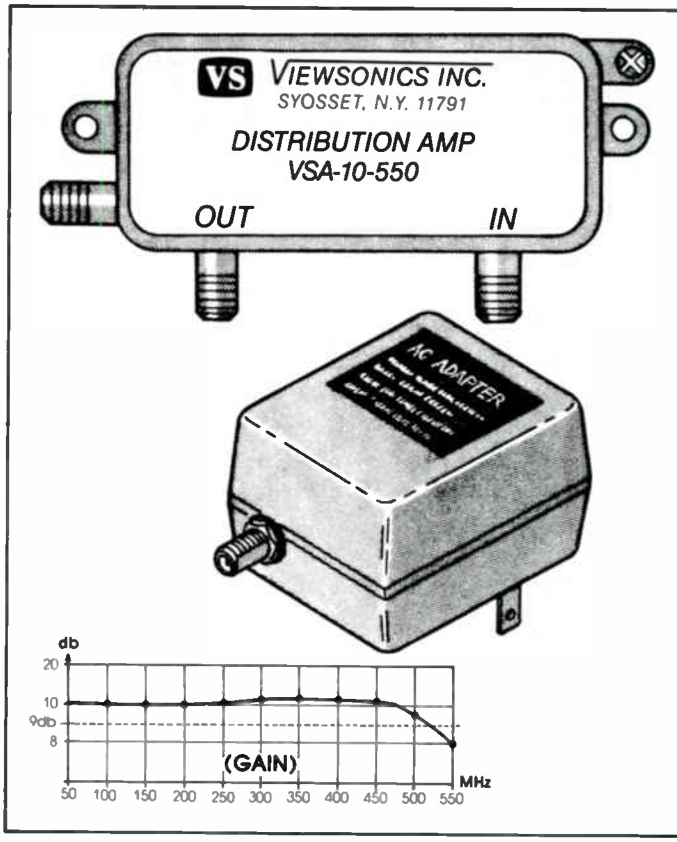
The cable industry was allowed relaxation in the signal threshold power level from 10^{-5} watts *peak* power to 10^{-4} watts *average* power. Aeronautical frequencies used by systems on or before Nov. 30, 1984, and cleared by the FCC are grandfathered with certain reservations until July 1, 1990. Cable systems using the new offset frequencies do not require prior clearance. However, they are required to notify the FCC in writing before they may use the new frequencies.

The path to the final rulemaking has not been an easy one for either the FCC or the cable industry. Making your system pass CLI will not in many cases be easy. The systems that have already instituted CLI measurements will have a greater chance for meeting the deadline. Remember, systems that are now grandfathered also must adhere to the new Rules on July 1, 1990. This not only means they will have to do routine monitoring and make CLI measurements but also realign their channels to the new offset requirements under the new Rules. Those systems hoping the FCC postpones the deadline may be in for a big surprise.

550 MHz Distribution Amplifiers

Best in Their Class!

- 78 CHANNELS
- SUPERB RFI INTEGRITY
- REMOTE, COAXIAL, 110 VAC POWER SUPPLY
- LOW DISTORTION CHARACTERISTICS



Model No. VSA-10-550
Model No. VSA-20-550

VIEWSONICS' apartment amplifiers are small amps with BIG line extender characteristics. Multiple dwelling units and long house drops now have a cost effective means for providing increased signal level without picture quality compromise....A virtually flat 50-550 MHz response with 10dB or 20dB gain and low noise, crossmod, triple beat and second order distortions.

Another VIEWSONICS first! UL approved, coaxially connected power supplies lend superior RFI technology and simplified installation. Utilizing standard drop cable and connectors, installers will fashion the power lead precisely to individual applications.

Model No. VSA-10-550-2W
Model No. VSA-20-550-2W

These units, similar to the above, offer the same performance with the added benefit of two-way capability. Both supply a passive return pathway for active reverse systems in the 5-30 MHz bandwidth.

Model No. VS-ISA-550

A 0-gain device, this active isolator utilizes comparable technology for the insertion of >40dB isolation against interfering off-air signal.

It is employed to prevent pick-up interaction between TV sets, VCR's, etc. or to shield the cable system from ingress of this high level broadcast signal.

SPECIFICATIONS:

Bandwidth:	50-550 MHz
Gain (fixed):	10dB or 20dB nom.
Slope (fixed):	Flat
Powering:	110 VAC Remote UL approved transformer, coaxial interconnect
Noise Figure:	7dB
Return Loss:	14dB min.
Distortions:	78 Channels @ +25 dBmV out
CTB:	< −70 dB
2nd Order:	< −74 dB
X-MOD:	< −70 dB

VS Viewsonics inc.

"PRODUCTS WITH INTEGRITY"

170 Eileen Way, Syosset, NY 11791
Call Toll Free: 800-645-7600
In New York Call: 516-921-7080
FAX: 516-921-2084

CLI revisited

This is the first of a two-part series on cumulative leakage index (CLI). Part II will address the management side of this topic.

By Pam King
Technical Training Coordinator
And John Green
Senior Quality Assurance Supervisor, Jones Intercable

We know you've heard it all before and you've been told, "Here is the formula, here are the requirements, here is your dipole, now go and do your CLI." So there you are, without a clue of your next direction, how long it will take or how many technicians are needed to complete the task. And July 1990 is not too far away. So first, we'll review some CLI basics for those who *haven't* heard it all before and then discuss how to perform a CLI.

Why do a CLI?

To put it simply, CLI testing identifies signal leakage that directly affects a cable system's picture quality. By using a CLI in conjunction with a preventive maintenance program and identifying and repairing leakage, you improve the overall operation of the system. This improvement includes better picture quality and satisfied customers.

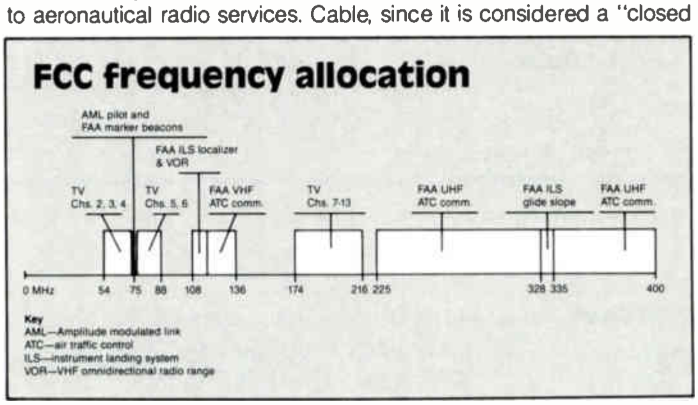
Also, the Federal Communications Commission requires all systems to perform CLI testing by July 1990 and pass with a figure of merit better than 64. However, this issue should be addressed not merely because it is an FCC requirement, but rather because the cable industry as a whole needs to convey an attitude of professionalism and concern for public safety.

Signal leakage was not much of a problem before the expansion of channel-carrying capacity. The mid-band frequencies are the same ones used for aircraft voice communication and air navigational aids, not to mention several other varieties of point-to-point services such as police, fire, forestry and industry.

The first incident in 1976 in Harrisburg, Pa., was a case of cable mid-band leakage that caused interference to an aircraft overhead. The Federal Aviation Administration was alarmed and demanded that all cable usage of these frequencies be stopped permanently. The cable industry defended its mid-band by saying that it would voluntarily monitor its systems and repair the leaks that were detected. The FAA agreed and there followed a period of about six years for cable during which time many systems did little or nothing about leakage.

In 1980, a second incident occurred over Flint, Mich., that caused interference to the voice channel of an aircraft flying many thousands of feet above the cable system. This resulted in an extremely thorough and professional analysis of the whole leakage situation involving flying grid patterns at various altitudes over large and small, old and new, and leaky and tight systems with data continuously going onto tape for lab analysis. The results were a better understanding of signal leakage, as well as FCC regulations. These flyovers indicate conclusively that the leaks in a system slowly form a "lumpy umbrella" of interference 15,000 to 25,000 feet over the system. The level of interference is the cumulative or accumulated effect of all the leaks, not just a few big leaks. The more leaks there are or the higher the level, the higher they extend.

CLI is a way to measure and determine the probability of interference to aeronautical radio services. Cable, since it is considered a "closed system," is not usually considered a source of interference to over-the-air radio services. However, poor construction or damaged cable could cause a leak strong enough to cause interference. CLI is a test designed to assess the overall signal leakage integrity of a given cable system at a given instant in time. This "snapshot" takes all the leaks above 50 μV/m into account and calculates a figure of merit. This potential to cause interference with aircraft and other communications is compared against an index of 64.



FCC frequency allocation

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

This formula gives a good indication of the potential for interference to aircraft. Typically, the larger the system for a given level of leak and number of leaks per mile, the greater the potential interference caused by the additive effect.

Harmful interference is any emission, radiation or induction that endangers the functioning of a radio navigation service or of other safety services, or seriously degrades, obstructs or repeatedly interrupts radio communication service. Candidates for possible interference include aircraft navigation/communication, radio amateurs, off-air TV reception, police, fire and industry users. Problems to cable systems include impaired pictures due to ingress, degraded overall (soft) pictures due to the addition of many degraded return losses, excessive and costly plant-related service and maintenance and aggravated system response problems. Last, but not least is the imposition of FCC fines and loss of credibility. The operator of a cable TV system that causes harmful interference should promptly take appropriate measures to eliminate it regardless of level.

FCC Rules Part 76.612 state that all aeronautical carriers greater than 10^{-4} watts (+38 dBmV) must be offset 12.5 kHz with ±5 kHz tolerance, with the exception of Channels A-1, A-2 and FF, which must be offset 25 kHz ±5 kHz tolerance. this includes multiples of 12.5 kHz and 25 kHz. The use of these offsets combined with a CLI index of less than 64 will eliminate the possibility of interference to aircraft communications and navigation. With this information in mind, all cable TV systems should offset and institute programs to ensure a passing CLI as soon as possible.

Prevention and training

During our initial CLI testing, we were surprised to observe that older systems do not leak any worse than newer ones. It appears that a diligent preventive maintenance program is a contributing factor. Also, studies have indicated that about 90 percent of signal leakage is caused by the drop portion of a system. Systems that have reduced their plant leakage have confirmed once again that this is the biggest producer of leaks in an otherwise well-maintained system.

Although individually lower in level, the cumulative effect of hundreds of leaking drops can be substantial. The best way to effectively combat this problem is to train all installers and service technicians in the proper way to perform installations. This includes arranging for all field personnel to have some form of detection equipment. If you find that after completing your leakage cleanup programs that your biggest problems are leaks caused by your own and contract installers, you are fighting a losing battle if you don't correct the situation.

Cable quality, cracks and poor construction also contribute to signal leakage. One way to avoid these problems is to make sure all new extensions comply with Part 76, thus ensuring a clean slate to begin with.

Per FCC requirements, there must be continuous monitoring, logging and repairing such that all parts of the system are covered on some set schedule. However, signal leakage monitoring and CLI testing are two different tasks. As stated earlier, the CLI test is a "snapshot" of your system's overall signal leakage integrity. Ideally, this should happen instantaneously. In addition to the CLI test, FCC rules state that cable TV operators transmitting carriers in the frequency bands 108-137 MHz and 225-400 MHz shall provide for a program of regular monitoring for signal leakage by substantially covering the plant every three months. This monitoring should be done during the daily activities of existing service personnel.

Technicians or installers properly equipped with leak detectors can perform random monitoring on a daily basis. A log should be kept of all leaks heard. Using a hand-held Dictaphone or tape recorder is an easy way to record leaks; the location of the leaks can be transcribed later. Logs should be returned to the office daily and kept in a binder. The logs can then be used to schedule repairs exactly like service calls, with the same mandated turnaround time as any other service call. (It must be noted,

RF leakage log

Date detected	Name of tech reporting leak & address or location	Source code	Cause of leakage and corrective action taken	Date correct and name of tech correcting

Source code
A—System monitoring B—Complaint of egress C—Complaint of ingress D—Complaint of picture quality

however, that repairing a leak is plant maintenance and should not be added into the total of service calls actually carried out.)

The purpose of the monthly ride-out is to determine the leaks outstanding. This refers to the estimated total number of leaks still remaining to be repaired. This method is especially important when the number of leaks is low. If leaks outstanding equal five, and leaks repaired equal 15, the resulting percentage of leaks is 300 percent; obviously not meaningful. "Leaks found" needs to be quantified by a mileage. Leaks outstanding can be statistically derived from a 10-mile sample as follows:

Leaks per mile = leaks > 20μV/m/actual miles driven

Leaks outstanding = (leaks per mile) × (total plant miles)

As an example, System A has had a leakage elimination plan running for several months, and 210 miles of its 500-mile plant are considered "repaired." System B has a balance of 290 miles. The monthly ride-out provided the following numbers:

In 5.4 miles of System A, identified three leaks total.
In 4.7 miles of System B, identified 16 leaks total.
System A leaks per mile = 3/5.4 = .556
System A leaks outstanding = .556 × 210 = 117
System B leaks per mile = 16/4.7 = 3.4
System B leaks outstanding = 3.4 × 290 = 987
Total leaks outstanding = 117 + 987 = 1,104

Reader Service Number 23.

Annual CLI

Every mile of plant should be driven out at least once a year. One way to do this is to divide the system into manageable areas using maps of a reduced size—small enough to be conveniently handled in the vehicles, but large enough to show individual streets. As each street is driven and logged it can be highlighted with a marker. This notation helps avoid driving any given street more than once and also helps prevent missing a street. The finished map can be kept on file as part of your log. The correct speed to drive is approximately 20 miles per hour, depending on your equipment.

When your scanner indicates that the leak is strongest, stop and measure the leak. Using a hand-held dictation machine in conjunction with the maps is an efficient way to do this logging. A neatly typed log can then be produced in the office from the tapes. By noting leaks on the map, potential problem areas or "hot spots" can be identified. Remember that fixing leaks is *not* part of a CLI test. Repair should be prioritized and scheduled the same way as service calls.

There are a few different philosophies describing the actual fixing procedures. One philosophy states that available time and energy should be devoted to an ongoing structured clean-up program. To do this, start with one manageably sized subdivision or area, clean it up completely and then keep it that way while moving on to the next adjacent area. In this manner, an area of leak-free plant can be built up, maintained and expanded in a logical and orderly manner. This helps eliminate logging the same leaks over and over without cleaning them up. Also, you will not be overwhelmed by the apparent size of the problem by attacking a manageable piece at a time.

