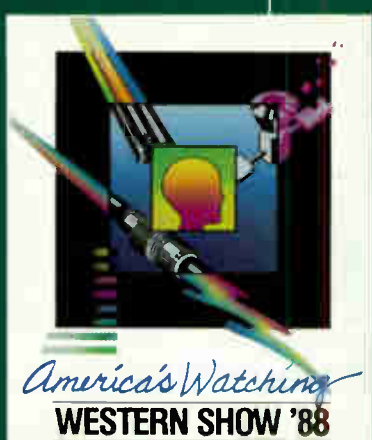
COMMUNICATIONS TECHNOLOGY

Official trade journal of the Society of Cable Television Engineers

Test equipment and accurate measurements



Facing technical issues in Anaheim

December 1988

Introducing

The World's

- smallest
- most cost-effective
- most reliable

Commercial IRD

Integrated Receiver Descrambler

Now Available Off-The-Shelf

Receiver covered by the famous NEXUS 5 YEAR WARRANTY.*
VideoCipher® Module covered by General Instrument's Warranty.

*Call or write for details.

TEL: (206) 644-2371 Bellevue, WA. or (604) 420-5322 Burnaby, BC. FAX: (604) 420-5941
WRITE: Nexus Engineering Corp., 7000 Lougheed Hwy., Burnaby, BC. V5A 4K4

NEXUS ENGINEERING CORP.
PERFORMANCE YOU CAN ~~SEE.~~ *rely on*

Reader Service Number 2.

STRENGTH

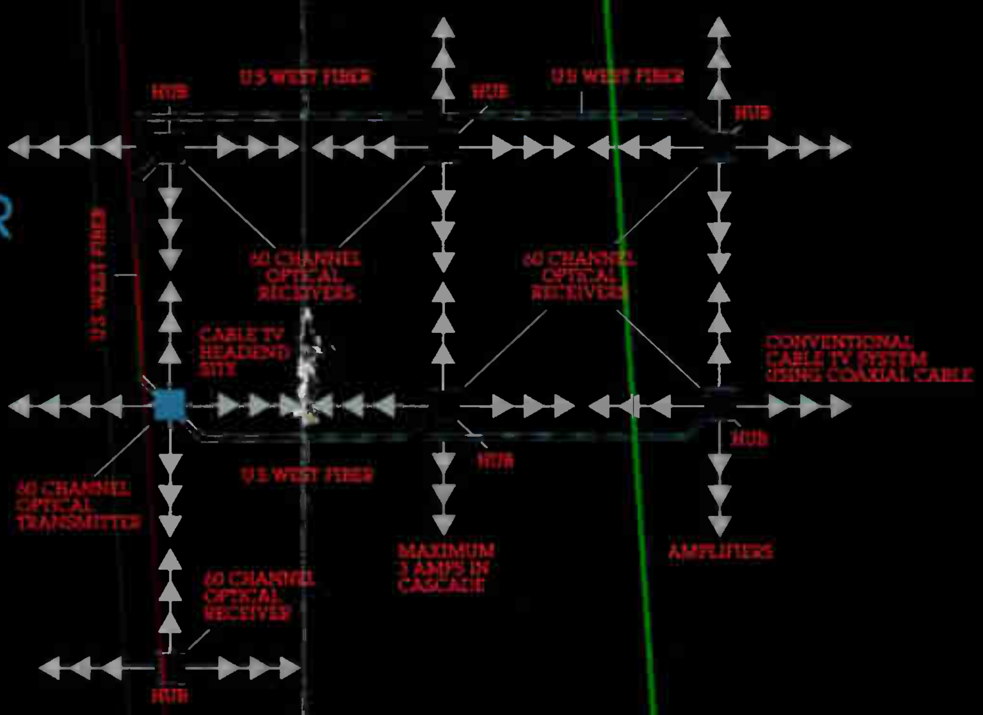
Using strategically located HUB sites, U S WEST can design and install fiber optic systems to reduce your amplifier cascade. This provides an economical system upgrade from 35 to 40-50 or 54 channels without shortening amplifier spacing. You can gain maximum channel capacity with a minimum of new capital investment. U S WEST's optical systems are designed to deliver up to 60 db SNR.

PRACTICALITY

U S WEST is usually the lowest-cost answer for your fiber optic transport needs because we can, in all likelihood, design a network to match your needs by following a fiber route to serve others or to serve U S WEST's own inter-office needs. Sharing the fiber investment makes the difference.

MULTIPLE OPTICAL HUB RECEIVER SITES

NOTE:
In this example the Amplifier Cascade is reduced to 3 or 4 — in some designs the maximum may be as high as 6 to 9 amplifiers.



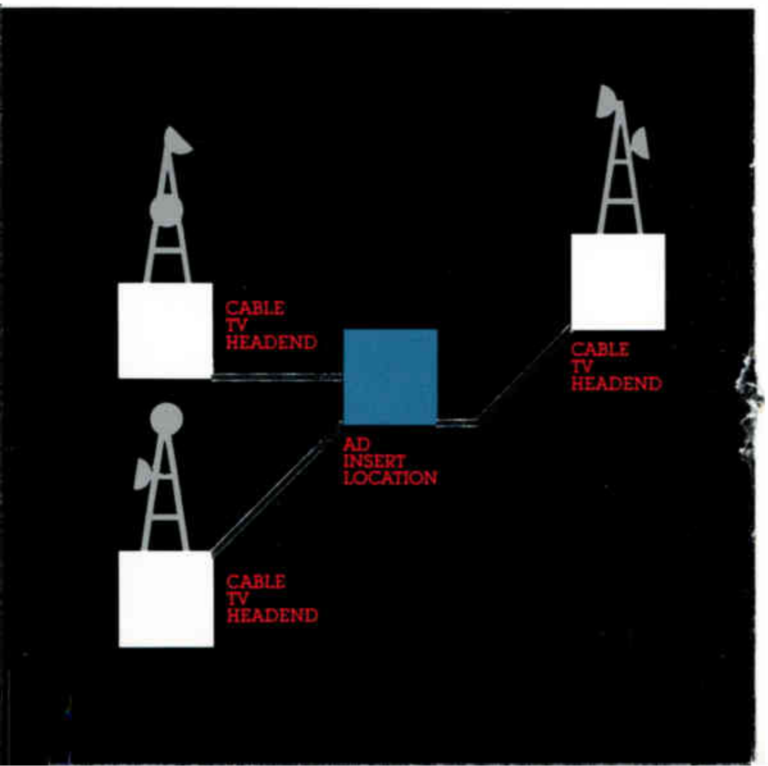
AD INSERTION NETWORK

Don't bicycle your ad tapes between headends; make direct ad insertions to multiple headends from a single location.

Streamline your ad insert administration and reduce ad insert failures to near zero.

Deliver a different ad to each headend and increase your ad time value.

U S WEST can deliver your ads to your headends for less than you think. Our delivery system is filled with possibilities that ad people dream about. All you need is a little of your own imagination.



OPTIONS

The replacement of conventional AML Microwave Links with IntraLATA fiber optic trunk service by U S WEST provides the following options:

▲ Super-trunking of cable TV signal using either AM or FM modulated analog to single or multiple sites from a multi-channel optical transmitter location.

▲ Super-trunking of cable TV signal to interconnect several stand-alone headend sites, which improves multi-system management.

▲ Interconnecting broadcast TV studio and cable TV headends, which may be economical in some cases for distances in excess of 100 miles. (This service can usually deliver RS-250-B, medium haul, broadcast quality signal to the cable TV headend.)

▲ Advertising insertion network, which is capable of delivering either a one-way or a two-way signal from a single ad insertion location to multiple cable TV headend sites. (This can lower your ad insert costs and improve your ad income.)

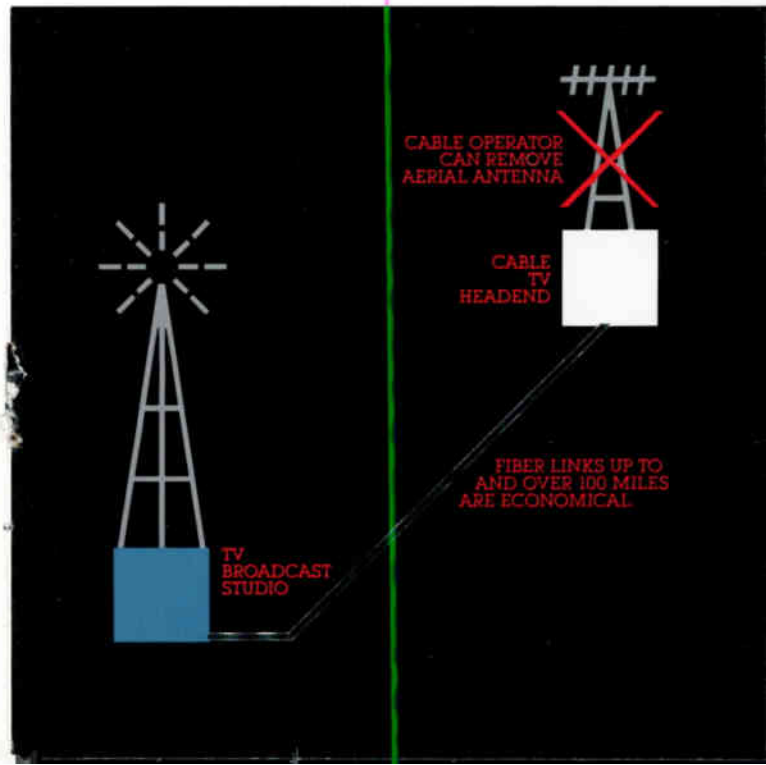
ARE YOU CURIOUS?

Are you interested in fiber transport but don't have the technical knowledge to design your own system?

Without any obligation to buy our fiber optic service, U S WEST will analyze your cable system needs and prepare a detailed proposal, which includes the monthly charge for the service.

Call either Justin Cislaghi at (303) 896-4691 or Walt Huff at (206) 345-5297.

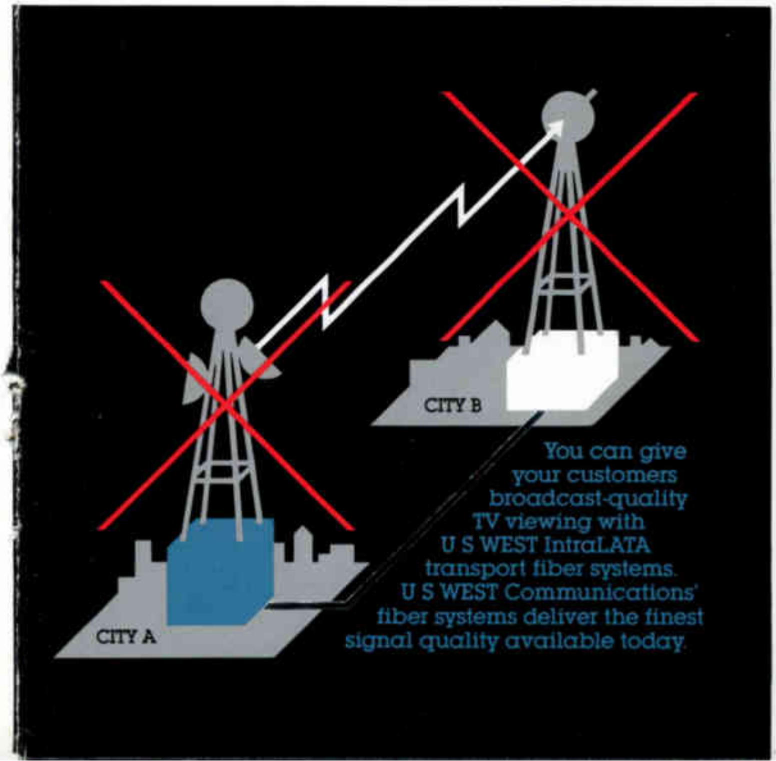
U S WEST COMMUNICATIONS



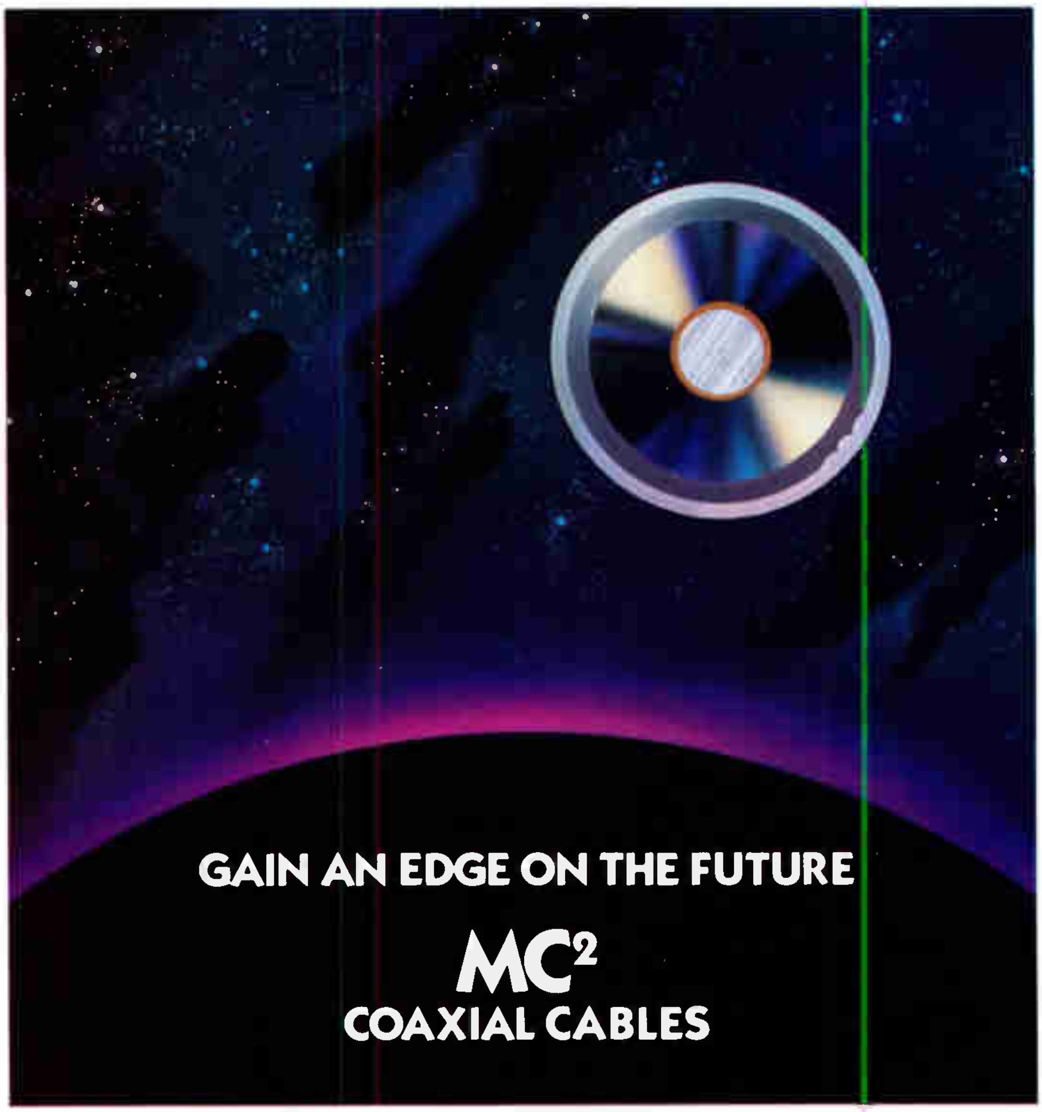
US WEST
COMMUNICATIONS

REMOVE OBSOLETE AML MICROWAVE LINKS AND REPLACE THEM WITH BROADCAST-QUALITY SIGNAL STRENGTH...

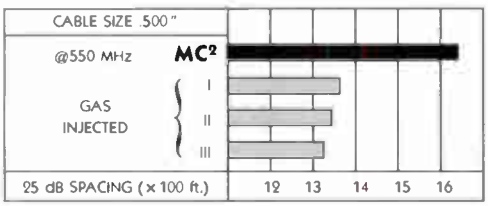
OVER A U S WEST COMMUNICATIONS FIBER OPTIC CABLE CONNECTION.



FOLLOW THE LEADER



Follow the leader, that's what our competitors are trying to do in order to approach the superior attenuation characteristics of MC² coaxial trunk and feeder cable. But they succeed only by increasing the standard diameters of MC² — our familiar .500" must become .565" or .625"; and our .750" must become .840" or .860" or .875". The space–saving benefit of MC² is now even greater than before.



The competition is also making a lot of noise about their new medium density jacketing. The MC² jacket has always been medium density. Trilogy leadership is clear.

TRILOGY LEADS IN TECHNOLOGY

Trilogy

COMMUNICATIONS INC.

Call or write for a free sample and brochure:

TRILOGY COMMUNICATIONS INC., 2910 Highway 80 East, Pearl, Mississippi 39208

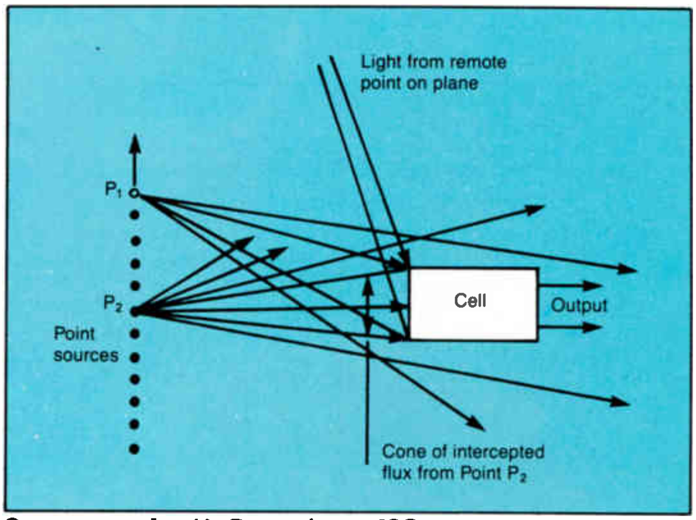
800-874-5649
601-932-4461

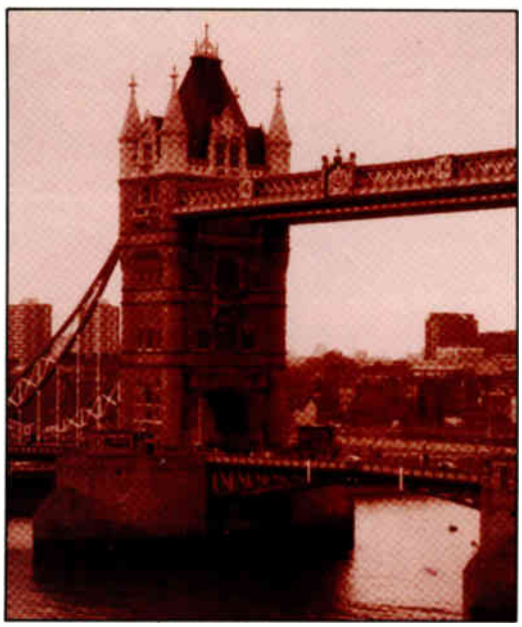
Reader Service Number 3.

CONTENTS

Departments

Cover
Photo courtesy Tektronix/Harlan Cook and Andy Scott of Willamette Cable; logo courtesy Pittelli & Partners/West & Wohler.





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. December 1988, Volume 5, Number 10. 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.

Jerrold Applied Media Lab

...exploring new paths to cable's future

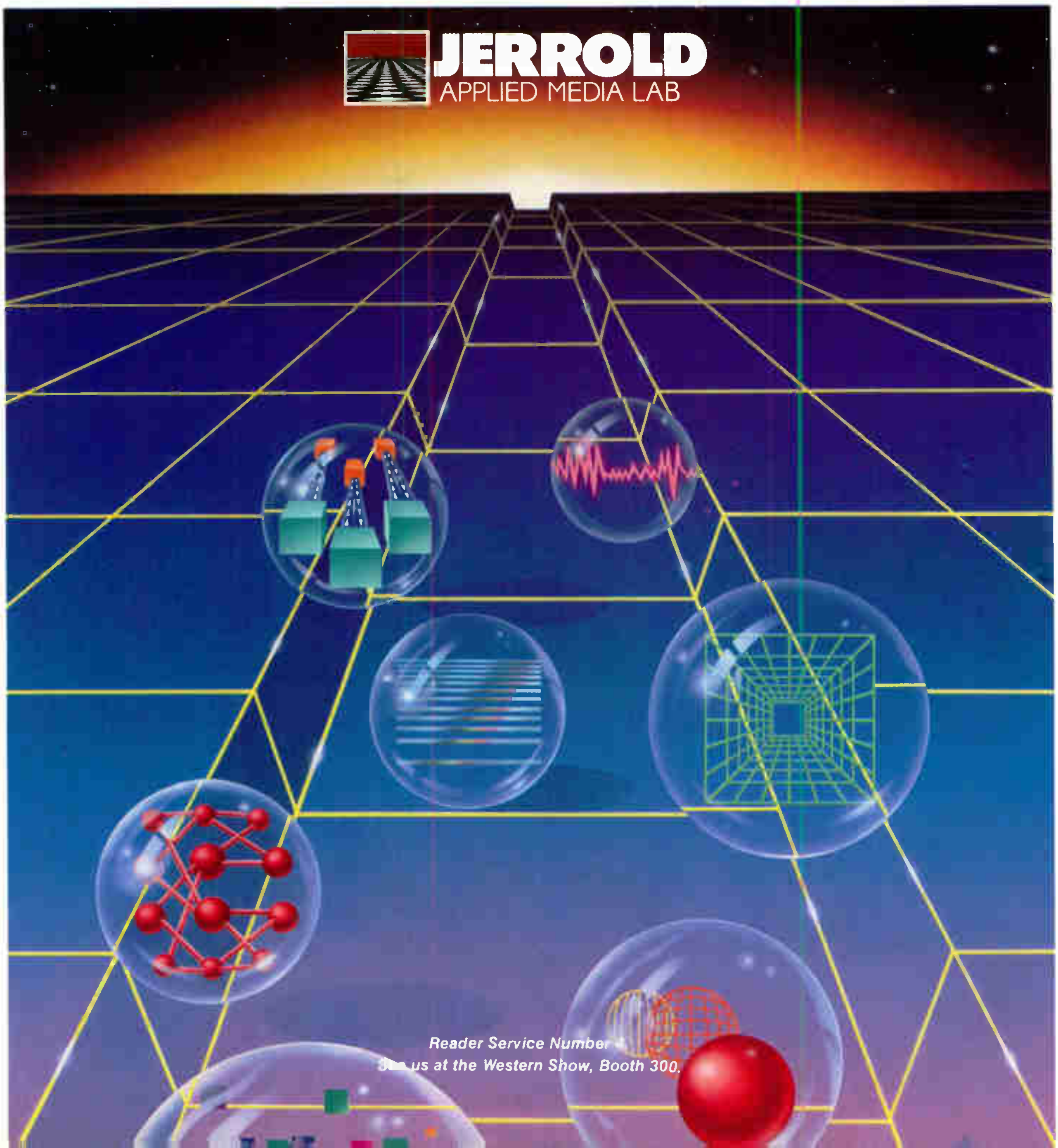
Cable television's broadband communications "pipeline" into the home is an enormous resource with a potential that remains largely untapped.

Exploitation of this potential depends upon a fusion of subscriber needs and technical R&D. Jerrold's Applied Media Lab is focused on the development of new technology to improve cable television and provide more choices for subscribers.

With your input and participation, the Applied Media Lab can serve as a conduit between today's technological innovations and tomorrow's practical applications.

For a brochure on current activity areas, contact Jerrold Division, General Instrument Corporation, 2200 Byberry Road, Hatboro, PA 19040. (215) 674-4800.

• HDTV • Interactivity • Fiber Optics • Digital Audio • Data • Headroom • Advanced Scrambling



PUBLISHER'S LETTER

America's watching us

It's early December, time again for the Western Show at the Convention Center in sunny Anaheim, Calif. The theme for this, the 20th annual convention of the California Cable Television Association, is "America's watching." Here are some suggestions of what to do while you're there:

1) *Learn*: Sit in on several outstanding CATV technical seminars (co-sponsored with the usual high standards by the CCTA and the Society of Cable Television Engineers). Topics include "FCC update," "Signal leakage," "Fiber and cable: A view of possibilities," "Fiber transmission systems: Exploration of system architectures," "High definition—Moving toward reality" and "Consumer electronics interface report." Also, take in the closing general session, an open forum on cable and telco issues.

2) *Walk*: Visit many of the 225 exhibitors on over 110,000 square feet of exhibit floor. See the latest technology from many of the leading hardware vendors. Just to tease you: Scientific-Atlanta will be exhibiting seven new products, including a fiber-optic transmission system, set-top converters and off-premise addressable equipment. Jerrold will be displaying an impulse-capable baseband converter (as well as celebrating its 40th birthday). Also, Zenith will display its new HDTV system and personal control center. Plus, many more exciting new developments from dozens of other manufacturers.

3) *Read*: Pick up a copy of our *CT Daily*, which each day brings you up to date on the various technical sessions and action from the exhibit floor. (If there's something happening at your booth that you'd like to get into the daily, please stop one of our staff members and tell us about it.)

4) But above all, *enjoy*!

Attention, attention

Attention, SCTE members: The Society will be announcing its new insurance benefits program for its membership during a press conference at the Western Show. The SCTE recently formed a relationship with Smith-Sternau Organization, an insurance broker that represents a large number of engineering associations. For those wishing to take advantage of this opportunity, the "group trust" program will allow the SCTE to offer reduced rates of insurance coverage.

Scheduled to be introduced next year will be major medical, excess major medical, term life, hospital indemnity and high-limit accident. Members can apply for one or any combination of plans to suit their requirements.

Also, be on the lookout for the *1988-89 SCTE Directory and Yearbook*, published and ready to mail by year's end. (And, hey—If you aren't already a member, get on the stick!)

Attention, *CT* readers: In the near future, we'll be printing photos and other graphics presented on the monthly SCTE Satellite Tele-Seminar Program. Watch for it, then tune in on the seminar.

We're working for you, and dedicated to the cable TV industry!

What's new at "CT"?

With this issue, we've recently made a few additions and changes in our masthead. First, Marty Laven was named vice president of sales and marketing. Marty brings a 10-year publishing and marketing communications background to our company. Prior to joining us he was communications director for United Way of Broward County, Fla. Some of you may remember him from his many years of experience in the cable industry in the late '70s and early '80s.

Laven

Other changes include: Neil Anderson, previously an account executive, was promoted to national sales manager; Marie Beert was promoted to marketing administrative assistant; and Shelley Bolin, formerly editorial assistant, was promoted to assistant editor. Danielle Kelley is our new receptionist.

Also on the new arrivals list is Leslie Read of Sammons Communications, who was recently named SCTE Region 4 director. Congratulations and welcome aboard, Les.

And last, but not least, we'd also like to welcome aboard Archer Taylor, senior vice president of engineering for Malarkey-Taylor Associates, who will be contributing a column beginning next month.

Happy Hanukkah, Merry Christmas and Happy New Year!

COMMUNICATIONS TECHNOLOGY

Paul R. Levine
President/Publisher

Martin L. Laven
VP of Sales and Marketing

Neil Anderson
National Sales Manager

Lu Ann Curtis
Account Executive

Marie T. Beert
Marketing Administrative Asst.

Maria Sullivan
Production Coordinator

Carroll A. Barnes
Production Asst./Classified Ad Mgr.

Mary L. Sharkey
Circulation Manager

Kenny Edwards
Controller

Toni I. Barnett
VP of Editorial

Wayne H. Lasley
Editor in Chief

Rikki T. Lee
Managing Editor

Shelley L. Bolin
Assistant Editor

Lawrence W. Lockwood
East Coast Correspondent

Sharon F. Lasley
Art Director

Brad Hamilton
Assistant Art Director

Geneva Hobza
Assistant to the Publisher

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

Western Show '88: "America's watching"

ANAHEIM, Calif.—The California Cable Television Association (CCTA) will present this year's Western Show at the Anaheim Convention Center Dec. 7-9. In cooperation with the CCTA, the Society of Cable Television Engineers will provide three days of technical seminars. The agenda for the show follows. (See accompanying breakdown for technical sessions.)

Tuesday, Dec. 6
2:30 p.m.—SCTE Interface Practices Committee meeting, Hilton Hotel
3-6 p.m.—Registration

Wednesday, Dec. 7
8 a.m.-6 p.m.—Registration
10 a.m.-6 p.m.—Exhibits open
1-2:30 p.m.—Opening general session: "America's watching"
1:30-4:45 p.m.—Technical sessions
4-6 p.m.—Exclusive exhibit hours and welcome reception

Thursday, Dec. 8
8 a.m.-6 p.m.—Registration
8:30-11:45 a.m.—Technical sessions
10 a.m.-6 p.m.—Exhibits open
Noon-1:45 p.m.—Luncheon
1:30-5 p.m.—Technical sessions

Friday, Dec. 9
8 a.m.-3 p.m.—Registration
9-10:30 a.m.—Technical sessions
10 a.m.-3 p.m.—Exhibits open
10:30 a.m.-noon—Closing general session: "Cable and telco"
Noon-3 p.m.—Exclusive exhibit hours

Technical sessions

Wednesday, Dec. 7

- 1:30-3 p.m.—"FCC update: An overview of technical and regulatory issues currently facing the cable television industry." *Moderator:* Bill Riker, SCTE. *Speakers:* Wendell Bailey, NCTA; John Wong, FCC; and Brian James, NCTA.
- 3:15-4:45 p.m.—"Signal leakage." *Moderator:* Robert Dickinson, Dovetail Systems. *Speakers:* John Wong, FCC; Roy Ehman, Jones Intercable; Steve Raimondi, United Artists Cablesystems; and Chris Duros, CableTrak Inc.

Thursday, Dec. 8

- 8:30-10 a.m.—"Fiber and cable: A view of possibilities." *Moderator:* Joe Van Loan, consultant. *Speakers:* Frank Little, Scientific-Atlanta, "A primer for the marriage of coaxial cable and fiber"; Brent Bayon, Viacom, "Remote satellite 4 GHz fiber link"; Jim Chiddix, ATC, "Strategic issues with fiber and cable"; and Jim Hood, Catel Telecommunications Inc., "TransHub—Transmission of AM and FM using fiber."

- 10:15-11:45 a.m.—"Fiber transmission systems: Exploration of system architectures." *Moderator:* Jim Chiddix, ATC. *Speakers:* Dave Large, Raynet Corp., "Video distribution using tapped bus architecture"; Dave Fellows, Scientific-Atlanta, "Strategic issues in fiber applications"; Dave Robinson, Jerrold Division/General Instrument, "Fiber-optic architectures for cable TV"; and John Holobinko, American Lightwave Systems, "Fiber-optic trunking systems."
- 1:30-3:30 p.m.—"High Definition—Moving toward reality." *Moderator:* Ted Hartson, Post-Newsweek Cable. *Speakers:* Wayne Luplow, Zenith Electronics, "A spectrum compatible HDTV system"; Dr. James Carnes, David Sarnoff Research Center, "ACTV update"; Yves Faroudja, Faroudja Laboratories, "NTSC revisited"; and Arpad Toth, Philips Laboratories, "Recent developments."
- 3:45-5 p.m.—"HDTV roundtable: Experts in allied television fields analyze the coming impact of HDTV." *Moderator:* Ted Hartson, Post-Newsweek Cable. *Panelists:* Gregory DePriest, Association of Maximum Services Telecasters; Brenda Fox, NCTA; Vito Brugliera, Zenith Electronics; Lex Felker, Mass Media Bureau, FCC; Larry Irving, House Subcommittee on Telecommunications and Finance; and Rupert Stow, CBS.

Friday, Dec. 9

- 9-10:30 a.m.—"Consumer electronics interface report." *Moderator:* Walt Ciciora, Ph.D., ATC. *Speakers:* Joe Van Loan, consultant, "Multiport update—Toward a success story"; Tom Mock, Electronic Industries Association, "The EIA multiport and advanced television systems"; Joe Stern, consultant, "A digital audio cable radio system using adaptive delta"; and Walt Ciciora, ATC, "Cable's high-definition TV priorities."

NCTA Engineering Committee report

"CT" is presenting a report of the bimonthly meetings of the Engineering Committee of the National Cable Television Association.

WASHINGTON,D.C.—The bimonthly meeting of the NCTA Engineering Committee was held here Oct. 19-20. The premeeting session was a review of priorities by the subcommittee chairmen and the setting of goals for the next year.

Wendell Bailey updated the committee on activity by the Federal Communications Commission and Congress. Congress is preparing to recess and it appears unlikely that the Gore bill will be attached to any other bills this session. An attempt was made to attach the legislation to one bill but it lost the vote. Senator Gore has indicated that if the situation does not improve he will attempt to move the legislation next session.

A petition for reconsideration of the syndex rules has been filed by the NCTA in an attempt to reduce the burden on cable companies. As the rules now stand a cable operator does not have to be told of the need to remove signals until 60 days before the implementation date. This may be insufficient time to obtain all of the equipment necessary to delete the program and insert another program.

The commission is reviewing the need for continued prohibition of telco ownership of local cable systems. It appears to believe that the ban could be removed with no harm to cable operators or subscribers. As Congress and Judge Green also would have to rule on the removal of the ban, the commission is considering a modification of the waiver process rather than change the law.

The FCC has adopted a modification to the terminal device regulations but the press release does not provide sufficient detail to determine the full effect to the changes. The text should be released within the next few weeks.

The Internal Revenue Service is reviewing the life of all assets and, in the initial round of reviews, companies using TV production equipment were reviewed. As cable systems have production equipment they were included in the review. NCTA has been providing the IRS with the information needed for its analysis.

The FCC has issued a tentative decision on advanced television. It prefers that proposed systems be compatible with existing broadcast television and not require spectrum outside present television bands.

A further notice of proposed rulemaking regarding technical deregulation has been issued by the FCC. It is proposing to include Classes 2, 3 and 4 video signals in the regula-

KNOWING WHERE YOU WANT TO GO,

You know where you want to go.

You want to stay competitive. And in the cable television industry, that means using the best, most cost-efficient technology. Maybe a new build is in order. Perhaps a system upgrade. Either way, you face a perplexing situation.

You know where you want to go. But how do you get there?

Making it Easier

At Catel, we realize that finding the answer isn't easy. There's a lot of talk and a great deal of confusion regarding CATV technologies—fiber optics, microwave, and coaxial.

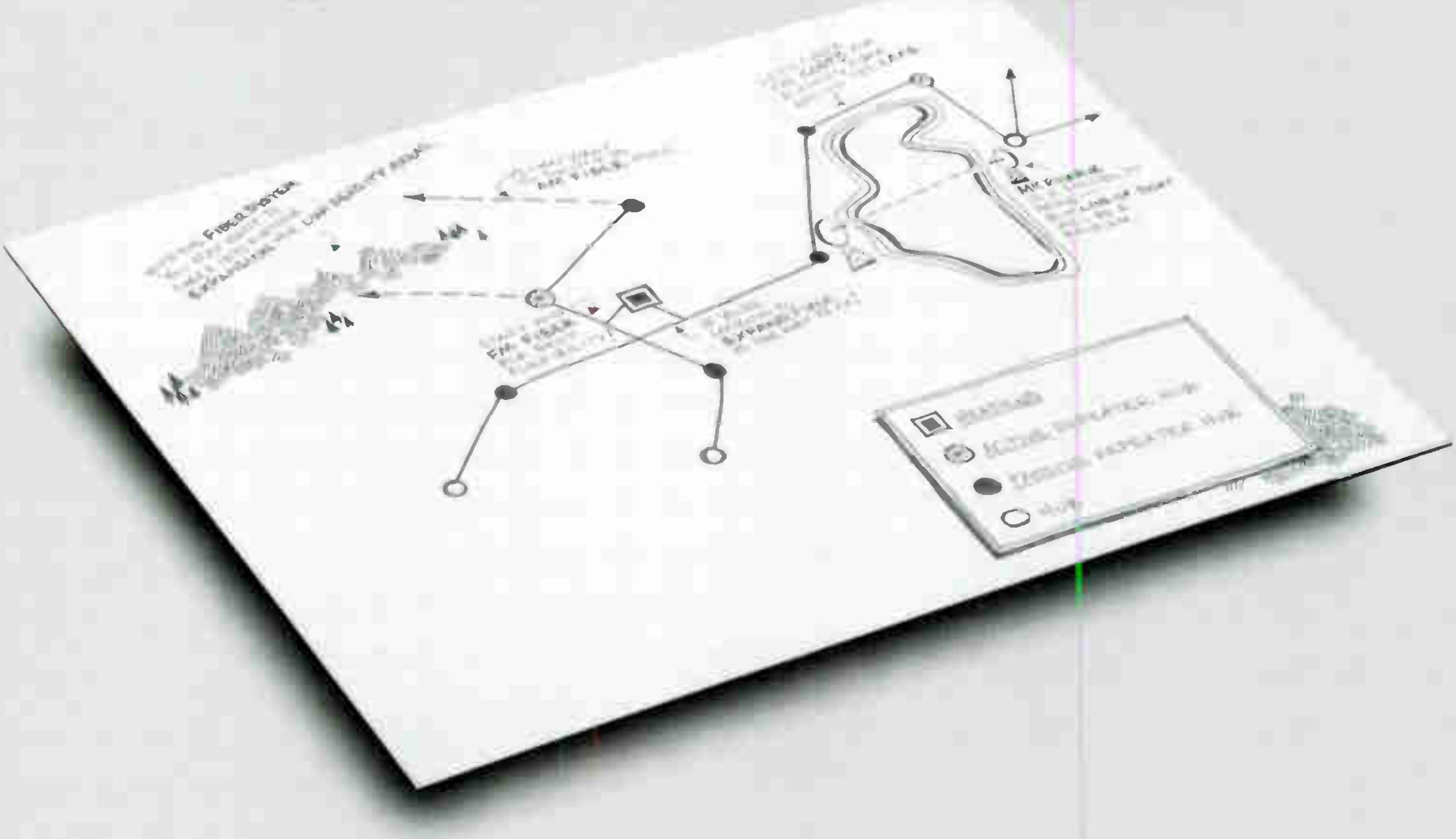
Catel can make the decision-making process easier by examining your specific network requirements. Together, we can determine your cost, network distribution, and overall system objectives.

Then—and only then—can a particular technology be considered.

The Best Route

Oftentimes, the best route may consist of more than one technology. Eventually you'll realize that Catel's fiber optic technology has several distinct advantages over the others—superior quality, future expandability, and maximum channel capacity, to name a few.

ISN'T THE SAME AS KNOWING HOW TO GET THERE



And because all Catel fiber optic products support both AM and FM transmission technology, network design flexibility is greatly enhanced.

More Than 20 Years

For more than 20 years Catel has provided the cable television industry with innovative solutions. The introduction of our full family of fiber optics products marks the beginning of an exciting evolution for the industry—an evolution which will bring about complete fiber-to-the-home CATV systems.

You know where you want to go. With Catel, you'll get there.

When it comes to fiber optics for cable television, there's only one clear choice—Catel. Give us a call today at 1-800-225-4046 or (415) 659-8988 (in California).

CATEL
THE CLEAR CHOICE IN FIBER

Reader Service Number 9.

tions. These would then be deregulated and the franchising authorities would be pre-empted from setting technical regulations that were tighter than those in the regulations.

The superstation copyright legislation has passed the House and is expected to pass the Senate before the recess. The bill would give a compulsory license to home dish owners similar to that granted cable companies.

Presentations were made by Eidak Corp. and Macrovision on the ability of their encoders to produce watchable pictures for direct viewing on a television but not allowing the picture to be recorded at home for later viewing. The principal application for this encoding would be to obtain earlier releases of movies while ensuring that the video sales of the movies are not hurt. These movies would normally be pay-per-view releases.

Subcommittee reports

National Electrical Code: The comments on the revisions for the 1990 edition of the National Electrical Code will be reviewed by the various committees. Approved applications for the various listed cables have been requested from cable operators so they can be compiled and used by other cable operators to help settle disputes with local electrical inspectors.

Advanced television: Activity in this area continues to be high with the various working parties of the FCC Advisory Committee meeting regularly. Written proponent system proposals have been submitted and the week of Nov. 14 has been selected for hearing verbal presentations on the systems. The Advanced Television Test Center is still in the formative stages with engineers being hired and equipment being specified. The procedures for the cable transmission tests are being reviewed and finalized by the Planning Subcommittee Working Party Four.

Attendance at the various committee meetings includes broadcasters, manufacturers and telephone company representatives with only token cable representation. It is imperative that the cable industry attend the working party meetings in order to have some influence over the decisions being made and the direction that advanced television is taking.

Test procedures: The final review of test procedures for the second edition of the *NCTA Recommended Practices*, which will be printed in early 1989, is under way.

Signal leakage: A series of seminars has been developed by the Engineering Committee to enlighten system personnel on the requirements of the regulations for continued use of the aeronautical band. These will be free to participants but attendance is limited and preregistration is required. A notice regarding the seminars will be sent to all systems in the next two weeks.

Multiport: The technical standards for the multiport have been completed and the specifications for pay-per-view ordering through the TV remote control are nearing completion. The full standard should be adopted by the end of the year. There will be a booth at the Western Show in conjunction with the SCTE to display the multiport on production TV sets and, possibly, with preproduction descramblers.

Smarthouse: Equipment is now in the breadboard stage. It is expected that 10 to 20 prototype homes will be built across the country in 1990. These will incorporate many of the advanced features of the Smarthouse concept, including a single-cable, two-way, in-home distribution system.

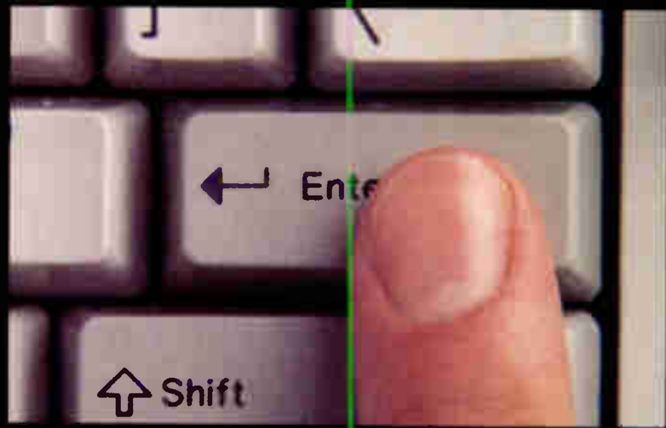
ARRL: There has been one complaint received through the ARRL regarding cable/amateur interference, which is under review. In this instance the amateur was getting into the cable system and the operator has not taken sufficient action to prevent the ingress. The amateur operator requested the help to ensure that he could continue to operate without bothering his neighbors.

Advanced signaling and control: A new subcommittee with Ned Mountain as chairman was set up. The Wegener system is becoming the de facto standard for the delivery of high-level control information for ad inserts. There is a 9.6 kbps channel available for transmitting additional information to the cable operator. The subcommittee will define a protocol for the use of the 9.6 kbps channel. The subcommittee is scheduled to meet at the Western Show.

Satellite practices: A training course for uplink operators is being sponsored by the National

(Continued on page 94)

NOW THERE ARE TWO WAYS TO COLLECT SYSTEM-WIDE SPECTRAL DATA.



SEND THE WHOLE FLEET.

GIVE ONE COMMAND WITH THE MAGNAVOX LINE MONITOR.

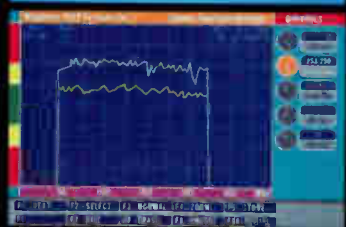
When you put Magnavox Line Monitors (MLM) to work it's like placing a spectrum analyzer at every critical point in your broadband system. MLM can monitor your *entire* system from any remote location and warn you when it strays from set parameters.

