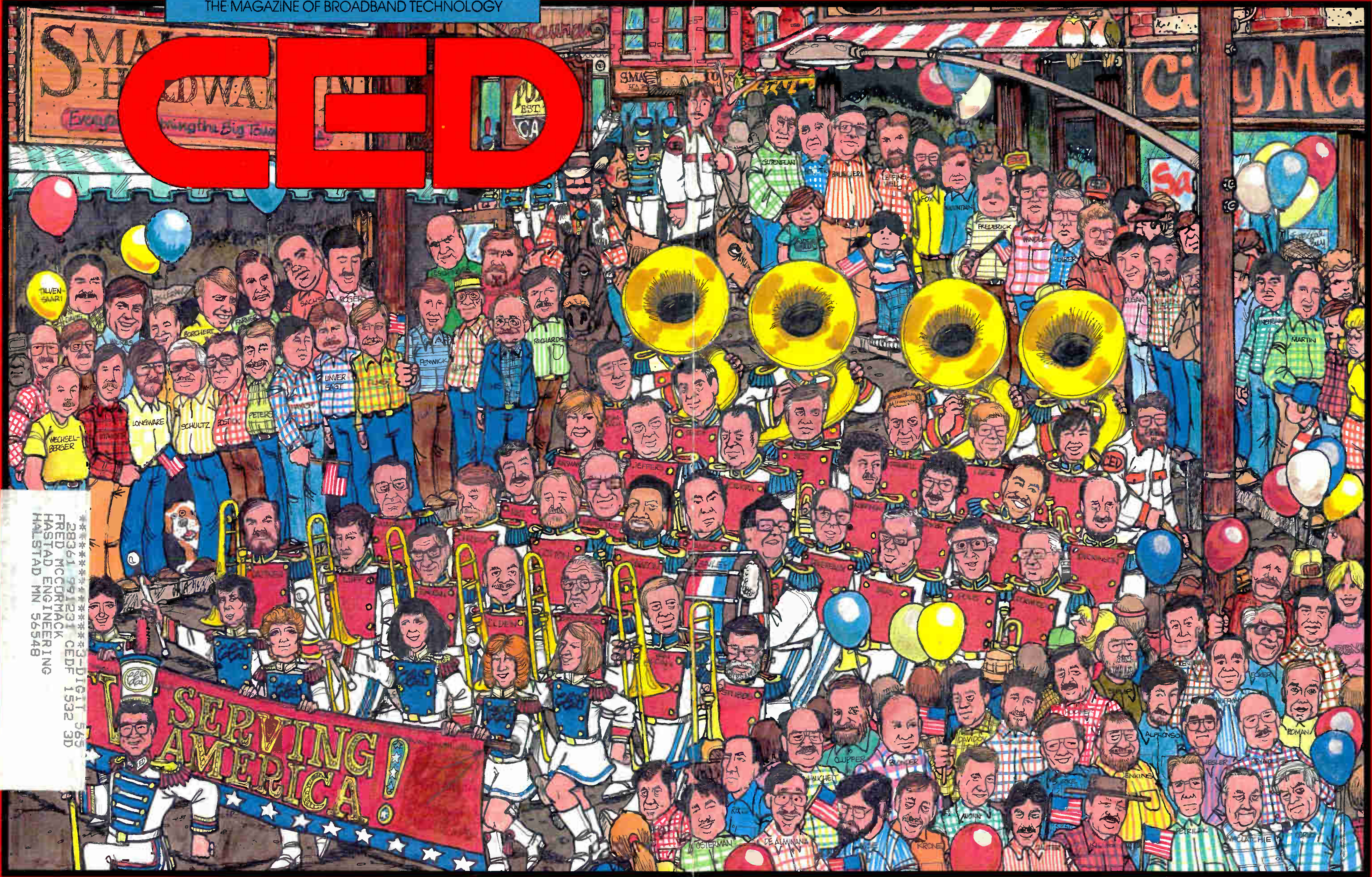
May 1987

COMMUNICATIONS ENGINEERING AND DESIGN
THE MAGAZINE OF BROADBAND TECHNOLOGY

CED



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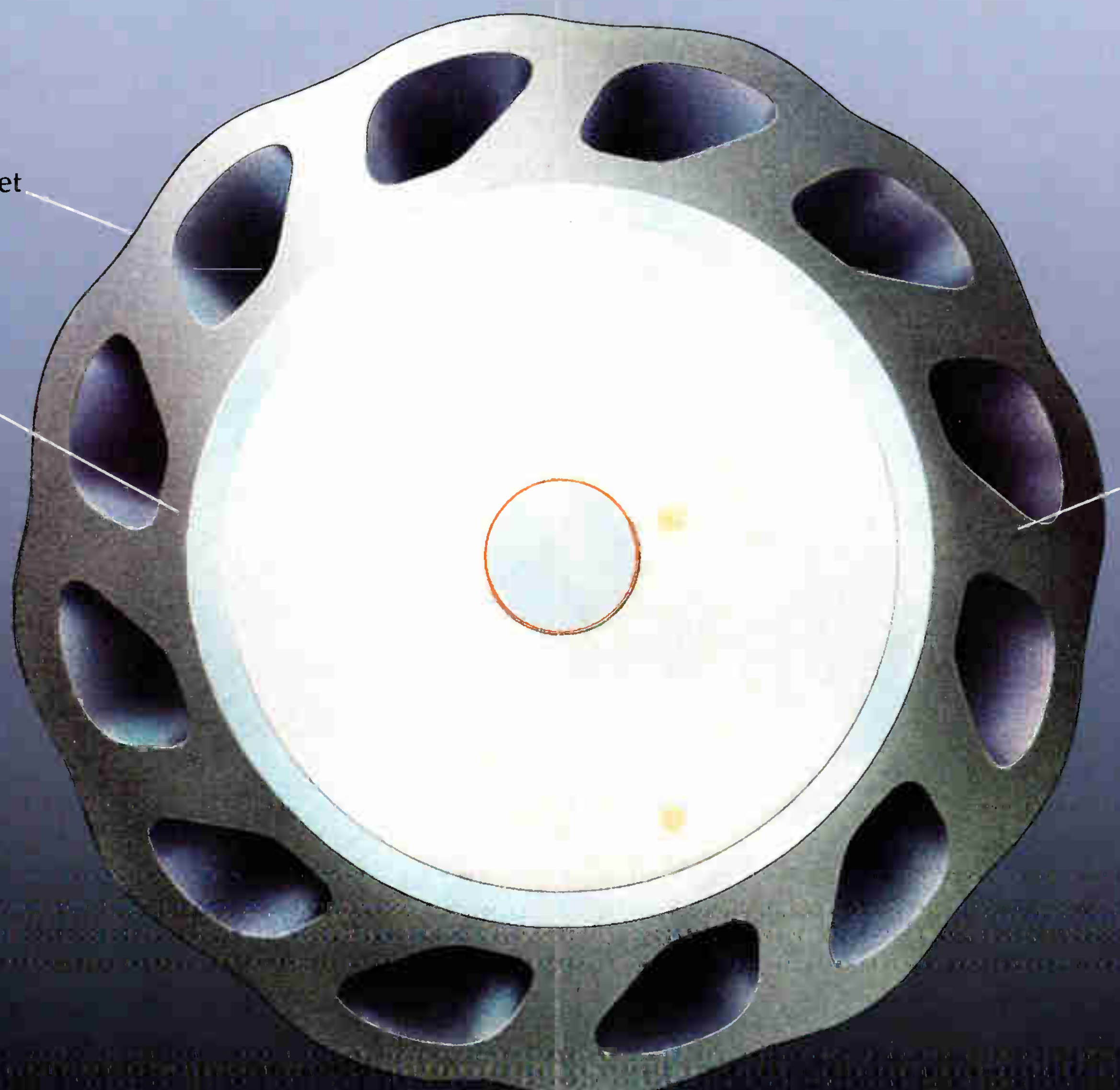