Others have found cleaning up the large leaks first works to their advantage. This way, the "phantom" leaks are eliminated. You need to examine the best way for your system.

FCC Rules Part 76.609(h) describes the measurement techniques and equipment required for performing CLI testing or monitoring. Be sure to verify that your equipment meets these specifications.

If your system's layout allows, it may be possible to have a horizontal dipole antenna on the system where all the trucks pass every day. You can easily make a dipole or buy one. To set up the system, use a feed of the desired carrier via a pad box and make arrangements such that the trucks can drive under the antenna, which will be exactly 10 feet above the horizontal truck dipole. The transmitting antenna should be at least a half wave away from any substantial sheet metal or reinforcing. Calibrate a receiver under these conditions using the internal white noise generator, then use the pad box to produce the same 20 μV/m on the receiver. Finally, replace the pad box with a fixed value pad. Trucks carrying leak detectors can drive under this setup every day when leaving for the field.

Logs

The cable operator must maintain an ongoing log containing the following information:

- date and location of each leakage source
- date on which the leak was eliminated
- the (probable) cause of the leak

The log must be kept on file for two years and be made available to authorized representatives of the FCC upon request.

Assistance with CLI calculations is available through a Lotus-based, macro-driven computer program, developed by Bruce Catter at Jones Intercable, that performs the calculations and serves as a log as well. Jones Intercable will make this program available at no charge. To receive a copy send a formatted 3½-inch or 5¼-inch disk and a self-addressed postage paid mailer to: Pam King, Jones Intercable, 9697 E. Mineral Ave., Englewood, Colo. 80112.

This overview by no means tells you everything you need to know about CLI, but it gives you a starting point. Be sure to familiarize yourself with FCC Rules Part 76 before starting. Contact the FCC to arrange a class for your system, if possible. Then train your people to be consistent in the recording of data and most important, eliminate the causes of signal leakage.

The authors would like to thank Roy Ehman and Bruce Catter of Jones Intercable for their input on this article.

FCC leakage limits

By Martin J. Walker
Vice President of Engineering, Simmons Communications Inc.

The FCC limits on leakage are 15 $\mu V/m$ at 100 feet for frequencies up to and including 54 MHz or frequencies over 216 MHz, and 20 $\mu V/m$ at 10 feet over 54 MHz up to and including 216 MHz. Since most systems use a signal level meter calibrated in dBmV to measure leakage, the accompanying chart provides an easy go/no go threshold for each channel.

To convert dBmV to $\mu V/m$, you must first convert from dBmV to μV with the formula

$$\mu V = 1{,}000 \times 10^{\left(\frac{dBmV}{20}\right)}$$

then convert μV to $\mu V/m$ with the formula

$$\mu V/m = \mu V \times 0.021 \times f_{MHz}$$

where:

f_{MHz} is the frequency (in MHz) of the signal being measured.

To convert $\mu V/m$ to dBmV, you must first convert from $\mu V/m$ to μV with the formula

$$\mu V = \frac{\mu V/m}{f_{MHz} \times .021}$$

Then convert μV to dBmV with the formula

$$dBmV = 20\log_{10}\left(\frac{\mu V}{1{,}000}\right)$$

Channel	dBmV	Measurement (in feet)
2*	–37.6	100
2	–35.3	10
3	–36.2	10
4	–36.9	10
5	–38.2	10
6	–38.8	10
FM band**	–40.3	10
A–2	–41.2	10
A–1	–41.7	10
A	–42.1	10
B	–42.5	10
C	–42.9	10
D	–43.3	10
E	–43.7	10
F	–44.0	10
G	–44.4	10
H	–44.7	10
I	–44.9	10
7	–45.3	10
8	–45.6	10
9	–45.9	10
10	–46.2	10
11	–46.4	10
12	–46.7	10
13	–46.9	10
J	–49.7	100
K	–49.9	100
L	–50.1	100
M	–50.4	100
N	–50.6	100
O	–50.8	100
P	–50.9	100
Q	–51.2	100
R	–51.4	100
S	–51.6	100
T	–51.8	100
U	–51.9	100
V	–52.2	100
W	–52.3	100
AA	–52.5	100
BB	–52.7	100
CC	–52.8	100
DD	–53.0	100
EE	–53.2	100
FF	–53.3	100
GG	–53.5	100
HH	–53.6	100
II	–53.8	100
JJ	–53.9	100
KK	–54.1	100
LL	–54.2	100
MM	–54.4	100
NN	–54.5	100
OO	–54.6	100
PP	–54.8	100
QQ	–54.9	100
RR	–55.0	100
SS	–55.2	100
TT	–55.3	100
UU	–55.4	100
VV	–55.5	100
WW	–55.7	100
XX	–55.8	100
YY	–55.9	100
ZZ	–56.0	100

*HRC only
**middle of band

Enter the 6th Dimension

Announcing T6

A cutaway of T6 cable.

Enter a world of sight, sound and higher definition television. A world where emerging technologies can be handled easily. A world where 600 MHz capacity cable exists. Enter the world of T6, the future dimension in trunk and feeder cable from Times Fiber Communications.

Why risk a costly upgrade with 450 or 500 MHz, when the highest capacity is available now! T6 is the only cable which is specified to consistently sweep to 600 MHz.

Specify a 600 MHz bandwidth cable for your semiflex needs.

T6, the advanced generation semiflex cable from Times Fiber, features the exclusive triple-bonding and full wall seamless construction. This construction provides increased protection against the elements, improving reliability and extending cable life.

Specify 600 MHz for your rebuild, upgrade or new plant. Enter the 6th dimension of total spectrum efficiency with T6 semi-flex and drop cable.

For more information contact:
Times Fiber Communications, Inc.
358 Hall Avenue
Wallingford, CT 06492
(203) 265-8482 or 1-800-TFC-CATV

TFC TIMES FIBER COMMUNICATIONS, INC.
an LPL company
358 Hall Ave · P.O. Box 384 · Wallingford, CT 06492

TFC *...Where technology meets the bottom line.*

Reader Service Number 27.

We're making a deep notch in the new trap generation!

Reader Service Number 28.

PRODUCTION PRODUCTS COMPAN
One Mezzy Lane
Manlius, New York 13104
1-800-468-2288
Tele-Fax 315-682-2386

Fundamentals of spectrum analysis

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

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

An amplitude modulated signal, when viewed in the time domain (as with an oscilloscope), might appear as in Figure 1. From this, we can determine the frequency of the carrier (f_c) and the frequency of the modulation (f_m). In addition, the percent of modulation can be calculated from the equation:

$$\text{Percent of modulation} = \frac{E_{max} - E_{min}}{E_{max} + E_{min}} \times 100$$

Figure 1

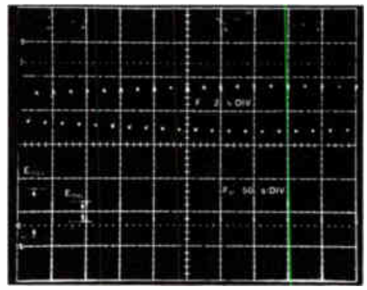


Figure 2

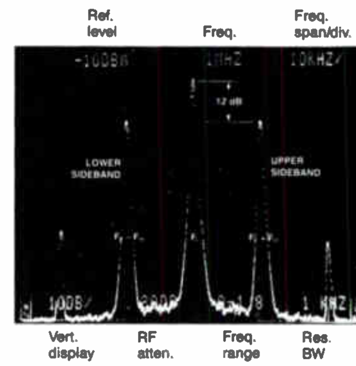


Figure 2 represents the same signal being displayed in the frequency domain on a spectrum analyzer. From this display f_c and f_m also can be determined. The percent of modulation also can be determined by noting the difference in amplitude (12 dB) between f_c and f_m and using Figure 3.

Figures 1 and 2 were prepared under controlled test conditions. In normal operation, the modulation will not be a pure sine wave but a

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

Figure 3

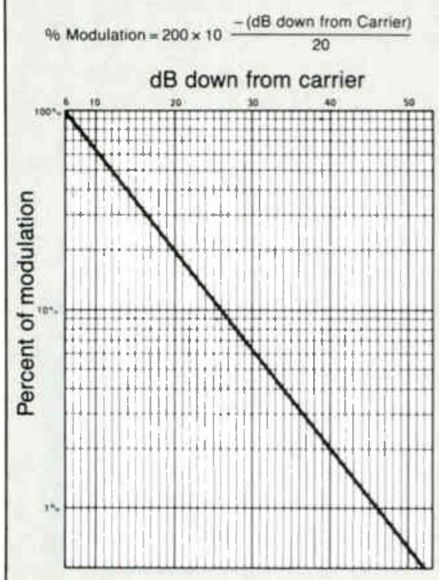
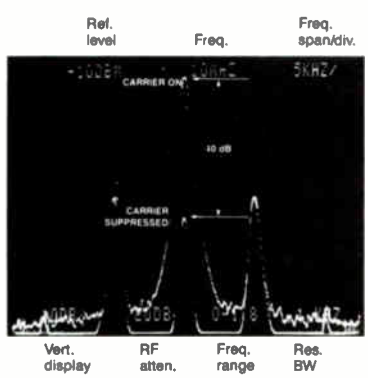


Figure 4

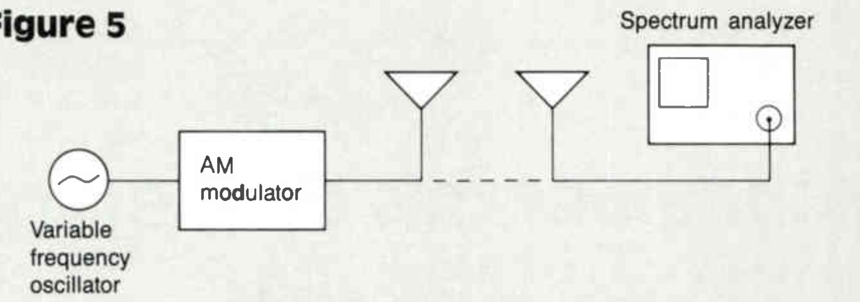


composite of multiple sine waves, and their frequencies cannot be determined in the time domain. However, the spectrum analyzer will accurately display all frequencies present.

A suppressed carrier system would be displayed on the analyzer as in Figure 4. The typical measurements to be made in this system would be carrier suppression. The measurement is the difference in carrier amplitude between when the carrier is turned on and when it is turned off. Figure 4 indicates the carrier is suppressed by 40 dB. Similarly, if the lower sideband were suppressed as well, we could determine the amount of this suppression by noting the difference in amplitude between the upper and lower sideband.

Another type of measurement that could be made on an AM system would be to check system flatness by sweeping the audio input with an audio generator of known or verified flatness. The RF carrier could then be monitored in a narrow span/div. and a deflection (scale) factor of 2 dB/div. By using the "max hold" function, we could construct a waveform to indicate the flatness of the total system. This waveform would also indicate any emphasis placed on the audio. Figure 5 shows the system described, and Figure 6 is a waveform of such a sweep.

Figure 5



"The total harmonic distortion...can be determined by noting the amplitude difference between the modulation signal and its harmonic products."

From Figure 6 we can see the system flatness of 1.3 dB (which in reality may be a type of emphasis placed on the audio), and the system 3 dB bandwidth in excess of 8 kHz. Both lower and upper sideband envelopes should be symmetrical. If the transmitter were seriously mistuned or was working into a poor antenna match, the spectrum analyzer would show how each sideband was individually affected.

Distortion

Distortion is the result of electronic circuits operating in a non-linear mode. Two of the most common methods of checking for distortion involve driving the equipment with known signals and monitoring the equipment output for signals other than those present at the input.

Harmonic distortion: A typical harmonic distortion measurement would be set up as in Figure 5 with the variable frequency oscillator set at some specified frequency. The modulator should be driven to a specified percent of modulation and the spectrum analyzer should be checked for the presence of only the signal that is put into the modulator. If harmonic distortion is occurring, additional products will appear on the screen at multiples of the modulating frequency. Figure 7 shows the result of a modulator being driven with a 5 kHz test signal. Harmonic distortion will show up as signals at 10 kHz, 15 kHz, 20 kHz, etc., from the carrier. The total harmonic distortion (THD) can be determined by noting the amplitude difference between the modulation signal and its harmonic products.

The sum of all the harmonic products must be used to determine the percent of harmonic distortion. THD can be determined by noting at what level below the fundamental each harmonic lies and by determining the percent ratio for each harmonic from Figure 8 and substituting in the following equation. This equation is only accurate if the upper and lower harmonic pairs are within one or two dB of each other.

Figure 6

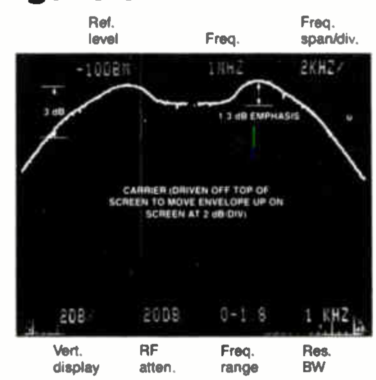
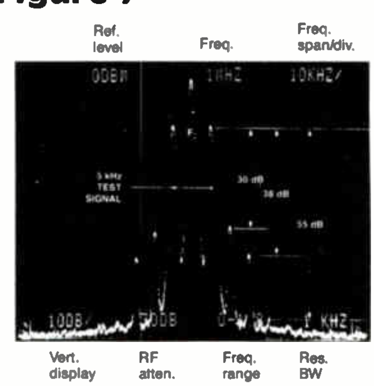


Figure 7



THD in percent =

$$\sqrt{\begin{aligned}&(\text{Second harmonic percent})^2\\ &+ (\text{third harmonic percent})^2\\ &+ (\text{fourth harmonic percent})^2\\ &+ \text{etc.}\end{aligned}}$$

From Figure 7, the THD is

$$\sqrt{0.0325^2 + 0.012^2 + 0.0018^2} = 0.035 = 3.5 \text{ percent}$$

When making this measurement, it is important to be sure the modulating signal from the audio oscillator is free from any harmonics. To do this, check the signal source with a spectrum analyzer.

