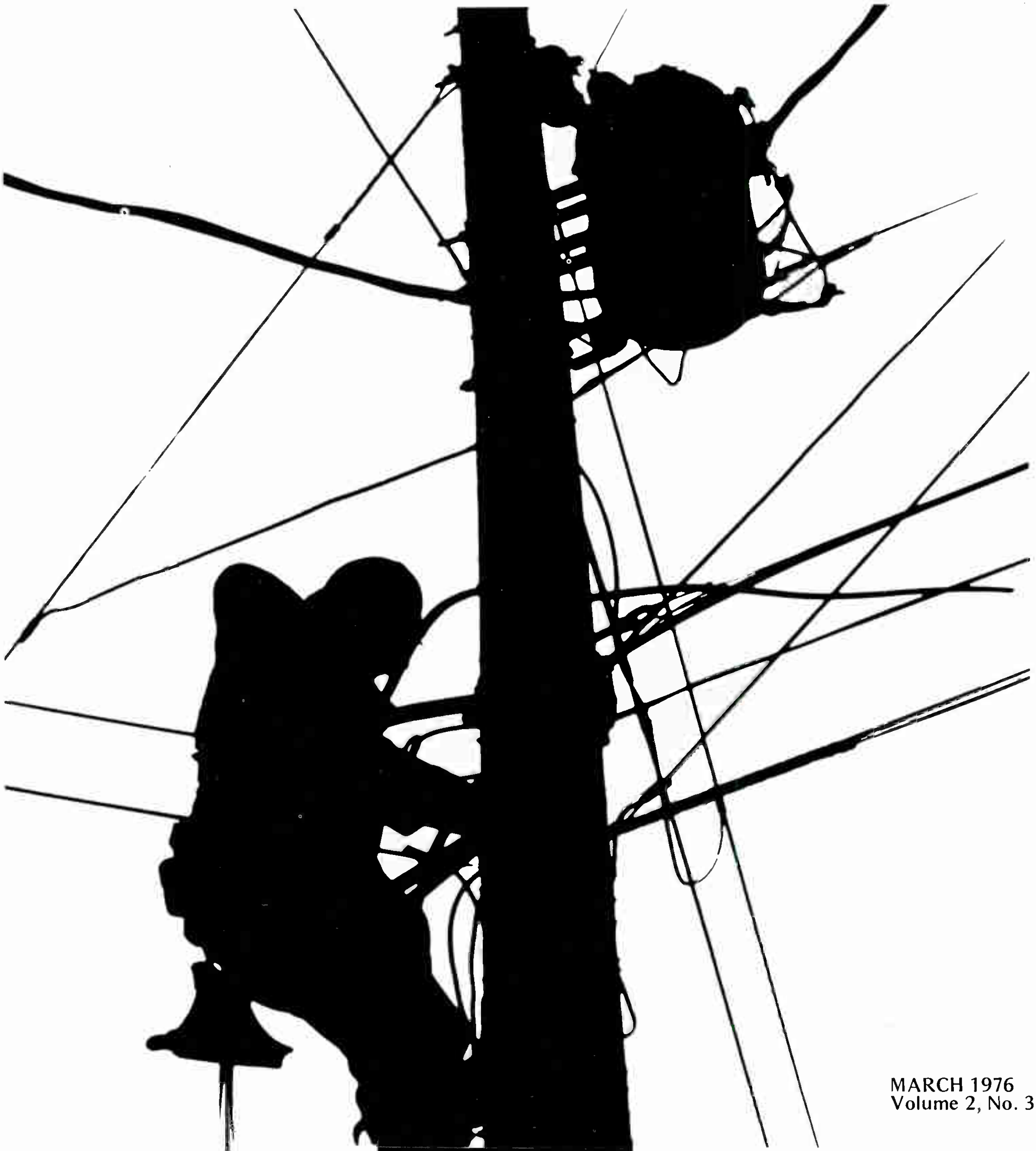
communications/engineering digest

reporting the technologies of broadband communications



MARCH 1976
Volume 2, No. 3

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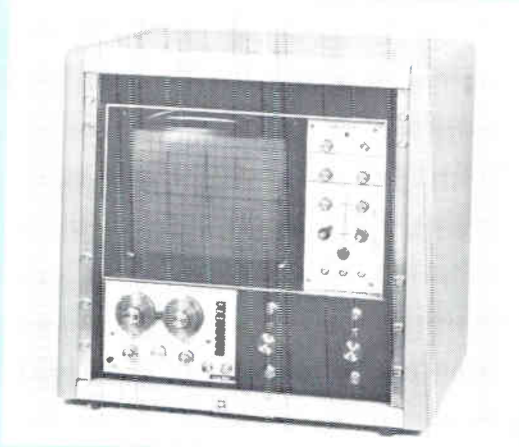

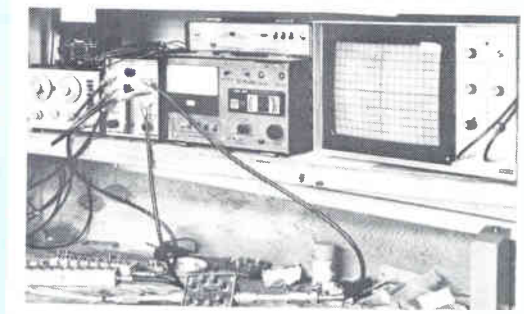

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Volume 2, No. 3

communications/engineering digest

reporting the technologies of broadband communications

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opinion/editorial

There is no doubt that the 1st Annual Conference on CATV Reliability, sponsored by the Society of Cable Television Engineers and the Philadelphia Chapter of IEEE, was a success. And, it appears that the event was a success in all respects—from a programming standpoint, from an attendance standpoint, from the standpoint of further education of technical personnel in the CATV industry.

Seventeen program participants came from all parts of the country to present papers, many at inopportune times to be away from family or business. But they came, because they had made a commitment. The luncheon speakers had traveled to Philadelphia for the same reasons, a commitment. The gentlemen who staged the event, planned the program, taped the sessions and encouraged participation spent many hours to ensure the success of the conference. They are to be congratulated for a job very well done.

About 170 people registered for the conference, February 5 and 6. The majority stayed throughout the entire program. There was never a question of picking which session to attend as they were all excellent. Even the food was good!

SCTE is already planning for a second conference on reliability to be held next year. Meanwhile, various other SCTE programs are scheduled throughout 1976 and, throughout the country. The group will continue to sponsor or co-sponsor seminars and conferences, technical sessions at national or regional shows and certainly encourages SCTE chapter meetings.

I am not a member of SCTE nor am I an employee of this fine group. I provide a service on a parttime basis which mostly comes down to marketing. I am proud to have an affiliation of any nature with SCTE and continue to wish them successes in the future.

The April issue of C/ED will feature the winners of the NCTA Technical Achievement Awards, both past and present, along with a photo-journalism report on the February reliability gathering.

I hope to see you at the Dallas convention in April. You shouldn't miss the sessions planned.

Judith Baer
Judith Baer,
Publisher and Managing Editor

scte comments

THE COST OF NOT KNOWING

A constant struggle goes on beneath the surface of the activity we call the business of cable television. It is a tug of war for dollars. The dollars I am referring to here are those dollars that are either expended or not expended as a function of management's philosophy vis-a-vis technical performance of the system and the technical employees. In CATV, these philosophies range from Protective Isolationism to Broad Search for Improvement. One end of this scale of technical management philosophy is constructed in part by concepts such as:

(a) The system must be working O.K.—people are paying.
(b) Education for technical people means higher salary demands.
(c) Exposure to new test techniques and equipment is just more costly equipment.
(d) Technical people should be guarded, not sent to conventions or regional meetings where they will be subject to "theft of personnel."

That's what I call the dark end of the scale. The light end of the scale is based on the belief that:

(a) Technical performance can improve and thereby satisfy and retain more subscribers.
(b) Properly directed education of technical personnel is a sound investment.
(c) Improved test techniques and associated equipment can reduce manhours and yield a net saving to the operator.
(d) That the exposure of personnel at conventions and trade meetings is a healthy and natural process.

Certainly there are variations between the two ends of my scale. The technique that works in any given situation is measured by the *bottom line.* It is an undeniable fact that the business decision is the ultimate one.

The Canadian Cable Television Industry has historically placed a greater value on technical performance and training. Their overall percentage penetration (and balance sheets) are more impressive than those in the U.S. One conclusion is that their's is not a misplaced belief.

If you believe in the goals of the SCTE as totally as I do, you believe that (a) the potential of technical understanding by personnel is latent and unlimited, (b) the technology of cable is still in its primitive stages.

Discounting our natural paranoia and the motivation to "find a place in the sun" and recognizing the inherent right of every cable operator to decide these matters for himself, the requirement to educate, expose, explore and improve is still good business.

Bob Bilodeau
President, SCTE

CCTA

canadian column

BROADCASTERS AND THE TELEPHONE COMPANIES

It is perhaps unfortunate, but nevertheless a fact of life, that both the off-air broadcasters and the telephone companies tend to be traditional adversaries of many Canadian cable television licensees. January saw new activity in Canada in both these arenas. In popular phrasology there was some bad news and some good news.

The bad news, certainly for cable television operators, concerned relationships with the off-air broadcasters. Canada's most eastern province, Newfoundland, has to date been essentially without cable television service. During the fall of last year the Canadian Radio-Television Commission (the equivalent to the FCC) held a public hearing in Newfoundland to consider 27 applications for cable television licenses to service that province. The commission has recently released its decisions which embody a number of precedents of critical interest and concern to Canadian cable television licensees. Perhaps the most startling provision is the Commission's action in granting monthly cable television subscriber fees in Newfoundland ". . . . on the understanding that portions of the fees proposed by certain applicants will be available for the support of off-air broadcasters to offset the damage caused by audience fragmentation." This subsidy to broadcasters is additional to amounts allocated by the applicants for community programming.

The CRTC's rationale for introducing a off-air broadcaster subsidary is that it ". . . does not consider that cable television is a proper means for the provision of first service to communities which, to date, have had no service or only one service. There is a need to ensure that the extension of off-air television broadcasting service available in Newfoundland is not hindered in any way by the introduction of cable television. Further, such services must be maintained and strengthened." We can only hope that the specific circumstances which pertain in Newfoundland, and which have inspired the imposition of this subsidy, will also serve to diminish its status as a precedent to be applied to other areas of Canada.

Being in a relatively remote area of Canada, cable television in Newfoundland is predicated upon the importation of U.S. signals by microwave. These signals come from Maine, and another area of concern for cable television operators is an additional portion of the decision that states that Newfoundland licensees will enter into agreement for the provision of these microwave signals with a consortium already in existence in our Maritime provinces of New Brunswick and Nova Scotia. So far this seems fair and reasonable. However, less reasonable is the requirement

continued on page 36

publications

Cable Television: Promise Versus Regulatory Performance, Jan. 1976: Committee on Interstate and Foreign Commerce, Subcommittee on Communications, U.S. House of Representatives Reprints. TV Digest, Inc., 1836 Jefferson Place N.W., Washington, DC 20036. 110 pages. $5.00 per copy. Make check payable to TV Digest.

CTAC Volume I Steering Committee Report, Final Report to FCC, May 1975: 216 pages. $8.50 SCTE members, $11.00 non-members. Circle RSC 4.

CATV Graphic Symbols, Proposed National Standards for Grid and Mapping Diagrams, Dec. 1975: Reprint from Communications/Engineering Digest. $5.00 per copy. Circle RSC 18.

Proof of Performance Series, 1975-76: Reprint from series in Communications/Engineering Digest. $10.00 complete series, 76.605(a)1-12. Circle RSC 17.

Cable Communications Publications Listing, April 1976: Lists over 500 books, periodicals, papers, etc. with addresses and ordering instructions. Published by Communications/Engineering Services. Prepublication orders received by March 31, 1976, $15.00 per copy; after March 31, $22.50 per copy. Circle RSC 23. Make checks payable to Communications/Engineering Services.

Longitudinal Sheath Currents in CATV Systems, April 1975: J. Shekel and J. Herman, NCTA Convention paper, not included in transcripts. SCTE, 607 Main Street, Ridgefield, CT 06877. $2.00 per copy. Make check payable to SCTE.

Protecting CATV Equipment Against Effects of Longitudinal Sheath Currents, April 1975: N. Everhart, NCTA Convention paper, not included in transcripts. SCTE, 607 Main Street, Ridgefield, CT 06877. $2.00 per copy. Make check payable to SCTE.

Conference Transcripts, 1st Annual SCTE/IEEE CATV Reliability Conference, February 1976: SCTE, 607 Main Street, Ridgefield, CT 06877. $15.00 SCTE and/or IEEE members; $18.00 others. Make check payable to SCTE.

Communications/Engineering Digest, Oct. through current month of publication, prior issues are available, Vol. 1, Nos., 1, 2 and 3; Vol. 2, Nos. 1, 2 and subsequent. $1.00 per copy. Order from C/ED, 1300 Army Navy Drive, Arlington, VA 22202. Enclose check, payable to Communications/Engineering Digest. Specific Volume and Issue number is required to fulfill order.

