communications/engineering digest

reporting the technologies of broadband communications

Pay Cable Security

NOVEMBER 1975
Volume 1, No. 2

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SCTE

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SOCIETY OF CABLE TELEVISION ENGINEERS

This month, the Digest takes a broad look at Pay TV/Security. It is so described because of the undeniable link between pay TV software and the security inherent in the delivery system. Security techniques range from the very soft offset FDM with normal video format to the more sophisticated electronic scramble/de-scramble and addressable delivery systems. In addition there is the old stand-by, the discreet (or not so discreet) notch filter.

Arguments for or against a particular technique depend on your posture as a system operator, software supplier, or hardware supplier. Regulatory agencies are also genuinely concerned with the subject matter-theft of service. The technique selected should be based on sound economic and technical considerations. However this is just a small first step. The real test is the administration of whatever scheme has been selected.

Security, like many other technical decisions, is really a bottom-line consideration – i.e. the costs of protection vs. the expected losses. A fool-proof plan is easy– a human-proof one is not. 100% security is not possible. The objective should be high reliability at relative cost.

Security is not a locking terminator or a black box that does something that another black box doesn't do. Security isn't colored tags, labels, home runs or devices that don't alter characteristics when you beat on them with a hammer. Security is not ***hardware;*** it is ***beware***. It's a philosophy of doing business, the elements of which are just as essential as picture quality.

But why the recent fuss over Security in Pay TV. What of the illegal multiple set hook-up in basic cable? How does this affect the bottom line? Hasn't this security been discharged with the attitude that it doesn't cost to serve illegals and it therefore doesn't hurt?

Security has traditionally gotten minimal attention from within the CATV industry. It is for this reason, that outsiders (movie producers, performers, etc.) view cable as a loosely guarded box office. Those who are accustomed to getting paid in a controlled environment do not feel secure with the excesses that CATV has allowed its subscribing public to indulge in.

As an industry, we must begin to ***think*** and ***practice*** security, not just install it. To disregard its economic importance is to be afloat in a leaky boat. If you're not far from shore and you swim well there is no real concern. By the way, you may allow any number of others to read this copy of the Digest without a multiple reader charge.

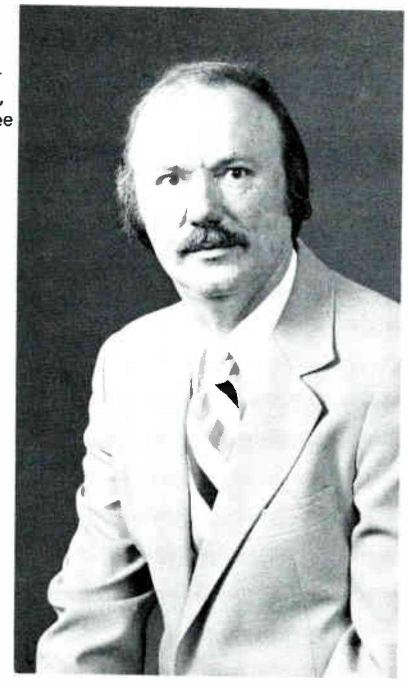
Bob Bilodeau

Bob Bilodeau

PROFILES

STUART L. BAILEY

Stuart L. Bailey, Consultant, Jansky & Bailey Division, Atlantic-Research Corp., Alexandria, Virginia. Together with C. M. Jansky, Jr. is founder of firm. Merged with Atlantic Research in 1959, retired to consultancy in 1970. BSEE and MS Universityof Minnesota. IEEE Fellow and Past President. Chairman Joint Technical Advisory Council. Member of National Academy of Engineering, active on Telecommunications Committee of Academy. Outstanding Achievement Award from University of Minnesota in 1956 for leadership in development of radio and TV. Forty-three years in communications field.



JAMES A. LUKSCH

James A. Luksch, Executive Vice President, Secretary and Treasurer of Texscan Corporation, Indianapolis, Indiana. BSEE, Magna Cum Laude from University of Buffalo. MSEE from University of Pennsylvania where he spent several years as a Ph.D. candidate. Six years spent with RCA, Morrestown, NJ as Microwave Design Engineer specializing in active microwave devices and low noise radar antenna systems. 1963 became Director of Engineering, Telonic Industries, Beech Grove, IN. 1965 cofounded Texscan Corporation, a company specializing in manufacture of sweep generators, spectrum analyzers, microwave components and system analyzers. He currently serves as chief operating officer.

RICHARD G. COVELL

Richard G. Covell, Manager, Turnkeys, GTE Sylvania, El Paso, Texas. Started in industry as technician in 1965, Mexico, Maine. Designed systems. Five years with Jerrold as Field Engineer. Joined GTE Sylvania in February 1972 as Manager, Field Engineering. Responsible for system specs for Turnkey and Bill of Material Contracts, 1973. Member SCTE.

JAMES B. WRIGHT

James B. Wright, Electronic Systems Manager, Rockford/Cablevision, Inc., Rockford, Illinois since 1972. Started in CATV in Warren, PA and Athol and Pittsfield, MA. Joined Jerrold Electronics Corp. in 1955. Built and managed systems in Ottawa and Streator, IL. Worked as technical consultant in mid-60's, joined LVO in 1967 developing mid-West cable and microwave systems. Member SCTE.

KENNETH L. FOSTER

Kenneth L. Foster, Chief, Division of Telecommunications of the New York State Commission on Cable Television since its inception in 1973. Assistant Director of Communications Engineering, State University of New York before appointment to NTSCCT, where in 1966 he designed first 12 channel all color capable cable system in the University. He was responsible also for design of first bi-directional system in the University. Member of CTAC Steering Committee; technical advisor to Governor Rockefeller's Task Force on Cable Television; member of State University of New York Technical Standards Committee. Career spans more than 25 years in communications. Member of SCTE and SMPTE.

critique

judging the merit of any work

COMMUNICATIONS/ENGINEERING DIGEST is designed to present varied views on technical and management topics of interest to personnel in the broadband/cable television industries. Since the industries are dependent on electronics technology, the people in the industry, whether management or technical, must be aware of changes that take place in these sciences.

DEFINING RESPONSIBILITY

Being realistic, this is an industry made up of more than 2,700 operating companies and hundreds of manufacturers supplying the operators. It is an industry made up of small businesses who do not have the time (if they are to survive), nor the money to stage large educational programs. The responsibility becomes that of a support organization to furnish the cable operators with materials, experiences and encouragement. This responsibility cannot be avoided because if we do not take care of our own business, we'll find ourselves without the support required to deliver services that we must to the public. Delivering those services provides income. That's what cable television is about—service is our product. Education and personal development is the responsibility fulfilled by SCTE.

MAKING DECISIONS

In designing a technical magazine, choices must be made as to what audience you wish to appeal to, who do you wish to address? In publishing a magazine you must decide whether or not you want to disseminate information, or make money selling advertising? Do you sacrifice content and space needed to share industry ideas? Do you sacrifice style to fill up paper? These are difficult questions that must be answered when developing format and defining future policy.

Additionally, questions must be asked about editorial position. Do you take stands and use the publication to promote your personal hopes and ideas? Will expounding your personal feelings achieve anything—for the publication, the group you represent, or, most importantly, for the industry you address. Does anyone really care about what you think? Is it necessary to tell people what they should think or is it possible that if you present material authored by others, and representative of as many sides of a topic as possible, readers can make up their own minds without your opinion?

ESTABLISHING RELATIONSHIPS

SCTE states its position through the letter each month at the beginning of the magazine. NCTA maintains complete editorial control over its Technical Topics insert each month. Any other organization that wishes to use *C/ED* to spread sound information that contributes to the growth of this industry, and more importantly to the growth of the people employed in the industry, may do so by establishing a relationship with the magazine. At no time will the publisher or editor take the posture of challenging material presented. Material is reviewed by the Editorial Advisory Board to validate the technical information received. This Board does not question the philosophy behind the article so long as the intent of the author is sound and the paper or article is of a sound engineering basis.

STATING THE GOALS

So, what is *C/ED* all about? Simply stated, it wishes to address all levels of engineering and technical talent in the broadband/cable television field. It will not be all things to all people at all times. That is impossible. It will try to maintain a balance in the level of engineering material presented. It will always have departments of appeal to technicians, and the articles are designed to be read by everyone. If *C/ED* addresses a particular type of hardware, we will present user and supplier viewpoints. If there are a variety of techniques available to accomplish the same goal, we'll address the varied techniques. The effort is valid and if you think we've left something out, this is the place to have your views aired. You will not find agreements within the pages. Authors are aware of other authors contributing on similar topics. There is no necessity for writers to agree with one another. That would be both boring and unadventurous.

I am introducing this department with a critique to explain the position we take. Which is: to disseminate information that is of value and to contribute to the personal growth of every member of the industry. No one has been able to tell me exactly what the words engineer and technician mean within this industry so I take the position that they are people who have jobs to do and are trying very hard to do them better. These are the people that ***COMMUNICATIONS/ENGINEERING DIGEST*** wishes to address.

Judith Baer
Managing Editor

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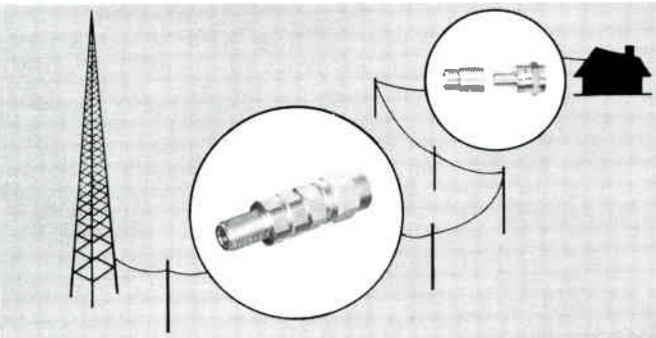

CATV systems specify LRC

Our advancements in the CATV connector industry have made us a leading supplier to major CATV systems. The hex crimp, longer crimp ring on "F" styles, controlled O-ring compression and captive parts on aluminum styles, are a few examples of pioneering research from LRC. LRC maintains the highest quality standards in the industry, assuring you of lasting connector quality. Our broad product line enables us to serve your connector needs from antenna to subscriber set.

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bulletin board

Spectrum Conservation Study Funded
The Office of Telecommunications of the White House has approved a contract with Aerospace Corp. to evaluate the impact of telecommunications technology upon management of radio frequency spectrum.

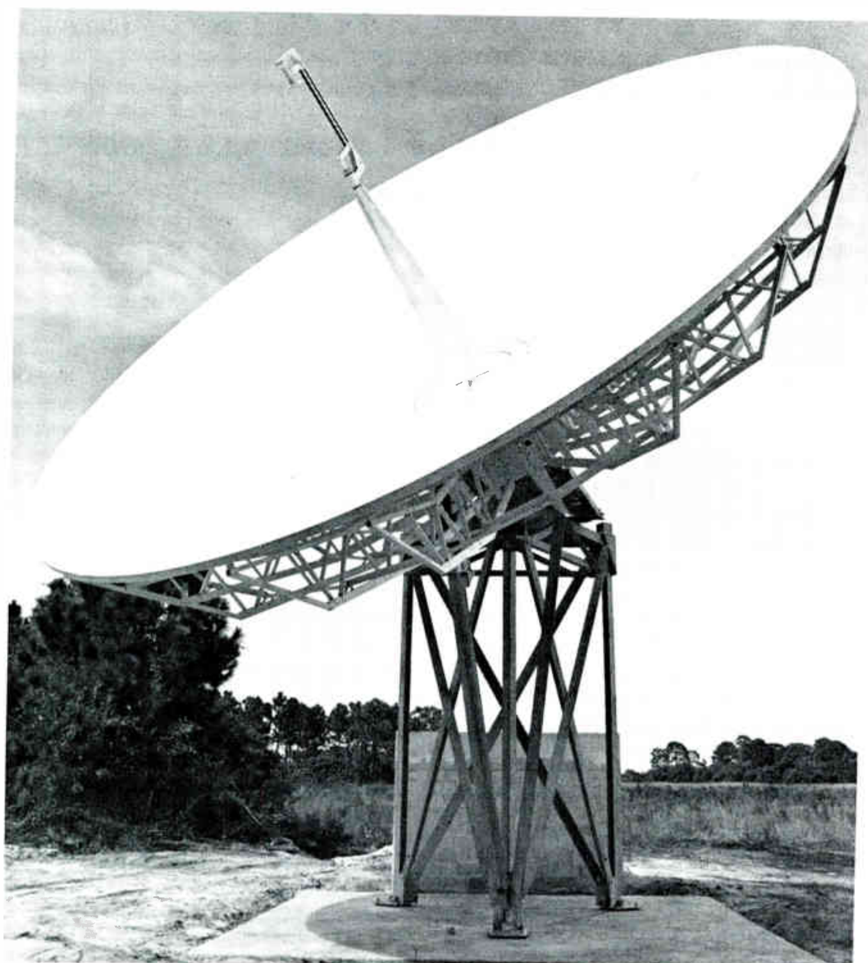
This report is hoped to predict unforeseen advances in communications techniques and engineering with regard to the expanding uses of radio frequency spectrum. The report will consider the abilities of using higher portions of the spectrum, applications of new and developing modulation concepts and investigate the varying characteristics of radio signals. OTP Acting Director John Eger expects the $200,000 contract to be concluded in about a year.

Scientific-Atlanta and Home Box Office, First Pay-TV Satellite Transmission
Tuesday, Sept. 30 saw the first U.S. Receiving Earth Terminal for pay TV operational. The terminal was designed and manufactured by Scientific-Atlanta, Atlanta, Georgia and installed in Ft. Pierce, Florida for UA—Columbia Cablevision.

Home Box Office, New York, provided the initial programming via satellite featuring the Ali-Frazier heavyweight championship fight live from Manila. This program is part of a new service offered by HBO to CATV operators. Sports events, first run films and special events will be transmitted via satellite to cable systems throughout the U.S. for distribution to subscriber homes.

This rapidly expanding market for domestic satellite transmission of video programming and the worldwide expansion of satellite communications, has led S-A to increase its production capacity. By doing so, S-A now can offer a receiving earth terminal for $65,000 which includes the reflector, feed and mount, a low noise factor (2.6 dB) transistorized preamplifier and a dual conversion, channel switchable receiver. The earth terminal meets FCC requirements for such service and can be completely assembled and installed at a CATV site in 3 to 5 days.

The initial transmission included a statement explaining the history-making event to viewers and the remarks of FCC Chairman Richard E. Wiley.



Scientific-Atlanta Receiving Earth Terminal

ComSonics Outlines Future Seminar Programming
Warren Braun, Pres. of ComSonics in Harrisonburg, Virginia, has announced schedules for technical seminars through March of 1976. All programs are taught at the advanced level, for system or group chief engineers and cover each topic with considerable detail, with substantial emphasis on practical application of data presented. Programs include System Reliability; FCC Testing; Large Scale System Transport Methods; Advanced System Testing Technology; Local Origination and Construction Practices. Sessions run about three days and are held on-site at ComSonics.

continued on next page

bulletin board continued

SCTE/IEEE Reliability Conference
Feb. 5-6, 1976 are set for Joint SCTE/IEEE CATV Reliability Conference in Philadelphia. Program will be sponsored by SCTE and Philadelphia Chapter of IEEE.

Programming will include topics of System Tests; Quick Systems Tests; Computer Aided Fault Localization and Testing; Protective and Back-up Systems; System Design for Reliability; Grounding and Bonding; Personnel Training and Equipment Design. Contact SCTE Executive Director for more information.

NCTA Announces Graphic Standards
Communications between cable engineers should be aided greatly through use of newly-adopted Graphic Symbols Standards for designation of electrical, electronic and pole line devices on layout drawings of CATV systems.

The NCTA Board approved the standards at its late September meeting. The standards were promulgated by a subcommittee of the Engineering Advisory Committee of NCTA chaired by Robert Hollis of Jerrold. They have also been adopted by the Canadian Cable TV Association and the International Electrotechnical Commission and are under consideration by the IEEE.

The standards, divided into 20 parts, set uniform symbols for such components as poles, amplifiers and signal processing locations. Symbols were designed for ease in drawing, interpretation and compatibility with similar standards of the electrical and electronics industries. They may be computer-generated.

Delmer Ports, vice president of engineering, announced that the standards will be published in about thirty days.

Call for Convention Papers
Persons submitting papers for publication in the 1976 NCTA Technical Transcripts of the April NCTA Convention will be notified by November 24, 1975 of acceptance of abstracts.

The completed paper will be due February 20, 1976 for publication.

Cable Handbook Available
Communications Press has announced the 1975-1976 CABLE HANDBOOK is available and provides a valuable addition to library reference shelves. This unique compilation of practical examples, advice, resource material and useful information was gathered under the auspices of Public-Cable, Inc., a well known national non-profit consortium of individuals and organizations interested in the development of cable and new communications technologies.