Intermodulation distortion: An additional measurement common to amplifiers or trans-

Figure 8

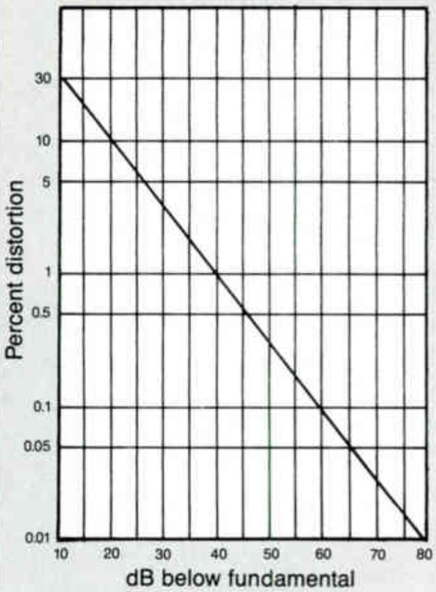
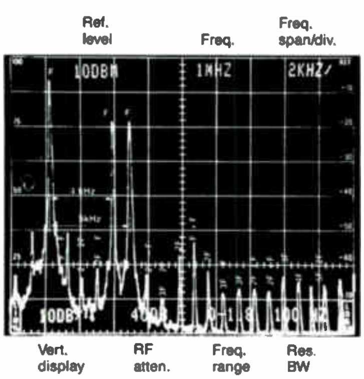
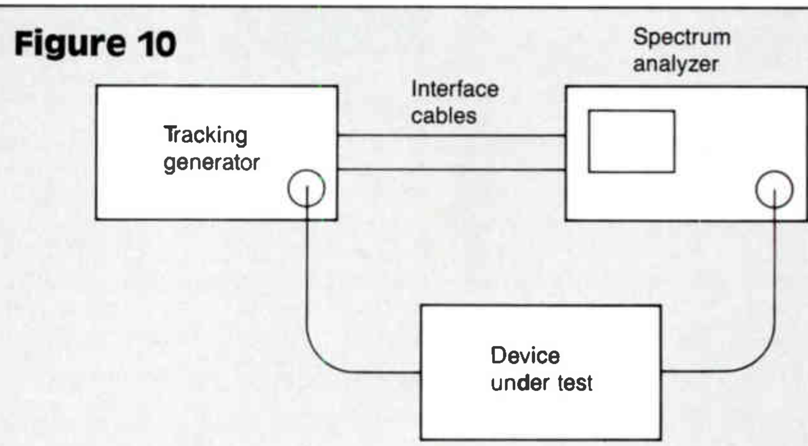


Figure 9



mitters is the two-tone intermodulation distortion (IM) test. This test is similar to the harmonic distortion check, except it requires an additional audio signal generator. The two audio generators are combined, and the result is applied to the modulator. The method of combining the two signals is very important, as mixing the two sources with each other can create unwanted products. Combining should occur in a directional bridge. A "T" connection or combiner can be used, provided each generator is sufficiently padded. A spectrum analyzer should be used to check the output of the directional bridge or combiner for any signals other than those applied prior to modulating the transmitter. The frequency of the modulating signals depends on the type of test to be performed and the type of equipment being checked. Our example uses a 4 kHz (f_1) and 5 kHz (f_2) signal. There are multiple IM products created, of which the first one is called the second-order IM product, which will occur around the carrier at $f_1 + f_2$, $f_1 - f_2$ and/or $f_2 - f_1$ (9 kHz and 1 kHz from the carrier). The third-order IM products will occur at $2f_1 + f_2$, $2f_1 - f_2$, $2f_2 + f_1$ and/or $2f_2 - f_1$ (13 kHz, 3 kHz, 14 kHz and 6 kHz from the carrier). Figure 9 shows a typical response and identifies the various second- and third-order products.

Figure 10



A tracking generator (TG), when used in conjunction with a spectrum analyzer, allows such items as filters, amplifiers, couplers, etc., to be observed with respect to frequency (i.e., frequency response). This is performed by connecting the output of the TG (output frequency is synchronized to frequency being analyzed by the analyzer at any point in time) to the input of the device being tested, and monitoring the output of the device with the spectrum analyzer (as shown in Figure 10). This type of measurement is known as an S12 magnitude-only measurement, since the phase shift of the signal through the device is not displayed.

The response displayed on the screen of the analyzer will be a combination of the unflatness of the TG and the response of the device being tested. The unflatness of the TG can be removed by using the "B-save A" function of the analyzer. First, connect the TG to the analyzer and save the flatness (or unflatness) of the TG/analyzer in the A memory by using the analyzer "save" function, and using the "vert. display" mode that will be used in the measurement. Then, connect the TG to the device being tested and monitor the device with the analyzer. Once a sweep has been made, the analyzer display will indicate the system response. By activating B-save A, the saved unflatness of the TG will be subtracted from the response of the system, and the corrected display will indicate the corrected frequency response of the device being tested.

Understanding multipath distortion

By Blair D. Fire
CATV Consultant
Precision Signal Corp., Off-Air Division

When multipath distortion (commonly referred to as "ghosting") appears on TV pictures distributed by CATV systems, telephones start ringing in the front office with calls from dissatisfied subscribers. One reason subs switch from rooftop off-air antennas to cable is because CATV operators promise superior reception of broadcast signals. Subs have been known to revert solely to their antennas because expectations are short lived.

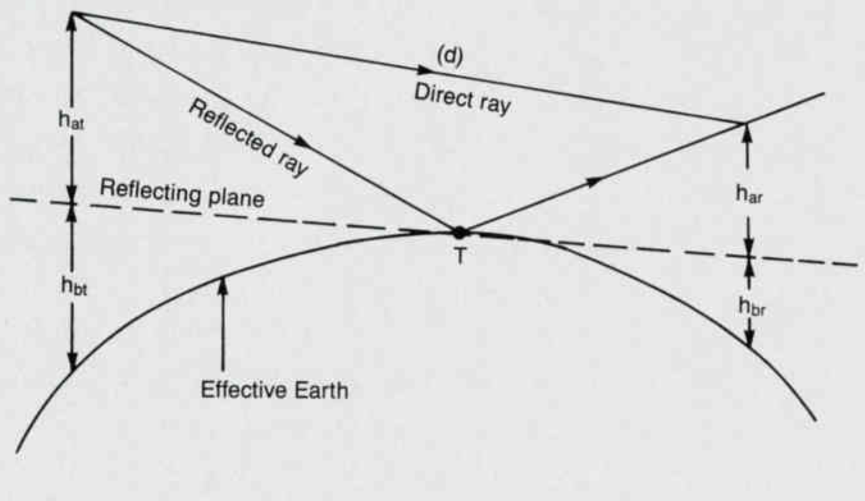
Studies into the causes and techniques for elimination of this multipath distortion interference will ultimately attract more subs (and hopefully keep them) because the cable system will deliver its promise of superior reception.

When a TV signal is transmitted, irrespective of polarization, it is susceptible to reflections (interruptions) of its intended free-space propagation by Earth ground obstructions—buildings, trees, etc., that provide reflective properties—that cause a time delay relative to the direct ray, which is the desired signal. Figure 1 illustrates the effects on a broadcast signal as it collides with effective Earth (behaving in a nonabsorbing, reflective manner) and reflecting onward to the receiving antenna at the identical frequency of the original direct ray. This model uses one reflective ray for illustration purposes; however, in theory the number of reflections that may occur is unlimited. When the ratio of the amplitude of the direct ray is not sufficiently greater than that of the reflected ray(s), multipath distortion will appear at the receive antenna output.

A single reflection combines in phase with the direct ray in the polar pattern of an off-air antenna, producing a ghost.

Identification of multipath effects, as opposed to other problems that cause ghosting, can be confusing. The accompanying photo shows an extreme case of a single reflection combining in phase with the direct ray in the polar pattern of an off-air antenna. Note that the ghost created by the reflection is identical to the primary image, but with substantially less amplitude. Second, the horizontal sync pulse (referred to by complaining subs as a "bar") is pronounced well into the picture pattern. Third, the ghosting is to the right of the primary image, which is usually the case with reflected signals. Finally, in severe cases, distortion is perceptible in the color burst and affects the audio carrier.

Figure 1: Signal reflected to effective Earth



From a technical perspective, examination of the delay response can be viewed only on a voltage-against-time basis. The equipment setup for accurate measurement includes a high quality off-air antenna, a precision demodulator and a waveform monitor. Delay cannot be readily seen in the picture carrier but can be examined by looking at the horizontal blanking interval of the video signal in question. Figures 2 and 3 compare a normal video signal and one containing a reflection.

The nature of reflection

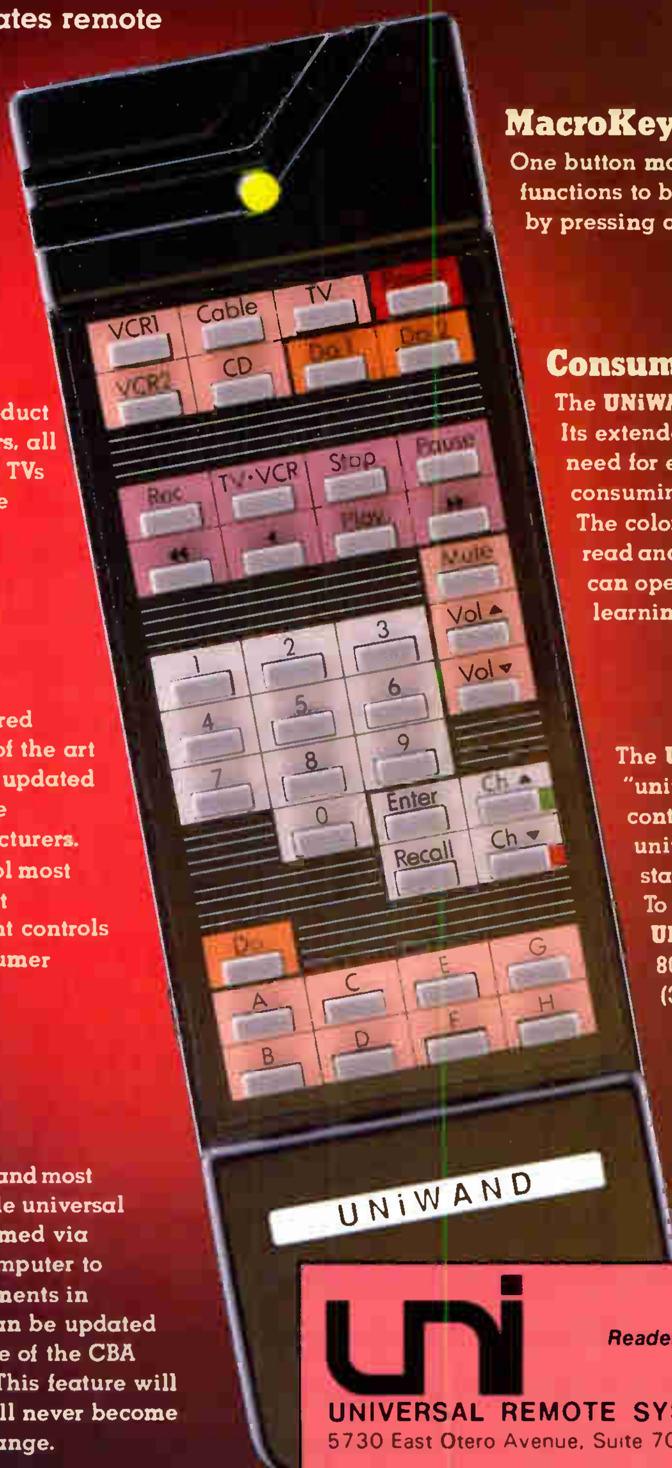
At this point, examination into the basic nature of reflection and resulting degree of distortion received by an off-air antenna needs to be addressed:

1) *Site of transmitter in relation to reflection surface(s):* Reflective surfaces may exist within the free-space propagation range of the transmitter site. Choice of site (or what frequently happens,

The one remote control for *ALL* your wireless remote components— *NOW...AND IN THE FUTURE*

The difference in universal remote control units is **UNiWAND**. The state of the art, user friendly, programmable hand controller.

The **UNiWAND** eliminates remote clutter, simplifies subscriber operation and will never become obsolete.



MacroKeys

One button macro keys allow multiple functions to be stored and implemented by pressing a single keystroke.

Audio/Visual Compatible

The **UNiWAND** enables the subscriber to control any product including all CATV converters, all VCRs, all CD players and all TVs manufactured with IR remote capability.

Consumer Friendly

The **UNiWAND** is a quick learner! Its extended database eliminates the need for extensive and time consuming learning modes. The color coded keys are easy to read and easy to use. The subscriber can operate the **UNiWAND** by learning just a few simple steps.

Latest Technology

The **UNiWAND** is manufactured under the most recent state of the art techniques. The database is updated continuously as new codes are implemented by the manufacturers. It has the capability to control most special features such as split screens, remote color and tint controls available on the latest consumer electronic products.

The **UNiWAND** is a truly "universal" universal remote controller. This very affordable unit will soon become the standard for the industry. To get all the facts about **UNiWAND**, call toll-free 800-777-2259 or (303) 694-6789 today!

Never Obsolete

The **UNiWAND** is the simplest and most cost-effective reprogrammable universal remote. This unit is programmed via an IBM PC or compatible computer to include any future advancements in technology. The controller can be updated at the cable office or any one of the CBA service centers nationwide. This feature will insure that the **UNiWAND** will never become obsolete as product lines change.

uni

Reader Service Number 33.

UNIVERSAL REMOTE SYSTEMS, INC.
5730 East Otero Avenue, Suite 700 • Englewood, CO 80112
A subsidiary of Cable Exchange, Inc

no choice) by broadcasters is key to this phenomenon. For example, in Chicago, two principal sites for TV transmitters exist: to the east, The John Hancock Building; to the west, The Sears Tower. Both are located approximately one mile from each other and are the highest sites in the area. Therefore, they provide the farthest possible range for signals to propagate. However, The Sears Tower is within the range of the transmitters located on the top of The John Hancock. The Sears Tower has proven to be a highly reflective surface; thus, signal quality from the transmitters on The John Hancock is adversely affected.