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GENERAL INSTRUMENT

Reader Service Number 1

SOMETIMES STANDARD JACKET IS TOO LITTLE PROTECTION AND ARMOR IS TOO MUCH.

CED

May 1987 Volume 13, Number 5

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CLASSICS

Cost trade-offs 20

This 1978 article by Dick Covell discusses the economic advantages of the now common-place 60-volt powering systems over 30-volts systems. The advantages usually become apparent after receiving your utility bill.

Construction survey of Texas, et al 26

The third of four quarterly construction surveys, including Alaska, Hawaii, Oklahoma, and of course, Texas, offers evidence of some interesting nationwide trends in rebuild activity.

Fiber frenzy 34

In 1985 Jim Chiddix published an article in the NCTA Technical Papers on a real-world performance test of optical fiber super-trunking. Those who are considering adding the technology to their systems will find his piece enlightening.

NCTA exclusive: Parts II and III 57

Because of a printer's error, a reprint of Part II of the NCTA Consumer Interconnection Guidelines, along with Part III of the guide, are in this month's issue. Also included is the first part of an article written by Oak Communications employees on multiple home terminal units, their convenience and security.

Billing callbook 90

Here is a listing of the major billing companies servicing the industry, their vital statistics and descriptions of what it is they can do.

Commercial insertion systems keeping up with the times 94

A study by Texscan indicates that your commercial insertion system had better be flexible if you want to take advantage of local ad sales.

Redundancy, redundancy... 118

Considering a broadband LAN? Outages that could cost you thousands of dollars can be avoided by adopting techniques outlined in this article by Lee Thompson and Dale Lutz of Scientific-Atlanta.

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About the cover

The NCTA cover includes industry vendors and engineers, as well as NCTA Engineering Committee members and SCTE Executive Committee members. A list of names and companies of people on the cover is on page 54. Illustration by Rob Pudim.

spotlight

Nick Worth

Red sky in the morning?

As an avid sailor, Nick Worth probably looks to the morning sky for clues as to whether the water will be smooth or choppy that day. In his role as vice president of engineering at TeleCable, he's concerned that the sky is beginning to take on a reddish hue, indicating an impending storm.

Exactly what the storm's magnitude will be is dependent upon how quickly four key areas are addressed. If the industry reacts soon to the consumer interface issue, improves reliability and picture quality, controls costs and develops a reliable IPPV ordering system, Worth says, it can safely sail calm waters instead of facing the challenge of navigating through a tough storm, where the outcome is unknown.

Worth, despite his youthful appearance, is a 14-year veteran of the cable industry. After a stint in the U.S. Navy that piqued his interest in communications and electronics, he went on to get degrees in electronics and electrical engineering from Capitol Institute of Technology and George Washington University.

In 1970, he landed a job with the prestigious Atlantic Research Corp. and dabbled in broadcast television, radio, microwave and cable TV. But it was the fledgling cable industry that held his interest and also offered immediate employment opportunities.

"It was a neat technology that had lots of growth promise and I wanted to get in on the ground floor," Worth recalls. When TeleCable offered him a job as director of engineering, he wasted little time accepting. At that time, the MSO served about 100,000 subscribers. Today, TeleCable is the 20th-largest operator, servicing nearly half a million customers. "Joining TeleCable was one of the best decisions I ever made," he says.

Facing and mastering the big technical challenges described above are necessary ingredients to the recipe of increasing penetration and/or staying ahead of competitive forces, Worth says. It may be a while before all the issues are sufficiently addressed, but efforts like Multiport are important developments, he says.

Multiport, designed as a set-back device, will restore the use of a TV or VCR remote control to consumers by eliminating the need for tuning converters. In addition, multiport can reduce costs by reducing in-home capital investments, help make addressability more friendly and perhaps offer better pictures by removing one signal processing step. "When an idea promises to help you solve four key challenges," says Worth, "you have to think it's a good idea."

The major obstacle to its success is sufficient field testing, says Worth. He, along with other MSOs, plan to initiate tests so that all the bugs can be worked out. "Once we clear that hurdle and the constraints are removed, we can begin to aggressively pursue it. But I think a false start would be worse than no start."

His test is slated to start later this summer, after Zenith delivers the decoders and enough Multiport-compatible TVs are rounded up. After that, the concentration will be on providing incentives to consumers, TV dealers and VCR dealers to buy and sell Multiport-equipped products. Efforts may include cross promotion, free installations and the like.

Despite all its promise, Multiport has one critical missing element—an impulse PPV ordering scheme, Worth says. Two options exist to correct the deficiency: Return the device to a set-top design, add an infrared receiver and issue universal remote controls to everyone; or redefine the standard to accommodate IR coding. Either way, it's an issue that needs to be addressed because the PPV promise means so much to the industry, according to Worth. "Pay-per-view is key to making our product fresh again," he says.

Based upon nearly a decade and a half of experience used to form a perspective, Worth says the industry has made great strides toward building better products. But he thinks there remains room for improvement. "I think caveat emptor is still an operative term," he says. "I'd like to see our suppliers get to the point where their attention to quality and detail is equivalent to that of the Japanese," who he admires very much.

Until these challenges are met, cable's underbelly remains vulnerable to the competition, which will no doubt become stiffer in the future. As telephone companies finish out installation of fiber, more bandwidth will be available for data and video transportation. "We may find ourselves in a tough competitive situation," says Worth. "That's why it's important we get better."