Unlike other status monitoring systems that typically measure just one or two signals, MLM monitors and measures all the signals in your CATV and LAN system. So you can quickly and automatically localize frequency-related faults and even identify other types of system performance degradation. With MLM your technicians spend their time fixing a problem, not tracking it down.

MLM has some features you'd find in more expensive digital spectrum analyzers. Like colorful and informative graphics that tell you at a glance how your system is performing. And storage and retrieval that gives you a complete record of system performance. MLM gives you all these features in an attractively-priced package, so you can install as many line monitors as you need to cover your whole system.

MLM is from Magnavox, a company you've come to know for quality, reliability and service. For application information and an MLM demonstration, call your Magnavox representative.

Compact MLM module is enclosed in a rugged housing that withstands the extreme environments of a cable system.



MLM display showing sweep response. White is actual response; yellow is stored response.

MLM display showing the video, color and sound carriers of Channel 3 with upper adjacent channel picture carrier and lower adjacent sound and color carrier also shown.

MAGNAVOX
CATV SYSTEMS CO.
A DIVISION OF CONSOLIDATED ELECTRONICS INDUSTRIES CORP.

100 Fairgrounds Drive, Manlius, NY 13104
(315) 682-9105 Fax: (315) 682-9006
Call 1-800-448-5171 (In New York 1-800-522-7464)

Reader Service Number 11.

The impossible dream—3-D TV

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

Virtually every engineer, inventor and learned professor concludes a commentary on the potential schemes for 3-D TV by admitting failure to simulate the quality of human binocular vision. In the June 1986 issue of *CT* I treated the subject of 3-D TV both historically and technically without proposing a 3-D modification of NTSC broadcasting or mentioning the other means for viewing 3-D TV in the home. Also, I failed to include the alternating eye-shutter light-switching devices synchronized to the TV field display. Toshiba, utilizing remotely actuated liquid crystal spectacles operating at twice the NTSC standard (avoiding 30 cycle flicker), carried an old concept to new heights. However, a $50 viewer and the demand for bandwidth will probably inhibit the marketing of this excellent system.

There seems to be a genuine impasse currently to the prospect for 3-D TV and, as a longtime fan of 3-D, I am loath to see its use confined to children's games and rich people's toys. Even though the researchers have not yet found the road to low-cost, user-friendly, reasonable bandwidth 3-D TV, we should keep the door open for the inventor, in case the flash of lightning strikes the right person at the right time and we get a practical 3-D TV system.

Thus my proposal: The Federal Communications Commission in setting the standards for HDTV shall assign sufficient bandwidth to accommodate two NTSC channels, as an option for the broadcaster, should it be moved to offer 3-D TV to the public. I am not yet aware of any proposed 3-D system that will motivate the broadcaster and the audience to dig into their pockets for this unique and pleasurable experience, but the future is bound to bring miracles. In the interim while we are holding our breath, there is a simple 3-D technique we can employ that is inexpensive for both the broadcaster and the audience.

Side by side

Let us assume that the FCC (in three years) will give the station 12 MHz instead of 6 MHz. A person at home places two identical TV sets side by side appropriately tuned to the right and left channels. To merge the two screens together into a 3-D image one only requires a prism viewer made of plastic—in quantity, probably under $1. Since you readers are inherently all skeptics (for good reason, of course) you can conduct your own proof-of-performance. At a distance of 10 feet from the two TV receivers (screen size, 21 inches) place a 15-diopter prism over one eye, or 8-diopter prisms for both eyes, relax your eyes for distant viewing and you will see three TV screens, of which the center image is in 3-D. Naturally, since both screens are driven from one source, you will not see a true stereo image. But I believe you will be surprised at the apparent 3-D depth as compared to the normal picture.

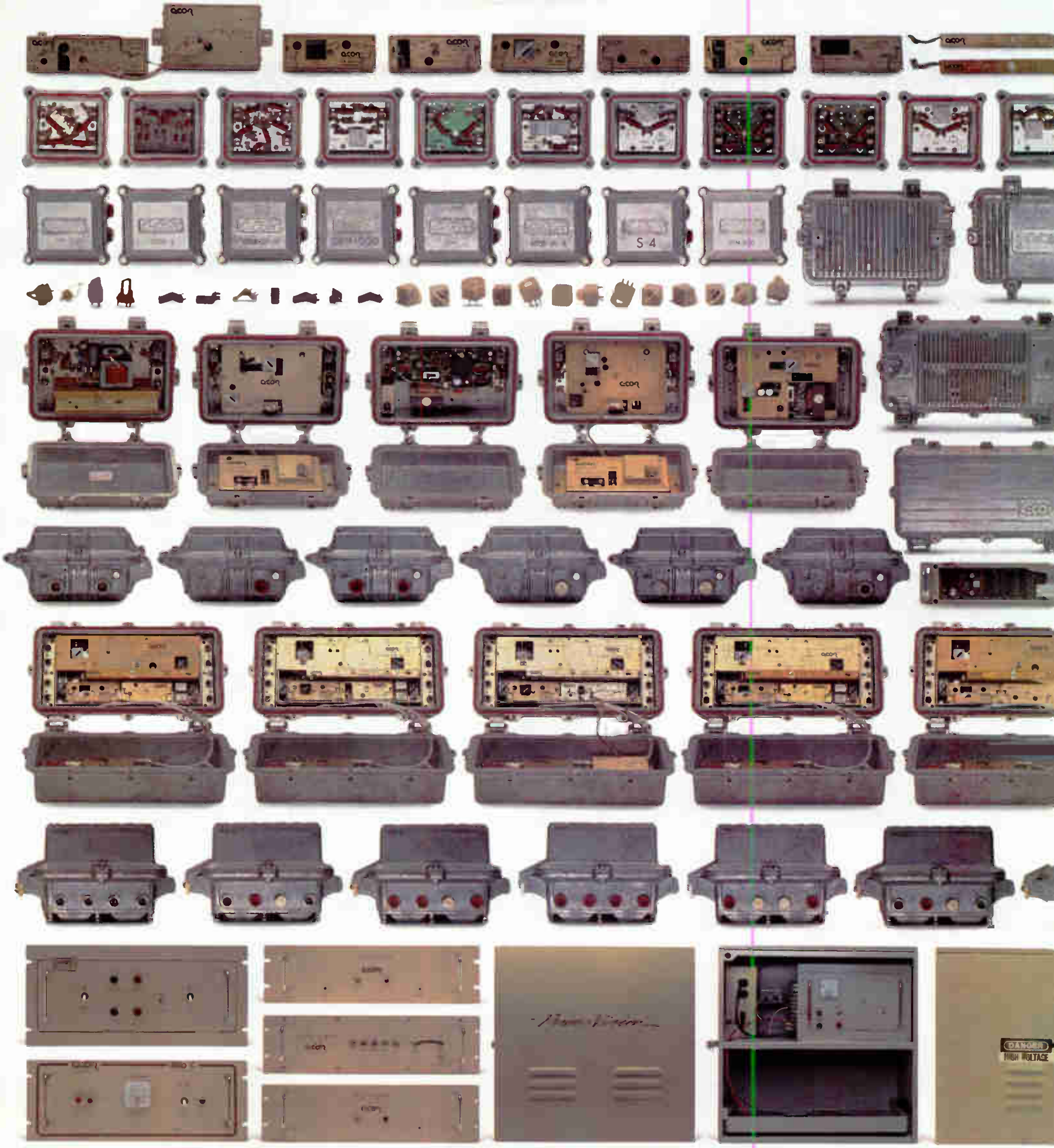
The prism diopter will change with the subtended angle presented to the eyes by the separation of the receivers. If you wished to use projection TV you would have to be located further back from the screen or use a higher value of diopter. Suppose the two sets were not identical makes; what problems would that present? Surprisingly, the human brain is capable of compensating for unequal images from the eyes but is very intolerant of vertical misalignment. You will find that you need to keep a level head or the images will come apart. Back in 1856, Sir David Brewster described a means of creating a variable optical prism. I made one according to his clear instructions; it enables you to sit at any distance from the two TV sets and achieve a binocular merger.

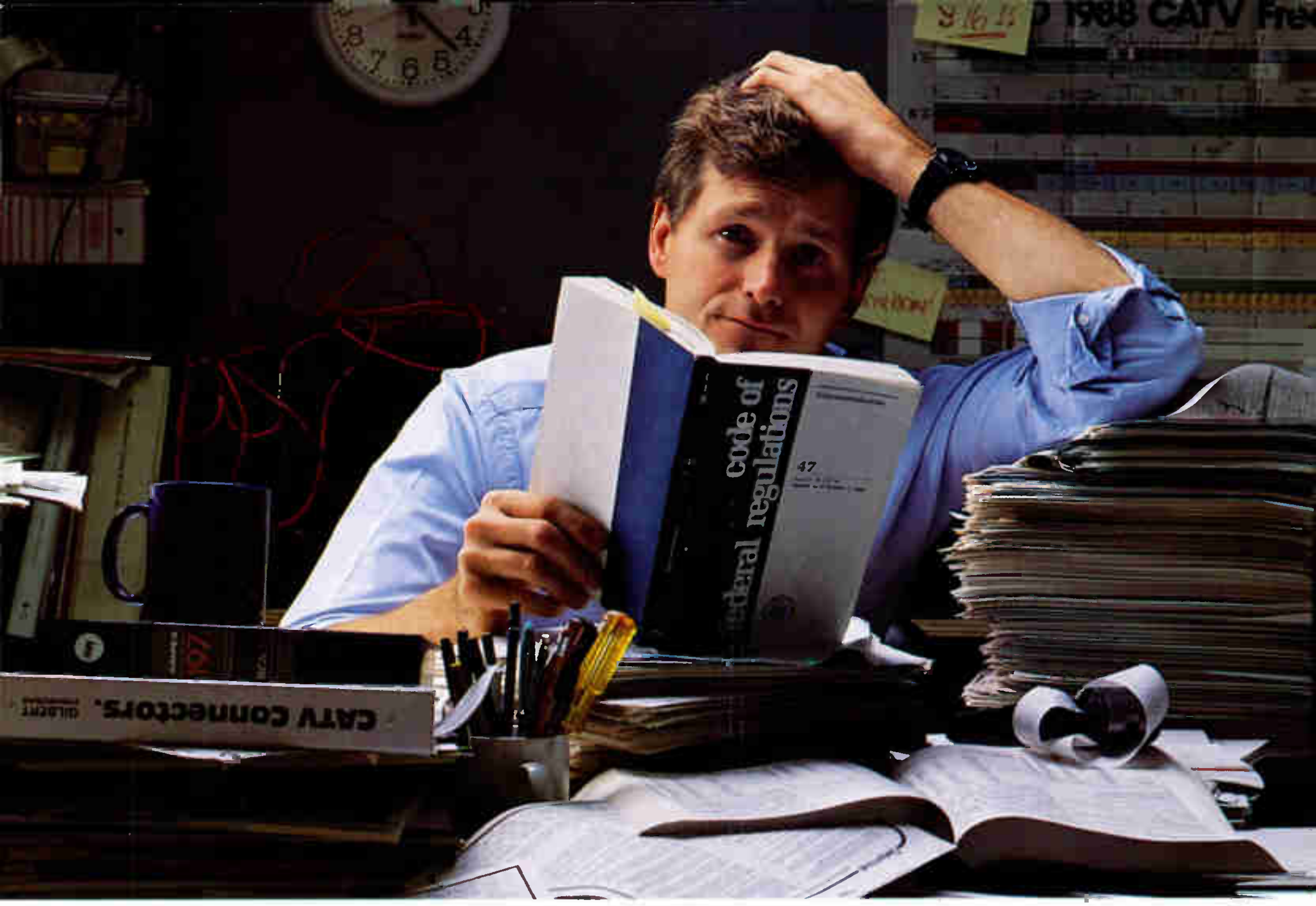
As long as the stereo pair is being transmitted, other known and available methods for viewing the broadcast stereo picture could be employed at the discretion of the spectator.

The most popular stereo design for the small screen is the combination of the two views from orthogonally polarized picture tubes by a half-silvered mirror and the spectator wears the typical Polaroid glasses. For the larger audience, polarized movie projectors on a screen together with a goggled gaggle of spellbound vacationers is the big attraction at fairs. Giant-sized lenticular screens suitable for the theater have been created, especially by Russia in the '30s. Although stereo vision is achieved with lenticular screens, the overall quality is low, seating has to be limited to fan-shaped zones and the cost is enormous. As many as six synchronized projectors are desirable! (You may have seen a Nimslo photograph that displays the limitations of the lenticular process.)

Lamentably, 3-D TV has had its brief moment in the sun, both at the movies and in the home. While up to 15 percent of the population may be functionally unable to form a stereo image in the brain, it can still bring an added dimension to television that could enhance both pleasure and learning.

We must look to the FCC to create the opportunity for delivering 3-D TV to the home and to the inventor for the design that meets the aesthetic and cost targets to attract mass audiences.





Don't worry.

With the FCC's Compliance Regulations, the way you seek, find and document cable leakage will be under careful scrutiny. It's going to take more technician time. It's going to take more administrative time. So, to play by the new rules, it's going to cost you. But if you don't play by them and get caught, it will *really* cost you.

Welcome to that comfortable spot between a rock and a hard place.

But wait, compliance is simply a function of locating, documenting and repairing leaks. And locating and documenting leaks is simply a function of the right equipment.

Presenting the new *Wavetek Cable Leakage Instrument (CLI) Series.*

The new CLM-1000: Amazing.
If you had one instrument to buy to solve your leakage problems, this would be it. It measures field strength at any frequency from 50 to 550 MHz. At any range from 9 to 100 feet. And what it finds, it remembers, so you've got foolproof recall to simplify your documentation.

The end of calculated risks.
With just the push of a button, the CLM-1000 takes precise measurements. The dipole antenna receives signals as far as 30 meters and as weak as 20 μV/m. All you do is approximate and input the distance between the antenna and the leak. The system automatically converts the measurement to a 3-meter distance. No number crunching with conversion tables or formulas. No question about accuracy. All the information you need is displayed in an easy to read two-line LCD display, including analog level bar. Nine instrument stored setups simplify even the most complicated situations.

As easy as rolling off a log.
The CLM-1000 contains a complete logging system. At the touch of a button you can store all the measurement data, leak location, date and time of measurement. Then you can print it out on site, or save it for downloading to your office PC.

The CLM-1000 memory bank automatically provides a detailed log—just for the record.

CLM-1000 digital readout takes guesswork and interpretation out of settings and readings.

Be happy.

It's easy. And so is retrieval, which cuts data tracking time to a minimum. So you can say goodbye to recording errors.

For the record, the CLM-1000 is the most precise, versatile field strength meter you can buy.

When second best will do.
For instances when you don't need all the sensitivity, memory and documentation capabilities of the CLM-1000, Wavetek has two new very trustworthy hand held CLI receivers. The CLR-1 and CLR-4. Both almost operate themselves and are virtually goof-proof.

CLR-1: One track mind.
Designed for easy, near-field use, the CLR-1 can detect and verify leaks at a subscriber installation or an amp. It tunes into one cable channel and gives you a precise reading. Locator tone pitch and LED readout verify leakage level. No knobs, no needles. And no signal generator is required.

All at a price that makes the CLR-1 impossible to do without.

The CLR-4: When there's more going on.
The CLR-4 covers the CATV spectrum, scanning four different channels simultaneously, or one at a time. It can tune channels 2, 3, D, and R as well as others. An exclusive Wavetek lock-out feature prevents interference from strong competing signals. LED's and locator tone pinpoint the leak source, quickly and precisely.

And all this technology is yours for a remarkably low price.

CLR-1 (right) and CLR-4 give you two very affordable and goof-proof ways to locate leaks.

Let the CLM-1000 do the walking, since it can detect and measure leaks up to 100 feet away.

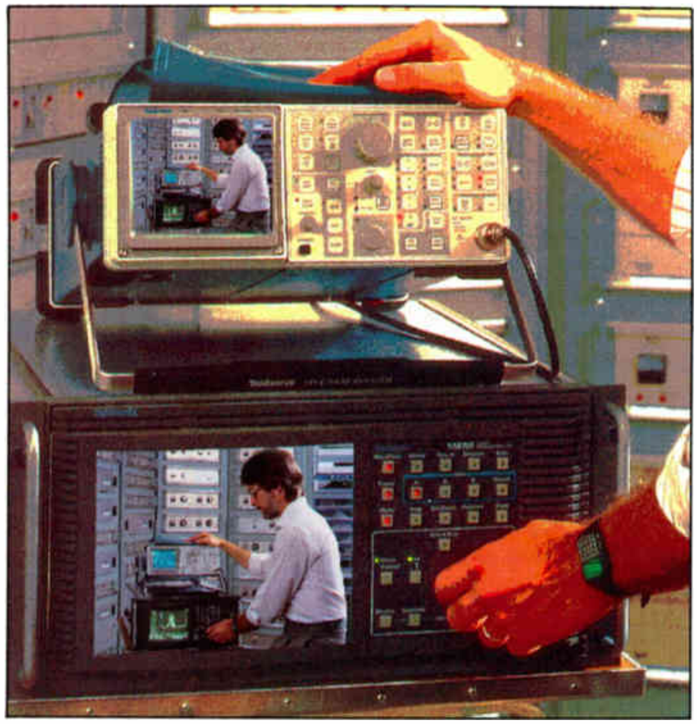
Compliance made easy.
Although compliance is mandated by law, in the long run, everyone will benefit from it. And it doesn't have to be difficult. It's really just a matter of applying the right equipment. With Wavetek's new line of CLI's, you've got the right equipment.

Make it easy on yourself. Call Wavetek at 1-800-622-5515 for more information and the name of your nearest rep. In Indiana call 317-788-5965. Then, don't worry. Be happy.

WAVETEK®

See us at the Western Show, Booth 626.
Reader Service Number 14.

Measuring video performance in CATV



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

Ultimately, all RF that the CATV operator distributes becomes video (as well as audio)—the final product we sell. Yet many operators rely solely on the spectrum analyzer for system testing. The fact is that many unsolvable problems exist because of examination performed only in the RF domain. To overcome this, it is critical for RF to be demodulated and tested as video before these problems can be pinpointed.

Spectrum analyzers measure only RF; therefore, they cannot totally and accurately predict the video qualities that will be delivered to subscribers; baseband measurements are intended to serve that purpose. Engineers are just now realizing the broad range of video analysis applications needed, not only for today, but because HDTV (high-definition television) knocks at their door. Accordingly, practical applications for determining predictable CATV systems performance on a video level have been developed.

In the past, two significant obstacles have prevented most engineers from performing precision video analysis: 1) cost—multiple measurement instruments were not within budget limits and 2) complicated manual measurements and calculations necessary to diagnose system problems. The logical answer was to develop a video measurement system overcoming these obstacles by being affordable to operators and providing engineers with fast, simple to interpret, precisely calculated results—within a single instrument. Furthermore, it should work in conjunction with the RF spectrum analyzer providing complete CATV system performance testing.

Video measurement instrument

Truly revolutionary in its concept and design, the VM700 video measurement set was developed by Tektronix Inc. Complete analysis of video can be made using its integrated digital waveform monitor, digital vectorscope, noise measurement set, group delay measurement set, automated monitoring system and automated measurement set. Figure 1 shows a (reduced) hard copy of detailed analysis of a demodulated (a Tektronix 1450-1 precision demodulator with TDC-1 tunable downconverter was used for all tests) off-air signal on Ch. 18

Figure 1

				Violated Limits Lower	Violated Limits Upper	
Avg. Picture Level	47.9	%				At [illegible]
Bar Top	------	% Carr	••	10.0	15.0	ZC Pulse Un[illegible]
Blanking Level	------	% Carr	••	[illegible]	[illegible]	[illegible]
Bar Amplitude	97.7	IRE				
Sync Amplitude	38.5	% Bar				
Blanking Variation	------	% Carr				ZC Pul[illegible]
Blanking Variation	3.0	% Bar				
Sync Variation	------	% Carr	••	0.0	[illegible]	[illegible]
Sync Variation	3.6	% Bar				
Burst Amplitude	107.6	% Sync				
Burst Amplitude	41.4	% Bar				
FCC H Blanking	10.84	us	•	[illegible]	[illegible]	
FCC Sync Width	4.72	us				
FCC Sync-Setup	9.59	us				
FCC Front Porch	1.25	us	••	[illegible]	-------	
Sync to Burst End	7.77	us				
Breezeway Width	0.86	us				
FCC Burst Width	7.9	Cycles	••	8.0	[illegible]	
Sync Risetime	502	ns	••	[illegible]	[illegible]	
Sync Falltime	131	ns				
RS-170A H Blanking	11.44	us	••	[illegible]	[illegible]	
RS-170A Sync Width	[illegible]	us	••	4.58	[illegible]	
RS-170A Sync-Setup	[illegible]	us	•	[illegible]	[illegible]	
RS-170A Front Porch	1.35	us	••	[illegible]	[illegible]	
Sync to Burst Start	[illegible]	us				
RS-170A Burst Width	8.6	Cycl[illegible]				
V Blank 4 IRE F1	20.0	Lines				
V Blank 4 IRE F2	20.6	Lines	•	[illegible]	[illegible]	
V Blank 20 IRE F1	20.0	Lines	•	[illegible]	[illegible]	
V Blank 20 IRE F2	20.6	Lines				
FCC Equalizer	50.2	[illegible]				
FCC Serration	[illegible]	us	••	[illegible]	[illegible]	
RS-170A Equalizer	[illegible]	us	•	[illegible]	[illegible]	
RS-170A Serration	4.75	us				
VIRS Setup	7.6	% Bar				
VIRS Luminance Ref	50.2	% Bar				
VIRS Chroma Ampl	108.4	% Burst	•	[illegible]	[illegible]	
VIRS Chroma Ampl	44.6	% Bar	••	[illegible]	[illegible]	
VIRS Chroma Phase	-12.0	Deg	••	[illegible]	[illegible]	
Line Time Distortion	8.8	%	••	[illegible]	[illegible]	
Pulse/Bar Ratio	92.8	%	••	[illegible]	[illegible]	
2T Pulse K-Factor	4.7	% Kf	••	[illegible]	[illegible]	
IEEE-511 ST Dist	------	[illegible]	••	[illegible]	[illegible]	[illegible]
S/N Unweighted	[illegible]	dB	••	[illegible]	------	[illegible]
S/N Lum-Weighted	[illegible]	dB				[illegible]
S/N Periodic	33.1	dB	••	[illegible]	------	[illegible]
Chroma-Lum Delay	78.1	ns	••	[illegible]	[illegible]	
Chroma-Lum Gain	[illegible]	%	••	[illegible]	[illegible]	
Differential Gain	11.79	%	••	[illegible]	[illegible]	
Differential Phase	[illegible]	Deg	••	0.00	1.50	
Lum Non-Linearity	8.93	%	••	0.00	6.00	
Relative Burst Gain	[illegible]	%				
Relative Burst Phase	-4.48	Deg				
FCC Multiburst Flag	------	% Carr	••	10.0	15.0	ZC Pulse Unselected
FCC Multiburst Flag	[illegible]	% Bar				
FCC MB Packet #1	58.4	% Flag				
FCC MB Packet #2	75.1	% Flag	••	57.6	63.0	
FCC MB Packet #3	48.8	% Flag	••	56.8	[illegible]	
FCC MB Packet #4	59.6	% Flag				
FCC MB Packet #5	61.3	% Flag				
FCC MB Packet #6	20.4	% Flag				
NTC7 Multiburst Flag	------	% Carr	••	10.0	15.0	No NTC-7 Combination
NTC7 Multiburst Flag	------	% Bar	••	90.0	110.0	No NTC-7 Combination
NTC7 MB Packet #1	------	% Flag	••	48.6	51.5	No NTC-7 Combination
NTC7 MB Packet #2	------	% Flag	••	48.0	52.5	No NTC-7 Combination
NTC7 MB Packet #3	------	% Flag	••	47.3	52.8	No NTC-7 Combination
NTC7 MB Packet #4	------	% Flag	••	[illegible]	[illegible]	No NTC-7 Combination
NTC7 MB Packet #5	------	% Flag	••	48.0	52.1	No NTC-7 Combination
NTC7 MB Packet #6	------	% Flag	••	46.1	[illegible]	No NTC-7 Combination
NTC7 20 IRE Chroma	------	IRE	••	18.0	22.0	No NTC-7 Combination
NTC7 80 IRE Chroma	------	IRE	••	78.0	82.0	No NTC-7 Combination
NTC7 Chr NL Phase	------	Deg	••	0.0	2.0	No NTC-7 Combination
NTC7 Chr-Lum Intmd	------	IRE	••	-2.0	2.0	No NTC-7 Combination
ICPM	------	Deg	••	-3.0	3.0	Acq Unlocked
SCH Phase	[illegible]	Deg	•	-45.0	45.0	
Field Time Dist	[illegible]	% Bar	••	-3.00	3.00	Full-Field Sq. Wave

FCC Color Bars

	Amplitude Error (%)		Phase Error (Deg)		Chr/Lum Ratio Error (%)	
Yellow	[illegible]		-13.3	••	16.7	•
Cyan	[illegible]		-11.5	••	8.1	
Green	4.3		-8.2	•	11.5	
Magenta	[illegible]		[illegible]		3.5	
Red	[illegible]		-6.1		0.8	
Blue	[illegible]		[illegible]		-7.9	

Figure 2

VITS Identification

Field 1	Field 2
Line 15 --> Pedestal	Line 15 --> Pedestal
Line 16 --> Pedestal	Line 16 --> Pedestal
Line 17 --> FCC Multi Burst	Line 17 --> FCC Color Bar
Line 18 --> FCC Composite	Line 18 --> FCC Composite
Line 19 --> VIRS	Line 19 --> VIRS
Line 20 --> Pedestal	Line 20 --> Pedestal

System Line is Field 1 Line 12

Figure 3

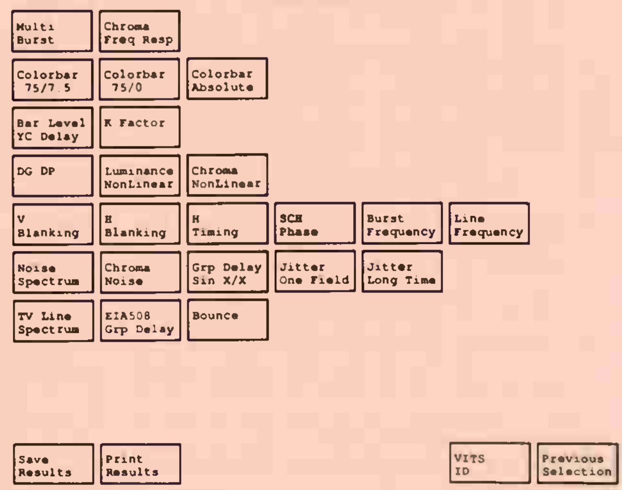
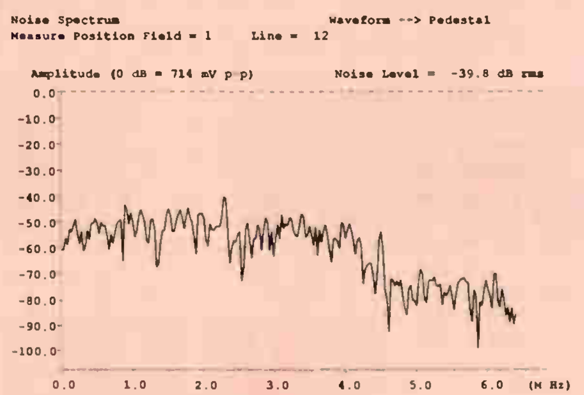


Figure 4



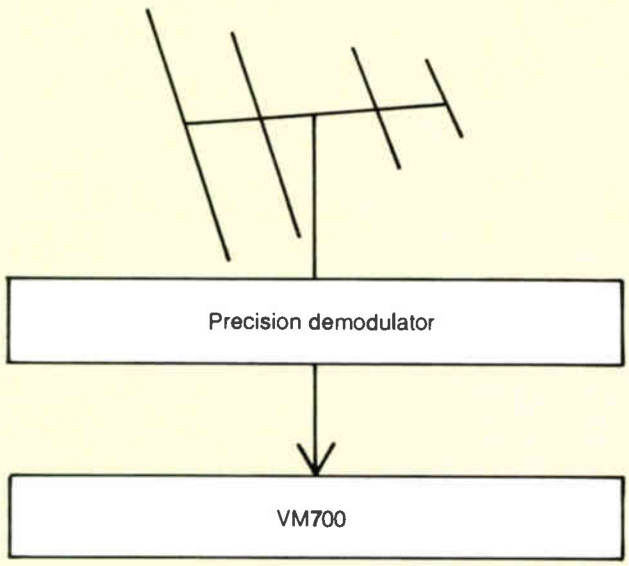
in the automatic measurement mode. The speed of output is less than 30 seconds with results displayed numerically with periodic updates. By industry standards, this is exceptionally fast.

The impact this device will have on the CATV industry is that now a 60 + channel system can be performance-tested on a video level within one-half day's time, including coffee breaks. Worthy of note for this significant accomplishment is that the National Academy of Television Arts and Sciences presented an Emmy to Tektronix for "Digital Intelligence in Professional Broadcast Monitors." The VM700 is the product of its talents in this field.

All measurements in the VM700 are made using digitized versions of the input signal. The input signal is fed into the analog front end where it is manipulated under software control to maximize use of the analog-to-digital converter (ADC). To produce the numeric results for auto mode, for example, the VM700 selects specific portions of the video input signal, converts the signal from an analog to a digital form and then analyzes the digitized sample values to produce numeric results. The user can then select a display of numeric values to confirm signal quality or, for further analysis, may view a graphic display of the test signal on which the measurement was made. The VITS ID (vertical interval test signal identification) display, seen in Figure 2, helps the engineer locate the test signals measured in the automatic measurement mode.

Most familiar to the CATV engineer, as shown in Figure 1, is the video signal-to-noise (S/N) unweighted readout. First, it is well known that noise components on a video signal, if sufficiently large, will degrade the received picture. This is due to the response characteristics of the human eye that certain noise frequencies are perceived to cause greater degradation in the viewed picture pattern. Therefore, it is critical to keep noise components to a minimum. The VM700 uses CCIR Recommendations 567 unified filter set to perform these tests and has an accuracy of ± 1 dB within a range of 26 to 60 dB, sampling the "quiet line" typically

Figure 5: Test setup for S/N



located on Field 1 on Line 12 of a video signal.

As seen by the S/N unweighted figure of 39.6 dB (note the violated preset limits indicated by the asterisks), two significant difficulties are revealed: 1) no possibility exists of delivering a high quality picture to the subscriber and, therefore, 2) it follows that the signal will not withstand the inevitable noise degradation from an amplifier cascade, removing any possibility of giving the last subscriber a picture that is at least watchable. Quite simply, this high noise figure requires further investigation.

The first step of the investigation is to reaffirm the noise level. This test is activated by pressing the "measure" mode button located on the front panel of the VM700. Figure 3 shows the different measurements that can be activated by touching the screen—another capability found only in this instrument. The "noise spectrum" function is pressed and, as shown in Figure 4, the overall noise level is −39.8 dB RMS (note the 0.2 dB change). Noise levels across the video spectrum are indicated in amplitude on the vertical scale and in frequency on the horizontal scale.

The solution to this problem is to increase the amount of desired signal and find the underlying problem for the unwanted random noise. This is most likely to be deterioration caused by one of the following areas: the off-air antenna, the aerial drop from the antenna to the headend and/or a component within the headend itself. To perform this trace for purposes of pinpointing the problem, a spectrum analyzer will indicate occupation and resulting amplitude on a frequency domain level and in some instances show some unwanted noise present. However, amplitude means little if the S/N is not at a desired level. Therefore, video analysis is the only true means to obtain the S/N with precision.

To begin pinpointing this problem (especially for problems relating directly to off-air), the proper equipment must be used as shown in Figure 5. Of importance in this diagram is the precision demodulator. One reason is that simple diode demodulators, the kind normally used by CATV engineers, are generally unstable when compared to instruments incorporating synchronous detection.

To save time, it is suggested that testing begin at the output of the antenna lead to avoid the possibility of an unnecessary tower climb. The amplitude should be recorded at this point in dBmV from an RF spectrum analyzer to ensure manufacturer's input specification requirements are met. Next, activate the auto mode function of the VM700 and note the S/N unweighted numeric. If the figure indicates unsatisfactory performance to this point, logically, a component within the headend is deteriorating video quality and needs replacement, repair or upgrade to improve the noise figure.

On the other hand, unsatisfactory performance at this point suggests that the problem may lie in the antenna drop or, perhaps, the antenna itself. After the antenna drop is replaced (this should be done if either

Figure 6

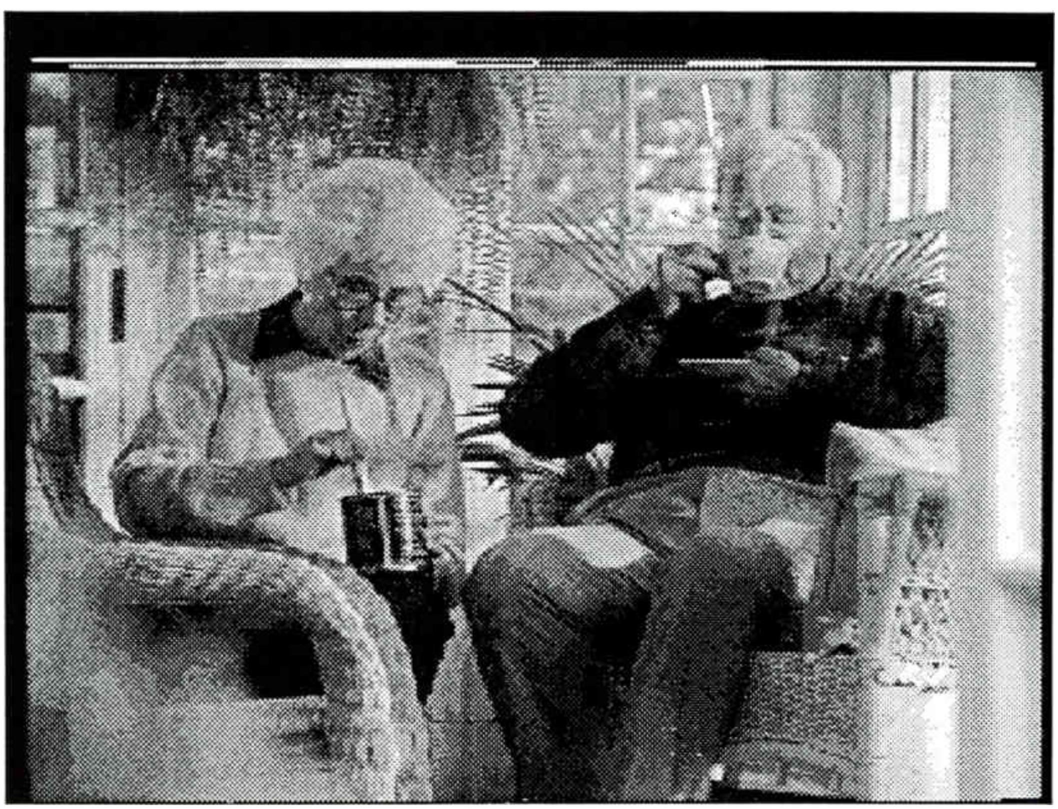
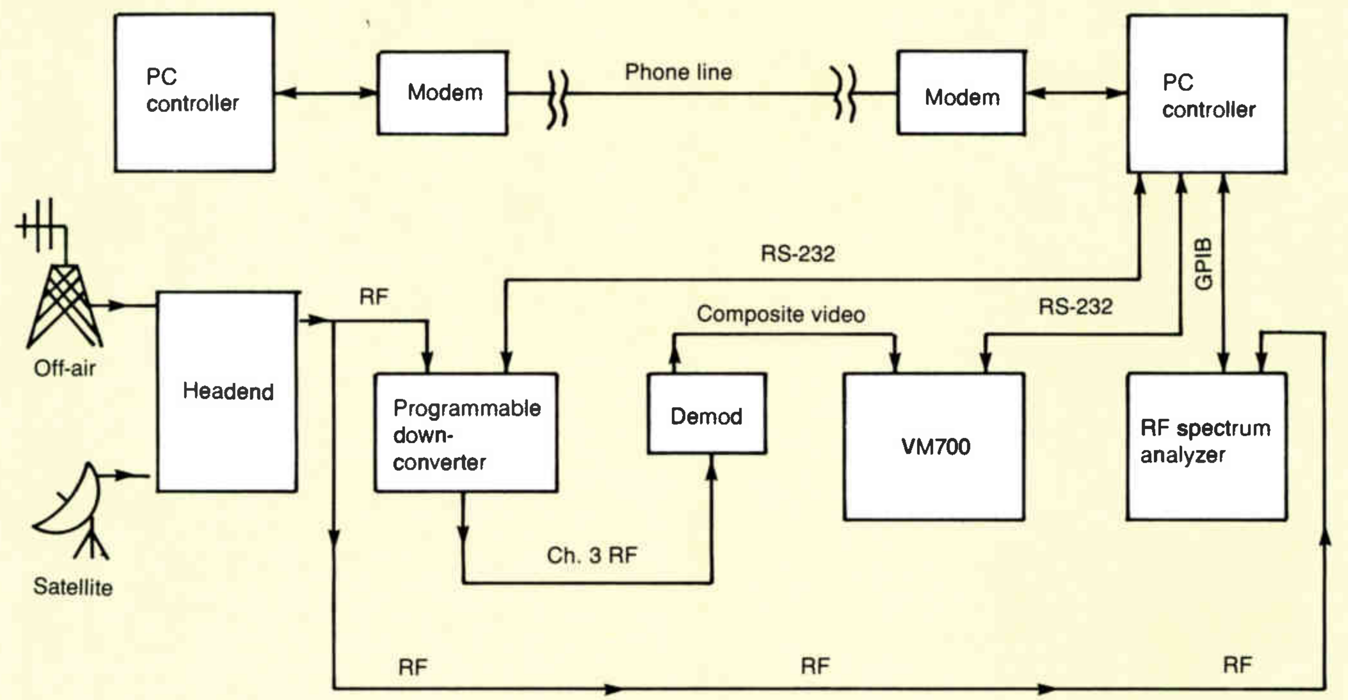


Figure 7: Remote monitoring system



component is suspected to save time and possibly another tower climb—wire is cheap compared to an accident), again the dBmV level from the RF spectrum analyzer should be recorded, and the S/N level noted with the VM700. If unsatisfactory noise figures still exist, the antenna needs to be: repeaked for best location within its polar pattern, raised (noting free-space benefits), relocated to prevent the desired signal's energy from being affected by nearby antennas or replaced.

Another problem CATV engineers face daily is multipath distortion. This can be observed and quantified using the "waveform" mode in the VM700. As shown in the July 1988 issue of *CT* ("Understanding multipath distortion," page 56), the reflection of the baseball player was obvious and demanded corrective action. That case had few alternatives for relief. However, is even a small amount of multipath, considering the effects of a long amplifier cascade, something that can easily be overlooked?

The answer, in most cases, is: "Absolutely not." A test for non-believers and those who measure the distance between direct and reflected images from the TV screen for the purpose of measuring distance between direct ray and the reflection surface is to place the output of an off-air antenna containing an RF signal with known distortion effects into a 20 dBmV output distribution amplifier. Drive a TV receiver with the distribution amplifier and note that what started out to be a minor visual impairment stretched in both length and distance and is also intensified in definition. Next, consider what happens to multipath distortion at the drop of the last subscriber. (Frightening, isn't it?)

Identification of multipath distortion effects and gathering data relative to cancellation techniques can be made only at the video level. Initially, the picture mode can be activated to view multipath effects. From the display (Figure 6), a faint horizontal sync pulse can be seen. But what is important to the engineer is to find the amplitude of the undesired reflection.

Critical decisions

When the relative reflection strength is obtained, critical decisions such as suitability of site and success of an adaptive array can be made with reliable authority. To obtain this figure, again, the equipment diagrammed in Figure 5 is a must.

First activate the "waveform" mode of the VM700 and select the channel containing the signal with multipath distortion. Use "select line" to display a "quiet" line from the vertical interval (typically Line 12 has no test signal). Use the horizontal and vertical "move" and "expand" controls to enlarge and center the bottom of the direct ray color burst on the display. Next, press the "menu" button and then touch the "cursors/timing" softkey located on the touch screen. Align the bottom of the burst vertically with the horizontal reference line of the graticule and touch the "reset diffs" softkey. Now use the knob to align the top of the color burst with the horizontal reference line. Record the voltage difference (mV) readout value.

Repeat the amplitude measurement procedure for the color burst of the reflected ray. To calculate the reflected ray signal strength (in dB) relative to the direct ray, simply insert the value obtained into the following formula:

$$\text{Relative reflection strength (in dB)} = 20\log_{10}(\text{reflected amplitude/direct amplitude})$$

One more point of interest to CATV is the VM700's remote capabilities. With minimal configuration, the instrument has standard remote operation abilities that can be performed using either a modem or direct RS232C by computer or from a terminal.

It can be argued, however, between RF spectrum and video analysis which of the two would provide the earliest detection of system deterioration, therefore avoiding outages. This article promotes neither individually, but together they provide a truly complete safeguard covering all phases (with the exception of audio analysis). Toward this end, Figure 7 provides a glimpse of "tomorrow's" remote CATV monitoring system.

The reasons for video analysis in conjunction with spectrum analysis are extensive. The ones presented are only just a few. CATV operators must look deeper into their signals, deeper than what RF spectrum analysis can provide if they are to ensure a quality product is delivered to the consumer.

References

1) Noah, J. "VM700 Video Measurement Set Option 01 NTSC Preliminary Operators Manual." Revised, August 1988.
2) Rice, S., Senior Hardware/Software Engineer, Tektronix Inc., Beaverton, Ore.
3) Tucker, T., Applications Engineer, Tektronix Inc., Beaverton, Ore.
4) Coleman, D., Electronic Engineer, Tektronix Inc., Beaverton, Ore.
5) Infanzon, M., Tektronix Inc., Rolling Meadows, Ill.

The OTDR—A universal tool

By Patrick Adiba

Senior Technical Marketing Engineer, Schlumberger Instruments

The idea of using light to convey information is by no means a recent one. From the earliest days, mankind has used visual media (sunlight, fire, smoke) to transmit messages, but the rate of information transmission was slow and the range was short.

It was the invention of the laser in 1960 and its capability to carry data that changed this concept. The laser generates coherent, stable and virtually monochromatic light and fulfills the same function in the luminous domain as the high frequency oscillator in radio and TV communications. Attempts were immediately made to use this new source for direct transmission over the air. Unfortunately, the Earth's atmosphere is a highly dispersive and absorbent medium; the result was that transmissions were considerably disrupted. The idea was then put forth of enclosing the light in a medium that would guide it with little or no attenuation. This light channel would eventually become known as the optical fiber.

The first optical fibers were introduced in 1972 and transmitted light with a wavelength of 850 nanometers (nm). They offered an attenuation of 4 dB/km and had a bandwidth of 40 MHz/km. Modern single-mode fibers offer attenuation as low as 0.4 dB/km at a wavelength of 1,300 nm and 0.2 dB/km at 1,550 nm. Bandwidths are now measured in GHz/km. Thoughts are already turning to transmissions in fluorinated glass fibers at a wavelength of 2,500 to 2,800 nm with attenuations measured in mere hundredths of a dB/km.