2) *Amplitude of direct ray on impact of reflection surface(s)*: This interaction ultimately determines the range of the reflection ray vector. The effect on an off-air antenna varies with conductivity of reflection surface and depends on impact relative to distance. At lower frequencies, for example, the length of the direct ray sinusoid is longer and thus will propagate farther. Accordingly, it will have more field strength available to react with reflection surfaces at farther distances. This is opposed to higher frequencies colliding with the same surface having little or no distortion on the picture pattern.

3) *Conductivity of reflection surface(s)*: Conductivity of the reflection surface determines: a) whether it is a reflective or absorbing surface and b) field strength retained by reflection ray relative to direct ray after impact determining range of reflection ray vector. Surfaces in general have particular levels of conductive retainance. In theory, the Earth is considered the perfect conductor (however, in actuality we know this is not the case), therefore also a good reflector—in most cases. On the other hand, man-made materials such as concrete have very little or no conductive qualities; thus, it is a non-reflective, absorbing surface. A point worth noting for practical purposes is that weather (precipitation/water) can turn a non-conductive surface into a conductive (therefore reflective) one.

"Choice of site by the CATV operator for receiving broadcast signals means the difference between success or complaining subscribers."

4) *Contour of reflection surface*: Two shapes of reflection surfaces exist: a) *specular*, meaning a "smooth surface"; and b) *diffuse*, meaning "rough." The latter creates multiple angles of incidence, therefore varying vectors and ranges. Specular surfaces produce a single angle of incidence and consistent vector and range.

5) *Received amplitude of reflection(s) vs. direct ray by off-air antenna*: To show relation between these components it is convenient to return to Figure 1. Simplified for illustration purposes, one reflected ray combining with the direct ray at the receiving point is used. The resulting field strength (neglecting the difference in angle of arrival and assuming perfect reflection at "T") is related to the free-space intensity, irrespective of the polarization, by

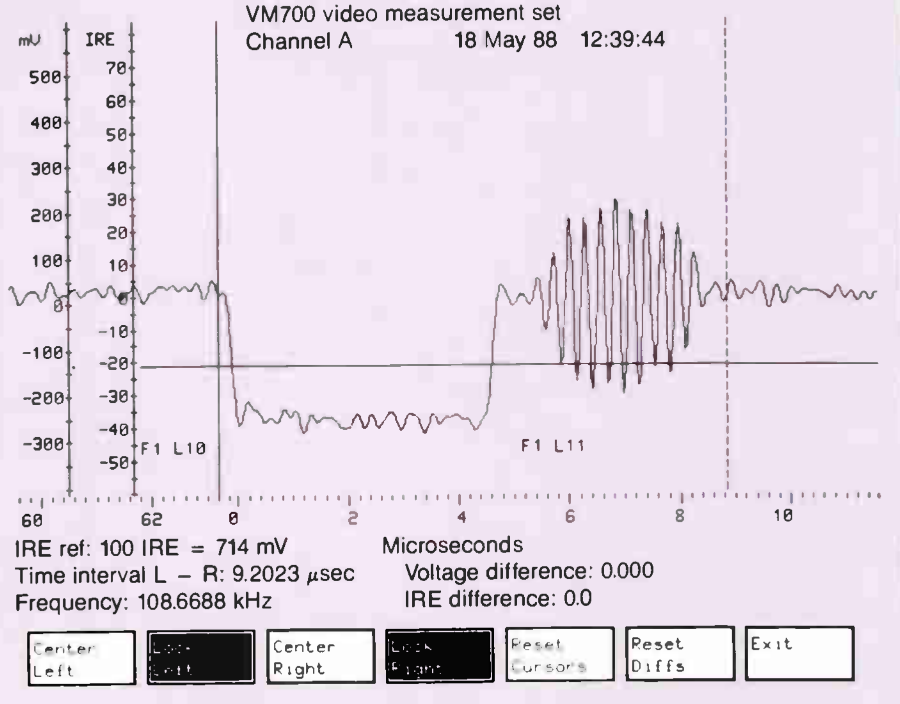
$$E = 2E_d \sin 2\pi(\delta/2\lambda)$$

where:
E = resulting field strength } same
E = direct ray field strength } units
δ = geometrical length difference between direct and reflected paths, which is given to a close approximation by $\delta = 2h_{at}\,h_{ar}/d$, where h_{at} and h_{ar} are the heights of the antennas above a reflecting plane tangent to the effective Earth.

6) *Polarization used by transmitter*: Polarization used by the transmitter, in relation to the transmitter site, has effect with respect to multipath distortion. Horizontal polarization, the type usually used by television broadcasters, transmits signals that lie in a horizontal plane and therefore are more susceptible to reflection. For known distortion problem vectors and ranges, for example, some types of horizontally polarized transmit antennas can be electively directed in

Track Down Tough To Find CATV, MATV And RF Distribution Troubles
• All Channel Digital Tuner (5 - 890 MHz)
• 5 Microvolt Sensitivity With Autoranged Attenuator
• Exclusive Frequency Offset Readout
• Automatic S/N And Hum On In-Use Channel
• Integrated Wideband Monitor
• AC/DC Volts Measurements Through RF Input
MODEL FS74
TV-RF SIGNAL ANALYZER
100% American Made and backed by Sencore's 100% "Made Right" Lifetime Guarantee
With The FS74 CHANNELIZER SR.™
TV-RF Signal Analyzer
$3495 Patented
Reader Service Number 35.
Send For Free FS74 Brochure
Call 1-800-843-3338
In Canada 1-800-851-8866
SENCORE
3200 Sencore Drive Sioux Falls, South Dakota 57107

Figure 2: Normal response



amplitude ±3 dB to reduce some reflection problems.

Circular polarization, authorized for use by the Federal Communications Commission in 1977, uses vertical and horizontal elements. The phase of the direct ray rotates in a right- or left-handed polarization and can be selectively shifted in an opposite direction of known reflection angles.

The use of horizontal vs. circular polarization for the purpose of multipath distortion cancellation is a hotly contested issue by broadcast engineers. Most engineers desire the change from horizontal to circular polarization not solely because their received signals are known to be distorted, but because twice the power is necessary for circular polarization over horizontal; therefore, the range of their signal is extended. The reason why circular polarization is not considered as a "foolproof" solution to distorted signals is due to unpredictable angles of incidence (diffused surfaces) that would increase distortion effects because of the higher power being used.

7) *Site of receiving off-air antenna*: Logically, taking into consideration all said previously, choice of site by the CATV operator for receiving broadcast signals means the difference between success or complaining subscribers. Furthermore, it follows that a thorough site signal survey is well worth the time, therefore the money. Meticulous operators who have leeway should conduct this survey prior to selecting a tower site.

An example of this regards antenna height. Hypothetically, if an antenna 100 feet above the ground is producing a signal with an amplitude of +30 dBmV and the reflection is −20 dB below that signal level, the reflection coefficient would be +10 dBmV. If distributed at this level, a distracting, distinguishable ghost will appear in the TV picture. Whereas, if the height of the antenna were to be lowered to provide minimum requirements, negligible ghosting or even elimination of it altogether could result. Where line loss is a problem, considerations should be made to

Reader Service Number 36.

supply power for a tower-mounted low-noise distribution amplifier. Attenuation by mechanical means tends not to work well in most cases.

Worthy of note, another method rising in popularity for systems that have multiple distribution sites is to transmit via microwave quality broadcast signal from sites that have little or no distortion problems to sites with severe problems.

8) *Design of off-air antenna* and *adaptive arrays*: If a site has been established and management finds moving costs prohibitive, success can sometimes be found at the antenna level. The yagi, log-periodic, broadband, etc., antennas all have their merits when applied to respective distortion areas; however, singly none can be applied universally.

A popular method used at the antenna level for reflection cancellation is an adaptive array. The simplest array employs a sidelobe canceler in which an auxiliary element is used with the main antenna to provide a single null, causing a 180° phase shift in the direction of the reflection vector. A feedback loop is used for adjustment of the phase and amplitude of the single element that produces this null. For multiple reflections, more sidelobe cancelers are constructed.

Off-the-shelf phased arrays designed by some manufacturers in the industry do not always mean cancellation will occur. Some reflection rays cannot be eliminated at the antenna level. This holds especially true when angles of incidence occur at less than 10° of separation and vertical opposed to horizontal paths go beyond prediction regarding the conditions of the intended site. Quite simply, money is not always the answer; caution should be used before a purchase is completed.

Literature available on the subject of the use of particular antennas (high-gain vs. low gain techniques) for multipath distortion elimination and, accordingly, adaptive arrays, is plentiful. Tests are currently being conducted using state-of-the-art measurement equipment and technology evaluating antenna performance in varied sites.

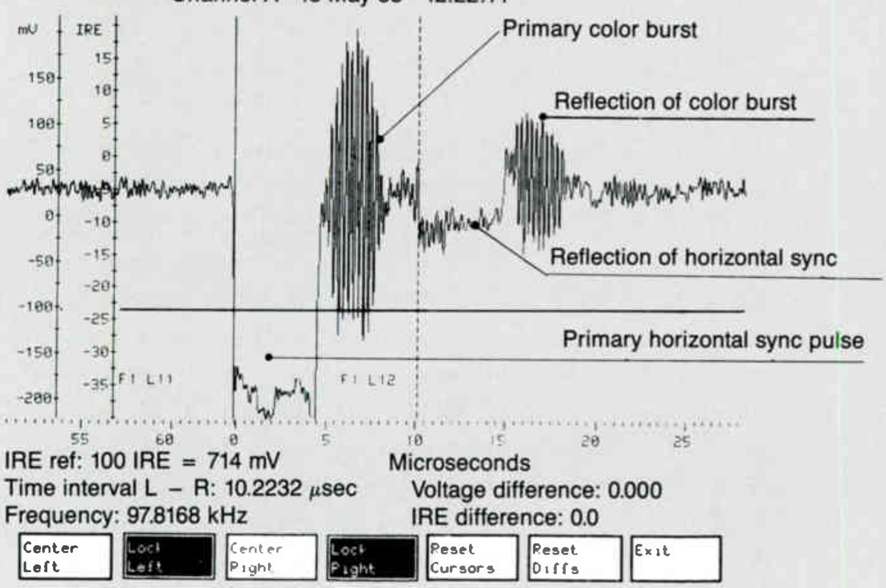
Other techniques

Briefly, other techniques for decisive elimination of distortion effects include collecting a signal, distorted by Earth obstructions, from space (i.e., satellite), where obstructions do not exist. Some of these signals are currently available to be received by this method. Finally, a direct link from the transmitter to clear paths protected by law through easements via microwave may be the definitive answer.

In conclusion, there are no easy solutions to this interference phenomenon that has existed since the advent of television. The number of distortion areas are destined to increase with the CATV operator having little control. If profit vs. expenditures to achieve quality is in question, just keep in mind: The system, in every aspect of operation, that gathers (and keeps) the most subscribers—which is the *bottom line*—is truly the superior system.

Figure 3: Abnormal response caused by reflection

VM700 video measurement set
Channel A 18 May 88 12:22:14



References

1) C.A. Balanis, *Antenna Theory*, Harper & Row, 1982, pg. 502-515 and 703-734.
2) K. Bullington, "Radio Propagation Fundamentals," *Bell System Technical Journal*, Vol. 36, No. 3 (1957), pg. 593-626.
3) E.C. Jordan, *Reference Data for Engineers: Radio, Electronics, Computer, and Communications*, Howard W. Sams & Co., 1986, pg. 32.42-32.43 and 33.1-33.27.
4) Winegard Products Catalog, "Circularly Polarized TV Signals," *Electronic Technician/Dealer* reprinted in March 1979 issue, pg. 28-29.
5) M.I. Infanzon and H. Elovitz, Tektronix Inc., Rolling Meadows, Illinois.

SCTE's Tuition Assistance Program

By Ron Hranac
President, Society of Cable Television Engineers

One of the SCTE's most important goals is "to encourage the increase and dissemination of operational and technical knowledge in the field of cable television." To this end, the Society has, among other things, established the Chapter and Meeting Group Program, transmitted videotaped training via satellite to systems every month, held numerous regional and national training seminars (including the Cable-Tec Expo), conducted technical workshops at industry trade shows and developed a professional designation certification program (BCT/E). One effort in particular has been moving along somewhat quietly, but very successfully: SCTE's Tuition Assistance Program.

In 1985, the Society's board of directors opened a certificate of deposit, with interest earmarked for educational assistance. The following year, the board established a Scholarship Committee, whose purpose was to award tuition assistance. Additional funding became available when Rex Porter contributed money to the SCTE; this was matched by the National Cable Television Institute (NCTI). The committee made arrangements with most of the major MSOs that have existing employee tuition reimbursement programs. Those MSOs will reimburse the SCTE if any of their employees are awarded tuition assistance by the Society. Since its inception, the Scholarship Committee has been awarding NCTI courses to qualified applicants. To date, more than a dozen people in the industry have benefitted from SCTE's Tuition Assistance Program.

The Scholarship Committee has subsequently received additional contributions from Porter, the NCTI and the New York State Cable Commission. The ATC National Training Center and Cleveland Institute of Electronics plan to contribute technical courses to the program. At its most recent meeting, the Scholarship Committee awarded the first college course tuition assistance to Jane Lode of Daniels & Associates.

Ongoing education

As the cable industry matures, so does the complexity of technology used by the industry. Recognizing the need for ongoing education to industry personnel, the SCTE has created programs such as its Tuition Assistance Program. These efforts have not gone unnoticed, either. The Society of Broadcast Engineers (SBE) has complimented the SCTE for its work in technical education.

You can apply for tuition assistance in two areas: NCTI courses or college-type courses related to your job. An application is on pages 63-64; even if your employer provides tuition reimbursement, you are encouraged to apply. The Scholarship Committee meets on a quarterly basis to review applications. To qualify for tuition assistance, you must be an active SCTE national member and employed in the cable television industry. The Scholarship Committee awards tuition assistance to those candidates who show the greatest potential for career advancement.

I encourage you to take advantage of this program. Your only investment will be your time; your return on that investment will be an education that will add to the foundation of your professional experience.