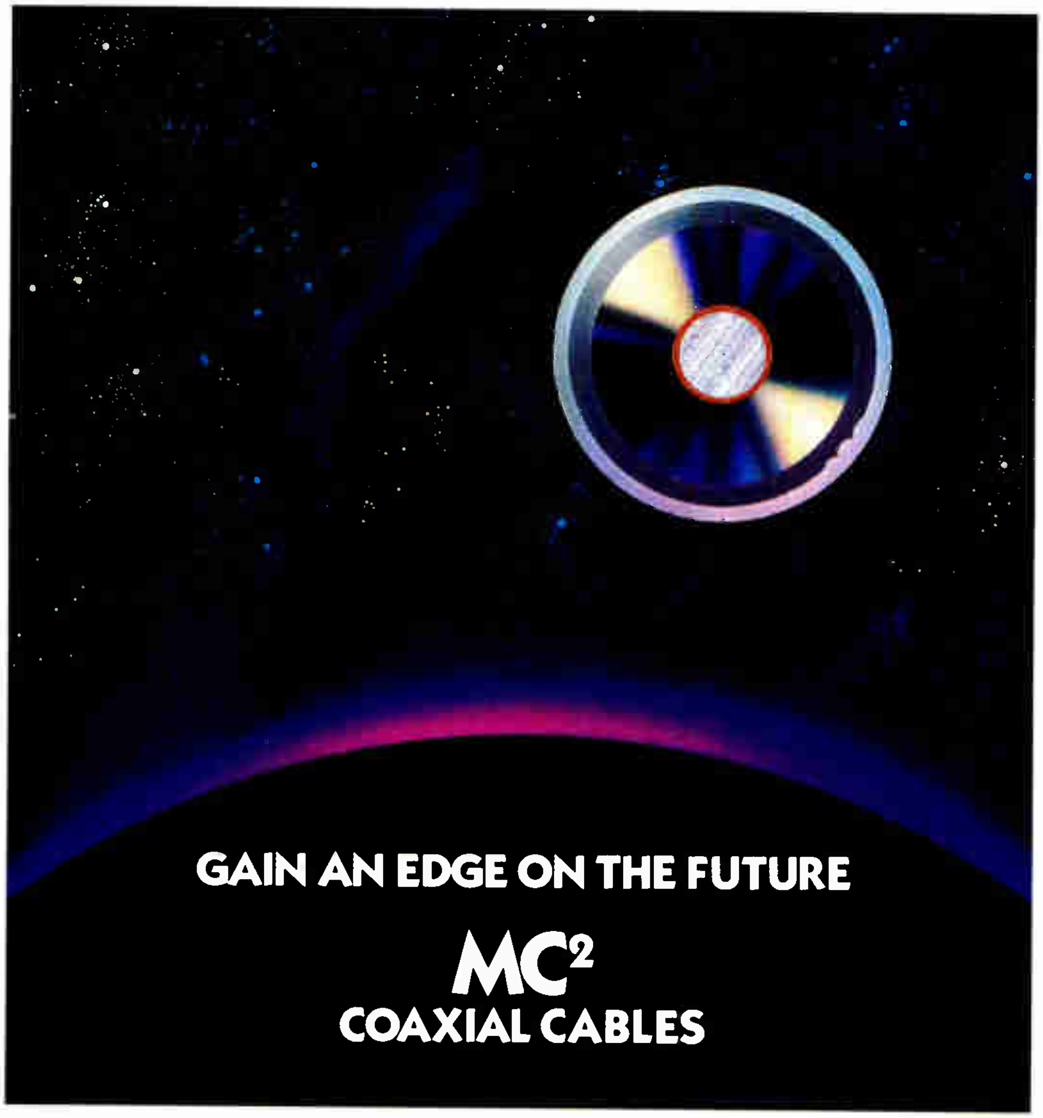
By meeting the tasks at hand, however, Worth feels that cable will "be OK." By the year 2000 he sees cable penetration in the 80 percent range, shopping from home via cable made convenient, a full menu of PPV selections available routinely, and quality and reliability improved by an order of magnitude.

By that time, the industry ought to be plying calm, smooth waters along with Worth, who is close to completing the construction of a 22-foot racing sailboat. The boat, the plans for which were garnered from a Naval architect, is a five-year project. Now that the sailboat is in the fourth year of construction, he's starting to get the itch. "I can't wait to finish and get it in the water," he says.

If the industry as a whole works as hard to tackle the tasks that threaten to slow its progress, there's no doubt it can weather any storm.

—*Roger Brown*

FOLLOW THE LEADER



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

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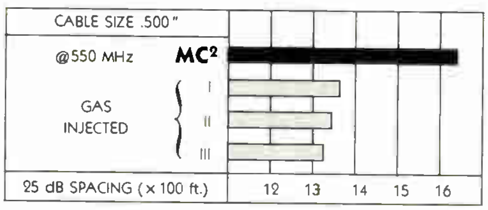

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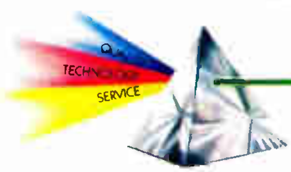

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Reader Service Number 3

my turn

IRC instead?

Early in 1970, I had a telephone call from an old friend in Canada, Israel (Sruki) Switzer. He wondered whether I would consider the idea of phase-locking the visual carriers to a 6 MHz harmonic comb to be a practicable way to reduce the appearance of "triple beats." The idea was incorporated in his paper on phase locking at the NCTA convention, June 1970, prepared with the help of Arie Zimmerman of Phasecom.

In a widely disseminated paper in August 1970, Bert Arnold, senior engineer with Electronic Industrial Engineering (which later became a division of RCA) calculated that 36 visual carriers would produce 22,680 spurious third order beats. Other engineers quickly pointed out that since most of the beats cited would be outside the band pass of any particular 6 MHz channel, the situation was not really as frightening as some had thought. Bert himself indicated in a December 1972 paper that all but about 350 of the 22,680 spurious beats would fall outside the band of even the worst case channel.

Although Sruki's phase-lock idea had not occurred to me, its import was immediately evident. I responded to his telephone inquiry by suggesting that zero-beating the triple-beat products of the visual carriers should certainly improve matters. However, my instincts told me that such improvement would most likely be limited by spurious sideband effects that would look much like cross-modulation. This, of course, is exactly what happens. Triple beats involving the chrominance and aural sub-carriers, and various sidebands, are not masked by phase-locking the visual carriers.

At first, it was thought that HRC would permit triple-beats to increase by as much as 10 to 12 dB (5 to 6 dB output level increase) before becoming noticeable. However, based on field experience, and reasonable caution, such expectations have been reduced somewhat by prudent designers, who generally allow for about 4 to 6 dB increase in composite triple beat (2 to 3 dB in output level).