The optical fiber has numerous other advantages in addition to those that make it an excellent transmission medium. It is insensitive to electrical and electromagnetic interference and is therefore ideal for transmitting information in environments where the level of interference is particularly high (examples include oil refineries, nuclear power stations, railway signaling, remote supervisory systems, etc.). The very low weight of optical fiber systems is particularly appreciated in the avionics industry. Of particular relevance to military applications, optical fibers cannot be detected underground, as can copper cables when using a metal detector. Finally, it is difficult to "pirate" information conveyed by optical means, an important consideration in applications where confidentiality is of primary importance.

Reflectometry and optical fibers

The optical time domain reflectometer (OTDR) has of late become the essential tool for everyone working in the guided lightwave domain. It needs access to only one end of the link to be tested and produces a complete "map" of the fiber. Relegated for some considerable time to locating faults, the OTDR was initially seen as an expensive and imprecise tool. Today, considerable advances in the areas of optical components and integrated microcomputing techniques have made the OTDR an essential adjunct to the conventional testing methods of attenuation and bandwidth.

Measurement is vital at all stages in the life of an optical fiber, from manufacture to on-site maintenance, from cable assembly to link installation. In all these varied sectors of activity, the OTDR has become the instrument of choice and provides the most comprehensive information on the physical state of the fiber.

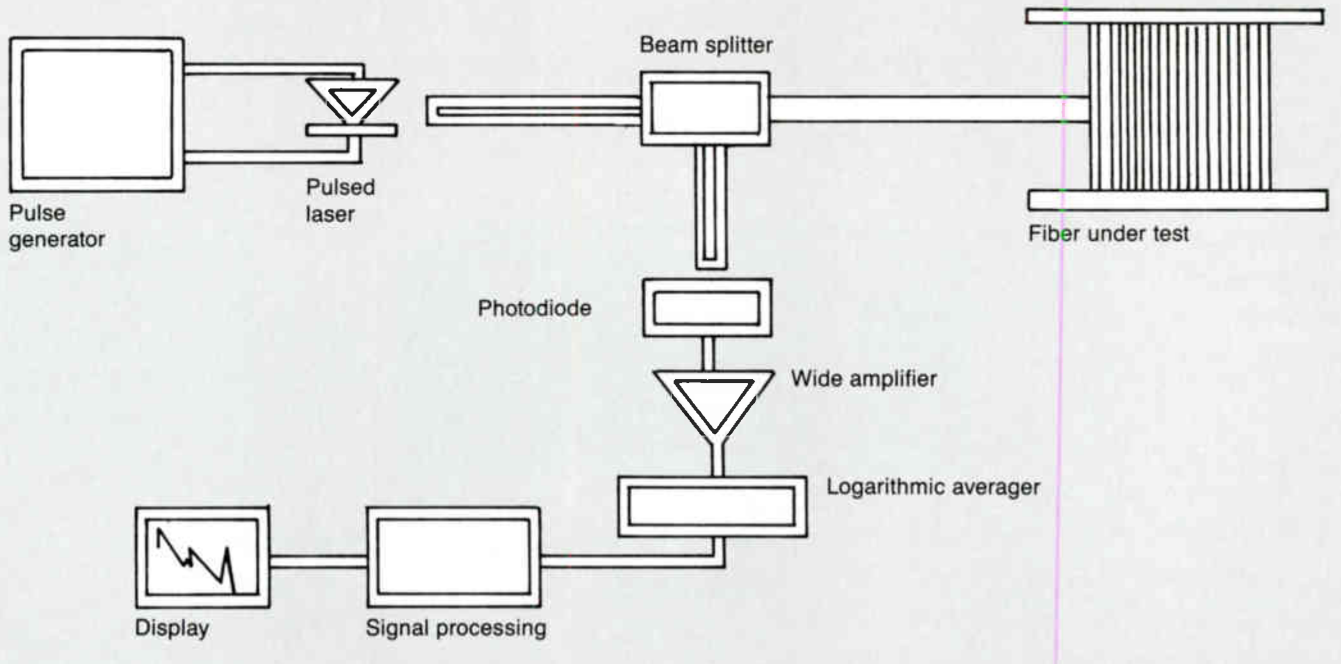
Performance requirements vary with the application. For example, when testing very long-range links, the major performance requirement will be dynamic range, while the spatial resolution limit will be most important when testing networks with multiple interconnections.

Measurement principles

Figure 1 shows a basic block diagram of an OTDR. A narrow laser pulse (lasting from a few nanoseconds to a few microseconds) is injected into the fiber under test. The pulse is reflected from all non-absorbent defects (according to Fresnel's principle) and fed into a beam splitter that channels the reflected data into an amplifier. By measuring the time for the pulse to return, it is possible to determine the distance to the defect. However, Fresnel reflections occur at only some types of defects: breaks perpendicular to the fiber axis, reflecting connectors, etc. The detection of non-reflective defects is based on the Rayleigh back-scatter principle. The heterogeneous structure of the fiber results in variations in concentration and density that constitute diffusion centers. At these points the incident light scatters in all directions in space, particularly backward. This back-scattered light represents a very small part of the incident power (approximately 1/100,000th). These extremely low levels therefore require a particularly sensitive detection technique.

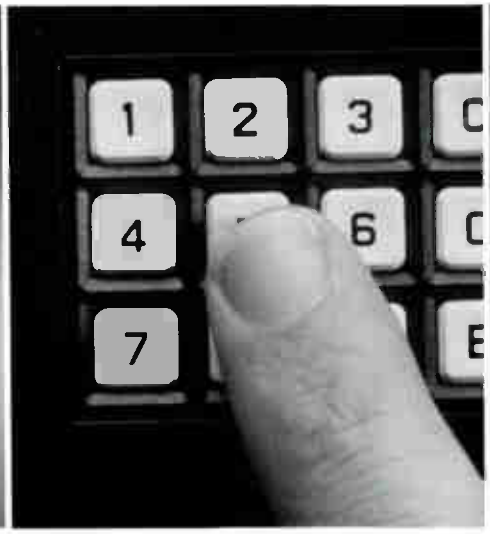
The back-scattering law is a decreasing exponential function of time. For convenience of display, the curve is represented on a logarithmic scale, producing a straight line. The slope of this straight line represents the attenuation of the fiber. It is then a simple matter to measure the seriousness of defects or discontinuities (breaks, splices, connectors) in terms

Figure 1: OTDR block diagram



MAINTAIN QUALITY STEREO THE EASY WAY.

PLUG IN.



SELECT ANY CHANNEL.

TEST.

Stereo programming is rapidly becoming the rule, not the exception. Even if you don't know everything you should about testing and maintaining quality stereo, TFT does. It's the reason we designed the 852 CATV Stereo Monitor: the all-in-one, easy-to-use instrument for fast, accurate measurements of your stereo transmission.

EASY-TO-USE, HARD TO ABUSE.

The 852 is rugged and compact, making it indispensable for testing multiple headends and earth station sites. Its frequency-agile channel selector and ability to accept 4.5 MHz, 41.25 MHz, baseband or RF inputs makes it useful for a wide variety of jobs. It can easily tell you if your stereo is working properly when troubleshooting maintenance problems or evaluating stereo equipment. It gives you quick results for channel separation, noise, distortion and frequency response measurements in addition to monitoring audio modulation levels and pilot channels.

If you're seriously concerned about pay-per-view and advertising revenues, you need the 852 to verify the quality of your stereo sound.

852

CATV STEREO MONITOR

NEARLY 20 YEARS IN THE MAKING.

TFT has delivered more than 300 Stereo Monitors to TV broadcasters throughout the world. We were participants on the committee that established the BTSC specification, and, for nearly 20 years, we've equipped thousands of AM, FM & TV broadcasters with precision, fail-safe aural modulation monitoring equipment.

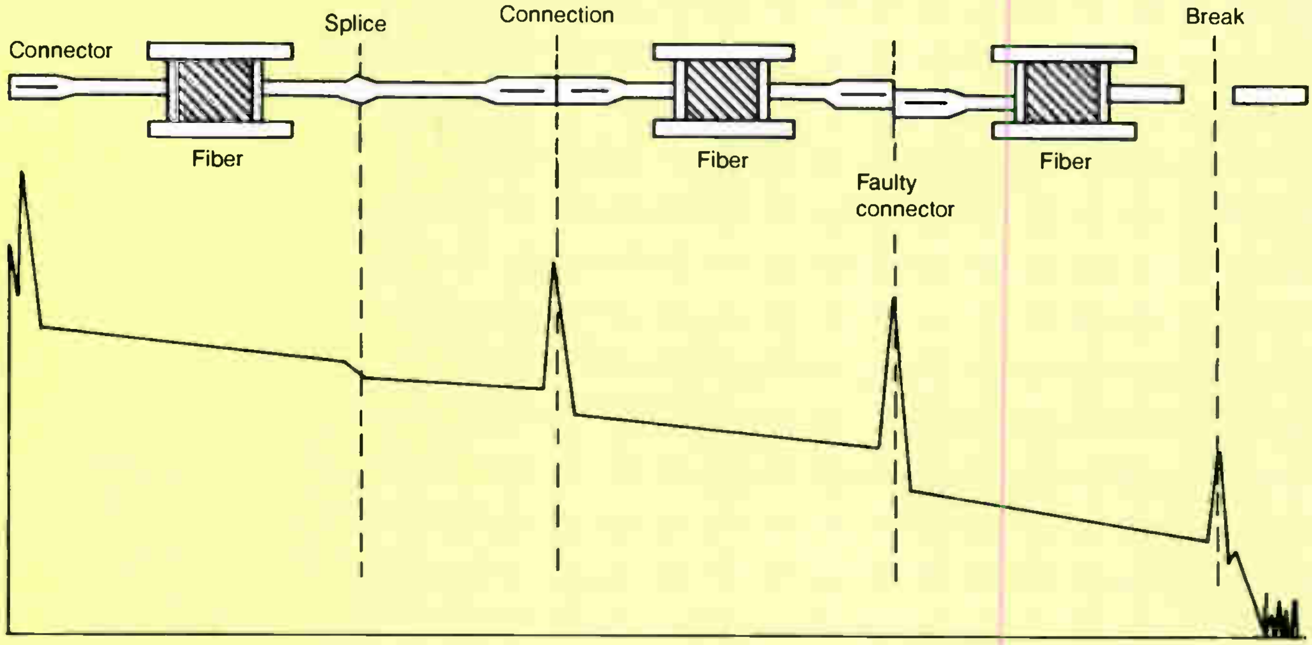
Contact us now for complete technical information on the 852 CATV Stereo Monitor. It's the *only* all-in-one, easy monitoring solution for cable stereo performance.

TFT INC The Stereo Experts.

3090 Oakmead Village Drive
Santa Clara, California 95052-8088
Tel: (408) 727-7272 Fax: (408) 727-5942
TWX: 910-338-0584

Reader Service Number 19.

Figure 2: OTDR field application



of the difference between the slopes on either side of them.

OTDR applications

In the laboratory: The OTDR is found everywhere in optical research laboratories. It provides information on the inherent behavior of the system studied, whether at fiber, component or transmission technique level.

In production: The quality of the transmission medium has to be checked at numerous stages in the fiber or cable manufacturing process. Manufacture of an optical fiber begins with a "preform," a bar of silica with dimensions very much larger than those of an optical fiber. This preform is heated and then drawn to form the fiber. During heating it is possible to inject gas that diffuses into the structure to give a particular index profile, for example. The temperature, the type of gas injected, the drawing speed and other parameters all affect the final transmission characteristics of the fiber. OTDR testing makes it possible to locate manufacturing microdefects that could lead to breakdown in the long term.

The next step is to construct the optical cable. This entails assembling one or more optical fibers into a common medium. The first step is therefore to test the fibers received from the fiber manufacturer, then to joint them end-to-end and finally to assemble the cable. The OTDR plays an essential part in the manufacture of an optical cable because it can check the quality of the fibers contained in the cable at all stages in the process. This non-destructive testing requires access to only one end of the fiber under test.

In installation and maintenance: When a system is installed the OTDR can be used to test all joints, splices and connectors and to determine the distance to them. It is then possible to draw an overall "map" of the link, showing connector positions and associated splice losses, which can be stored for future maintenance needs. Figure 2 shows a sample display of a fiber network with various splices and faults.

In the context of maintenance operations, the OTDR makes it possible to locate the defec-

25 Models of Amplifiers

15,000 UNITS IN STOCK

550 MHz • 100dB RFI • UL APPROVED POWERING •
BI-DIRECTIONAL • MULTI-PORT OUTPUTS • RACK MOUNT
GAINS: 10-50dB "F" and HARDLINE

See us at the Western Show, Booth 602.
Reader Service Number 21.

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

tive item. The defect may be something precise (a break) or simply a loss level that, minor in itself, disturbs transmission due to some other constraint (tension, bending, aging, etc.).

Key OTDR features

Obviously, there are a number of OTDRs on the market today. It is important to look for particular features that will make your investment in this instrument much more worthwhile. There are at least four basic requirements you should look for:

- *Simplicity of use:* This means very simple access to the basic functions with sufficient processing capability for refined analysis of curves in difficult situations. All keys vital to making measurements should be accessible from the front panel. A large number of other functions (such as configuration and processing) should be accessible through a simple menu system. The instrument should therefore be very simple in appearance—with few keys—and not intimidate the occasional users. By use of the menu system, the experienced user can carry out many further operations for a more detailed analysis.
- *Measurement performance:* The measurement performance, in particular the dynamic range, should be generously rated to allow for future expansion of optical links, in particular with regard to transmission distances. At least one brand of OTDR on the market today has automated measurement functions that enable the instrument to deliver totally repetitive results independently of the user and the operating mode. A single keystroke can enable even a complete beginner to measure the whole of a fiber.

"Measurement is vital at all stages in the life of an optical fiber from manufacture to on-site maintenance, from cable assembly to link installation."

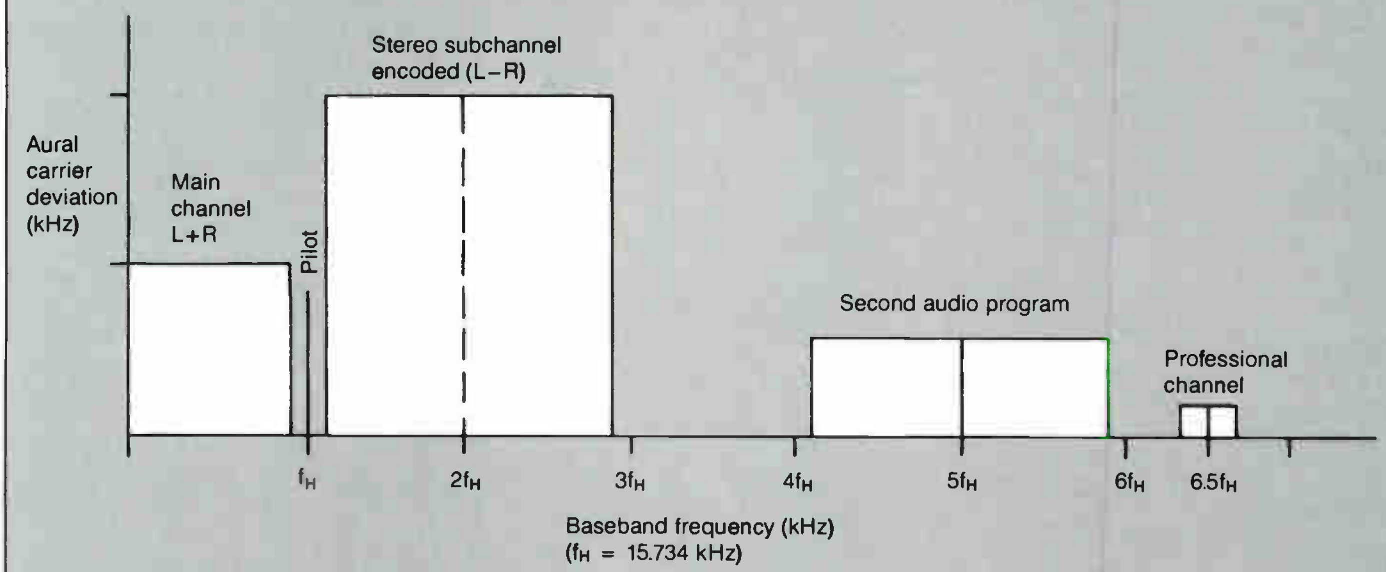
- *Repeatability of measurements:* It is very important to have repetitive measurements available when a link is acceptance tested by a customer. In all cases it is essential to be able to dispel any doubts concerning the equipment or its use.
- *Archive storage:* If the measurements made at the time of manufacture can be archived, then comparison techniques can be used to locate a problem on the fiber with minimal delay. This also provides a way to monitor the aging of links. The archive storage may be on paper (plots) or on magnetic media (data). Magnetic media would be more desirable in most cases. If this is the case in your application, the instrument should include multiple memories for comparison of several measurements and an optional built-in floppy disk drive available for storing curves for off-line processing or archive storage. This facility is extremely beneficial in the area of preventive maintenance, for example. Once all the curves have been acquired, all the various measurements and processing operations (comparisons, measurement in both directions) can be performed off-line using the same instrument.

There are several other features that also should be considered, especially when the product is to be used in a field installation or maintenance environment. The OTDR should be compact and light in weight. It should be ruggedized to operate in severe environments (vibration, impact, terperature, etc.). A 12 VDC input should be available for operation from an external power source (such as an automobile battery). IEC 625 and RS232C interfaces should be incorporated in all instruments that have automated measurement applications.

Also desirable is adequate computing power built into these instruments to enable multitasking operations. It is therefore possible to display, measure, print and capture data simultaneously, representing a considerable time-saving step for the user, who (to give just one example) can prepare the next measurement while printing the current one.

Reader Service Number 23.

Figure 1: BTSC composite signal spectrum



Monitoring BTSC stereo

By Eric B. Lane
TV Product Marketing Manager, TFT Inc

How much managing does BTSC stereo require? Stereo is much less forgiving than monaural sound: A few tenths of a dB in signal level or a few degrees in phase shift can greatly deteriorate channel separation. Managing stereo is not difficult, but you have to know what you're looking for and have the tools available to measure it.

The penetration of TV stereo is ahead of original projections (accord-

Figure 2: BTSC worksheet

Frequency	Signal level L or R	Separation		THD	
		L into R	R into L	Right	Left
50 Hz					
100 Hz					
400 Hz					
1 kHz					
5 kHz					
10 kHz					

Tests performed by: ______________________

Date: ______________________

Access point: ______________________

Pilot injection ______________ kHz

SNR, left – ______________ dB

SNR, right – ______________ dB

ing to the EIA) but is still in the infancy stage. Stereo set penetration in the United States is presently at 8 percent and is projected to reach 25 percent by 1992. As more viewers are capable of receiving stereo sound and are trained through experience to evaluate it, stereo will become a major factor in determining the selection of programming—whether by standard cable channels, pay channels, videotapes or direct

Figure 3: Monitoring the L+R main channel

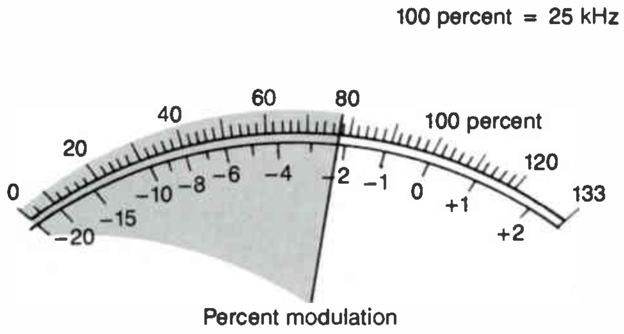


Figure 4: Overmodulation of L−R subchannel

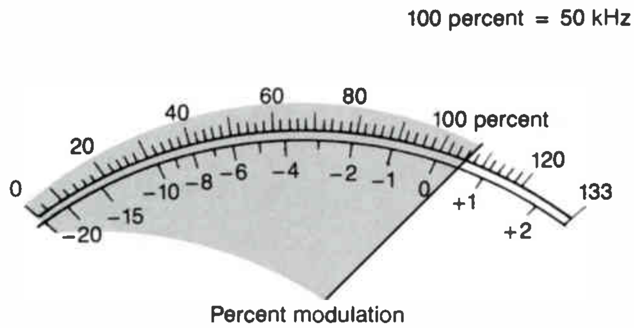
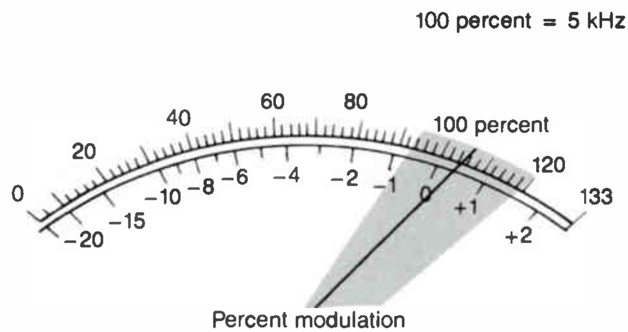


Figure 5: Monitoring the pilot



satellite pickups. Determining the value of TV stereo requires consideration of many subjective factors.

A true stereophonic effect requires a minimum of about 15 dB of separation. Separation is the key measure for delivering good stereo. It is the measure of how much the left and right audio channels do not leak into each other—how "separate" they remain. Zero separation is monaural sound with no difference between left and right audio channels. With as little as 6 or 7 dB of separation, you can hear some differences between the left and right speakers, but you will not perceive the added dimension or depth that stereo can add.

A good example of this was *Top Gun*. This movie had excellent stereo not only in the music but as the jet was flying across the screen. Viewers felt the plane move and the excitement was greatly enhanced. *Top Gun* also has been widely viewed at home on VCRs, but when it hit pay channels there was less acceptance than from either the theatre or VCR showings. Viewing it on cable, in most cases, did not produce the dimensionality and excitement from the stereo that viewers had gotten used to.

Another incident has occurred many times: A subscriber calls to complain that the stereo light on a certain channel is no longer lit; yet that channel was never delivered in stereo. The stereo light was probably lit from audio energy in the 15 kHz region or video energy spillover into the sound carrier. The problem is that with the stereo detector activated a monaural signal is worse than if it were processed through normal monaural circuits. The opposite occurs, too: One cable system measured zero separation on one of its BTSC encoders that had been in use for 1½ years.

A closer look at the L + R and L − R channels

TV stereo uses a composite signal. Left and right audio channels are passed through a BTSC encoder and the output is composite stereo (Figure 1). The L + R main channel is the sum of the left and right audio and is usually called the "sum" channel. It occupies the region from 50 Hz to 15 kHz on the composite signal. This region corresponds to the audio range received in non-stereo receivers and determines the monaural compatibility of the composite signal. That is why the sum of left and right was chosen for this region; it represents the total audio or the full monaural signal.

The level of the L + R main channel should be set for the best monaural compatibility and will determine loudness in monaural TV sets. Measuring the level of this signal in both stereo and monaural channels will give you control over loudness parity between channels.

The L − R subchannel contains information on the difference between the left and right audio channels. It is called the "difference" subchannel and is centered around 31.468 kHz. Because it is located at a higher frequency than the L + R, it tends to experience rolloff and have more noise. To compensate for this, a noise reduction scheme is included on the difference subchannel. This scheme, called *companding*, is similar to pre-emphasis but uses a multitude of pre-emphasis curves instead of the normal 75 microsecond curve. This greatly improves signal-to-noise ratio, but the system is then very sensitive to accuracy of the signal level and phasing.

If the signal level is not set precisely, the companding system will mistrack and not allow proper decoding back into left and right audio. For a BTSC encoder to produce good separation, the L − R subchannel must be set to a precise level that corresponds to optimum separation. Even a few tenths of a dB variation from this level will result in a severe loss of separation.

The signal located between the sum-and-difference main and subchannels is the pilot, used to identify the signal as being in stereo. When a stereo receiver detects the pilot, it activates the stereo decoding and companding circuits and also turns on the stereo light on the front of the TV set.

The pilot is centered at 15.734 kHz and is specified to have between 4 and 5 kHz of deviation. Proper setting of the pilot deviation is not critical but too much deviation will cause overflow into adjacent main and subchannels; too little may not activate the pilot detector in the receiver.

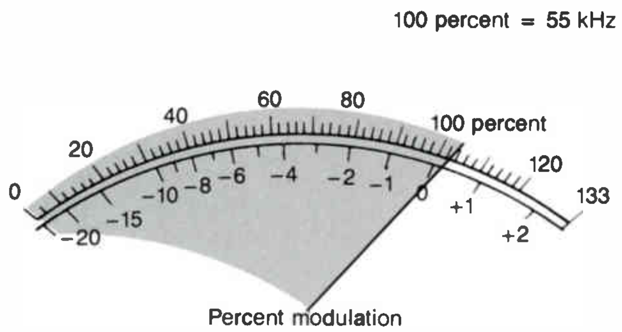
As you can see, the level of each of the three signals in the composite stereo signal is determined by a different factor:

What is 100 percent modulation?

An FM signal has a center frequency and a range around that center in which the signal can vary. The amount that the signal varies from the center frequency is either the deviation or the modulation. The term "deviation" is used when expressed in units of frequency. For example, the sum main channel on a TV stereo signal can have a maximum deviation of 25 kHz. "Modulation" is used when referring to the percent a signal is varying from the maximum allowed. For example, if the sum channel deviation is 20 kHz, this is 80 percent of 25 kHz, or 80 percent modulation.

Signal	Center frequency (kHz)	Maximum deviation (kHz)
L+R	Baseband	25
L−R	31.468	50
Pilot	15.734	5
Composite	Not applicable	55

Figure 6: Monitoring composite stereo signal



Signal	Level determined by
L + R	Loudness and monaural compatibility
L − R	Optimum separation
Pilot	Fits into defined range

A headend engineer normally does not have any control over the modulation level settings on a BTSC encoder; they are all preset at the factory. It is therefore critical that encoders be verified before they are put on-line. Performance also should be determined with the BTSC encoder installed in the equipment chain. Both of these test procedures require the use of test tones. Figure 2 is a sample worksheet with the information needed to evaluate basic stereo performance. Doing a good proof at installation is key.

Operational monitoring is also very important. Systems drift with time, temperature and human intervention. Some of the key things to monitor during operation are:

- L + R main channel
- L − R subchannel
- Pilot
- Composite stereo signal
- Decoded left and right audio

Monitoring the *L + R main channel* shows loudness as heard on a monaural receiver. The measurement is made with a modulation monitor and typically read as a percent of the allowed deviation. The L + R is specified to deviate up to 25 kHz, and typical programming material will usually be between 60 and 80 percent of that with occasional peaks going higher (Figure 3). Programming that has the L + R constantly above 100 percent modulation is too loud. If the modulation level is too low, several things may be happening: L + R is set too low, the measurement was made during a quiet portion of the audio or the left and right signals are out of phase with each other and are cancelling when added. Listening to the program material while monitoring the modulation will help determine which is the case.

If there was no companding, monitoring the *L − R subchannel* would tell you exactly how different your left and right audio channels were from each other. The effect of companding is that small levels of L − R are boosted up, so you can't really read how much separation there is. If there is little or no L − R modulation, however, you're probably receiving a monaural signal. If your L − R is too high (approaching or over 100 percent), the signal level is probably misadjusted and you are losing separation (Figure 4).

The L − R subchannel uses twice the deviation as the L + R to get more energy at the higher frequency. The maximum allowed deviation of the difference subchannel is 50 kHz.

During normal programming, the *pilot* is the only portion of the composite stereo signal that remains constant. The sum-and-difference channels will move with the programming but the pilot should not and, therefore, is a key tool in monitoring performance of each stereo channel (Figure 5).

If the signal level of the pilot has changed, we can assume that the signal level of the L − R also has changed, which results in a loss of separation. If the pilot level jumps around or varies by more than a few percent, either noise or spectral overflow problems are occurring. If the overflow gets into the L − R, the companding system will mistrack, resulting in a loss of separation.

In a recent situation, this unsteady pilot was observed while monitoring at a cable drop. Additional observations at several points in the headend equipment chain showed that overflow was present after the 4.5 MHz modulator but not before. The modulator was an older unit and was subsequently scheduled for replacement.

The pilot is specified to have a maximum of 5 kHz deviation and is most often set between 4 and 5 kHz.

The *composite stereo signal* (Figure 6) is the total modulation for the L + R, L − R and pilot signals. Whereas the sum-and-difference channels are allowed 25 and 50 kHz maximum deviation respectively, their total cannot exceed 50 kHz. Interleaving of the components of a composite stereo signal usually keeps them within this limit. If we add in the 5 kHz for the pilot, we have a total of 55 kHz.

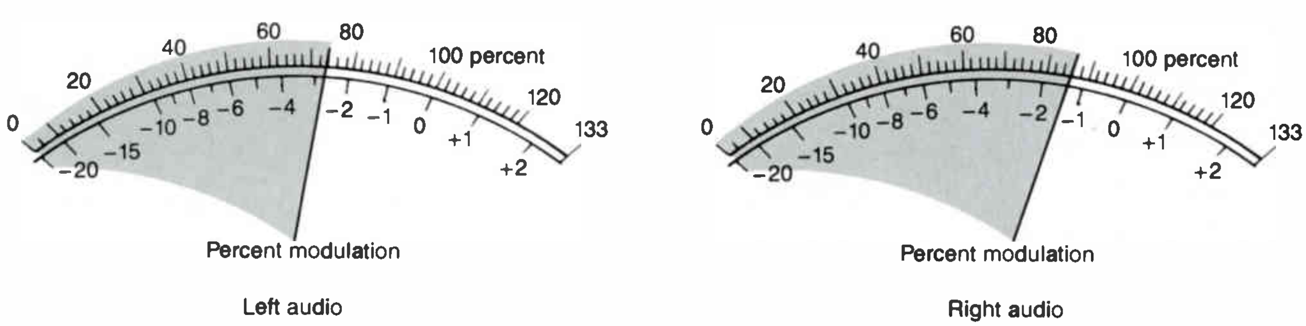
Overmodulating the composite stereo signal can cause audio distortion and overflow into other channels. This may occur if the input levels to the BTSC encoder are set too high, or if the BTSC encoder is set incorrectly. Overmodulation also can occur if there is excessive overflow from another channel.

It is also very useful to decode the composite stereo signal back into *left and right audio* and monitor the audio levels. Visually monitoring the maximum levels for both left and right audio channels can help you determine if both are matched (Figure 7).

If you know the content of the programming material (mono or stereo; voice, music, etc.), monitoring left and right audio channels can give you some indication of separation by observing how differently the meters track.

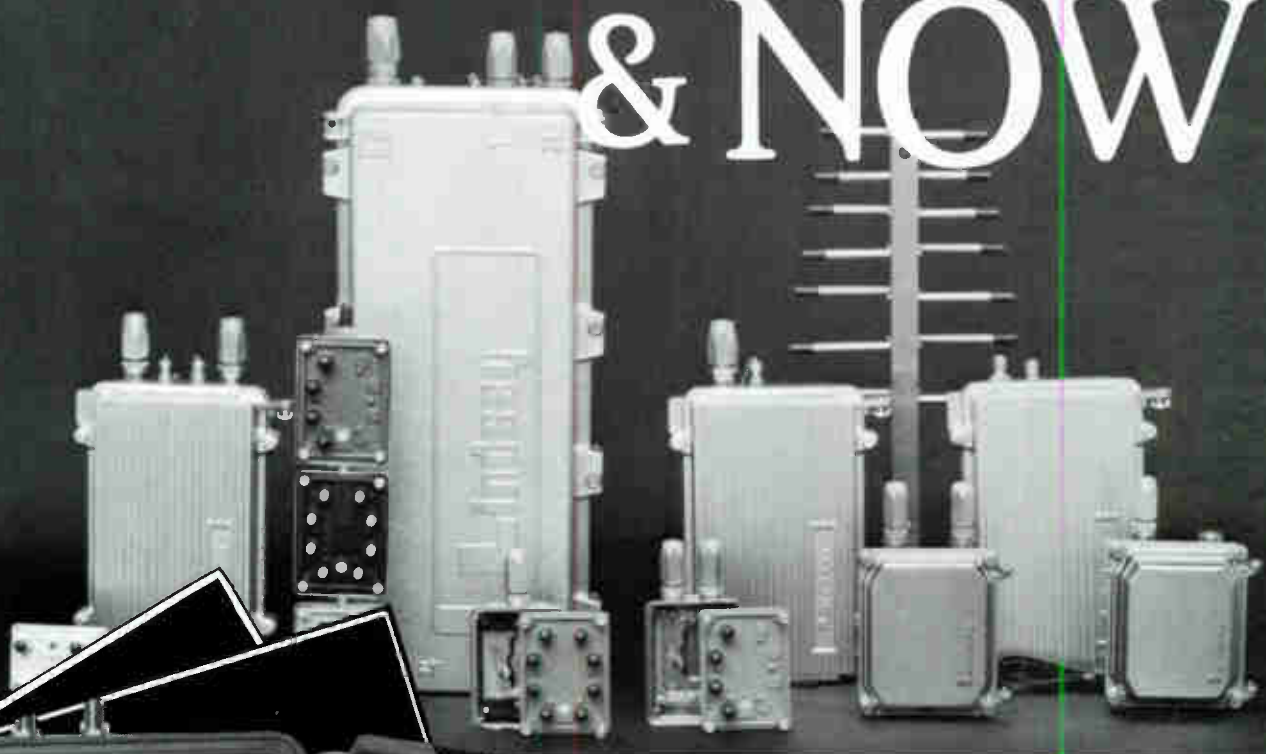
These techniques, as well as many others, will assist you in managing your BTSC stereo and providing quality audio to your subscribers.

Figure 7: Monitoring decoded left and right audio channels



Thirty years of service, reliability...

& NOW



THE ULTIMATE

APARTMENT AMPLIFIER

550 MHz

POWER DOUBLING

Lindsay

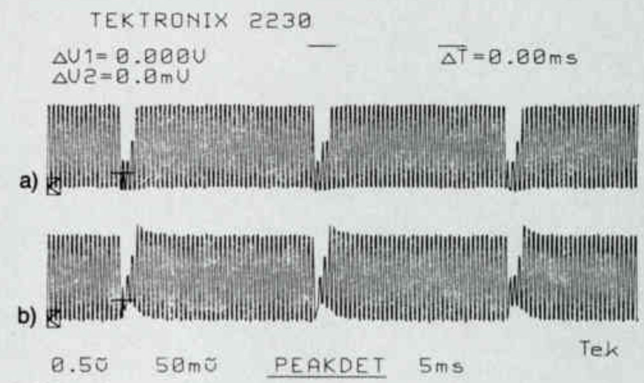
PA	Toner Cable Equipment	(215) 675-2053	NJ	Frank Cristell & Co.	(201) 223-2034
FL	Interstate Cable Enterprises	(800) 245-4423	MN	Grunwald Burns & Associates	(218) 739-3961
IL	Anixter	(312) 677-2600	MT	Kip Hayes	(406) 752-5487
PA	Jim Morton & Associates	(717) 243-4653	CA	Western CATV Distributors Inc.	(213) 539-8030

LINDSAY SPECIALTY PRODUCTS LIMITED 50 Mary Street, Lindsay, Ont., Canada, K9V 4S7 (705) 324-2196 Telex 0-6962-860

Reader Service Number 30.

Figure 1: Interfering signal in the video

Figure 2



a) Video has good frequency response
b) Video coupling capacitor decreased 50:1, low-frequency rolloff response, field time distortion

Video hum distortions and measurements

By Glen Wittrock
Project Engineer, Sencore Electronics

The NTSC transmission system is analog. The complex baseband video signal and its amplitude, phase and frequency characteristics are "encoded" onto the RF carrier in the modulation process. The video signal can be thought of as two frequency bands: The high-frequency portion (over 200 kHz) gives detail to the picture; the frequencies below 200 kHz are used to synchronize the receiver to the high-frequency analog components and to shade large areas of the picture. Distortions to these analog signals can be tolerated only so far; and when they occur, we have to define and measure them.

Linear and non-linear distortion

There are two broad classes of video signal distortions—linear and non-linear. Long-time linear distortions of a TV signal are those that occur fairly slowly and can easily be perceived by the eye as changes in picture brightness or flicker. Linear distortions appear independent of the signal level and often occur as a result of incorrect frequency response. Non-linear distortions vary with the average or instantaneous amplitude of the picture video signal.

Field time distortion (one type of linear distortion) should be explained. Incorrect low-frequency response or the introduction of extraneous low-frequency components into the system will result in field time distortions. If the coupling between stages of an AC-coupled video amplifier is insufficient, low-frequency rolloff will be evident in the signal (Figure 2). For example, if a video coupling capacitor is decreased to 2 percent of its value, low-frequency rolloff changes the video waveform. This appears as a difference in shading from the top to the bottom of the picture.

Extraneous signals coupled into the system, most notably power supply and power line hum, also will be seen as field time distortions, and their effect will be present regardless of the level of the picture signal. With color systems in which the vertical rate is not locked to the power line frequency, hum will become evident as horizontal bands of varying brightness scrolling upward through the picture. This is caused by the difference between line frequency (60 Hz) and field rate (59.94 Hz) in the NTSC color system (Figure 3).

"There has been no adequate way to measure field time distortion on an in-service basis."

Long-time linear distortions can be introduced into a video system either from an external source or by inadequacies in the equipment itself. Linear distortion, for example, could be caused by a video amplifier that cannot tolerate an abrupt DC axis shift (white to black) in the video signal. This level shift is usually caused by the inability of the sync separator and DC restorer to follow the variation. External sources are power line hum and power supply ripple. A cable system may inadvertently introduce low-frequency power line signals to channels in any part of the system after a defective amplifier.

The contribution of noise, hum and field rate distortions by the signal source is often in ques-

The business of competition means one thing.

WIN

NING

To win, you never compromise on critical equipment. At Scientific-Atlanta, we never have. That's why we helped deliver cable to 45 million American homes–by delivering products with purpose that fulfill their promise.

And that's why we bring you the newest, best and broadest product line in the history of the cable industry. New addressables with user-friendly features that win subscribers for you. New basics that pack more function into the smallest footprint ever. New headend equipment that makes space and cost-saving sense. New distribution products that go the distance.

And because the *business of vision* is the future of cable, we're working to bring you the benefits of fiber, off-premises, HDTV and other innovative technologies.

Because at Scientific-Atlanta we're committed to making sure our customers are the winners.

WIN THROUGH FRIENDLINESS

Our new addressable product line is the friendliest and fullest featured in the industry.

The new 8590 volume control set-top's unique display lets subscribers *see* sound and get optimum stereo separation. And it keeps a secret better, too. With over 50 security modes using three advanced technologies: dynamic sync suppression, dropped field and video and sync inversion.

The new 8570 has all the features of its older brother, the industry standard 8580, and then some. It makes impulse easy. Like the 8590 with a one-touch buy key on both remote *and* set-top. And it takes our **plug-in Micro-Pulse Module.** Because the easier we make things, the more they're used. That puts our experience with 400,000 IPPV set-tops in hotels, processing 12 million transactions a year, to work for you. And all are compatible with Oak and a long list of others.

Our Complete Remote Control is so smart it eliminates multiple remotes by quickly learning their functions–providing volume control without a volume control set-top–that's friendliness subscribers will pay for.

S
pl
t
W

o
ay
o
in...

WIN THROUGH BASICS

Our new line of basics stands out–the broadest and friendliest in the industry. With volume control. Sleek new styling. And they're the smallest in the business, so subscribers watch TV–not the converter.

The new 8540 has the same *see* sound volume control as its new addressable counterpart. And it helps subscribers be more friendly by letting them adjust sound *before* turning on the TV.

Their **attractive new styling** blends in easily with today's clean, contemporary home entertainment center.

From the functional 8510 to the feature-rich new 8529–from the descrambling 8536 to the volume control 8540–**we never stop improving on basics. Because fundamentals pay off for our customers.**

WIN FROM THE START

The headend is where it all begins. And more headends begin with Scientific-Atlanta equipment than all other manufacturers combined. Because Scientific-Atlanta is the best and stays the best. The new 9650 IRD, the new Frequency Agile Drawer, and the new 6380A are just a few of the reasons why.

The industry's first integrated receiver/descrambler, our new 9650 IRD, beats today's rack space squeeze. It cuts space needs in half by integrating the leading CATV receiver–the 9640–with a satellite descrambler in one package the size of the receiver alone. Result: twice the channels in the same rack–with perfect compatibility.

Our new Frequency Agile Drawer delivers agility when you need it–and only when you need it. One drawer backs up an entire headend. And, it provides quick, dependable slide-in convenience for those industry standards, the 6350 modulator and the 6150 processor. Plus, its 550 MHz range and built-in FCC offsets are compatible with every cable system.

We've also enhanced the industry's most popular stereo encoder–the 6380A. Clear, clean, crisp stereo. Its peak limiter assures consistent audio across all channels. The 6380A even lets local ads run in stereo through its alternate audio inputs.

wi
th
•
win
ed

ith

ne.

ning

ge...

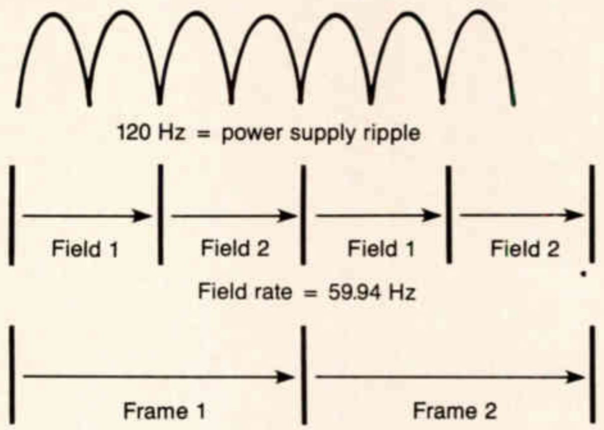
WIN IN THE STRETCH

Scientific-Atlanta is the leader in distribution because we go the distance. More capacity. Higher quality. Saving costly respacing.

Like our new FT bridger and line extender amplifier. Takes super trunk performance out to the feeder. With the higher output needed for upgrades without respacing–taking those high quality AT, feed-forward, or fiber signals all the way to the home. It has twice the output of power doubling. Half the distortion and 27% less power consumption than the competition. So it's cooler and more reliable.

Our trunk amplifiers set the pace, too–with feedforward for broad upgrades and the AT for narrow ones–both outdistancing power doubling. **Our new taps fill out the winning lineup.** They're easier to install. Almost impossible to break. And prepared for any environment. So you can mix and match to optimize performance all the way from the headend to the home. Growing your system most economically. With high picture quality and drop-in upgrade convenience.

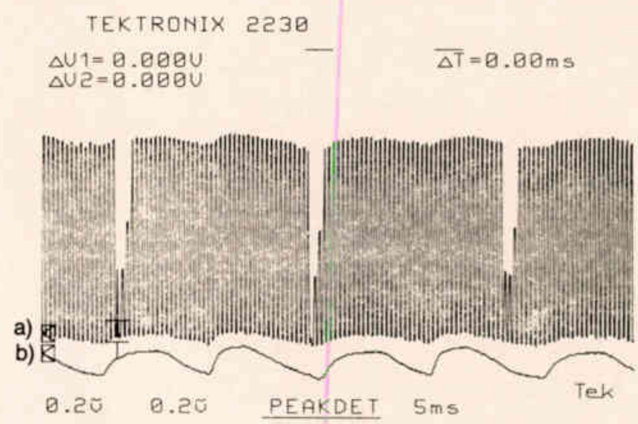
Figure 3: Hum phase changes



Frame rate = (color carrier × horizontal scanning frequency) ÷ lines per field

$$\left(3.579545\text{ MHz} \times \frac{2}{455}\right) \div 262.5 = 59.94\text{ Hz}$$

Figure 4



a) Video with line hum
b) Supply ripple getting into modulator

tion. (Measuring hum with a standard receiver is not practical, and oscilloscope measurements in the field are cumbersome and difficult.)