SCTE TECHNICAL TUITION ASSISTANCE APPLICATION

SCTE
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

Nat'l Member? ______ Yes ______ No

Chapter or Meeting Group Name: ______________________

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 39.

Upgrading for increased capacity

This is the first installment of a two-part series. Part II will deal with effects of adding channels on composite triple beat.

By Richard Covell
Applications Engineer, General Instrument/Jerrold Division

Upgrading your system for greater channel carriage requires a number of considerations. To keep your trunk amplifiers in their existing locations and provide a system with the same distortion and carrier-to-noise (C/N) performance, there are three major considerations to address:

1) Increased gain to compensate for the higher cable attenuation at the higher frequencies.
2) Improved output capability and/or noise figure to offset the effects of the increased cable attenuation.
3) Improvement in output capability required by the additional channels to be carried.

Let's look at gain requirements. Figure 1 gives the formula for computing the gain (or cable attenuation) at the new upper cable frequency, while Table 1 (developed from the formula) charts the increase in attenuation between the typically available upper bandwidth limits (220, 240, 270, 300 MHz, etc.). Spacings from 18 to 31 dB are listed. Since 22 and 27 dB amplifier gains are commonly available, these spacings are highlighted. As an example, if you wanted to increase your 22 dB spaced system from a bandwidth of 220 MHz to 330 MHz, the table shows that the spacing at 330 MHz will be 26.9 dB. Table 1 assumes minimum trunk spacing of 18 dB, maximum of 31 dB, with typical being 22 dB; suggested upgrade spacing of 27 dB. Highlighted for each of the bandwidths is 22 dB, as well as the bandwidth upgrade if a 27 dB gain amplifier is substituted.

Output capability is a measure of an amplifier's ability to deliver output power while remaining in a linear mode. This parameter is used in determining the output level and/or number of channels an amplifier can carry for a given percentage of distortion. Each 1 dB improvement in output capability equates to 2 dB improvement in cross modulation (X-MOD) or composite triple beat (CTB) distortion if the station is operated at the same level as before. Or each 1 dB improvement in output capability allows operation of the station at a 1 dB higher output level for the same X-MOD or CTB distortion as before.

The formula to find the output capability improvement required as a result of the increased spacing (assumes "flat" trunk output levels) can be found in Figure 2. It simply solves for the difference between the "new" and "old" attenuation values for the cable. If input levels in your

Figure 1: Amplifier gain required for greater bandwidth (higher frequency)

Amplifier gain = cable attenuation at highest frequency

Formula: $A_n = A_o \times \sqrt{F_n/F_o}$

where:
A_n = new amplifier gain (at highest frequency)
A_o = old amplifier gain (at highest frequency)
F_n = new highest frequency
F_o = old highest frequency

Problem: You have a system that is spaced at 22 dB at 220 MHz. What will be the station gain requirements if the upper frequency is raised to 330 MHz? Substituting the given values in the formula:

$$\begin{aligned} A_n &= A_o \times \sqrt{F_n/F_o} \\ &= 22\sqrt{330/220} \\ &= 22\,(1.225) \\ &= 26.9 \end{aligned}$$

Answer: You will need an amplifier with 26.9 dB of gain.

Figure 2: Output capability requirements caused by increased spacing

If you desire to keep your input levels the same as before and you have increased your spacing: You must raise the output level of your amplifiers by an amount equal to the *increase* in spacing; and you will need 1 dB of output capability improvement for each dB you raise the amplifiers' output. To find this increase in output capability use this formula:

$$OC_s = (A_o \times \sqrt{F_n/F_o}) - A_o$$

where:
OC_s = output capability improvement required for increased spacing
A_o = old spacing
F_o = old upper frequency
F_n = new upper frequency

Problem: Find increased output capability requirements to change spacing from 220 MHz to 330 MHz. Substituting in the formula:

$$\begin{aligned} OC_s &= 22\sqrt{330/220} - 22 \\ &= 22\sqrt{1.5} - 22 \\ &= 22\,(1.225) - 22 \\ &= 26.9 - 22 \\ &= 4.9 \end{aligned}$$

Answer: Additional output capability requirement for increased spacing is 4.9 dB.

COMMUNICATIONS TECHNOLOGY

I wish to receive/continue to receive *Communications Technology*.
Yes ☐ No ☐

Name ______________________
(please print/type)
Title ______________________
(please be specific)
Company Name ______________________
Address ______________________
City ______________ **State** ________ **ZIP** ________
Signature ______________________ **Date** ________

1. Are you a member of the SCTE (Society of Cable Television Engineers)?
Yes ☐ No ☐

2. In the performance of my job, I authorize, specify or purchase products and/or services.
Yes ☐ No ☐

3. Please check the category that best describes your firm's primary business (please check only one).

1. Cable TV Systems Operations
   - ☐ a. Independent Cable TV Systems
   - ☐ b. MSO (two or more Cable TV Systems)
- ☐ 2. Cable TV Contractor
- ☐ 3. Cable TV Program Network
- ☐ 4. SMATV or DBS Operator
- ☐ 5. MDS, STV or LPTV Operator
- ☐ 6. Microwave or Telephone Company
- ☐ 7. Commercial Television Broadcaster
- ☐ 8. Cable TV Component Manufacturer
- ☐ 9. Cable TV Investor
- ☐ 10. Financial Institution, Broker, Consultant
- ☐ 11. Law Firm or Government Agency
- ☐ 12. Program Producer or Distributor
- ☐ 13. Advertising Agency
- ☐ 14. Educational TV Station, School or Library
- ☐ 15. Other ______________ (please describe)

CT 7/88

COMMUNICATIONS TECHNOLOGY

Name ______________________
Title ______________________
Company Name ______________________
Address ______________________
City ______________ **State** __________ **ZIP** ________
Phone Number (_____) ______________________

FREE INFORMATION
Reader Service Card

July 1988 (Valid until September 1988)

Simply circle the number(s) below corresponding to products of interest!

1 **SCTE**

2	16	30	44	58	72	86	100	114	128
3	17	31	45	59	73	87	101	115	129
4	18	32	46	60	74	88	102	116	130
5	19	33	47	61	75	89	103	117	131
6	20	34	48	62	76	90	104	118	132
7	21	35	49	63	77	91	105	119	133
8	22	36	50	64	78	92	106	120	134
9	23	37	51	65	79	93	107	121	135
10	24	38	52	66	80	94	108	122	136
11	25	39	53	67	81	95	109	123	137
12	26	40	54	68	82	96	110	124	138
13	27	41	55	69	83	97	111	125	139
14	28	42	56	70	84	98	112	126	140
15	29	43	57	71	85	99	113	127	141

CT 7/88

NO POSTAGE NECESSARY IF MAILED IN THE UNITED STATES

BUSINESS REPLY MAIL

FIRST CLASS PERMIT NO 1667 SIOUX FALLS, SD

POSTAGE WILL BE PAID BY ADDRESSEE

SENCORE

3200 Sencore Drive
P O Box 5062
Sioux Falls, SD 57117-9949

Call 1-800-843-3338 And Discover How To Cut Your System Analyzing Time In Half With The FS74 CHANNELIZER SR.!

NO POSTAGE NECESSARY IF MAILED IN THE UNITED STATES

BUSINESS REPLY MAIL

FIRST CLASS PERMIT NO. 1571 ENGLEWOOD, CO

POSTAGE WILL BE PAID BY ADDRESSEE

CT PUBLICATIONS CORP.

P.O. Box 3208
Englewood, CO 80155

NO POSTAGE NECESSARY IF MAILED IN THE UNITED STATES

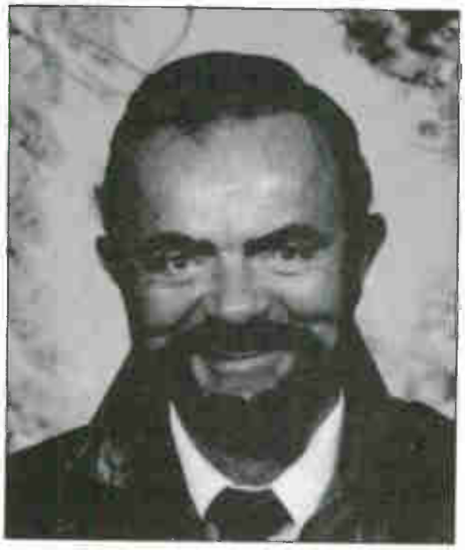
BUSINESS REPLY MAIL

FIRST CLASS PERMIT NO. 1571 ENGLEWOOD, CO

POSTAGE WILL BE PAID BY ADDRESSEE

CT PUBLICATIONS CORP.

P.O. Box 3208
Englewood, CO 80155



"(The) higher amplitude of third-order products produced at the highest channels is sufficient to make them the worst contributors in most situations."

upgraded system are to remain the same, the replacement amplifier's output level must be raised by an amount equal to the attenuation change. Likewise, if the distortion level is not to increase, the output capability must improve by the same amount the level is raised. Table 2 shows the output capability improvement re-

Table 1: Trunk amplifier spacing for system upgrade

Bandwidth (MHz)	220	240	270	300	330	400	450	500	550	600
Channel carriage	23	27	32	37	42	53	62	70	78	87
Spacing (dB)	**22.0**	23.0	24.4	25.6	**26.9**	29.7	31.5			
	21.0	**22.0**	23.3	24.6	**25.8**	28.4	30.1	31.8		
	19.9	20.7	**22.0**	23.2	24.3	**26.8**	28.4	29.9	31.4	
	18.8	19.7	20.9	**22.0**	23.1	25.4	**26.9**	28.4	29.8	31.1
	17.9	18.9	19.9	20.9	**22.0**	24.2	25.7	**27.1**	28.4	29.7
			18.1	19.0	20.0	**22.0**	23.3	24.6	25.8	**26.9**
				18.0	18.8	20.7	**22.0**	23.2	24.3	25.4
					17.9	19.7	20.9	**22.0**	23.0	24.1
					17.0	18.8	19.9	21.0	**22.0**	23.0
						18.0	19.1	20.1	21.0	**22.0**

Table 2: Output capability requirements due to increased spacing

Bandwidth (MHz)	220	240	270	300	330	400	450	500	550	600
Channel carriage	23	27	32	37	42	53	62	70	78	87
	22.0	1.0	2.4	3.6	**4.9**	7.7	9.5			
		22.0	1.3	2.6	**3.8**	6.4	8.1	9.8		
			22.0	1.2	2.3	**4.8**	6.4	7.9	9.4	
				22.0	1.1	3.4	**4.9**	6.4	7.8	9.1
					22.0	2.2	3.7	**4.1**	6.4	7.7
						22.0	1.3	2.6	3.8	**4.9**
							22.0	1.2	2.3	3.4
								22.0	1.0	2.1
									22.0	1.0

quired as a function of increased spacing when upgrading between any two of the listed bandwidths. This table shows the output capability improvement necessary for a flat system to handle the higher levels required to maintain original input levels with the increased spacing. Output capability for 27 dB spacing is highlighted.

Improvement in output capability required to maintain the same X-MOD performance when increasing channel carriage can be determined with the following formula:

$$OC_I = 10\log(CC_n - 1/CC_o - 1)$$

where:

OC_I = output capability improvement required
CC_n = new channel carriage
CC_o = old channel carriage

Maintaining CTB distortion

The output capability improvement required to maintain the same CTB distortion while increasing channel carriage, however, has been the subject of much discussion and disagreement within the cable TV engineering community. Although both X-MOD and CTB are 20log functions and behave in the same manner when the output level of an amplifier is varied, the performance of CTB differs from that of X-MOD when adding channels because:

1) The number of triple beats produced as you add channels increases on a logarithmic basis rather than linearly, and
2) The discrete triple beat performance varies as a function of frequency.

Higher frequencies produce a higher amplitude of three-tone third-order distortion products, enough so that although there are more beat products at lower frequencies, this higher amplitude of third-order products produced at the highest channels is sufficient to make them the worst contributors in most situations.

The integrated circuits (ICs) produced in the mid-70s had three-tone discrete beats 10 dB worse at 300 MHz than at 220 MHz, while today's state-of-the-art devices don't degrade by 10 dB until nearly 500 MHz. In addition, the discrete performance at *any* frequency has been enhanced. These two improvements have provided the industry with amplifiers having sufficiently improved CTB performance to allow the construction of cable systems carrying 70+ channels.

Signal level meter

Sadelco's Super 600 Digital signal level meter features illumination for both the LCD panel and microammeter, a digital keypad for frequency/channel selection and a weatherproof case with one-inch foam padding.

This unit has a built-in frequency range from 4.5 MHz to 600 MHz with an accuracy of ±0.5 dB. The frequency accuracy is ±20 kHz and NiCad total discharge protection is standard.

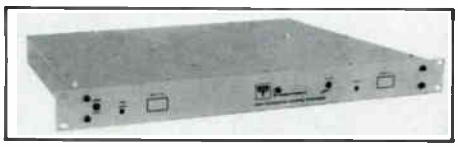
For further details, contact Sadelco, 75 W. Forest Ave., Englewood, N.J. 07631, (201) 569-3323; or circle #127 on the reader service card.

Mixing networks

Pico Macom is offering Models MX-4U and MX-4V four-channel mixing networks that combine single-channel antennas for use with broadband amplifiers. Both units also separate signals coming from a broadband antenna and balance signals on a broadband system. They can be used in homes where two antennas are required due to the home's location between two broadcast centers.

The MX-4U allows separation or combination of up to four UHF non-adjacent channels; the MX-4V is for up to two low-band and two high-band non-adjacent VHF channels.

For more details, contact Pico Macom, 12500 Foothill Blvd., Lakeview Terrace, Calif. 91342, (818) 897-0028; or circle #131 on the reader service card.



Headend systems

Blonder-Tongue Laboratories announced the availability of its low-cost CATV headend systems featuring the company's ESHP A/V channel processor and an improved ESHM-C modulator. Both units feature a +60 dBmV output level and provision for in-field channel conversions. The ESHP is a SAW-filtered heterodyne converter board for both input and/or output channel changes.

The ESHM-C is now designed with separate aural and visual IF loop-through for premium program scrambling. The modulator also is SAW filtered with a heterodyne conversion system.

For more information, contact Blonder-Tongue Laboratories, 1 Jake Brown Rd., Old Bridge, N.J. 08857, (201) 679-4000; or circle #125 on the reader service card.