At the 1972 NCTA convention, Sruki presented a comprehensive discussion of the coherent (phase-locked) carrier system for cable TV, and, on Oct. 2, 1972, filed application for patent. On Aug. 5, 1975, U.S. Patent No. 3,898,566 was issued to Israel Switzer, Arie Zimmerman, and others, assigned to Phasecom, entitled: "Method and Apparatus for Reducing Distortion in Multicarrier Communications Systems." This patent covers HRC, and the fine-tuning of the relative phasing of individual carriers.

Thus, Sruki Switzer's letter to *CED* (Disagreeing with Colquitt, March 1987, p. 14) must be considered authoritative and generally correct as to the facts. Among other points, he properly calls attention to the fact that FCC has provided for both HRC and IRC offsets from aeronautical frequencies. (See FCC Rules and Regulations 76.612). However, the offsets specified by FCC for HRC are generally much less than 12.50 kHz. At channel 53 HRC, for example, (66 × 6.0003 = 396.0198 MHz) the offset from 396.025 MHz is only 5.2 ± 0.066 kHz, substantially below the 12.5 ± 5 kHz requirement for non-HRC systems. In the A-1 and A-2 channels, the non-coherent offset requirement is 25 ± 5 kHz. Yet, the HRC rule accepts 19 × 6.003 = 114.0057 MHz, providing only 5.7 ± 0.019 kHz offset from 114.000 MHz.

True, FCC has adopted the HRC offsets. But, you may ask, if 5.7 kHz offset is acceptable in the NAV band for NRC, who do non-HRC systems have to maintain 25 ± 5 kHz? Answer: I don't know. It may be that FCC (and FAA) will eventually soften and accept offsets of 10 ± 5 kHz for all; or, they may even throw out the more lenient HRC rule. In any case, when the NAV channels are split down to 25 kHz, as they probably will someday, the HRC offsets may no longer work.

This brings up an issue that Walter Colquitt only touched on tangentially: HRC is inflexible. Sruki points out in his letter that, with HRC channelling, you cannot phase-lock to local TV signals to reduce direct pickup interference. You cannot change the aeronautical offsets, if 5 kHz turns out to be insufficient in the aviation channels. Once you choose HRC, the logistics of changing converters from HRC standard or IRC are likely to be quite difficult. The A/B switch will be a special problem for HRC systems, even if the customer does pay for it.

In my view, we have so many problems at the receiver/VCR interface that we hardly need to add a non-standard HRC channelization plan to the mess.

Sruki accurately describes an IRC headend as an "HRC headend that has been shifted upward by 1.25 MHz." Except for the special problem of channels 5 and 6, the IRC system has most of the advantages of a coherent (phase-lock) system, but few of the disadvantages. Except for the channels 5 and 6 problem, you can change easily from standard to IRC. Since all channel frequencies are standard (except 5 and 6) you have almost no special problems with cable-ready, VCR, or non-cable-ready TV sets. Even with IRC, however, you cannot phase-lock to the strong local TV signals.

I say "most of the advantages." Sruki is absolutely correct that HRC shifts most third-order, all second-order, and all harmonics to zero beat. IRC shifts only the most important classes of third order, but not harmonics or second order products. His formulas as to which beats fall zero beat, and which do not, are not quite correct, but I am sure we know what he means. The fact is that the components not masked by IRC occur at lower levels than the triple beat components that are masked.

Ken Simons (Proc IEEE, July, 1970, pp. 1071-1086) has shown that second

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

Since IRC offers practically the same advantage of HRC, with fewer disadvantages, why not use IRC instead?

harmonic levels are 6 dB below the sum and difference beat levels; intermodulation levels ($2 f_1 - f_2$) are 6 dB, and third harmonic levels 15.5 dB, below triple beat levels. The relative level of second and third order components depends on the ratio of the constants in the mathematical power series, which depend on the accuracy of push-pull cancellation, and the nature of the non-linearity of the actual devices. Since it is the low level components that do not fall to zero beat in IRC, it can easily be shown that the difference between HRC and IRC, in terms of the masking effect of zero beat is extremely small.

Therefore, instead of asking, as Sruki did: "Unless coherent channelling creates other problems, why not use it?"; I would ask: "Since IRC offers practically the same advantage of HRC, with fewer disadvantages, why not use IRC instead?"

As a matter of fact, I have recently observed that both suppliers and operators are seriously suggesting standard, non-coherent channelling initially (in newbuilds or rebuilding), retaining the option to add the IRC reference comb later if circumstances warrant. Admittedly, this poses problems with respect to the handling of channels 5 and 6.

Walter Colquitt rather bluntly chooses feed-forward over HRC. I am inclined to agree with Sruki to the extent that the issue is not really that clear-cut. I believe manufacturers now acknowledge that feed-forward performance depends on delay lines and phase cancellations, which in turn are significantly affected by age and temperature. Expectations have been lowered, as to the improvements from either feed-forward or coherent channelling.

Sruki is correct in saying that increasing output level on feeders without increasing distortion is important; and, that increasing output level in trunks without increasing distortion directly increases carrier-to-noise and signal-to-noise ratios. But the designer, installer, or maintenance technician should realize that increasing output levels too far may introduce disastrous higher order (5th, 7th, 9th, etc.) components in addition to the well-controlled 3rd order. Output levels must not be raised beyond the point where the composite triple beat starts to increase more than 2 dB for 1 dB output increase. Feed-forward stage gain is based on a single hybrid, and does not have much headroom in this regard. The parallel hybrid (power doubling) raises total output levels by combining the output of two or more hybrids, neither of which operates at levels likely to cause higher order distortion. For this reason, the parallel hybrids appear to be better adapted to feeders, while feed-forward may be better adapted to trunk amplification. ■

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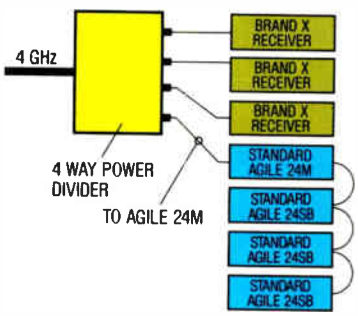

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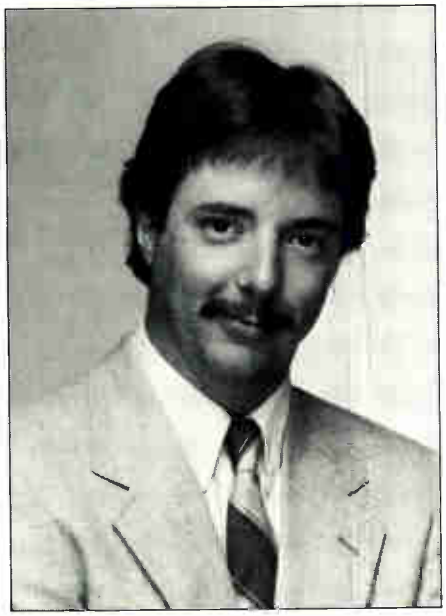
in perspective



When three isn't a crowd

Communication. To make it work there has to be two participants: The writer and the reader, the speaker and the listener, the actor and the audience, etc. And the quality of that communication depends heavily upon the number of people participating and the amount of interaction that occurs among them. Obviously, a panel discussion encompassing several divergent opinions is much more lively than a program consisting of just one person. Similarly, an article based on interviews with several respected individuals is much more readable than a one-on-one interview.