The transmitting power needed to relay the high-frequency analog video portion is just a portion of the power level of a normal NTSC broadcast. That's because the vast majority of the RF power needed by a TV transmitter is used to reliably transmit the low-frequency video information, sync signals and DC value (black restoration) of the signal. Signals mixed into the composite video spectrum affect the effective signal-to-noise (S/N) ratio. The spectrum analyzer can be used directly at RF to measure C/N (carrier-to-noise) as well as hum and low-frequency distortions.

To measure hum and field rate distortions:

1) Set up the test equipment at an RF test point or test antenna and tune in the picture carrier.
2) Set the detector bandwidth and gain to the low-frequency range desired. With 1 MHz/div. frequency span the entire channel can be viewed. Using 300 kHz resolution, the video, color and sound carriers will stand out in the display.
3) Set the input attenuator on the spectrum analyzer so that the picture carrier is at the top graticule. If there are many channels in the RF spectrum at the instrument input, care should be given to how much dynamic range the instrument has.
4) Disable or immobilize any automatic gain circuits or closed loop connection systems.
5) To measure hum and field rate distortion (tilt), tune the picture carrier at 3 MHz resolution, zero span and fine tune for maximum upward deflections.
6) With the VAR IF gain control, adjust until the picture sync tips are just at the top reference line. Then switch to the linear mode. With linear mode and zero sweep you will have a display just like a TV video detector connected to an oscilloscope.
7) Both hum and field rate distortion are measured as a percentage of full screen, from the reference power to a no signal input line.

Note: Signal-to-noise and hum can be measured on any part of the transmitting chain from the studio through the processing equipment using a demodulator and waveform monitor. The question of contribution of the noise in the test equipment or the clamping of hum and field rate distortions must be considered.

There has been no adequate way to measure field time distortion on an in-service basis. A gross check on field time distortion while the system is operating can be made by viewing the blanking level or sync tip and observing any variation between the vertical blanking interval and the picture level. This is an unsatisfactory test except for emergency troubleshooting and the waveform monitor DC restorer should be off during this test.

To test low-frequency response, a 60 Hz square wave can be used for out-of-service tests. Since most TV equipment requires sync pulses to operate satisfactorily, a special 60 Hz square wave with synchronizing pulses is required that is extremely sensitive to low-frequency response errors or field time distortions. Other similar signals, such as a window or full field bar signal, also may be used, but are much less sensitive to field time distortions than 60 Hz square waves.

One of the new field strength meters enables the technician to quantify and confirm what customers may see in their pictures that is a cable or a set problem. The old FCC standards specified that hum should be less than 5 percent; this level would indeed be noticeable and cable systems are built much better than this.

The meter uses a stable PLL tuning system that avoids tuning errors, preventing detection errors in the measurements. If, for example, the measuring circuit were to use synchronous detection, the detector-tuned circuits would have to have the carrier at the proper frequency and amplify it to detect properly.

In this meter, stable fixed IF amplifiers avoid instrument-introduced gain change that would add or, more likely, subtract from the hum reading. The AGC circuit in the IF/detector portion of the meter is made slower than what would be common in a television.

The output of the video detector is linear. The linear amplitude distortions of the modulation vary the sync pulse amplitude along with the video signal; the sync pulses should be a constant level. Any variation in amplitude will be a measure of hum.

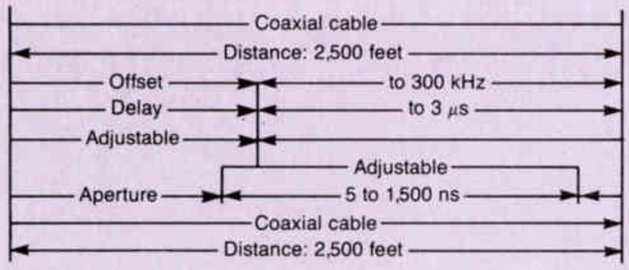
If only a CW signal is measured a simple diode detector could be used, but with video RF modulation the vertical and horizontal sync pulses make the diode detector output amplitude vary. With this meter, the sync pulses gate a sample and hold circuit, with sync circuits similar to a standard TV set. By sampling the horizontal sync tips, the sample rate is fast enough to show any amplitude changes up to several kilohertz. If no signal is present (no sync tips), the sample and hold circuit runs freely, permitting measurement of AM change of the CW signal as well as composite video.

After the sample and hold circuit, an analog-to-digital converter measures the detected output. The high and low values are stored, from successive samples, for a period greater than the field rate. Then the difference is computed and displayed as hum percentage.

Reference

Tektronix, *Video Frequency Broadcast Measurements*, Third Edition, 1984.

Equipment operating parameters



Apertures (in nanoseconds) for RF span of 1,000 MHz

	Rate of scan (in milliseconds)			
	1	0.5	0.2	0.1
3 kHz	33	16	10	5
10 kHz	100	50	20	10
30 kHz	300	150	75	30

The offset of 100 kHz provides 500 ns of delay.

Apertures (in nanoseconds) for RF span of 200 MHz

	Rate of scan (in milliseconds)			
	1	0.5	0.2	0.1
3 kHz	165	80	50	25
10 kHz	500	250	100	50
30 kHz	1500	750	375	150

The offset of 100 kHz provides 2,500 ns of delay.

A new look at coaxial cable: Time selective swept return loss

By John L. Huff
Staff Engineer, Times Mirror Cable Television

The detection of a swept radio frequency response from a return loss bridge will indicate the quality of coaxial cable used in the system. The bridge also makes impedance and reactance measurements possible. But there are other devices that make the same impedance measurements. RF bridges with port-to-port isolation of 60 dB from 10 kHz to 1 GHz are available. Bridge effectiveness, however, is limited largely by the interface connector return loss. Resolution of two reflections with a swept return loss display is possible; for three or more reflections it is unsure.

The time domain reflectometer (TDR) with a stepped output measures the impedance characteristics of coax. Broadband frequency response using a TDR is not easily determined. Making TDR measurements with signals and power present on the cable system is not within the TDR's operational mode.

However, the time selective swept return loss (TSSRL) technique may change the way one thinks and uses the spectrum analyzer and tracking generator. The block diagram of the test equipment and connections to the coax is conventional with a coaxial T or bridge. There will be differences in the setting of equipment operating parameters. There is no set way the equipment should be connected to a test point. The connecting of cables should be as direct and short as possible to minimize standing waves and standard procedures for blocking power to the test equipment should be observed. The procedures for connecting cables will be dictated by differences in equipment.

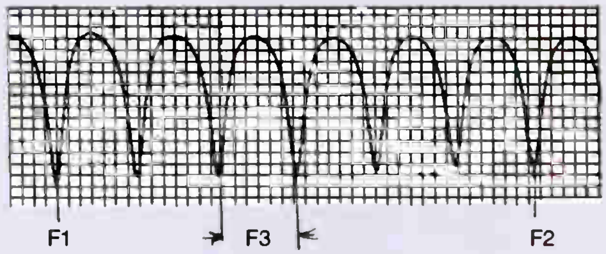
Theory of TSSRL

The reciprocal of frequency is time. With a known propagation velocity and a measured time, the length of a coaxial cable can be determined. There are two discrete time references when using the TSSRL technique. The first reference is the time it takes the spectrum analyzer and tracking generator to scan a band of frequencies. The second reference is the time it takes a signal to travel the length of coax. Both times are used to calculate the frequency (delay) between the spectrum analyzer and tracking generator.

The "tracking" adjustment is used to track the spectrum analyzer with the tracking generator. It also is used to adjust the offset frequency, which determines the time or delay between the tracking generator and the spectrum analyzer and determines the point of the segment of cable to be analyzed. The offset delay is adjustable from zero to over 3 microseconds or 2,400 feet.

By adjusting the IF bandwidth scan time and frequency span, one can determine the aperture of the spectrum analyzer. By adjusting the aperture, one selects the time or length of coax to be analyzed. The aperture is variable in time from 5 to 1,500 ns, or from 5 to 2,500 feet in coax (see table). The aperture table will not change with the types of equipment used, although calibration correction factors will change because standard CATV test equipment is not calibrated to operate TSSRL accurately. The operating limit of the time scan will depend on the spectrum analyzer local sweep oscillator's ability to track a linear time and sweep frequency.

Figure 1

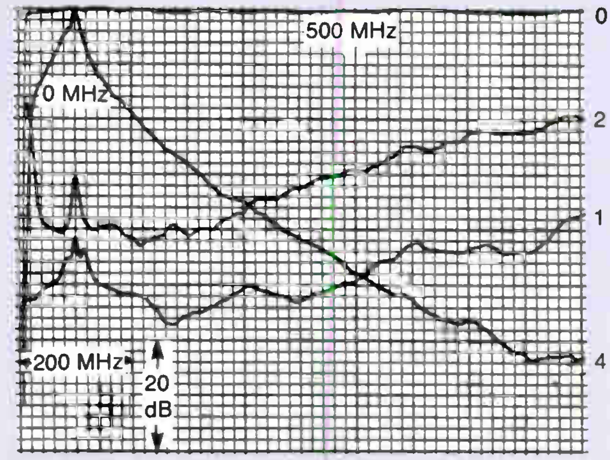


(1/[(F2−F1)/6]) × 0.5 = time in microseconds
Microseconds × 984 = free space distance
Free space distance × 88 percent = coaxial feet

F2 = 79.581 MHz
−F1 = 63.947 MHz

15.634/6 = 2.6056 MHz = F3
1/2.6056 = .38378
.38378 × .5 = .19187 microseconds
.19187 × 984 = 188 feet free space
188 × 88 percent = 166 feet coaxial cable

Figure 2



0) Zero dB reference level.
1) 50 dB return loss of bridge and a standard termination return loss at 500 MHz.
2) 29 dB return loss at 500 MHz of F81 connector and .500 cable.
4) 48 dB return loss at 500 MHz of .500 cable unterminated at 1.8 microseconds long.

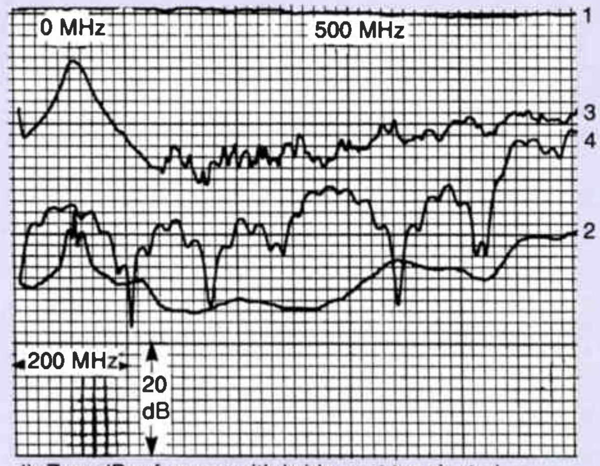
With some tracking generator and spectrum analyzer combinations, tracking may not be able to be adjusted to provide with enough offset range. A second adjustable oscillator can be used to give the needed offset. The adjustable oscillator output is read directly with a frequency counter.

Scan and frequency amplitude response loss do not apply the same with TSSRL. The high sweep speed and narrow IF bandwidth will reduce the effect of other signals that are on the system and enhance the desired signals.

Operational conditions

Five operating conditions exist with TSSRL that would not be normal

Figure 3



1) Zero dB reference with bridge not terminated.
2) Bridge return loss of 50 dB with standard termination at 500 MHz.
3) A standard return loss measurement of 23 dB at 500 MHz, cable not terminated.
4) A reduced sweep at 400 MHz of 100 MHz trace lowered by 10 dB showing scan resolution loss.

for conventional swept RF measurements: a narrow IF bandwidth, a high rate of swept RF, a wide band of frequencies swept, at least 50 ns of propagation time delay and a very linear frequency and time sweep of the first local oscillator. It is not usual to sweep test with a narrow IF bandwidth. The IF bandwidth affects markers or other signal responses occupying critical swept frequencies. Standing waves of sweep frequency amplitude response are used to cross-check total length of a coaxial cable and to calculate delay time correction (Figure 1).

Operation is as follows: Connect a coaxial T to the tracking generator output, then connect one leg of the T to the spectrum analyzer input. The third leg is connected to a length of coax not less than 200 feet. The other end of the cable should not be terminated. Using the standing waves interference pattern, the cable length can be measured.

Set the spectrum analyzer scan width to 500 MHz, the sweep speed to 5 or 10 ms, the IF bandwidth from 3 to 30 kHz and the vertical scale to log 10. Adjust the tracking generator frequency offset to about 100 kHz. Set the vertical dynamic range to 70 or 80 dB. The vertical response above the noise floor is the return loss. Continue the offset through 300 kHz. The open end of the length of the coax will be a swept RF amplitude response. The response will be twice the throughloss of the coax. The coaxial T coupling provides an accurate output level reference.

Figure 2 shows the TSSRL of a sample .500 cable 1.8 microseconds long, while Figure 3 illustrates the standard method return loss bridge of the same cable. Figure 4 presents plots of the TSSRL technique with selected delays.

A fast-moving train

Compare the TSSRL technique to an old western movie: Picture a fast-moving train, with robbers riding their horses alongside the train and able to board any car. One horseman takes out the F81 rattlesnake while the others pace the train to check couplings and cargo and to prepare for boarding. The present bridge method for return loss measurements is like putting railroad ties on the track to stop the train. The result is a pile of train cars on the railroad tracks.

To use the TSSRL technique, a frequency counter and a second or third local oscillator is not needed. To improve accuracy and reduce time and equipment operational confusion, a second offset oscillator is desirable. A frequency counter could be used with the offset oscillator in the tracking generator if there was a sample output of that oscillator.

There is an alternate method to offset frequency measurement. Stop the sweep of the spectrum analyzer in midsweep and count the frequency of the tracking generator. A second frequency measurement

We're out to convert the cable industry.

Panasonic's new TZ-PC 140/170 series cable converters carry the industry's first 5-year warranty.

Reliability. It's what you demand from CATV converters. It's how you avoid costly service calls and replacements. It's what you expect from Panasonic.

Now, Panasonic, the industry's leader, proudly unveils a new standard in reliability: the new PC 140 and 170 series cable converters. And we're backing them up with an unprecedented 5-year warranty.

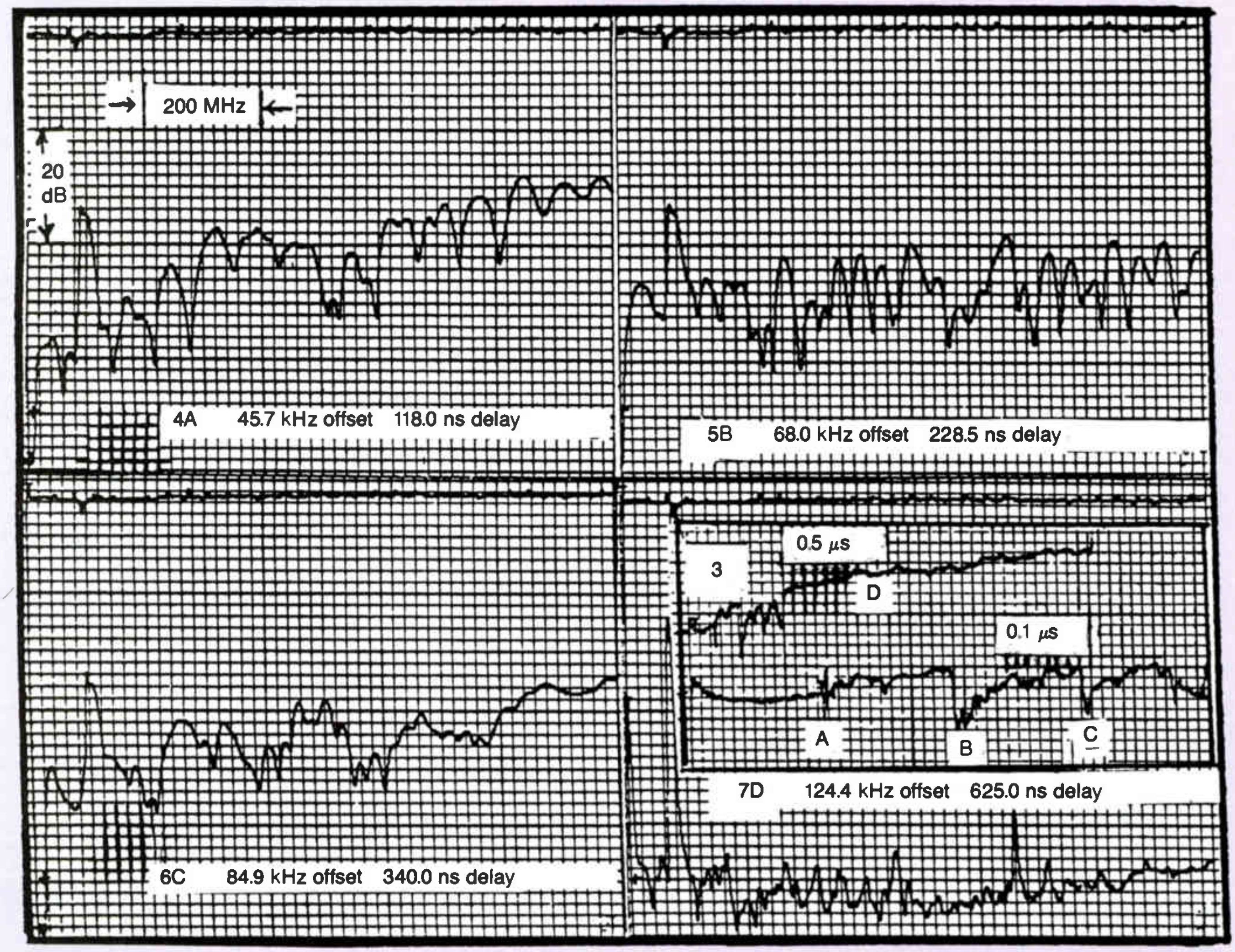
That 5-year warranty covers a high-performance package: 550-MHz/85-channel, phase-locked synthesizer circuitry, an all-function, wireless remote, built-in BTSC stereo-compatibility and Up-Down Channel Scan. Plus Sleep Timer, a Parental Guidance Control option and more.

For product or dealer information, call (201) 392-4709. Panasonic's new PC 140/170 series cable converters: the means to end-user satisfaction.

Panasonic
CATV Products

Reader Service Number 35.

Figure 4



Plot 3 time domain reflectometer traces of .500 coaxial cable 1.8 microseconds long.
Plot 4A, 5B, 6C, and 7D are frequency domain reflections of Plot 3 Points A, B, C and D.
Point A is a .500 cable connector.
Points B and C are faults in underground coaxial cable with characteristics unknown.
Point D characteristic in manufacturing of periodic impedance changes 9.6 inches apart.

is made after a tracking offset change has been made. The midsweep output frequency difference is the offset. The frequency offset of the tracking generator will determine the spectrum analyzer time delay.

One has a 50/50 chance that the first offset frequency adjustment will be in the right direction. Only one direction has a response from on-frequency tracking. The offset frequency determines the delay time of the spectrum analyzer. A delay is an increase in frequency of a tracking generator offset oscillator. There is a decrease in the frequency of the offset oscillator in a spectrum analyzer.

The bridge or directional coupler will extend the dynamic range of the spectrum analyzer. The bridge or directional coupler provides the isolation for observation of the reflections close to their test port. Isolation created by the directional coupler or the bridge must be included in return loss calculations.

Characteristics of a bridge are displayed as the balance is adjusted. The bridge balance adjustments are not effective as the spectrum analyzer delay time moves away from the response of the bridge.

Time selective swept return loss examines any section of a coaxial cable. All the passive equipment that is placed on the coax to the next active device can be examined for return loss. The advantages of TSSRL will become apparent when you see the return loss of coax being 70 dB or better. A connector at 500 feet may have a return loss of 40 dB at 50 MHz and 20 dB at 400 MHz.

Coaxial cable loss must be subtracted from the return loss measured. All intervening coax loss and the resulting return loss from that section of coax is added. The swept radio frequency throughloss is in one direction of a length of the coax. The throughloss is half of the return loss of the signal reflected from a coax that is not terminated.

The relative location of two close-spaced reflections or the interference pattern of multiple reflection can be resolved with ease. The coaxial characteristics will be displayed in a variety of new responses. Other passive devices on the cable also will reveal their particular characteristic influence.

Try TSSRL on TV-receiving antennas and coax. The true return loss of the coax or antenna can be determined. But TSSRL is not a "solve-all" nor a cure-all. The technique will solve many problems dealing with signal loss and distortion on a coaxial cable. A new user may accept the technique as being a more normal function of the spectrum analyzer and tracking generator. With test equipment calibrated and control panels marked to perform the required functions of this technique, operations will be easier.

Reprinted with permission from the National Cable Television Association's "1988 NCTA Technical Papers."

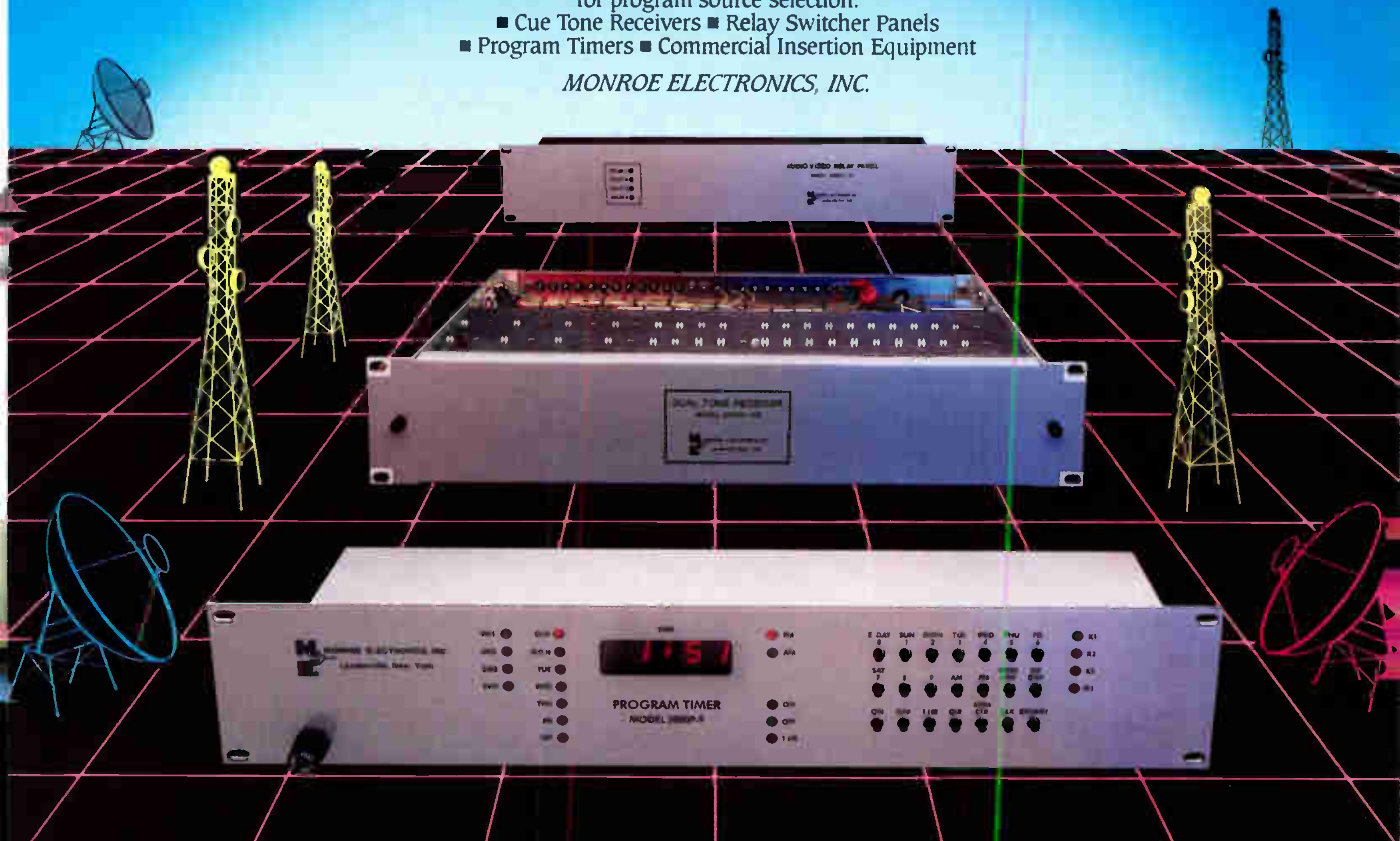
Program Switching

Complete systems to monitor & control unattended sites via DTMF signals.

Monroe Electronics, the pioneer of cue tone signaling, offers complete systems for automatic, unattended operation of headend switching functions in response to network cue tones, remote telephone control or timed signals. Decodes Touch-Tone® DTMF signals transmitted over satellite transponders or telephone lines. Switches audio/video modulator input. Provides timing sequences for program source selection.

■ Cue Tone Receivers ■ Relay Switcher Panels
■ Program Timers ■ Commercial Insertion Equipment

MONROE ELECTRONICS, INC.



MONROE ELECTRONICS, INC.

100 Housel Avenue, Lyndonville, NY 14098
Phone: 716-765-2254 ● FAX: 716-765-9330 ● Telex: 75-6662

ComSE Sales Corp.
Lawrenceville, GA 800-241-1232 404-963-7870

CATV SERVICES
Fremont, CA 800-227-1200 (In CA 800-223-3152)

NCS INDUSTRIES INC.
Willow Grove, PA 800-523-2342 (In PA 800-492-2032)

CWY electronics
Lafayette, IN 800-428-7596 (In IN 800-382-7526)

Cable Technology Associates, Inc.
Syracuse, NY 800-437-3100 (In NYS 315-451-9450)

WESTFAHL & ASSOCIATES
Albuquerque, NM 505-881-0995

MHz MEGA HERTZ

A & M COMMUNICATIONS
St. Louis Park, MN 612-920-521[illegible]

CABLE EQUIPMENT CORPORATION

REMEMBER WHO INTRODUCED YOU TO FIBER OPTICS TWELVE YEARS AGO?

In fiber optics, the competition is twelve years behind the Times.

While America celebrated the Bicentennial, Times Fiber introduced fiber optics to the cable industry. We pioneered the application of lightwave technology in cable television. We went beyond fiber supertrunking back in the early '80's. And took lightwave distribution all the way into the home.

In recent years, Times has been concentrating on coax. So who's been researching, developing, improving fiber optic technology? Our sister company which was created for that express purpose: American Lightwave Systems, Inc.

Now we've joined forces with them to offer you the very latest in FM and AM lightwave transmission systems. And the experience and expertise to help you make the right decision about how best to implement fiber in your system.

Don't trust your future to some lightwave-come-lately. Times has been out in front of the pack for years. And we plan to stay there.

For more information call (203)265-8658

Or write to 358 Hall Avenue, P.O. Box 384, Wallingford, CT 06492.

TFC

TIMES FIBER COMMUNICATIONS, INC.
an LPL company

See us at the Western Shown, Booth 452.
Reader Service Number 37.

SLMs for all technical levels

By Steve Windle
Senior Applications Engineer, Wavetek RF Products

Anyone involved in the technical aspects of cable TV knows that a signal level meter (SLM) is a basic requirement for system maintenance. The design and technical limitations of the system make it necessary to measure signals and parameters related to those signals at many different locations in the cable plant. Plant managers and/or chief engineers must make an educated decision on which of the wide variety of meters on the market is appropriate for each of their employees. As such, decision makers should be aware of new developments in SLM technology that make the latest meters easier to use, more reliable and more accurate than ever before.

SLMs are designed for different job functions, and each of these functions requires different measurement capabilities. In spite of these differences, there are some common requirements for field portable test equipment used in the CATV industry. As in any industry, test equipment of high quality and at a reasonable price is desirable.

In order to keep costs acceptable, the sophistication of the meter's measurement capability may be limited to that required to perform the critical tasks for the specific job function. In most areas of responsibility the meter must be taken outside into the sometimes hostile environment. This means that the instrument should be able to shed water and endure temperature changes and rough treatment. Meters also should be accurate, but accuracy has an effect on the cost. In addition, different amounts of precision are needed in different areas of responsibility. An installer's meter won't require the same degree of accuracy as a meter used by the trunk tech who makes critical adjustments that can have a major effect on the quality of picture the subscriber receives. This is one area where a tradeoff may be made—less precision for lower cost.

Installer's meter

One of the installer's responsibilities is to measure the signal level out of the converter to verify that it is of an acceptable level. However, some question the necessity for an installer to actually measure signal levels. They believe if the pictures are reasonably good on the subscriber's TV, the drop has been done correctly. This is not necessarily true, since the system is designed to provide at least 0 dBmV to the TV set; but a set can have a good picture with a lower signal level. An installer can therefore be misled by using the TV set as a test instrument, and the customer may later be the one that finds the problem. The set's window of acceptable operation is too wide to permit its use as a drop quality verifier. Installation contractors know installers are often called back to repair faulty installs. This time- and money-wasting rework can be eliminated by using the proper tool for verifying installation quality—an installer's SLM. For troubleshooting purposes, if a problem is discovered, the signal level meter can then be tested at the tap, at the ground block as it goes into the converter and as it comes out of the converter to the TV.

An installer's meter is designed for simplicity and to provide quick measurements, enabling the installer to quickly measure the levels of at least two carriers (usually at high and low ends of the spectrum). These meters are usually the least expensive and simplest of the range of SLM products.

Tuning: A measurement can be made with most installers' meters simply by pressing a button. The meters usually tune to both a high- and low-end channel. Sampling a channel in the middle of the spectrum helps to provide a general indication of the response at the test point. One SLM on the market can tune to three different channels, permitting a sample of a channel signal level in the middle of the system's spectrum for a rough frequency response indication. This decreases the possibility of missing a critical response problem in the drop. It is also important that the installer's meter be able to tune relatively close to (within a few channels) the high end of the system in order to ensure that there is not a drop-induced high-end rolloff.

The tuning in an SLM is usually crystal controlled and any change in frequency due to system configuration changes would require a special factory modification. Synthesized tuning, besides being very precise, allows the user to change the frequency by simply switching a hidden DIP switch. This makes it possible to use the same meter on a wide variety of systems—an attractive benefit for contract installers.

Measurement result display: It is helpful in many instances for the installer to record the results of the signal level measurements made at the drop. Because of this, it is important that the result be easy to read and not subject to interpretation. If the meter has attenuators that must be switched to obtain a correct reading, there is a potential for human error in the measurement. This possibility can be eliminated by using an SLM with an auto-ranging attenuator. An installer's meter may display the measurement result either on an LED bar graph or with a direct LCD readout of the actual signal level.

Service (distribution) tech's meter

In large systems, a service tech may be responsible for the distribution system, from the bridger amplifier to the subscriber drop. This includes not only ensuring that the bridger and line extender output levels are correct, but troubleshooting problems pointed out by installers or (hopefully less frequently) subscribers.

The service tech's meter must tune throughout the occupied spectrum

Strongest link.

Your satellite receiver is the first link in the transmission chain. And one thing you can always count on—the head-end signal never gets better than it is at the receiver.

Which is a very good reason to specify Standard's Agile 40 C/K Satellite Receiver—but it's not the only reason.

The Agile 40 C/K was designed from the ground up solely for commercial applications. So it has all the features cable operators need most: rock-solid 100 kHz PLL tuning and total flexibility for the most accurate C/Ku-band operation; 70 MHz IF with a front-panel test point to minimize terrestrial interference; and a power supply built for the demands of 24-hour-a-day operation.

The Agile 40 C/K is also the receiver to have when you're expanding your headend. Because our internal 950-1450 MHz active loop-thru design eliminates signal splitters, so you can add up to 16 additional receivers on the same polarity—with no signal loss.

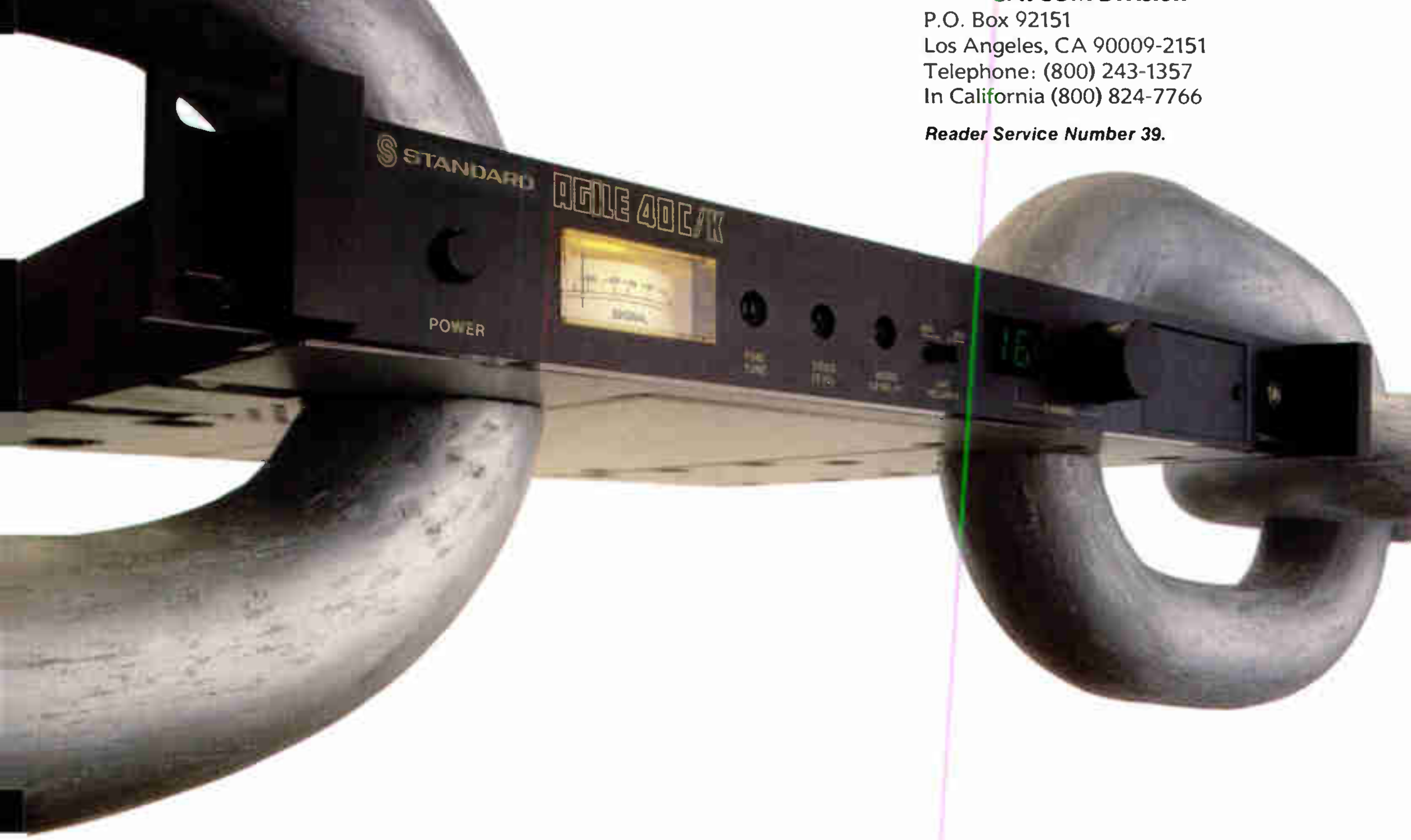
And because it draws only 32 watts maximum, the 40 C/K runs cooler, lasts longer, and saves money year after year. So you'll probably never need our five-year replacement/warranty program.

To get the best signal, start with the peace of mind that only quality equipment can give you. Link up with an Agile 40 C/K.

For pricing and specifications, contact the SATCOM Division for the Standard representative nearest you.

Standard
Communications
SATCOM Division
P.O. Box 92151
Los Angeles, CA 90009-2151
Telephone: (800) 243-1357
In California (800) 824-7766

Reader Service Number 39.



of the system. The meter must have accuracy to maintain proper signal levels, keeping distortion and carrier-to-noise (C/N) ratio in check. As in all SLMs, this one, too, must be rugged, reliable, water resistant and stable with temperature changes.

Tuning: Most service techs' meters are tuned using an analog dial method. This method can be relatively quick once the tech becomes accustomed to it, but it still can't compare to the speed and accuracy of digitally synthesized tuning. The old analog tuning scheme requires selection of the proper frequency band then "eyeballing" the dial with some tolerance for non-linearity in tuning. The audio feature is used to help in tuning, by listening for the telltale signs of a video or audio carrier. However, a synthesized tuning scheme eliminates the band selection switch. This makes tuning to any channel or frequency as easy as entering the digits associated with the channel or frequency and pressing the channel or frequency key. The tuning is right on target.

One question about this tuning that may come to mind is, "What about AFC?" AFC is not required on synthesized tuning meters. Also you may ask, "What if my carrier frequency is offset?" This is not a problem either, since the tuning increment on these meters is 125 kHz. The resolution bandwidth is 280 kHz, which means that a signal appearing 140 kHz away from the center tuned frequency would read 3 dB lower than its actual level. If the signal is 140 kHz from the tuned frequency, the logical move is to increment the tuning by 125 kHz. This puts that signal only 15 kHz away from the tuned center frequency and still well within an accurate measurement range.

To test the worst case a precision signal generator was set up in the lab and tuned away from the tuned center frequency of the meter in kHz increments. At the worst-case frequency (62.5 kHz offset or one-half of a tuning increment) the measured level dropped only 0.2 dB. This is still well within the specified accuracy of the meter even at the worst case.

Accuracy: To effectively address the accuracy of an SLM, we must consider four different sources of error: flatness, detector non-linearity, attenuator error and temperature effects.

Flatness is the most commonly specified level accuracy parameter and is usually specified relative to a calibration at the operating temperature. Traditionally, SLMs can only rely on the RF head to provide a flat measurement response across the frequency tuning range. But some of the latest instruments use a microprocessor and memory technology to significantly enhance the performance of the RF head. An automated test setup consisting of a precision, computer-controlled signal generator and a computer (of course) is used to obtain specific data on each SLM. The computer simultaneously increments the SLM tuning and the signal generator output frequency. The computer collects the measured level from the SLM, compares the measured level to the actual output level of the generator and creates a look-up table for each tuned frequency. This look-up table is then accessed whenever the SLM is tuned to that frequency and the measurement is automatically compensated for any flatness error. This method enables better flatness than that obtainable using the traditional heavily calibrated RF head.

Detector non-linearity, although usually not specified, also has an effect on measurement accuracy. The flatness calibration takes into account any change in accuracy as the frequency changes while the level to be measured remains constant. On the other hand, detector linearity affects measurement accuracy as the level to be measured changes while the frequency remains constant. Ideally, detectors will be perfectly linear and, as the amplitude of the measured signal changes linearly, the measurement will accurately (linearly) reflect this change. As we well know, the real world is not perfect. SLMs have had no way to eliminate this source of error until now. The same setup as previously described is used to determine the actual detector linearity. By incrementing the signal generator output level and comparing the measured level to the actual level, a compensation look-up table is created.

Attenuator error, another often overlooked SLM specification, also can be eliminated using the computer-controlled look-up table creation technique. The attenuator error is tested by changing the meter input level by attenuator step increments, comparing the measured level to the actual input level and building a look-up table for each attenuator setting.

Temperature changes have been a source of irritation for SLM users, requiring the meter to be calibrated at its operating temperature to assure maximum accuracy. Using the computer-controlled look-up table technique to characterize meter performance over the probable operation temperature range minimizes the potential for temperature related error.

Ruggedness: "A signal level meter is a delicate, precision instrument." Is this true? An SLM *is* a precision instrument, and although every new design results in a diligent attempt to make it more rugged than before and although great strides have been made in this design area, a meter should be treated gently as a delicate instrument. But considering the environment in which a meter is used, it must be rugged and impervious to water.

Reliability: A service tech's meter must not only be rugged but must be able to take a lot of use. The meters that meet this requirement best are simple (less can go wrong) and use reliable parts for the user interface. If keyboard tuning is provided, the keyboard should be tested and reliable (waterproof). Slide switch attenuators are a source of reliability problems. Switched electrical relay attenuators make the meter more reliable and have been tested to over a million operations.

Trunk tech's meter

A trunk tech may be responsible for all of the system's trunk from the headend to the end of each trunk leg. This position requires accurate signal level measurements to make sure the system is operating according to design and that distortion and C/N ratios are kept at optimum. The trunk tech may be called on to help a less experienced service tech with a particularly boggling troubleshooting problem.

The trunk tech's meter must be very accurate, reliable and quick and easy to use. The meter must have not only signal level measurement capability but C/N and hum test functions as well. Because of the typically far-reaching responsibility of the trunk tech, this meter is usually the one with the most measurement capability.

Tuning: A trunk tech's meter, depending on its sophistication, will be tuned by the analog method described earlier or, for those more fortunate, by a digital keyboard with an LCD display of tuned frequency. Even with the obvious speed advantage of the digital tuning method, there is room for improvement. Consider two primary tasks: measuring pilot carriers to verify proper levels and adjusting levels to obtain the proper system tilt. These operations are simplified in some meters through the use of user-configurable high and low pilot tuning. A key designated "Hi/Lo" enables the operator to quickly tune from one to the other by simply pressing the single key.

To make the task of aligning for proper gain and tilt quicker and easier, some meters feature a special "tilt" function. This enables the operator to monitor the high pilot level while simultaneously monitoring system tilt. This eliminates a lot of tuning back and forth; the user could easily perform this alignment with one hand.

Considering that a trunk tech's meter is sometimes used in the headend, a video/audio carrier level relationship function should be provided. The operator not only can tune from video to audio carrier with the press of a key but can get an LCD display of the difference between the two levels by pressing two keys. For testing video/audio carrier ratios in the headend the operator may enter this test mode and simply press the "up" or "down" arrow (increment/decrement) keys to move up or down one channel at a time.

Carrier-to-noise and hum: A trunk tech must keep careful tabs on C/N and hum to verify that the system is working according to design and to have early awareness of impending failures. One of the conventional methods for testing C/N with an SLM is to measure the carrier level—making a mental note of its level—then tune off into the noise floor (removing attenuation to get a reading), switch the C/N compensation switch, then subtract the latter measurement from the former to obtain the C/N measurement.

This procedure is a little time-consuming and requires a little mental gymnastics. But in newer SLMs, the user simply tunes to the peak of the reference carrier, enters the C/N function and tunes to a noise null (the attenuator is auto-ranging). The measurement is displayed on the LCD display. If the C/N is beyond the measurement range of the meter, the SLM displays the deepest measurement it can make and indicates "out of range" by flashing.

Hum measurements have always been easy on instruments designed for this function and can be made by simply tuning to a CW test carrier frequency and entering the hum test function.

How to set video depth of modulation

By Ron Hranac
Senior Staff Engineer, Jones Intercable Inc

The video carrier of a TV channel is amplitude modulated with a rather complex baseband video signal. This complexity requires that the modulated carrier's percentage of modulation—or depth of modulation, as it is more commonly known in broadcasting—be precisely adjusted. Correct depth of modulation will ensure that overmodulation does not occur and that the picture will be faithfully reproduced in the receiver. In cable TV, proper depth of modulation also may affect the operation of addressability, set-top converters/descramblers and in-band data transmission. As well, it can affect BTSC stereo in either broadcasting or cable transmission.

For optimum operation, depth of modulation should be adjusted to 87.5 percent relative to a 1 volt peak-to-peak video signal. The use of front panel indicator lights or meters on headend modulators is not a particularly accurate method of performing this task, and adjusting for what appears to be "about right" on the TV set in the headend isn't acceptable at all.