SCTE EYEOPENER KICKOFF

Zero Defects and Value Engineering

Monday, April 5, 1976.
8:00 a.m.
Dallas, TX

Conferences, publications, seminars, technical sessions and chapter meetings are being held across the country by the Society of Cable Television Engineers and its various Chapters. SCTE also sponsors technical sessions at the NCTA national conventions each year, assists in the NCTA Technical Achievement Awards programming and holds a seat on the Engineering Advisory Committee of NCTA.

In 1976, SCTE will present the EYEOPENER KICKOFF Technical Session in Dallas on Monday morning, April 5 at the NCTA 25th Annual Convention. This session will feature Philip Crosby, Vice President, Quality for ITT. Crosby is responsible for product and service quality in ITT's world-wide operations—and he knows what he is talking about. Zero defects and value engineering will become an increasingly important part of cable /broadband system operation. Crosby, the author of three books, plus a panel of cable industry engineering and management leaders will start your mind working, and give you some food for thought.

Another way of saying zero defects is reliability. Another way of saying excellent programming is the Society of Cable Television Engineers.

ncta technical topics

how important is a dB?

INTRODUCTION

How important is a dB? Much as we hate to admit it, we don't really know. This is especially true when we are talking about human responses to visual and aural perception. We now have a chance to find out. From the CTAC work came a recommendation for a project to measure signal quality of television signals as perceived by everyday human beings compared with the signal quality as measured by the various accepted techniques of measuring electrical quantities. This project is also supposed to measure how these same human types would rate these same signals with respect to degrees of acceptability. The project has now been started under the sponsorship of the National Science Foundation.

We have asked Archer Taylor, Chairman of CTAC Panel 2 and one of the principal architects planning for the project, to describe the plans for the project.

DESCRIPTION OF PROJECT TO MEASURE CABLE TV PICTURE QUALITY

The primary objective of the project is to find out how ordinary, everyday television viewers rate television pictures which have been deliberately impaired in the following ways:

- random noise (snow)
- intermodulation noise (near zero triple beats)
- synchronous cross-modulation
- single frequency beats
- various combinations of the above

While there are many other possible causes of picture quality degradation, these particular impairments were selected for quite specific reasons.

The effect of random noise on picture quality has probably been studied formally by more investigators all over the world than any other kind of picture signal impairment. Signal-to-noise ratio, therefore, is the common denominator by which meaningful comparison and correlation of a wide variety of test methods and conditions can be made.

Intermodulation noise, or the near zero triple beat as it is sometimes called, is almost unique to multichannel cable television. Viewer response to IM noise has been investigated to a limited extent by several equipment suppliers, but never before with systematic, professionally controlled psychometric techniques. Data collected to date have been too widely scattered to generate much confidence in the results.

For several years, we seemed to have a generally satisfactory standard of tolerable cross-modulation of the type causing windshield wiper effects. However, with the transition to color and tightly controlled sync timing, most operators now believe the old standard is too restrictive. This project will obtain, for the first time, scientifically controlled data on synchronous cross-modulation.

The tests involving more than one impairment at a time will roughly double the present amount of published data on combined impairments.

Perhaps the most important feature of this research project is that, for the first time, the subjective parts of the tests will be designed and executed by a trained and experienced specialist in psychometrics, not by engineers. 750-900 observers, representative of the total population with respect to age, sex, eyesight and other characteristics, will make nearly 75,000 picture quality judgments in about 500 rating sessions.

Separate tests are planned to measure the effect on viewer ratings of scene content, still versus motion pictures, length of time viewers are exposed to the picture, viewing distance, the television experience of city grade versus fringe area viewers, television technicians versus non-experts. The test pictures will be presented to half

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Delmer C. Ports, Vice President-Engineering • Hazel S. Dyson, Administrative Assistant

the viewers in one random sequence, and to the other half in a different sequence to minimize any possibility of bias.

The TASO rating scale, with which we are so familiar in the United States, is only one of nearly a dozen rating scales used for viewing tests elsewhere. Europeans use a 5-grade scale; the British and TASO use a 6-grade scale; Bell Telephone Laboratory uses a 7-grade scale. Sometimes the words are confusing. Is "bad" worse than "poor"? Is "fine" better than "excellent"? Is a "marginal" rating acceptable, or unacceptable? Is "annoying" any different from "objectionable"? Does the term "objectionable" mean the same thing to a home television viewer as to a technician evaluating network feeds?

For the first time, controlled tests will be performed to compare the response of viewers to six different categorical scales.

But this research will do much more. All of the tests will be performed using a psychometric technique called ratio estimation, developed nearly 40 years ago for measuring human response to sensory stimuli of all kinds without the semantic problems encountered in using word scales. In ratio estimation scaling, the viewer is asked to compare two pictures, displayed simultaneously. Computer programs have been designed to enable the investigator to determine the relationship between Perceived Picture Quality and the measured signal impairment merely from the viewer responses as to which of the two pictures have better quality. However, the viewer will also be asked to indicate whether, in his judgment, the poorer of the two pictures is only half, or two-thirds or some other fraction, as good as the better one. Of course, there will be a scatter of results depending on individual differences. But many years experience in using this technique indicate that the law of perception of picture quality as a function of measured signal impairment can, in fact, be determined in this way with a high degree of confidence.

Still another scaling technique called metric triads, will be used in two additional tests. This technique has been used at Eastman Kodak for evaluating color photographs, and is an outgrowth of another technique known as "multi-dimensional scaling" developed at Bell Telephone Laboratories for measuring human response to complex stimuli. In metric triad scaling, three pictures are viewed simultaneously and arranged so that the best quality picture of the three is at one side, and the poorest at the other side. The viewer is then asked to indicate how he perceives the quality of the picture in center with respect to the other two. Is it about midway between? Or is it nearly as good as the better one? Or is it only slightly poorer than halfway? He indicates his judgment by placing a mark on a line at the appropriate point between the ends of the line.

Out of all these tests will come a curve (or a formula) expressing the numerical value of the Perceived Picture Quality as a function of the measured technical characteristics of the electrical signal, or waveform. Once this law of perception of picture quality has been determined, the data from the word grading scales can be correlated to provide a highly reliable determination of the manner in which the public evaluates the pictures delivered by cable television systems.

Fortunately, and deliberately, engineers will have nothing to do with the conduct of these psychometric tests. This is a specialist field in which engineers are seldom competent.

Engineers will be responsible for setting up the viewing monitors and generating the test pictures and controlled impairments. The proper signal to interference ratio must be set for each viewing judgment by attenuator adjustments. For ratio estimation, two attenuators have to be adjusted; for metric triads, three. For ratio estimation tests with combinations of two impairments, four attenuators have to be adjusted; six for metric triads. Considering that the picture will be displayed for only 10 or 15 seconds, with 5 or 10 seconds black between pictures, it is obvious that manual operation would not only be difficult, but subject to serious adjustment errors.

The engineering staff at the Public Broadcasting System is constructing special facilities for these tests, using programmable attenuators so that all adjustments can be established rapidly and correctly by computer. This is a first for tests of this type. Still another first is the use of video tape (2-inch) and split-screen techniques.

The project is sponsored by the University of Missouri at St. Louis, funded by the National Science Foundation. The Principal Investigator is Robert E. Welch, a specialist in psychometrics at the University. The Public Broadcasting System will produce the necessary video signals and video tape recordings. Malarkey, Taylor and Associates will coordinate and direct the technical aspects of the project. Viewing tests will be conducted in part at KETC, the PBS affiliate in St. Louis, and in part at PBS headquarters in Washington.

The project is particularly fortunate to have the guidance, support, and assistance of a remarkable Advisory Board.

Donald G. Fink, Chairman of the Advisory Board, is currently Executive Consultant to IEEE following his retirement after many years of service as General Manager.

Stuart L. Bailey, Jansky and Bailey, Washington consultants, is a past president of the IEEE, and highly respected in the field of telecommunications engineering.

Edwin J. Breneman, Color Photography Division of Eastman Kodak Research Laboratories, is very experienced

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announcements/new products

READER SERVICE ANNOUNCEMENT

COMMUNICATIONS/ENGINEERING DIGEST has initiated a new Reader Service Card format with this March issue of C/ED. Included in one card is the ability to inquire about all display advertisers and all new product announcements appearing in the publication. Additionally, inquiries for subscriptions, membership in the Society of Cable Television Engineers and various industry events may be made on the all purpose card. You may also order publications with it.

To inquire about new products appearing in this magazine, please circle the appropriate number and place the card into the mail with your name and address supplied please. No postage is required. Responses will come directly from the manufacturer or sponsor of the event.

SCTE PROGRAMS VALUE ENGINEERING & ZERO DEFECTS

SCTE Announces Convention Program

Quality counts! System performance, reliability, delivering a quality product to the subscriber, managing your internal business affairs, evaluating employees and evaluating yourself, all things important to survive in business.

SCTE will present Philip Crosby, Vice Pres; Director-Quality of ITT Corp. as the featured speaker Monday, April 5 during the NCTA Convention in Dallas TX. In his capacity as director of quality for ITT, Crosby is responsible for product and service quality in ITT's 225 divisions and subsidiaries in 67 countries. He is the author of several articles and three books "Cutting the Cost of Quality," "The Strategy of Situation Management," and the recently published "The Art of Getting Your Own Sweet Way."

SCTE speaker Phil Crosby, ITT

Crosby will be joined by a panel of cable industry management and engineering talents to provide a lively session to start the entire convention technical programming.

SCTE's Tuesday Eye Opener Session will theme on Alpha-Numeric Displays and Wednesday will address practical day-to-day engineering technology on Earth Stations.

The SCTE Annual Meeting will be held Sunday, April 4 and awards for SCTE Man of the Year will be presented. NCTA and the South Central West Chapter of SCTE will co-host the Engineer's Reception, Monday evening April 5 where the Technical Achievement Awards will be presented. (Circle Reader Service Card No. 100)

NCTA CONVENTION TECH PROGRAM

Satellite Cable Interconnection, Designing Reliable Systems, Two-Way and Auxiliary Services, and an Engineering Forum are among the topics for NCTA technical sessions at the NCTA convention, April 4-7, 1976 at the Dallas Convention Center, Dallas, TX.

Dr. Richard Marsten, Dean of Engineering at City University of New York and formerly of NASA, chairs a discussion on Satellite Cable Interconnection at the session Monday, April 5. The Advanced Techniques panel on Tuesday, April 6, features a demonstration of fiber optics applications.

A second technical session on Tuesday, Two-Way and Auxiliary Services, will emphasize data transmission services via CATV. The panel features a case study in banking by cable, by Bankers Trust Co., New York. Nationally recognized researcher, G.O. Shelton of GTE, will deliver a paper entitled "Transmission of High-Speed PCM Signals on CATV Systems" during the panel discussion.

A special Engineering Forum—a roundtable discussion of cable engineering problems and solutions—will be the main focus on Wednesday, April 7. NCTA's Engineering Advisory Committee chairman James Lahey, Muskegon Cable TV, will head the panel comprised of EAC members.

A complete list of technical program panelists and papers is available from NCTA. Advance registration for the convention is $135 for NCTA or SCTE members and $185 for others. (Circle Reader Service Card No. 100)

VITEK EXPANSION

To meet the increasing demand for the new Pay TV Super Trap manufactured by Vitek Electronics, Inc., Robert Geissler, President of Vitek announced that he has added 4500 square feet of production area to his facility and has increased his production staff. In a recent interview, Mr. Geissler stated that "more and more people in cable TV are coming to the realization that our trap is the best in the industry. We've added to our production capabilities to meet the expanding needs of our new and existing customers." (Circle Reader Service Card No. 101)

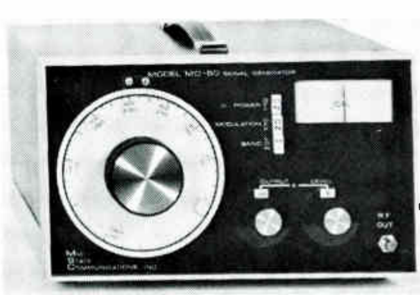
RF TERMINATIONS

Fixed (Models A56T50S and A56T75S) and Variable (Models A56T50 and A56T75) RF Terminations. VSWR: 1.02:1 max 0-500 MHz (40 dB return loss); 1.006:1 max 0-300 MHz (50 dB return loss). The Fixed type is in a male type "N" connector. The Variable type has type "N" female connector standard. Available in 50 or 75 ohm impedance. These terminations complement the Series A57 Fixed and A56 Variable RF Impedance Bridges manufactured by ***Wide Band Engineering Company, Inc.,*** Phoenix, Arizona (Circle Reader Service Card No. 102)

MID STATE SIGNAL GENERATOR/ METER CALIBRATOR

Model MC-50 has been designed specifically to calibrate signal level meters used in measuring television and C.W. signals. This design was necessary because of errors exhibited by peak detector circuits in SLM's and was met by incorporating circuitry to modulate the output signals. Amplitude modulation frequency is 15.75 kHz with a duty cycle of 7% which simulates modulation produced by the horizontal sync of a TV carrier.