Now that the industry is emerging from its high-growth era, MSOs are placing more emphasis on reducing system operational costs while increasing penetration levels. A result of that mandate is pressure upon the technical community to reduce costs and use people more efficiently while striving to provide better service and improved picture delivery. That's going to be a tough job.

One way to make it easier is to talk to others in the industry who've already traveled that path—people out there are experimenting with ways to improve service without increasing staff. Others work on reducing powering costs, increasing bandwidth by using new technology, sweeping systems without disrupting service, and other tricks to get the most for the money invested.

Based on some of the comment cards we receive from our readers, there is a critical need for this kind of information—and you can help. Maybe you did a rebuild this year. Well, what did you learn? Did you do anything different, novel? Did you discover some surprises that others in the same situation ought to know? Do you have a question that another reader might be able to answer?

If you have tips for others but don't know how to commit it to paper, we're making it easier for you. Beginning this month, we'll be inserting a "Letter to the Editor" card in every issue. Use it to pass along an idea, a tip for others, comments about the articles and commentaries you've read. Take a stand on a controversial issue like the consumer interface challenge, addressability, impulse pay-per-view, signal leakage or A/B switch requirements. Then, just drop it in the mail to us and if we need more information, we'll get back to you.

Are you doing some system construction? Write a short letter and explain some of the problems you've encountered. What should other operators look out for, based on your experience? Maybe you added feedforward technology. How did that affect the rest of the system? If you added addressability, is it going to be 100 percent or a hybrid system? Why? Are traps still the best way to keep your system secure? Why?

Or maybe you've got technical questions you can't get answered. Write an open letter to our readers and get a running conversation going. How to calculate CLI, how to detect and eliminate signal leaks, how to power budget for a rebuild, how to eliminate interference, etc. We'll publish your question for others to read and respond to.

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We look long and hard at the letters and comments we receive. They're important ingredients when we plan what kinds of articles to publish. With your input we can work to bring you the kind of article you want to read today.

In this issue, you'll find parts II and III of the NCTA interconnection guidelines. Part II is being reprinted from last issue because of a printer's error in one of the figures. After the final part runs in the June issue, the entire bound package will be available to the industry. Watch for the order form to appear in June.

Also, coverage of the SCTE's highly successful Cable-Tec Expo, held in Orlando, is included. System engineers and technicians from all over the country attended the show in record numbers to participate in workshops ranging from cable system design to subleties of sync suppression scrambling. A complete list of award winners is also included.

And finally, the third installment of our quarterly construction survey can be found, beginning on page 26. The survey covers the Southwest part of the United States, Alaska and Hawaii, and, like the previous two parts, includes information on upgrades, rebuilds, newbuilds, pay-per-view and addressability. The final installment, along with a full summary, will appear in the August issue. Watch for it. Better yet, write and let us know what you think.

Roger J. Brown

MOST FOLLOW STANDARDS...

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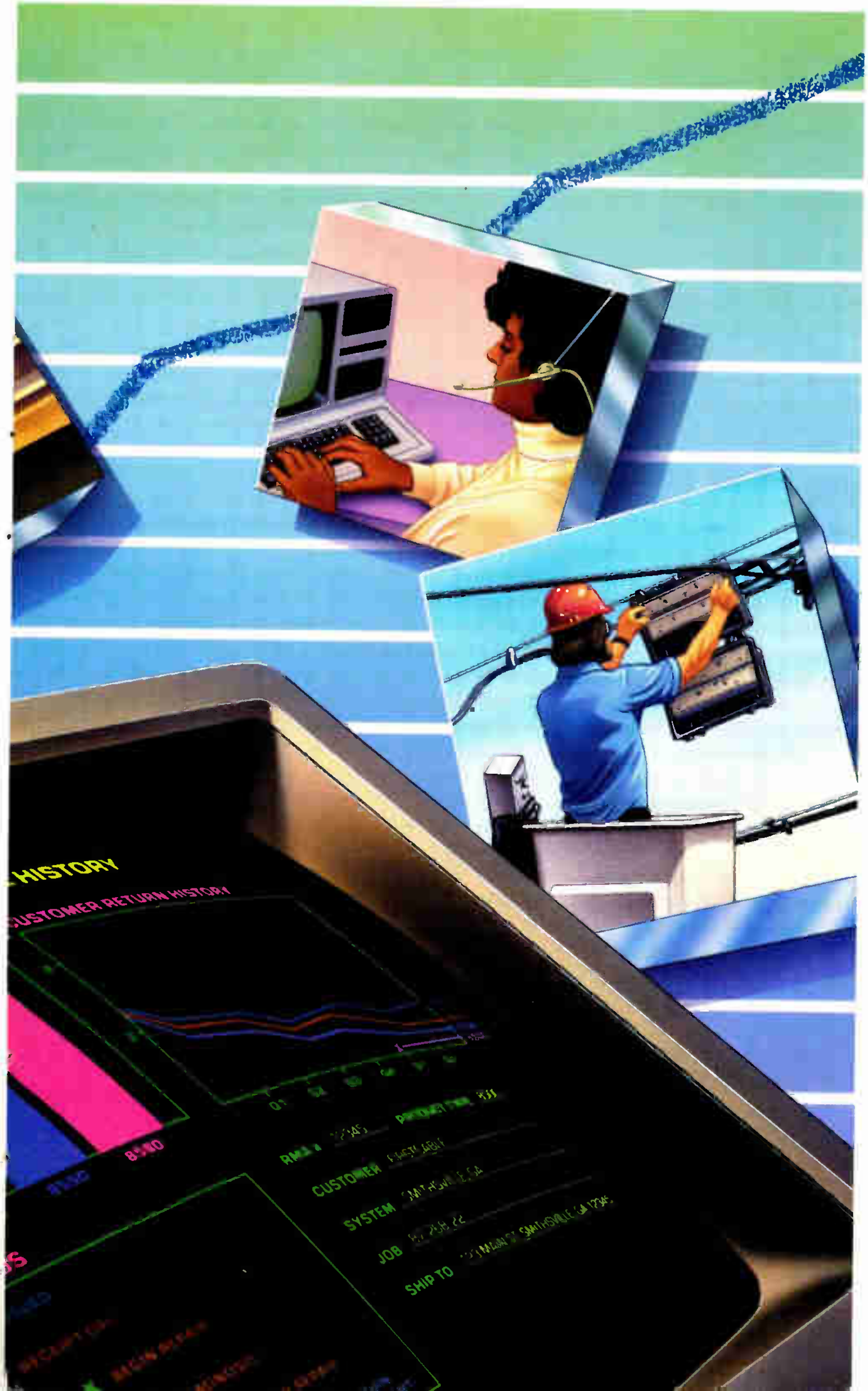