The volume is available from Communications Press, Inc., 1346 Connecticut Ave., N.W., Washington, D.C. 20036. Price is $7.35 per copy which includes postage and handling.

Emerson Forms New Company

James B. Emerson, formerly Director of Communications for Magnavox CATV Division, has formed MARCOM-Marketing Communications in Fayetteville, N.Y.

ComSonics Inc., supplier of widely varied CATV and TV technical support services has announced appointment of this new firm as representative to the CATV industry. Emerson is chartered to vastly increase the knowledge and availability of ComSonics' key technical services and products to the widest spectrum of CATV operations.

NCTA Affiliate and Individual Memberships Created
Two new membership categories have been established by NCTA: Affiliate Membership and Individual Patron Membership. The new groups will be included within NCTA's Associate Membership Category. The basic "system membership" is available only to operating CATV systems and franchises.

The NCTA Board of Directors created the new groups in order to provide special membership services to people and companies involved in the CATV industry.

EIA to Meet at NAEB Convention
A two day seminar, designed to take a careful look at the development of communication systems within colleges and universities, health care institutions, correctional institutions and defense training institutions, will be part of the 51st annual convention of the National Association of Educational Broadcasters, "The American Revolution in Communication," scheduled November 16-19 in Washington, D C.

The seminar, "Internal Institutional Communications—The Next Ten Years," has been developed by the Closed Circuit Communications Section of the Electronic Industries Association. The seminar will run Monday and Tuesday afternoon, November 17 and 18 from 2:30 to 5:30 in the Forum Room of the Shoreham-Americana Hotel.

The Monday afternoon session will consist of two one and one-half hour segments. Session I, on "Requirements," will be moderated by R.N. Vendeland, Vice-president of Marketing for DYNAIR Electronics, Incorporated. Session II, discussing "Available Technology," will be moderated by Robert W. Peters, Director of Communication Industries Research at Stanford Research Institute. This later session will feature speakers from the MITRE Corporation, Arthur D. Little, Inc., IBM Corporation, and AT&T.

A three-hour discussion on "Implementation" will take place Tuesday afternoon, structured as three one-hour panels—a consultant panel, an installation/contractor panel, and a system procurement panel.

The seminar on Internal Institutional Communication is a special feature of the NAEB Convention, which is the single largest annual meeting of professionals involved in public and instructional telecommunication.

Composed of over 100 carefully selected and planned sessions, the NAEB Convention offers a wide variety of topics in the fields of management, instruction, production, programming, engineering, broadcast education, graphics, and research.

In addition to these sessions, the Convention is planned in conjunction with the 1975 Communications Technology Equipment and Materials Show, which will feature over 70 exhibits of electronic equipment and software materials.

Texas A&M Communications Symposium

Significant dates for the cable communications industry should be Dec. 3, 4, and 5, when the Cable Communications Training Division, Texas Engineering Extension Service, Texas A&M University System, holds its Third Annual Cable Communications Symposium at Renner, Texas, near Dallas.

The symposium brings together personnel and manufacturers from the cable communications industry for three days of concentrated sessions on a variety of topics of interest to industry personnel.

All sessions will be video taped for future use in cable industry training programs and manufacturers will have equipment on display with representatives available to provide information and answer questions.

The first day's program will deal with job training and safety, including construction, grounding and the Occupational Safety and Health Act.

Signal propagation, antennas, signal surveys, processors and system maintenance will be covered during the second day, followed by an informal dinner sponsored by manufacturers. An open forum for questions and problems will be held on the final day.

Information may be obtained by contacting Tom Straw, Cable Communications Training Division, Texas Engineering Extension Service, Texas A&M University System, F.E. Drawer K, College Station, Tex., 77843, A/C 713/822-2323.

Western Cable Television Show & Convention

SCTE and the Western Cable Television Show have programmed outstanding sessions for the November 12-15 show at the Disneyland Hotel. Special rates for CATV technical personnel are available at a considerable discount than the full program registration.

James Collins Receives Morris Dunn Award

James Collins, Regional Engineer, National TV Cable and president of the South Central East Chapter of SCTE was awarded the Morris Dunn Award

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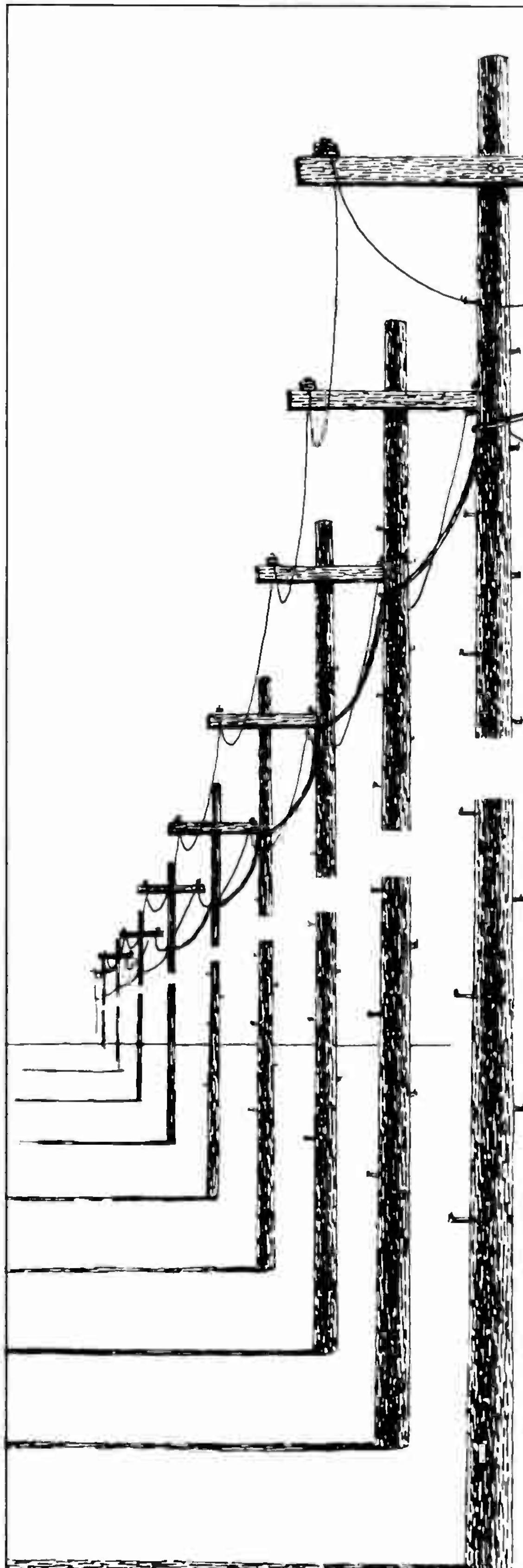


The local Cable TV Company doesn't want an arm and a leg...

only a foot.

One foot of surplus space.

One foot of otherwise useless space. That's what Cable TV rents on poles owned completely by PG&E. At rates that return to PG&E profits far in excess of 100%. The California Public Utilities Commission has refused to regulate these rates by PG&E.

Cable TV wants rates set at a reasonable level. More importantly, Cable TV wants PG&E to make more poles available (only about 10% are now). *Most* importantly, Cable TV wants to compromise.

We have to if we are to survive. PG&E doesn't want to compromise. And PG&E is PG&E.

No, the local Cable TV company isn't asking for an arm and a leg. But we know someone who is.

Western Pole Committee

forum

a medium of open discussion; a program involving discussion of a problem by several authorities

a forum is not a podium

The surface of the bar had been rubbed with beer and loving care for over a hundred years. Glasses sat upon it, their mirror image reflected in the warm surface defying gravity. By looking deep into the wood you could watch the level of beer rise towards the surface with each swallow.

The after work crowd had left, a few of the regulars were still joking and nursing a last beer or gin and tonic. Street lights had begun to shine, making puddles of light on the wet asphalt outside. The room was quiet, with long, pleasant pauses between comments. It was the time of day when you could stop and consider before replying, and all of us made use of the moment.

John and Bill were both behind the bar. It was the changing of the guard. John, drinking his first beer of the day, was closing out his books. Bill was reviewing the inventory in anticipation of the evening's crowds.

Two men were sitting at the far end of the bar. Occasionally their voices would boom out as they argued some obscure point.

"You're gonna have to watch those two, Bill. They've been in here since lunch."

"Have they paid the tab?"

"Yeah, they're o.k. so far. I'm just glad to leave them for you."

"Thanks."

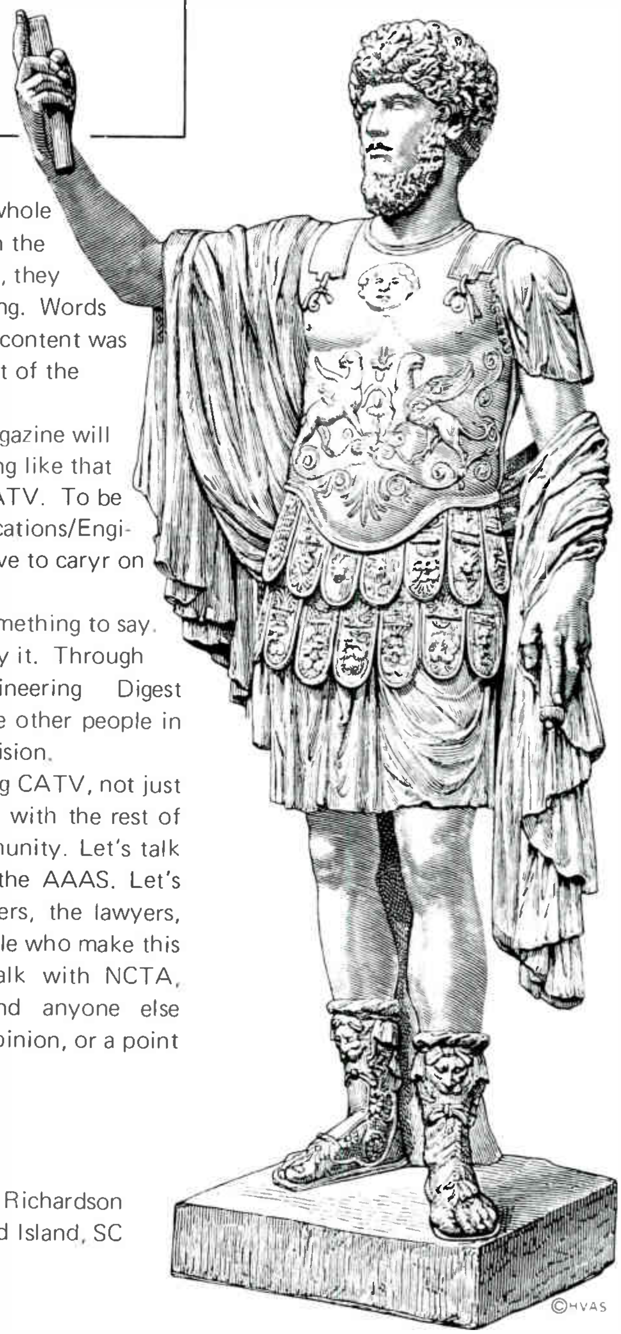
The two men were far past the relaxed stage. They sat together, never noticing the empty chairs that separated them from the knot of people at the other end of the bar. Finally their voices rose, one turned to his companion.

"You got the time?"

There was a pause while the other searched for his wrist.

"Yeah."

"Thanks."



The point of this whole tirade is that although the two men were talking, they weren't communicating. Words were spoken, but the content was withheld from the rest of the world.

Hopefully, this magazine will help prevent something like that from happening in CATV. To be successful, Communications/Engineering Digest will have to caryr on conversations.

All of you have something to say. This is the place to say it. Through Communications/Engineering Digest you can talk with the other people in and out of cable television.

Let's start discussing CATV, not just among ourselves, but with the rest of the engineering community. Let's talk with the IEEE and the AAAS. Let's talk with the managers, the lawyers, and all the other people who make this industry go. Let's talk with NCTA, CATA, the FCC and anyone else who has an idea, an opinion, or a point of view.

It's an open forum.

James A Richardson
Hilton Head Island, SC

proof of performance timetable

when to do it — how to do it . . .

76.605 TECHNICAL STANDARDS

(7) The peak-to-peak variation in visual signal level caused by undesired low frequency disturbances (hum or repetitive transients) generated within the system, or by inadequate low frequency response, shall not exceed 5 percent of the visual signal level.

What this means is that if you divide the visual signal into 100 parts, not more than 5 parts can be hum or low frequency interference. To comply with the rule, hum must be measured at the headend and in at least three (3) field locations. At least one of the field locations must be representative of the longest amplifier cascade in your system. You should measure hum at the headend, record the readings, and then move to the field test points. This will allow you to subtract the headend hum from the field hum and know exactly how much is produced in the system.

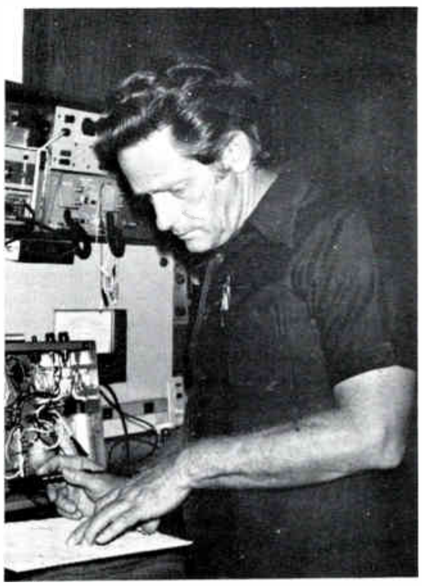
HUM MEASUREMENT

Equipment required: A signal level meter (FSM) with a video output jack, an A.C./D.C. coupled oscilloscope, a two-prong A.C. adaptor plug and miscellaneous cable jumpers.

For field use, battery operated test equipment, a D.C. to A.C. inverter or other A.C. source is necessary.

Hum must always be measured on an unmodulated carrier. In our systems, we use the pilot carrier (if available) and two or more standby carrier signals. Since daylight viewing of oscilloscope waveforms in the field is difficult at best, we do our hum measurements during the early morning (3 a.m. to 6 a.m.) hours. In the darkness, we can easily see the scope trace, some of the standby carriers are already on and we do not interfere with the subscriber's pictures. We do get stopped by policemen and bitten by dogs occasionally.

subpart K hum measurements



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

PROCEDURE

Hook up the test equipment as shown in *Drawing 1*. Be sure you use the two-prong adaptor on the scope A.C. cord. This is to minimize the possibility of stray hum loops. They will appear on the scope as if they were system hum. Operate the FSM on battery if at all possible. If not, an adaptor must be on its A.C. cord also.

Connect the cable signal to the R.F. input on the FSM. Signal level should be greater than +10dBmV for best results; however, lower signals will work on most meters. Hook up a short cable jumper between the video output jack on the FSM and the vertical input connection on the scope. Tune the FSM to a carrier, set the gain to the manual position and adjust with the pads and compensator for full scale deflection on the meter. Most meters will now be producing about .8 volts (p/p) at the video output jack. Temporarily disconnect the input signal from the FSM.

Now set up your oscilloscope as follows:

1) Adjust the controls for a clear, sharp line on the screen.

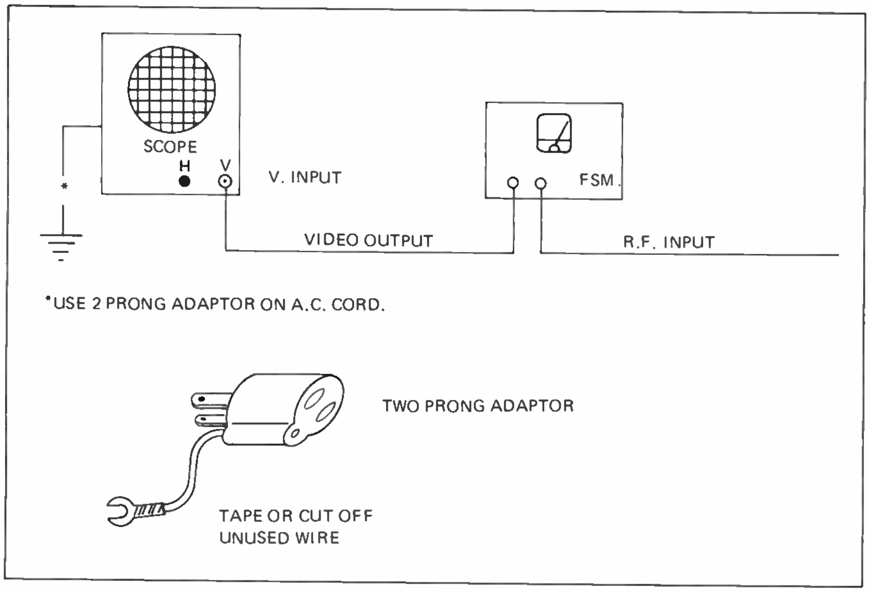
2) Set the A.C./D.C. coupling switch to D.C.