MC-50 may also be used as a standard signal generator in the unmodulated mode. The frequency range is from 4 MHz to 300 MHz and output level is guaranteed to be within ±0.25 dB. Output level may be set anywhere from -30 dBmV to +50 dBmV in 1 dB steps. The output is controlled by precision attenuators. The output level control circuitry is monitored by a front panel meter, and a rear panel connector provides a +40 dBmV signal for use with a frequency counter. (Circle Reader Service Card No. 103)



Mid State MC-50

COMPLETE PORTABLE CABLE MAINTENANCE SYSTEM

A new, Medium-Duty Fault Locating System consisting of a 25 kV Impulse Generator, 25 kV Proof Tester, and 50 mA Fault Burner in one, self-contained unit is available from James G. Biddle Co., Plymouth Meeting, Pa. This compact "Thumper" is available in two lightweight versions: a 25 kV-2uF model providing 625 watt-second output weighing just 100 lbs; and a 25 kV-4uF model available for 1250 watt-second output weighing only 125 lbs. Both units incorporate numerous operator safety features, versatile and simplified operation. Both are competitively priced. Rugged design and solid state circuitry assure reliable field performance. Either set may easily be carried by two men, or transported in an automobile trunk or light van. (Circle Reader Service Card No. 104)

Biddle Thumper

ASTROLOGES CHAIRMAN, WORLD PAY TELEVISION

Frank A. Astrologes, president of Oak Industries, Inc. since 1970, has relinquished that post to become chairman and chief financial officer of World Pay Television, a Los Angeles joint venture Oak recently formed to operate a broadcast pay television business.

Mr. Astrologes also has been named chairman of a newly created finance committee of the board of directors of Oak.

E. A. Carter, chairman and chief executive officer of Oak, will assume the additional title of president.

World Pay TV's Astrologes

World Pay Television is a joint venture of Oak and Chartwell Communications, a private investor group headed

continued on next page

announcements/new products continued

by A. Jerrold Perenchio of Los Angeles. Mr. Perenchio is president and chief executive officer of World Pay Television.

CAMPAIGN '76

In a special letter during January, NCTA Pres. Robert L. Schmidt called upon the cable industry to undertake a national demonstration of CATV's capability to facilitate the flow of information about vital national and local issues to the public.

Schmidt urged cable TV operators wherever possible to provide free or low-cost cable time to bona fide candidates for public office, and encourage use of cable TV channels for public discussion of campaign issues by candidates. He noted that in past years cable TV operators have provided free or low-cost time to federal, state and local officials, have organized special public affairs programs and debates on cable TV, and in some cases have joined together to distribute programs through state-wide CATV networks.

"I know that CATV can play an even bigger role in 1976," said Schmidt. "We now serve 10 million American homes and many of those homes can be reached through political and public service cablecasting," Schmidt added.

JERROLD NAMES VP/MFG. OPERATIONS

Jerrold Electronics has named Philip W. Semisch as vice pres. in charge of manufacturing operations. Semisch will report directly to JEC president,

P. W. Semisch, VP of Mfg., Jerrold

Robert D. Eisenhardt, Jr. and his responsibilities include the company's production facilities, recently centralized service and repair facility, corporate quality control, material control, distribution warehousing and the central manufacturing support staff.

Mr. Semisch served 19 years with General Electric in various management assignments, his most recent being manager of GE's Decatur, IL operations. He received his BS in Business Administration from Drexel University and his MBA from Syracuse University.

THETA-COM AML PERFORMANCE IMPROVEMENT

Theta-Com of Phoenix announces a major design innovation which improves the noise figure of its multichannel AML receivers by 3 dB.

This improvement literally doubles receiver sensitivity with a corresponding improvement in overall system performance while also reducing cost and size of antennas required for the same performance with present AML receivers.

The new design improves signal-to-noise ratio and propagation reliability as well as reduces severity of signal propagation fades. It also allows user's signals to reach a large number and/or more distant receiving points.

The improvement will also be available to existing Theta-Com AML systems on a retrofit basis. A. H. Sonnenschien, Theta-Com Director of Engineering, stated that this was a continuation of the company's established policy of minimizing product obsolescence by making major design improvements available to owners of older equipment. (Circle Reader Service Card No. 105)

THETA CABLE TELEVISION

LOS ANGELES—Wallace D. (Dee) Miller has been appointed General Manager of Theta Cable Television. In his new position, Miller will be responsible for the overall operation of one of the country's largest cable television systems. Theta, owned jointly by Teleprompter Corporation and Hughes Aircraft, services over 77,000 cable subscribers and 28,000 pay cable subscribers to the Z Channel in the Los Angeles area. Miller most recently

Miller, Gen. Mgr., Theta Cable

served as Teleprompter Northwest District Manager, in charge of 10 cable systems located in Montana, Washington and Idaho.

WAVETEK NEW PRODUCTS

Wavetek Indiana has introduced a VHF Sweep Generator, Model 1050A, selling for less than $500. The 1050A covers a frequency range of 1 to 400 MHz, and has a calibrated RF output of XX + 10 dBm to -60 dBm. PIN diodes provide flatness of ±0.25 dB. Harmonic and non-harmonic spurious signals are 30 dB below output. (Circle Reader Service Card No. 106)

Wavetek has also announced a new 35 channel CATV Sweeper, Model 1402A which includes a programming switch presenting the center frequency

continued on next page

announcements/new products continued

of 36 positions covering the 1 to 400 MHz range. The unit is crystal controlled with pulse type markers at the picture and sound carrier of each unit. (Circle Reader Service Card No. 107)

JERROLD PRODUCT ANNOUNCEMENTS

"Levelite" Signal Indicator"

Designed to indicate the presence (or absence) of a TV signal, Jerrold's new ***LEVELITE*** indicator incorporates a selective amplifier that responds only to VHF high-band TV signals. Hence, interference from FM radio signals cannot cause false readings.

"Our new ***LEVELITE*** signal indicator is a very handy special-purpose tool," says Raymond G. Pastie, general sales manager for Jerrold's CATV Systems Division. "It can be used to *instantly* detect whether or not sufficient signal strength is available to a TV set."

Levelite Model L-200

In citing the convenience of this new troubleshooting test tool, Ray Pastie states: *"The **LEVELITE*** indicator incorporates two LEDs, one red, one green. The red light indicates battery power is okay. The green light indicates the positive presence of a TV signal."

Also incorporated is a local/distant switch. In the local position any signal with a minimum level of +6 dBmV (2,000 μV) will light the green LED. The brightness will be maximized with a +10 dBmV signal. In the distant position, the green LED will light with a -6 dBmV (500 μV) signal; and the maximum brightness will occur with a -2 dBmV or greater signal.

"Jerrold's new ***LEVELITE*** indicator can be connected quickly and conveninetly to virtually any TV-signal source," says Ray Pastie. "In addition to checking for CATV signals in subscribers' homes, this handy tool may be used to check signal levels at the antenna, headend, amplifier, splitter, tap-off, or any place you need to find out in a hurry if the signal is really there."

The ***LEVELITE*** provides reliable results over a temperature range of 20° to 100° F, and the complete L-200 package includes: standard 75 and 300 ohm adapters for connection to any F or G fittings, autoplug-type fitting or 300-ohm terminal screws; and a convenient padded holster-type carrying case with belt clip. (Circle Reader Service Card No. 108)

75-ohm RF Bridge

For accurate return-loss measurements over the entire 1 to 300 MHz frequency range, a new RF bridge offers better than 60-dB balance. This new Jerrold/Texscan RF bridge, model RFB-1/75, features a built-in, tamper-proof reference termination. Specifications include: 15-dB insertion loss; 1-dB maximum open-short ratio; and 35-dB minimum test-port match. The test-port connector is GR-874. Input and output connectors are type F. A series of precision adapters is available for measurements on equipment having other commonly used 75-ohm connectors. Precision 75-ohm terminators are available as accessories. (Circle Reader Service Card No. 109)

Bench-Mount Attenuator

A new "packaged attenuator" from Jerrold/Texscan may be used for measurement-by-comparison and reduction of high-level signals to sweep generators, oscilloscopes and spectrum analyzers. Designated the model 577, specifications include: 0-80 dB attenuation in 1 dB steps; 75 ohm impedance; 500 MHz frequency range; accuracy of ±0.1 dB at 30 MHz and ±0.3 dB at 500 MHz for 0-10 dB attenuation, ±0.2 dB at 30 MHz and ±0.5 dB at 500 MHz for 11-70 dB, and ±0.3 dB at 30 MHz and +0/–1.5 dB at 500 MHz for 80 dB of attenuation; insertion loss is less than 0.3 dB at 30 MHz and less than 0.8 dB at 500 MHz; maximum power dissipation is 1 watt (average) at 25°C; VSWR is less than 1.2:1 (20 dB return loss) at 500 MHz. Standard F female connectors are supplied with the new model 577. BNC, TNC and N connectors are available.

Jerrold attenuator

The advantages of the "packaged attenuator" concept are convenience for operation (single unit versus a pair of non-attached attenuators which are easy to misplace) and a neater test bench—plus dependable reduction of high-level signals or measurement-by-comparison tests with the Jerrold/Texscan Sweep-and-Marker Generator, model SS-700-7F, or the Jerrold/Texscan RF Coaxial Comparator, model TC-2-7F. The new "packaged attenuator" may also be used as part of a triple-trace set up in conjunction with the SS-700-7F, TC-2-7F, and the Jerrold/Texscan Large-Screen Display Oscilloscope, model DU-720. (Circle Reader Service Card No. 110)

continued on page 18

proof of performance timetable
when to do it — how to do it . . .

subpart k terminal isolation and radiation

Glenn Chambers
Regional Engineer
American Television & Communications
North Central Division
Appleton, Wisconsin

76.605-a TECHNICAL STANDARDS

(11) The terminal isolation provided each subscriber shall be not less than 18 decibels, but in any event, shall be sufficient to prevent reflections caused by open-circuited or short-circuited subscriber terminals from producing visible picture impairments at any other subscriber terminal.

In the "good old days," when pressure taps and resistive and/or capacitive taps were the rule, this isolation would have been hard or impossible to meet. With the newer type of taps, 18 dB isolation would be considered poor. Most taps, particularly the higher values, are now achieving 30 to 40 dB isolation figures.

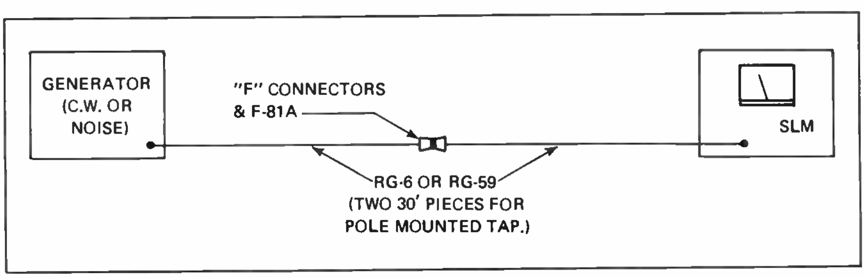
EQUIPMENT REQUIRED

An accurate SLM, a signal source (wide band noise generator or c.w. generator) and jumper cables.

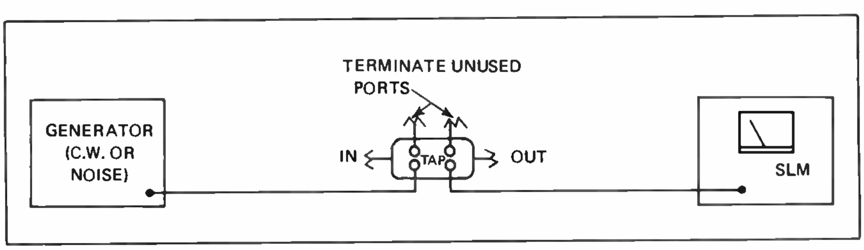
PROCEDURE

Connect the equipment as shown in *Drawing 1*. Read and record the signal level on highest and lowest frequencies normally carried on the cable, usually channels 2 and 13.

Connect the test equipment as shown in *Drawing 2*. Make sure that all unused ports are terminated. Read and record the signal levels at the same two frequencies as before. Subtract the second readings from the first and you have the terminal isolation figure. Even with low value taps, you should have more than 20 dB isolation.



Drawing 1. Terminal Isolation



Drawing 2. Terminal Isolation

76.605-a

(12) Radiation from a cable television system shall be limited as follows:

Frequencies	Radiation Limit (Microvolts/Meter)	Distance (Feet)
Up to and including 54 MHz	15	100
Over 54 up to and including 216 MHz	20	10
Over 216 MHz	15	100

Most of us will be primarily concerned with the 20 microvolts/meter at 10 feet.

I have not seen any system over 3 years old that has no radiation in any part of town. It is true that the radiation may be less than 15 μv/m, but there is still some there. One of the hard parts is finding a channel that has no off-air signals to confuse the readings. If one or more pilot carrier signals are used as AGC/ASC controls, they can be used for test purposes. However, many pilot signals, particularly 73.5 MHz, are normally carried 8-10 dBmV below their associated visual levels. This can give an erroneous reading compared to actual visual radiation levels. The best test signals are visual signals (such as weather-scan), which have no off-air reception, and which are carried at levels comparable with the adjacent channels.

EQUIPMENT REQUIRED

An accurate SLM, a dipole test antenna, a preamplifier with known gain, test leads and the proper chart for your dipole.

The dipole can be either a home-made folded dipole (see *Drawing 3*), a

continued on next page

proof of performance timetable continued

Simons dipole (see *Drawing 4*) or any number of commercial units such as the Mid-State RD-1, with built-in preamplifier, or the Singer MD-105-T1 or others. The preamplifier should have between 15 and 30 dB gain from at least 54 to 216 MHz (for channels 2-13) and the response should be flat. Battery powering is preferred.