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The quality of the professional

At the recently concluded SCTE Cable-Tec Expo in Orlando, sessions on professionalism and engineering management, while generally well attended, were clearly not the most popular workshop sessions at the convention. I find this puzzling. Is there anyone who would not like to be thought of as doing his or her job in a professional way? Surely not the people who come to the Cable-Tec Expo and spend hour after hour in workshops and seminars while the Florida sun shines outside.

On the other hand, I find it understandable for the simple reason that concepts and components that we associate with a professional are hard to grasp. They are nebulous in the extreme and they have a nasty habit of creating the well-known "horns of a dilemma." Indeed, when confronted head-to-head with many of these concepts in real life, painful choices are usually the result.

Wendell H. Bailey, NCTA, vice president, Science and Technology

These concepts embody such qualities as competence, loyalty, morality, ethics, honesty and fairness. These things sound good on paper and are fairly easy to define in the abstract, but we're not talking about the application of these qualities in the abstract. We're talking about how they apply to daily situations and crises that may arise.

Most people get chances to struggle with the values discussed here but they come at the most inopportune times, like in the middle of a deadline situation. My puzzlement over why these sessions were not more popular is based on the fact they offered a chance to debate situations with hard, troubling choices in an environment where the consequences do not have an immediate or personal result.

Let me try to relate what it is about the quality of a professional that so clearly distinguishes an employee from a co-worker. Two employees can both be adequate or, indeed, excellent at their job and yet it is possible to see the difference if one has the attributes of a professional. The difference is almost always more readily apparent in times of stress.

By stress I mean the conflict and turmoil brought on by projects, crises, personnel decisions, deadlines and things of that sort. While each employee may be competent at dealing with each of these things, the hallmark of the person with a professional attitude is the way in which that person considers the impact of any action or decision he is about to make on areas outside his realm of authority.

The person with a non-professional attitude will only consider the immediate ramifications to the area under his control. For example, the decision of an engineer to stop recommending a particular equipment supplier that has been providing service and goods to a company for a long time may seem straightforward. You may agree that such a decision could be based on a variety of factors, such as cost, quality or product, serviceability of the contract or one of several other reasons. The average employee is likely to consider those things only, then make a decision. The professional, however, considers a wide variety of other issues. What about the vendor? What will be the impact on marketplace competition? If there are several companies making that product, competition may be vigorous and the effect unnoticeable. But if there are few competing companies, rejecting one of them outright may impair the ability to get competitive prices and products in the future. The employee who considers those aspects that fall outside his realm of authority is clearly the more professional.

Some may argue that the above example does not necessarily demonstrate professionalism, only a more clever employee who is a better strategic thinker than his co-worker. I would argue that the kind of person who constantly considers the world around him and what impact his activities have on it, and vice versa, is someone who is demonstrating a professional attitude.

This example only demonstrates one part of what a professional attitude is. Real professionalism comes in the ability to resolve the conflicts that inevitably arise around the issues of honesty, morality, ethics and fairness, when major projects or decisions reach critical points. Those who can perform the necessary thinking and have the fortitude necessary to resolve the conflicts in these areas are those who carry the attitude and ability that also suggests they may be more professional that their co-workers.

You'll notice that none of these qualities include education, degrees, intelligence, charm or personality. None of these are necessary to be seen as a professional. Indeed, there are many educated people who no one would mistake for a professional just as there are many people with little or no formal education who show their competence and a grasp of the impact of their actions on the surrounding environment. Today, this quality is rare enough to be remarked upon. It need not be that way. Most of the people who work in our industry are capable of looking at their day-to-day jobs in a way that expands the possibilities for professionalism to a point where this quality will no longer be remarkable.

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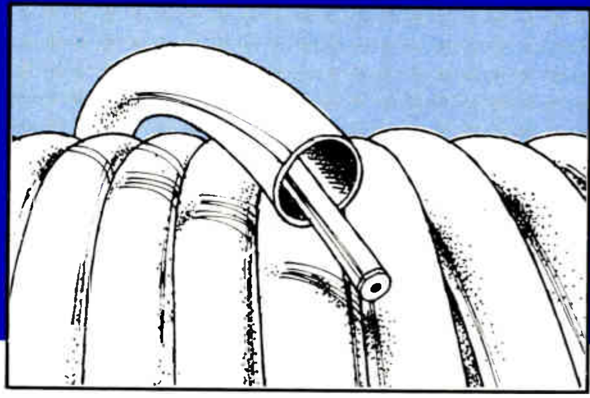

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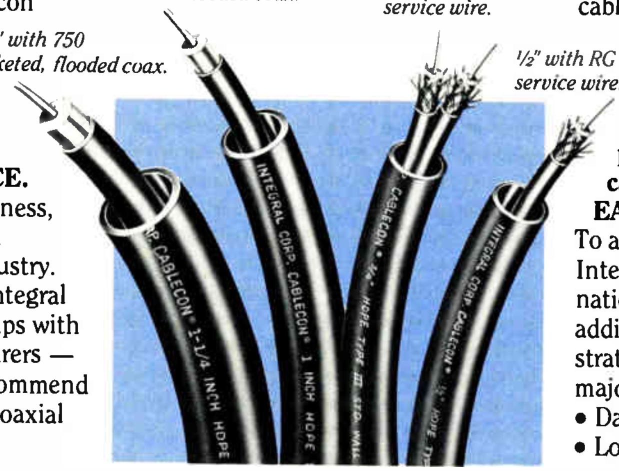

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Reader Service Number 9

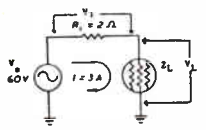
The economics of system powering

With today's high cost of energy and the need to conserve a dwindling supply of fossil fuels, the CATV operator must be knowledgeable in the ways he can design his system for economical powering.