Optical tester

Now available from Siecor, the OT-100 is a compact, lightweight device for testing optical power in fiber-optic communications line, field and bench applications. This unit incorporates an optical power meter and stabilized light source, with a measurement of +10 dBm to −60 dBm. Product features include one-touch selection of relative or absolute level, auto ranging and relative-mode buzzer alarm for detection of loss in connectors.

For additional details, contact Siecor Corp., 489 Siecor Park, Hickory, N.C. 28603-0489, (704) 327-5000; or circle #140 on the reader service card.

Status monitoring

C-COR released Quick Alert Version 4.0 software for status monitoring of broadband systems, employing pull-down menus, color graphics and on-line help messages. It also features a horizontal bar graph display for identification of actual operation of a single unit within user-specified tolerances, automatic loading of nominals and color selection.

For further information, contact C-COR Electronics, 60 Decibel Rd., State College, Pa. 16801, (814) 238-2461; or circle #139 on the reader service card.

Stereo generator

The MTS-3 BTSC stereo generator from Leaming utilizes dbx companding and generates a high quality composite multiplex signal. The unit is available with 4.5 MHz subcarrier output and has typical stereo separation of greater than 30 dB and frequency response of 20 Hz to 14 kHz, ±1 dB.

A Bessel null deviation test tone is built in for simple and accurate setup, according to the company. A peak limiter to protect against overmodulation and dual five-segment peak reading LED bar graph metering also are provided.

For additional information, contact Leaming Industries, 180 McCormick Ave., Costa Mesa, Calif. 92626, (714) 979-4511; or circle #133 on the reader service card.

Stripping tool

The SM-160B from Maverick Cable Services is a tool designed for preparation of headend cable for F connector installation without damaging the surface of the center conductor. It is manufactured from aluminum and hard anodized for durability. Replaceable blades are ground from hardened tool steel.

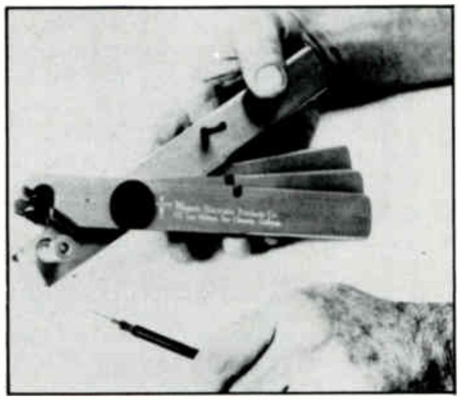
For more details, contact Maverick Cable Services, 1056 Christobal Lane, Colton, Calif. 92324, (714) 873-0666; or circle #137 on the reader service card.

CLI software

Telecommunication Products introduced CLIDE, a software program designed to help CATV technicians control RF signal leakage in their systems. CLIDE monitors the level of signal leakage with ground-based inspection, rather than flyovers, and uses the data accumulated to calculate the system's CLI. This data and subsequent repair data are stored and printed to form an FCC leakage report log, greatly simplifying records, according to the company.

CLIDE is menu-driven with a wide selection of printed reports available. Unrepaired leaks may be sorted by leak intensity and/or location.

For more information, contact Telecommunication Products, 115 Spring Valley Rd., Chambersburg, Pa. 17201, (717) 267-3939; or circle #128 on the reader service card.



Cable stripper

According to Western Electronic Products, the CX-1 coaxial cable stripper prepares most cables from .075 to .485 diameter in a single operation with any desired stripped configuration.

Three independent cutting members and a replaceable cable holder allow the operator to turn the cable in contact with the cutters and sever the insulation and shielding. Precision screws adjust the depth of each cut and built-in length adjustment allows any desired center conductor length to be stripped.

For more information, contact Western Electronics Products, 107 Los Molinos, San Clemente, Calif. 92672, (714) 492-4677; or circle #130 on the reader service card.

Laser sources

Fotec introduced two new fiber-optic laser sources for use in testing single-mode fiber-optic cables. The S380 and S390 are for 1,300 and 1,550 nm wavelength outputs, respectively, with −10 dBm and stability of better than 0.1 dB per day. The sources are available individually or as part of a Fotec T330 central office/local loop test kit.

For more details, contact Fotec, The Schrafft

Center, 529 Main St., Box 246, Boston, Mass. 02129, (617) 241-7810; or circle #134 on the reader service card.

Micro-ohmmeter

According to Simpson Electric, its Model 444 micro-ohmmeter is designed for low-resistance measurement applications where high accuracy and repeatability of results are required. Testing voltage of 100 μV maximum, and current of 5 mA ensure against "punching through" contamination or corrosion.

The unit features a 20,000 count, 4½-digit LCD display; four resistance ranges and user-adjustable set points that activate audible and/or visual alarms.

For further information, contact Simpson Electric Co., 853 Dundee Ave., Elgin, Ill. 60120, (312) 697-2260; or circle #124 on the reader service card.

Set-top converter

Now available from Qintar, the Model CV-133S set-top converter offers 133 channels and includes a separate input for a home UHF antenna. The unit has baseband audio and video outputs for direct hookup to a VCR. A remote also is offered with functions including volume control and mute, 12 favorite channel memory, RF Channel 3 or 4 output, last channel recall and cable/antenna selector.

For additional information, contact Qintar, P.O. Box 8060, Moorpark, Calif. 93020-8060, (800) 252-7889; or circle #126 on the reader service card.

Descrambler

Oak introduced the GSD, an addition to its Sigma compatibles product line that descrambles most signals using the basic gated sync scrambling technology, including its TotalControl and Multi-Code sync suppression systems.

The Sigma compatibles employ a drop-in module to recover the sync suppressed signals while retaining all the capabilities of the original Sigma decoder. This allows systems currently using older piracy-prone scrambling technologies to upgrade gradually to PPV-ready features.

For more details, contact Oak Communications, 16935 W. Bernardo Dr., Rancho Bernardo, Calif. 92127, (619) 451-1500; or circle #136 on the reader service card.

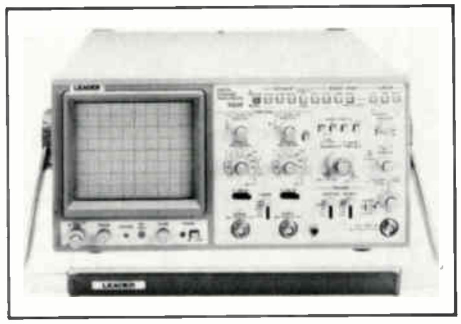
Power conditioner

Sola, a division of General Signal, designed its microprocessor-based electronic power conditioner (EPC) to offer 94 percent efficiency at full load plus high in-rush overload capacity. It is available with output capacities of 500, 1,000 and 2,000 VA and protects sensitive electronic

equipment from almost all AC power problems except total power failure, according to the company.

The 60 Hz EPC is UL listed, CSA certified and conforms to FCC Class B requirements; the 50 Hz model is built to VDE and IEC requirements. Output voltage is measured continuously and corrected every 16 milliseconds.

For additional information, contact Sola, 1717 Busse Rd., Elk Grove Village, Ill. 60007-5666, (312) 439-2800; or circle #138 on the reader service card.

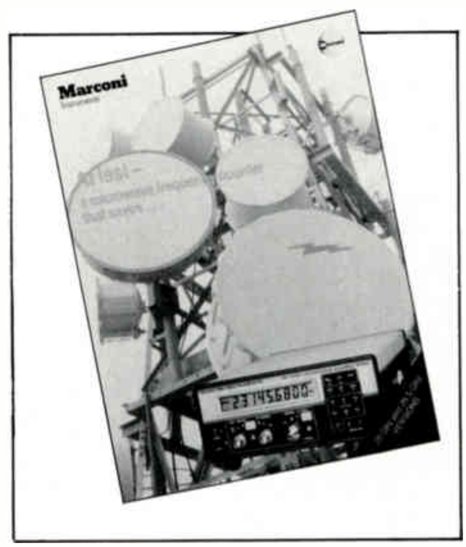


Digital o-scope

Leader Instrument's Model 3060D digital storage oscilloscope is equipped with a 4K word memory, 40 MS/s maximum sampling rate and 60 MHz real-time bandwidth. It also offers CRT cursor readouts of voltage, time, frequency, phase, and voltage and time difference ratios.

Standard features include a GPIB interface allowing the unit to be used in remotely controlled systems conforming to IEEE 488 standard and a plotter interface to create a hard copy of stored waveforms. Up to four waveforms can be stored and evaluated with X100 expansion along with waveform interpolation.

For further information, contact Leader Instruments Corp., 380 Oser Ave., Hauppauge, N.Y. 11788, (516) 231-6900; or circle #132 on the reader service card.



Brochure

Marconi Instruments released a new four-color brochure describing its compact microwave counters, including the Model 2440, with

Help Wanted

QUALITY ASSURANCE TECHNICIAN

Jones Intercable, an innovative leader in the communications industry, has an immediate opening for a Quality Assurance Technician to service our east coast cable systems.

This person will be responsible for ensuring that our cable systems meet all Federal, state, local and corporate technical standards, as well as ensuring they are providing reliable and quality cable television service.

Qualified candidates will have an Electrical Engineering degree, cable television experience, and the willingness to travel 60-70% by vehicle.

In addition to a competitive salary and excellent benefits package, we offer a challenging work environment in a growth industry. Please send resume and salary history to:

JONES INTERCABLE
Director of Personnel
9697 E. Mineral Ave.
Englewood, CO 80112

EOE M/F/H/V

Business Opportunity

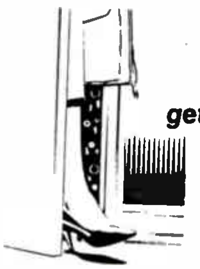
ATTENTION

CATV HARDWARE SALES PROFESSIONAL

AN OPPORTUNITY TO ESTABLISH YOUR OWN SALES REP FIRM!

National Manufacturer will help you start a CATV sales-rep venture to target Midwestern States. We offer an established product line; as well as start-up capital and administrative support.

RESPOND IN CONFIDENCE TO:
CT Publications/BO1
P.O. Box 3208
Englewood, CO 80155



Let your classified ad get through the door!

Call (303) 792-0023 for placement!

Equip for Sale/Rent

MLE

Main Line Equipment Inc.
1650 W. 180th St.
Gardena, CA 90248
1-800-444-2288

FOR SALE
Quality-Refurbished-Guaranteed

CONVERTERS:

JRX-3	2,000 pcs
JSX-3	5,000 pcs
RCSW	2,000 pcs
V-26	500 pcs
G-26	200 pcs
DRX-3-105	1,200 pcs
ZTACS	8,000 pcs
TC-35	1,000 pcs
DRX-3-DIC	2,000 pcs
DRX-2-DIC	44 pcs
DSX-3-DIC	200 pcs
M-35B	2,000 pcs
T-35	1,000 pcs
SA6783	500 pcs
SA6703	400 pcs
JSM-DIC	725 pcs
JSM	400 pcs

As-is or refurbished.

LINE GEAR:
"New Magnavox Line Gear In Stock"

EQUIPMENT WANTED:
Jerrold or Magnavox Line Gear
RCA 0013 & M153 Converters
S/A 6783 & JSX3-DIC

If you need quality guaranteed converters or line equipment call us. It's free; 800-444-2288

We Also Trade
"A BETTER SOURCE"

CLASSIFIEDS INFORMATION

Three Easy Ways To Place Your Classified Ad

- Fill out the attached classified ad form and return it to CT Publications Corp.
- Call (303) 792-0023 for assistance with your ad placement.
- To save time and mailing costs, use our **TELEFAX (303) 792-3320.**

Mechanicals

2¼″ × Depth
Minimum: 1″ in depth, additional ½″ increments

Classified

12 point Helvetica boldface heads
9/10 point Helvetica medium body copy

Display Classified

Typestyle same as classified or as specified by advertiser. Any display ad designed by publisher will be subject to production costs of $50 per hour. Maximum: ½-page display advertisement.

Publisher's Policy

1. Advertisements costing less than $200 must be paid in advance.
2. Deadline will be 1st of each month prior to publication date.
3. Ad copy must be submitted in typed format.
4. Cancellation date will be the 1st of each month prior to publication date. No cancellations accepted after this date. Cancellations must be received in writing.
5. The contents of advertisements are subject to publisher's approval.

Rates

Classified	1 column × 1 inch = $75
Display	1 column × 1 inch = $79

Ad Information

Date of Insertion ______________________

Headline ______________________

Copy (attach additional sheet if necessary) ______________________

____

____

____

____

Address ______________________

____

____

Blind Boxes are available.

Business Directory

CABLE SYSTEM SURVEY CO.

MAPPING • DESIGN • AS-BUILTS
COMPLETE DRAFTING SERVICES

Precise Map Calibration Services

17 Peddler's Row
Newark, DE 19702
(302) 368-2436

518 North Main Street
Tekonsha, MI 49092
(517) 767-4185

Reader Service Number 60.

SIGNAL LEVEL METER REPAIR

Prompt, Professional Service at Reasonable Prices

JGL ELECTRONICS, INC.

4425 BLACKSTONE DRIVE
INDIANAPOLIS, INDIANA 46237
317/783-6130

Reader Service Number 61.

THE INSTALL PEOPLE.®

"SERVING THE INDUSTRY SINCE 1974"

- ☐ Aerial Installs
- ☐ Underground Installs
- ☐ Drop Transfer
- ☐ Commercial Developement
- ☐ Design
- ☐ Tap Audits
- ☐ Underground and Aerial Construction

ENGLISH ENTERPRIZES
P.O. Box 6494
Orlando, Florida 32853
1-407-898-7134

Reader Service Number 62.

Quality Reconditioned Test and Measurement Instruments

Signal Level Meters — *Spectrum Analyzers*
Network Analyzers — *Sweep Generators*
Microwave/Waveguide Components

hp *Tektronix* *Riser Bond* *Texscan* *Wavetek*

Calibration and Repair Service

EMS Instruments 800-234-7434

Reader Service Number 63.

Harold Bigham
President

Bigham Cable Construction, Inc.