"For optimum operation, depth of modulation should be adjusted to 87.5 percent relative to a 1 volt peak-to-peak video signal."

One of the easiest and most accurate ways to set depth of modulation is with a spectrum analyzer. Even if your system does not own one, if you can borrow or rent a spectrum analyzer for an initial setup, an oscilloscope or waveform monitor can be used to maintain proper depth of modulation by ensuring that 1 volt of video is present at the input to the modulator. The important thing to remember here is that the modulator should be set to 87.5 percent depth of modulation relative to 1 volt of video at its input. Further adjustments need only be made to the video source not the depth of modulation control.

Three things are necessary to set depth of modulation: an oscilloscope or waveform monitor; a reference video source, preferably one that contains VITS (vertical interval test signals); and a spectrum analyzer.

It is important to differentiate between true spectrum analyzers and those that actually are spectrum monitors. A spectrum analyzer will have three primary controls: 1) amplitude controls that consist of vertical display modes in both logarithmic and linear scales, plus input attenuation and reference level adjustment; 2) frequency controls that tune the analyzer to the frequency of interest and span/division adjustments that vary the width of the RF spectrum being observed; and 3) a resolution bandwidth control to vary the IF bandwidth of the analyzer by selecting appropriate internal bandpass filters.

Making measurements

To set a modulator's video depth of modulation:

- Turn on the oscilloscope or waveform monitor, spectrum analyzer and reference video source. Check to make sure that all controls are in the "CAL" position and after at least a 30-minute warmup, verify instrument calibration per the manufacturers' instructions.
- Ensure that the reference video source is providing a 1 volt peak-to-peak signal at the modulator's video input (see "How to set video levels with an oscilloscope" in the January 1988 issue of *CT*).
- Connect the reference 1 volt video source to the modulator video input and the spectrum analyzer to the modulator's RF test point. It is better to use the modulator test point rather

(Continued on page 92)

n Cable TV.

products. What was true in the past is still true today and our commitment to the industry means that it will still be true tomorrow. From drop cable to trunk and distribution cables. Even fiber optic cables. We've got it all. We are 'The CABLE in CABLE TV.'

For more information about PIII, QR, Cable Guard, Super Trunk, Drop Cable, Optical Reach or any of our great line of products, call us today 800/982-1708 (800/222-6808 in NC).

Comm/Scope Inc.
THE Cable in Cable TV.

PO Box 1729, Hickory, NC 28603 800/982-1708 (800/222-6808 in NC), Telex: 802-166

Reader Service Number 42.

(Continued from page 72)

than the headend combiner test point because the presence of the lower adjacent sound carrier at the input to the spectrum analyzer will affect the accuracy of the measurement.

- Adjust the spectrum analyzer's controls to the following settings:

Vertical scale (logarithmic)	10 dB/division
Resolution bandwidth	300 kHz
Span/division	1 MHz
Time/division	automatic
Trigger source	free run or line
Trigger mode	normal

Figure 1

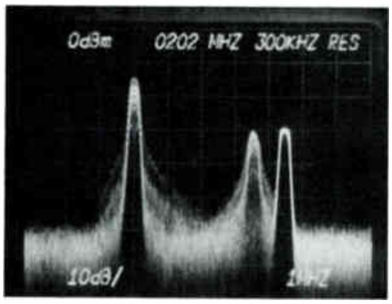


Figure 2

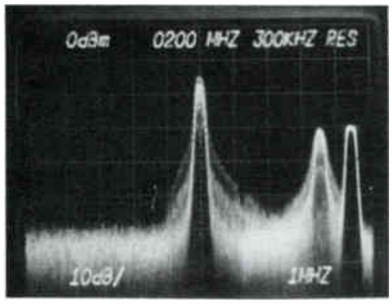


Figure 3

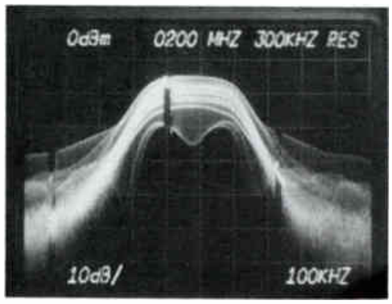
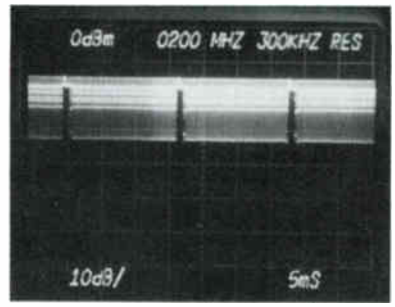


Figure 4



- Tune to the channel being measured using the "center frequency" control and adjust "input attenuation" and "reference level" controls to produce a display similar to Figure 1.
- Center the TV channel's video carrier on the spectrum analyzer display (Figure 2) with the "center frequency" control.
- Using the "span/div." control, reduce the frequency span per division to "spread out" the video carrier (Figure 3) until you reach a zero span display (Figure 4).
- Switch the spectrum analyzer's vertical scale controls to "linear," and "resolution bandwidth" control to 3 MHz. You should have a display similar to Figure 5.
- Adjust the spectrum analyzer center or

Affordable Masterpiece

No specifications equal those of the Signal Vision Directional Tap. It is, mechanically and electronically speaking, a work of art.

High art commands a high price, right? *Wrong.* The price for this tap is a value *any* critic would admire.

So you don't have to be an art expert to make your own appraisal. The Signal Vision Directional Tap is nothing less than a masterpiece.

Call Signal Vision for price and information about our new Directional Tap or for a catalog of our entire product line.

SIGNAL VISION, INC.

We Make The Connection

Three Wrigley • Irvine, CA 92718
714 / 586-3196

2-WAY & 4-WAY OUT-PUT MULTI-TAPS

MODELS: SVT-20 SVT-40

Features:

True performance to 550 MHz and beyond • Machined brass F ports • Corrosion resistant 360 aluminum alloy housing and protective epoxy coating • Aluminum gasket for maximum RFI integrity • Stainless steel spring loaded clutch • Tapered entry for center conductor • Neoprene weather-proof gasket • Aerial or pedestal mounting without changing center seizure screws • Center pin stop in seizure block • Plastic PC board housing cover • Excellent insertion loss to 550 MHz.

Specifications:

Bandwidth:	5-550 MHz	Tap loss:	1 db of assigned value
Tap-to-Tap isolation:	30 db	Impedance:	75 OHMS
Return loss:	20 db minimum all ports	RFI:	−100 db
	18 db 5 MHz tap port	Input/Output ports:	5/8 female
Power passing:	6 Amp AC/DC	Subscriber ports:	F-Type female (brass)

Reader Service Number 44.

Figure 5

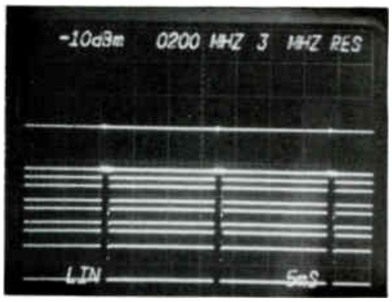


Figure 6

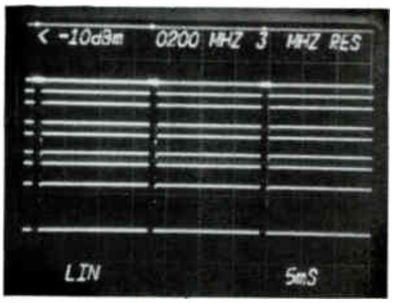


Figure 7

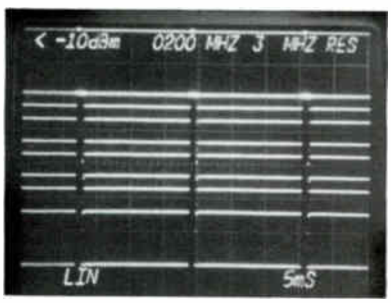


Figure 8

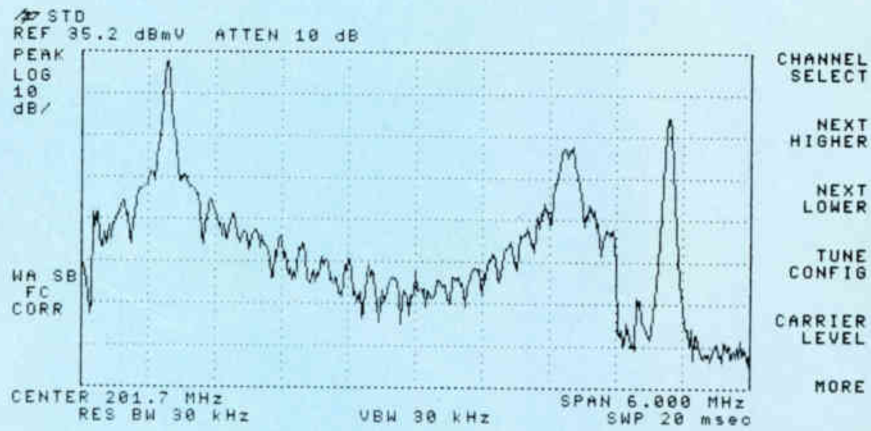
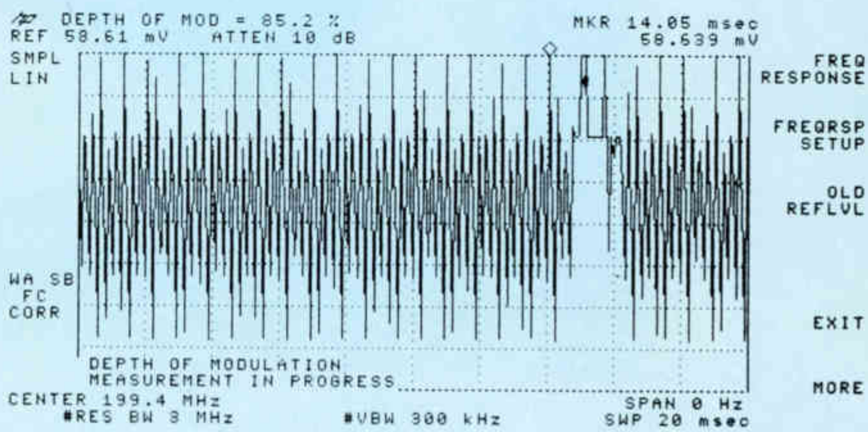


Figure 9



fine tuning control again to peak the display.

- Adjust the "input attenuation" and/or "reference level" controls to place the TV channel's sync tips at the top graticule (Figure 6).
- Adjust the modulator's "depth of modulation" control until the peak white portion of its modulating video reaches the seventh graticule from the top of the spectrum analyzer's display (Figure 7). Video depth of modulation is now 87.5 percent. Since the analyzer display has eight vertical divisions, and the bottom graticule represents zero carrier in "linear" mode, adjusting video peak white to the seventh graticule corresponds to 87.5 percent because 7/8 × 100 = 87.5.
- Verify that the normal program video for the modulator is 1 volt peak-to-peak then reconnect it to the modulator's video input.
- Repeat these procedures for each channel to be measured.

Automated measurements

The use of microprocessors in modern spectrum analyzers has simplified complicated measurements like the one described in this article. Hewlett-Packard has introduced such an instrument that incorporates cable TV-specific software to automate most system performance measurements. Video depth of modulation measurements on the new HP 8590A/H50 are as easy as pushing a button.

In fact, to perform the same depth of modulation measurement on the HP 8590/H50, all you need to do is enter the cable TV mode by pressing the "menu 2" button, then the "CATV" softkey next to the screen. Press the "channel select" softkey to tune to the TV channel you want to measure (Figure 8), followed by the "more" softkey to get to the next "page" of cable TV software functions, then press the "depth mod" softkey. The spectrum analyzer does all the rest and will produce a display like the one in Figure 9. That's all there is to it (for best accuracy, the video signal should contain VITS).

NCTA report

(Continued from page 20)

Association of Broadcasters. This should help reduce the amount of interference caused by improper operation of portable uplinks. The FCC is expected to adopt a position on ATIS within the next few weeks. The standardization of audio levels is still under consideration by the subcommittee but, due to the number of standards in use, it will be very difficult.

Cable Labs: The bylaws were modified to allow all founding members to nominate one representative each to the technical advisory committee. Walt Ciciora was appointed chairman of the technical advisory committee and an interim budget was approved. Meetings have been held with ATTC representatives to determine where it would be beneficial to work together in testing the advanced television systems. Ciciora will work for Cable Labs parttime as the director of advanced TV activities. Dick Leghorn was designated the father of Cable Labs.

CE bus: The equipment development for the booth at the Winter Consumer Electronics Show is on schedule. Interfaces between the various buses have been built and are working.

Contractor billing for system damages

By Joey Caballero
Plant Manager, Comcast Cablevision

I was sitting at my desk one day at the end of the second quarter of 1987. While reviewing my budget figures against actual year-to-date costs, I realized we would exceed our budget if action was not taken. We had been experiencing a growing number of unexpected repairs for damages caused by contractors excavating within our system for new home construction in Palm Beach County, Fla.

Looking back on the situation, I knew that we received many requests from UNCLE to flag areas about to be excavated. (UNCLE is an abbreviation for Utility Notification Center Liaison for Excavators, formed and funded by participating utility companies and municipalities in the interest of community and job safety and improved service through damage reduction to the utilities.) We reviewed each request to determine if our cables were in jeopardy and dispatched a technician when necessary. Despite these preventive measures, some contractors did not contact us prior to excavating or did so at the last minute, after excavation had begun and before we could dispatch a tech to the site.

In addition, we experienced damage during new home construction in remote areas or installation of swimming pools and landscaping, etc., that was not reported by the contractor and undetected by us because no subscribers had been activated on that feeder. Something had to be done about reducing the number of damage incidents, thereby reducing the number of outages to our subscribers. If these incidents continued to occur, we would exceed our maintenance budget long before the year was over.

You break it, you buy it

It occurred to me that the contractor responsible for the damage should reimburse us for its actions. We chose one of our most experienced and competent employees and asked her to begin sending invoices to contractors for damages incurred. Because this function was new and appeared not to be time-consuming, it was assigned to her in addition to her other duties.

In the ensuing weeks we continued to experience damage and send out invoices. Needless to say, contractors are not known for being quick to accept responsibility for mistakes made by their employees or the subcontractors they hire. They also have proven to be slow in paying and are not likely to write letters even when they wish to dispute the matter.

One of the problems with in-house billing is the coordination of effort between the technicians taking the damage calls and the billing person getting that information on a timely and complete basis. Even if this is done, there are many incidents where little or no information is available to the tech on-site. Our techs do not have the time or training to do the investigative work required to provide sufficient information on who is responsible for the damage.

As a result of our efforts, we had a small number of invoices that were paid, but the large majority required time-consuming follow-up by our billing person. Some invoices had to be rebilled to a second or third contractor. It was apparent that even though we had found a partial solution to our problem, further actions were necessary.

One possible solution to this dilemma was to dedicate a full-time person to this activity, with other duties assigned only if the workload permitted. However, this solution, while solving one problem, would create budget and staff "head count" problems.

Outside help

It was early in December when a man came into our offices inquiring about doing collections. He had worked for a major corporation in our area and had 20 years of accounts receivable, marketing, technical and administrative experience. He and his son had started a small business, known as Randall Enterprises, and were registered with the state of Florida, Palm Beach County and the city of Boca Raton as a collection agency.

At first, our office manager started using them to do bad debt and unrecoverable converter collections. We gave them a list of subscribers where previous efforts were unsuccessful in recovering converters. In addition, they were often successful in collecting the unpaid balance. They got surprisingly good results and were given more recent discontinued subscriber bad debt and converter activity.

While relating our collection problems with contractor billing, we decided that this small company might be able to dedicate more time, experience and other intangible factors that would make it more successful than we had been. Effective Jan. 1, as an experiment, we turned over our entire backlog of uncollected invoices and gave Randall full responsibility for all future contractor damage claims. Now, the same day we get a damage claim we place a call to Randall; its employees go to the site and begin gathering information and taking pictures. While at the site, they advise the contractor or job supervisor that the contractor will be billed for the damage incurred by Comcast. They also obtain the name, address and insurance information of the general contractor or owner of the property involved from the Boca Raton Building and Zoning Department.

Randall put together a "damage worksheet" that all our technicians carry so they are able to accurately document as much information as possible on where and what damage was done. Where possible they provide the following information: contractor name and address; contractor contact name and telephone number; permit number; type of work (aerial or underground); if UNCLE was called and site was flagged; description of damages, work done, time spent, etc.; a sketch on the worksheet to show where damage occurred; and a list of materials, cable lengths and equipment used.

Contractors should be responsible for damage done to the cable plant.

As a courtesy to the contractor and an expediting factor if an insurance claim must be filed, Randall mails a letter of explanation and an invoice directly to the contractor's place of business. If no response is received after 10-14 days, Randall contacts the owner of the business to confirm the receiving of the invoice and establish if and when payment can be expected.

In cases where the contractor disputes responsibility, an attempt is made to set up a meeting at the contractor's office or at the site where the damage occurred. The facts are discussed and the contractor is reminded of the requirement by the Florida statute and the city of Boca Raton that all contractors have general liability insurance for property damage on file and that an insurance claim will be filed if payment is not made.

The contractor may choose to pay the invoice to avoid Randall submitting an insurance claim for an amount smaller than the deductible. Or the contractor may approve the invoice for payment by the insurance company and submit the claim. The latter option is always preferable to submitting a claim without the cooperation of the contractor.

If Randall has to submit a claim to an insurance company, the claim is usually mailed to a local agency first. The degree of agency cooperation can vary greatly and must be monitored closely. In several cases in the past, the agency contacted the insured and were told not to process the claim. The agency then took no action and did not inform Randall or Comcast in writing of this decision.

In cases like these, Randall must remind the insurance agency that they cannot stop the filing of a claim and it is up to an insurance adjuster to decide if the claim is valid and should be paid.

"The contractor responsible for the damage should reimburse us for its actions."

This is where a well-documented claim with copies of letters, UNCLE tickets, pictures and facts on where and what damage occurred is essential for a claim to receive payment from the insurance company.

Recently we invoiced a contractor for relocation of cables and equipment at its request. In this instance, a developer requested the movement of a major trunk line so it could build a shopping center. When the invoice for nearly $4,000 was first presented, the contractor balked at payment and felt he had no obligation to do so. Before it was all over, Randall wrote several lengthy letters in response to letters from the developer and his attorney and had several face-to-face meetings with them. The final payment was a negotiated settlement beneficial to us.

We also have invoiced for as little as $75 for subscriber drops cut by lawn services and pool installation companies, as well as requests for relocation of subscriber drops and pedestals to install driveways and sidewalks.

Even though we have described what has been a success story for Comcast Cablevision of Boca Raton, caution must be advised when attempting to duplicate our efforts. Whether an employee or an outside firm is engaged for this activity, it should be understood that there is no sure formula for success. The individual chosen should have the necessary skills to be a detective, administrator and negotiator, as well as be prepared to spend considerable time and patience, to succeed.

We highly recommend that a personal computer be used in letter writing, invoicing and record-keeping. This will help reduce repetition due to the necessity to customize some letters. Software need not be extensive; a simple word processing package can be used for the letters and computer-generated invoices. However, any financial calculations for an invoice must be done by hand and entered into the computer.

We pay Randall Enterprises on a percentage basis (33 percent) of the total amount collected. They handle all investigative work, billing, verbal and written communications and insurance company follow-up. Once we give them a worksheet noting the type of damage and the necessary cable and equipment to repair the damage, they construct the invoice themselves.

New-found source

So far we are very happy with the results and have used this new-found source of income to help our system budget. We feel we also have accomplished one of our goals, which was to put out the word to builders and contractors that they must be more careful when excavating or be subject to the very expensive penalties. As a result, the number of system outages has been reduced. ■

HDTV and the vestigial sideband syndrome

By Archer S. Taylor
Senior Vice President of Engineering
Malarkey-Taylor Associates

For nearly 20 years, the Japanese have been working on a new generation, sophisticated, high tech standard for crisper, cleaner color TV pictures with a wider screen aspect ratio than is possible with the NTSC 525-line standard.

The Federal Communications Commission Notice of Inquiry in Docket No. 87-268 lists eight specific deficiencies in the NTSC interlace and color specifications that limit its video quality, in addition to the limited resolution and compressed aspect ratio inherent in the NTSC standard.

Most of the research and development effort in the advanced TV (ATV) field has been concentrated on the characteristics of the baseband video signal. Yet—except for a VCR playing to a video monitor—no video signal, however excellent it may be, can be displayed in the home without first being modulated on a radio frequency (or optical) carrier.

"Most people must watch television through a virtual scrim decorated with gaussian noise, multipath ghosts, edge overshoots, chroma delay and other defects."

Figure 1: VSB/AM technique

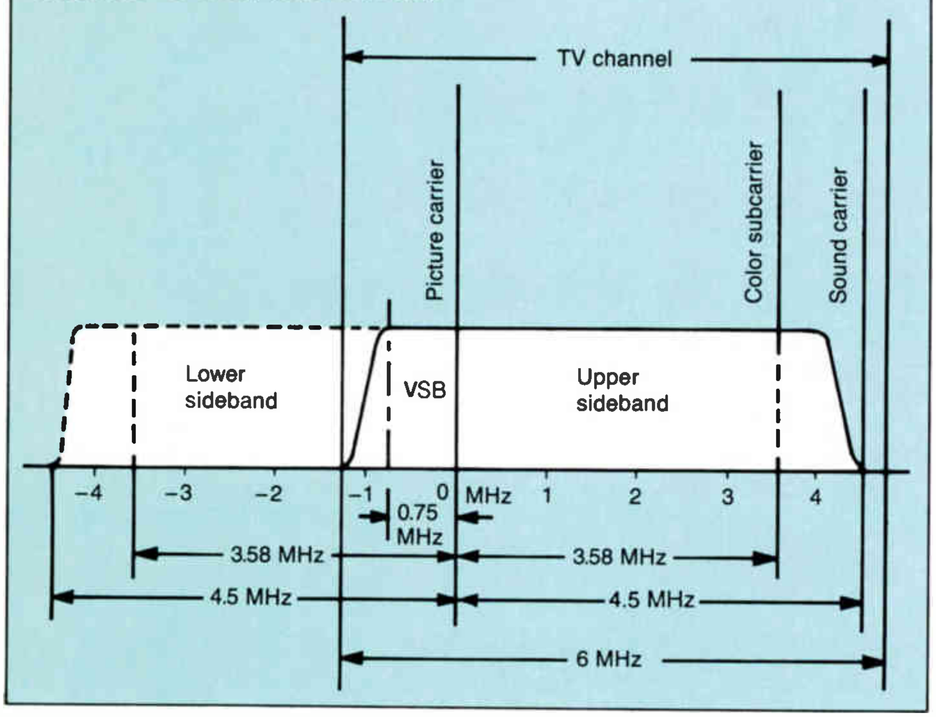
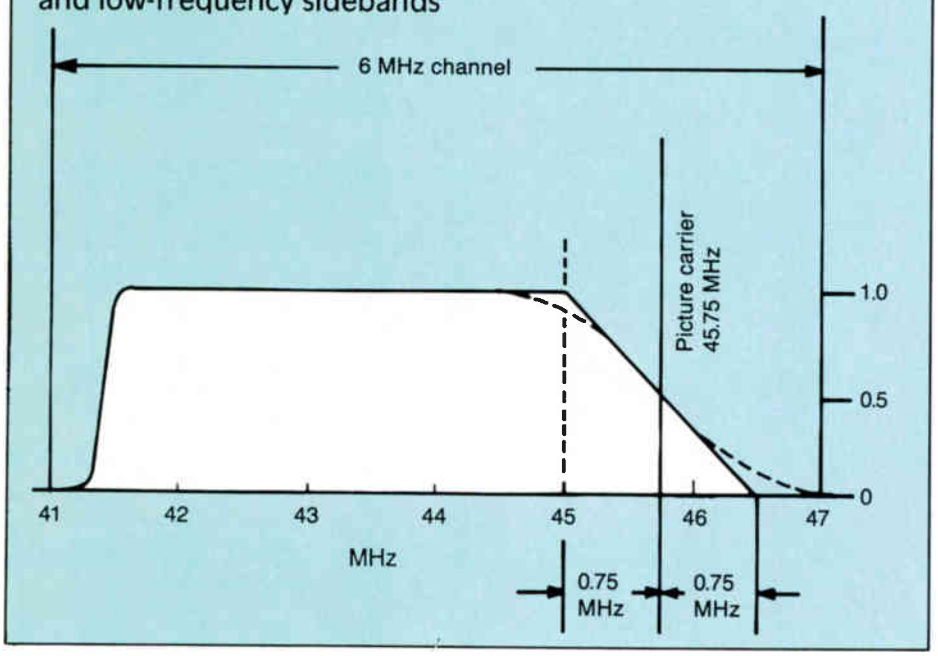


Figure 2: Ideal attenuation curve for carrier and low-frequency sidebands



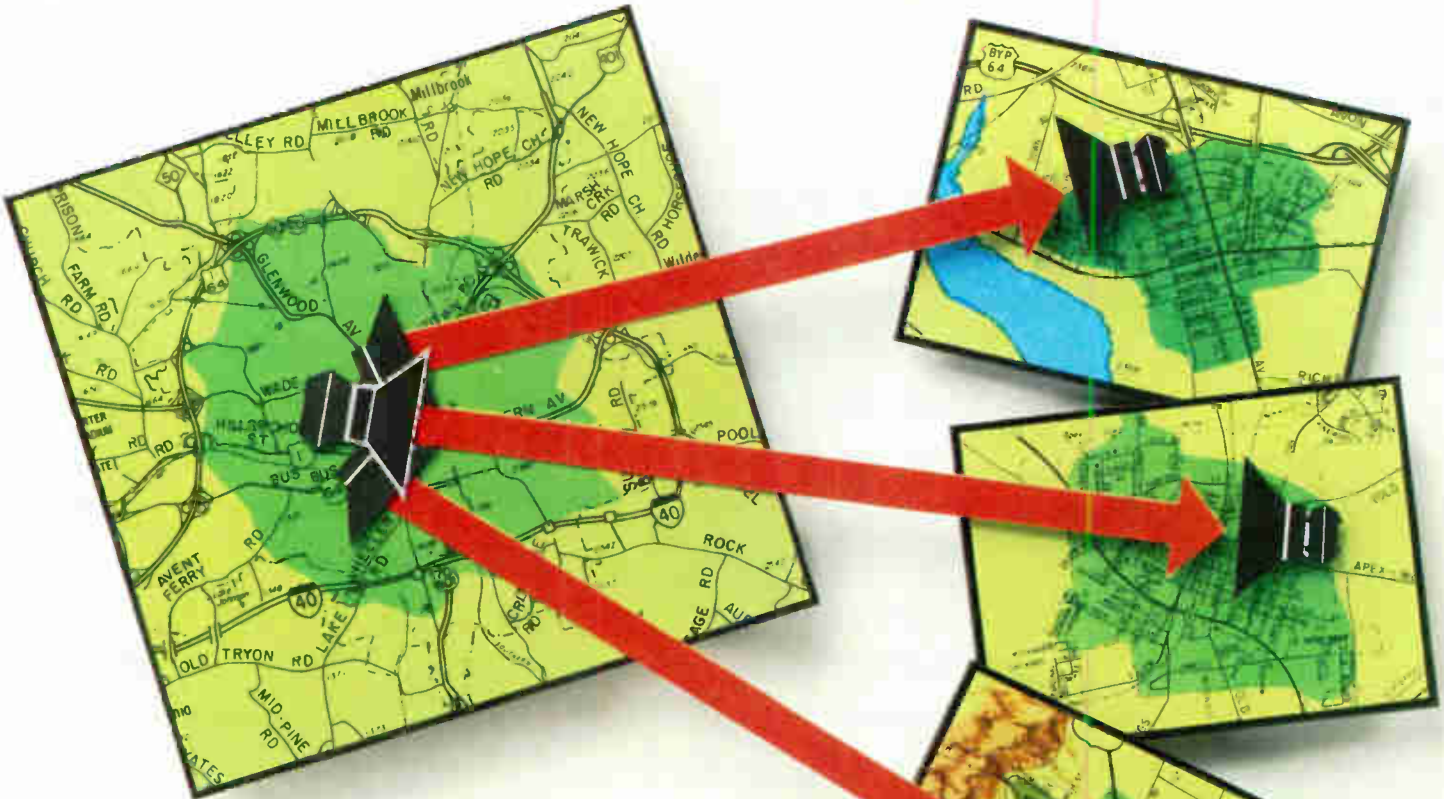
As a matter of fact, while baseband techniques and standards do set upper limits, it is the transmission and reception of the modulated carrier that determine the actual quality of the image displayed on the home viewing screen. If NTSC television pictures could be viewed on the average home TV set with the quality seen over the years on monitors throughout the NAB convention exhibit hall, there would be little public interest in HDTV (high-definition television). Most people must watch television through a virtual scrim decorated with gaussian noise, multipath ghosts, edge overshoots, chroma delay and other defects introduced by modulation and demodulation of the RF carrier transmitted over-the-air or by wire or fiber.

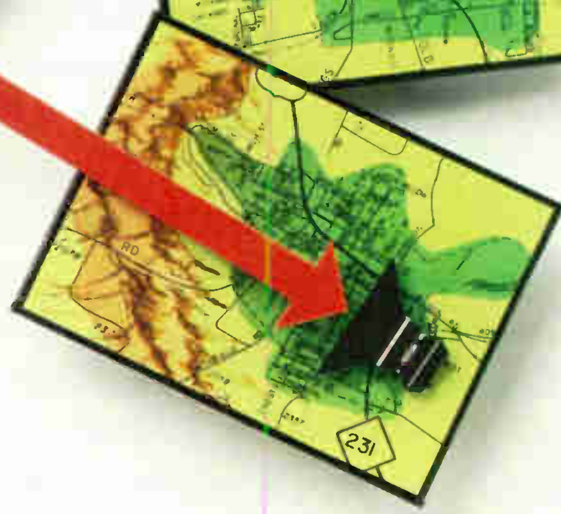
In 1938, the Radio Manufacturer's Association (RMA) Standards Committee agreed to adopt as standard the vestigial sideband/amplitude modulation (VSB/AM) technique developed 10 years earlier at Bell Telephone Labs by Dr. H. Nyquist.[1,2] This technique (shown in Figure 1), which made it possible to expand the video bandwidth from 2.5 MHz up to 4 MHz within the designated 6 MHz channel, also was recommended by the first National Television System Committee (NTSC) and adopted by the FCC in 1941.

During the television freeze that followed shortly after World War II, while there still appeared to be some flexibility in the allocation of spectrum for television, the late Earl Cullum advocated changing to frequency modulation. He emphasized the noise improvement and co-channel interference advantages of FM over AM. Considering the state of the technology in 1941 and the politics of spectrum management in 1950, it would be unfair to fault the second NTSC for going along with the retention of the 6 MHz VSB/AM standard for color TV. In hindsight, however, we would have been much better positioned to adopt new high-definition standards had Cullum (and others) prevailed. →

Under $95,000!

MICRO-BEAM® 5-Watt Transmitter, 3 Receivers, 60 Channel System...Installed.





For cost-effective multi-shot systems, MICRO-BEAM® allows you to economically consolidate system equipment to a single headend. 1, 2, 5 & 10-watt high performance patented CARS-Band microwave systems can be designed in a variety of hub configurations - no matter what your system needs may be now or in the future.

And for smaller, single path applications, a 1-watt MICRO-BEAM® transmitter and receiver can deliver 60 channels for under $35,000.

All MICRO-BEAM® Systems are:

- **Fully weatherized for tower mounting**
- **Rigorously tested and computer monitored for 1000 hours**
- **In-stock, giving you the fastest lead time in the industry**
- **Backed by a 24-hour, 7-days a week technical and warranty service.***

***Continental U.S. Only.**

The MICRO-BEAM® standard equipment and service package comes complete with everything you need to make your system operational (excluding antennas and towers), so you won't have to worry about "high cost" options.

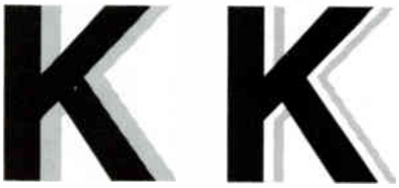
For more information on how you can make your cable system more profitable, contact:
Jim Crownover, MICRO-BEAM® Sales Manager.

See us at the Western Cable Show, Booth #241.

Channel Master Division of Avnet, Inc.
P.O. Box 1416, Industrial Park Drive, Smithfield, N.C., 27577 (919) 934-9711
Prices subject to change without notice.

Reader Service Number 49.

Figure 3: Reflection vs. edge effect



Reflection — VSB group delay error

The vestigial sideband syndrome

Webster defines "syndrome" as a group of symptoms that occur together and characterize a particular disease or abnormality.

Some of the symptoms of the vestigial sideband AM disease are:

- Black overshoot (edge effect)
- White streaking
- Chrominance-luminance crosstalk
- Reduced resolution
- Color desaturation
- Differential phase

These defects in the transmission system are quite capable of obscuring the effect of ATV baseband improvements.

There is no reason to doubt that vestigial sideband transmission and reception facilities can be made to perform well. SAW (surface acoustic wave) technology, digital filters, synchronous detection, phase equalizers and low-level modulation are certainly useful techniques to this end. But can a practicable vestigial sideband system be assembled, at manageable cost, that is sufficiently robust to perform well over transmission paths including such diverse segments as network facilities, satellite relay, VCR delayed playback, cable TV and—last but not least important—TV receivers designed and manufactured, or assembled, by many different entities, without effective enforceable performance standards?

Many broadcasting, cable TV and consumer electronics engineers seem to be unfamiliar with the vestigial sideband syndrome. Its most noticeable manifestation is an overshoot and "pop-up" in the waveform following a fairly sharp change in luminance. The result is seen as a slightly delayed replication of sharp edges. It is sometimes called a "trailing edge effect" or a "close ghost." It is not a reflection, as many engineers seem to believe. In 1970, a JCIC report[4] swept it under the rug as a "multipath effect." In fact, it is neither a reflection from nearby structures or terrain, nor from transmission line impedance discontinuities. Rather, it is the result of low-frequency group delay distortion caused by phase errors near cutoff of the vestigial sideband filters in both transmitter and receiver.[5,6,7]

Perhaps the phenomenon can be better understood by considering a square wave, with T-step rise time, modulated on a TV carrier. The Fourier series for such a signal consists principally of about 125 cosine terms for the odd multiples of the line scanning frequency, the amplitudes of which decline according to (sin x)/x. In amplitude modulation, each term of the Fourier series generates a pair of sidebands, ideally of equal amplitude and opposite phase. In the vestigial sideband receiver, however, the carrier and low-frequency sidebands should be attenuated according to the ideal curve shown in Figure 2. Theoretically, the lower one of each of the nine pairs of sidebands between 0.74 MHz (47th multiple) and 0.99 MHz (63rd multiple) above and below the visual carrier should be attenuated to zero, while the upper one is detected as single sideband with slightly suppressed carrier. Actually, in the real world, the lower sidebands do exist with finite amplitude and often with incorrect phase. Likewise, the upper sidebands may be somewhat attenuated, also with incorrect phase. Whether demodulated synchronously or by envelope detection, the vector sums of each of these nine pairs of sidebands are typically delayed from their proper timing in the Fourier series because of the phase errors. The delayed arrival of this group of frequencies, which helps to define the T-step transition, results in the edge effect characteristic of VSB/AM.

It is not difficult to tell the difference between a true echo or reflection and the edge effect of vestigial sideband group delay. In a true reflection, the entire image is replicated to the right of the main image, as shown at the left side of Figure 3. The vestigial sideband edge effect on the other hand reproduces only the edge, with a blank space between the main

edge and the delayed edge (shown at the right side of Figure 3).

It is not always easy to pinpoint the defective component. Receiver IF filters have probably been one of the main causes in the past.[8] Broadcast transmitters and cable TV modulators have no doubt contributed.[9,10] Sideband filters (filterplexers) required to operate at high power were especially suspect.

There is almost no way the broadband parts of the cable TV distribution network can contribute to this effect.[11,12] However, any single-channel equipment such as heterodyne processors, modulators, demodulators for microwave or fiber-optic transmission, AML (amplitude modulated link) transmitters and set-top converters—especially baseband units—may be contributing. VCR receivers are at least as likely as any TV receiver to introduce low-frequency group delay; and the VCR modulator may be even more suspect, especially when cascaded with a demodulator.

Cumulative effect

Several photos were taken from the screen of a relatively new 20-inch consumer TV set, under highly adverse conditions, to demonstrate the "edge effect" at its worst. The accompanying photos (on page 106) were taken during the same half-hour CBS news program, transmitted from the full power Ch. 9 TV station approximately 10 miles from the cable TV receiving site. After demodulation and remodulation, the signal was relayed by high power, single-channel AML microwave to a broadband downconverter for transmission by cable. The Ch. 9 signal was selected by a baseband converter, demodulated to baseband and remodulated to Ch. 3, which was received and demodulated again in a VCR for recording. The tape-recorded signal was then played back by modulating the Ch. 3 carrier to which the TV set was tuned and demodulated again in the TV set for display on the CRT.

The photos are unusually bad because of cascaded transmission through vestigial sideband filters. They represent an especially severe case of accumulated low-frequency group delay. However, it must be recognized that, while such extreme cases may not be common, neither is the simple case of a transmitter and receiver with no intervening facilities. Cable TV is now available to 80 percent of all TV households in the United States, and more than half are already connected. Moreover, there are nearly 50 million VCRs in use, most of which are equipped with receivers and Ch. 3 or 4 modulators, used primarily with cable TV connections.

The TV industry has never been able to agree to an apportionment of tolerances among the various independent elements.[13] Each segment of the distribution chain, from camera to CRT, independently seeks its own level of technical performance. Tempered by practical considerations of cost and available technology, some segments by themselves succeed only in barely reaching the threshold of tolerance, with no safety factor for accumulated degradation. Considering the diversity of independent entities involved in the TV chain, it is probably unrealistic to expect otherwise. Obviously, however, only one threshold performer can be accepted in the chain without adverse results.

The search for new TV standards offers the opportunity to adopt a more robust technology in which overall performance is largely unaffected by the performance or variability of the independent segments of the distribution chain. The other side of that coin, however, is that if the new, advanced TV transmission standard is not technologically robust, many of the fine features of the baseband standard may not reach the consumer.

At the recent NCTA show in Los Angeles, for example, NHK displayed its excellent 1,125/60 HDTV system in the compressed 8.1 MHz MUSE format, transmitted on the coaxial RF distribution network with VSB/AM in a 12 MHz channel. Word spread rapidly throughout the exhibition hall that the NHK picture fell short of expectations. The edge effect, characteristic of VSB/AM transmission, was clearly evident. The same problem also can be observed in retail TV dealer displays where most (but not all) of the new TV sets show the characteristic edge effect. It has been observed that random adjustment of rabbit-ear antennas causes the edge effect (carefully distinguished from multipath ghosts) to appear or disappear, as does adjustment of manual or automatic fine tuning.[5]

Multilink™

Multilink Inc.
Communication Division

KLEIN

KLEIN EST INC TOOLS

196 Morgan Avenue P.O. Box 955 Elyria, Ohio 44035
Office & Plant (216) 324-4941
FAX: (216) 324-4947

Multilink and our manufacturing representatives have teamed-up with Klein Tools

to offer you the best at super competitive prices!

We have in stock for your immediate delivery All of Klein Tools all-time best seller tools for cable TV

Next time you order Klein, call us for competitive prices and prompt service.

Klein Tool Catalogue and price sheet available.

100% VALUE SERVICE QUALITY

Reader Service Number 53.

CONTACT YOUR MULTILINK REPRESENTATIVE

A & M COMMUNICATIONS (612) 920-5215 MN, ND, SC, SD, NE(N), WI
dB COMMUNICATIONS (800) 526-2332 MA, NJ, VT, NH, RI, NY, CT, ME
W. WHITAKER & ASSOC. (317) 447-3345 IN, IL, OH, KY, MI
CABLE EQUIPMENT (215) 886-8652 PA, VA, DE, DC, MD
COM-TEK (415) 785-4790 OR, WA, ID
MICRO-SAT, INC. (800) 438-0812 GA, TN, AL, SC, NC, MS, FL
MEGA HERTZ SALES (314) 878-6881 KS, MO, WY, NE(S), IA
SELECTCOM SUPPLY, INC. (604) 946-0124 Canada
CABLE-TEL COMM., INC. (416) 475-1030 Canada
TURNER TECH. (408) 734-3231 HI
SPECTRUM MEGA HERTZ (800) 628-0088 TX, OK, AR, LA
PATTERSON COMM., INC. (805) 529-6693 CA, AZ, UT, CO, NM, WY, NV

BUSINESS REPLY CARD
(216) 324-4941
Fax: (216) 324-4947

1. ☐ Please send me a free sample of a Klein Tool Catalogue and price sheet.
2. ☐ I have an immediate need for Klein Tools, have a Multilink Representative call me.
3. ☐ Send me a Multilink Catalogue.

Name ____________________
Title ____________________
Company ____________________
Address ____________________
City ____________ State ____________ Zip ____________
Phone ____________ Ext ____________

Mail to: **Multilink Inc.**
196 Morgan Ave.
or
P.O. Box 955
Elyria, Ohio 44035

Multilink™
Engineered to make the Difference
Elyria, Ohio

CT 12/88

These photos were taken from the screen of a relatively new 20-inch consumer TV set to demonstrate the "edge effect" at its worst.

With respect to just one segment of the chain, the Network Transmission Committee (NTC) is sponsored by the four TV networks, jointly with the Bell System, to develop "an understanding...on technical performance objectives for video facilities leased by the major television networks from the Bell System." The NTC-7 Report[14] defines *short-time waveform distortion* "as the departure of the output pulse or step from its original shape." The performance objective is that the "peak-to-peak amplitude variations preceding or following the T-step transitions to the line-bar test signal shall not exceed 10 IRE units." Although the illustrative waveform shows damped ringing following the T-step, the objective is broad enough to include the low-frequency group delay distortion associated with VSB/AM. At 10 IRE units, the objective is only 20 dB below black level, which is probably well within the threshold of perceptibility.

If the Bell System can allow a −20 dB edge effect, imagine what would happen if that were combined with the additional effect of transmitter and receiver filters, cable TV and VCRs.

Compatibility

A direct, or downward, compatible ATV system must by definition depend on VSB/AM for reception by any of the 162 million TV sets in use. (The 1988 edition of *Television and Cable Factbook,* Stations Volume pg. B-202, shows a worldwide total of 648,480,765 monochrome and color TV sets, 214.5 million of which are in the United States. Subsequent investigation by David Lachenbruch, vice president and editorial director of the *Factbook,* too late for the 1988 edition, indicates that 162 million is probably more nearly correct for the total number of TV sets in use in the United States.) Otherwise, it could not be considered directly compatible. This means that the new generation ATV receivers also must be designed to receive VSB/AM transmission. Only in a dual system, simulcasting NTSC on one channel and ATV on another, would it be possible for ATV to use more robust modulation technology.

Europe seems already to have made the decision for a dual system. Direct broadcasts from satellites will conform with new noncompatible ATV standards, while terrestrial broadcasting will continue indefinitely according to the conventional PAL and SECAM standards. Moreover, the HD-MAC format planned for ATV is likely to be encrypted for highly secure conditional access, thereby facilitating direct payments from viewers.