PROCEDURE

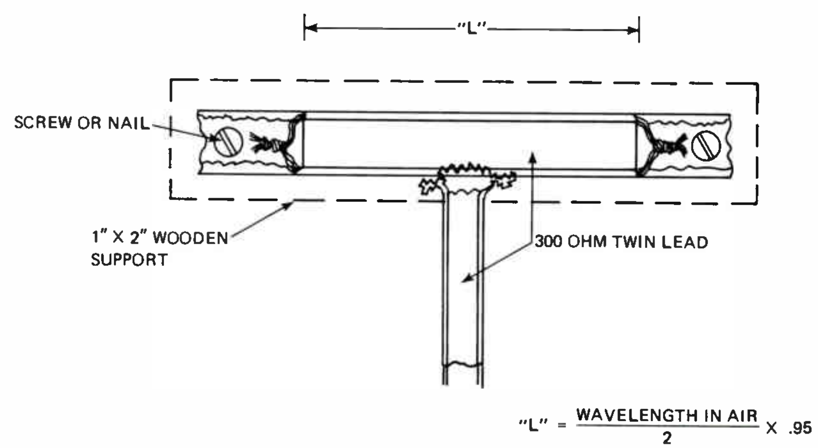
On adjustable dipoles, adjust each side to correct length. See *Table 1*. Connect the test equipment as shown in *Drawing 5*. At the field location where tests are to be made, place the dipole under the cable to be tested. Remove attenuation from the SLM until a reading is obtained. You should always get some indication, even if it is just the noise of the preamp. Tune the SLM to the frequency to be tested and try for a peak meter reading. If there is no discernable peak near the frequency desired, you are probably reading only noise. Set the meter back to the correct frequency and raise the dipole to approximately 10 feet below the cable. Slowly rotate the dipole 360 degrees, again looking for a peak indication. If you receive no indication, the location is radiation free. If there is a peak, tune the SLM for maximum indication and rotate the dipole for maximum pickup. Be sure that the dipole is about 10 feet below the cable and not near other wires and cables. Record this level in dBmV.

To get actual radiation figures, some calculations must be made. First, sub-

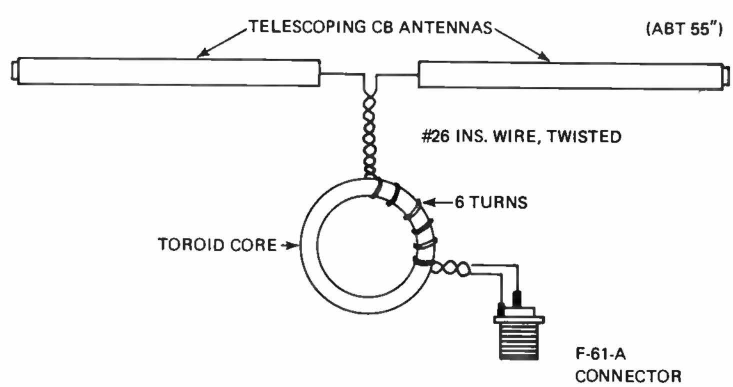
TABLE 1

Channel	Video Carrier Frequency (MHz)	Antenna Output Level at FCC Limit (dB above one microvolt)	Length of Antenna Rods (inches)
2	55.25	25	51
3	61.25	24	46
4	67.25	23	42
5	77.25	22	36
6	83.25	21	34
A	121.25	18	24
B	127.25	18	22
C	133.25	17	21
D	139.25	17	20
E	145.25	16	19
F	151.25	16	18
G	157.25	16	18
H	163.25	15	17
I	169.25	15	16
7	175.25	15	16
8	181.25	15	15
9	187.25	14	15
10	193.25	14	14
11	199.25	14	14
12	205.25	13	13
13	211.25	13	13

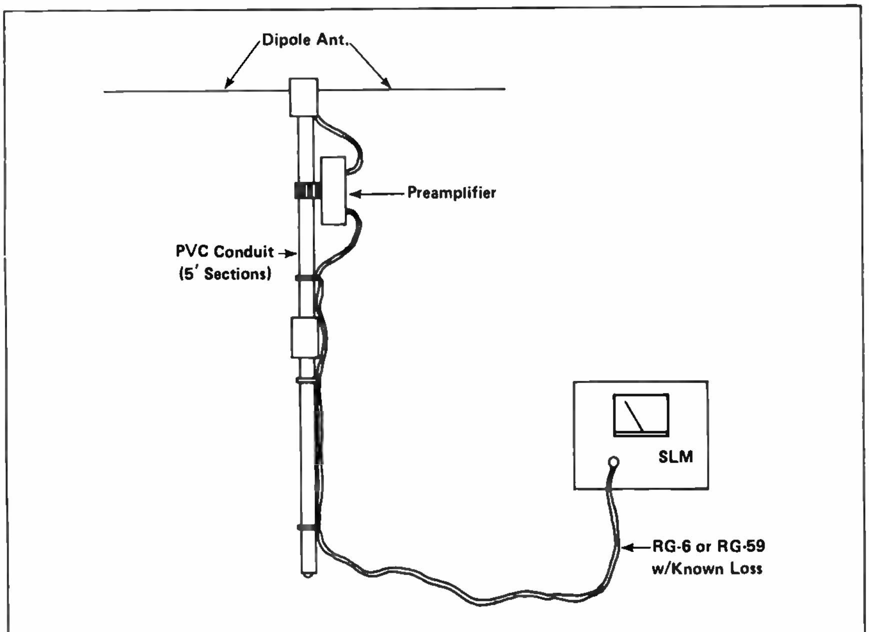
CHANNEL	2	3	4	5	6	7	8	9	10	11	12	13
"L" IN INCHES	98.31	89	81.18	71	66	31.62	30.62	29.62	28.68	28	27	26.31



Drawing 3. Folded Dipole Antenna



Drawing 4. Simons Dipole Antenna



Drawing 5

tract the gain of the preamplifier. Remember that when you subtract from a negative number, the digits will be larger, such as subtracting 20 from -10 will give you -30. Next *add* the attenuation of the test cables at the frequency measured. This number will usually be less than two (2) dBmV. You will now have the actual radiation level at this test point. You can then compare it with the maximum permissible level on the proper radiation table.

Example: (Folded dipole antenna)
Signal Measured @ Channel 13 = -20.7
Subtract preamp gain = -30.3
Add the downlead loss = + 2.0

Total Radiated Signal = -49.0

The table states that maximum radiation on Channel 13 can be -47. Your radiation is 2.0 dBmV below maximum allowed.

FOLDED DIPOLE RADIATION TABLE

Chan	Level	Chan	Level	Chan	Level
2	-36	C	-43	7	-46
3	-37	D	-44	8	-46
4	-38	E	-44	9	-46
5	-39	F	-44	10	-46
6	-40	G	-45	11	-47
A	-43	H	-45	12	-47
B	-43	I	-45	13	-47

If the radiation is less than is shown on the chart for the channels tested, you can move on to the next test point. If the radiation is more, you should locate and correct the problem now. Radiation can be caused by many things including connectors, cables, amps, etc. The dipole is an excellent location tool. Just keep moving it in a direction that increases the SLM reading until the radiation source is located.

To convert the radiated signal from dBmV to microvolts and then to microvolts per meter, use the following table and formula:

CONVERSION TABLE

Minus dBmV to Microvolts (RMS)

(Minus) dBmV	(UV) RMS	(Minus) dBmV	(UV) RMS
20	100.00	40	10.00
21	89.10	41	8.91
22	79.40	42	7.94
23	70.80	43	7.08
24	63.10	44	6.31
25	56.20	45	5.62
26	50.10	46	5.02
27	44.70	47	4.47
28	39.80	48	3.98
29	35.50	49	3.55
30	31.60	50	3.16
31	28.20	51	2.82
32	25.10	52	2.51
33	22.40	53	2.24
34	20.00	54	2.00
35	17.80	55	1.78
36	15.90	56	1.59
37	14.10	57	1.41
38	12.60	58	1.26
39	11.20	59	1.12

continued on page 19

announcements/new products continued

NCTA ELECTS NEW OFFICERS

Burt I. Harris, president of Harris Cable Corp., Los Angeles, was elected chairman of the National Cable Television Association at the NCTA Board of Directors meeting February 3.

Harris, an NCTA director since 1972, served as vice president during the present term, and also served on NCTA's convention and subscription cablecasting committees. Harris assumes the chairmanship during the NCTA convention, April 4-7.

Harris entered the cable TV industry eleven years ago when he purchased cable systems in Palm Springs, California and Flagstaff, Arizona. After a series of mergers, his company, Cypress Communications Corp., became part of the nation's second largest cable company. Harris later sold his participation and established Harris Cable Corp.

Also involved in broadcasting, Harris is president of Harriscope Broadcasting Corp., which operates TV and radio stations in several states. He is a member of the National Academy of Recording Arts and Sciences, Hollywood Radio and Television Society and the National Academy of Television Arts and Sciences.

Daniel Aaron, VP and co-founder of Comcast Corp., Bala-Cynwyd, Pa., was elected NCTA vice chairman. Aaron, elected to the NCTA Board in 1973, served on the executive committee of the Board during the current term. Aaron has served as chairman of NCTA's Project '77 committee and as a member of the NCTA legislative, public utilities and public relations committees.

Ralph Baruch, President and Chief Executive Officer of Viacom International, Inc., New York City, was elected Secretary. Baruch has served as an NCTA Director since 1973. Last year he received the industry's Outstanding Committee Chairman Award for his work in the NCTA Subscription Cablecasting Committee.

He has been President and Chief Executive Officer of Viacom, one of the nation's largest CATV companies, since 1971. Previously he was President of the CBS-Viacom Group and had been associated with CBS in various executive positions since 1954.

NCTA's new Treasurer is Henry W. Harris, President of Cox Cable Communications, Inc., Atlanta, Ga. Harris, a member of the NCTA Board since 1973, is a member of the NCTA Subscription Cablecasting Committee and has served on the Association's Pole Line Negotiating, Executive and Copyright Committees. Prior to becoming president of Cox Cable in 1966, Harris served as its vice president-director of operations and as the chief financial officer.

NEW COMPANY ANNOUNCED

A new company, EAGLE Com-Tronics, Manlius, NY, has been formed to supply electronic products to the cable TV industry. The founder and president of EAGLE, Andrew F. Tresness, is former systems marketing and product manager of Magnavox CATV Division. Tresness relates, "The company was started to provide devices of high quality and unusual durability needed for longer-lived, more simply maintained CATV systems." EAGLE's initial offerings are notch filters and accessories for pay TV security applications. EAGLE has successfully started volume production and has delivered early, large orders for security devices.

Tresness forms company

ncta continued

in the field of perception of visual images, and in the design of perceptual experiments.

Harry Fine, Deputy Chief Engineer of the FCC, has a particular background of experience in TV quality ratings by TASO.

Delmer Ports, V.P. and Director of Engineering for NCTA, is a Fellow in IEEE with extensive experience in telecommunications engineering.

Forest Young, Professor at the University of North Carolina, is in the Psychometrics Laboratory, with particular experience in multidimensional scaling.

We thank Archer for his presentation. The results of this project will be extremely important to cable TV. I believe that it will allow us to be very realistic in the design and operation of cable systems so that we are not guilty of either over-engineering or inadequate engineering and cable operations. Either extreme would be disastrous.

proof of performance timetable continued

CONVERSION FORMULA

Microvolts to Microvolts per Meter
Microvolts per meter (UV/M) = .021 X E X F, where E is signal level in microvolts and F is signal frequency in MHz.

Example: Total radiated signal (from previous example) = -49 dBmV @ Channel 13. From the conversion table, -49 dBmV = 3.55 microvolts. .021 X 3.55 (E) X 211.25 = 15.75 microvolts per meter.

This is well under the maximum radiation acceptable by the FCC.

The NCTA Technical Topics bulletin, "SIGNAL LEAKAGE AND THE MARCH 31, 1974 TESTING DEADLINE," has complete specifications for the Simons dipole antenna. Construction details are included here.

Reprints of the entire Proof of Performance Series are available, 76.605-(a) 1 through 12, for $10.00/set. To order, circle Reader Service Card No. 17.

Construction Details of the Simons Dipole Antenna as discussed in this issue are available from COMMUNICATIONS/ENGINEERING DIGEST by circling Reader Service Card No. 12. Cost is $2.00 per copy.