3) Set the voltage/cm control to the .1 V/cm position.

4) Set the sweep time/cm control to 1 ms.

5) Set the trigger level control at the minimum level that will keep the trace on the screen.

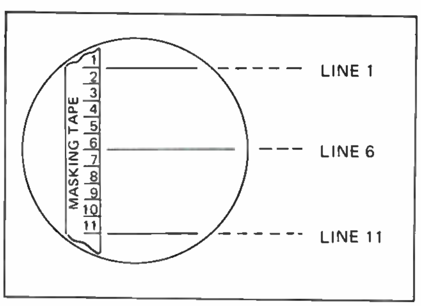
6) With the vertical centering control, adjust the trace to the bottom graticule line. If your scope screen, like mine, has less than 11 horizontal graticule lines (centimeters), you will now have to make some changes. You can either add lines at 1 cm spacing with a grease pencil or make up a 10 cm "ruler" on a piece of masking tape and stick it on the left side of the screen. See *Drawing 2* for details. It is essential that all the lines be equally spaced. This will be your "percentage counter" for the hum.



Drawing 1

Now, readjust the trace to the bottom graticule line (line 11) on the scope.

Reconnect the signal to the FSM input and make sure you still have full scale deflection on the meter. The trace should have moved up the face of the scope about 8 divisions. Using the manual gain control on the FSM, increase the signal until the trace is on the top line (line 1) of the scope. The meter will be pegged but this will not harm the meter if done slowly. Disconnect the signal again and make sure the trace returns to line 11 on the bottom of the scope face. If not, readjust the vertical centering control.



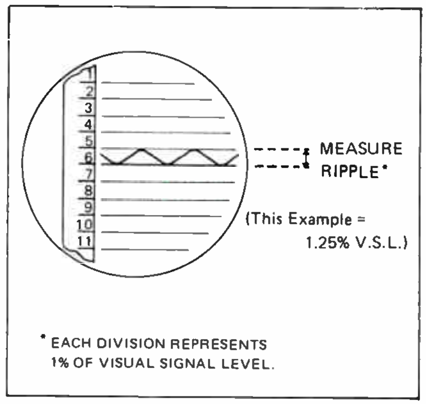
Drawing 2

When properly set up, the trace will be on the bottom line (line 11) with no signal and on the top line (line 1) with the signal on. What you are doing here is just voltage measurement. We are taking a 1 volt signal and dividing it into 10 one centimeter segments. Each segment (cm) will now equal 10% of the visual signal level. Leave the signal on.

Switch the A.C./D.C. coupling to A.C. The trace may bounce around some but this is normal. Using *only* the vertical centering control, move the trace to the center of the scope screen (line 6). Any distortion now noted on the trace (ripple or bumps) is hum or low frequency interference. Since each cm equals 10% of the visual signal level, if you see hum here, you have problems. Five percent hum is only one-half of one division. If no distortion is seen, turn the voltage/cm control to the .01 volts/cm position. Each cm is now equal to 1% of the visual signal level. Any hum can now be easily seen. Measure the hum (if any) by adjusting the trace (see *Drawing 3)* until the lowest point of the ripple just touches line 6 on the screen. Count the cm lines to the top of the ripple. This gives you the peak-to-peak voltage of the hum since each centimeter is equal to 1/100 volt or 1% of the visual signal level; see *Photo 1* on page 20.

To find the percentage of hum ***modulation***, just multiply the peak-to-peak reading by .5. The percentage of modulation is simply one half the peak-to-peak reading.

To determine system hum only, subtract the hum measured at the headend from the hum measured in the field. You can then tell where most of your hum is being produced.



Drawing 3

For those who want to calculate how much hum a system may have normally, you can use the following tables.

Conversion of percentage of modulation to dB relative to 100% modulation:

Modulation	dB
50.0%	-6.0
10.0%	-20.0
1.0%	-40.0
0.1%	-60.0

continued on page 20

matv techniques

Skip Cole, Strathmore Communications in Sarasota, Florida has some strong ideas about MATV installation. The following text is from communications with C/ED that Skip hopes to share with others in the CATV/MATV business.

"For the past five years I have been associated with Paver Development Corp., and I have been allowed to take liberties that were denied to the people that preceded me, and this is a very challenging position.

VERTICAL vs. HORIZONTAL

"What I find is sub-contractors using the old loop-thru system in buildings that have recently been completed. Since the company (Paver) manages a good many condos other than their own, I get called to check the lines out to find out where they went wrong. The first mistake they made—trying to do vertically what should be done horizontally.

"Most of the blame does not belong to the sub-contractors, but to the developers and building contractors. They buy the cheapest installation they can get. The net result includes more cost to rebuild, decreases in value of the building when it is sold, and that many companies in the area, such as Storer, do not like to take the rebuild program on. Hence, they will not put signal to these substandard buildings.

"High-rise buildings wired vertically with the old loop-thru system cannot be tolerated for a very simple reason. Let's assume you have a ten story high rise: 10 X 10 = 100 feet of RG59 cable-6 dB loss. Let's also assume there are four outlets in each apartment. Now you have 40 taps at 1.5 dB loss per tap, equaling 60 dB more loss. Now let's also assume there is 30 more feet of RG59 cable used in each apartment to complete the loop-thru. You've got an additional 300 feet of RG59 or 18 dB more loss for a total of 84 dB loss. Let's also assume the building has ten apartments on each floor and you have ten vertical lines feeding the building. The problem is now larger than before. Since there is no device made that has unity gain, you would now have to resort to directional couplers in series to feed your ten lines with 8 dB loss. This also means that it would require ten line extenders to make the system work.

DEMANDS ARE GETTING GREATER

"The time is coming fast when the cliff dwellers are going to demand the same service their neighbors are getting from the larger system in the local area. I get inquiries about the stock market and movies that Storer is running plus the other goodies they have.

INSTALLATION TECHNIQUES

"I am demonstrating this system on an isometric drawing (see opposite page), but the building is all one, with a hallway down the middle, with apartments on each side of the hall. In all cases the RG59 will be less than thirty feet to either the two- or four-way splitter that feeds the apartment. Each apartment has its own spigot from the DT, as shown on the drawing. All apartments have four outlets, the 412 cable is hung on the sprinkler system pipes, and all DT's will have an access door built in.

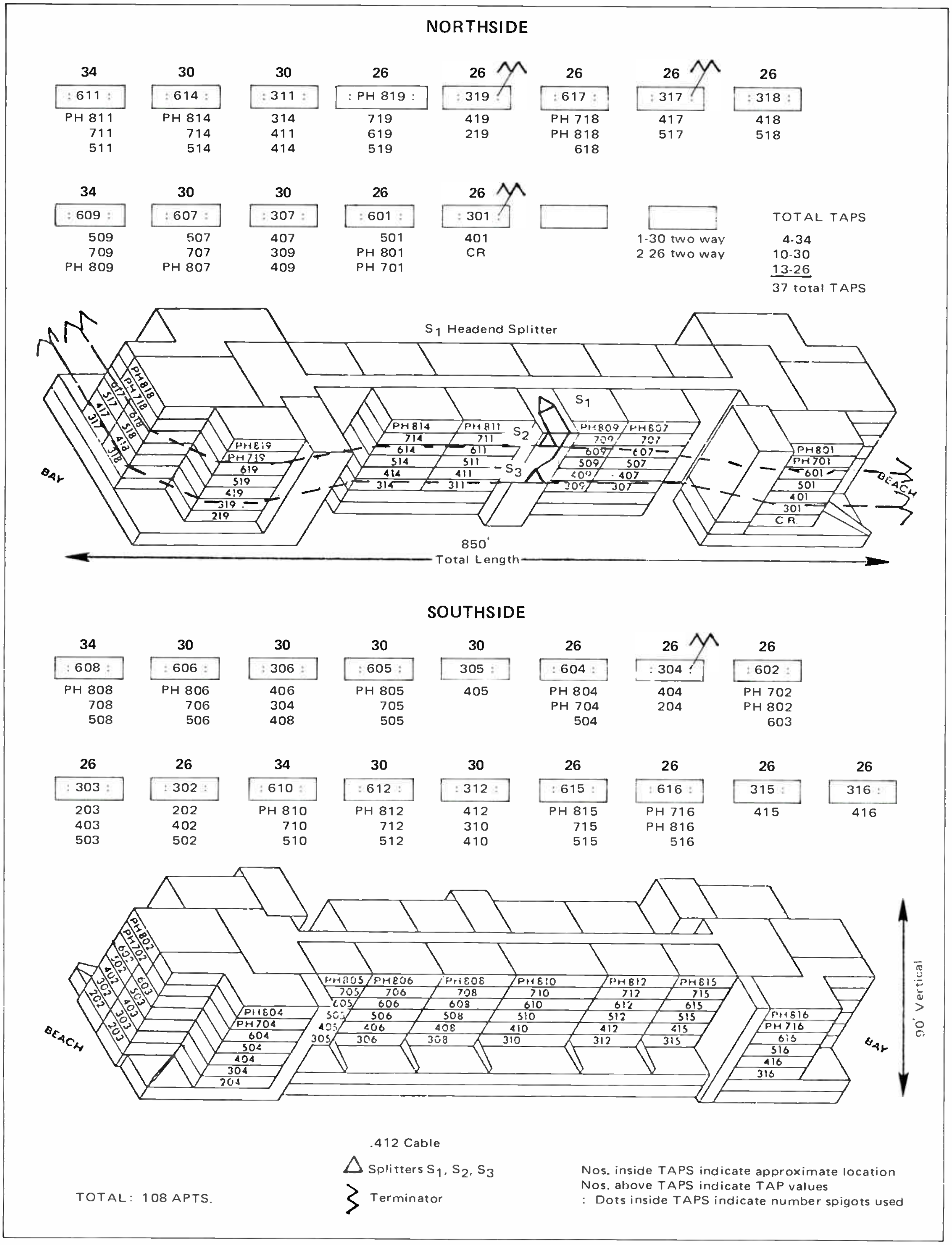
"All high-rise buildings that I have designed are wired with either 412 or 500 cable. If the building is large enough I will go to 1750 cable to avoid the use of line extenders. All DT's are 4 to 300 MHz for future use.

INCREASING VALUE

"When a building is wired and designed as a CATV system, (in miniature), the building becomes more valuable for resale, and more attractive to the local CATV system in any area. All the operating company's engineer has to do is take the readings with his meter (usually about 55 dB) at the headend site and use an amplifier that will give the required dB, with no rewiring to do.

RELIABILITY AND REPAIR

"The systems that I design are all fed from the headend with no line extenders, and each strip has automatic gain control. This makes a very efficient working system. If a tap needs to be changed, you don't take out your neighbor's TV while changing it. With the loop-thru system, depending on which floor the tap is on, you take out everyone below or above, whichever the case may be. Also, the loop-thru is very susceptible to voltage or lightning surges, mostly because the system is not properly grounded."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PH 701
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: 301 :
401
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1-30 two way
2 26 two way
TOTAL TAPS
4-34
10-30
13-26
37 total TAPS
S1 Headend Splitter
S1
S2
S3
BAY
BEACH
850'
Total Length
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PH 808
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315 :
415
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316 :
416
BEACH
BAY
90' Vertical
.412 Cable
Splitters S1, S2, S3
Terminator
TOTAL: 108 APTS.
Nos. inside TAPS indicate approximate location
Nos. above TAPS indicate TAP values
: Dots inside TAPS indicate number spigots used

coming in the c/ed december issue

- A Primer on Satellite Communications
- MATV, Technical Topics and Proof of Peformance —continued
- More on Security Devices
- Standards and Symbols

ncta technical topics

the FCC inspector

The Radio Inspector (RI in radio amateur slang) is an institution of long-standing. He is the representative of the Federal Communications Commission, and his job is to see that the rules in those matters in radio and communications under the jurisdiction of the FCC are respected. Cable system installations have now been added to their list of responsibilities and the inspectors have started their first round of visits. Approximately 300 cable systems have been visited so far.

WHAT'S HE LIKE

The list of responsibilities of the RI is fantastic. He must cover radio and TV, vehicular communications, radio amateurs, radio marine services, and citizens band operations among others. The citizens band alone is expanding at the rate of 200,000 new licensees per month. This large order would totally frustrate ordinary human beings.

The whole operation is under the management of the Field Operations Bureau of the FCC in Washington, D.C. The 370 RI's constituting the field force operate out of 24 district offices. These offices are distributed throughout the 50 states and Puerto Rico. These 370 men are headquartered in the various districts and use these district offices as their base of operations. They obviously are on the go a large portion of their time.

The life of the RI is interesting but not easy. He is educated and holds an engineering degree. Most of them have had military service with communications and electronics experience. Typically, he is married with children in school. Most of them live in suburbs of the area of their district offices. His hobbies include sports, boating, assembling kits, and similar pursuits. They must be selected to adapt to his extensive traveling schedule. Many of them own and operate citizens band systems. He receives special training as an FCC inspector, and an introduction to cable TV technology is being added to his schooling.

WHEN HE ARRIVES . . .

There is a right way and some wrong ways for you to respond when he visits your installation. These visits may come either announced or unannounced. When he comes, get acquainted with him on a first-name, personal basis. A good rapport with the RI is worth 10,000 excuses. Both you and he can learn a lot by establishing a good fluent dialogue. He needs to learn about your system, and he is in a position to teach you a number of things from his own experiences. He will eventually be equipped with testing equipment that will be either different or beyond the scope of things available to you. Thus, you can confirm what you are doing with your equipment and check calibrations.

His main objective above all others is to help you operate better than the law requires.

WHEN HE LEAVES . . .

What should you do after he visits? Obviously, you should take advantage of the things you may have learned about your performance and how you compare generally with the present state of the art. If you should get a letter as a follow-up from the district office commenting on any deficiency, or worst yet, a citation, there is one cardinal rule to follow. Don't ignore it. You should respond and do it promptly with an explanation and evidence of corrective measures The usual case is a letter. Despite their reputation, citations are relatively rare.

Copies of the correspondence get to Washington eventually. They are collected in Washington, not for disciplinary purposes but so that they may be analyzed to provide a general overview of the state of the industry.

THE RESULTS

The first round of visits to cable systems has produced some interesting results. Inevitably, discrepancies were found and noted. The types of these discrepancies were rather varied but

continued on page 20

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proof of performance timetable continued

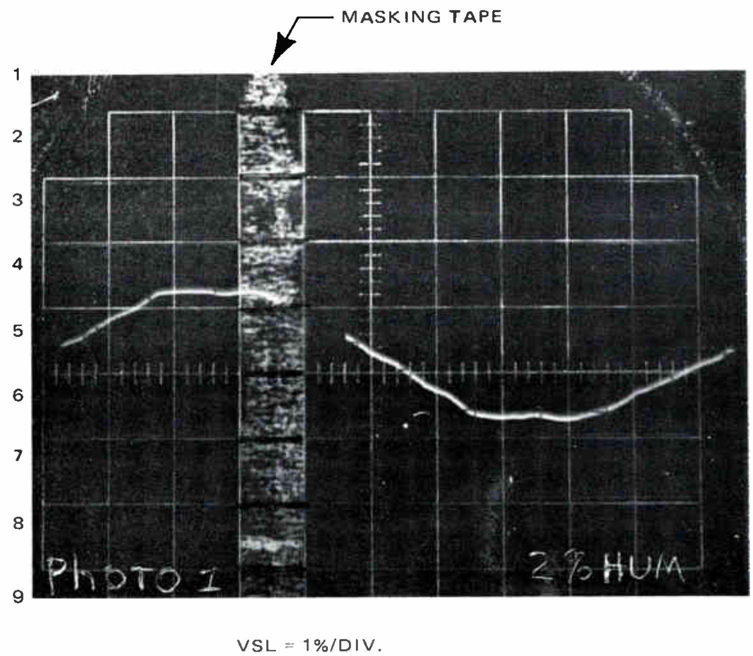

Photo 1

Assuming the hum is in phase and all amplifiers are identical, worst-case hum modulation in a cascade of amplifiers would increase by:

No. of Amps.	dB Increase
1	0.0
2	6.02
4	12.04
8	18.06
16	24.08
32	30.10
64	36.12

The dB modulation will increase by about 6 dB each time the number of amplifiers in cascade is doubled. Assuming a 30 amplifier cascade, worst-case hum modulation would still be less than 2%. In actual systems, it is almost impossible to find a 30 amplifier cascade with all hum in perfect phase. Any out of phase hum will subtract from the above readings.

This detailed explanation may seem long and complicated. In practice, after you become familiar with the procedures, it takes less than 5 minutes per carrier measured.

This method can also be used in system hum trouble shooting with good results.

bulletin board continued

at the Southern Cable Television Association Convention, Monday September 29, 1975. The award was presented by Polly Dunn, Columbus TV Cable Corp., Columbus, Mississippi at the Monday luncheon event. Basis for the award as explained during the presentation was centered on integrity and continued support of the development of the cable industry.