If the decision in the United States is to try to correct the VSB/AM syndrome, considerable research will be required to determine how to do so. We do not know, for example, how much low-frequency group delay in the final CRT (cathode ray tube) display is subjectively perceptible, or tolerable. The edge effect may be subjectively different from the simulated baseband echoes tested rather exhaustively at the Bell Labs for NTSC 525-line systems by A.M. Lessman in 1972,[15] and 20 years earlier by N.H. Christopher, A.D. Fowler and Pierre Mertz.[16] With a better understanding of the necessary overall objective, we then need to learn what are the practical, realizable low-frequency group delay characteristics of TV receivers, VSB/AM transmitters and modulators, network facilities, cable TV equipment such as AML microwave, demodulators and fiber-optic transducers, and whether such facilities can be cascaded within the overall cumulative limits of tolerance.

When all of the facts are in, the likely conclusion could be that VSB/AM technology is too fragile for dependable high quality ATV performance. If the industry persists, because of compatibility, the public is likely to be disappointed whenever the edge effects are seen to collide with the promise of crisp, clean pictures on expensive ATV receivers.

Zenith "spectrum compatible system"

Early in September 1988, Zenith presented to Congress, the FCC and the public its "spectrum compatible HDTV system."[17] This is probably the first proposal to address in a comprehensive way the transmission side of HDTV. The Zenith system uses double-sideband quadrature AM with suppressed carrier, operating at peak power 17 dB lower than normal within standard 6 MHz channels. It is not directly compatible, but would not be subject to the VSB syndrome. Zenith asserts that the low transmitted power level would remove adjacent channel interference problems so that the extra spectrum needed for simulcast compatibility would be available, even in major markets.

Assuming that Zenith's projections are confirmed in appropriate field tests, the proposal is technically attractive. Of course, broadcasters would probably not be enthusiastic about the cost of constructing and operating a second transmitting facility. And most cable operators would have to make some hard, imaginative decisions in the face of the possible need for 12 MHz per program until such time as the population of HDTV receivers becomes sufficient to justify discontinuing NTSC transmissions.

Conclusion

Without simulcast compatibility, the vestigial sideband syndrome seems likely to remain endemic, probably spoiling the high expectations for ATV and HDTV. The Zenith proposal represents the first technically detailed example of an HDTV transmission method for providing simulcast compatibility. This is an important contribution to the development of advanced television standards in the United States.

References

1. H. Nyquist, "Certain Topics in Telegraph Transmission Theory," *Transactions of AIEE*, April 1928.
2. H. Nyquist, U.S. Patent No. 1,748,186 filed Feb. 11, 1928, issued Feb. 25, 1930.
3. Siegfried Dinsel, "Quadrature Distortion Correction for TV Vestigial Sideband Transmission," *Journal of SMPTE*, January 1966.
4. Wendell C. Morrison, "Final Report," Subcommittee on Transmission and Transmission Paths, Ad Hoc Committee for Color Television Study, Joint Committee for Intersociety Coordination (JCIC), July 30, 1970.
5. Richard C. Palmer, "System Delay Characteristics in NTSC Color Television," *Proceedings of IRE*, January 1954.
6. R.D. Kell and G.L. Fredendall, "Standardization of the Transient Response of Television Transmitters," *RCA Review*, March 1949.
7. G.L. Fredendall, "Delay Equalization in Color Television," *Proceedings of IRE*, January 1954.
8. Wilfred L. Hand, "Measurement of Receiver Phase Characteristics," *IEEE Transactions on Consumer Electronics*, November 1970.
9. T.M. Gluyas, "TV Transmitter Luminance Transient Response," *IEEE Transactions on Broadcasting*, March 1974. (NOTE: This paper was reprinted in the October and November 1985 issues of *CED* magazine.)
10. W.L. Behrend, "Performance Comparison of TV Transmitter RF Demodulators and the Home Receivers," *IEEE Transactions on Broadcasting*, March 1971.
11. Fred J. Shulz, "Envelope Delay, Phase Delay, Group Delay, Chroma Delay...What does it Mean? How is it Measured?" *NCTA*

(Continued on page 123)

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 407-747-5000 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 54.

Fiber optics in local area networks

This is the second of two parts on the application of fiber-optics technology for local area networks (LANs). The first installment, which appeared in the September issue, discussed the differences between fiber and other transmission media.

By Robert Southard
Manager, Systems Technology
Electro-Optics Division, AMP Inc.

As shown in Figure 1, rings are one of the more popular LAN topologies frequently used for fiber-optic (FO) networks. It is important to note that a ring consists of a number of point-to-point connections. The various stations are connected only to their adjacent neighbors on the ring and to no other station.

Since no taps are required, the ring topology is one of the more important arrangements for FO network implementation. The point-to-point connections take advantage of both the high speed and low attenuation properties of fiber, allowing high network performance as well as long distances, if needed. The point-to-point links used in ring networks allow for great flexibility in the choice of materials used in network wiring, including fiber size, cable type and connector style.

One example of an FO ring network is being standardized by the ANSI Accredited Standardization Committee X3T9.5. The proposed network, FDDI (fiber distributed data interface), operates at 100 megabits per second (Mbps), fully 10 times the speed of Ethernet. It can support as many as 500 stations and cover up to 200 km in total network length. No additional repeaters, amplifiers or other signal conditioning equipment are required. This very high level of performance is obtained with commonly available fibers and electro-optical components.

As shown in Figure 2, the FDDI network is based on a backbone of dual counterrotating fiber-optic rings. The dual ring consists of a primary and a secondary ring. The topology allows the network to continue operating in the event that one of the stations on the ring fails or even if one of the point-to-point FO segments were disabled. This counterrotating ring is connected to single-fiber "slave" rings through concentrators. Bypassing of inactive stations is accomplished with FO switches as permitted by the draft standard, although this is not required. The concentrator also can bypass stations on the slave ring electronically.

No existing LAN standards allow data throughput as high as the FDDI network. Only proprietary networks and host processor channels

"The evolution of fiber-optic technology makes it an important contender in the realm of LAN communications."

Figure 1: Ring topology

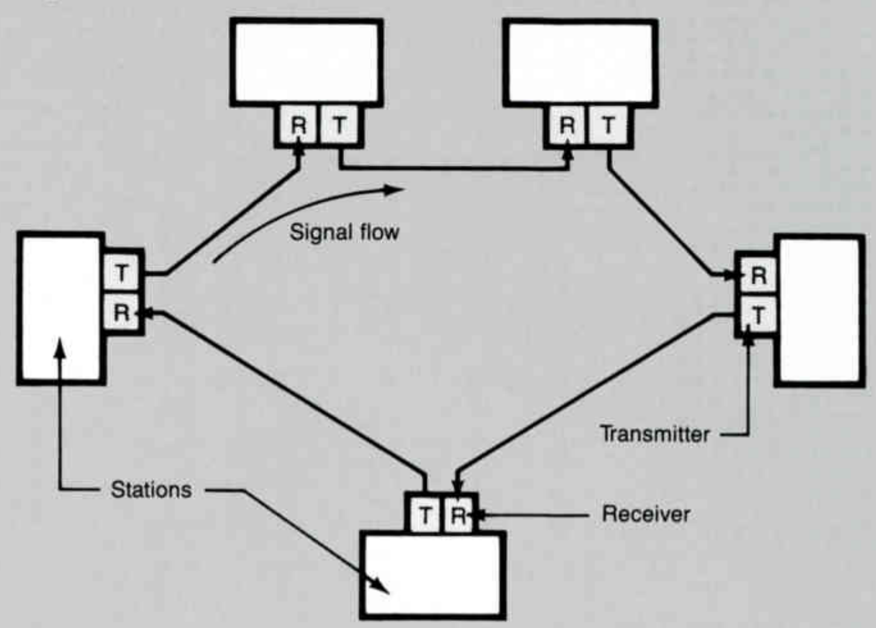
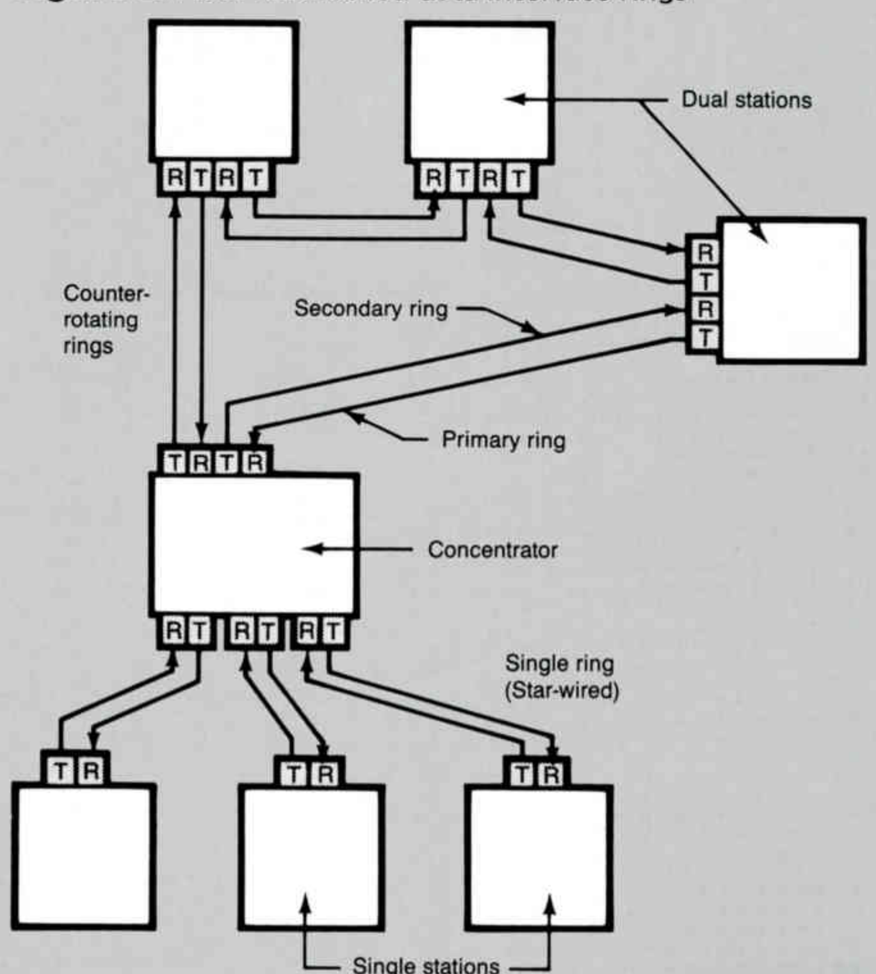


Figure 2: Fiber distributed data interface rings



Lockheed Has General Instrument At The Controls.

"General Instrument offers a reliable, cost effective solution."

Mac McComb of RFI Communications.

"We chose General Instrument because their X-2000 LAN amplifier provides a reliable, cost effective solution for dual cable Local Area Networks. The X-2000 LAN mainstation amplifies and monitors both cables in a single housing. That was important to us."

"It's extremely easy to implement and operate."

"In addition," McComb said, "the General Instrument Advanced Status Monitor is a very effective diagnostic system. And it's easy to operate."

End User:	Lockheed Missiles & Space Company, Inc.
Contractor:	RFI Communications, Inc., San Jose, California.
Equipment:	Dual cable 450MHz broadband Local Area Network (LAN) supporting data and video to 19 buildings.
Vendor:	General Instrument, Jerrold Division, LAN Systems.

General Instrument is the industry leader.

You'll find General Instrument electronic communications systems at work for a wide variety of users . . . from America's largest auto makers to legislative centers in Washington and abroad . . . from leading hospitals to high-security government installations . . . from space flight monitoring facilities to major universities.

Find out why so many companies are turning to General Instrument. Write for our broadband LAN brochure today.

GENERAL INSTRUMENT

Jerrold Division
LAN Systems
2200 Byberry Road
Hatboro, PA 19040
(215) 674-4800

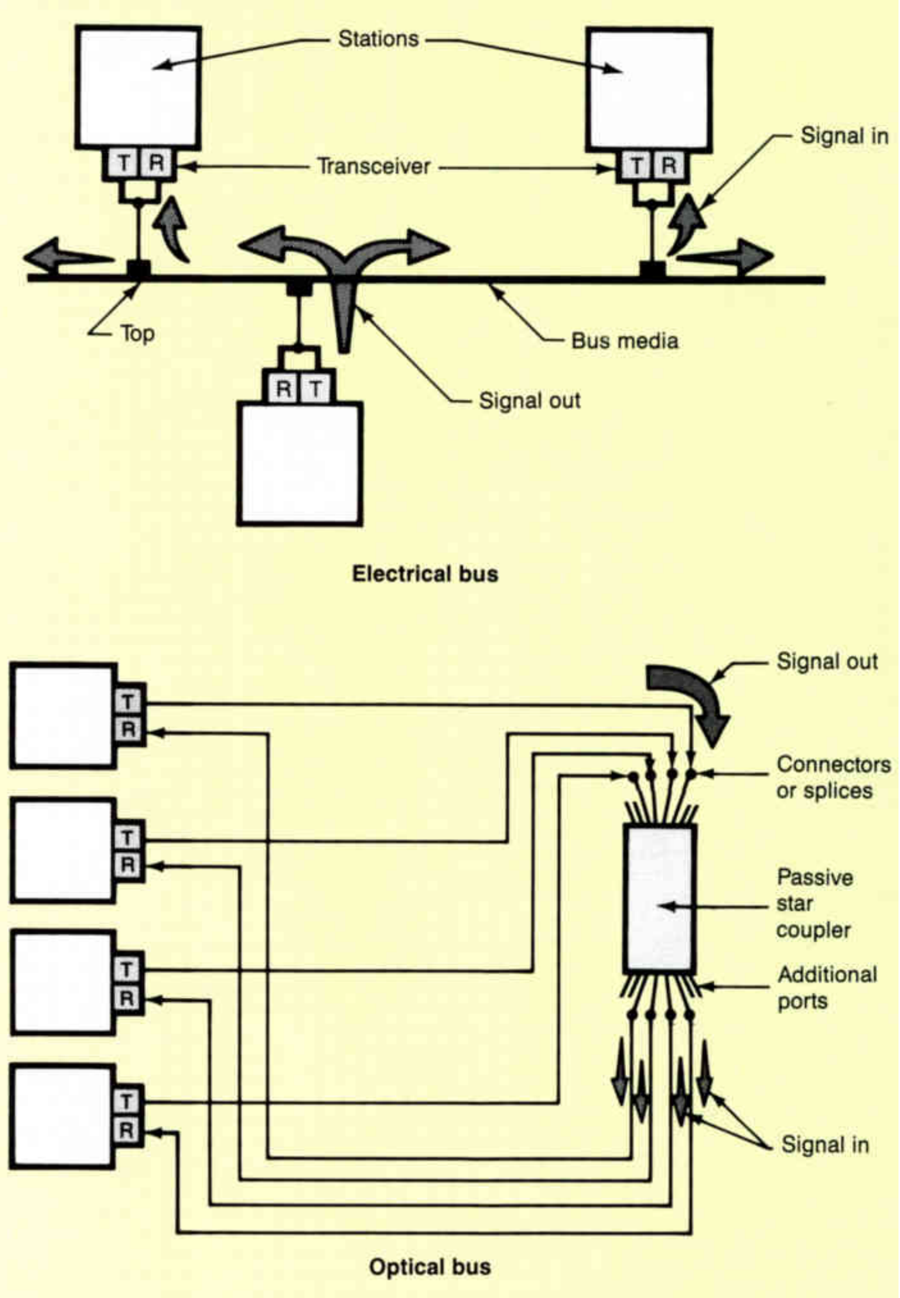
See us at the Western Show, Booth 300.
Reader Service Number 55.

approach this level of performance. The FDDI network will find numerous applications for communication between computer mainframes, peripheral controllers, data storage devices, communication access ports and even high performance workstations. The robustness of the FDDI network design has even led to a proposed version called FDDI-II, which is being designed to allow PBXs to be connected to the network to support combined voice and data traffic.

Ring topologies are also very popular for networks of proprietary design. Several companies offer network products that rely on FO rings. These networks are typically very high in performance, with speeds of up to 200 Mbps and distances between network nodes of up to 3 km (1.8 miles).

Some networks employ a series of hierarchically connected rings, with lower speed rings providing local communications between workstations, and higher speed rings serving to move data between the lower speed rings as needed. The networks allow for economical station attachment, since only low-speed electronics are required at each workstation, while the network itself supports very high throughput.

Figure 3: Bus topology



Buses topology

Many electrical networks are based on a bus topology. Fiber-optic implementations are, therefore, very important. As shown in Figure 3, a bus provides what is fundamentally a broadcast medium. When any station on the bus generates a signal, all other stations on the bus receive that signal. Whether or not they perform some action based upon that signal is a function of the access method and protocols that are used on the network.

The waveguide nature of optical fiber requires bus topologies to be approached differently than in copper wire-based networks. The simplest and most economical approach is to allow one station to send a message to all others through the use of an optical coupler. A coupler is a passive optical device, designed so that the signals that arrive on any one of the input ports of the coupler are distributed to all of the output ports on that coupler. The energy of the incoming optical signal is divided relatively evenly among all output connections. The energy distribution property of an optical coupler is the optical analog of what the copper cables and taps do on an electrical bus.

Since the number of ports on an optical coupler is fixed, the coupler size and the maximum number of stations that it will allow to communicate are determined at the time of installation. To increase the available number of stations, a coupler with a large number of ports must be substituted for one previously installed. Alternatively, a second additional coupler could be added in series onto one of the output ports of the first coupler. Due to the rationing of optical energy among the stations, power budgets must be carefully calculated in either case. Amplifiers or repeaters may be required whenever the number of stations is large (32, 64 or more) or multiple cascaded couplers are used.

One important application for FO buses is the implementation of optical Ethernet networks. FO versions of this very popular network are being addressed by the IEEE 802.8 Standardization Committee through a special subgroup in coordination with the IEEE 802.3 working group. Several vendors already offer FO Ethernet-compatible products based on passive coupler technology. A special optical transceiver is used at the workstation for conversion to optical signals, but standard Ethernet interface boards and network software are used in these networks. In some cases, additional electronic circuitry is added to the passive coupler to enhance the collision detection capability of the network.

Another important application for fiber is the implementation of token passing buses, which are being standardized by the IEEE 802.4 committee. This committee also has a special subgroup that is drafting a standard to allow the use of passive couplers in implementing the required bus topology. Furthermore, this standard will permit electronic apparatus to provide bus-type signal distribution, in place of or in combination with passive couplers. Optical token passing bus networks are of particular interest to the MAP (manufacturing automation protocol) users' group, since factory applications of fiber optics are a high priority. Passive couplers are of great interest in factory applications due to their high reliability as a purely passive component.

Star topology

Star topologies are shown in Figure 4. It is inter-

What Is The Best Selling CLI Software?

Right.
The LES - Leakage Evaluation System.

There are hundreds of systems coast to coast using LES. In fact, nearly 50% of the Top 50 MSO's have operators with LES. Times Mirror has standardized on LES. And what program does Cablevision Systems - Woodbury, the nation's largest system use? Right again, LES!

Five Good Reasons Why:

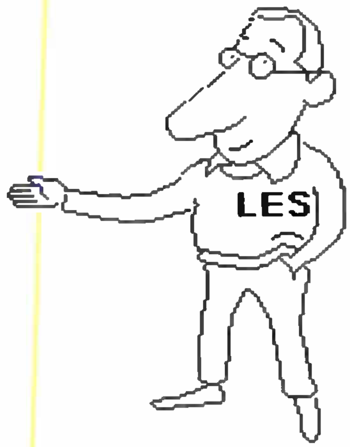
1. **Quality** - LES is reliable. The one and only user reported "bug" was almost a year ago.

2. **Ease Of Use** - Even our skeptics without a computer background have told us LES is easy to learn and use.

3. **Support** - With your LES purchase you get one year's unlimited free technical support and upgrades to protect your investment.

4. **Features** - Long Systems was the first to introduce a full featured CLI program in 1987. As the technology leader, LES contains many features not available anywhere else.

5. **Price** - Surprise! LES is also the price leader, and our multi site licensing has heads turning.



Now, what is the other guy using for CLI software? Right, once more! The emerging industry standard, The LES - Leakage Evaluation System. Call us today for a free demo disk and information. Long Systems is moving up in the world. Please note our new address and phone.

Long Systems, Inc.

8388 Vickers Street
Suite 201
San Diego, CA 92111
(619) 278-2700

Reader Service Number 56.

esting to note that the FO passive star is identical to the FO bus. In both cases a passive coupler is used for signal distribution.

The FO active star relies upon electronics to provide signal distribution. The electronic star wiring center may be nothing more than a repeater or it may provide more complex functions, encompassing higher level protocols, such as message routing, error checking and network reconfiguration. In any event, the FO links that connect to the electronic box are the familiar point-to-point links previously seen in the ring topology. The same advantages of simplicity and flexibility of optical link design observed in the ring topology also apply in the case of active stars.

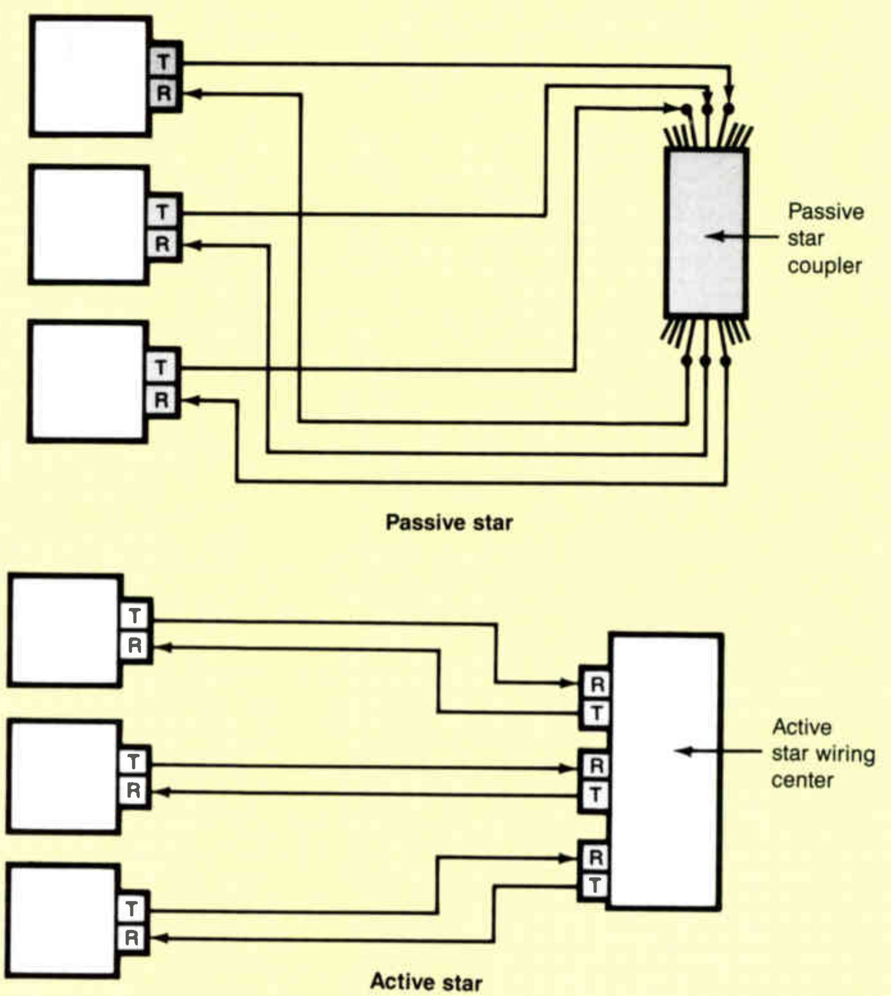
The active star wiring center can provide logical implementations of network topologies over and above the star configuration. For example, a bus topology is easily implemented. In this case, the star wiring center performs the same function that the passive coupler does in the bus topology. Even a ring topology can be easily implemented by an active star center. In this case, the electronic box is configured so that one station is connected to the next, and so on, to complete the ring.

The versatility of the active star arrangement is an important concept in premises wiring. Simple star wiring and point-to-point connections can be installed throughout a building in the same manner that many buildings are wired today. Electronics located in the wiring closets or communication rooms can then determine the network configuration, transparently to the users.

As always, there are tradeoffs. One potential problem in the use of active star centers is the single point of failure that the electronic apparatus presents. Any failure in this device will cause the stations connected to it to be cut off from each other and the rest of the network. This problem can be minimized through the use of high reliability design techniques and uninterruptible power supplies, much as PBX systems are built today. However, this clearly represents a weakness in this network configuration. The added cost of the active star also may be a consideration.

One noteworthy commercial implementation of an FO active star is for Ethernet applications. SynOptics, a spin-off from Xerox, uses this approach for Ethernet installations. For compatibility, FO transceivers are placed at each network connection point, with the fibers running from there to the active star. Fibers are used to connect stars together and the whole system functions as a standard Ethernet.

Figure 4: Star topology



Repeaters

One other important application of fiber optics in LANs should be mentioned. Repeaters are used to connect one section of a LAN with another, particularly when the two sections are further apart than what the network would normally allow. The two sections operate together to function as a single network. Repeaters are often used when connecting between floors in a building or from one building to another.

Since repeaters are called upon to operate over long distances, which often involve outdoor cable installation, fiber-optic media is the clear choice. Immunity to outside interference and lightning strikes are important advantages. In addition, network security is enhanced, signal degradation is minimized and network performance is maintained.

A good example of an FO repeater is the DEREP-RA, manufactured by Digital Equipment Corp. This product attaches directly to an Ethernet through a standard transceiver on one side, and a standard fiber cable on the other. Connecting another repeater at the far end of the fiber provides communication with a remote Ethernet segment.

The token passing ring that is being standardized by the IEEE 802.5 committee is another network that takes advantage of FO repeaters. An example of such a repeater is IBM's 8219. This repeater joins two local rings and allows them to be separated by as much as 2 km (6,500 feet). No network performance penalties result from installing repeaters other than signal propagation delay time related to the increased length of the network.

Other products such as bridges and gateways can make good use of fiber optics. Bridges are used to connect together two similar networks much like a repeater connects together two sections of a single network. All of the same advantages of fiber apply in this case. Gateways connect together networks of a dissimilar nature and can be fiber-compatible as well.

A clear mark in the world

Fiber-optics technology has made a clear mark in the world of telecommunications. Every long-haul carrier has made sizable investments in the technology. The economics of fiber optics make installation of other types of systems much less attractive in terms of capability and cost. The evolution of fiber-optic technology makes it an important contender in the realm of LAN communications as well.

FO connectors, cables, tools and data links are all available today at reasonable cost. In addition, many products have been designed with networking applications in mind. Today, optical fibers are used routinely for communications at the workstation level. Proprietary LANs designed to use optical fiber have been available for a number of years. Movement in the industry standards committees is strengthening fiber's place in our communication systems, which assures the future of LAN technology will provide ample, exciting opportunities. ■

Like you, this Bay Area CATV operator looked at coax, fiber and microwave. He chose Hughes AML as the best way to cover his six service areas...and at considerable less cost in time and money.

That's great! Performance *plus* design flexibility. Hard wired technologies, like fiber or coax, aren't capable of meeting many of my design, schedule, and revenue objectives.

With Hughes AML you can...

Achieve clustering and regional networking easily and at low cost. So you can share local advertising and special events with your systems and with other cable operators nearby.

Jump immediately to high-density subscriber areas to gain quick revenues. And you avoid pole and duct rentals, line construction expenses and "dry trunk."

Break up long cascades quickly and inexpensively to cope with expanding and maturing service areas.

Deliver 58 dB carrier/noise performance. That's because our new high power solid state transmitter and new receiver hubs have been designed specifically to provide high quality signals at distances up to 20 miles.

Have a triple-duty system that can serve you now, later and in between. Whether you use it for the primary, secondary or interim transportation of your multichannel video signals, a Hughes AML microwave system will be there to serve you.

For more information, contact Hughes Aircraft Company, Microwave Communications Products toll free: (800) 227-7359, ext. 6233. In California: (213) 517-6233. In Canada: COMLINK Systems Inc. Pickering, Ontario, (416) 831-8282.

Hughes AML is more than hardware.

HUGHES

Reader Service Number 57.
See us at the Western Show, Booth 402.

Engineering with the PC

By James H. Kuhns
President, Broadband Associates

Personal computers. They're everywhere and seem to be capable of doing almost anything. But how do they relate to CATV engineering? What software and peripherals do you need to really do the job?

Apple, IBM, Radio Shack, Commodore and a host of others all manufacture personal computers. For the most part these machines are not compatible with one another; programs designed for one manufacturer's computer usually will not run on anything else. For the sake of simplicity, we will deal specifically with the IBM PC and computers compatible to the IBM PC standard.

Computer equipment can be broken down into two general categories: hardware and software. Hardware consists of the actual machines and peripheral devices such as printers, monitors, modems, hard disks, etc. Software is the programming instructions that tell the hardware what to do. Software can be broken down into subcategories, such as spreadsheets, word processors, communications, data bases and so on.

There are three general classes of IBM compatibles on the market today. These are the PC (which includes the XT), the AT and the 386. In conversation all of these classes are generally lumped together and referred to as PCs. But before we get involved in the different classes of machines it is important to have a general understanding of digital clock speeds and bus width.

Traffic on the freeway

Think of the processor bus as a freeway. The bus width would be the number of lanes on that freeway. The more lanes available, the greater the amount of traffic that can be moved from Point A to Point B in a given amount of time. Clock speed can be likened to the speed limit on the freeway. The higher the speed limit the faster you will reach your destination. Study this analogy carefully, for it is the basis of understanding how a PC processes data and why some machines seem to do the job quicker than others.

The *PC* uses an 8088 or similar processor. It has a clock speed of 4.77 MHz and is an eight-bit (this means the bus width is eight lanes wide) processor. A variation of the PC is the turbo PC. It uses an eight-bit processor like the regular PC but runs at a faster clock speed. This increased clock speed results in a slight increase in processing speed. While the speed has been increased the bus can still only move eight bits of data at a time. The XT and turbo XT are identical to the PC and PC turbo internally. The PCs come equipped with one or two floppy disk drives, while XT machines come with one floppy and one hard disk drive. This means any PC can be upgraded to an XT simply by adding a hard disk and controller.

The *AT* uses the 80286 processor, which has a 16-bit bus. Clock speeds vary from 6 MHz for the original IBM AT to 16 MHz for some of the compatibles. The obvious advantage over the XT and turbo XT is that now, in addition to increased speed, you have doubled your bus width. This means that an AT running at 10 MHz will process data much faster than a turbo XT running at the same speed.

The *386*: The 80386 processor is the latest in the evolution of the PC. It has a 32-bit processor and clock speeds go as high as 25 MHz. (By the time you read this they may be even higher.) These machines approach the capabilities of minicomputers and are waiting for software and peripheral speed to catch up to them. This is the state-of-the-art processor in computing at this time and its full potential in most cases has yet to be realized.

The *P/S 2*: IBM recently introduced a new line of personal computers called the Personal System 2. These computers are compatible with IBM's original PC standard and use the processors previously described.

The cost of personal computers

After reading about the awesome capabilities of the 386 you might wonder why anyone would bother with anything else. Right? Well, maybe not. Like cars, speed and performance in computers have their price. And the price can be sobering indeed. But all is not lost. A turbo PC compatible can be had from the mail-order houses for under $400. XT systems that include monitor, display adapter and hard disk can be purchased for well under $1,000. Some XT system packages even include a printer for under $1,000. ATs start at under $1,000 and complete systems for under $2,000. In most cases $2,000 will give you a medium sized, relatively fast hard disk and an enhanced graphics adapter (EGA) and EGA monitor. Some 386 machines can be found for under $2,500 but that price is misleading. To do the 386 justice you need a lightning-fast hard disk. You need a suitable display adapter and monitor. That $2,500 can quickly become $5,000 and 386 systems between $10,000 and $15,000 are not uncommon.

Keep in mind the 386 is new technology and prices should continue to drop as they did with the 8088 and the 80286 machines. Cost must be considered vs. the type of information and the amount of information to be processed. Too little computer can wind up being very frustrating and not very cost-effective. Too much computer can be a very expensive mistake sitting on your desk. A note of caution: Quality is a factor! Check with friends and find out where they purchased their machines. Most of the mail-order houses are reliable but quality of workmanship does vary greatly in some cases. A little asking around *before* you buy can save you a lot of headaches *after* you buy.

We have discussed in very general terms the various classes of IBM compatible machines. Further information may be obtained by reading *Inside the IBM PC* by Peter Norton and published by Brady Books, Prentice Hall Press. It is most informative for those who are considering buying a PC or for those who already have a PC and would like to understand better the history, operation and inner workings of their equipment. ■

Jim Kuhns designed and compiled "CATV Wizard," available from the Society of Cable Television Engineers.

Living with lightwaves

"Lightwave transmission is more a revolutionary than an evolutionary development, and everybody starts at the same point."

By Bill Grant
President, GWG Associates

The history of the development of mankind to the social level we know today is punctuated with a series of breakthroughs of basic knowledge. Although the learning process has been continuous, milestones of major advancement can be clearly identified. Consider the impact of mastering fire, for example, or the development of the wheel. More recently we have electricity, flight, atomic energy and space travel itself. And each major breakthrough adds to the sum total of our basic knowledge and thus leads inevitably to further advances.

Now we have transmission through light. Although the popular term is "fiber optics," I submit this is a misnomer. The glass fibers employed are the transmission medium, just as copper wires are the medium for electrical transmission. But the technology itself is more correctly identified as lightwave transmission, not fiber optics. We don't, for example, refer to waveguide transmission in microwave systems—we use the term "microwave" itself. And lightwaves do propagate through free space as in blinker light semaphore between ships, for example, without the use of any connecting transmission medium such as glass fibers. Surely the term "lightwave transmission" is more appropriate.

If we consider the evolution of telecommunications and transmission, we can identify plateaus of major developments just as we did in the general history of mankind. Restricting ourselves to electricity, we had the telegraph, then the telephone, then radio, television and eventually satellites. For transmission medium development there was individual open wires on cross-arms, then multiple-pair cables and coax.

As these developments emerged, we were able to understand them rather easily, since they were all based upon the principles of electron flow and wave propagation. Earlier developments had exposed us to a solid base of understanding of these principles. But along comes light.

The phenomenon of light is certainly no stranger, and its history as a method of telecommunication goes way back. Signal fires and beacons, for example, were understood and utilized centuries ago, but perhaps we have never been obliged to diligently apply ourselves to the study and understanding of light quite as much now.

Many questions

Why is the sky blue? Why is a particular dress red? Why is a page in a book white? When the snow melts, where does the white go? Why is the grass green? These levels of questions are all familiar, usually as posers for school children, often accompanied by somewhat simplistic answers or explanations. And, as far as it goes, this was perhaps adequate. How did *you* do with these?

But if we are to effectively apply lightwaves as a transmission technology, we really need to develop a deeper level of understanding of light itself, don't we? Is it power or is it illumination? How does light propagate in space, in other media? Does it travel in a wavefront? What is color? How do we measure the intensity of light as illumination? How do we measure the level of energy of light as power? What units of measure apply in these cases? Are you completely comfortable with your answers to these questions?

One interesting aspect of the evolution of lightwaves as a modern transmission technology is the fact that most of us do not have a solid base of previous experience to call on, as we did somewhat with electricity. Even those of us with 20 or 30 years of transmission or telecommunications experience find ourselves at the same point on the learning curve as the younger folks when we are obliged to address lightwave transmission for the first time. In a very real sense, everyone is starting from scratch.

Now it certainly is possible to function in this new field without an in-depth understanding of the technology. It is sad but true that many people functioning in the CATV business today have only a superficial grasp of the basics of RF transmission on coaxial cable. Many people are simply functioning by rote rather than by reasoning. They may be able to adequately design a trunk-feeder type CATV system. But they may not have the slightest idea why that type of configuration is being utilized or even understand that other configurations are not only possible and technically sound but may even be economically superior for some applications.

At some levels of responsibility this degree of understanding or knowledge may suffice, and working CATV careers have been pursued and successfully concluded with even less knowledge than this. You will agree, however, that anyone aspiring to a degree of professionalism should be better informed. Eventually a lack of in-depth knowledge will become a career limitation.

You can quickly get into lightwave technology by simply familarizing yourself with the terminology and by blindly accepting all technical designs or presentations as offered, just as it is possible to survive in the CATV field this way. But the ongoing potentialities of this new technology —lightwave transmission—are so exciting and so wide in scope that it would seem very shortsighted to do so.

Lightwave transmission is more a revolutionary than an evolutionary development, and everybody starts at the same point. Isn't this an opportunity to catch up or perhaps to overcome some basic handicap of limited formal technical training? This is a similar career opportunity that the CATV industry has always extended to so many people, except that it may well offer a much greater potential now.

Just what level or depth of understanding is required? Is it essential or even practically useful to be able to design a laser or a lightwave detector or receiver? If you are primarily concerned with the design, construction or operation of transmission links or systems, of course not. What you really need is applications knowledge that I define as a basic grasp of the technology itself sufficient to evaluate and select the component elements of a link or system, such as the transmitter and receiver and the particular optical fiber that is best suited for the application, as well as enough knowledge to be able to assemble these components as a functioning system or link.

To become adequately knowledgeable in this area, it is essential that you are thoroughly familiar and comfortable with the principles of physics that are involved in the propagation of light and in the factors of attenuation and distortion that optical fibers introduce, as well as the optional techniques of modulation, detection and signal multiplexing. Note the use of the terms thoroughly familiar and comfortable. It's not really enough just to recognize the terms that may be employed; you need to understand their meaning and impact as well. You must be able to understand and generate system performance specifications. And let's not forget the economics of systems either, which is a primary obligation of sound applications engineering.

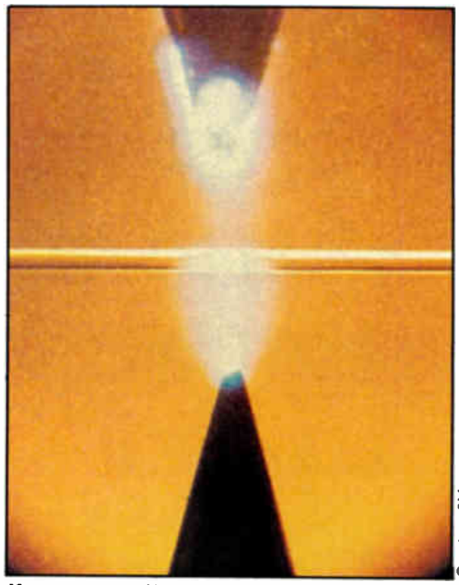
Available instruction

And what does the scientific or engineering community offer today to help acquire the necessary knowledge, particularly in the form of self-study material for those whose technical background has been largely on-the-job experience?

There's one level of instructional materials that assumes a substantial student understanding of light itself and simply leaps ahead into the all-too-familiar line drawings of light rays bouncing down an optical fiber but never establishes the foundations of understanding of refraction, wavelength, velocity of propagation, etc. Students are left to themselves to recognize and make up these deficiencies or (more probably) are simply thrust into ever higher levels of technical sophistication without regard for the superficial base of comprehension on which they are obliged to build.

The second level of instructional material available might more correctly be called a "semi-private correspondence" between scientists of unquestionable credentials who address the most advanced theories of developments in increasingly complex mathematical terms. Not much help to the people in the bucket trucks on a pole line or to the regional engineer trying to operate and develop a dozen medium-sized CATV properties.

So, how can *you* get started on this new challenge? How can you build a sound base of understanding, so that articles and papers you



Courtesy 3M

If we are to effectively apply lightwaves as a transmission technology, we really need to develop a deeper level of understanding of light itself.

see in the technical journals do make sense and are useful to you? It may sound too simple, but one excellent point of departure is to dig out some old high school or freshman college physics books. And don't overlook the *Encyclopedia Britannica* or one of the *Books of Knowledge* series, however old they may be. These are basic principles and the laws of physics haven't been repealed. And how about your local library? The librarians are trained in research techniques and materials.

Although lightwave transmission as it is generally presented today is cloaked in a certain mystique of its own, complete with a multiplicity of intimidating terms such as "nanometers," "material dispersion," "numerical aperture," etc., it is not difficult to understand if you approach the task logically and apply yourself diligently. The advent of lightwave systems does present a brand new opportunity for developing expertise; and such skills, once acquired, should be highly marketable and deeply rewarding.

Think back for a moment to your first day of employment in the CATV industry. I'll bet you were unfamiliar with many of the terms then and with the technology as well. It was a bit intimidating, wasn't it? But you handled that and it has been a satisfying career, hasn't it?

Here's a new opportunity, but learn from the last one. If you haven't done all your CATV homework, if you haven't mastered that technology as well as you might or should have, make sure that when you address lightwave transmission you don't cut any corners on basics at all. A house built on sand will always be a little shaky.

By the way, if your job has become a bit of a drag, if life seems a little dull or routine, perhaps you have forgotten how exciting, how much real fun and how satisfying it can be, to take on a new challenge and do it well. Get on the lightwave bandwagon. It hasn't left the station yet, and it could be your key to career advancement or just personal satisfaction. ■

Reader Service Number 61.

Designing the fiber backbone

By Monica Younger
Drafter/Field Engineer
American Television and Communications Corp.

From a construction standpoint, the first difference between fiber and coax is the amount of cable on a reel. A typical reel of coax consists of about 2,500 linear feet. Fiber cable can be ordered in several different lengths, but the smallest reel available is 7,000 feet. Since the cable should not be allowed to lay on the ground overnight (to prevent the possibility of vandalism), the crew will need to lash up the entire length of cable in one day. This means we will have to plan our route carefully to avoid obstacles and keep production at its peak.

Drive-off method

If there are no hindrances, we can use the drive-off method. In this approach, we pull the truck and trailer to the pole and lash up the cable as we drive under the span. Driving off does not work in areas where telephone wire exists below cable on the pole, where tall signs block access to the poles or in heavily travelled urban areas. All these factors must be checked beforehand—unlike a coax build, where problems can be solved as they become apparent.

In areas where drive-off won't work, the reel is placed at the midpoint of the area to be completed. It is pulled up onto the poles and lashed in one direction only. Then, the remaining cable on the reel is taken off and laid on the ground in a figure eight pattern. The other end is taken up onto the poles in the opposite direction.

Why go to such trouble just to lash cable? First, fiber cable can withstand only a maximum pull of about 600 pounds or a distance of about 3,000 feet. When this tension is reached, the cable starts pulling out of the sheath. Therefore, the crew must stop when the tension becomes too great and pull off the remainder of the cable.

Another reason for the tremendous amount of forethought is the cost of splices. Fiber splicing must be done in a controlled environment by a trained professional. The cost of a fiber splice is roughly $1,200 for one location and 10 fibers, while the cost of a coax splice is close to $10-$12.

Fiber splices are almost always made at midspan instead of at the pole. The crew must determine how much extra cable must be looped up and lashed in order to bring the spliced area down to the ground to work on it. Care must be taken in looping the cable up so that there is not less than a 10-inch radius in the loops for light to travel freely through the fiber.

Fiber backbone design

Now that we have successfully installed the fiber cable, let's become the people who design the electronic configuration of the trunk run and decide which poles that equipment needs to sit on. The design department is routinely designing extensions, rebuilds and upgrades of existing plant with the conventional coax feeder and trunk.

However, the system is changing from a typical tree-and-branch to a fiber backbone approach that employs long fiber runs out to several minihubs. These minihubs are called "nodes," from which the conventional design originates. From these nodes, coax goes out to trunk/bridgers, then feeder cable comes out of the bridger ports—business as usual.

The exciting part of the design is the amplifier output levels that can be achieved by using a fiber backbone. A typical conventional system uses certain output levels based on the fact that there are a relative large number of trunk amplifiers in cascade. Each amplifier boosts but also adds noise and distortion to the signal. The more

(Continued from page 106)

amplifiers the signal has to go through and the higher the operating levels of each amplifier, the worse the distortion problem gets. By the time a signal reaches the end of the long amplifier cascade, it is still good enough to give a quality picture but not capable of being amplified again.