ERRATA: Jan. C/ED, P.11, 76.605-(a)(8) should read "The amplitude characteristic shall be within a range of ±2 decibels from 0.50 MHz to 5.25 MHz above the lower boundary frequency of the cable television channel, referenced to the amplitude at 1.25 MHz above the lower boundary frequency." Adopted by Report and Order, Jan. 6, 1975, *"In the Matter of Editorial Amendment of Sections 76.5 and 76.605 of the Rules and Regulations to effect consistent terminology."*

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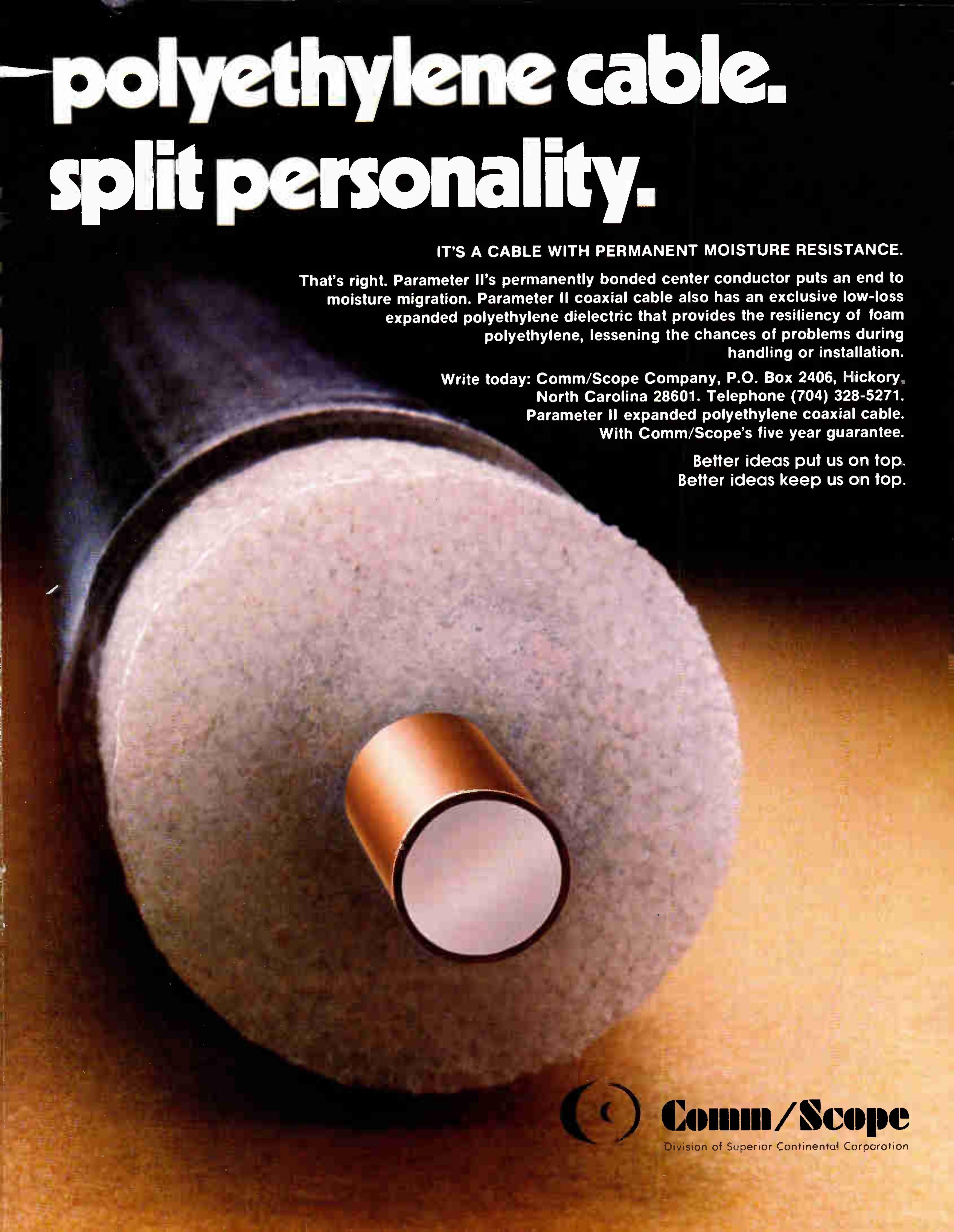

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DOMSAT Television Earth Station System Analysis

Charles M. Siperko
Microdyne Corporation
Rockville, MD

INTRODUCTION

On September 30, 1975, Home Box Office officially inaugurated paid television satellite service at Vero Beach and Ft. Pierce, Fla., with live coverage of the Ali-Frazier heavyweight championship fight from Manila. The initial paid programming service is through Western Union's Westar I satellite. In early 1976, satellite service will be switched to the RCA Globecom satellite which was placed in orbit on December 12, 1975.

Satellite paid programming has generated a high level of enthusiasm among CATV firms; and, in growing numbers, CATV engineering personnel are initiating design analysis to establish their own system requirements. In implementing and offering paid programming service, CATV operators are very much aware of the fact that they must take whatever steps are necessary to insure that signal quality is maintained at all times. The consensus is that since cost to the customer for a single channel of programming is equivalent to what customers are now paying for ten channels or more, the signal quality of that single channel cannot be permitted to deteriorate at any time.

The implication is that operators must implement and enforce a continuous monitoring and maintenance schedule to detect potential problems before they occur, or at the worst, as soon as they occur. It also means that in the design of the system, adequate margins should be designed in so that minimum acceptable signal standards can be maintained under worst case conditions. The minimum acceptable standards would be established by the operator and would be well above that permitted by the FCC.

Satellite service expands the scope of technical expertise required of CATV technical personnel. This paper will describe and analyze a satellite-earth station system from the output of the satellite antenna to the headend modulator for retransmission through the cable system or microwave link. It is hoped that the analysis will be of assistance to CATV technical personnel in the design of their particular system.

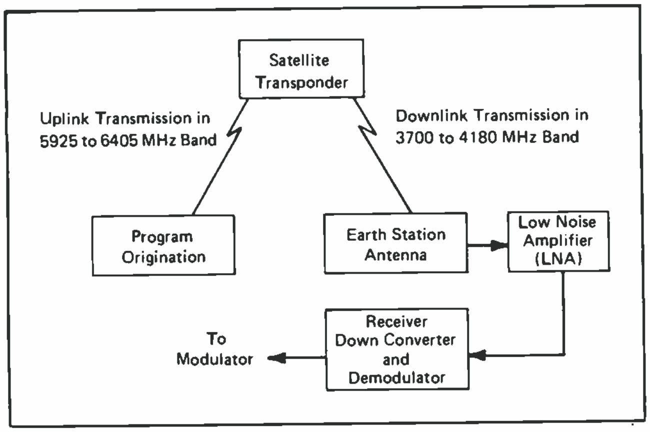

Figure 1. Satellite-Earth Station System, Block Diagram

SATELLITE TELEVISION SYSTEM

Figure 1 is a block diagram of a satellite television system.

The program origination block includes the program material, transmission of programming to an earth station site, and an earth station up link transmitter facility which provides the means of transmitting program material to the satellite. Up link transmission is within the 5925 to 6405 MHz band.

The satellite is a transponder which will receive up link transmissions on one or more bands within the 5925 to 6405 MHz frequency range; down convert the received signal to a corresponding band within the 3700 to 4180 MHz frequency range; provide amplification of the down converted signal; and retransmit down link at the down converted frequency.

The Westar I satellite presently in use is capable of receiving, down converting, and retransmitting up to twelve channels of information at average per channel radiated power output levels ranging from 31 to 35 dBw directed throughout the continental forty-eight state area. The bandwidth of each channel is 40 MHz which includes a 36 MHz information channel with 2 MHz guard bands at each end, although there is some speculation that the information bandwidth of the HBO transmissions may be reduced to 34 MHz with 3 MHz guard band. Band center frequencies are spaced 40 MHz apart beginning at 3720 MHz. Each channel is capable of handling one color television transmission or up to 1200 voice channels.

The RCA Satcom I satellite will provide essentially the same radiated power level and information handling capabilities. The major difference is that the Satcom I satellite is capable of twenty-four channel operation, channel widths being 40 MHz wide, all available within the 5925 to 6425 MHz up link and 3700 to 4200 MHz down link frequency ranges. Twenty-four channel operation is obtained by transmitting twelve channels in a vertically polarized plane and twelve channels in a horizontally polarized plane. Center frequencies of the information bands are spaced 20 MHz apart with adjacent bands alternating between the vertically and horizontally polarized planes.

The receive only earth terminal includes the earth station antenna, low noise amplifier, and the receiver (down converter/demodulator). Each of these elements is discussed functionally in this section. Operating parameters and their effect on system performance will be discussed in some detail in the analysis sections of this paper.

The antenna is the input element of the earth station. Types, sizes, and shapes of antennas are manyfold, each possessing its own advantages and disadvantages in the varied earth station applications. Antenna selection constitutes an important decision for the system designer in that it is an element offering significant cost-performance tradeoffs consistent with system performance requirements.

Regardless of the application, the purpose of the antenna is to intercept a portion of the satellite's radiated energy and to contribute to the optimization of input carrier-to-noise performance within prescribed limits. A figure of merit reflecting antenna system performance has been defined as the ratio of antenna gain to total system noise temperature (G/T). System input carrier-to-noise ratio is directly proportional to the antenna system G/T. One can immediately see that for a specified input C/N, an antenna system G/T is defined and tradeoff possibilities exist

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Mr. Siperko has been employed by Microdyne Corporation since 1968, initially as assistant Director of Engineering and for the past seven years as Director of Manufacturing. His prior background includes twenty-two years of experience in the electronics industry in various Engineering Management posts and as a design engineer.

He received his Bachelor of Science Degree from The Johns Hopkins University in 1964, and his Master of Business Administration Degree (Finance) in 1973 from Loyola College. He is a Registered Professional Engineer in the State of Maryland.

between antenna gain and system noise temperature so long as the G/T ratio is held constant.

The antenna output feeds a low noise amplifier which can be: cooled or uncooled parametric amplifiers; cooled or uncooled GaAs FET amplifiers; or a bi-polar transistor amplifier depending on system signal parameters. The low noise amplifier is the major factor in determining system noise temperature and is the second important element in tradeoff considerations. Since the LNA is the first stage of gain in the system, its noise temperature modified by antenna feed and coupling losses is reflected directly in system noise temperature. Typically, the gain of LNA's is in the neighborhood of 50 dB. As a result, noise contributions from system elements beyond the LNA are reduced to insignificant levels when reflected to the system input. This fact will be clearly demonstrated in the system analysis. In addition to the foregoing, the LNA also provides selectivity at the system input, passing signals within the 3700 to 4200 MHz band, and rejecting signals outside the band.

The final element in the earth station is the receiver which provides channel selection, down conversion, additional system gain, and demodulation of received signals. The receiver input is driven from the LNA output; therefore, the receiver noise characteristics are not generally a factor in system noise temperature.

The input section of the receiver is the tuner or down converter. The tuner provides the necessary selectivity to select a desired channel within the 3700 to 4200 MHz RF band, down convert the selected information band to the first IF frequency, and provide some amplification of the down converted signal. Tuners are available which will provide VFO tuning across the entire down link frequency band and provide selection of discrete channels across the band. Frequency selection can be accomplished on either a local or remote basis.

Synthesized double conversion tuners are also available providing discrete frequency selection across the band locally or remotely. These tuners are capable of computer control using BCD input coding for channel identification. Remote tuning capability is an important factor in CATV application.

At the present time, HBO has three satellite channels planned: one intended for transmissions to the East Coast; one intended for transmissions to the West Coast; and a third for other applications. In event of failure in one channel, the earth station will be notified to manually switch to the second channel in use or to the backup channel. Further, it may be required that particular areas of the country be blacked out for some reason, in which case, all other areas in the U.S. will be switched to one channel and the blacked-out area to the second channel. It is expected that as total system development continues, switching will be accomplished automatically through some form of coding included with the VITS signals. Earth station system designers should consider this factor in their design and select equipment with automatic switching capabilities. It is then only necessary to add an appropriate decoder to the system providing the necessary interface to tuner switching inputs.

The tuner output feeds an IF amplifier and FM discriminator section of the system receiver. The IF stages, in addition to providing added system gain, contain the bandwidth determining elements, and gain controlled stages. For television applications, the nominal overall IF bandwidth is 36 MHz. The FM discriminator extracts the baseband information from the input carrier. At this point, the baseband information includes the color picture video and the audio subcarrier from which the program sound is extracted in a subsequent subcarrier discriminator. In design of these stages, gain-frequency, phase-frequency, dynamic operating range, and discriminator linearity are all extremely important parameters having a direct bearing on ultimate picture quality. These design parameters and their effect on picture quality are discussed in detail in the analysis section.

The post detection video section is the final receiver section containing the video amplifiers, de-emphasis circuitry, clamping circuit, audio subcarrier discriminator, and audio de-emphasis circuit.

Earth station interface with the CATV system includes the de-emphasized clamped video, de-emphasized audio, and control lines.

SYSTEM ANALYSIS

In the system analysis that follows, the satellite, antenna, low noise amplifier, and receiver parameters are:

Satellite EIRP = 35 dBw (Westar I)
Antenna 10 meter dish; Gain = 51 dB;
Noise temperature = 28° (including feed loss)
Low Noise Amplifier Gain = 50 dB
Noise temperature = 240°
Receiver Noise Figure = 15 dB.
Satellite-Earth Station Link = 25,000 mile link used for calculations.

The parameters for a specific system will vary from those above depending on the technical characteristics of system elements and the EIRP contour on which the earth station is located. The order of the calculations presented here is oriented to evaluation of an existing system made up of the elements whose operating parameters are known. In developing a new system, calculations would normally be made in reverse order to determine the parameters of the individual elements required.