Collins was cited for his quiet, determined and very effective contributions to cable development in the southeast. He also was the recipient of the 1975 SCTE Man of the Year Award for his contributions to SCTE. He is a charter member and a great promoter of the Society in the southern portion of the United States.

ncta continued

somewhat as you would have anticipated although there were some surprises. Illegal operations and excessive signal leakage were noticeable among those observed. It is impressive, if not surprising, that different types of deficiencies seem to concentrate in geographical areas. This suggests that at least some deficiencies may be contagious.

There have been the inevitable reports of abuses of authority. Unfortunately, those few that have occurred have been amplified and multiplied way out of proportion, and everyone has suffered as a consequence. His primary objective, even though he does have the legal authority of an enforcement officer, is not to issue citations but to help you avoid the necessity of receiving one. So get acquainted with him, enjoy his visits, feel free to ask his advice, and welcome him back.

Pay TV Filters

Roger G. Wilson
Vice President, Engineering
Hamlin International Corporation
Seattle, WA

The success of pay television has created a sudden demand for inexpensive "hard security". "Security" is the ability of a CATV system to restrict distribution of pay programming to those subscribers who pay for it. "Hard security" is a form that is difficult for an unauthorized person to overcome, making it hard to sneak into the theatre without paying, so to speak.

The simplest form of hard security is a trap placed in the tap end of each non-Pay TV subscriber drop. Secure because so little signal enters the subscriber's home that no matter what he does, he can't view it satisfactorily. The *hard* security comes from placing the trap off his premises, in a location that is difficult to access and illegal to contact; the CATV plant. There have been tens of thousands of these filters placed in service to date and their effectiveness is beyond doubt. They work.

The combination of immediate and future demand has created a familiar situation; electronic manufacturers have rushed into production of filters. The result is a number of filter styles, sizes, shapes and performance characteristics. Some are good, some so-so, and some terrible.

The purpose of this paper is to discuss electrical and physical requirements for pay TV filters and their limitations.

DEFINING NOMENCLATURE

First, terminology. This device for pay TV security is known variously as a trap, notch filter, band stop filter or band reject filter, just different names for the same thing.

To illustrate what a band reject filter should be, consider the frequency response of the ideal filter as shown in Figure 1. This shows zero dB attenuation from zero frequency to f_1 and from f_2 to unlimited frequency. This is the pass band of a band reject filter and consists of two segments of spectrum. The reject band is between frequencies f_1 and f_2 and the reject bandwidth is f_2-f_1. Attenuation in the reject band is unlimited. Such a filter would have no effect on the spectrum below f_1 or above f_2 since the sides of the response curve are vertical. Of course, such performance in an actual filter is impossible.

To those accustomed to thinking in terms of band *pass* filters the first consideration of band reject filters may be confusing. Everything seems upside down. And so it is.

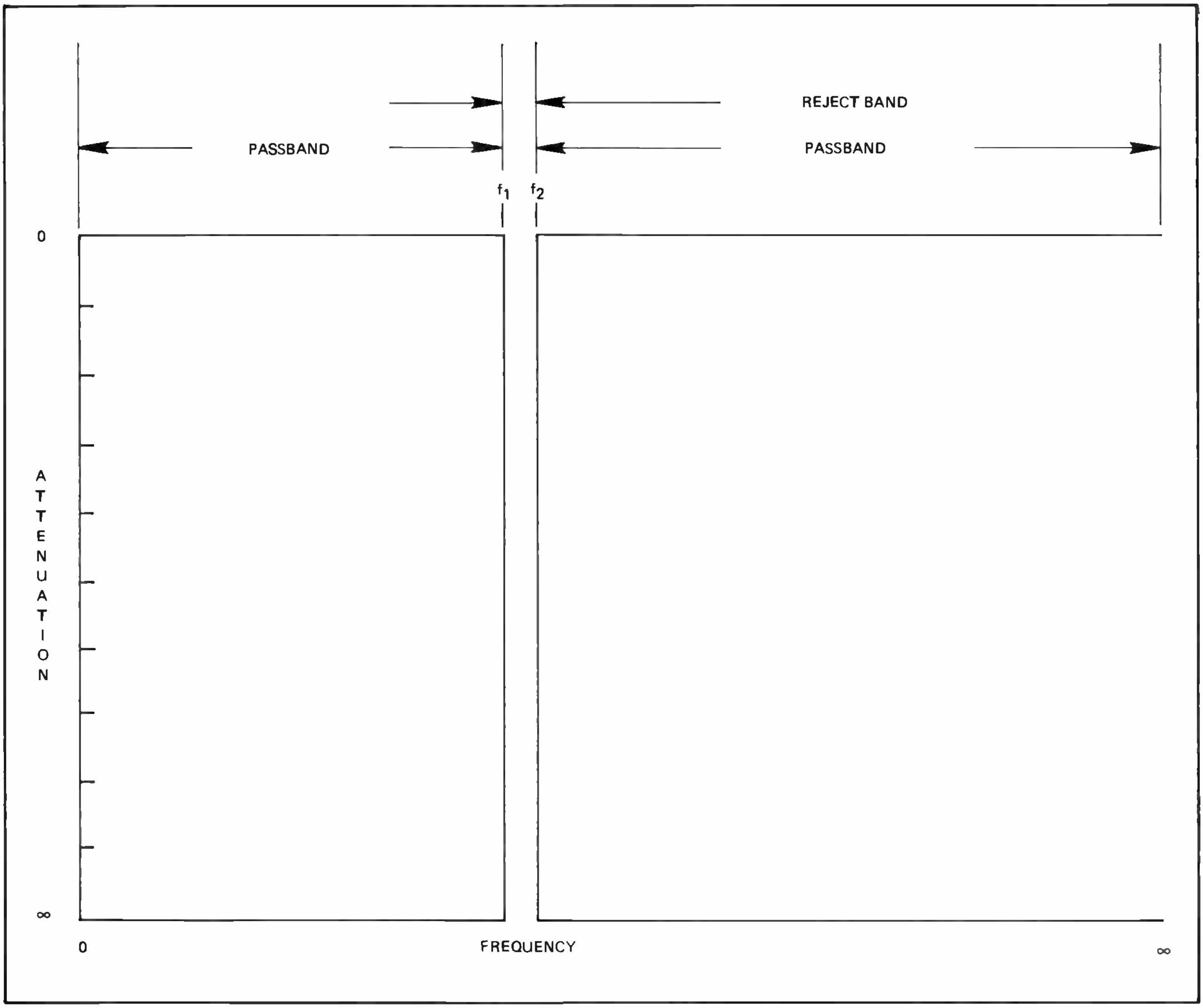

Figure 1

If the curve of Figure 1 is simply inverted with the attenuation and frequency scales remaining just as they are, we have the response of the ideal bandpass filter: zero dB attenuation between f_1 and f_2 with unlimited attenuation at all frequencies above and below.

Let's look at a representation of a real life filter as shown in Figure 2 to see how it departs from the ideal. The most obvious differences are that the sides of the curve are sloped and the bottom occurs at a specific value of attenuation. As we move along the attenuation (vertical) scale the corresponding bandwidth changes continuously. Then how do we ever come up with specific bandwidths to use for describing filter performance?

TWO WAYS TO DETERMINE SPECIFICATIONS

A. **We determine our own bandwidth requirements and design or evaluate filters on that basis.** For example, since f_0 for pay TV filters is a picture carrier we may decide that the adjacent picture carriers shall be attenuated 1 dB or less by the filter. Since the adjacent picture carriers are 12 MHz apart (f_2-f_1), the filter must then have a 1 dB bandwidth of 12 MHz. We could have said the adjacent picture carriers

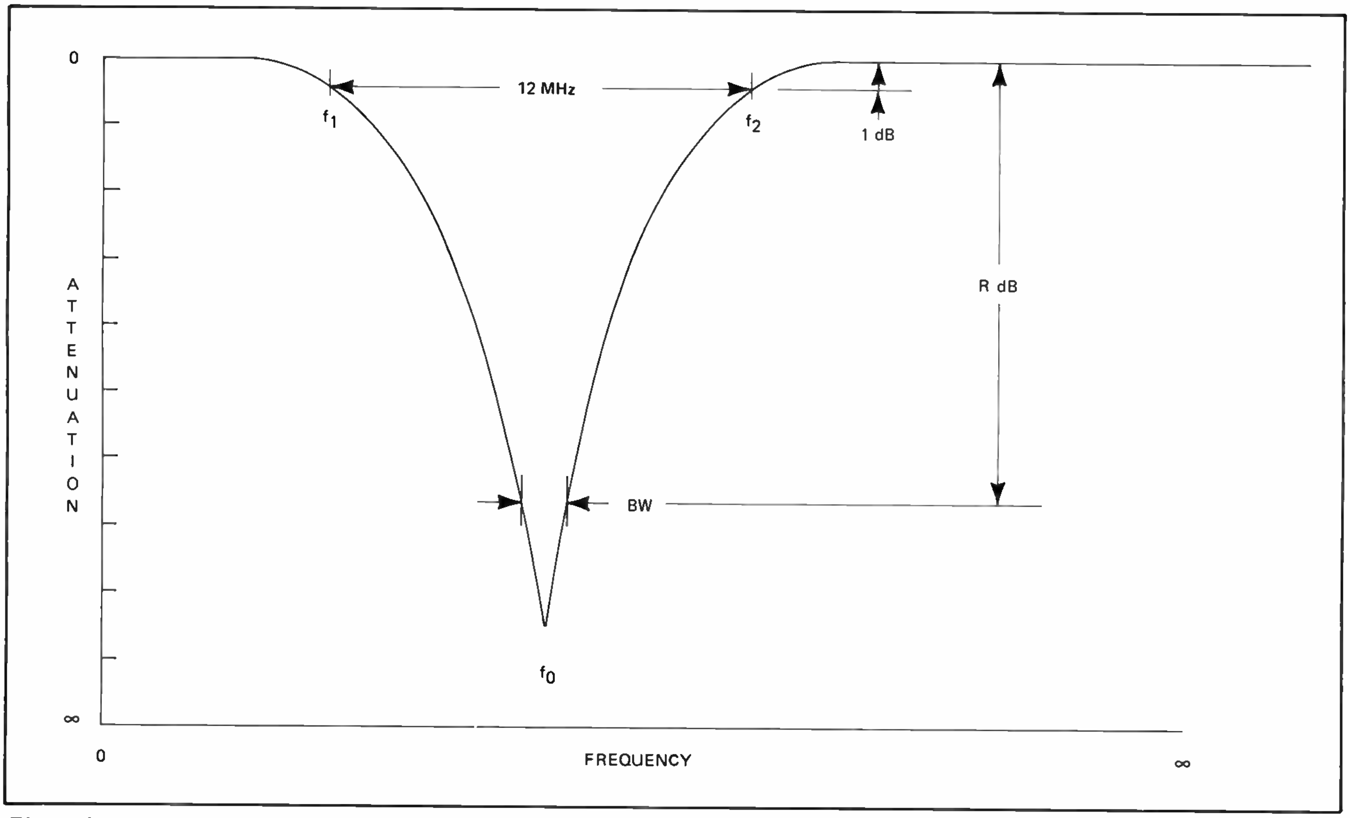

Figure 2

shall be attenuated 0.5 dB or less, for 0.5 dB bandwidth of 12 MHz. Or, 2 dB for a 2 dB bandwidth of 12 MHz, etc. 1 dB bandwidth of 12 MHz is shown in Figure 2.

B. We can use 3 dB bandwidth to specify filter performance. "3 dB bandwidth" is established as a standard to which filters are specified and designed and much design information is oriented to 3 dB bandwidth performance. It is based on the fact that signal coming out of the filter at frequency f_1 or f_2 will be half the power (3 dB attenuation) of signals without attenuation.

If you are evaluating rather than designing filters, knowing their 3 dB bandwidths isn't very helpful. If the filter manufacturer tells you his product has a 3 dB bandwidth of 8.0 MHz, you don't know what it does to adjacent picture carriers at 12 MHz apart. They will be attenuated less than 3 dB, but how much less?

If you're evaluating filters and model X pulls the adjacent picture carriers down 3 dB (3 dB bandwidth of 12 MHz) and model Y pulls them down 1 dB (1 dB bandwidth of 12 MHz), model Y obviously has the most desirable (narrowest) bandwidth.

Figure 2 also illustrates a filter that is ***symmetrical.*** The shape of the response curve below f_0 is the same as it is above. This is typical of the filters used for pay TV and is one of their limitations. That is, they take out as much spectrum below f_0 as above. Since they take 6 MHz above f_0 to return to a low value of attenuation, they take a like amount below. That's why I've been referring to adjacent picture carriers in the plural. Due to their symmetry, the filters have the same effect on each of them. (Any experts who see some simplification in the last statement, please excuse. The error is slight in these filters.)

Most of the 6 MHz above f_0 is the pay channel you want to obliterate. That's fine, but the 6 MHz below contains another channel and it's badly damaged by the intrusion of the filter into its spectrum. Thus a filter requires the next channel below it be unused for TV, though there's usually enough of it left for data or some audio channels in the vicinity of the picture carrier. Figure 3 illustrates this situation.

Well, why not make the filter response sufficiently narrow that it doesn't attenuate the lower adjacent channel,

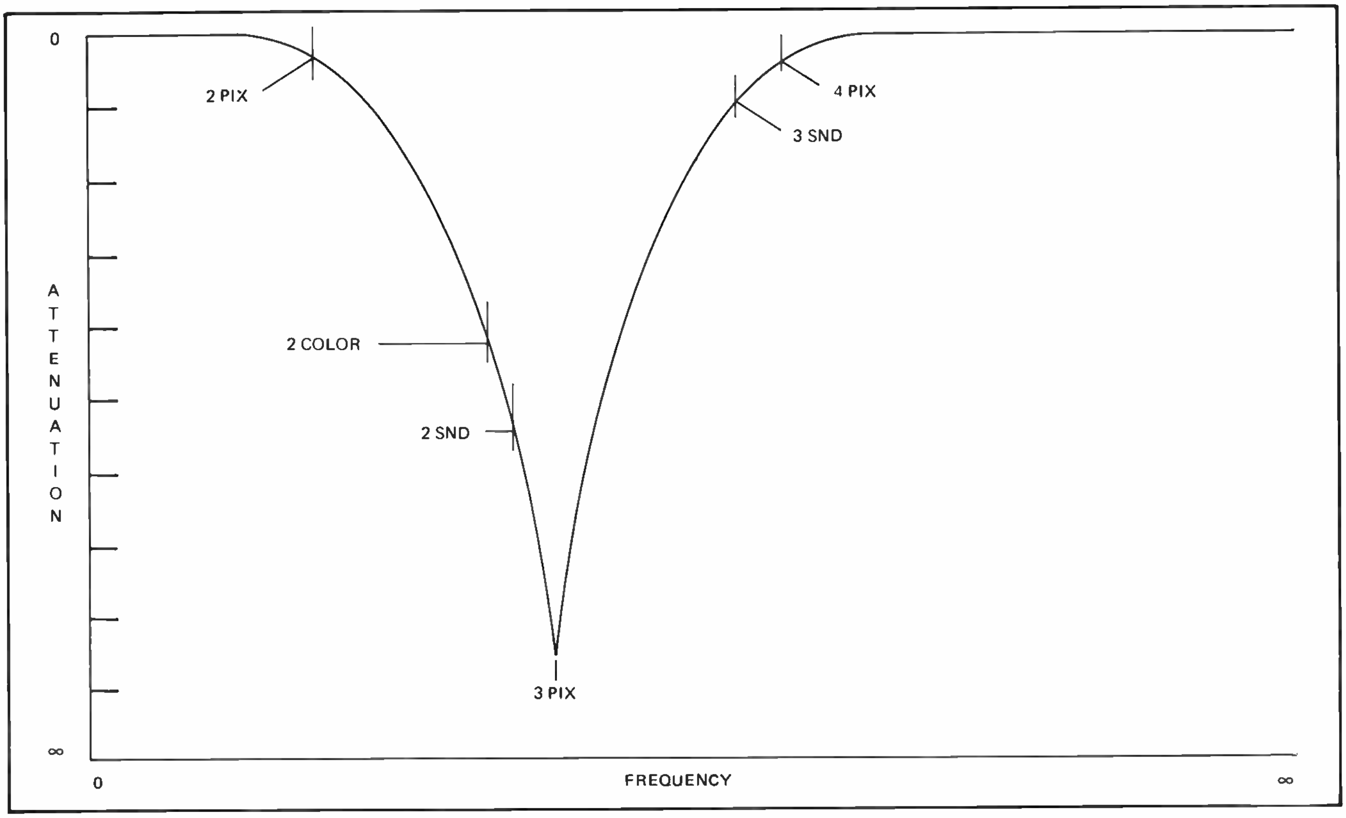

Figure 3

but just takes out the pay picture carrier? To do so would require a filter design using large, high quality (expensive) inductors, very high quality (expensive) capacitors, and a large, sturdy compartmented (expensive) box. In addition, it would be difficult to stabilize for temperature variations and physical abuse. Even then it could only be accomplished on the few low band channels. It's not likely you would pay the price for it.