Using the fiber backbone design, however, the usual number of amplifiers in cascade is only (ideally) four. Hence, the distortion problem is much less. Also, the fewer amplifiers a signal has to travel through, the higher each amplifier's output can be. Therefore, a system designed at 270 MHz can install a fiber backbone and upgrade easily to 330 or 400 MHz with a minimal amount of equipment changes.

Usually nodes are designed with backup fiber running from one node to another. For example, if Sector 3 goes down, either Sector 2 or 4 can supply enough signal to Sector 3 to keep the signal flowing until emergency crews can trace the problem.

In a typical coax system, the first amplifier out of the headend is the most crucial. If anything happens to it, the entire system goes down. Not so with the fiber backbone. At worst, if the first amplifier out of a node goes bad, only one-fourth to one-eighth of the subscribers are without service.

Another advantage to running separate fibers to each node is the flexibility in programming it allows. Node locations can be designed so that they feed a particular area that may have different programming needs. For example, the node feeding the rural area might carry programming that caters to farmers. A node feeding the business district could carry international business news, stock prices or other narrowly focused information. The only way to get this kind of specialization from a conventional coaxial system is to add more channels or run separate supertrunks to each area. Either alternative is costly and time-consuming.

With everyone working together to implement this new technology, the result will be better customer service, higher signal quality and better integration of the field personnel and the engineering staff. Fiber will change our job functions, no doubt, but the reduction of service calls and maintenance will be worth the effort it takes to learn something new.

Acknowledgments: The author would like to thank Dave Maholick of ATC's construction division and George Salvador of the design department for their valuable insight.

References

1) Donald J. Sterling Jr., *Technician's Guide to Fiber Optics*, Delmar Publishers Inc., 1987.
2) William O. Grant, *Understanding Lightwave Transmission: Applications of Fiber Optics*, Harcourt Brace Jovanovich, 1988.

Official Transcript, July 1971, NCTA convention.

[12] G. Rogness, "Contributing Sources and Magnitudes of Envelope Delay in Cable Transmission System Components," *NCTA Official Transcript*, Technical Volume, May 1972, NCTA convention.

[13] Howard T. Head and G. Norman Penwell, "Sources of Degradation in the Overall Television System," *Proceedings of National Electronics Conference*, December 1970, (Sponsored by ITT, IEEE, NWU and the University of Illinois.)

[14] *NTC Report No. 7*, June 1975, revised January 1976, Published by Public Broadcasting Service. (Obtainable from PBS Engineering Services, 1320 Braddock Pl., Alexandria, Va. 22315, (703) 739-5000.)

[15] A.M. Lessman, "The Subjective Effects of Echoes in 525-Line Monochrome and NTSC Color Television and the Resulting Echo Time Weighting," *Journal of SMPTE*, December 1972.

[16] Pierre Mertz, "Influence of Echoes on Television Transmission," *Journal of SMPTE*, May 1953.

[17] Zenith Electronics Corp., "Spectrum Compatible HDTV System," Sept. 1, 1988, filed with FCC Docket No. 87-268.

Figure 1: Effects of permeability and splitter windings

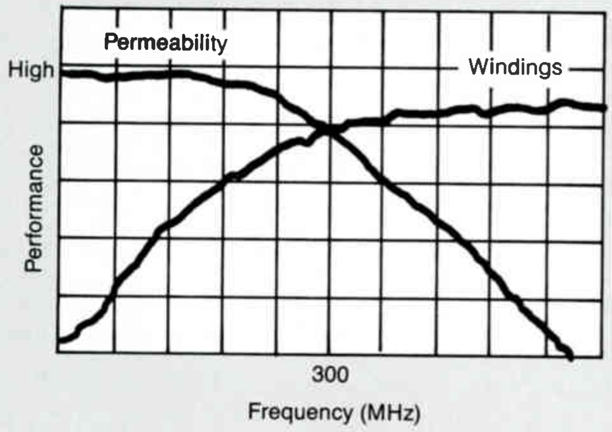
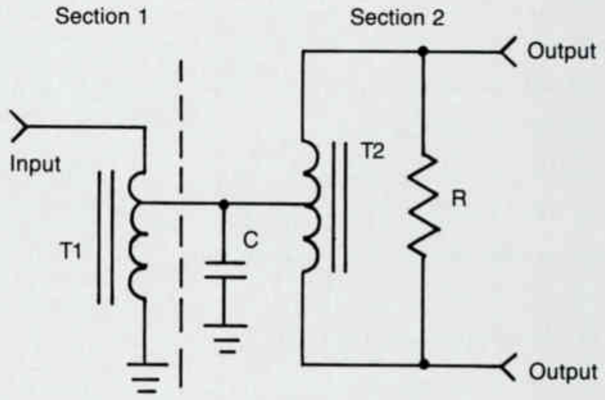


Figure 2: Splitter schematic with 75 ohms in, 75 ohms out



RF splitter design

This is the first of two articles on RF splitters. This installment covers splitter design; Part II will focus on test and measurement methods.

By Michael Holland
President, Pico Macom Inc

Before discussing splitter design, remember that the top six splitters used today have the same circuit design that has been used for 20 years. In order to fully understand the performance limits of today's splitter, its design must be understood in detail.

Originally, the criteria set for splitter electrical design were low insertion loss, high isolation and good matching (high return loss). To meet these criteria a hybrid design using transformers was developed. These transformers can split the signal with minimal insertion loss and provide isolation using oppositely wound windings to "buck" each other in the port-to-port direction.

The CATV splitter has a unique design trade-off not found in other applications of this circuit. The property of the core material, most responsible for signal transmission, is called *permeability*. Unfortunately, at 300 MHz, this permeability decreases to almost nothing.

Above 300 MHz the splitter windings act as an air core transformer and increase the coupling coefficient and thus efficiency as the frequency rises.

As Figure 1 indicates, the splitters' low-frequency performance is determined by the core permeability, whereas the high-frequency performance is determined by the shape and placement of windings in the equivalent air core transformer.

At this point, two conflicting situations occur in the splitters' design:

1) At higher frequencies, the more core windings you have, the better the performance (due to increased coupling).
2) At low frequencies the more windings, the worse the performance (due to more inter-

"The CATV splitter is really two devices—a high-frequency splitter and a low-frequency splitter built together."

Figure 3: Ideal auto transformer

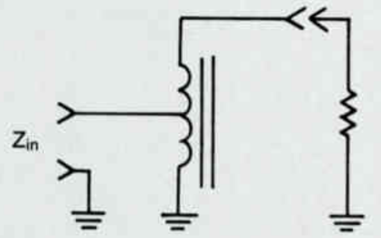


Figure 4: Transformer equivalent circuit

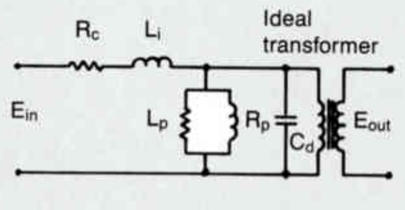
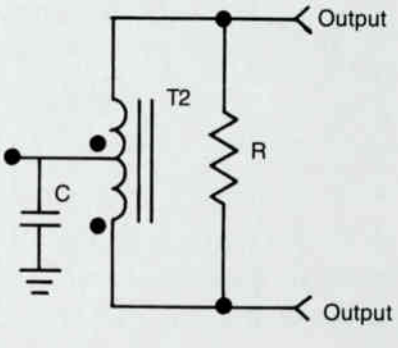


Figure 5: Power splitting or combining with high isolation



winding capacitative losses).

In other words, the perfectly designed splitter achieves a balance between minimizing the turns on the core at low frequencies and maximizing the number of turns and shape factor at high frequencies. Maximizing permeability is desireable but is limited by ferrite technology to a maximum of 400 MHz. If the core is enlarged to increase total inductance, longer wires are needed thus countering the coupling improvement with interwinding capacitance losses.

It is important to recognize that the CATV splitter is really two devices—a high-frequency splitter and low-frequency splitter built together.

Design considerations

The schematic in Figure 2 is a classic splitter design. The input side converts 75 ohms to 37.5 ohms and the output section converts 37.5 ohms to two 75 ohm outputs. Note that this circuit uses auto transformers rather than the traditionally isolated winding style transformers. (See Figure 3.)

Impedance transformation is represented in Equation 1 as:

$$Z_T = \left(\frac{N_S}{N_p}\right)^2 \qquad (1)$$

where:
N = turns of primary or secondary

The winding ratio is directly proportional to the square root of the impedance transformation.

Auto transformers are used in place of traditional dual winding types for a number of reasons. Primarily, they are preferred because of their lower cost and winding ease (they have one winding and a center tap). Auto transformers also feature reduced interwinding capacitance.

Why can't we adjust the windings in splitter Section 2 (see Figure 2) to convert 75 ohms directly to two 75 ohm half-power outputs? When designing a transformer for the maximum repeatable performance, certain parameters suffer as the turns ratio or extent of transformation is extended. Often, it is more efficient to use more transformer sections of lesser impedance change than one section with greater change.

Using the minimum winding ratio, we have better control of turns and parasitic degrading factors. Since it is expected that the splitter will work from 5 to 600 MHz with the highest coupling coefficients and matching, it is necessary to ensure every part of the circuitry is working at a maximum efficiency. In Figure 4:

L_p = Equivalent parallel inductance
R_p = Resistance of primary
C_d = Winding capacitance
L_i = Leakage inductance

Note that L_p and R_p establish the low-frequency rolloff with L_p predominating. C_d and L_i are responsible for high-frequency rolloff.

Section 2 of the transformer converts a one-half impedance (37.5 ohms) to two 75 ohm impedances with equal power. Figure 5 has been described as the classic circuit used for power splitting or combining with a high degree of isolation.

Figure 6 is a center tapped transformer and bridging resistor twice the impedance of each load. Generator E_x causes equal currents I_1 and I_2 to flow as shown. I_1 then creates voltage drop E_1 across the transformer left-hand winding, while I_1 creates voltage drop E_2 across the right-hand winding. By transformer action, however, E_1 induces E'_1 into the right-hand winding that cancels E_2, since E'_1 and E_2 are of equal magnitude but opposite polarity. In the same fashion, E_2 induces E'_2 into the left-hand winding, canceling E_1.

Thus, there is no net voltage drop across either transformer winding. If currents I_1 and I_2 are flowing through the windings with no net voltage drop, then the winding impedances each must effectively be zero. Thus, as far as generator E_x and its 37.5 ohm source resistance R_x are concerned, the effective load is simply 75 ohm resistors R_a and R_b in parallel, or a net load of 37.5 ohms. The system is therefore matched and the source power equally divides between the two 75 ohm load resistors with no loss over and beyond the 3 dB "split." The 150 ohm bridging resistor can be ignored in this instance, since the equal voltages at points A and B allow no current to flow through this resistor.

The most confusing aspect of the splitter

Figure 6: Center-tapped transformer and bridging resistor

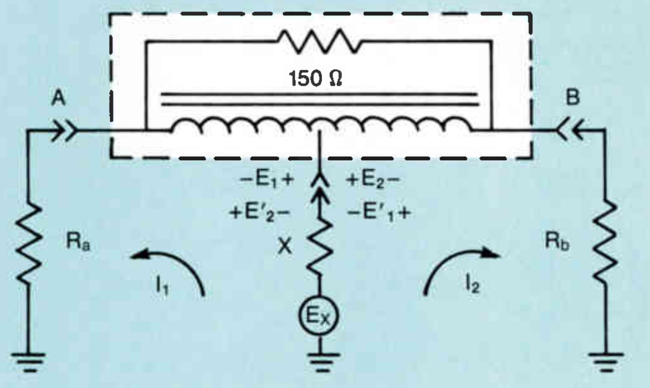
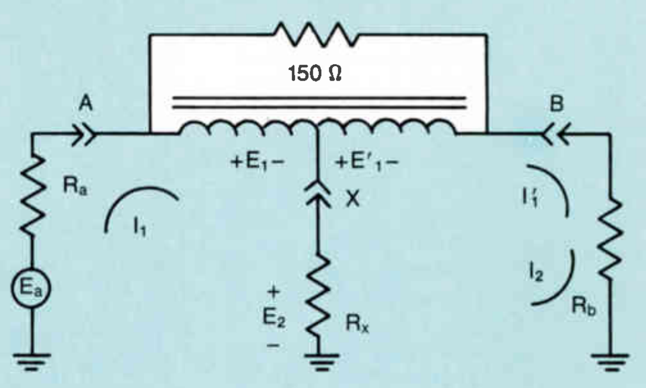


Figure 7: Generator in series with load resistor



design for many people is the means by which isolation exists between ports A and B. The nature of this isolation is easily explained. Referring to Figure 7 we have the same design as in Figure 6, but with the generator (E_A) placed in series with R_A (one of the two 75 ohm load resistors) rather than R_x.

E_A causes current I_1 to flow, resulting in voltage drop E_1 across the left-hand winding and voltage drop E_2 across the 37.5 ohm resistor. Since the effective impedance of the left-hand winding is also 37.5 ohms (the 150 ohm bridging resistor is stepped down to 37.5 ohms by 4:1 auto transformer action) E_1 must equal E_2. By transformer action, E_1 results in E'_1 appearing across the right-hand winding. Since E'_1 is equal to E_1, E'_1 must also equal E_2. However, since E'_1 and E_2 are opposite polarity, resulting currents I'_1 and I_2 in the right-hand loop cancel, and there is thus no net current flow through R_B. Since no power from generator E_A has reached R_B, we therefore have isolation between ports A and B.

Furthermore, since no current flows through R_B, the isolation exists for any value of R_B, and the amount of power transferred to 37.5 ohm resistor R remains unchanged. Perfect isolation can only exist if the 150 ohm bridging resistor is four times the value of R_X. For any other ratio, E_2 will no longer equal E_1 and E'_1 and right-hand loop currents I_2 and I'_1 will no longer cancel, thus resulting in some current flow through R_B.

The power delivered to R_X in Figure 7 is simply:

$$P = \frac{E_2^2}{37.5}\ \text{watts} \qquad (2)$$

The power delivered to the 150 ohm bridging resistor is:

$$P = \frac{(E_2 + E_2)^2}{150}\ \text{watts} \qquad (3)$$

Since $E_1 = E'_1 = E_2$, we can rewrite Equation 3 as:

$$P = \frac{(E_2 + E_2)^2}{150}\ \text{watts}$$

$$= \frac{4E_2^2}{150}\ \text{watts} \qquad (4)$$

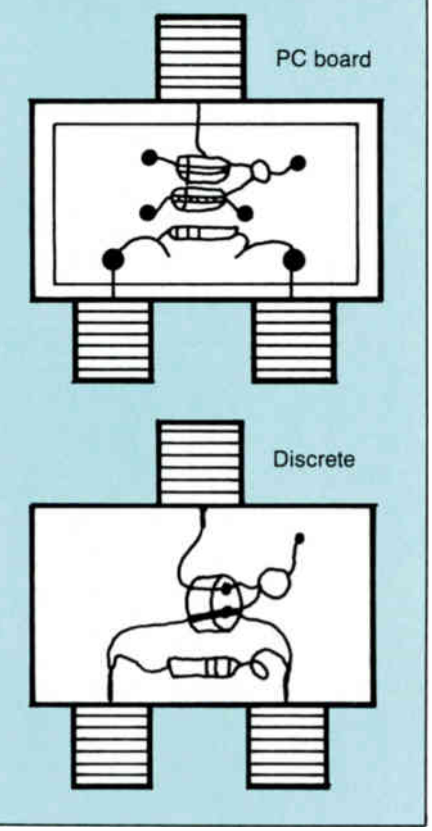
$$= \frac{E_2^2}{37.5}\ \text{watts} \qquad (5)$$

Since Equation 5 is identical to Equation 2, the power delivered to the 150 ohm bridging resistor must equal the power delivered into R_x. Thus, half the input power at port A is delivered to R_x and the remaining half dissipated in the bridging resistor.

It is important to remember that the circuit impedances are extremely complex with the previously mentioned equivalent capacitive and inductive parameters playing an important role in the splitter's final performance. At frequencies above 400 MHz the careful placement of leads and winding can be the deciding factor in attaining a high degree of balance, isolation and return loss.

Commonly used splitter cores consist of ferrite materials with initial permeabilities of 5,000. When the core size is increased, the overall inductance is increased resulting in improved performance of the transformer. However, a large core that is too large requires too much wire, which in turn lowers the low-frequency performance (due to increased interwinding capacitance).

Figure 8: PC board vs. discrete assembly



Assembly—PC board vs. discrete

Splitters are assembled both on PC boards and free floating between connector pins and the ground lug. (See Figure 8.)

It is a common misconception that the PCB assembly is more reliable than the discrete assembly because there is less component weight on the connections. In actuality, because each component is soldered on the PCB and the entire PCB is soldered to each connector pin, we have two to three times the number of solder connections and thus less reliability. Moreover, because the component weight to lead strength ratio is so low, the discrete design cannot be considered a limited reliability factor.

It should be noted that the use of a PCB does improve the consistency of the high frequencies' performance (400-600 MHz), where placement and lead lengths play a more important role.

When PCBs are used it is also important to use a material with an RF consistency from production to production. Glass epoxy or special phenolic types are made from applications.

It is important to note that inside cavity size and shape can play an important part of reaching that top specification.

This article was presented as part of a workshop at the SCTE's 1988 Cable-Tec Expo, reprinted with permission.

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

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

Reader Service Number 65.

Part II: Light measurement

This is the second installment of a three-part series on the terminology of light. Part I, which appeared in the October issue, discussed the nature and measurement of light as well as photometric measures and units.

For years the necessity for a complete understanding of light for the production of good TV scenes has been a "given." As the importance of fiber optics in communications increases, the corollary importance of light and its measurement in that field follows. Over the many years of the study of light, a jungle of often bewildering technology developed. The lack of uniqueness, in addition to everyday connotations of much visual terminology, often confuses the reader not familiar with the subject.

It is further confusing because light measurement has two different generic approaches. From a physicist's viewpoint light is radiant energy and thus can be measured in watts—radiometry. Over the course of time, the measurement of light as we see it and photograph with it, for use by human observers, has produced light measurement units (lumens) in photometry. The formulas for various radiometric quantities are analogous to the ones for the corresponding photometric quantities. If watts are substituted for lumens, the units (in the international MKS unit system) in the radiometric quantities are the same as those of the corresponding photometric quantities.

Customarily, photometric measurements are used in general illumination and photography (film and TV), whereas radiometric measurements are widely used in scientific applications, e.g., microwave/satellite RF, fiber optics, etc.

By Lawrence W. Lockwood
President, TeleResources
East Coast Correspondent

"Even a trained observer cannot judge absolute luminances accurately."

One foot-lambert (ft-L) is defined as the luminous emittance of a perfectly diffuse surface emitting 1 lm/ft^2 or with a luminance of $1/\pi$ cd/ft^2. The following is of most importance since it treats the relationship of foot-candles and foot-lamberts. These are terms that are quite often confused and misused. They are not interchangeable unless certain other factors involved in the lighting are known, since they are measures of different quantities; i.e., illuminance and luminous emittance, respectively. (*Lumen* is another term whose relationship is most often misunderstood. The lumen is a measure—as explained in Part I, of luminous flux or luminous energy, which is analogous to radiant energy—of the brightness-producing capacity of a radiant source.)

The foot-candle is the more generally used measurement. However, the foot-lambert is a convenient unit because a perfectly diffuse surface with a reflectance of 1 and illuminated with 1 lm/ft^2 (one foot-candle) also has a luminous emittance of 1 lm/ft^2 (one foot-lambert). (As noted, the same surface has a luminance of $1/\pi$ cd/ft^2.)

Thus, the illumination in foot-candles need only be multiplied by the reflectance of the surface to get the luminance emittance in foot-lamberts. Unfortunately, the term *luminance* is used in an ambiguous manner that ignores its alternative interpretations. The following confusions are typical:

1) The foot-lambert is commonly referred to as a luminance unit, when it is actually a unit of luminous emittance.

2) The names given the various units are misleading. One instance given was that of the foot-candle. A similar situation exists for the Lambert unit. For instance,

1 Lambert = $1/\pi$ candle/cm^2
1 meter-lambert = $1/\pi$ candle/m^2
1 foot-lambert = $1/\pi$ candle/ft^2

Obviously, the Lambert should be called the "centimeter-lambert." The lack of consistency is compounded with regard to another common Lambert unit, the millilambert. The millilambert (mL) is 10^{-3} Lambert and only accidently is nearly equal to a foot-lambert (.929 mL = 1 ft-L).

Table 1 presents values of luminance for some typical self-luminous sources, while Table 2 lists some typical luminance values. It is common practice to state luminance values in Lambert units for non-diffuse surfaces. If the conditions of measurement are specified, no great harm is done; however, that procedure can result in con-

Figure 1: Simplest photometric configuration

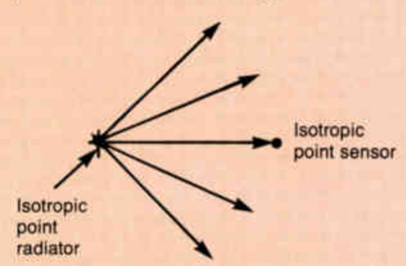


Table 1: Luminance of self-luminous sources

Source	Luminance in foot-lamberts	Source	Luminance in foot-lamberts
Sun at meridian	4.8 × 10^8	Tungsten filament	3.5 × 10^6
Sun near horizon	1.75 × 10^6	Inside-frosted 60 watt bulb	27,000
Moon	750	Fluorescent lamp 40 watt T-12 tube	1,800
Clear sky	2,300	High intensity carbon arc	2 × 10^8
Overcast sky	650		
Candle flame	2,900		

Figure 2: Basic diagram of illuminometer

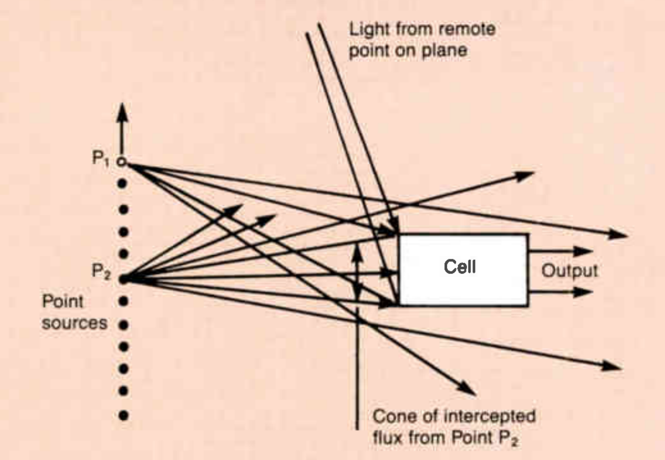
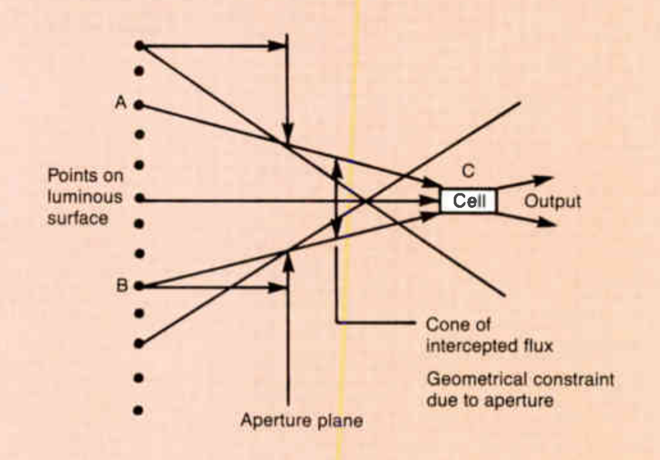


Figure 3: Basic aperture photometer



fusion. It has been suggested that some clarification can be achieved by dropping unnecessary terms such as foot-candles and Lamberts and state quantities in terms of the basic units; i.e., lumens/ft^2, cd/ft^2, etc. Additional clarification would require analysis of the basis of photometric units and agreement as to their use. A useful conversion chart is given in Table 3, while definitions and conversions of several photometric units are given in Table 4.

Instrumentation and methods

The original method of photometry consisted of comparison of an unknown and known luminous source by simultaneous visual observation and then, by some means, regulation of the relative intensities in a predictable manner until they appeared equal in brightness to the observer. The eye makes a good null comparator if the colors of the sources are similar. Repetitive trials and averaging under ideal conditions may achieve accuracies of 1 percent or better. However, even a trained observer cannot judge absolute luminances accurately, and it is next to impossible to calibrate the eye for use at a later time.

Certain types of photoelectric cells can be calibrated and made to have an electrical output that varies linearly with incident illumination and furthermore they will retain this calibration for an extended period of time if properly handled.

Basic design principles of photometers using photocells

Photons radiate in all directions and predetermined geometrical constraints must be placed upon the radiation being measured.

Incident illumination: The simplest photometric situation is that of a point source and a point detector as shown in Figure 1. Of course, if any radiation whatsoever is to be intercepted by the detector, it must have some finite receptive area, which means it will subtend some solid angle with respect to the radiator. This solid angle varies inversely as the square of the distance between the receptor and the source; therefore, if the detector is removed twice as far, it will receive one-fourth as much radiation, etc. It is this purely geometrical principle that determines the inverse square law of radiation *intensity* and not any attenuation of the radiation itself as it is propagated. A given amount of radiation is merely distributed over larger and larger areas as the distance increases, as was shown in Part I.

A real photocell does have a finite area. This may be of significant proportions either by intent (in order to provide spatial integration) or by necessity because of the size of the detector or its accessories, so that the diagram of an illuminometer as seen in Figure 2 more closely represents the real situation. Figure 2 is a configuration of a simple photometer for the measurement of radiant or luminous "intensity" from a point or area source. The total incident radiation is the sum of the cones from all points seen. Geometrical constraint is caused by the finite cell diameter.

When either the source or the cell has a significant diameter, the inverse square law will not hold at relatively close distances. A commonly used rule of thumb is that the error will not exceed 1 percent if the intersurface dimension is at least 15 times the diameter of the largest element, be it either the source or the cell.

Photovoltaic cells are employed in most high-level illuminance meters. They have little utility cost below 1 fc and ideal directional response qualities (cosine law) have been sacrificed (in some cases) in these instruments to increase sensitivity. This is particularly true at angles greater than 1 rad from normal incidence and significant errors may occur when measuring obliquely incident illumination. Measurements of low illuminance may be achieved with photomultipliers mounted in special housings having carefully designed light entry ports known as "cosine collectors." These may have several configurations, usually consisting of a diffusion disk of translucent plastic with slightly exposed edges or a system of multiple lens facets molded into a transparent window.

Luminance measurements: The aperture photometer is ordinarily suitable only for relatively large self-luminous areas. Consider the basic geometry of the aperture photometer (used for measurement of flux per unit area from area source), shown in Figure 3. In the illuminometer of Figure 2, the angular constraint is placed upon the cone of rays by the cell diameter; in the aperture photometer, the cone is limited by a separate aperture (sometimes called a "stop") that is some distance from the cell surface. As long as the surface is larger than the base of the cone ABC and if the surface is of uniform luminance, the photometer reading will be independent of its distance from the surface.

The simplest practical form of the aperture photometer is exemplified by the Weston foot-lambert meter; the cross section of a cup-type meter is diagrammed in Figure 4. In this case the round cell lies at the bottom of a black cylindrical cup, which is about as deep as it is wide. The rim of the tubular cavity becomes the aperture of the instrument. Normally, the cell housing of such a device is held against the luminous surface to be measured, which must of course be as large as the aperture. If the luminous area is much larger than the aperture, the housing may be backed off some distance without any change in reading; the output will begin to drop only when any portion of the cell is able to see a non-luminous part of the field.

There are several disadvantages to this basic photometer. In the first place the surface must

Table 2: Typical luminance values (in foot-lamberts)

Sun at zenith	4.82 × 10^8
Perfectly reflecting, diffusing surface in sunlight	9.29 × 10^3
Moon, clear sky	2.23 × 10^3
Overcast sky	9 × 10^2 to 20 × 10^2
Clear sky	6 × 10^2 to 17.5 × 10^2
Kinescope	30
Motion-picture screen	10

CT PUBLICATIONS CORP.

FOCUS

December 1988

As we approach the beginning of our sixth year of publishing, it's important to remember that we are here today because of our dedication to our readers—and to the cable TV industry. And in the coming months, you'll be reading more about just how we're working for you, as well as getting to know the people of CT Publications, such as those below.

Paul R. Levine
President/Publisher

Marty Laven
VP-Sales and Marketing

Lu Ann Curtis
National Sales Manager

Patricia Wilbourn
Account Executive

Neil Anderson
National Sales Manager

Geneva Hobza
Assistant Controller

Marie Beert
Mkt. Administrative Asst.

Shelley Bolin
Assistant Editor

We're Working for You!

(Front row, seated) Brad Hamilton, Danielle Kelley, Shelley Bolin, Lu Ann Curtis; (middle row) Sharon Lasley, Marla Sullivan, Marty Laven, Marie Beert, Mary Sharkey, Patti Wilbourn; (rear) Wayne Lasley, Toni Barnett, Paul Levine, Kenny Edwards, Kathleen Jackson, Rikki Lee, Geneva Hobza, Neil Anderson.

Dedicated to the Cable TV Industry

...isn't just a catchy slogan: It's how we feel. Because cable TV prides itself on service and a high quality product, why shouldn't all of us, as part of this industry, do the same?

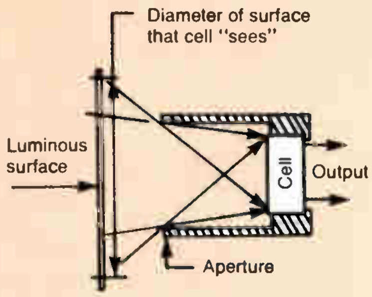
We owe a lot to our subscribers, so we make every effort to be aware of and sensitive to their needs. Our trade journals—**Communications Technology, Cable Strategies** and **Installer/Technician**—are designed to assist our readers at their jobs and provide effective forums and useful information about all facets of the industry—all in the goal of promoting their professional development.

And we owe a lot to our advertisers, too. It's through their support that we're able to serve our industry. So, if you're at the Western Show and happen to run into one of us, let us know what you think—after all, we're working for you.

CT PUBLICATIONS CORP.

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

Figure 4: Basic foot-lambert meter



be self-luminous or lit from the reverse side since the instrument produces a shadow, even when at some distance. A more serious drawback for display photometry is the fact that many surfaces of interest are much too small to be measured with such a large device. In order to overcome these problems, a more complex instrument variously known as a "telephotometer," "telescopic luminance meter" or "spot photometer" has come into common use.

Referring to Figure 5, it is evident that an area from the luminous surface can be focused on the image plane, in which an aperture or cell with a defined area is located. A conceptual derivation may be made as follows: If one takes the simple aperture photometer and continues to restrict the aperture in an effort to measure even smaller areas, the end result is a system much like a pinhole camera. The light-gathering power in such an instrument is very low, so the pinhole is replaced with a lens just as was done in the camera. The end result is a still narrow and controllable angular field of receptivity but with immensely improved light-gathering power. It is well to point out that the effective area of the lens of such a device is the primary factor in determining the light-gathering power. Such factors as relative aperture and focal length are secondary and are chosen for engineering and economic reasons.

The configuration shown in Figure 5 is that of a microphotometer, because the image is larger than the object. A telephotometer differs basically only in having a much longer front focal length, with concomitant demagnification of the image. Other common methods for extracting a portion of the light from the field at the image plane include small elliptical mirrors, partial mirrors and mirrors with elliptical apertures that reflect all of the image to the eye lens, except that which passes through the aperture to the photocell. Typical instruments can measure from 10^{-4} to 10^{8} fc with viewing angles of 6, 15, 30, 60 and 120 minutes of arc.

It might seem that the ideal telephotometer should approximate the human eye in both focal length and entrance pupil size but this is not always the case, even if it were easily accomplished. A major problem is that of sensitivity. At low illumination levels, a lens no larger than the human pupil would cause a serious limitation to sensitivity. Moreover, because of the short focal length, the measurement of targets of very small

Table 3: Conversion factors for photometric units

(Value in unit in side column times the conversion factor equals the value in unit shown at the top of the column.)

	C/mm^2	C/cm^2	C/m^2	Stilb (H)	C/in^2	C/ft^2	L
Candles per square millimeter	1	1×10^{2}	1×10^{6}	1.111×10^{2}	6.452×10^{2}	9.290×10^{4}	3.142×10^{2}
Candles per square centimeter (CIE Stilb)	1×10^{-2}	1	1×10^{4}	1.111	6.452	9.290×10^{2}	3.142
Candles per square meter	1×10^{-6}	1×10^{-4}	1	1.111×10^{-4}	6.452×10^{-4}	9.290×10^{-2}	3.142×10^{-4}
Hefner candles per square centimeter [Stilb (H)]	9×10^{-3}	9×10^{-1}	9×10^{6}	1	5.806	8.361×10^{2}	2.828
Candles per square inch	1.550×10^{-3}	1.550×10^{-1}	1.550×10^{3}	1.722×10^{-1}	1	1.440×10^{2}	4.869×10^{-1}
Candles per square foot	1.076×10^{-5}	1.076×10^{-3}	1.076×10	1.196×10^{-3}	6.944×10^{-3}	1	3.382×10^{-3}
Lamberts (equivalent centimeter candles, apparent lumens per square centimeter)	3.183×10^{-3}	3.183×10^{-1}	3.183×10^{3}	3.537×10^{-1}	2.054	2.957×10^{2}	1
Millilamberts	3.183×10^{-6}	3.183×10^{-4}	3.183	3.537×10^{-4}	2.054×10^{-3}	2.957×10^{-1}	1×10^{-3}
Microlamberts	3.183×10^{-9}	3.183×10^{-7}	3.183×10^{-3}	3.537×10^{-7}	2.054×10^{-6}	2.957×10^{-4}	1×10^{-6}
Millimicrolamberts (Micromillilamberts)	3.183×10^{-12}	3.183×10^{-10}	3.183×10^{-6}	3.537×10^{-10}	2.054×10^{-9}	2.957×10^{-7}	1×10^{-9}
Micromicrolamberts	3.183×10^{-15}	3.183×10^{-13}	3.183×10^{-9}	3.537×10^{-13}	2.054×10^{-12}	2.957×10^{-10}	1×10^{-12}
Apostilb (Hefner lumens per square foot)	2.864×10^{-7}	2.864×10^{-5}	2.864×10^{-1}	3.183×10^{-5}	1.848×10^{-4}	2.661×10^{-2}	9×10^{-5}
Foot-lamberts (equivalent foot-candles; apparent foot-candles; apparent lumens per square foot)	3.426×10^{-6}	3.426×10^{-4}	3.426	3.807×10^{-4}	2.210×10^{-3}	3.183×10^{-1}	1.076×10^{-3}
Photons**	1.273×10^{-6}	1.273×10^{-4}	1.273	1.414×10^{-4}	8.213×10^{-4}	1.183×10^{-1}	4×10^{-4}

* In converting measures of brightness into photons, multiply the conversion factor by the square of the pupil diameter in millimeters.
** In converting photons to measures of brightness, divide the conversion factor by the square of the pupil diameter in millimeters.

Table 4: Photometric units

Bougie Decimale (intensity of source): 1 International candle approx.
Candle, International (intensity of source): 0.104 Carcel unit approx.; 1 International lumen per steradian; 1 Pentane candle approx.; 1 English sperm candle approx.; 1.11 Hefner unit approx.
Candle per square centimeter (surface brightness): 3.1416 lamberts, 3141.6 millilamberts.
Candle per square inch (surface brightness): 0.48695 lambert, 486.95 millilamberts.
Carcel unit (intensity of source): 9.6 International candle approx.
English sperm candle (intensity of source): 1 International candle approx.
Foot-candle (illumination of a surface): 1 lumen incident per square foot, 1.0764 milliphots, 10.764 lumen per square meter, 10.764 lux.
Hefner unit (intensity of source): 0.9 International candle approx.
Lambert (surface brightness): 0.3183 candle per square centimeter, 2.054 candles per square inch, 1 lumen emitted per square centimeter of a perfectly diffusing surface.
Lumen (flux of luminous energy): is emitted by 0.07958 spherical candle power. A source of one spherical candle power emits 4π or 12.566 lumens.
Lumen per square centimeter per steradian (surface brightness): 3.1416 lambert.
Lumen per square foot (illumination of a surface): 1 foot-candle, 10.764 lumens per square meter.
Lumen per square foot per steradian (surface brightness): 5.3816 millilambert.
Lumen per square meter (surface illumination): 1×10^{-4} phot, 0.092902 foot-candle or lumen per square foot.
Lux (illumination of a surface): 1×10^{-4}, 0.1 milliphot/0.092902 foot-candle, 1 lumen per square meter.
Meter-candle (illumination of a surface): 1 lumen per square meter.
Millilambert (surface brightness): 0.929 lumen emitted per square foot (perfect diffusion).

angular subtense would require an impracticably small aperture at the image plane. These practical considerations usually dictate larger devices. Photometric microscopes have lenses varying from 2 to 10 mm in diameter and usually have back focal lengths of about 160 mm. Telescope lenses are from 1 to 10 cm in diameter with back focal lengths usually three to four times the diameter. The sensitivity of the instrument is proportional to the effective area of the lens and is not directly related to the f/number. (The f/number is the ratio of the principal focal length of a lens divided by its effective diameter and is a measure of transmission effectiveness. A smaller f/number indicates a "faster" lens.)

This difference in dimensions from those of the eye can, on occasion, have seriously misleading consequences, several examples of which follow:

1) In certain devices that have collimating systems, such as gunsight reticles, the exit pupil is of limited size, perhaps 10 mm. This will always be larger than the pupil of the human eye even when dark-adapted. If, however, a telephotometer with a 50 mm lens, which has been calibrated against a large luminous surface, is used to measure the luminosity of a surface within the gunsight, it will read only about 1/25 of the real level (the square of the ratio of the diameter of the exit pupil to the diameter of the telescope

mL	μL	mμL	μμL	Apostilb (H)	ft-L	Photons*	
3.142×10^5	3.142×10^8	3.142×10^{11}	3.142×10^{14}	3.491×10^6	2.919×10^5	7.854×10^5	Candles per square millimeter
3.142×10^3	3.142×10^6	3.142×10^9	3.142×10^{12}	3.491×10^4	2.919×10^3	7.854×10^3	Candles per square centimeter (CIE Stilb)
3.142×10^{-1}	3.142×10^2	3.142×10^5	3.142×10^8	3.491	2.919×10^{-1}	7.854×10^{-1}	Candles per square meter
2.828×10^3	2.828×10^6	2.828×10^9	2.828×10^{12}	3.142×10^4	2.627×10^3	7.069×10^3	Hefner candles per square centimeter [Stilb (H)]
4.869×10^2	4.869×10^5	4.869×10^8	4.869×10^{11}	5.411×10^3	4.524×10^2	1.217×10^3	Candles per square inch
3.382	3.382×10^3	3.382×10^6	3.382×10^9	3.758×10	3.142	8.454	Candles per square foot
1×10^3	1×10^6	1×10^9	1×10^{12}	1.111×10^4	9.290×10^2	2.500×10^3	Lamberts (equivalent centimeter candles, apparent lumens per square centimeter)
1	1×10^3	1×10^6	1×10^9	1.111×10	9.290×10^{-1}	2.500	Millilamberts
1×10^{-3}	1	1×10^3	1×10^6	1.111×10^{-2}	9.290×10^{-4}	2.500×10^{-3}	Microlamberts
1×10^{-6}	1×10^{-3}	1	1×10^3	1.111×10^{-5}	9.290×10^{-7}	2.500×10^{-6}	Millimicrolamberts (Micromillilamberts)
1×10^{-9}	1×10^{-6}	1×10^{-3}	1	1.111×10^{-8}	9.290×10^{-10}	2.500×10^{-9}	Micromicrolamberts
9×10^{-2}	9×10	9×10^4	9×10^7	1	8.360×10^{-2}	2.249	Apostilb (Hefner lumens per square foot)
1.076	1.076×10^3	1.076×10^6	1.076×10^9	1.196×10	1	2.691	Foot-lamberts (equivalent foot-candles; apparent foot-candles; apparent lumens per square foot)
4×10^{-1}	4×10^2	4×10^5	4×10^8	4.444×10	3.716×10^{-1}	1	Photons**

lens). In this case, the entrance diameter of the telescope must be stopped down smaller than the exit pupil of the sight and then recalibrated.

2) In the aforementioned device, the collimating lenses in the gunsight cause the rays to leave in a nearly parallel bundle, so the reticle will appear to be at infinity. In a sighting system that is either intentionally or accidentally focused at other than infinity, the rays diverge or converge as they leave the device. Now, not only must the photometric telescope be refocused but also the distance from the sight is of importance. An accurate absolute reading of the sight's effective visual luminosity requires a complete understanding of the light paths of the complete system. *When measuring through auxiliary optical systems, beware.*

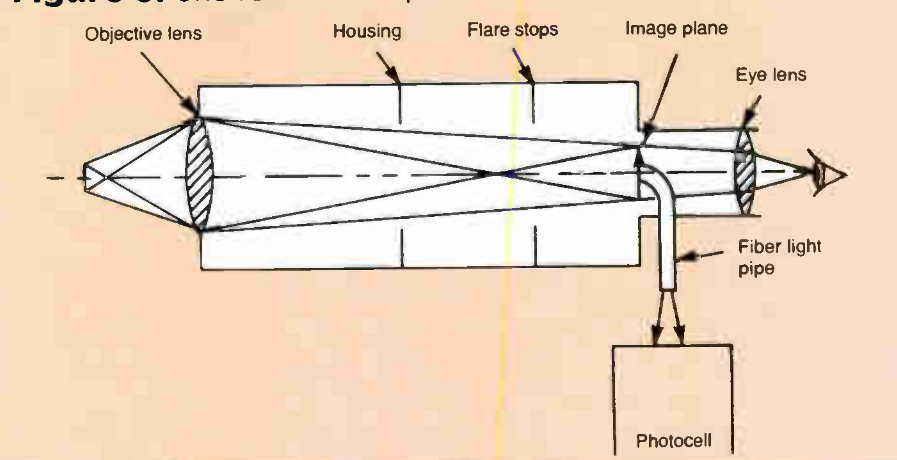
3) Surfaces with highly directional properties, including lenticular and Fresnel screens, retroflective devices and special paints containing glass beads, are also likely to introduce error and confusion for similar reasons.

4) When measuring the luminance of a surface that is semidiffuse in nature and is lighted by several sources, not only the diameter and back focal length but also the front focal distance of the telescope are of importance. For example, when observing a distant light reflected somewhat diffusely (as with glare) from a nearby surface, the luminance reading when the instrument is focused on the surface will be different from the reading taken when it is focused at infinity. In general, it may be said the most nearly accurate results will be obtained at an infinite focus.

A spot photometer also may be used to determine the foot-candle values upon a surface fairly well by the use of a plaque with known diffusivity and reflectivity. Probably the most widespread application of spot photometry is in cameras to measure lighting in the scene for control of automatic exposure adjustments.

Part III of this series will cover radiometric quantities and units as well as conversion between lumens and watts.

Figure 5: One form of telephotometer



Audio level control

According to FM Systems, its ALM673 Audio Level Master "dual mono" audio level control system can control as many as six mono or three stereo audio channels in as little as 1¾ inches of rack space. This system uses split spectrum control, program-dependent time constants and independent noise gating and can be converted from two separate monaural channels to one stereo. It also has 30 dB of true automatic level control without waveform distortion.