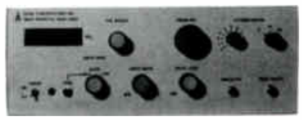
Complete CATV Construction
Specializing in Rebuilds

(904) 932-6869

P.O. Box 903
Gulf Breeze, FL 32561

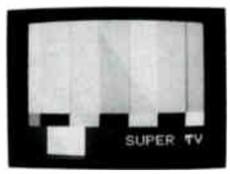
Reader Service Number 64.

SWEEP GENERATOR MODEL 6082



A new generation of sweeper technology you can afford.

CHANNEL IDENTIFICATION GENERATOR



Identify your company or cable channel on a color bar signal.

Kalun Communications Inc.
11A Glen Watford Drive, Unit 17, Scarborough, Ontario, Canada M1S 2B8 (416) 293-1346

Reader Service Number 65.

CT PUBLICATIONS CORP.

Neil Anderson
Account Executive

COMMUNICATIONS TECHNOLOGY • CABLE STRATEGIES
INSTALLER/TECHNICIAN

12200 E. Briarwood Ave. • Suite 250 • Englewood, Colo. 80112 • (303) 792-0023
Mailing Address: P.O. Box 3208 • Englewood, Colo. 80155
TELEFAX (303) 792-3320

Your business card is an effective and economical way to promote your company!

For more information and placement call us at (303) 792-0023!

a frequency range of 10 Hz to 20 GHz; and the Model 2442, with a frequency range of 10 Hz to 26.5 Ghz. Three pages are devoted to the various applications of the 2440 Series such as bench tests during maintenance and GPIB automated measurements on microwave VCOs. There is also a specification summary page outlining additional features and the accessories available.

For more details, contact Marconi Instruments, 3 Pearl Court, Allendale, N.J. 07401, (201) 934-9050; or circle #123 on the reader service card.

Component catalog

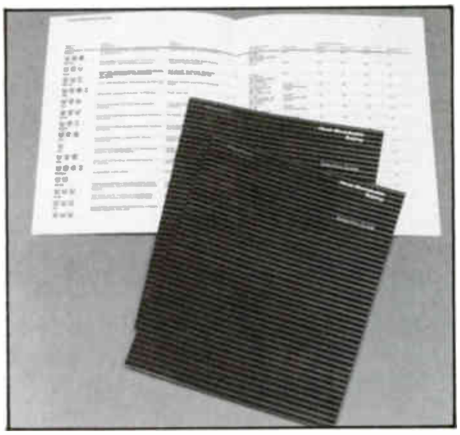
BradPTS released a catalog featuring the most commonly replaced electronic components in cable converters. The most frequently ordered capacitors, diodes, integrated circuits and transistors also are listed and, along with the company's other parts, are inventoried on computer and cross-referenced. This catalog is available free of charge.

For further information, contact BradPTS, 5233 Highway 37 South, P.O. Box 272, Bloomington, Ind. 47401, (812) 824-9331; or circle #135 on the reader service card.

Control tag

Telecrafter Products is offering its new activity control tags for identification of authorized pay services, installation dates and other drop information. It contains six numbered punch-out buttons, a write-on area and is available in eight colors for a number of coding possibilities.

For further information, contact Telecrafter Products, 200 Union Blvd., Suite 411, Lakewood, Colo. 80228, (303) 986-7700; or circle #129 on the reader service card.



Tubing guide

A new tubing selection guide from Raychem describes basic properties and typical applications for the company's Thermofit thin-wall heat-shrinkable tubings. The literature also contains information on applicable specifications and ratings, flammability, operating temperatures and shrink ratios. A separate section on MIL spec tubings is included.

Product names are accompanied by symbols illustrating the tubing's major functions, including insulation, strain relief, wire bundling, mechanical protection, identification and environmental protection.

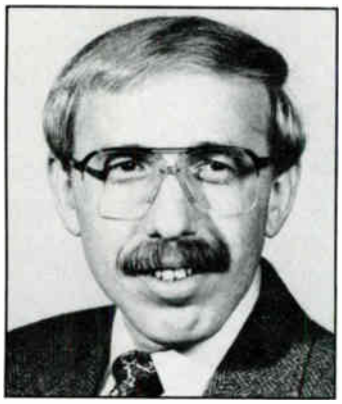
For more information, contact Raychem Corp., Thermofit Division, 300 Constitution Dr., Menlo Park, Calif. 94025-1164, (415) 361-3860; or circle #119 on the reader service card.

Portable tester

A new hand-held test instrument with the capabilities of five separate instruments has been unveiled by B&K Precision. The Model 388-HD is a 41-range voltmeter, ammeter, ohmmeter, frequency counter, capacitance tester, logic tester, transistor tester, diode tester and continuity tester. All of these capabilities are contained in a case the size of a conventional hand-held digital multimeter.

According to the company, the product is built to professional user standards with internal circuitry protection and high accuracy. It features reverse polarity protection, overload protection and high-energy fusing. DC and AC current measurement capabilities extend to 20 amps, with resistance measurement to 2,000 megaohms. Five capacitance ranges extend to 20 microfarads. The frequency counter capability extends to 200 kHz with resolution of up to 1 Hz.

For additional information, contact B&K Precision, Division of Maxtec International Corp., 6470 W. Cortland St., Chicago, Ill. 60635, (312) 889-1448; or circle #122 on the reader service card.


Schindell

Reliable Electric/Utility Products appointed **Bernie Schindell** as marketing communications manager. He was previously with the company's Product Management group. Contact: 11333 Addison St., Franklin Park, Ill. 60131, (312) 451-5521.

Kenneth Wood was named director of product development for **LRC Electronics**. Also, **Leonard DeRenzo** was appointed director of sales for the LRC and broadband engineering product lines offered to the CATV market. Contact: 901 South Ave., Box 111, Horseheads, N.Y. 14845, (607) 739-3844.

CaLan appointed **Jon Lander** as sales engineer for the Midwest region. Prior to this, he served in production and sales positions with Wavetek. Contact: R.R. 1, Box 86T, Route 739, Dingman Plaza, Dingmans Ferry, Pa. 18328, (717) 828-2356.

C-COR Corp. appointed **Leroy Stump** as Northeast regional account executive for the company's Cable TV group. Previously he was regional account executive for ComSonics. Contact: 60 Decibel Rd., State College, Pa. 16801, (814) 238-2461.

Nexus Engineering Corp. recently named **David Ilagan, Fritz Christo** and **Patricio Ibarra** international sales reps. It also appointed **Brent Smith** and **David Reid** as MSO account reps. Contact: 7000 Lougheed Hwy., Burnaby, British Columbia, Canada V5A 4K4, (604) 420-5322.


Haygood

Dale Haygood was named vice president of manufacturing for **Lightning Master Corp.** He has been involved in the development of manufacturing techniques, new product design and refinement of existing products. Contact: P.O. Box 446, Brooksville, Fla. 34605-0446, (904) 799-6800.

Cable Services Co. recently named **Al Starr** as sales representative. Contact: 2113 Marydale Ave., Williamsport, Pa. 17701-1498, (800) 233-8452.

Cable Link recently promoted **Fritz Juskalian** to senior account executive. It also promoted **Dave Allman** to account executive. Contact: 280 Cozzins St., Columbus, Ohio 43215, (614) 221-3131.

Bob Tyler was named vice president and general manager of the **B&K Precision** division of Maxtec International. He was previously president of Maitland K. Smith Inc., an electronics sales representative covering the southeast United States. Contact: 6470 W. Cortland St., Chicago, Ill. 60635, (312) 889-1448.

Texscan Instruments promoted **Charles McLaughlin** to group manager, instrument products. He has 18 years experience in quality control, manufacturing, engineering and manufacturing management.

Michael Richardson was named sales manager, instrument products. He has 13 years of direct sales management experience. Contact: 3169 N. Shadeland Ave., Indianapolis, Ind. 46226, (317) 545-4196.

Stakes

Richard Stakes retired as chief executive officer of **Summit Communications**. Stakes will continue to serve on the board of Summit and its Executive and Compensation committees. Contact: 115 Perimeter Center Place, Suite 1150, Atlanta, Ga. 30346, (404) 394-0707.

Gerard Stoesser was appointed sales manager for **Leaming Industries**. Prior to joining the company, he held sales management positions with Pico and Oak Communications. Contact: 180 McCormick Ave., Costa Mesa, Calif. 92626, (714) 979-4511.

Midwest CATV added three new sales representatives to its Central and Southern regions. **Walt Van Lue** is covering several states in the Midwest. Most recently, he was a regional engineer for Multimedia Cablevision in Edmond, Okla.

Mark Vawter is working in the Central region's headquarters in telemarketing. Prior to this, he was with Comcast Cablevision in Indianapolis.

Doug Huston is covering the Southern region. He was formerly founder, co-owner and president of AudiCable in Oklahoma City. Contact: P.O. Box 271, Charleston, W. Va. 25321, (304) 343-8874.

Phil Atkins was named as international sales manager for **Matthey Electronics**. Previously he was with RS Components and was technical manager for Grundig International. Contact: Burslem, Stoke-on-Trent, United Kingdom ST6 3AT, 0782-577588.

Times Fiber Communications promoted **Ralph Hillburn** to national sales manager. Previously he was territory sales manager. Contact: 358 Hall Ave., P.O. Box 384, Wallingford, Conn. 06492, (203) 265-8500.

Curtice

Dr. Walter Curtice, manager of CAD/gallium arsenide modeling for **Microwave Semiconductor**, was named an IEEE Fellow for his contributions in the area of GaAs FET modeling and simulation. Contact: 100 School House Rd., Somerset, N.J. 08873, (201) 906-3810.

For-A appointed **Randall Smith** as Western regional sales manager. Prior to this, he specialized in technical support and applications engineering for Paltex and Datum, respectively. Contact: Nonantum Office Park, 320 Nevada St., Newton, Mass. 02160, (617) 244-3223.

David Showalter was promoted to vice president and general manager of **Jerry Conn Associates**. Contact: 130 Industrial Dr., P.O. Box 444, Chambersburg, Pa. 17201, (717) 263-8258.

Jay LaBarge was promoted to vice president of marketing for **Microwave Filter Co.** Prior to this, he was marketing manager for the company.

Robert Portmess was promoted to vice president of manufacturing. Prior to this, he was the company's manager of manufacturing. Contact: 6743 Kinne St., East Syracuse, N.Y. 13057, (315) 437-3953.

Kurt Ladendorf joined **Acrian** as mechanical and thermal design engineer. He was previously with Teledyne MEC in the mechanical engineering and advance development departments. Contact: 490 Race St., San Jose, Calif. 95126, (408) 294-4200.

Dipole antennas

By Ron Hranac
Jones Intercable Inc.

A type of antenna that is commonly used to measure signal leakage is the half-wave dipole, an antenna whose overall length is close to half the electrical wavelength of the signal being measured. The length of a half-wave dipole in free space can be found with the formulas

$$\text{Length in feet} = \frac{492}{\text{frequency (MHz)}} \qquad \text{Length in inches} = \frac{5{,}904}{\text{frequency (MHz)}}$$

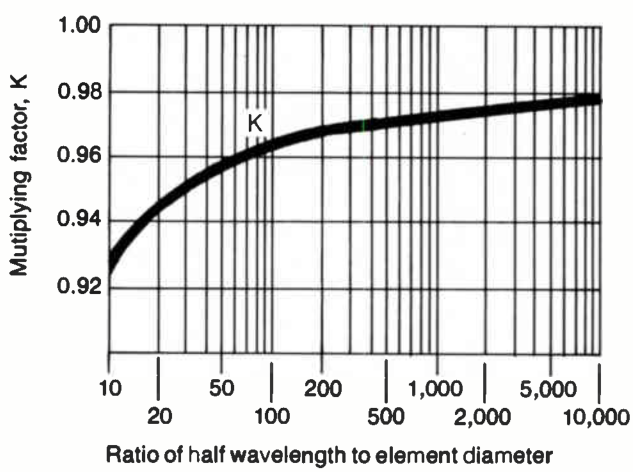
Because of the relationship of the diameter of an antenna's elements to the wavelength of the signal being received (or transmitted) by that antenna, a dipole's actual length is usually somewhat less than its free space length. The length of a half-wave dipole for frequencies below 30 MHz can be found with the formulas

$$\text{Length in feet} = \frac{492 \times 0.95}{\text{frequency (MHz)}} \qquad \text{Length in inches} = \frac{5{,}904 \times 0.95}{\text{frequency (MHz)}}$$

For frequencies above 30 MHz, the element diameter-to-wavelength relationship is even more critical. Here the formulas must use a multiplying factor, K, which can be derived from the graph at the bottom of the page. The length of a half-wave dipole above 30 MHz can be found with the formulas

$$\text{Length in feet} = \frac{492 \times K}{\text{frequency (MHz)}} \qquad \text{Length in inches} = \frac{5{,}904 \times K}{\text{frequency (MHz)}}$$

To determine the multiplying factor, K, for the above formulas, you must first calculate the ratio of a signal's free space half-wavelength to the antenna's element diameter. Find that ratio along the bottom of the graph; where the ratio intersects the curved line above it is the multiplying factor, K.



Source: *The Radio Amateur's Handbook*

Examples

Problem: To comply with CLI measurement requirements, you need to construct a half-wave dipole for Channel A, which is operating with +12.5 kHz offset in your system. If 1/8-inch diameter tubing is to be used for the antenna element, what will its overall length in inches be?

Solution: First, you must determine the free space half-wavelength of Channel A's offset video carrier (121.2625 MHz) using the formula

$$\text{Length in inches} = \frac{5{,}904}{\text{frequency (MHz)}} = \frac{5{,}904}{121.2625} = 48.69 \text{ inches}$$

Next, determine the ratio of Channel A's free space half-wavelength to the antenna element diameter:

$$= \frac{48.69 \text{ inches}}{0.125 \text{ inches}} = 389.5$$

From the graph on the preceding page, a ratio of 389.5 corresponds to a multiplying factor, K, of about 0.97. You can now calculate the length of the half-wave dipole using the formula

$$\text{Length in inches} = \frac{5{,}904 \times K}{\text{frequency (MHz)}} = \frac{5{,}904 \times 0.97}{121.2625}$$

$$= \frac{5{,}726.88}{121.2625} = 47.23 \text{ inches}$$

Problem: What will the half-wave dipole length for the same frequency be if the antenna is made out of 22 AWG wire (0.0253-inch diameter)?