Down Link Losses

The Westar I satellite is in an equatorial orbit at an assumed radial distance from the Rockville, MD area of approximately 4.0×10^9 centimeters. Path loss over this distance is primarily a result of scattering of the radiated energy and is given by:

$$L_P = -20 \log \left(\frac{4\pi d}{\lambda}\right)$$

where: $\lambda = 7.1$ cm (4.2 GHz)
$d = 4 \times 10^9$ cm

$$L_P = -20 \log \left(\frac{12.56 \times 4 \times 10^9}{7.1}\right)$$

$$= -20 \log 7.1 \times 10^9$$

$$= -20(9.849)$$

$$= -197 \text{ dBm.}$$

Power Received

The received power is a function of satellite EIRP, path loss, and antenna gain and is given by:

$$P_R = EIRP + L_P + G_R$$

where: EIRP = 35 dBw
$L_P = -197$ dB
$G_R = 51$ dB

$$P_R = (35 - 197 + 51) \text{ dBw}$$

$$P_R = -111 \text{ dBw.}$$

Antenna Gain to Noise Temperature Ratio (G/T)

The antenna system G/T is the ratio of antenna gain to total system noise temperature. Total system noise temperature is:

$$T_{°K} = T_{(ant+feed)} + \frac{T_{LNA}}{G_{feed}} + \frac{T_{RCVR}}{G_{LNA} + G_{feed}}$$

where: $T_{(ant+feed)} = 28°$K
$T_{LNA} = 240°$
$G_{feed} = .98$
$T_{RCVR} = 8996°$K
$G_{LNA} = 50$ dB = 100,000

$$T_{°K} = 28 + \frac{240}{.98} + \frac{8996}{(.98)(100{,}000)}$$

$$T_{°K} = 28 + 245 + .58$$

$$T_{°K} = 273$$

Antenna gain is 51 db, therefore:

$$\frac{G}{T} = 51 - 10 \log 273$$

$$\frac{G}{T} = 51 - 24.4$$

$$\frac{G}{T} = 26.6 \text{ dB/°K}$$

As a matter of interest to those readers accustomed to working in noise figure terms, the noise temperature is related to noise figure by:

$T_{°K} = (F - 1)T_0$ where: $T_0 = 290°$K
F is expressed as a power ratio.

Carrier to Temperature Ratio (C/T)

The carrier to system temperature ratio reflects the effect on usable received carrier power as a function of system noise temperature. Carrier to temperature ratio is obtained using either of the following expressions:

$$\frac{C}{T} = P_R - 10 \log T_{°K}$$

$$\text{or } \frac{C}{T} = EIRP + L_P + \frac{G}{T}$$

Using the first relationship:

$$\frac{C}{T} = -111 - 24.4$$

$$\frac{C}{T} = -135.4 \text{ dBw/°K}$$

The same result is obtained using the second relationship:

$$\frac{C}{T} = 35 - 197 + 26.6$$

$$\frac{C}{T} = -135.4 \text{ dBw/°K}$$

Carrier to Noise Ratio (C/N)

The final relationship to be evaluated in the RF link analysis is the one that tells the tale, the carrier to noise or input signal to noise ratio. C/N is a function of the system IF bandwidth which is 36 MHz in the system being evaluated.

As will be seen later, video S/N ratio is also related to C/N; therefore, assuming all other factors affecting video S/N ratio are optimized, further video S/N ratio improvement can only be obtained by improving the C/N ratio.

C/N ratio is given by:

$$C/N = \frac{C}{T} - K - 10 \log BW$$

To see how this expression is derived, recall that:

$$E_N^2 = KTBR$$

Noise power is then:

$$\frac{E_N^2}{R} = KTB$$

where: K = Boltzman's constant
B = IF bandwidth
T = system noise temperature

$$C/N = \frac{C}{KTB} = \frac{C}{T} - K - 10 \log BW$$

where K is expressed in dBw/°K (228.6 dBw/°K)

$$\therefore \frac{C}{N} = -135.4 + 228.6 - 75.6$$

$$C/N = 17.6 \text{ dB.}$$

Video Signal to Noise Ratio

In the following, the video S/N ratio is first determined assuming a zonal baseband filter (i.e. rectangularly shaped filter). The S/N expression is then modified to account for the rolloff present in a normal baseband filter.

In an FM system, the video S/N ratio is given by:

$$S/N = 3m^2 \left(\frac{B}{2f_m}\right)\left(\frac{C}{N}\right)$$

where: m = deviation ratio
B = IF bandwidth
f_m = highest baseband modulating frequency

For a television signal, the S/N ratio is:

$$\frac{S_{P\text{-}P}}{N_Q} \quad \text{where: } \frac{S_{P\text{-}P} \text{ is the peak-peak luminance signal}}{N_Q \text{ is the weighted noise}}$$

The luminance component of the video signal is 0.714 volts which is 2.9 dB below the peak-peak level.

The peak-peak level of a sine wave is the average value + 9 dB i.e. Average value + 3 dB = peak value and peak value + 6 dB = peak-peak value.

The combined effect of the de-emphasis circuit and the noise weighting filter will provide a noise improvement of 13 dB.

Adding these correction factors, the $S_{P\text{-}P}/N_Q$ ratio expression now becomes:

$$\left[\frac{S_{P\text{-}P}}{N_Q}\right] \text{dB} = 10 \log \left[3m^2\left(\frac{B}{2f_m}\right)\right] + \left(\frac{C}{N}\right) \text{dB} + 9 \text{ dB} - 2.9 \text{ dB} + 13 \text{ dB}$$

$$\left[\frac{S_{P\text{-}P}}{N_Q}\right] \text{dB} = 19 \log \left[3m^2(B/2f_m)\right] + \frac{C}{N} \text{dB} + 19.1 \text{ dB}$$

With a deviation ratio, m = 2.86, the $S_{P\text{-}P}/N_Q$ ratio is:

$$\therefore \frac{S_{P\text{-}P}}{N_Q} = 19 \log 105.17 + 19.1 + (C/N) \text{ dB}$$

$$\frac{S_{P\text{-}P}}{N_Q} = 39.31 \text{ dB} + \left(\frac{C}{N}\right) \text{dB}$$

The C/N previously calculated for the system being evaluated is 17.6 dB; therefore, the $S_{P\text{-}P}/N_Q$ of the system using zonal baseband filtering is:

$$\frac{S_{P\text{-}P}}{N_Q} = 39.31 + 17.6 = 56.91 \text{ dB.}$$

A more exact expression for S/N ratio includes the effect of baseband filter rolloff. Typically, baseband filters are designed to roll off at 6 dB, 12 dB, 18 dB, 24 dB etc. per octave. The S/N expression including rolloff is:

$$S/N = \frac{2K}{\pi} \sin\left(\frac{3\pi}{2K}\right) D_0^2 \left(\frac{B_{IF}}{2f_0}\right)\left(\frac{C}{N}\right)$$

where: K = 1 for 6 dB per octave rolloff
K = 2 for 12 dB per octave rolloff
K = 3 for 18 dB per octave rolloff
K = 4 for 24 dB per octave rolloff etc.

$$D_0 = f_p/f_0 = \frac{\text{frequency deviation}}{\text{baseband cutoff frequency}}$$

The television signal video $S_{P\text{-}P}/N_Q$ ratio is:

$$\frac{S_{P\text{-}P}}{N_Q} = \left(\frac{2K}{\pi}\right)\sin\left(\frac{3\pi}{2K}\right)\left(\frac{f_p}{f_0}\right)^2\left(\frac{B_{IF}}{2f_0}\right)\left(\frac{C}{N}\right) + 19.1 \text{ dB}$$

For a baseband filter with an 18 dB/octave rolloff, K = 3

$$\frac{S_{P\text{-}P}}{N_Q} = 10 \log \left[\left(\frac{6}{3.14}\right)\left(\sin\frac{9.42}{6}\right)(8.18)(4.29)\right] + \left(\frac{C}{N}\right)\text{dB} + 19.1 \text{ dB}$$

$$\frac{S_{P\text{-}P}}{N_Q} = 10 \log [(1.91)(.999)(8.18)(4.29)] + 17.6 + 19.1$$

$$\frac{S_{P\text{-}P}}{N_Q} = 18.24 + 17.6 + 19.1 = 54.9 \text{ dB.}$$

As baseband filter rolloff increases (i.e. K increases), the S/N ratio rapidly approaches that obtained by assuming zonal filter characteristics.

FM Improvement

The satellite television system is an FM system and one can expect a S/N improvement over an AM system designed to carry the same information. Again, the FM S/N ratio is:

$$(1)\quad S/N_{out\ FM} = 3D^2\left(\frac{B_{IF}}{2B_m}\right)\left(\frac{S}{N}\right)_{in\ FM}$$

and $(2)\quad N_{in\ AM} = \frac{2B_m}{B_{IF}} N_{in\ FM}$ where N is noise

Substituting (2) into (1)

$$S/N_{out\ FM} = 3D^2 \cdot S/N_{in/out\ AM}$$

The expected S/N improvement of an FM system over an AM system is $3D^2$, which is the FM improvement ratio.

Threshold C/N Ratio

In the foregoing evaluation of video S/N ratio, the calculations are valid only if the C/N ratio is above threshold. Below threshold, a small change in C/N ratio can result in relatively large changes in S/N ratio. Calculations to illustrate the effects of C/N on S/N below threshold will not be shown since it is expected that normally the television earth station design will have sufficient margin that operation will always be above the threshold level. Threshold level is given by:

$$(C/N)_{thres} = 5 + 5 \log \left(\frac{B}{B_m}\right)$$

where: B = 1/2 the IF BW
B_m = baseband filter cutoff frequency

$$(C/N)_{thres} = 5 + 5 \log \frac{18}{4.2}$$

$$(C/N)_{thres} = 5 + 5 \log 4.3$$

$$(C/N)_{thres} = 8.2 \text{ dB}$$

At threshold, the theoretical video S/N ratio is approximately 39.31 + 8.2 = 47.5 dB.

Interference—Co-Channel—Multipath

An FM system operating in the presence of co-channel signals or multipath signals is insensitive to these interfering signals where relative power levels are greater than 3 dB apart.

Assume the presence of two signals, A and aA ($a < 1$) at frequencies ω_c and ω_{ctr} (where r is difference frequency). The resultant signal is:

$$E_{(t)} = A \sin \omega_{ct} + aA \sin (\omega_{c+r})t = V_t \sin(\omega_c + \theta_t)$$

The phase angle θ_t after limiting is given by:

$$\theta_t = \sin^{-1}\left[\frac{a \sin(rt)}{\sqrt{1 + a^2 + 2a\cos(rt)}}\right]$$

The discriminator output is the time derivative of θ_t and is:

$$\theta'_t = ar\left[\frac{a + \cos(rt)}{1 + a^2 + 2a\cos(rt)}\right]$$

The phasor diagram representing the discriminator output is shown in Figure 2.

The resultant signal over any complete cycle of the difference frequency is equal to the phase angle acquired by the stronger signal; therefore, the average frequency of the

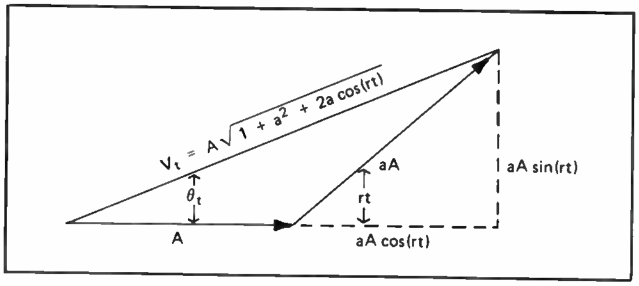

Figure 2. Discriminator Output Phasor Diagram

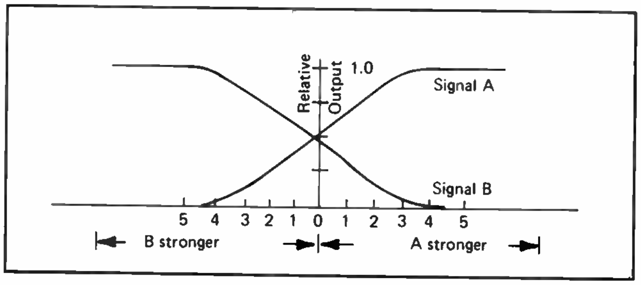

Figure 3. Typical Capture Characteristics

resultant signal is exactly equal to that of the stronger component. This is called the capture effect.

If the two signals are nearly out of phase (i.e. $rt \approx \pi$), the resultant signal experiences a rapid change of phase causing spikes to appear at the discriminator output, with an amplitude proportional to:

$$\left(\frac{1 + a}{1 - a}\right) r$$

Where: a is relative power level
r is difference frequency

The difference frequency *r* is important in co-channel interference. If *r* is outside the channel bandwidth, a sharp cutoff filter can be used to eliminate the interfering signal. If *r* falls within the channel bandwidth, two factors combine to reduce its effect:

1. Pre-emphasis/de-emphasis provides discrimination against the fundamental difference frequency and its harmonics.
2. The magnitude of the interfering signal and its harmonics varies proportionately to the difference frequency *r*.

Typically, with relative power ratios of 3 dB, the contribution from the weaker signal is almost completely suppressed—the stronger signal remaining unaffected. A measure of the rejection capabilities of an FM receiver is the capture ratio, defined as the maximum ratio of interfering signals which can be accommodated by the receiver to produce at least a 20 dB S/N ratio at the output. Figure 3 illustrates typical FM capture characteristics.