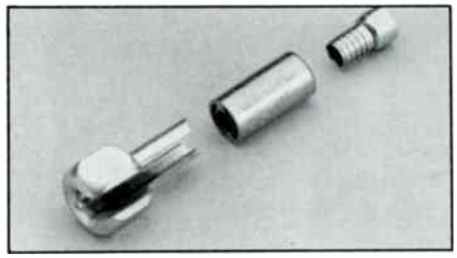
For further information, contact FM Systems, 3877 S. Main St., Santa Ana, Calif. 92707, (714) 979-3355; or circle #139 on the reader service card.

FO transmission

The Catel AM fiber system accepts CATV RF signals generated by a conventional headend or TransHub. Up to 24 channels of AM TV signals may be carried on one single-mode fiber, with the combined signals providing modulation for an OT-1010 AM optical transmitter. The optical signal is then carried over fiber to a receiver, where it is converted back to the original RF modulation signal. Outputs of several of these receivers are combined to form the complete CATV RF spectrum that then feeds the coaxial distribution system.

This system is said to handle all types of CATV signals, including scrambled signals and FM broadcast, as well as those of high-definition TV and other newly emerging technologies.

For more details, contact Catel, 4050 Technology Pl., Fremont, Calif. 94537-5122, (415) 659-8988; or circle #131 on the reader service card.



F connector

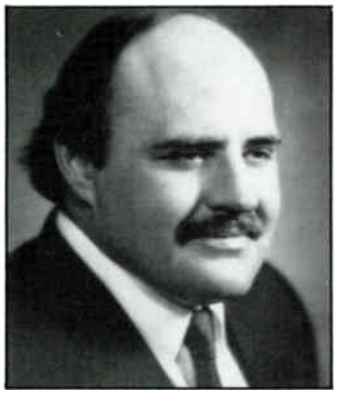
According to Viewsonics, its newly patented Lockin' F connector is tamper proof and provides additional security and RFI. It can be installed with the same tool/key as Viewsonics locking terminator, Pedlock, padlock, MDU boxes, etc., and comes in F59 and F56 sizes.

For more information, contact Viewsonics, 170 Eileen Wy., Syosset, N.Y. 11791, (800) 645-7600; or circle #122 on the reader service card.

FO test system

Siecor is offering a return loss option with its CME 1000 attenuation test equipment. New and existing units can be equipped with this feature. According to the company, the use of the option condenses return loss measurements into three steps, also minimizing variables for a direct, accurate readout. The new option tests the reflection of systems that may result in bit rate errors due to reflection from connectors, mechanical splices and other interfaces.

For more details, contact Siecor Corp., 489 Siecor Park, Hickory, N.C. 28603-0489, (704) 327-5000; or circle #136 on the reader service card.



Sadel

Joe Sadel was promoted to vice president of marketing at **Sadelco**. He was previously director of research and development.

Les Kaplan was named general manager of the corporation. Prior to this, he was director of operations. Contact: 75 W. Forest Ave., Englewood, N.J. 07631, (201) 569-3323.

Tony Wechselberger was promoted to senior vice president, domestic operations for **Oak Communications**. Formerly, he was vice president of engineering. Contact: 16935 W. Bernardo Dr., Rancho Bernardo, Calif. 92127, (619) 451-1500.

Schonewill

Sachs Communications named **John Schonewill** as technical account manager for the Western region office. He was previously installation manager for Mile Hi Cablevision.

Kay Ahr was appointed inside sales manager for the Western region office. Prior to this, she was senior buyer in the transportation department of American Television and Communications Corp.

The company promoted **Sam Wells** to national technical manager for Canada and the United States. He was formerly the national training manager. Contact: 30 W. Service Rd., Champlain, N.Y. 12919-9703, (514) 361-3685.

Anixter Brothers promoted **Raymond Geraci** to senior vice president of advertising and public relations. He was formerly vice president of advertising.

Vincent Buchman was appointed vice president of advertising. Before this, he was director of marketing and communications for Allied Van Lines.

The company named **Bill Millholland** vice president of training and development. Previously, he was vice president of contractor sales.

W.D. Wilkens was named to the newly created position of chief engineer. He was previously with Ericsson Cables and has had 19 years of engineering and quality assurance experience. Contact: 4711 Golf Rd., 1 Concourse Plaza, Skokie, Ill. 60076, (312) 677-2600.

Alexander McLanahan joined the **VideoCipher Division** of General Instrument as site manager of its Hickory, N.C., facility. Before this, he was national service manager for the Luskins Co. Contact: 6262 Lusk Blvd., San Diego, Calif. 92121, (619) 455-1500.

Thomas Brooksher was appointed as director of marketing for the **National Cable Television Institute**. Prior to this, he was director of sales and marketing for Human Resources International.

Howard Newell was named NCTI's instructional designer. He was previously a consultant and technical writer for JRS Enterprises. Contact: P.O. Box 27277, Denver, Colo. 80227, (303) 761-8554.

Cable Exchange

Technically certified equipment
Largest database of equipment available

The following is a partial listing
available for immediate shipment to qualified buyers.

Call: 1-(800)-422-2567 to place your order.

Item Number	Description
C229760	INPUT CONV. 6150 CH-A
C229860	OUTPUT CONV. 6350 CH-02
C229865	OUTPUT CONV. 6350 CH-07
C229868	OUTPUT CONV. 6350 CH-10
C229870	OUTPUT CONV. 6350 CH-12
C229871	OUTPUT CONV. 6350 CH-13
C229872	OUTPUT CONV. 6350 CH-A
C229873	OUTPUT CONV. 6350 CH-B
C229874	OUTPUT CONV. 6350 CH-C
C229875	OUTPUT CONV. 6350 CH-D
C229876	OUTPUT CONV. 6350 CH-E
C229877	OUTPUT CONV. 6350 CH-F
C229878	OUTPUT CONV. 6350 CH-G
C229882	OUTPUT CONV. 6350 CH-K
C229884	OUTPUT CONV. 6350 CH-M
C229888	OUTPUT CONV. 6350 CH-Q
C229890	OUTPUT CONV. 6350 CH-S
C230250	SPECTRUM INVRT. 6350
C274780	LO REF. LOOP THRU 6350
C342690	AUDIO MOD. 6350
C345153	OUTPUT CONV. 6350 CH-A+
XRPG-3	PILOT CARRIER GENERATOR
122006-02	POWER SUPPLY TRUNK AMP
142000-01	BRIDGER AMP T4XX
142014-02	BRIDGER AMP
300199-01	POWER SUPPLY T4XX
E-417E	LINE EXTENDER
E-417H	HOUSING FOR E-417E
T400H	HOUSING W/PS T4XX
T400HB	HOUSING BER T4XX
T421-002	TRUNK AMP
T470-002	TRUNK AMP
T470-003	TRUNK AMP
T470-030	TRUNK AMP
T470-051	TRUNK AMP
T470-052	TRUNK AMP
T500H	HOUSING W/XF T5XX
T507-030	TRUNK AMP
JLE-300	LINE EXTENDER 300 MHZ NH
JLE-300H	HOUSING FOR JLE 300
JLE-7400-2W	LINE EXTENDER 400 MHZ
JLE-7450-2W	LINE EXTENDER 450 MHZ
JLH	HOUSING FOR J SERIES L.E.
RCG-115N	RETURN CARRIER GENERATOR
SAM	AUTO SLOPE MOD.
SAM-PT	AUTOMATIC MODULE
SAM-PT-300	AUTOMATIC MOD. 300 MHZ NH
SAS-300	AUTO SLOPE AMP 300MEG
SAS-S	AUTO SLOPE AMP
SAS-S-300	AUTO SLOPE AMP 300 MHZ NH
SBM-300	BRIDGER MAN. 300 MHZ NH
SBM-P	BRIDGER MODULE
SBM-S	BRIDGER MODULE
SCD	TRUNK CHASSIE
SCD-2W	CHASSIE FOR TRUNK AMP
SCD-2W-300	TRUNK AMP 300 MHZ NH
SCD-2W-300H	HOUSING FOR SCD-2W-300
SCD-2W-R115	TRUNK CHASSIE W/RFC-115
SCD-2W-T108	TRUNK CHASSIE W/TRA-108M
SCD-2W-T30	TRUNK CHASSIE W/TRA-30M
SCD-2WD	CHASSIE FOR TRUNK AMP
SCD-2WE	BASEPLATE CHASSIS
SCL	TRUNK CHASSIE
SCL-2W	CHASSIE FOR TRUNK AMP
SCL-2WD	TRUNK CHASSIE

Item Number	Description
SDH-P	DISTRIBUTION MOD.
SDHP-300	DIST. AMP 300 MHZ NH
SJAS-400	TRUNK AMP 400 MHZ NH
SJBM-300	BRIDGER MODULE 300 MHZ
SJBM-301	BRIDGER MAN. 300 MHZ NH
SJBM-400	BRIDGER MAN. 400 MHZ NH
SJBM-450	BRIDGER MANUAL 450 MHZ NH
SJDL-301	DIST. AMP 301 MHZ NH
SJDL-400	DIST. AMP 400 MHZ NH
SJDL-405	DIST. MOD.
SJDL-450	DIST. AMP 450 MHZ NH
SJM-400	TRUNK AMP 400 MHZ NH
SJMM-300	MANUAL MODULE 300 MHZ NH
SJMM-301	MANUAL MODULE 301 MEG
SJMM-400	MANUAL MODULE 400 MHZ NH
SJMM-450	MANUAL MOD. P/P 450 MHZ NH
SJSP-60	POWER PACK 60V
SJSW-30	POWER PACK
SJSW-60	POWER PACK 60V
SLE-2P	LINE EXTENDER
SLE-300	LINE EXTENDER
SLE-300-2W	LINE EXTENDER 300 MHZ NH
SLE-300A-2W	LINE EXTENDER 300 MEG
SLE-300H	HOUSING FOR SLE-300
SLH-2	STARLINE L.E. HOUSING
SLR-300-2W	LINE EXTENDER
SMM	MANUAL MOD.
SMM-P	MANUAL MOD. NH
SMM-PT	MANUAL MODULE
SMM-S	MANUAL MODULE
SMMS-300	MANUAL MOD. 300 MHZ NH
SPCM-30	POWER CONTROL MOD 30V
SPCM-60	POWER CONTROL MOD 60V
SPP	POWER PACK
SPP-30	POWER PACK
SPP-60	POWER PACK 60V
SPP-S-30	POWER PACK
SPP-S-60	POWER PACK 60V
SPS-12	POWER SUPPLY 12V
SPS-30	POWER SUPPLY 30V
SPS-30B	POWER SUPPLY 30V
STH-7	STARLINE TRUNK HOUSING
STH-7B	HOUSING BER
TRA-108A	RETURN AMP
5-D440	DISTRIBUTION AMP 440 MHZ
5-T330	TRUNK AMP 330 MHZ
5CC-440	COMPLETE CONTROL 440 MHZ
5LE-440/30	LINE EXT. 440 MHZ 30V
5LE-440/60	LINE EXT. 440 MHZ 60V
MX-504H	HOUSING FOR MX-504
CEPS-3	POWER SUPPLY (CASCADE)
234430	TRUNK I/T FORWARD NH
CTN-1200	POWER SUPPLY
KCMG	MANUAL GAIN BRIDGER
PCAB-1	TRUNK AGC BRIDGER
PCAD-1D	BRIDGER TRUNK AGC NH
PCAD-1H	HOUSING FOR PCAD-1D
PCM-4	TRUNK AMP NH
PCM-4H	HOUSING FOR PCM-4
PCMB-2	TRUNK AMP NH
PCMB-2H	HOUSING FOR PCMB-2
PCRA	RETURN AMP

Cable Exchange

Item Number	Description	Item Number	Description
PCTB-6	TRUNK TERMINATING BRIDGER	FFT4-17D	TAP 4W 17DB
PH	HOUSING—P SERIES TRUNKS	FFT4-17F	TAP 4W 17DB
T3LE	LINE EXTENDER NH	FFT4-20	TAP 4W 20DB
T4CM	CONTINUITY MOD. NH	FFT4-20D	TAP 4W 20DB
TFAV	TRUNK AMP AGC	FFT4-20F	TAP 4W 20DB
TFM	TRUNK AMP MGC	FFT4-23	TAP 4W 23DB
TFPS	POWER SUPPLY	FFT4-23D	TAP 4W 23DB
TH	HOUSING FOR T SERIES L.E.	FFT4-23F	TAP 4W 23DB
XH	HOUSING FOR X SERIES L.E.	FFT4-23H	TAP 4W 23DB
XR2A	FORWARD AGC MOD.	FFT4-26	TAP 4W 26DB
XR2B	BRIDGER INTERMEDIATE	FFT4-26D	TAP 4W 26DB
XR2B-2	BRIDGER 2 OUTPUT	FFT4-29	TAP 4W 29DB
XR2B-4	BRIDGER 4 OUTPUT	FFT4-29D	TAP 4W 29DB
XR2DA	DIST AMP HYBRID AGC	FFT4-32D	TAP 4W 32DB
XR2DM	DIST AMP HYBRID MGC	FFT4-7T	TAP 4W 7DB
XR2F-1	INPUT MOD.	FFT4-7TD	TAP 4W 7DB
XR2F-13	INPUT MOD.	FFT8-4D	TAP 8W 4DB
XR2F-14	OUTPUT MOD.	SHS-2	HYBRID SPLITTER
XR2F-19	OUTPUT MOD.	SO-2	FEEDER MAKER
XR2F-3/110	INPUT MOD.	SO-4	FEEDER MAKER 4DB
XR2F-4	INPUT MOD.	SPJ-2	POWER COMBINER
XR2F-5	OUTPUT MOD.	SPJ-3C	DIRECTIONAL COUPLER 3DB
XR2F-7/110	OUTPUT MOD.	SPX-0.5	PAD 0.5 DB
XR2F-8	OUTPUT MOD.	SPX-00	PAD 00 DB
XR2HA	LINE AMP HYBRID HRC	SPX-01	PAD 01 DB
XR2HM	LINE AMP HYBRID HRC	SPX-02	PAD 02 DB
XR2LA-PS	POWER SUPPLY	SPX-03	PAD 03 DB
XR2LAF-1	POWER INPUT MOD.	SPX-06	PAD 06 DB
XR2LAF-2	POWER INPUT MOD.	SPX-09	PAD 09 DB
XR2LAF-3	POWER OUTPUT MOD.	SPX-1.5	PAD 1.5 DB
XR2LAF-4	POWER OUTPUT MOD.	SPX-12	PAD 12 DB
XR2LARA	REVERSE AMP MOD.	SSP-12	POWER INSERTER
XR2LS-3	LINE EXT.	STC-12	DIRECTIONAL COUPLER
XR2M	FORWARD MGC MOD.	STC-12C	DIRECTIONAL COUPLER 12DB
XR2PS	POWER SUPPLY	STC-16	DIRECTIONAL COUPLER
XR2RHA110	REVERSE AGC MOD.	STC-3	DIRECTIONAL COUPLER
XR2SPH	HOUSING FOR XR2SP	STC-3B	DATA LINE
XRBI	INTERMEDIATE BRIDGER	STC-3C	DATA LINE
XRCE-3	LINE EXT.	STC-3D	DIRECTIONAL COUPLER 3DB
XRCE-6	LINE EXT.	STC-8	DIRECTIONAL COUPLER
XRDC-16	LINE EXT.	STC-8B	DIRECTIONAL COUPLER 8DB
XRDC-8	LINE EXT.	STC-8C	DIRECTIONAL COUPLER 8DB
XRLA	LINE EXT.	STC-8D	DIRECTIONAL COUPLER 8DB
XRLS-2	LINE EXT.	DCW-06DB	MINITAP 06 DB
XRLS-3	LINE EXT.	DCW-09DB	MINITAP 09 DB
XRPR	POWER SUPPLY	DCW-12DB	MINITAP 12 DB
XRRP	LINE EXT.	DCW-16DB	MINITAP 16 DB
XRSP	LINE EXT.	DCW-20DB	MINITAP 20 DB
N4-S5	TRAP CH. 5	2-14BW	TAP
BPF-B	BAND PASS FILTER CH. 8	2-17BW	TAP
BADC	B.A. DIRECTIONAL COUPLER	2-20BW	TAP
BAEQ-12-1	B.A. EQUALIZER	2-23BW	TAP
BAEQ-3-3	B.A. EQUALIZER	2-26BW	TAP
BAEQ-8-1	B.A. EQUALIZER	4-08BW	TAP
BASP	B.A. SPLITTER	4-14BW	TAP
CSA-300-3	EQUALIZER T4XX	4-26BW	TAP
DISP-3	DISTRIBUTION SPLITTER 3-3	4-32BW	TAP
EQ-450/13	EQUALIZER 450 MHZ 13DB	8-17BW	TAP
EQ-450/15	EQUALIZER 450 MHZ 15DB	8-20BW	TAP
EQ-450/8	EQUALIZER 450 MHZ 8DB	8-26BW	TAP
EQA-1A	EQUALIZER T4XX	8-29BW	TAP
EQA-220-2	EQUALIZER T4XX	8-32BW	TAP
EQA-220-4	EQUALIZER T4XX	EQ-04DB	EQUALIZER 450MHZ
EQA-220-6	EQUALIZER T4XX	EQ-08/250	EQUALIZER
EQS-0	EQUALIZER LAN 0DB	EQ-08/300	EQUALIZER
EQS-186-4	EQUALIZER LAN 4DB	EQ-08DB	EQUALIZER 450 MHZ
EQT-450/10	EQUALIZER 450 MHZ 10DB	EQ-12/300	EQUALIZER
PB-0	PAD 0DB	EQ-15DB	EQUALIZER 450MHZ
PB-1	PAD 1DB	EQ-16DB	EQUALIZER 450MHZ
PB-2	PAD 2DB	EQ-18DB	EQUALIZER 450MHZ
PB-5	PAD 5DB	PCSPL-1	SPLITTER
PB-6	PAD 6DB	PCSPL-2	SPLITTER
PPLUG	POWER PLUG T4XX	PCSPL-3	SPLITTER
DS-200	SPLITTER 2-WAY 3.5 DB	PD-0	PLUG-IN PAD 0DB
DS-300	SPLITTER 3-WAY 5.5 DB	PD-3	PLUG-IN PAD 3DB
DS-3EL	SPLITTER 3-WAY 5.5 DB	PD-6	PLUG-IN PAD 6DB
DS-400	SPLITTER 4-WAY 6.5 DB	PD-9	PLUG-IN PAD 9DB
DS-4GB	SPLITTER 4-WAY 6.5 DB	PPLUG	POWER PLUG
DS-800	SPLITTER 8-WAY 11DB	T4BDC-8	PLUG-IN PAD
FFT4-10D	TAP 4W 10DB	T4BDL-12	PLUG-IN PAD
FFT4-10F	TAP 4W 10DB	T4SPL	PLUG-IN PAD
FFT4-14	TAP 4W 14DB	VEQ-08/300	EQUALIZER
FFT4-14D	TAP 4W 14DB	VEQ-12/250	EQUALIZER
FFT4-14F	TAP 4W 14DB	VEQ-12/300	EQUALIZER
FFT4-17	TAP 4W 17DB	XR2-13	TAP 4WAY 13DB

Equipment For Sale

Distribution Equipment

In stock for immediate delivery Factory reconditioned to meet or exceed manufacturers specs.

- Jerrold
- Scientific-Atlanta
- Texscan
- Other Major Brands

Complete Trunk Stations

- Line Extenders
- Replacement Modules

Savings of 50% or more

Call 1-800-999-2723
In Indiana
1-812-824-9331

Surplus Equipment Purchased

BradPTS™

QUALITY COUNTS
(Precision Converter Repair)

We have found that both quality and integrity count. We know that you want to be able to count on your converter and decoder repair facility for just that. At SCI Service and Repair, we offer you both — integrity and quality.

SCI's repair expertise covers the following:

- Authorized OAK SIGMA™ addressable repair center.
- All OAK™ addressable decoders and converters.
- OAK™ authorized HEAD-END and satellite repair center.
- Pioneer, Jerrold, Scientific/Atlanta, Hamlin non-data addressable converters/decoders.

Benefits:

- Turn-around on most orders is less than 3 weeks.
- Six-month limited warranty. • Recently modernized facilities.
- 99%+ perfect last 18 months – few warranty returns.

When Quality Counts . . . OUR QUALITY SHOWS

(619) 438-1518

SCI

See us at the Western Show, Booth 116.

2265 Camino Vida Roble, Carlsbad, California 92008

SWEEP GENERATOR MODEL 6082

A new generation of sweeper technology you can afford.

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

Help Wanted

BakerScott & Co.

THE PROFESSIONAL CABLE PLACEMENT PEOPLE

Positions available at all levels
of management from coast to coast.
Call or write in Confidence
David Allen, Judy Bouer - Principals
We don't talk cable, we know cable.
1259 Route 46, Parsippany, NJ 07054
(201) 263-3355

Cable Business Associates

Now hiring two positions in Southern California:

1) Direct sales for CATV equipment
   Base salary plus commission
2) Technician CATV equipment

Please call Cable Business Associates, a subsidiary of Cable Exchange
(303) 694-6789

Professional Services

ANALOG RF DIGITAL ENGINEERING RESOURCE

30 YEARS EXPERIENCE
FOR DETAILS CALL OR WRITE

SERENICS, INC.
129 SOUTH TAFT AVENUE
CHALFONT, PA 18914
TELEPHONE (215) 822-8249

Television Engineer

The leading microwave subscription television MSO is seeking an engineer to be responsible for our systemwide scrambling equipment and our microwave reception equipment. The successful candidate will have a BSEE and a minimum of 5 years in cable TV headends and scrambling equipment. Z-TAC and microwave experience a plus. Competitive salary, full benefits, 401K. EOE. Send resume with current salary to:

The Microband Companies Inc.
655 Third Avenue, 9th fl.
New York, N.Y. 10017
Attn: Engineering

Situation Wanted

Plant Manager

- 15 years experience/FCC licensed
- Administrator & staff motivator
- AML/FM microwave
- Budget & Operations
- Design & Drafting
- Headend activation
- High level & sweepless sweep
- Preventive maintenance
- Proof of performance
- Rebuild & new-build

Phone (214) 892-8842

Business Directory

CABLE SYSTEM SURVEY CO.

MAPPING • DESIGN • AS-BUILTS
COMPLETE DRAFTING SERVICES

Update Your Maps, Reduce Them And Pass Them Around.

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

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

SIGNAL LEVEL METER REPAIR

Prompt, Professional Service at Reasonable Prices

JGL ELECTRONICS, INC.

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

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

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*

Harold Bigham
President

Bigham

Cable Construction, Inc.

Complete CATV Construction
Specializing in Rebuilds

P.O. Box 903
Gulf Breeze, FL 32561

(904) 932-6869

"Cable Television - Second Edition"
By Bill Grant

A complete text on basic CATV technology for self-study or reference including

Hard cover - 400 pages - 140 illustrations
Complete index - 10 page Glossary of Terms

$32 per copy includes mailing inside USA
(add $5 for shipment outside USA)

Send check or money order to:
GWG Associates, PO Box 473
Richmondville, N.Y. 12149
Phone (518) 234-7405

IRWIN SCC SUPERIOR GENTEC COMPANY

Communications **III**

Construction, Inc.

"Committed To Service Excellence."

Customer Installations • Multiple Dwelling Units
Plant Construction and Maintenance

(714) 542-1055 • (619) 442-0713

CONTRACTOR'S LICENSE NO. 526824-A/SUPERCC121M2

L.C.E.

Long Cable Electronics

"For the Finest in Converter Repair"
"Equipment Brokered"

Call Ned:
518-393-5415

1228 Albany Street, Schenectady, NY 12304
See us at the Western Show, Booth 740.

Fiber-optics glossary

By Hal Williams
Jones Intercable Inc.

This is the final installment of a three-part series defining important terms in fiber optics, arranged in alphabetical order.

O

opacity—A substance is opaque when it transmits no light; an opaque material thus may be regarded as a light insulator.
optical cable—A fiber, multiple fibers or fiber bundle in a structure fabricated to meet optical, mechanical and environmental specifications. Synonym: *optical fiber cable*.
optical cable assembly—An optical cable that is connector-terminated. Generally, an optical cable that has been terminated by a manufacturer and is ready for installation.
optical cavity—A region bounded by two or more reflecting surfaces, referred to as mirrors, end mirrors or cavity mirrors, whose elements are aligned to provide multiple reflections. The resonator in a laser is an example of an optical cavity.
optical density—A measure of the transmittance of an optical element. The higher the optical density, the lower the transmittance. Optical density times 10 is equal to transmission loss expressed in decibels; for example, an optical density of 0.3 corresponds to a transmission loss of 3 dB.
optical detector—A transducer that generates an output signal when irradiated with optical power.
optical fiber—Any filament or fiber made of dielectric materials that guides light, whether or not it is used to transmit signals.
optical filter—A device capable of passing one portion of the optical spectrum while attenuating all other portions.
optical link—Any optical transmission channel designed to connect two end terminals to be connected in series with other channels. Sometimes terminal hardware (e.g., transmitter/receiver modules) is included in the definition.
optical repeater—In an optical waveguide communication system, an optoelectronic device or module that receives a signal, amplifies it (or in the case of a digital signal, reshapes, retimes or otherwise reconstructs it) and retransmits it.
optical spectrum—Generally, the electromagnetic spectrum within the wavelength region extending from the vacuum ultraviolet at 40 nm to the far infrared at 1 nm.
optical system—The combination of lenses, mirrors or prisms and their accessory devices assembled to perform a desired function.
optical waveguide—1) Any structure capable of guiding optical power. 2) In optical communications, generally a fiber designed to transmit optical signals.
optical waveguide connector—A device whose purpose is to transfer optical power between two optical waveguides or bundles and that is designed to be connected and disconnected repeatedly.
optics—The science of light and its applications and of the instruments used in measuring light phenomena.
optoelectronic—Pertaining to a device that responds to optical power, emits or modifies optical radiation, or utilizes optical radiation for its internal operation. Any device that functions as an electrical-to-optical or optical-to-electrical transducer. Photodiodes, LEDs, injection lasers and integrated optical elements are examples of optoelectronic devices commonly used in optical waveguide communications.

P

packing fraction—In a fiber bundle, the ratio of the aggregate fiber cross-section core area to the total cross-sectional area (usually within the ferrule) including cladding and interfiber areas.
peak wavelength—The wavelength at which the radiant intensity of a source is maximum.
photocell—A device for converting light energy into electrical energy or for controlling the flow of an electric current by means of light. There are two general types: photoconductive cell and photovoltaic cell.
photoconductive cell—A photocell with a resistance that decreases when the cell is illuminated and that accordingly can be used as a light-controlled variable resistor to control an electric current.
photoconductivity—The property in which some substances—such as selenium, cadmium sulfide and lead sulfide—undergo a temporary change of conductance (and accordingly of resistance) under illumination.
photocurrent—The current that flows through a photosensitive device (such as a photodiode) as the result of exposure to radiant power. Internal gain, such as that in an avalanche photodiode, may enhance or increase the current flow but is a distinct mechanism.
photodetector—A device that senses incident radiation.
photodiode—A diode designed to produce photocurrent by absorbing light. Photodiodes are used for the detection of optical power and for the conversion of optical power to electrical power.
photoelectron—An electron that is ejected from an atom by light energy.
photoemission—The ejection of electrons from any atom by action of light.
photon—A quantum of electromagnetic energy. The energy of a photon is $h\nu$ where h is Planck's constant and ν is the optical frequency. See *Planck's constant*.
phototransistor—A solid-state device similar to an ordinary transistor except that light incident on the PNP junction controls the response of the device; offers built-in gain and greater sensitivity than photodiodes.
photovoltaic effect—The generation of an electrical potential between two electrodes when radiation is incident to one of them.
physical optics—The branch of science that considers light a wave phenomenon. Light propagation is studied by waveforms rather than by rays. (Compare with *geometrical optics*.)
pico—A prefix in the SI system meaning 1×10^{-12}. Abbreviation: p.
pigtail—A short length of optical fiber permanently fixed to a component, used to couple power between it and the transmission fiber.
PIN photodiode—A diode with a large intrinsic region sandwiched between P- and N-doped semiconducting regions. Photons absorbed in this region create electron-hole pairs that are then separated by an electric field, thus generating an electric current in a load circuit.
Planck's constant—The number *h* that relates the energy E of a photon with the frequency ν of the associated wave through the relation $E = h\nu$. $h = 6.626 \times 10^{-34}$ joule second.
plane—A surface that is perfectly flat (no curvature).
plastic clad silica (PCS) fiber—An optical waveguide having silica core and plastic cladding.
PN junction—The boundary between P-type and N-type materials in a single semiconductor crystal.
popular inversion—The condition in which there are more excited atoms than ground-state atoms in a material so that stimulated emission will predominate over spontaneous emission.
primary coating—The material in intimate contact with the cladding surface, applied to preserve the integrity of that surface.
pulsed laser—A laser that emits energy in short bursts or pulses, remaining inactive between each burst or pulse.

Q

quantum efficiency of a photosensitive device—The ratio of the number of carriers generated to the number of photons incident upon the active region.

quantum theory—This theory states, among other things, that electromagnetic waves can act like particles. Thus, such particles (or "quanta"), called *photons* in radiated light, collide with and displace the electrons in photoelectric materials.

quiescent—At rest. Specifically, the condition of a circuit when no input is being applied to it.

R

radiant—Pertaining to electromagnetic radiation, with the contributions at all wavelengths weighted equally.

radiant energy—Energy transmitted as electromagnetic waves; e.g., radio, heat or light waves. Symbol: Q_e.

radiant exitance—Radiant flux per unit area leaving a surface. Symbol: M_e.

radiant flux—Radiant energy per unit time. Symbol: Φ_e.

radiant incidence—Radiant flux per unit area on a surface. Symbol: E_e.

radiant intensity—Radiant flux per unit solid angle. Symbol: I_e.

radiant power—The time rate of flow of radiant energy, expressed in watts. Within the optical industry, the prefix is often dropped and the term "power" is used.

radiant sterance—Radiant flux per unit solid angle, per unit area of emitting surface, at angle θ with respect to surface normal. Symbol: L_e.

radiation angle—Half the vertex angle of the cone of light emitted by a fiber.

radiation pattern—Relative power distribution as a function of position or angle.

radiometry—The measurement of radiation in the infrared, visible and ultraviolet portions of the electromagnetic spectrum.

ray—A thin line of light, visualized as passing from the light source or reflector and continuing in a straight line until obstructed.

Rayleigh scattering—Light scattering by refractive index fluctuations (inhomogeneities in material density or composition) that are small with respect to wavelength. The scattered field is inversely proportional to the fourth power of the wavelength.

reflected ray—The light ray leaving a reflecting surface, indicating the path of light after reflection.

reflection—Return of radiation by a surface without change in wavelength. May be specular from a smooth surface, diffuse from a rough surface or a combination of both.

refraction—The bending of a light ray as it passes from a medium having one refractive index to a material having a different refractive index.

responsivity—The ratio of a photodetector's output current to input radiant incidence.

ruby laser—An optically pumped solid-state laser that uses a ruby or sapphire crystal rod doped with chromium ions as its lasing medium.

S

scattering—The change in direction of light rays or photons after striking a small particle or particles. It also may be regarded as the diffusion of a light beam caused by the inhomogeneity of the transmitting medium.

scattering losses—In an optical fiber, power losses due to dimensional irregularities and imperfections in the fiber material.

sensitivity—Imprecise synonym for *responsivity*. In optical system receivers, the minimum power required to achieve a specified quality of performance in terms of output signal-to-noise ratio or other measure.

SI—*Systeme International d'Unites*, the international system of units.

single-mode fiber—A step index fiber having a very small core diameter that will propagate only one mode.

solid-state laser—A laser using a crystal or glass material as its active lasing medium. (See *ruby laser.*)

source efficiency—The ratio of emitted optical power of a source to the input electrical power.

spectral—Pertaining to or as a function of wavelength.

spectral bandwidth—The spectral bandwidth for single-peak devices is the difference between the wavelengths at which the radiant intensity is 50 percent (unless otherwise stated) of the maximum value.

spectrum (plural: spectra)—1) A continuous band of frequencies or wavelengths. 2) The visible spectrum showing the component colors of visible light.

spontaneous emission—Radiation emitted when the internal energy of a quantum mechanical system drops from an excited level to a lower level without regard to the simultaneous presence of similar radiation. Examples of spontaneous emission include: 1) radiation from an LED and 2) radiation from an injection laser below the lasing threshold.

step index fiber—An optical fiber whose core has a uniform refractive index.

steradian—The unit solid angle subtended at the center of a sphere by an area on its surface equivalent to the square of the radius. The unit of solid angular measurement. Abbreviation: sr.

sterance—Flux per unit solid angle, per unit area measured normal to the direction of propagation.

stimulated emission—Radiation emitted when the internal energy of a quantum mechanical system drops from an excited level to a lower level when induced by the presence of radiant energy at the same frequency. An example is the radiation from an injection laser diode above lasing threshold.

T

threshold current—The driving current corresponding to lasing threshold.

total internal reflection—The reflection that occurs within a substance because the angle of incidence of light striking the boundary surface is in excess of the critical angle.

transmission loss—Total loss encountered in transmission through a system.

transmittance—The ratio of transmitted power to incident power. In optics, frequently expressed as optical density or percent; in communications applications, generally expressed in dB. Formerly called *transmission*.

U-V-W

ultraviolet—An invisible portion of the optical spectrum whose wavelengths begin immediately beyond the violet end of the visible spectrum. Ultraviolet wavelengths range from approximately 10 to 380 nm.

ultraviolet fiber optics—Special glasses that extend the usable range of fiber optics well into the ultraviolet region. The fibers have a core of high purity, non-fluorescing quartz clad with an ultraviolet-transmitting plastic material.

velocity of light—In a vacuum, the velocity of light in round numbers is 300,000 kilometers per second or 186,000 miles per second. It is only slightly slower in air, but the velocity is lower in all other media.

vitreous silica—Glass consisting of almost pure silicon dioxide (SiO_2). Synonym: *fused silica*.

wavefront—The locus of points having the same phase at the same time.

waveguide dispersion—For each mode in an optical waveguide, the process by which an electromagnetic signal is distorted due to dependence of phase and group velocities on wavelength. This occurs as a result of the geometric properties of the waveguide. In particular, for circular waveguides, the dependence is on the ratio (a/λ), where a is the core radius and λ is the wavelength.

waveguide scattering—Scattering (other than material scattering) that is attributable to variations of geometry and index profile of the waveguide.

wavelength division multiplexing (WDM)—A provision for the transmission of two or more channels over a common optical waveguide, the channels being differentiated by optical wavelength.

CALENDAR

December

Dec. 6: SCTE Interface Practices Committee meeting, Hilton Hotel, Anaheim, Calif. Contact Tom Elliot, (303) 721-5349; or Joe Lemaire, (415) 361-5792.

Dec. 7: SCTE Greater Chicago Chapter technical seminar on CLI. Contact William Gutknecht, (312) 690-3500.

Dec. 7: SCTE Tennessee Meeting Group technical seminar. Contact Joe Acker, (205) 932-7264.

Dec. 7: SCTE Delaware Valley Chapter technical seminar on system preventive maintenance, Williamson Restaurant, Horsham, Pa. Contact Diana Riley, (717) 764-1436.

Dec. 7-8: Trellis Communications fiber-optics seminar, Bay Harbor Inn, Tampa, Fla. Contact Richard Cerny, (603) 898-3434.

Dec. 7-9: Western Show, Convention Center, Anaheim, Calif. Contact (415) 428-2225.

Dec. 10: SCTE Rocky Mountain Chapter technical seminar on video and audio. Contact Steve Johnson, (303) 799-1200.

Dec. 12-13: Scientific-Atlanta technical training seminar, Minneapolis. Contact Patti Kitchens, (404) 925-5480.

Dec. 13: SCTE Chattahoochee Chapter technical seminar, a tour of AT&T's fiber manufacturing plant. Contact Dick Amell, (404) 394-8837.

Dec. 13-14: Financial Times' World Telecommunications seminar, Hotel Intercontinental, London. Contact 01-925-2323.

Dec. 14: SCTE Oklahoma Chapter technical seminar. Contact Herman Holland, (405) 353-2250.

Dec. 14: SCTE Great Lakes Chapter technical seminar. Contact Daniel Leith, (313) 549-8288.

Dec. 15: SCTE Central Indiana Chapter technical seminar and BCT/E testing, Wavetek offices, Indianapolis. Contact Steve Murray, (317) 788-5968; or Joe Shanks, (317) 649-0407.

Dec. 27: SCTE Satellite Tele-Seminar Program, a BCT/E review course on Category III, 12-1 p.m. ET on Transponder 7 of Satcom F3R. Contact (215) 363-6888.

January

Jan. 7-8: National Cable Television Association seminar on FCC's signal leakage regulations, Airport Hilton, Seattle, Wash. Contact (202) 775-3637.

Jan. 7-10: Caribbean Cable TV Association annual meeting, Frenchman's Reef Beach Resort, St. Thomas, Virgin Islands. Contact Cathy Eaglen, (809) 795-5040.

Jan. 18: SCTE Ohio Valley Chapter technical seminar. Contact Robert Heim, (419) 627-0800.

Jan. 23-25: Technology Dynamics Institute course on optical fiber communications systems, San Diego. Contact (213) 935-4649.

Jan. 24-25: National Cable Television Association seminar on FCC's signal leakage regulations, Hilton Hotel, Albuquerque, N.M. Contact (202) 775-3637.

Jan. 24-26: C-COR Electronics technical seminar, Los Angeles. Contact Shelley Parker, (800) 233-2267.

Jan. 31: SCTE Satellite Tele-Seminar Program, a BCT/E review course on Category V, 12-1 p.m. ET on Transponder 7 of Satcom F3R. Contact (215) 363-6888.

Planning ahead

Feb. 22-24: Texas Show, Convention Center, San Antonio, Texas.

May 21-24: NCTA Show, Convention Center, Dallas.

June 15-18: Cable-Tec Expo '89, Orange County Convention Center, Orlando, Fla.

Aug. 27-29: Eastern Show, Atlanta Merchandise Mart, Atlanta.

February

Feb. 5: SCTE Delaware Valley Chapter technical seminar on developing an in-house training program, Williamson Restaurant, Horsham, Pa. Contact Diana Riley, (717) 764-1436.

Feb. 7-8: Arizona Cable Television Association's annual meeting, Sheraton Hotel, Phoenix, Ariz. Contact (602) 257-9338.

AD INDEX

Shattering an HDTV myth

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

The myth of a single universal HDTV (high-definition television) standard is a subject I've addressed in previous columns, papers and presentations. Yet it is such a difficult but important subject that it warrants at least one more discussion. The importance of this topic comes from the need for cable to be competitive in HDTV delivery and for American consumers to have access to the best HDTV possible. The difficulty of this issue lies in the fact that having more than one standard generates confusion and increases costs. Also, some of those who might be technologically limited in their ability to provide the ultimate quality would like others who are not so limited to be artificially restricted by regulation.

In the best of all worlds

In the best of all worlds, there would be only one technical standard for all delivery of HDTV. Consumer confusion would be avoided, manufacturing economies would be maximized. Competition would be on the basis of program content. We have had several examples of the problems caused by multiple technical standards that do essentially the same thing. The growth of the VCR marketplace was most likely slowed by the introduction of two standards, VHS and Beta. Many consumers simply waited out the battle. It took longer for manufacturing economies to be realized. Distributors and dealers had to stock double inventory. The same is true of tape rental shops.

A real cable benefit of a single HDTV standard is the immediate availability of HDTV to a new subscriber who already has broadcast HDTV. For the most part, cable operators would prefer not to have to add new HDTV boxes, convertors or plug-ins or to require them of their subscribers.

Unfortunately, we don't live in the best of all worlds. Our world has some notable imperfections. Some of these blemishes work against the goal of a single universal HDTV standard.

Television technology has become much more complex since the early days of black-and-white. Now video consumers have multiple options for the delivery of programming. Many of these options involve very different technologies with differing quality levels. The differences essentially prevent a truly universal standard. Broadcast signals are amplitude modulated and propagate over a very limited spectrum that often has quality problems. Direct broadcast satellite (DBS) signals require an FM receiver. VCR and videodisc machines require no receiver at all. The telephone industry promises digital video. No single standard can cover such diverse technologies.

The regulatory picture is likewise complex. The differing media are regulated in different ways. Prerecorded media, discs and tapes, are essentially unregulated.

While broadcasters may lack spectrum quantity or quality to compete with the less regulated and non-regulated media, cable can compete from a technical perspective. Artificial regulatory ceilings must be avoided so cable's technology can allow its full competitive potential.

It would be naive to think that HDTV will be in everyone's homes in five or so years. It would be equally naive to think that all broadcasters and cable programmers will be providing HDTV signals in a similar time frame. Experience teaches that such a rollout will take years. In fact the typical rollout scenario of a consumer electronics product involves almost 10 years of slow growth before 10 percent penetration of the market is achieved. Then, in two or three years, penetration reaches 80 to 90 percent. It then takes decades to reach near total penetration.

A major limitation on the rate of growth of HDTV penetration comes from the recognition that HDTV is a large-screen phenomenon. All focus group tests to date have verified the obvious. Consumers can't see significant differences on small screens viewed from more than five picture heights. Consumers will only spend the money when large-screen displays become commonplace and affordable. Large screens and HDTV are so synergistic that if one fails to achieve market acceptance or technical realization, the other will likely fail also. Developing bright, large-screen HDTV displays will take time. Cost-reducing them will follow the usual consumer electronics experience curve.

A practical approach to cable HDTV is to identify proposals that work well for broadcasters, provide adequate initial video quality and have the potential for later upgrade if the competitive situation demands. Cable must allocate adequate resources to evaluate proposals for these features. Some proponents will make upgradeability claims that cable needs to verify. Other proponents may choose not to make the claim to upgradeability.

HDTV proposals need to be evaluated in the light of at least three aspects: 1) how well will the proposal work on cable, 2) will it provide enough initial improvement in quality to be commercially attractive and 3) does the proposal have the potential to evolve to higher levels of performance if the competitive situation demands.

Cable must evaluate the proposals and rank them. Those that pass muster must be supported and encouraged. Those that fail cable's needs may benefit from cable help and consultation. This is especially important for proponents who have a reasonable potential of being adopted by other media, such as broadcast.

Cable must take an active part in the standards evaluation and setting process to ensure its goals and needs are adequately covered. While Cable Labs involvement is a step in the right direction, it cannot be enough. Cable Labs activity will take time to ramp up and will not likely ever reach enough scope to cover all aspects. Individual MSOs must support the effort with their own technical talent and participation.

The Future Is Here!

The ANIXTER Fiber Optic Laser Link AM CATV System

AT&T and Anixter Cable-TV have joined forces to bring you — *today* — the most exciting technological advancement in the cable-TV industry. And, we're proud to say it's the *only* system that is truly *"Made in U.S.A."*

It's Anixter's Fiber Optic Laser Link AM CATV System — a major breakthrough for cable TV in the transmission of multiple AM analog television channels over long distances. Following extensive, highly successful field tests, initial installations of the Laser Link System will be made *this year* by many MSO's. Major features and benefits include:

- Easy installation and maintenance
- Compatible with existing CATV networks
- Low start-up costs
- Reduced maintenance costs
- Easy network upgrades
- Improved signal quality and reliability

For more information, call the Anixter office in your area.

ANIXTER CABLE TV

CORPORATE HEADQUARTERS: ANIXTER CABLE-TV, 4711 Golf Road, Skokie, IL 60076 (312) 677-2600 — Telex 289464

See us at the Western Show, Booth 528.

Reader Service Number 74.