Why not move f_0 up halfway between the pay and upper adjacent picture carriers so the response will have less effect on the lower channel? Partly because it will attenuate the upper adjacent picture carrier more, but mostly it will no longer adequately ruin the pay TV reception.

If you want to destroy a TV channel with a band reject filter, nothing succeeds like centering the filter response on the picture carrier. Not only is the picture carrier required by the TV receiver to reconstitute video information but the synchronizing signals and the big chunks of picture information are close to it in frequency, hence are greatly attenuated by the filter. At Hamlin International we made one such between-carriers filter, with attenuation at f_0 of more than 60 dB. The effect on the filtered channel was elimination of fine detail and some blurring, hardly objectionable at normal viewing distance. It didn't even kill the color, and sound was unaffected. This was a channel on a cable system with adjacent channels operating. True, the lower adjacent channel wasn't wiped out but then neither was the "pay channel".

Referring again to Figure 2, it's necessary to specify some minimum value of attenuation that will render the pay channel unusable. It's also necessary to have some bandwidth centered on f_0 at this attenuation level for not only is more information removed from the signal, but more important, there is room for the rejection notch to shift frequency without the attenuation at f_0 becoming less than specified. This will happen with changes in tuning due to time, temperature and handling. These filters are ordinarily located in an outside environment where they are subject to considerable temperature variation. Also they are small, inexpensive and usually installed at a considerable distance above ground, all of which gets them plenty of knocking around, so adequate bandwidth at the specified attenuation level centered on f_0 is very important. This attenuation level is shown in Figure 2 as R dB and the bandwidth is indicated by BW.

DETERMINING BANDWIDTH

How much bandwidth is adequate? Enough so that during its service life, the total environmental impact will not reduce its attenuation below the minimum specification at picture carrier frequency. Minimum attenuation during test will be maintained thru specifications 2 and 3 following, if bandwidth is adequate.

Making bandwidth measurements at room temperature before environmental cycling, isn't conclusive. Model Y may be well constructed and compensated so that its 200 KHz bandwidth is adequate, while model X may be so poorly designed and constructed that its 500 KHz bandwidth isn't adequate to keep f_0 below R dB as the filter lives in the real world.

Performance characteristics that should be specified are:

Minimum attenuation provided at pay channel picture carrier (R dB, Figure 2). Since the picture deteriorates gradually with attenuation, it's necessary to arbitrarily determine an attenuation value that degrades the picture sufficiently to discourage viewing. This must be so at the upper signal levels expected to enter a subscriber's home. The most difficult situation for a pay TV filter is providing security for a channel that has no adjacent channel in operation. The filter attenuates system noise as well as signal so pay channel security then lies in getting the signal down into the noise level of the TV set (or converter, if used).

A more desirable situation is to have an upper adjacent channel in operation. Then when the filter reduces the amplitude of the pay carrier, the AGC on the TV set opens up the gain and the adjacent channel rushes in, assuring the destruction of the pay picture. The adjacent channel helps scramble the pay channel. This is the reason you can't just put an attenuator in the drop to a TV set and determine what a given value of carrier attenuation will look like with an adjacent channel in operation. The adjacent channel will be attenuated the same amount as the pay carrier. You *can* do this to get an idea of what a given amount of carrier attenuation will do to the channel in the absence of an adjacent channel, since you are taking both carriers down equally into the noise. Of course, you should go into the attenuator with a representative drop signal level, and into a converter if they are to be used.

No matter how many vacant channels in the broadcast spectrum there may be on a cable system, it would always be possible to place a pay channel adjacent to another channel except channel 13, to assist in "scrambling" when the pay TV filter is in place. Therefore, the only time a pay channel should have no adjacencies would be if it were placed in non-broadcast spectrum, in which case a converter would be used.

Assume a converter with a noise figure of 10 dB (good for a converter), gain of 5 dB, and TV set noise figure of 6 dB (possible for a late model set on the low band). If we further assume a drop level of 10 dBmV and minimum filter attenuation of 46 dB (R dB in Figure 2) we would have a signal/noise ratio of 10 − 46 + 59 − 10.4 = 12.6 dB in the vicinity of the picture carrier. This produces a picture only a blind person could enjoy. I say this advisedly because it's characteristic of these filters in general that they don't usually eliminate the audio portion of the pay channel.

The simplest way to measure the specified minimum attenuation of a given filter is to:

a) Tune a signal generator to picture carrier frequency of the pay TV filter. This must be done quite carefully as the rejection bandwidth is very small right at picture carrier. A frequency counter is highly desirable for this purpose. The best way is to use a crystal controlled source such as the pay channel modulator or a crystal controlled signal processor on the pay channel in standby carrier mode. Either of these sources should be used unmixed with other signals. Or use the appropriate module in a X-mod rack. Set signal level to 50 dBmV or more.

b) Put 60 dB as a starting value in an adjustable attenuator.

c) Connect the signal source through the attenuator to an SLM and peak the SLM, noting the reading. See Figure 4A.

d) Connect the filter in the circuit and remove dB from the attenuator until the reference reading on the SLM is re-established. The amount of dB removed from the attenuator is the attenuation of the filter. Obviously, if all the attenuation is removed and the SLM reads below "c" above, it will be necessary to recalibrate with more attenuation.

A simpler way is to place the amount of attenuation specified by the manufacturer for the filter in the attenuator when setting reference level. If removal of all this attenuation leaves the SLM below reference level after inserting the filter, it makes spec. The filter will be very poorly matched at this frequency since it's reflecting most

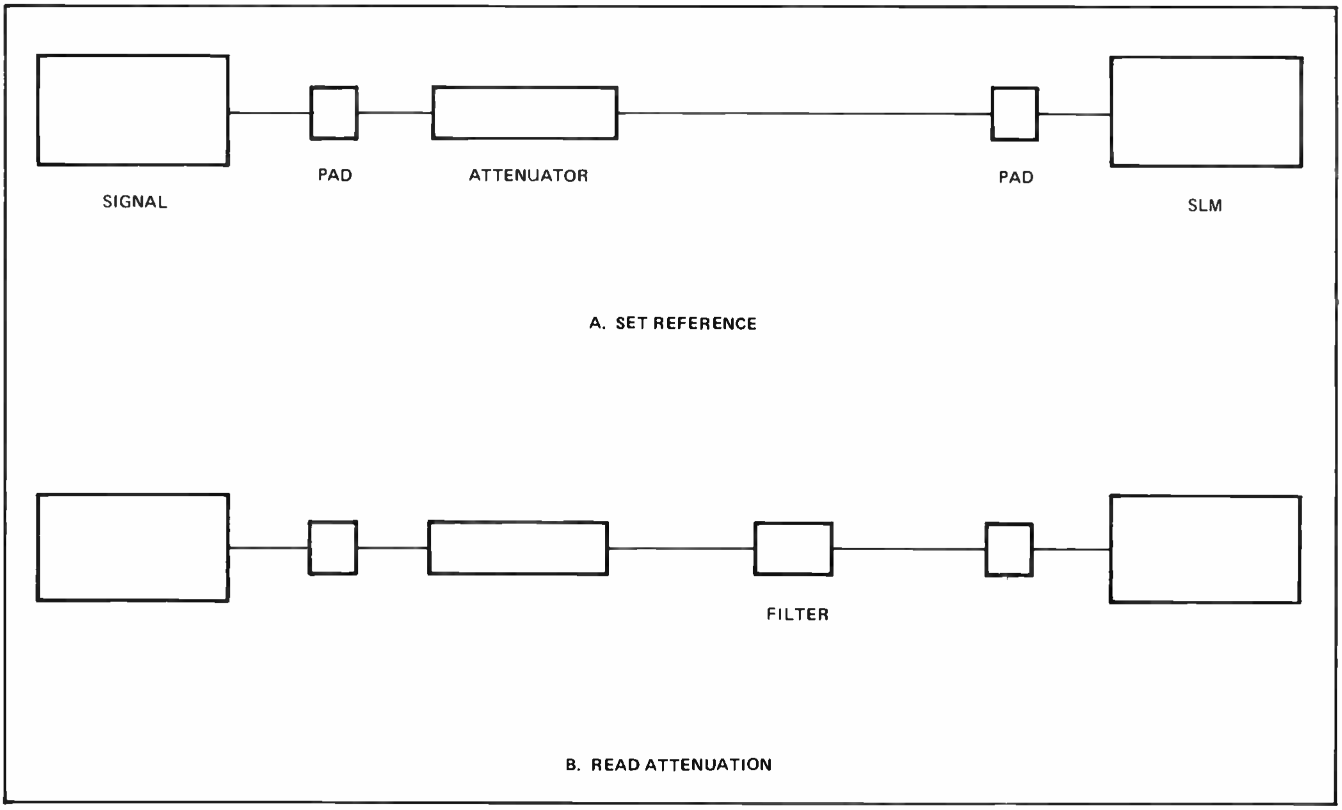

Figure 4

of the input signal, so the output match of the signal source and input match of the SLM are significant. Use as much fixed pad on each side of the filter as practical. See Figure 4B.

Temperature range over which the specified attenuation will be maintained. Certainly the filter should provide the specified minimum attenuation on a winter night as well as a summer afternoon. A thermometer or thermocouple instrument of the right temperature range, and sources of heat and cold are of course necessary to test this performance. After the temperature of the ambient air in which the filter is placed has arrived at the desired value, it's important to leave the filter exposed long enough for all its parts to arrive at that temperature. Five minutes in front of a hair dryer, or on an ice cube, leave a great deal to be desired by way of temperature performance information. The filter should spend at least 15 minutes in air at the desired temperature before measuring attenuation, and 30 minutes minimum if potted.

A filter constructed to serve in any U.S. location (except perhaps Alaska) should maintain specified rejection from approximately -30°F. to 130°F. You would be correct in checking them for the extremes experienced in your climate.

Mechanical shock. As mentioned previously, pay TV filters are small, inexpensive and will be handled in large quantities by system personnel. All of which make it likely they will be handled with considerable abandon. Therefore, their ability to provide specified performance after absorbing physical punishment is important. But how much punishment? The worst likely form of accidental mistreatment will occur to a filter dropped from strand height (say 20 feet) onto concrete or asphalt. This calls for great care in mechanical design and construction, for a small amount of physical displacement of internal components can ruin its performance. It's most likely a damaged filter will continue to pass the non-pay channels; it will simply pass the pay channel also, so you may never know. Any filter that can withstand a 20 foot drop test will be untroubled by the knocking about it gets in routine handling.

12 MHz bandwidth. Since the filter is going to damage the lower adjacent channel in any event, the attenuation it has at the upper adjacent picture carrier is of principal concern and must be minimal to avoid damaging the upper channel also.

Again, some number is chosen that is a practical compromise between cost and performance. 1 dB is achievable for the low band channels and 2.0 for the midband. Since the filter is symmetrical the same attenuation affects the lower adjacent picture carrier 12 MHz away. This would be stated as a 1 dB bandwidth of 12 MHz for the low band and 2.0 dB bandwidth of 12 MHz for the midband.

No mention has been made of spectrum above midband. This is because the bandwidth of the filters becomes increasingly broad as center frequency is increased and the upper adjacent picture carriers begin to be pulled down too much by the filter's response. It also becomes more difficult to get and maintain adequate rejection at the filtered carriers, so inexpensive, adequate filters aren't likely above the midband.

If a filter you are considering has no bandwidth specification, or for a bandwidth of other than 12 MHz, or doesn't mention attenuation at the adjacent picture carriers, you should measure it. It's an important characteristic. Unless, of course, you don't plan on ever having channels close enough to the filter's response for it to matter.

Since this attenuation will be only a few dB at most, it can be measured on a sweep setup as well as a signal level meter. The SLM may be best since you can read fractional dB's on its face. Feed signal on the desired frequency directly into the SLM and adjust for a full scale reading on the dB scale. Insert the filter and note how many dB the reading decreases. The accuracy of the frequency setting isn't nearly as critical as when measuring notch attenuation because the slope of the response curve will be much less.

Insertion loss outside the filter response. The insertion loss to the rest of the spectrum outside the filter response should be low or all the other channels suffer from use of the filter. It can be on the order of 0.25 dB from 5 to 300 MHz and can be measured as in 12 MHz bandwidth above.

Return loss above and below center frequency. Within the reject band of the filter, return loss in dB will be low since the filter is returning signal rather than passing it. As we move toward the passband either above or below center frequency the dB return loss number will increase. So the questions are; (a) to what value should it increase and (b) how far from center frequency should the increase take place?

The return loss looking into any tap port on most directional taps is 20 dB or more. Since the filter connects between a tap port and a drop cable its return loss should be at least 20 dB to avoid degrading the match characteristics of the drop.

How far from center frequency the return loss will become 20 dB depends on the bandwidth. The narrower the bandwidth the closer the 20 dB points will be to center frequency. Typically, a good filter would have 20 dB return loss within ± 10 MHz of center frequency in the low band and ± 15 MHz midband. It will be less than 20 dB at the adjacent picture carriers (±6 MHz) because there is still some attenuation, hence reflected signal there.

Return loss is best measured with a bridge just as for cable, amplifier ports, etc. Both passband return loss and insertion loss are characteristics that affect the entire spectrum outside the filter response, so they're important. This is opposite from a bandpass filter where only the few MHz within the passband require attention as to match and insertion loss.

Atmospheric seal. Since the filter depends for its performance on low loss, very precisely tuned circuits, and moisture has a lossy, detuning, and sometimes corrosive effect on such circuits, it's highly desirable to keep the circuits away from the atmosphere. This can be done in two ways: the housing and connectors can be made airtight, or the circuits and their supporting structure coated with a protective material. Rather than being coated the circuits may be completely immersed, or potted, in the protective material.

POTTED CIRCUITS—BUBBLES MEAN TROUBLES

If the circuits are coated or potted, there isn't much you can do to check the protection except visually inspect some samples, but most present day filters rely on sealed housings and connectors for circuit protection, and are impossible to check visually for seal. Fortunately there is a simple test. Heat a container of water until bubbles begin to rise from the bottom, then let it cool until the bubbles just subside. The temperature will be about 170°F. Completely immerse the filter. As the air inside the filter heats, its pressure will increase, causing bubbles to rise from even the tiniest leak points including the center conductor holes in the connectors. A word of caution: there will be air trapped in the connectors which will also expand, and so even connectors which are well sealed to the inside of the housing will bubble, but only for 15 to 30 seconds or so, then they will stop. Usually with a final bubble that only makes it halfway out the end of the connector. If there are bubbles still breaking away from the filter after about 30 seconds of submersion there is probably a leak.

If the filter has an integral pigtail or jumper it should be cut off as close to the housing as possible so any leakage can be seen. Again, a few bubbles of trapped air would trickle out from under the remaining ferrule and bushing, but would subside if there was no leak.

"LUMPED CONSTANTS"

There are pay TV filters built using helical resonators, $\lambda/4$ wave-transmission line sections and inductor-capacitor combinations in a number of circuit arrangements and physical shapes.

They all have advantages and disadvantages, of course, but a design using inductors and capacitors, or "lumped constants", has the following advantages:

1. Components are small and light so mounting them on a PC board is practical and results in the rigidity necessary to withstand mechanical shock.
2. Components are standard off-the-shelf items so are inexpensive and readily available, keeping cost down.
3. Temperature compensating components are widely available for stabilizing temperature performance.
4. The PC board assembly is compact and allows use of a seamless metal can with solder-in lid for atmospheric seal.
5. The metal can permits use of airtight connectors for atmospheric seal.
6. Construction and adjustment are simple and straightforward, again keeping cost down.
7. Insertion loss outside the reject band (all the rest of the 5 to 300 MHz spectrum) is negligible.
8. Return loss outside the reject band can be 20 dB or better.

Figure 5 shows the schematic of a representative band reject filter using lumped constants. Since L_1C_1 and L_3C_3 are series resonant circuits they appear as low values of resistance at resonance. L_2C_2 are parallel resonant and appear as a high value of resistance at resonance. Since they are all resonant at the same frequency, the equivalent circuit at this frequency would appear as Figure 5B. The resistance values are valid approximations, giving an attenuation of 65 dB and return loss of 1.15 dB. This would be right at the bottom of the reject notch. Specified attenuation would be higher on the response curve where bandwidth would be greater.