The typical capture characteristics illustrated in Figure 3 will hold if the following inequality is satisfied:

$$\frac{4\, f_m\, \Delta f}{B_\omega 2} < 1$$

SYSTEM OPERATING CHARACTERISTICS AND PICTURE VIDEO DISTORTION

Operating Characteristics Affecting Picture Video

Each element in the television earth station system can introduce distortion on the picture video signal resulting in poor picture quality. Distortion is generally divided into two classes: linear distortion and non-linear distortion. Linear distortion is primarily a function of gain versus frequency and phase versus frequency characteristics of RF/IF circuitry within the system, and is independent of signal amplitude. Non-linear distortion can be introduced in RF/IF or baseband circuitry within the system and is a function of signal amplitude.

Ideally, design of the system's RF/IF circuitry would result in a: flat amplitude or gain response; linear phase response leading to flat group delay characteristics; wide dynamic operating range; and adequate coupling time constants. Design of baseband video circuitry should also produce the same results.

Generally, ultimate or ideal operating performance cannot be attained and distortion is introduced. The principal types of distortion and the resulting effects on picture quality is reviewed in subsequent paragraphs.

Linear Distortion

Linear distortion is amplitude independent and the result of amplitude (gain) versus frequency, phase (group delay) versus frequency variations, and inadequate AC time constants.

Amplitude Distortion. Amplitude distortion causes relative chrominance to luminance amplitude or gain errors resulting in saturation errors in the color picture. Color information for a scene is conveyed by the resultant of the chrominance-luminance vectors (i.e. R-G, G-Y, B-Y). Changes in amplitudes of components of color vectors will produce resultant vectors which change in length and relative position. These variations change the proportions of red, blue, green, and brightness in reproducing color, thus saturation or color purity will vary from the original scene.

The satellite earth station system is an FM system and amplitude variations with frequency are removed in the limiter stages. As a result, amplitude versus frequency distortion arises in post limiter stages.

Phase (Group Delay) Distortion. Phase (group delay) distortion causes misregistration of color and brightness information in the color picture. To retain the relative time relationship between chrominance and luminance information, system elements should exhibit linear phase versus frequency characteristics. The phase slope should be such that group delay will be constant (or flat) across the frequency band of interest. Phase distortion can arise in RF/IF and video sections of the earth station system and is directly proportional to modulating frequencies. Phase equalizers are generally incorporated in design of earth station receivers to linearize phase versus frequency characteristics.

AC Time Constants. Improper time constants in coupling, decoupling and damping circuits can result in short time, line time, and field time waveform distortion. Generally, these distortions are in the form of waveform tilt, undershoot, overshoot, and ringing.

Short time distortion affects picture sharpness. Undershoots make the picture soft or blurry at transitions. Overshoots, if not too great, improve picture sharpness at transitions. Ringing results in halos.

Line time distortion causes horizontal streaking in the picture, which is negative if due to overshoot and positive if due to undershoot.

Field time distortion causes shading in the vertical direction on the picture and is generally the result of waveform tilt.

Long time distortions which exceed 16 msec (field time) cause flicker in the picture.

Non-Linear Distortion

Non-linear distortion is amplitude sensitive, and a function of the dynamic transfer characteristics of system circuits. The predominate forms in color television result from intermodulation between chrominance, luminance, and APL.

Luminance into chrominance results in differential gain and differential phase which cause changes in saturation and hue, respectively.

Chrominance into luminance results in changes in birghtness of highly saturated parts of the picture.

Non-linear distortion of luminance, chrominance, sync, or burst which is a function of picture brightness, is primarily APL generated.

Differential Gain. Differential gain has been defined as the difference in gain encountered by a low-level, high frequency sinusoid at two stated instantaneous amplitudes of a superimposed high level, low frequency signal. The staircase or ramp extends from blanking to peak white level with the color subcarrier superimposed at constant amplitude. Differential gain is measured relative to the gain at blanking level.

Differential gain results from cross modulation of the color subcarrier by the luminance (ramp or staircase) signal due to non-linearities in circuit transfer characteristics resulting in amplitude modulation of the color subcarrier. Reference measurements are generally made at 50% APL. Measurements are then made at 10% and 90% APL to determine the worst case differential gain.

Differential gain distortion can arise in RF/IF or baseband circuits in the system. The magnitude of differential gain arising in RF/IF circuits is proportional to the square of the modulating frequency, whereas it is independent of modulating frequency in baseband circuits.

To minimize differential gain distortion design of RF/IF and baseband, circuits should exhibit wide linear dynamic gain characteristics.

Since the result of differential gain is amplitude changes in the color subcarrier, lengths of vectors representing the color information will change. These changes in turn lead to changes in resultant vector lengths and position, resulting in saturation variations in the reproduced color pictures.

Differential Phase. Differential phase has been defined as the difference in phase shift encountered by a low-level, high frequency sinusoid at two stated instantaneous amplitudes of a superimposed high level, low frequency signal. Differential phase is relative to color subcarrier phase at blanking level.

Differential phase results from delay of the color subcarrier due to circuit dynamic transfer non-linearities in the RF/IF and baseband sections of the system. Reference measurements are made at 50% APL. Measurements are then made at 10% and 90% APL to determine the worst case differential phase.

Differential phase distortion in RF/IF circuits can arise from delay distortion resulting from non-linearity of circuit transfer characteristics or by amplitude versus frequency (AM) variations produced in one circuit followed by conversion of amplitude variations to phase modulation or changes in a succeeding circuit with non-linear transfer characteristics. In baseband circuits, differential phase is the result of group delay characteristics of the circuit.

Again, designing circuits for linear operation over wide dynamic operating ranges will minimize differential phase distortion.

The result of differential phase is a relative change in phasing between color subcarrier and luminance components of the picture signal. Changes in relative phase angle between vectors representing color information and vectors representing luminance information shift the angular position of the resultants causing color or hue changes in the reproduced color picture.

Chrominance Into Luminance Intermodulation. Chrominance into luminance intermodulation distortion causes changes in luminance or brightness of strongly colored portions of the reproduced color picture. Distortion varies in square law fashion with subcarrier level and is a function of luminance level and APL.

Non-linearities in circuit transfer characteristics, again, produce this type of intermodulation distortion. As before, designing circuits with linear transfer characteristics over wide input signal dynamic ranges will minimize the distortion.

Distortions Caused by APL. Luminance, chrominance, sync, or burst distortions which are a function of picture brightness are APL generated. APL changes can shift the operating point of a circuit into a non-linear operating range if the circuit does not have adequate dynamic operating range. The effect is more pronounced in AC coupled circuits since the DC reference is lost and coupling time constants will cause a shift in the average DC level. In baseband circuits which are DC coupled, reference levels are retained; hence, the problem is not as severe.

Shifting the operating point of a circuit into a non-linear region can result in intermodulation, cross modulation, compression, clipping or other forms of distortion. Different types of signal information is affected in one or more ways as a result of the non-linear characteristics. To minimize distortions which are produced as a function of APL, circuit design must provide the necessary linear dynamic range characteristics to accommodate the worst case DC shift plus the peak AC signal amplitude.

SUMMARY

The major points to be noted from the analysis presented are that:

1) System sensitivity is determined by attainable system noise temperature, primarily a function of the antenna and low noise amplifier.
2) System threshold performance is not only a function of C/N ratio, but is also dependent on the design characteristics of the system receiver IF filter, demodulator, and baseband filter relative to theoretical threshold C/N.
3) Having determined system noise temperature and C/N requirements, cost/performance tradeoffs exist between the antenna size and LNA noise temperature/gain.
4) System performance in the presence of interference is primarily a function of the receiver characteristics.
5) Picture quality and related signal distortions are primarily determined by the receiver dynamic operating characteristics.

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FCC Radiation Measurements: Burden or Blessing?

by R.L. Shimp and W.L. Braun, ComSonics, Inc.

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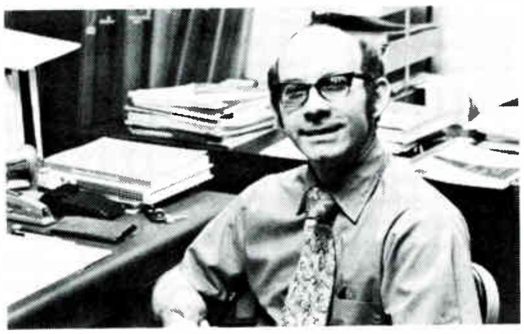

Richard L. Shimp, Director of Research & Development. Dick has been ComSonics' Director of R & D since 1970. Born in Ephrata, Pennsylvania, he received his basic electronics training in the Air Force. Dick is also a graduate of the CIE Electronics Technology Program. Before coming to ComSonics, he was involved in the control apparatus for the first Lunar Excursion Module Program at General Electric. Dick has done extensive R & D work on his own which includes electronic devices for radio controlled airplanes and other related equipment.

EXISTING MEASUREMENT TECHNOLOGY

Anyone who has conducted FCC radiation compliance tests has experienced the awesome problems inherent in making meaningful measurements. First off, we obtain a stable signal level meter. No problem, several good ones are on the market. Then add a calibrated dipole, homemade or "store bought." We are now ready to make FCC radiation measurements—almost. Calculating the signal delivered by a dipole at FCC radiation limit levels reveals that we need about 20 dB more gain than is available from the SLM. After adding the SLM preamp, we are now prepared to make FCC measurements down to -50 dBmV. Now let's make some actual measurements in the field. We turn on the SLM/preamp combination and read "buzzing" signals that seem to be coming from the overhead power lines. Diagnosis correct! The typical peak power line noise is often much higher than the FCC permissible radiation limits. Then too, the 60 Hz buzz of the power line noise sounds very much like the "sync buzz" of the TV signal, making discrimination difficult. After moving to an area free of power line noise we find radiated signals—or do we?

Many engineers have had the exasperating experience of tracking down a radiated signal, only to find it was the wrong signal on the same channel as the system carriage. Perhaps it was a station just beyond the horizon and the propagation was excellent on the day of the measurements. Unfortunately, tropo-scatter signals reach the FCC limit levels quite frequently in many markets. Ideally, we ought to have a CATV signal with unique modulation to differentiate between cable TV signal radiation and extraneous signals.

Since the CATV system is so large, we would really like to measure the radiated signal at a lower level so we could scan the CATV plant at a distance greater than 10 feet, such as from a van moving down either side of the street at moderate speeds. Immediately our measurement technology fails miserably as we now need a sensitivity of at least -60 dBmV. Added preamp gain is of no assistance, due to the reality of achievable preamp noise figures and the noise bandwidth of typical SLM's. What is needed is a SLM with much narrower noise bandwidth.

Having found excessive radiation, we still must localize the source and repair the system defect. In some cases, and with considerable experience this is feasible, however, those who have extensive radiation location experience with sophisticated FSM—dipole combinations are acutely aware of the difficulty in accurately pinpointing RF leaks with a dipole or other antenna. It is usual to switch to an electric field intercept device at this point to pinpoint the precise source of the RF leak.

IDEAL MEASUREMENT SYSTEM

Any measurement device to be used for FCC radiation test must be very light to minimize operator fatigue, since system radiation remedial work can involve considerable time. Also, the signal detection should be very simple—almost go-no-go, so less qualified personnel can be used to perform the system radiation audit.

Summing up the desired measurement system properties:

- Super sensitivity—at least −60 dBmV.
- Unique reception capability discriminating against AC and stray CATV signals.
- Capable of utilizing dipole and electric field intercept devices.
- Lightweight—non-technical operation.

WHAT A SNIFFER IS

A sniffer is a system designed to perform the following functions:

1) A receiver sensitivity of at least −80 dBmV, with a unique narrow band detection/bandwidth system. Non-technical aural detection—system "weedle-bleeps" upon detection of radiated CATV signal. Receiver is lightweight 1.36 kg (3 lbs), battery operated, uses either field intercept probe or antennae.

2) A transmitter—encoder—located at headend, with signal injected much like a pilot carrier, generates unique modulation for receiver. Two frequencies, 217.25 MHz for a 12 channel CATV system or 108.625 MHz for those who utilize Channel J.

So What? Now we have a super RF leak detection system—what is its value? To fully appreciate the value of such a system, consider the following—a field intercept probe used with (and an integral part of) the sniffer permits us to locate ***which*** screw is loose in a four-way tap cover plate, or which ***one*** of four terminators are loose on a tap!

JUSTIFICATION FOR A NEW TECHNIQUE

But why bother with such low level RFI? The very sound reasons are:

- Locate the CATV freeloaders who, by radiation or illegal connection have made an interconnection to the system that radiates, or are receiving reception via system radiation.
- Locate sources of signal ingress easily and conveniently in a passive fashion with downstream-only signal carriage. Save time and money.
- Make FCC compliance simple. System radiation audit is accomplished by non-technical personnel.
- Permit a new level of sophistication in plant maintenance.

Reflection on the last point, it is now possible to radiation-qualify all connectors, drops, and system remedial work in a simple, convenient fashion. Now loose RF connectors are easily located and checked ***after*** tightening-no guess work. As we now know, most expansion loops made in the past are subject to early radial crack failure. These sheath cracks are now detectable (with the electric field intercept probe) before they circle the cable and cause a system outage.