Notwithstanding the sometimes arbitrary methods employed by power companies in their determination of how much a particular CATV system should pay for being connected to its secondaries, the lower the actual kilowatt hours per month the system devours, the lower will be its retribution.

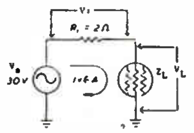
A working knowledge of the effects the following items can have on the design of a CATV system will aid in producing one with greater reliability and reduced power consumption.

R_1 = The resistance of 2000′ of .750 coaxial cable with copper clad center conductor (.98 ohms/1000′)
V_s = Pole-mounted power supply
Z_L = Load consisting of 3 amplifier stations.
W = Wattage dissipated within the cable
V_1 = Voltage drop across cable resistance
V_L + Voltage available at load



$W = I^2R$	$V_1 = IR_1$	$V_L = V_s - V_1$
$W = 3^2(2)$	$V_1 = 3(2)$	$V_L = 60 - 6$
$W = 18$	$V_1 = 6$	$V_L = 54$

A



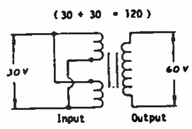
$W = I^2R$	$V_1 = IR_1$	$V_L = V - V_L$
$W = 6^2(2)$	$V_1 = 6(2)$	$V_L = 30 - 12$
$W = 72$	$V_1 = 12$	$V_L = 18$

B

FIGURE 1

1. Whether the system is to be powered for 30- or 60-volt operation
2. The current drawn per active device
3. The real wattage per active device
4. The number of active devices per unit of system length
5. The loop resistance of the cable used to power the devices
6. The effect of input voltage level on equipment operation, wattage and current consumption
7. The percentage loading of the pole-mounted power supplies
8. The location of the pole-mounted power supplies

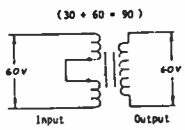
A 30 volt surge in phase with the 30 volt input voltage will produce a 120 volt output.



Transformer Wired
For 30 Volt Operation

A

A 30 volt surge in phase with the 60 volt input voltage will produce a 90 volt output.



Transformer Wired
For 60 Volt Operation

B

FIGURE 2

Power calculations become somewhat difficult due to the interrelation of some of these factors, which can influence the effects of each other almost as much as they directly influence the total power consumed. This total power is, of course, the sum of that used by the active devices, that which is dissipated in the cable, and that which is lost to the efficiency of the pole-mounted supplies.

For a given system, a 30-volt powering source will cause twice as much current to flow in the coaxial cable than if supplied with 60 volts, and the power dissipated in that cable (the cable's resistance multiplied by the square of the current) is increased four times! In Figure 1, Example 1A shows that with 60-volt operation the power is dissipated in 2,000 feet of .750 cable with copper clad center conductor (.98 ohms per 1,000 feet loop resistance) is 18 watts, while Example 1B shows that this same cable would dissipate 72 watts for 30-volt operation.

In this same example the voltage (IR) drop in the cable with 60-volt operation would be 6 volts, and would deliver 54 volts to the stations. With 30-volt operation, the cable's IR drop would be 12 volts, providing the stations with a "too low" 18-volt input.[1]

Sixty volt operation improves system reliability, too. The rectifier portions of most DC power supplies are designed to "see" the same AC input voltage, whether the system is powered by 60 or 30 volts (by changing primary or secondary transformer winding connections). In Figure 2, the power transformer's dual primary is connected in parallel for 30-volt operation which provides a 2:1 voltage step-up at the secondary output, while a 1:1 transformation is used for 60-volt systems by connecting the primary windings in series.

Thus in Figure 2, a 30-volt induced surge (as may be caused by sheath currents) in phase with 30-volt cable powering will result in 120 volts being delivered to the rectifier rather than the desired 60 volts (Example 2A). This

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Richard G. Covell, applications engineer, General Instrument/Jerrold.

Cable Classics

Do you know why 60-volt powering is commonly used in cable systems? Do you have any idea what percentage of the power used by cable plant is actually dissipated in the cable itself (and never reaches amplifiers)? Are you aware of the trade-offs between cable costs and the costs of pole-mounted supplies (and utility bills!)?

This paper by Dick Covell, first published in 1978, discussed these considerations and the placing of power supplies for economical powering of cable distribution plant. Published at a time when 30-volt powering was commonplace, and gives insight into ways of minimizing powering costs.

Graham S. Stubbs
Consulting Engineer

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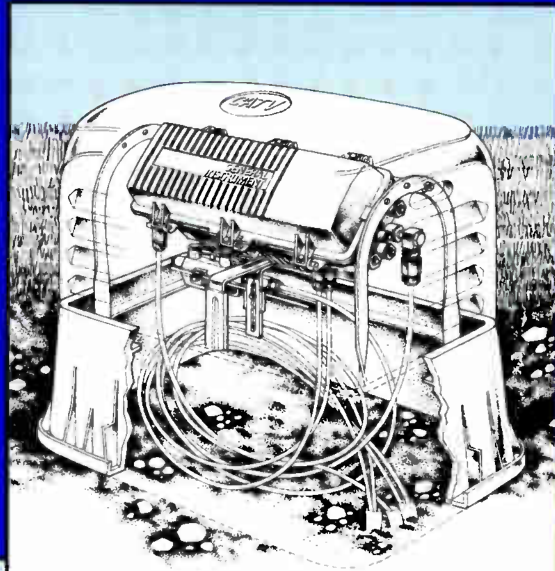

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CPH-1230 (15 per pallet).	Regularly—$96.20 each **Special price—$76.95 each**
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Houses line extender and tap/splitter combinations

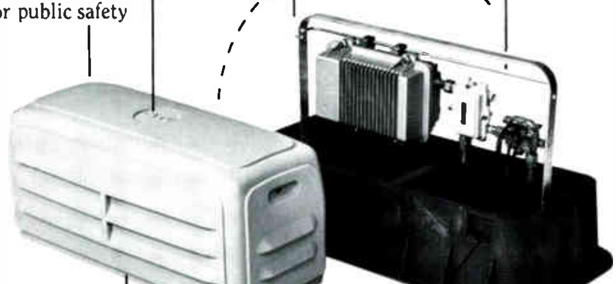
360° working access

*Concealed high security locking system

Universal hot dipped galvanized strand bracketry permits mounting of equipment without modification

"CATV" identification permanently molded into cover

Rounded corners for public safety



Constructed of HDPE plastic. Cover easily removed and replaced

Anchor slots for concrete sidewalk applications

Ground skirt acts as a foundation support system for active equipment and allows for storage of excess cable. Also, active re-splice capabilities are maximized without having to re-plow, re-pull, or re-trench coax cables.

*Hasp padlock system also available at no additional cost.