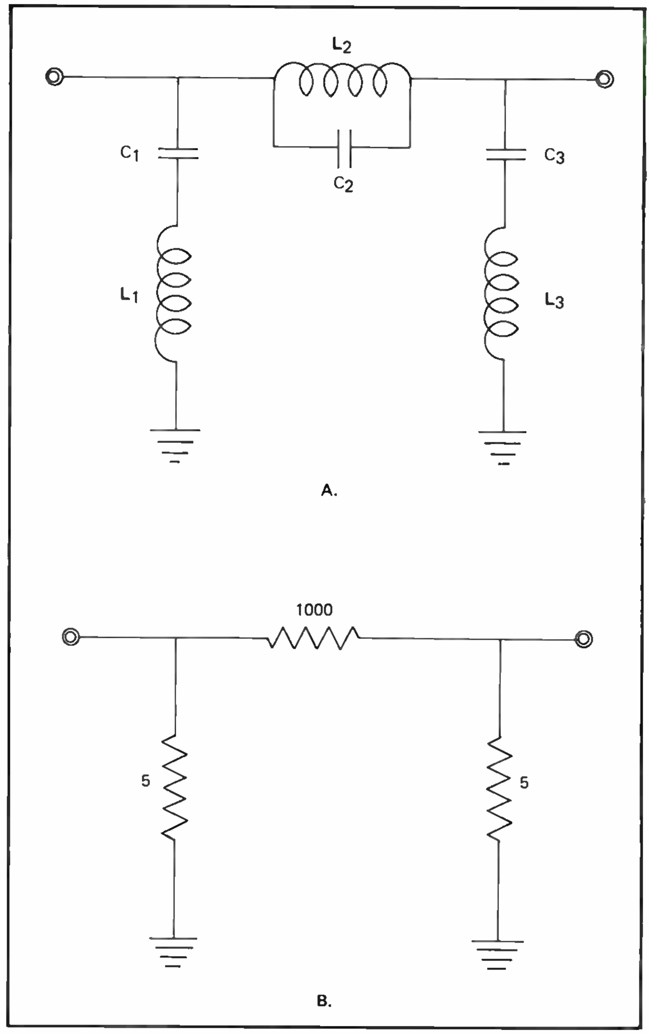

Figure 5

YOU GET WHAT YOU PAY FOR!

Pay TV filters are purchased in large quantities and represent a sizeable cost to the system, so the tendency is to emphasize low cost when making a purchasing choice, but performance characteristics can't be overlooked. You can degrade performance on all channels, not just the pay channel, with poor filters.

Worse yet, the pay subscriber potential could be seriously diluted if the filters are inadequate. It's highly unlikely a non-subscriber to pay TV who has found to his delight he can see the pay programming free will call the cable office to report this.

So do all you can to make certain the filters you install do the job now and will continue to do so.

Oak Designs for Pay

Alex Azelickis, Vice President Technical Relations
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Pay cable offers promise to many cable systems of increasing cash flow and opening the financial traffic pattern at least to a "caution" level and perhaps lead to an open traffic pattern.

The added cost required to enter into pay TV, including pay cable equipment, will be viewed primarily through the dollars it will generate for the cable system. Since its inception, cable television has been a capital intensive industry and its history over the past two years, coupled with dramatic increases in prime rate, has caused many lenders, banks, and insurance companies to go from "green" to "caution" to "red" in enthusiasm.

Because the cable system must prove its capability to increase capital availability, "security" (the degree of protection against illegal interception of a pay TV signal without being detected) becomes a major concern for the cable system operator.

This article will describe the relationship between degree of security and cost of pay TV equipment, as well as present one equipment manufacturer's approach to supplying equipment needed to satisfy most of the security levels and service refinements desired by a wide variety of cable systems in this country. Since it is important to protect the security of pay TV channels, technical description of encoding and decoding can only be presented in rough block diagram form.

SECURITY VERSUS EQUIPMENT COMPLEXITY AND COST

Even the simplest form of pay TV requires an investment in equipment, as well as in software. Consequently, the system operator needs some protection to ensure that cable subscribers can enjoy pay programs only if they agree to pay a premium over and above the regular monthly rate for non-pay TV services.

There are at least two basic technical requirements for pay TV:

1. Picture quality degradation by signal processing, if any, should be virtually imperceptible to the viewer.
2. No interference should occur to other cable channels or service.

In addition, it would be desirable to occupy no more than a standard 6 MHz bandwidth for each pay channel. In other words, no channel space should be wasted.

At the present time, the FCC does not have any technical specifications for pay TV cable channels (Class III), and the Cable Television Technical Advisory Committee (CTAC), Panel 9, recommended that no standards be imposed that could inhibit the technological development of this new service. The equipment designer, therefore, has freedom to experiment and to test many ideas with a certainty that his product will not be made obsolete by new regulations in the foreseeable future, and the cable system operator who uses his equipment is assured that its cost will be amortized before any legislation could make it valueless.

The security of pay TV service can be "soft" or "hard," and encompasses a wide range of equipment and features. Obviously, "soft" security requires the least expensive equipment, but with a maximum risk of unauthorized use and loss of some income. "Hard" security can only be defeated with considerable effort and money, if at all, and it offers maximum protection to the operator.

The CATV Division of Oak Industries Inc. has developed equipment in both the "soft" and "hard" security categories which has found many users. At the present time, 28 cable systems are using these products, which constitute a large percentage of the division's manufacturing output.

"SOFT" SECURITY

Reception of pay-TV channels can be denied in several ways. Two are rather widely used—passive channel traps mounted on poles at all non-pay TV subscriber drop cable taps, and inexpensive converters for pay TV subscribers only. Both approaches require no encoding and decoding of pay TV signals, so the headend equipment expense is lower than for "hard" security.

In the case of traps, one trap per pay channel must be installed at every drop cable in the system, and then removed from the pole when a subscriber decides to avail himself of pay TV service. Although traps are relatively inexpensive, they have to be installed at the start of pay TV service on poles, and in large numbers.

One can get an idea of the needed investment by looking at two extreme situations. In one case, when a system is new and without any pay TV subscribers, each drop must have one trap per pay channel, and the material cost is maximum. In the opposite case, when every cable subscriber is also a pay TV subscriber, no traps are needed and all existing traps must be removed. Maintenance costs will be minimized, but inventory of disconnected traps will be high, as will be the cost of labor. These are, of course, extremes and with the present pay-subscriber penetration, the first case is closer to an actual situation. The use of traps is relatively new, and their reliability in field use has yet to be established. Traps which are effective in denying the pay channel to non-subscribers usually also degrade adjacent channels.

The technical expertise of the Oak CATV Division lies in design and manufacture of electronic terminal equipment for CATV. It was, therefore, a natural decision to offer low-cost converters to 12-channel systems to enable them to add one or more pay channels in the midband at minimum initial cost. Converters will be needed only in homes of pay TV subscribers, and the cost of converters is spread over a period of time with gradually increasing numbers of "converts" to pay TV. Converters can be re-used in case of disconnects.

Single-channel and block converters are inexpensive and, since pay signals are not scrambled at the headend, decoding circuitry cost is avoided.

SCC (Single Channel Converter). This converter (Figure 1) is intended for only one unscrambled pay TV channel, G or H. It passes the regular channels 2-13 unmodified, and converts the pay channel to either Channel 3 or 4. Single conversion with non-inverted carriers is used.

ECONOBLOC. The Oak Econobloc converter block diagram is shown in Figure 2. It passes the standard VHF cable channels 2-13 unconverted, through an isolation amplifier, and converts seven midband channels A-G (or B-H, or C-I) to channels 7-13 when the band-switch is in midband position. Channel I is not recommended for pay signals because some TV receivers can be retuned to receive the channel allowing a subscriber to avoid payment of additional charges.

"Pirating" of pay TV signals is possible with both traps and converters, although with some difficulty and at a risk to the "pirate." At least one state has enacted legislation making such activities illegal and punishable, and a proposal is being considered to make it a federal offense. Pirating, therefore, may soon become hardly a worthwhile effort.

"HARD" SECURITY

To make unauthorized reception of pay TV cable programs even more difficult, the signals are encoded at the headend, and then decoded at each authorized subscriber terminal. Headend scrambling should be so effective that insufficient picture information is available on the television set of an unauthorized subscriber. At the same time, picture and sound quality should not be perceptibly degraded when unscrambled at an authorized subscriber's television set.

Oak has developed a coding method which gives effective scrambling of video information and good quality

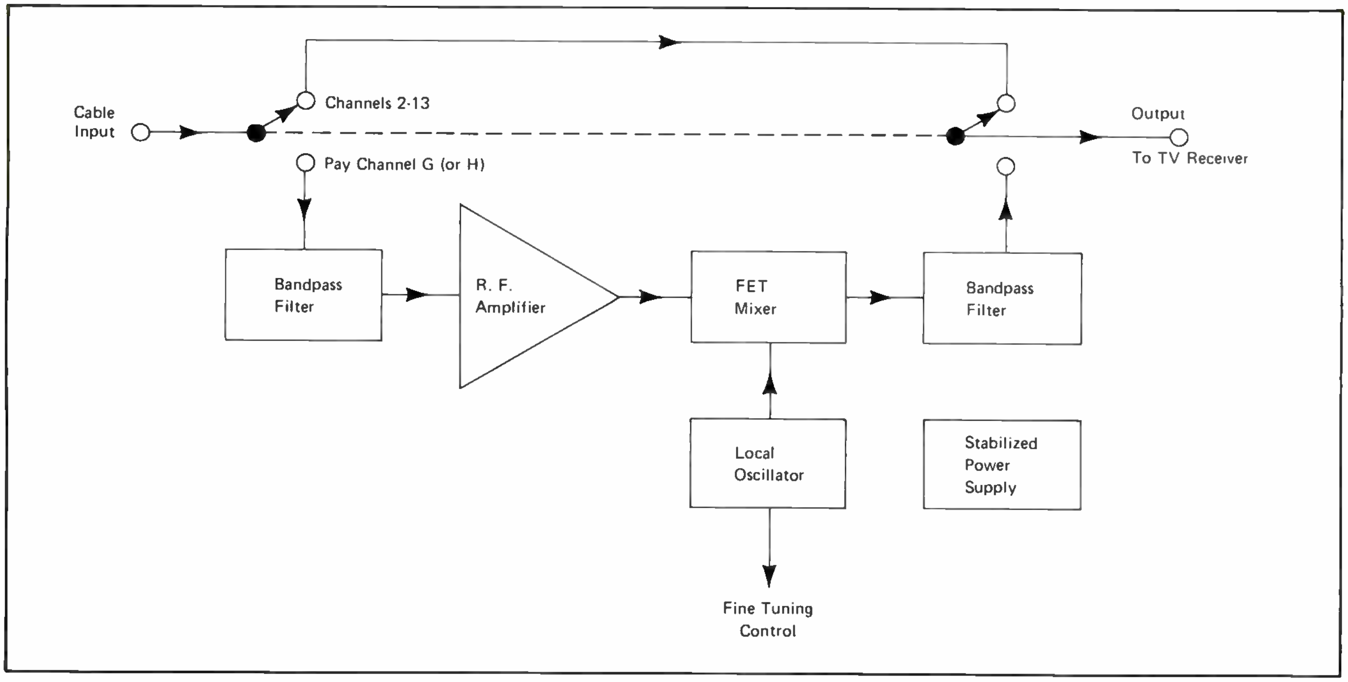


Figure 1. Oak Single Channel Converter Functional Block Diagram

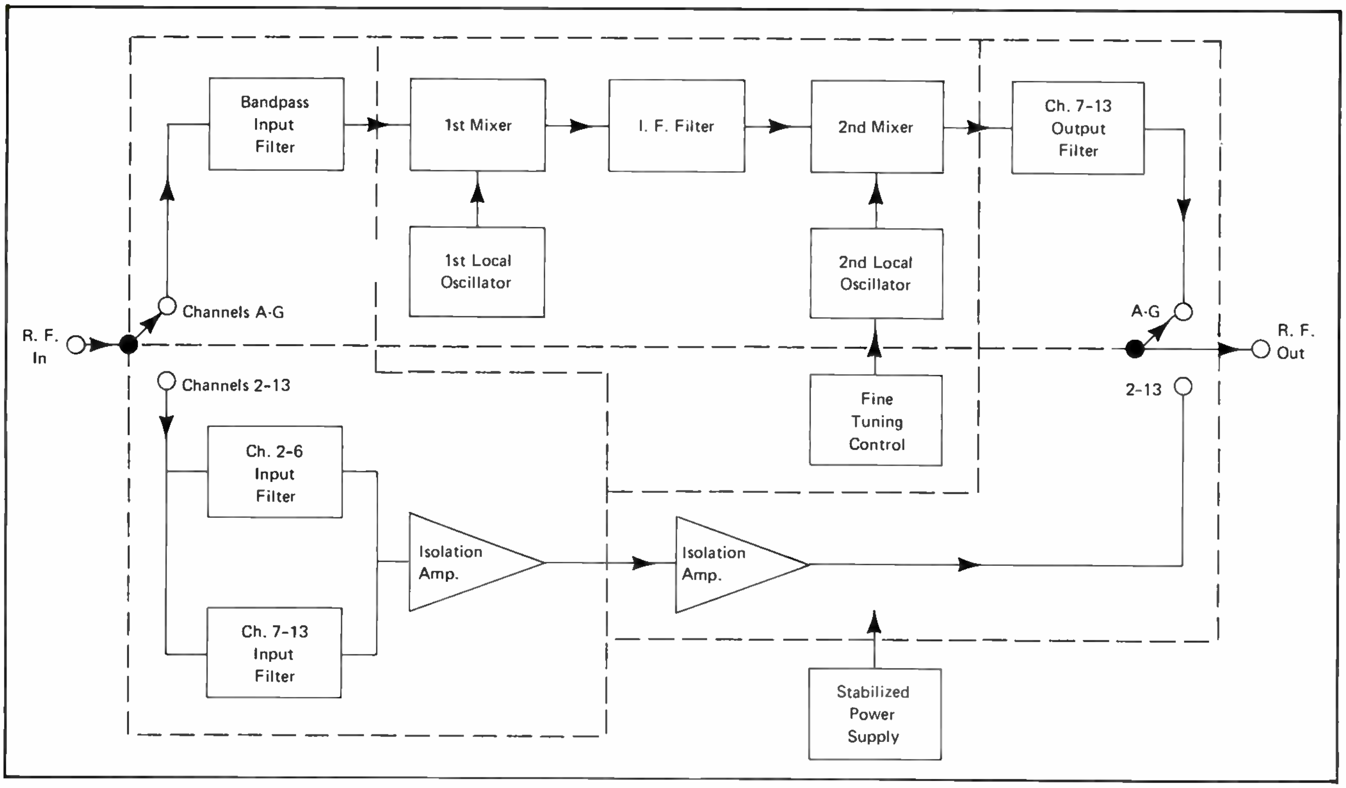


Figure 2. Oak Econobloc Converter Functional Block Diagram

decoded picture at relatively little expense for use in each of its three basic decoder-converters. Sound is left unscrambled and serves as a teaser to tempt the viewer to subscribe to pay TV in order to see the picture.

Oak uses amplitude modulation of both carriers by a sinusoidal wave phase-locked to the horizontal sync frequency (Figure 3). Sync peaks are suppressed and video modulation is enhanced so that a TV receiver sync locks to the random peaks of video modulation rather than to 15, 750 Hz sync pulses, which are then too low in amplitude to pass through the receiver's sync clipping stage.

The decoder can be incorporated into any Oak varactor converter without affecting performance characteristics in any way. The audio carrier is amplitude modulated with the scrambling sine wave which is amplified, detected, and applied in proper phase and amplitude to the AGC amplifier stage. Thus, the correct relationship between the horizontal sync tip and video modulation amplitudes is restored and all amplitude modulation is removed from the FM sound carrier.

Figures 4 and 5 show block diagrams of the scrambling system and of the decoder-converter.

Although the coding system is a moderately priced arrangement, it is sufficiently complicated to defeat. It requires considerable electronic circuit knowledge and practical design experience, along with proper component and operating parameter selection, to satisfactorily defeat its security.