As we all know, squirrels and gophers have a peculiar affinity for aluminum cable. They will gnaw through the outer sheath into the dielectric, admitting rain and creating corrosion (and high loss) of the center conductor. Squirrels and shotguns seem to go hand in hand, so quite often we will find pellet holes in the cable. A sniffer can locate these holes, faciliting repair before water damage can occur in the system.

Underground versions of such a system can permit location of underground sheath breaks.

Lost Descrambler Statistics

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One of the major concerns of CATV operators using descramblers is the fear of potential loss of descramblers upon disconnect of pay cable services. Horror stories of replacing 25 percent of converters each year for some metropolitan systems have permeated the industry.

A survey of six cable systems using Jerrold scramble-descramble systems showed excellent management and control of descramblers and projected loss of descramblers per year to be insignificantly low. The data shows:

1) Of a total of 2,007 gross pay cable disconnects over a period of six months, 84 descramblers were not retrieved or 4.2 percent of gross disconnects.

2) Assuming an annual gross pay cable disconnect rate of 25 percent, the projected lost descramblers per year is 1.1 percent of the pay cable subscribers.

The data is even more dramatic if the statistics of one system are removed from the analysis. The lost descramblers reduce to 1.6 percent of disconnect and 0.4 percent per year of the pay cable subscribers.

We feel the following reasons may account for the excellent control of the descramblers.

- The industry as a whole is exercising far better management and control techniques on the descramblers than early experiences with CATV converters. Most operators track descramblers with serial numbers.
- Most operators require the pay cable subscribers to sign a bona-fide contract which permits the cable operator to gain access to the home as well as setting a liability of up to $250 for the loss of the descrambler. (Since converter services are usually part of the franchise requirements, generally no contracts are involved.)
- Armed with $250 liability for each lost descrambler, the cable operators are pursuing the matter through collection agencies and small claims court with good results.
- Descramblers may not be as universally reusable as converters. For instance, remote controlled converters such as RSC and RSX can be used by the public even if not on cable.

Data on each of the systems is shown in the table. This table represents the status through October 1975. To project lost descramblers per pay cable subscribers per year, it is assumed that gross pay cable disconnect rate will reach the gross CATV disconnect rate after one year.

LOST DESCRAMBLERS FROM PAY CABLE DISCONNECTS

System	Pay Cable Subs.	Gross Discon.	Lost Descrambler	Pay Cable Period	CATV Subs.	Gross CATV Discon.
1	1,600	105	3	4 mos.	7,300	840
2	2,500	525	0	4 mos.	14,000	825
3	2,600	548	60	6 mos.	8,500	1,500
4	2,900	288	3	8 mos.	22,400	3,800
5	3,800	337	12	6 mos.	27,000	2,100
6	18,000	404	6	6 mos.	64,000	9,500
	31,400	2,007	84		144,200	18,565

	All 6 Systems	Without System #3
Lost Descrambler Per Disconnect	4.2%	1.6%
Annualized Gross Pay Disconnects/Year	13.7%	11.1%
Annualized Lost Descramblers/Pay Cable Subs/Year	0.6%	0.2%
CATV Gross Disconnects/Year	25.6%	25.0%
Projected Lost Descrambler/Pay Cable Subs/Year	1.1%	0.4%

The Difference Between a VIR

Frank Davidoff
Engineering & Development Department
CBS Television Network

The use of special signals in the vertical blanking interval of a television program signal was formalized in 1958 when the FCC allowed broadcasters to use a portion of line 17 and all of lines 18, 19 and 20 in both television fields for reference, checking, cue and control functions pertaining to the operation of a television broadcast station. Since that time, many broadcasters have used these vertical interval lines for various signals. Some of the more prominent of these signals have been:

- Four lines of NTC-5 signals designed to check broadcast distribution facilities to affiliate stations.
- Three lines of test signals specified by the FCC for use with remotely controlled transmitters.
- A single line composite signal used by ABC.
- A single line test signal for testing of international circuits.

All these signals were called Vertical Interval Test (VIT) signals and were designed to diagnose transmission problems in various equipment and transmission facilities. They were not specifically related to any of the programs with which they were used and were in fact independent of them. The VIT signals generally had a complex format because they were designed to perform many functions and provide detailed data on a large variety of linear and non-linear distortions.

When the problem of variability in color programming was studied some years ago by an all-industry committee, it was considered necessary to establish a reference signal that was program-related, that is, one which would represent various parameters of a television program signal and allow these parameters to be re-established at any subsequent point in the broadcast system. The result was the Vertical Interval Reference (VIR) signal. The VIR signal is intended to be associated with a particular television program as an operational tool for checking the parameters of that program and as a reference for that program. Therefore, the VIR signal should be inserted into the program signal at a point in the video system, where and only where both the correct amplitudes and phase of the composite color signal are established and the artistic judgment is made that color reproduction is as desired.

The VIR signal has been designed to act as a reference for only a limited number of program characteristics:

and a VIT Signal

1. Luminance Level (Used for overall signal level)
2. Black Level
3. Chrominance Level
4. Chrominance/Burst Phase

The signal has been deliberately kept simple so that it may be easily generated, observed and interpreted. The format has been chosen so that many transmission distortions will not affect its usefulness. The components of the VIR signal represent, as far as practicable, typical program levels rather than extreme or peak values, so that a maximum amount of information may be obtained for average conditions.

A VIT signal on the other hand is generally quite complex. Some VIT signals use three or four different lines of the vertical interval to thoroughly analyze a facility. The VIT signals that occupy a single line are very sophisticated because a great deal of information is compressed into the one line. The structure of VIT signals is chosen so that they will be very sensitive to transmission distortions. The format generally represents extreme or peak signal excursions so that the boundaries of equipment or transmission facilities are explored.

The function of the VIR and VIT signals can be considered complementary. If repeated observations of a VIR signal at a distant location show that there is a consistent error, then a VIT signal should be used on the transmission facility to analyze the distortion condition and corrective action should be taken. As stated previously, the VIR signal is not intended to serve as a diagnostic signal and is not considered to be a substitute for a VIT signal. The VIR signal is primarily intended to permit random and non-repetitive signal variations that occur on a program by program basis to be corrected.

It is clear then that the VIR and the VIT signals perform very different functions and are each designed to be as effective as possible in the performance of these functions. Many broadcasters have found that the VIR signal can be used as a VIT signal under some circumstances because of its simplicity and ease of observation. This use is improper because it defeats the purpose of the VIR signal. The primary purpose of a VIR signal is to be program-related and to act as a reference for its associated program so that the program parameters can be re-established at any subsequent point in the television system.

Mr. Davidoff has been with CBS since 1961. His principal activities have been in the fields of film recording, wirelock equipment and general video circuit design. His present activities are to keep in touch with new developments in technology which may affect CBS broadcasting operation. Previous to joining CBS, he was with Telechrome as a studio video equipment designer.

Mr. Davidoff is a Fellow of the SMPTE, a Senior Member of the IEEE and a member of the SPIE and SPSE. He is chairman of the IEEE Broadcasting Group Audio-Video Techniques Committee and a member of many other national and international technical committees. He has received BEE and MEE degrees from CCNY and NYU.

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canadian column continued

that this connection entail no expense to Newfoundland licensees, apart from the extrodinary cost incurred in delivery of signals to a coastal terminal. What this means is that the Newfoundland licensees have been directed to take a feed from the end of an existing microwave link without contributing to the cost or upkeep of that link. In addition, the Commission considered that it would be desirable to have a representative of the Newfoundland licensees on the Board of the private consortium operating the microwave link from the main border to the coastal terminal. In the view of the CCTA these provisions reflect an alarming tendancy toward increased autocracy on the part of the Canadian Radio-Television Commission.

The good news, although it is possible that this may eventually be qualified, is that Bell Canada has announced that they will permit pole access for cable television companies. This is a complete reversal of their previous policy which has adamantly prohibited pole access or strand rental despite a number of hearings in front of their regulatory body, the Canadian Transport Commission.

Bell Canada is the major telephone company in the Provinces of Ontario and Quebec in Canada. As such, it controls the utility poles that the great majority of Canadian cable television licensees use for distribution. The firm policy of Bell Canada in the past has been to permit so-called partial agreements or full agreements only. With both of these agreements the ownership of the cable itself remains with the telephone company, while with the latter the ownership of all plant including amplifiers and other hardware remains with the telephone company.

In general the position of Canadian Cable Television licensees has been in opposition to this policy, and this has resulted in the past in a great deal of disagreement between the two industries. The Bell Canada announcement was sudden and unexpected, and not proceeded by any negotiations between the two industries.

Since the announcement however, Bell Canada has indicated its willingness to discuss and negotiate the details of pole access agreements.

Canada is therefore now in the position of the United States a short while ago where pole access is a principle that has been agreed to, but the details of cost and conditions are still to be agreed upon.

Ken Hancock
Director of Engineering
Canadian Cable Television Association

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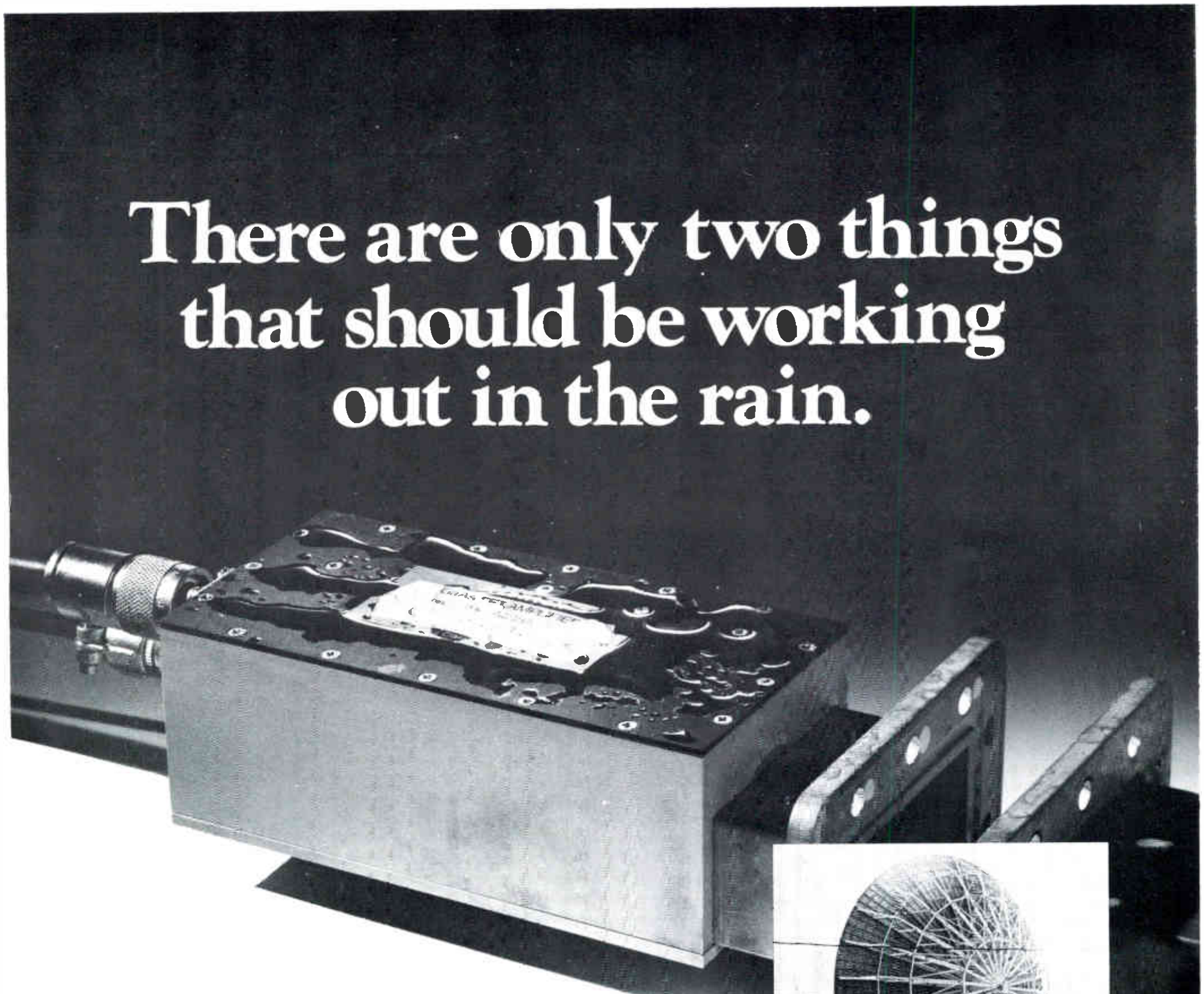

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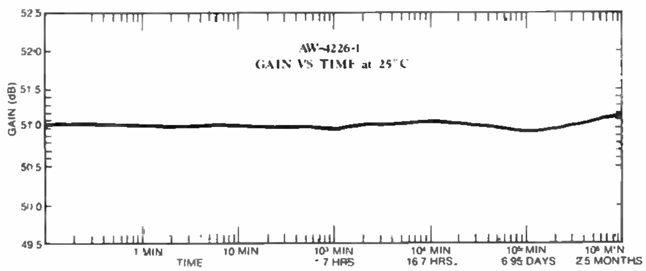

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