Solution: First determine the ratio of Channel A's free space half-wavelength to the antenna element diameter:

$$= \frac{48.69 \text{ inches}}{0.0253 \text{ inches}} = 1{,}924.51$$

From the graph, a ratio of 1,924.51 corresponds to a multiplying factor, K, of about 0.975. You can now calculate the length of the half-wave dipole using the formula

$$\text{Length in inches} = \frac{5{,}904 \times K}{\text{frequency (MHz)}} = \frac{5{,}904 \times 0.975}{121.2625}$$

$$= \frac{5{,}756.40}{121.2625} = 47.47 \text{ inches}$$

CALENDAR

July

July 9: SCTE Razorback Chapter technical seminar and BCT/E testing, Days Inn, Little Rock, Ark. Contact Garry Bowman, (501) 935-3615.

July 11-14: New England Show, Tara Hyannis, Cape Cod, Mass. Contact William Durand, (617) 843-3418.

July 13: SCTE Gateway Meeting Group technical seminar. Contact Darrell Diel, (314) 576-4446.

July 14: SCTE Central California Meeting Group technical seminar on fiber-optics technology. Contact Andrew Valles, (209) 453-7791; or Dick Jackson, (209) 384-2626.

July 19-21: Florida Cable Television Association annual convention, Amelia Island Plantation Resort, Amelia Island, Fla. Contact Robert Brillante, (904) 681-1990.

July 20: SCTE North Central Texas Chapter technical seminar "FCC update." Contact Vern Kahler, (817) 265-7766.

July 20: SCTE North Jersey Chapter technical seminar. Contact Art Muschler, (201) 672-1397.

July 23: SCTE Rocky Mountain Chapter BCT/E testing, Ramada Republic Park, Denver. Contact Steve Johnson, (303) 799-1200.

July 25: SCTE Golden Gate Chapter technical seminar on safety programs. Contact Wayne Sheldon Sr., (408) 264-2728.

July 25-28: Siecor Corp. technical seminar on fiber-optic installation and splicing for LANs, building and campus applications, Hickory, N.C. Contact (704) 327-5539.

July 28: SCTE Rocky Mountain Chapter BCT/E testing, Beaver Run Resort, Breckenridge, Colo. Contact Steve Johnson, (303) 799-1200.

August

Aug. 3: SCTE Rocky Mountain Chapter technical seminar on distribution systems. Contact Steve Johnson, (303) 799-1200.

Aug. 8-11: Siecor Corp. technical seminar on fiber-optic installation and splicing for utility applications, Hickory, N.C. Contact (704) 327-5539.

Aug. 8-12: Hughes Microwave technical training seminar on channelized AML equipment, Torrance, Calif. Contact (213) 517-6244.

Aug. 10: SCTE Oklahoma Meeting Group technical seminar. Contact Herman Holland, (405) 353-2250.

Aug. 11: SCTE Central California Meeting Group technical seminar on troubleshooting power problems. Contact Andrew Valles, (209) 453-7791.

Aug. 16: Oklahoma Cable Television Association annual convention, Marriott Hotel, Oklahoma City. Contact Steve Lowe, (405) 943-2017.

Aug. 17: SCTE Delaware Valley Chapter technical seminar on HDTV, Super-VHS and impulse pay-per-view, Williamson Restaurant, Horsham, Pa. Contact Diana Riley, (717) 764-1436.

Aug. 17: SCTE Ohio Valley Chapter technical seminar. Contact Robert Heim, (419) 627-0800.

Aug. 22-25: Siecor Corp. technical seminar on fiber-optic installation and splicing for LANs, building and campus applications, Hickory, N.C. Contact (704) 327-5539.

Aug. 23-24: SCTE Cascade Range Meeting Group technical seminar "Hands-on equipment workshop," Red Lion Inn at the Quay, Vancouver, Ore. Contact Randy Love, (503) 370-2770.

Aug. 23-27: Wyoming Cable Television Association annual convention, Jackson Hole Racquet Club, Jackson Hole, Wyo. Contact Mike Ross, (307) 742-8258.

Planning ahead

Sept. 7-9: Eastern Show, Atlanta Merchandise Mart, Atlanta.

Sept. 27-29: Great Lakes Expo, Cobo Hall, Detroit.

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

Oct. 18-20: Mid-America Show, Hyatt Regency, Kansas City, Mo.

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

Moving?

Please attach your mailing label here and clearly print your new address below. Mail to: Circulation Department, P.O. Box 3208, Englewood, CO 80155. Please allow 6 weeks for address change.

Name ______________________

Address ______________________

City ______________ State ______ ZIP ______

The Paperback Movie

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

In previous columns we've considered video quality and the competitive effects of advanced television, high-definition television, Super-VHS and, ultimately, digital delivery of video. It's possible to become so preoccupied with one aspect of competition that we overlook something coming from the opposite direction.

Important aspects of the entertainment experience are convenience and price. Portability is a convenience feature that cable has always lacked. Direct portability is likely to always remain impossible for cable. We are going to look at a technology that is based on portability and consider how cable may eventually play a role.

Before we begin, it's worth remembering a technology that revolutionized the way we enjoy music: the Sony Walkman. Akio Morita, one of the founders of Sony, asked his development staff to implement his concept of battery-operated, portable, personal audio. Initial reaction from the marketing department was negative. Fortunately, he was in a position to tell them to do it anyway.

The rest is history. The portable compact audio disc player is just an extension of the Walkman idea. Sony has taken this principle to its next logical step: battery-operated, portable, personal *video*. Small, lightweight machines with 8mm VCRs, TV and radio tuners and 3- to 5-inch color liquid crystal displays ares now available along with prerecorded 8mm tapes. The VHS camp has competing models that are only a little larger. VHS rental movies are, of course, more plentiful. The only thing missing is an attractive price point. Let's see how that could change with the addition of digital technology.

The Paperback Movie

There is a digital development that in many ways runs counter to most other trends and in some ways may be the most dangerous of all. The Paperback Movie project at the Massachusetts Institute of Technology (MIT) has as its objective the creation of a movie distribution business that closely parallels the paperback book business. The intention is to develop a medium that has costs similar to those of a paperback book; the distribution methods for these movies also would be very similar to books. Just as the price of a paperback book is too low for anyone to be motivated to copy it, so the price of Paperback Movies will be too low to tempt copying. This is its main attraction to the movie industry. In fact the price would be so low that even renting the Paperback Movie would be more trouble than it's worth. Most readers buy their own paperback books.

The vision behind the Paperback Movie is of a digital bandwidth reduction technology that would allow a two-hour movie to be placed on a 5-inch compact disc. This is an ambitious technical challenge but not an unreasonable one. Two major contestants in the contest to put movie length video on compact discs are the Media Lab at MIT and RCA. The MIT work is under the direction of Andy Lippman; hopes are high for being able to demonstrate the work this year. RCA Labs, now called the David Sarnoff Research Center, has shaken the video world with its technology called digital video interactive (DVI). DVI may not yet have adequate quality for Paperback Movies, but it gives credibility to those who predict that the potential exists for such a technology.

The disc itself has the possibility of being a very low-cost medium to manufacture. It is literally stamped out, cookie cutter style. It will eventually cost less to make a compact disc than to print a paperback book.

The Paperback Movie concept is complementary with an important trend in consumer electronics—personal video. As described earlier, portable battery-operated VCRs are already available; portable CD players are also available. When the color liquid crystal display is added to the CD player, the ultimate Paperback Movie playback device is achieved. Personal, portable viewing of movies anywhere, anytime becomes possible. There is reason to be concerned that the way consumers enjoy movies may be changed by this technology.

A factor that mitigates the difficulty of compacting two hours of video onto a 5-inch disc is a willingness to take a reduction in video quality as a tradeoff in gaining the compression. The willingness to reduce the quality requirement stems from the fact that in personal video the screen size is small. As mentioned in our previous discussions on HDTV, resolution becomes important only in large screens. Good old NTSC is actually beyond the capabilities of a 5- to 10-inch screen. Its full resolution and quality is not visible on screen sizes of less than 17 inches. These dimensions are much too large for personal video. So the challenge of bandwidth reduction for the Paperback Movie is made easier if the targeted video quality level is appropriate for personal video.

The cable connection

The initial concern for cable is that subscribers will find Paperback Movies to be an attractive alternative to subscription TV and pay-per-view. It appears that there are two likely answers to this problem: HDTV and digital downloading.

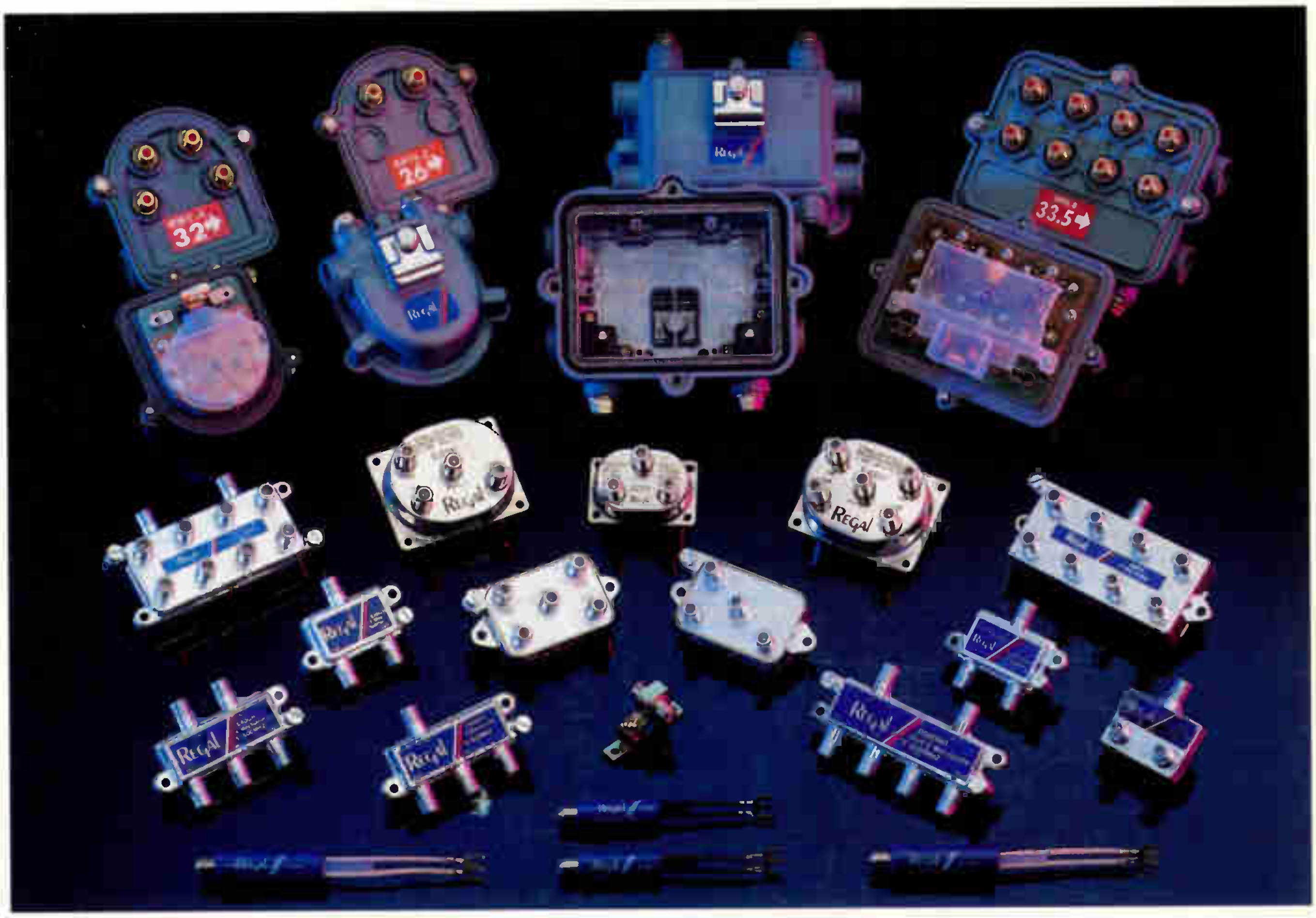
Cable-delivered full HDTV will be a compelling video experience that cannot be duplicated in personal video. If cable capitalizes on its ability to deliver this level of quality and resists the temptation to make bandwidth, compatibility and cost compromises, movies will remain an important part of cable's future.

As discussed last month, digital downloading is not likely to be important until recordable consumer videodiscs become practical. Cable needs to think through scenarios for being the delivery mechanism for the video to be used with portable personal video. The consumer will still likely buy Paperback Movies, but cable can capture an important share of that business with digital downloading.

AD INDEX

Reader Service Number 56.

Let ANIXTER deliver REGAL for your next rebuild!



REGAL is the quality name in distribution passives. When planning your next rebuild remember that only Anixter stocks a complete line of Regal taps, splitters and matching transformers.

- 500 & 600 MHz bandwidths available
- "F" ports are machined brass
- TAP Housings are 360 aluminum alloy
- "F" ports are compatible with EZF connector
- Full use of P.C. boards insures consistency
- Brass "F" ports are cadmium rated to minimize corrosion
- Threads machined to insure perfect "F" conn. fit
- TAPS have epoxy coating to protect against elements
- RFI shielding (110 db typical) for 2, 3, & 4-way horz. splitters.

ANIXTER®

WIRING SYSTEMS SPECIALISTS
VOICE/VIDEO/DATA/POWER

Call our toll-free HOTLINE
1-800-323-0436

or call your nearest Anixter Stocking Location for details.

In an emergency, weekends and holidays or after 5 P.M. call toll-free 1-(800) 323-8167.
CORPORATE OFFICES, ANIXTER BROS., INC., 4711 Golf Road, Skokie, IL 60076, (312) 677-2600

ANIXTER **DEPT. REGAL**
4711 Golf Rd., Skokie, IL 60076

☐ Please send me more information on Regal taps, splitters and matching transformers.

NAME ____________________

TITLE ____________________

COMPANY ____________________

ADDRESS ____________________

CITY ____________ STATE ______ ZIP ______

CT 71

TELEPHONE ____________________

Reader Service Number 57.