Because cable systems vary greatly in need, Oak designed systems at three different feature and price levels in the "hard" security classification:

ECONO-CODE. This system uses a single channel converter-decoder (Figure 6). It has a two-position switch for reception of standard unscrambled channels 2-13 and for

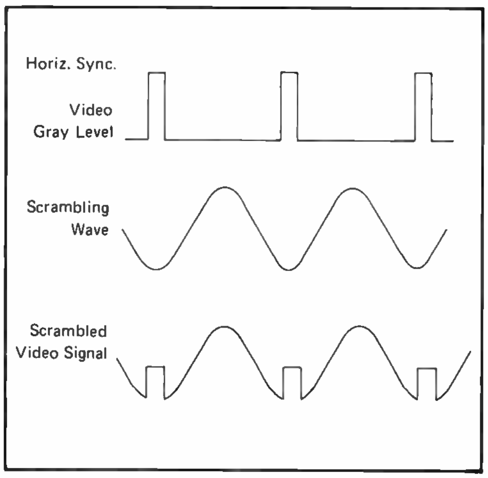


Figure 3. Scrambling Waveforms

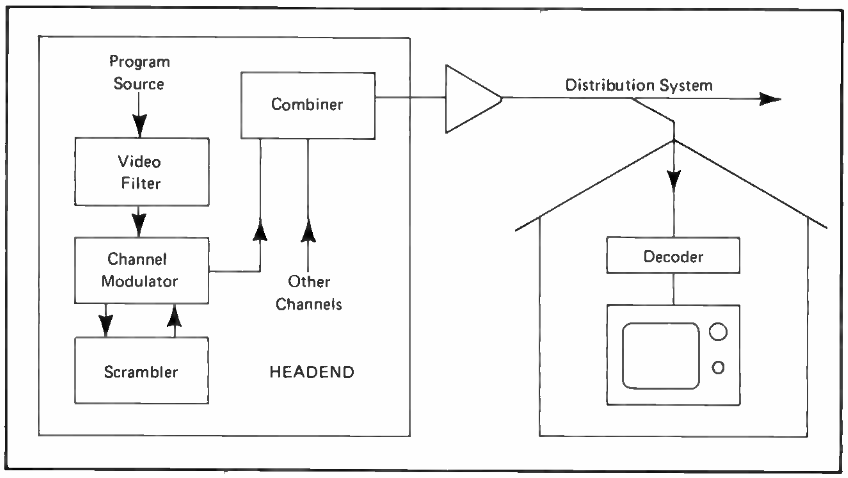


Figure 4. Oak Multi-Code System Block Diagram

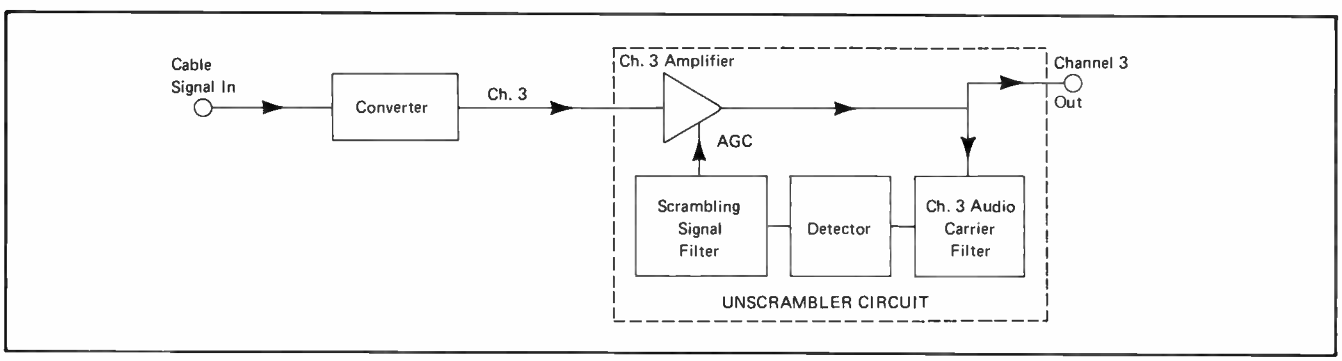


Figure 5. Oak Decoder Block Diagram

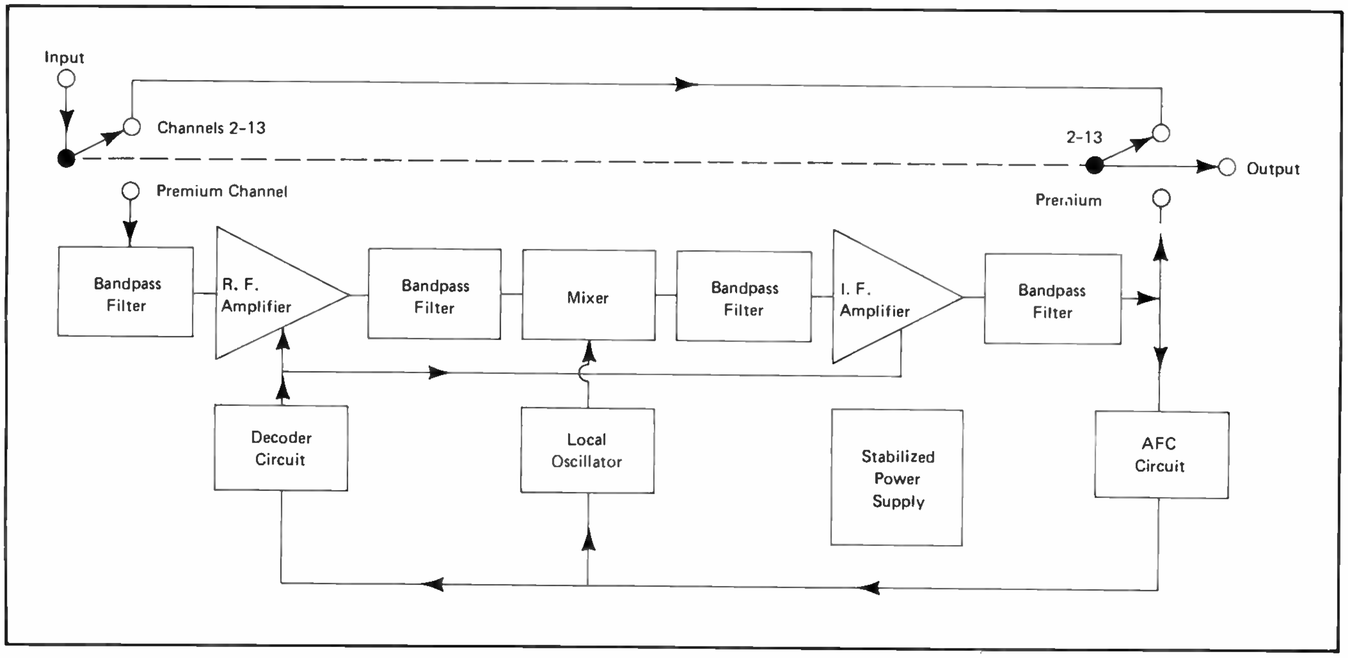


Figure 6. Oak Econo-Code Converter/Decoder Functional Block Diagram

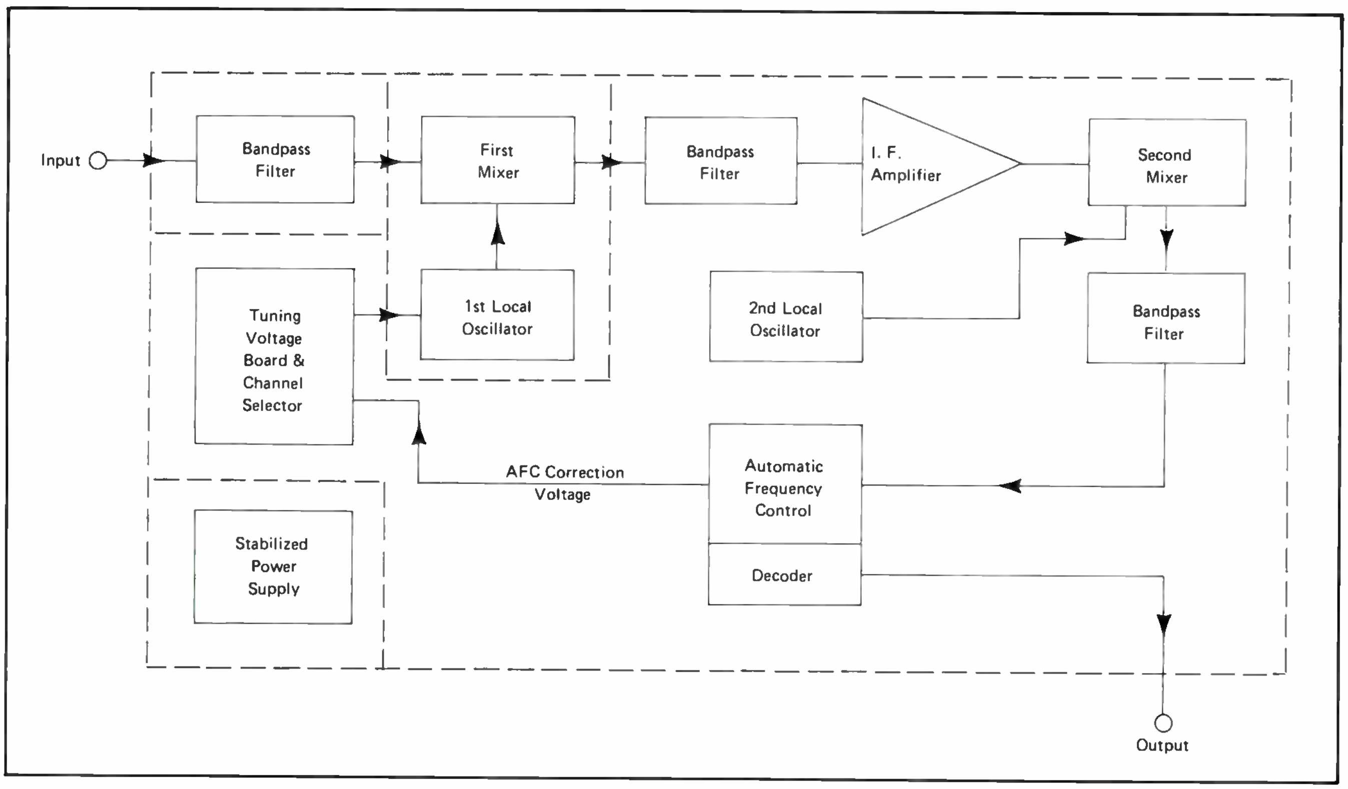


Figure 7. Oak Multi-Code Converter/Decoder Functional Block Diagram

decoding one pay TV channel (choice of G, H, or I). Parental control of the premium channel is possible with an optional keylock. Automatic frequency control ensures pay-channel output frequency stability.

MULTI-CODE. The converter-decoder used in this system (Figure 7) gives the cable system operator the option of predetermined selection of any number of pay TV channels up to a total of 31, in his choice of remote or set-top style for channel selection. A keylock will be installed for parental control of premium channels, if desired. A single rotary switch controls both the standard and premium channel selection. The latter channels are unscrambled automatically. As in all Oak varactor converters, automatic frequency control stabilizes the output channel frequency.

Econo-Code uses the single-conversion principle without inverting carriers, and Multi-Code converter-decoders use the double-conversion type. Both are intended for the subscription payment plan.

ADDRESSO-CODE. This system allows complete control of each pay subscriber from the cable system headend. Thus, both subscription and per-program payment plans are possible, since each decoder in the cable system is individually addressable.

A block diagram of the system is shown in Figure 8, and the addressable converter-decoder is shown in Figure 9. The headend equipment setup is shown in Figure 10.

The per-program charge system uses the telephone, and can handle over 100,000 subscribers with one mini-computer receiving simultaneous orders from up to at least 256 phones.

Other program marketing options can be accommodated singly, or in combination, in addition to per-program and monthly subscription, such as:

1. Subscription to a series of programs.
2. Subscription to one or more channels for a specified time period.
3. Any channel for one day.

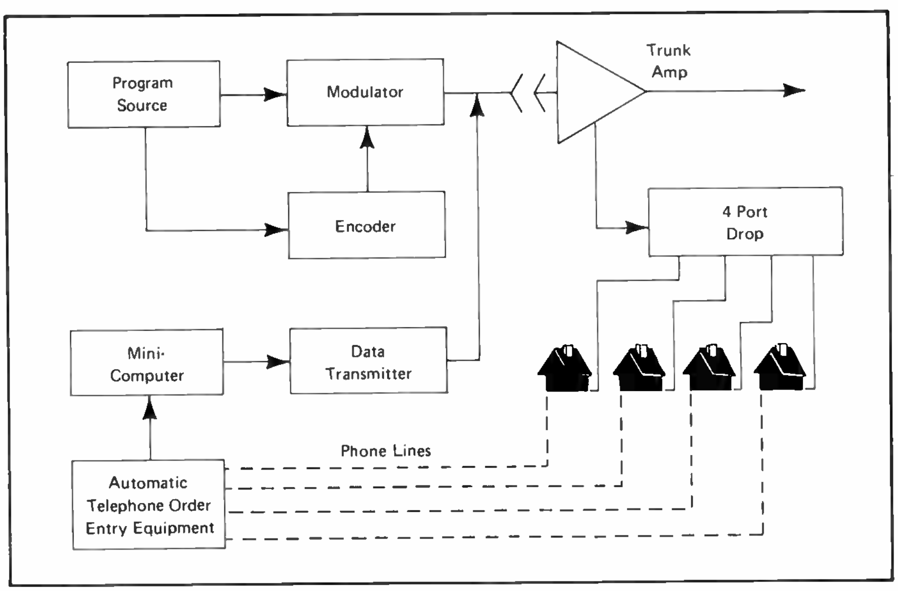
The headend mini-computer equipment collects information from each phone order which it stores for billing. It also accumulates statistics concerning cable premium program operation. The mini-computer automatically authorizes each subscriber at the proper day and time. The Addresso-Code System can be adapted to two-way cable.

Oak supplies special headend equipment required for all three encoding systems designed for "hard" security installation.

CONCLUSION

The future of pay cable looks bright, and the activity involving various means of signal transmission and distribution is growing rapidly. Because of this, a higher degree of security requiring more costly headend and subscriber terminal equipment has been designed by the Oak CATV Division and will be ready for production should the market develop, creating the need for increased complexity.

Figure 8. Oak Addresso-Code System Block Diagram



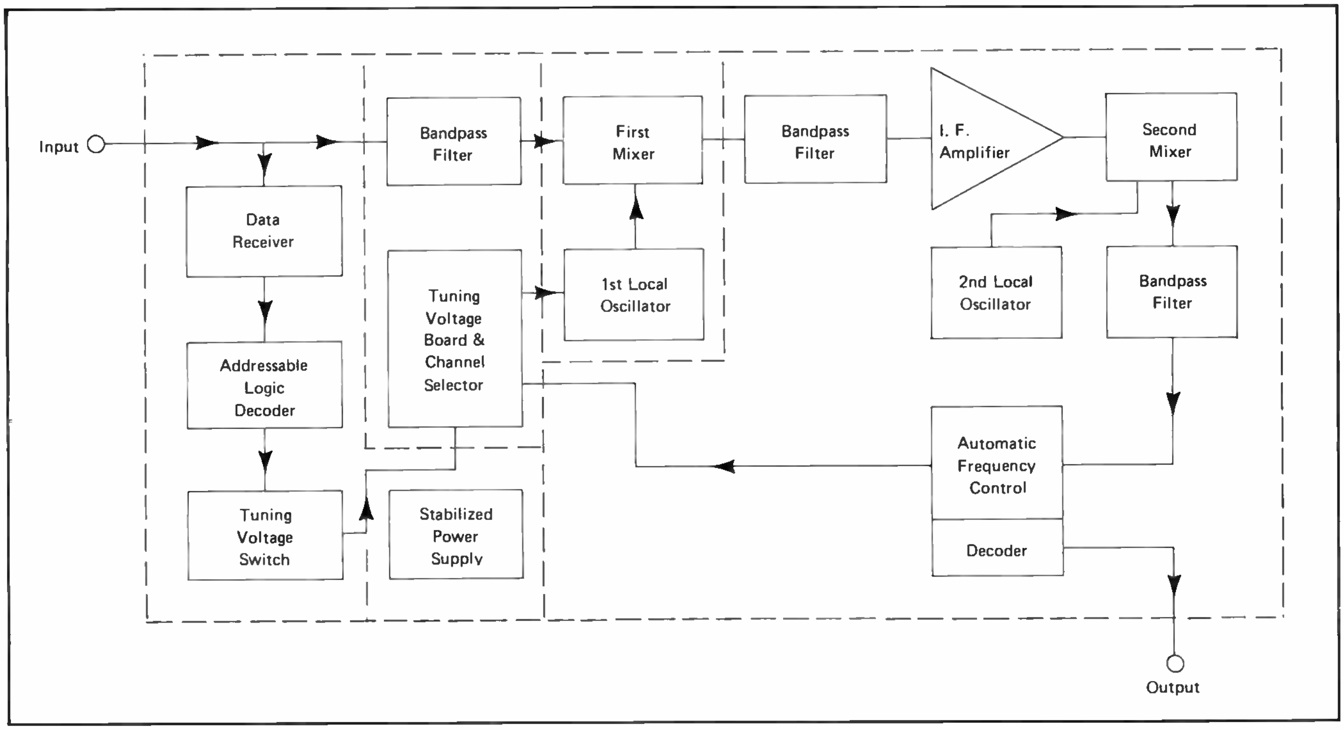


Figure 9. Oak Addresso-Code Converter/Decoder Functional Block Diagram

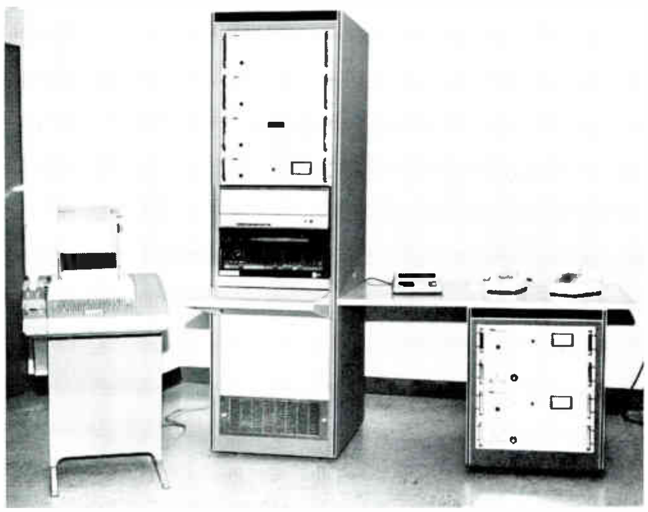


Figure 10. Oak Addresso-Code System Headend Equipment Setup

Scrambling for an even higher degree of security should be virtually immune from any attempt to unauthorized reception of the premium program. Therefore, both video and audio information should be scrambled. This can be accomplished with a time-variable code, using either digital or analog means.

Technological limits do not stand in the way of the growth of pay cable. Availability of low-cost financing, high-quality programming, along with minimum and justifiable regulation appear to be the main keys to successful premium cable ventures.

Trapping Economics

Glyn Bostick
President and Chief Engineer
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PAY-TV TRAP COSTS

True trap cost includes basic trap price, installation cost and the cost of "trap guards": any accompanying hardware to prevent trap circumvention. Expenditures for the latter are sometimes emotionally inspired and, unless controlled, can exceed the extra revenue expected of them. Therefore, a checking formula is required.

For the purpose of our discussion, a trap is defined as a single frequency notch filter applied to the picture carrier, and installed in the subscriber's drop. This definition excludes the more rugged trunk trap and wide band notch filters used, for example, to blank a series of channels.

The single frequency notch filter type trap is produced in large quantity, generally for system (non-subscriber) trapping. In lesser quantity, these devices are also beginning to be used in scrambler and converter systems to block identified cheaters and pay subscribers in arrears of payment for service.

Quantity prices for these traps range from $3.50 to $7.00 each with the majority of prices near $5.00 per unit.

As in any other commodity, you get just about what you pay for. If your requirements are for nominal trapping (about 35 dB) and you are not overly concerned with ruggedness, the cheapie will do. If you want customized extras—different connector arrangement, built-in jumper cable, special packaging shapes, etc.—be prepared for the higher prices.

DETERMINING THE COST OF INSTALLATION

A deficient trap represents a successful cheater—a subscriber who will probably ***never*** subscribe to pay TV. Hence, a deficient trap is a "revenue robber."

At installation you must be prepared to check out each and every unit. A signal source at the picture frequency (frequency monitored) and a Field Strength Meter will do. Anticipate that testing will cost you about five percent of the basic trap price.

Test 20 units per hour at $4.50 per hour = $0.225 per unit. Excluding any trap-guard hardware (see following section), you may expect installation costs of about twelve percent of the basic trap cost.

Install 60 units per day per man at $4.50 per hour = $0.60 per unit. You can expect then, that the cost of the trap installed will be about 1.17 times trap price.

TRAP-GUARDING HARDWARE (TGH)

Trap-guard hardware (TGH) is any device or operation (with a cost incurred) attached to traps to increase the difficulty of circumventing their purpose. Such hardware may take the form of connector locks, "security shields," shrink tube sleeves, enclosures, welded straps, epoxy bonding, etc.

Since traps are installed to compel payment of services, every circumvention represents a loss of potential revenue to the cable system operator.

RATIONAL APPROACH vs EMOTIONAL DECISION

Many operators view theft of services as a personal affront and tend to overreact by adopting "all means" prevention without a rational examination of cost versus pay off. The key word is ***potential*** revenue. ***All*** would-be thieves who fail will not subscribe. So we must employ the math of probabilities in figuring just how much trap-guard hardware is enough.

In order to avoid a potential emotional hang-up and its result (over spending of potential revenues), an analysis similar to the following is suggested.

We can certainly agree on ***RULE ONE: The cost of TGH should not exceed revenue expected to result from buying TGH.***

Let's define some terms:

- Pc = Probability (0.0 to 1.0) that the typical non-subscriber will try to circumvent the trap
- Ps = Probability (0.0 to 1.0) that an unsuccessful thief will subscribe
- E = Probability (0.0 to 1.0) of theft failure if attempted
- X = Cost of TGH per non-subscriber
- R = Net revenue per ***pay subscriber*** per year (taking into account that amortization of basic trap and installation has already been figured into costs)
- N = Number of non-pay subscribers in system

Number of thefts actually prevented by TGH:

$$= (N)(Pc)(E)$$

Extra total revenue realized as a result:

$$= (N)(Pc)(E)(Ps)(R)$$

And total amount spent for TGH:

$$= (X)(N)$$

Return: (Extra revenues)/(TGH expense):

$$= \frac{(N)(Pc)(E)(Ps)(R)}{(N)(X)} = \frac{(Pc)(E)(Ps)(R)}{(X)}$$

Referring to RULE ONE:

$$(X) \leqq (Pc)(E)(R)(Ps)$$

PLAYING IT WITH NUMBERS

We have removed the problem from the emotional reaction mode and formalized it. We may now concentrate on finding a realistic number for each symbol.

Only the individual operator is in a position to insert reliable numbers: those squaring with his particular experience. However, we can "play" with what appear to be current common sense numbers and perhaps generate some insight:

Pc = 0.20. It is hard to imagine that as high as 20 percent of non-subscribers will attempt theft. After all, with the trap at the top of a 20 foot pole, the aged, infirm and lazy, at least, are eliminated.

Ps = 0.25. Average pay penetration rates are estimated at 25 percent. One would think that a lesser rate would apply to current ***non-subscribers***.

E = 0.75. It is also hard to imagine any low-cost device or trick which would resist 75 percent of concentrated efforts to crack it.

So we have:

$$(X) = (0.20)(0.25)(0.75)(R) = .0375R$$

If we estimate resulting ***net*** revenues at \$20.00 per year, then maximum (X) = \$0.75.

So, if the above assumptions are correct, we are actually ***losing*** money if we spend more than \$0.75 per non-subscriber to "lock up the trap."

The operator must of course plug in his own numbers and draw his own conclusions.

What About

Joseph L. Stern, President
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New York, NY

Ten Years Down the Road?

If our technology continues to grow over the next ten years at the same rate that it grew in the past ten years we're in for some fantastic changes in communications. If our previous patterns hold true, the average family would have bought two new cars in that time period and at least one new television set. The question is what will be on that new television set and how will it get there?

Ten years from now many new television sets will undoubtedly have a large screen and some of them will have on-the-wall TV screens. The set will be automatic in many of its functions and the picture, in color of course, will be clear and have the proper color balance almost all the time. An important factor is that the set that will be in the living room ten years from now will tune to all of the off-the-air channels conveniently and easily and also will tune to all of the cable-TV channels, both midband and superband, which now require the use of a converter.

What will be on the TV set? Well, there will be the normal fare produced by the networks; as well as some new innovative programming. In addition, there will, I think, be the special information programs such as the BBC type of "Ceefax" and the British ITA type of "oracle" presentations. These are alphanumeric presentations of specialized information services sent "piggyback" on TV programs. They are not unlike some of the special channels used on CATV systems to provide sports, financial and special weather information.

One of the most important things that will also be on that TV set is premium TV or pay TV programs. I think they will be coming from the cable system rather than over the air. I think that we will see a variety of movies and sports programs on the TV receiver. I think we will see movies on a variety of levels; not only the blockbuster movies, not only the new movies, but groups of older movies and groups of "baby-sitter" shows and educational programs as well. Additionally, ten years from now and undoubtedly before that, we will have specials on the TV screen—special sports programs, as well as special movie programs. All of these will be pay TV, for which a premium price will be paid.

How will all the signals get there? Well, the majority of services will come over-the-air as they do today. In addition to that there will be extensive cable TV, much larger than we have today, but not quite a wired nation. The services will be provided by coaxial cable and by fiber optics. The majority of these services will be one-way services sent from the cable system headend or the broadcast transmitter plant; one way, to the TV set. There will be some two-way services for the special interest groups and people who can afford special services but I seriously doubt if we will see the on-call film libraries or much of the interactive computer that we heard about or dreamt about ten years ago. People aren't ready to pay for that kind of service and the cost of providing such services on cable systems and even on fiber optic systems is still prohibitive.

RECEIVERS OF THE FUTURE

Let me expand just a bit. As far as the TV set is concerned, we have been looking forward to a CATV type of receiver for the past five years. Most of the manufacturers have been reluctant to make such a set because the market is too small. The market is definitely growing and in ten years all forecasts show tremendous growth in CATV. That isn't the reason that we are going to have that set however. The reason is that technology has changed and the method of tuning TV sets has changed. Only last month RCA announced that its new top-of-the-line TV receiver, which will be out this year, will be remotely controlled and fully digitally tuned and capable of being tuned to any off-the-air channel as well as any CATV channel. This is going to make a major difference and obviously all of the manufacturers are going to follow. The major difference that it is going to make, however, is that it is going to affect the CATV system operators' method of distributing premium or pay TV.

CURRENT DEVICES WILL BE OBSOLETE

Many of the cable operators today are using converters and special frequencies not normally found on TV sets, to distribute pay TV programs to those subscribers who wish to purchase them. When the TV set is available which will tune to those channels, this method of distribution just must be given up.

What other methods are there? Well, a scramble system such as is presently in use is the next thing to come to mind. These are in use today and will be growing for a while. However, there is another method on the forefront which probably will appear within a year, and I think it will take precedence over all of the systems.

This is a scheme which controls all of the programming and all of the signals which go into the home. This is a scheme which mounts a facility outside of the home and controls all of the signals that go into the home. For years our CATV systems have been plagued by the problem that all of the signals on the cable go to all of the locations. In order to prevent this, CATV operators have had to provide special frequencies not normally found on TV sets. They have had to provide scrambling systems and descramblers installed in the home or had to go to every location where the customer does not wish to purchase the pay TV service and install a radio frequency trap in the cable drop in the home to prevent that customer from getting the signal.

The new device that I believe will be in full operation in ten years and probably start in its operation within the next year is called a headend addressable tap. It is also called by some, a "smart tap". This device replaces the present tap on the cable system which brings the signal into the home. It responds fully to signals sent from the headend and can control whether the subscriber receives any service at all. It can also control a number of pay TV channels. The control is available at relatively high speed. This device will allow the selling of premium or pay TV on a per program basis or on a class of service basis. I believe that in ten years we will have pay TV on cable systems sold on subscription basis, a class-of-service basis and a per program basis. All of this can be provided on a one-way cable system without a major investment on the part of the cable operator.

SIGNAL DISTRIBUTION WILL CHANGE

In addition to headend addressable control of the signal that goes to the subscriber's location, we will also see a change in the method of distributing signals. Today, CATV systems simply place their signals on a coaxial cable. The signals are distributed as radio frequencies on VHF channels and also on special channels, on frequencies above channel 13.

In ten years we will see many systems utilizing fiber optics; a method of distributing TV signals by sending light through hair-thin fibers made of glass. You've been hearing about these glass fibers for the past ten years and they are now coming into their own. Fiber optics are already in use in specialized military applications. They've been used for a number of years to indicate to Cadillac and Corvette owners that their headlights are on or that their directional signals are operating and I am sure that a few of you have also seen fiber optics gracing the waiting rooms of a number of offices as decorative lighting displays.

Fiber optics carry signals through a thin piece of glass not with radio frequency waves but with light. Work on fiber optics has been underway for many years by Bell Laboratories, RCA, IBN, ITT, Bell-Northern and many, many others. They've been trying to find a way to take this laboratory experimental device and put it into the field. They've been trying to find a way to make its transmission more efficient and also to find a way to cut the cost of the devices which go on both ends of the fibers. They have succeeded. They have found the answers. Fiber optics have always been called the future communications medium. It will be with us very shortly. It will surely be in full use in ten years.

THE TECHNOLOGY IS HERE FOR FIBER OPTICS

Within the next year a number of phone companies will be experimenting with fiber optics extensions for their existing plants and some for extensions of subscriber service. AT&T will be using fiber for trunk interconnections between the central offices. Australian, Japanese and British communications companies are already experimenting with fiber optics for trunks. The French national telephone company has announced plans to rewire the Paris telephone system with fiber optics. Anything would help. I predict within the next two years, we will see at least two or three cable TV companies utilizing fiber optics on an experimental basis to carry signals at least between trunk hubs and in some cases to carry signals directly to subscribers.

Fiber optics, at least in the manner it is now being utilized, has a potential as great as that of integrated electronics. That is, we now have integrated optics and subminiature components that are used in the optical systems. The advantages that will accrue will be similar to those that came from integrated electronics, or large scale integration.

Many of you will remember that a few years ago when CATV was starting, there was considerable thought given to using a switched distribution system. That is, a system similar to a telephone system, where you can control what program is sent to every receiver. The one system which most of us recall was the one proposed by Rediffusion of England and is actually still in use in England. It didn't find much favor in the US because it took a great deal of space for equipment and was far more costly than the system we presently use in this country. Fiber optics can change that. All of the advantages of the switched system are easily and economically obtainable with fiber optics.

These thin fibers can be utilized in a cable of, let us say, six or seven fibers, each carrying six TV channels and this whole cable can have a diameter of about ¼ inch. This cable can replace one of the ½ inch diameter, expensive cables used as a trunk path for CATV. This cable can also feed a small device which can be mounted on a cable TV strand or in a manhole and that device can do the switching for a couple of hundred customers. We now have the potential of a completely switched system.

BUSINESS SERVICES POTENTIAL
When we look at the CATV systems of the future and particularly those which will exist ten years from now, we also have to recognize that it will be using or rather it will be carrying business communications. The present CATV system using coaxial cable FDM distribution doesn't lend itself too readily to large density data transmission in one section of town while it has low density TV distribution in another section of town. If a fiber optics switched system is built on a nodal basis, very dense in one section and not dense in another, then all of the dreams that we've had for carrying business communication, high-speed facsimile, television and audio teleconferencing systems and a variety of specialized educational and social service programs for municipal and social service agencies, then that can all be carried on fiber optics, and the fiber can also carry CATV signals.

The natural question comes up as to who is going to provide the system? Well it would appear that the telephone company has a leg up on the whole scheme. But assume that we have a telephone company planning to put in an extension to a rural area. The normal procedure would be to provide a copper pair which can be used to feed one, six or ten subscribers. For about the same cost, they can put up a fiber optic cable and this can service 100 to 6000 customers. It can also be used to carry video signals. Let's assume also that out in the rural area there is an earth-receive-station for satellite signals. The normal procedure to get the satellite video signal into the center of town would be to carry it on microwave. If the fiber optic cable is there, they may just as well carry the signal on that cable. You might say, why don't they carry CATV on the same cable. Well, they might very well do that.

I predict that in ten years, we are going to see some switched systems come into their own. They will particularly surface in the major cities and particularly with fiber optics because this provides the opportunity to carry, between business centers, a variety of high-speed data, video and audio teleconferencing, high-speed facsimile and all the services most of us would like to have in business but cannot afford to pay the telephone company for and all the services that cable TV would like to offer but is not presently structured to provide. It's not economically practical for a cable system to carry all of these two-way business communications services on a standard CATV system, basically designed to carry a set of TV signals to homes. The high density of customers and the variety of services that are required in one sector of the town are hundreds of times larger in volume and demands on bandwidth than they are in another sector of town where you have nothing but residences. A fiber optics system can be constructed on a nodal basis with switched service and provide full two-way communications for a wide variety of services. It may get to the point where we may very well find that the communications system in the future, ten years down the road, particularly in major cities, may be a communications system of a new kind of carrier; some superspecialized common carrier. This carrier may install the fiber systems that we are talking about and he could very well lease "space" on this system to CATV companies. I am not sure whether the CATV operator would be happy or sad not to own his own hardware. I do know, however, that if the cost of leasing such service is considerably less than the cost of depreciation and maintenance of his own system, he is going to be a very happy man.

REGULATION
What about regulations? Well that is a very good question because we are talking about light in fiber cables and the FCC, as yet, has no authority over light, but they are obviously looking into it very carefully.

SUMMING IT UP
What does it all add up to? Well, ten years from now or probably in half that time, I predict that we will see cable TV companies run more like a utility, that is they are going to have better control of their customers, better control of what is provided and better control of payments, much of this through the use of addressable taps. I think we are also going to see per-view programming of "specials" or at least a multilevel programming service on pay TV, of one or two channels. I think we are going to have fiber optics data systems and fiber optics telephone systems in the major cities. And CATV fiber optics systems as well.

[Mr. Stern's remarks are transcribed from an off-the-cuff dinner talk presented during late summer 1975, to a group of broadcasting and cable television people.]

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