(Trunk amplifier application not shown)

CPH-1730 Low Profile Enclosure

Houses trunk amplifiers and passive combinations

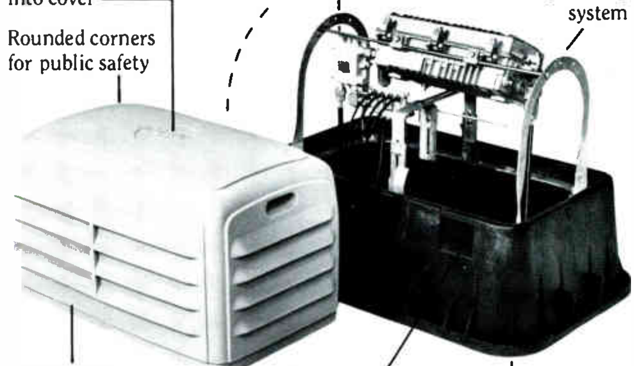
360° working access area

Universal hot dipped galvanized strand bracketry permits mounting of equipment without modification

"CATV" identification permanently molded into cover

*Concealed high security locking system

Rounded corners for public safety



Constructed of HDPE plastic. Cover easily removed and replaced. 400 Series Cover has louvers on both the sides and ends. Provides ventilation for active equipment that is comparable to any other CATV enclosure.

Anchor slots for concrete sidewalk applications

Ground skirt acts as a foundation support system for active equipment and allows for storage of excess cable, Also. active re-splice capabilities are maximized without having to re-plow, re-pull, or re-trench coax cables.

Optional 500 Series cover with"attic".

*Hasp padlock system also available at no additional cost.

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Designed to house small diameter taps and for above ground service wire applications.

Dimensions: 5" diameter, 11"-15" above grade.

Shipping: 12 per carton.

CPH-658

Houses all taps currently available in the CATV industry.

Dimensions: 6.5" diameter, 11" - 15" above grade.

Shipping: 8 per carton.

CPH-816

Houses tap and splitter combinations.

Dimensions: 8" diameter, 20" - 24" above grade.

Shipping: 2 per carton.

CPH-1016

Houses tap, splitter and line extender combinations, or small amplifiers.

Dimensions: 10" diameter, 21" - 25" above grade.

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(CPH-6512, CPH-1006, CPH-1022 not shown.)

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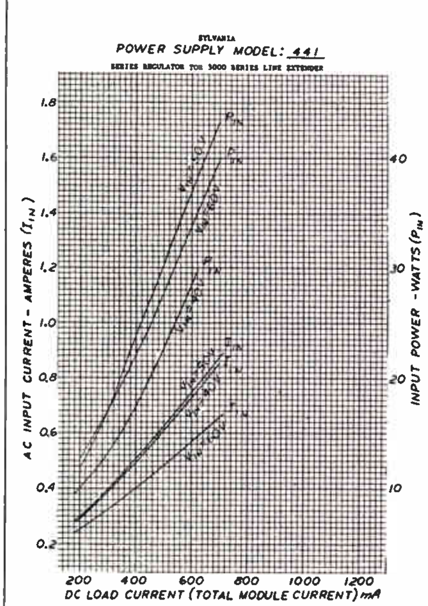
Technology you can trust!

Unless there are compelling reasons to the contrary, 60 volts is today's best choice for system powering.



same 30-volt surge, however, will only produce a 90-volt output at the secondary when set for 60-volt operation (Example 2B). A 50 percent reduction in surge voltage is certainly a worthwhile consideration.

Obviously, unless there are compelling reasons to the contrary, 60 volts is today's best choice for system powering.

The system designer should use the current carried in the coaxial cable to determine the power dissipated in that cable and the voltage available at an amplifier connected to that cable. He should not, however, use the voltage appearing at a station times that station's current draw (VA) to calculate the station's "real power" unless the station offers a purely resistive load. Fortunately, the reactive nature of the typical station power supply causes the voltage to be several degrees out of phase with the current, resulting in a lesser "real power" usage and a correspondingly lower utility bill.

As an example, the VA or "apparent" power of one manufacturer's trunk station with ALS (automatic level and slope) and bridger is 33 watts (60V × .55A), while the "real" or actual power consumed is 29.5 watts ... a reduction of 10.6 percent. This same manufacturer's line extender with a switching regulator (SR) power supply has an apparent power of 15 watts (60V × 250 mA), but the "real" power consumed is less than 12 watts, a better than 20 percent reduction.[2]

The system designer should also consider the cost tradeoffs in selecting high gain, high output capable amplifiers, (even for 12-channel systems), as the higher operating levels permitted will result in fewer stations per mile. Not only is power consumption less, but often the total equipment cost as well.

The selection of the size and type of coaxial cable is often made with too little regard for its DC attenuation. Referring again to Figure 1, had a solid copper center conductor (.68 ohms/1,000 feet) been chosen in lieu of the copper clad (.98 ohm/1,000 feet), the 30-volt powered example would have dissipated 32 percent less power in the cable, and the input voltage to the amplifiers would have risen from a marginal 18 volts to an acceptable 21.8 volts. The same percentage reduction in dissipated power applies equally to 60-volt systems, and should the approximately 15 percent increase in cable cost for solid copper center conductor be offset by an equal savings in reduced pole-mounted supply locations, a better system will result.

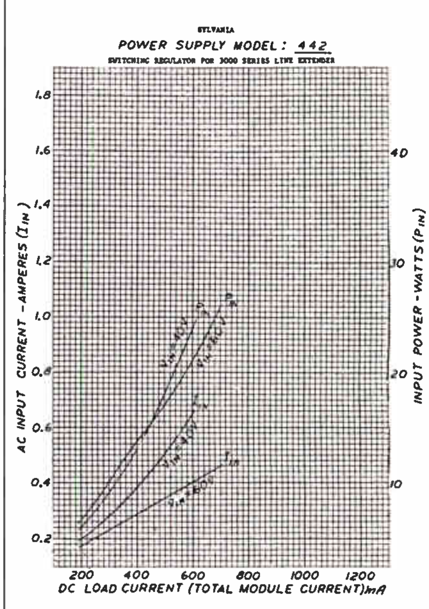
The efficiency of a ferro-resonant pole-mounted power supply improves as it is operated closer to its rated output, as indicated in the following table:

% Rated Output	% Efficiency
100	90
80	85
50	80
30	70

Ideally, then, the designer should try to locate these units such that when all present and planned options are installed in the stations to be served by each power supply, the amperage drawn will be just under the maximum specified rating. Doing this will have reduced the number of power supply locations, improved the efficiency of those remaining, and if his power supplies are to be individually metered, he may have reaped still another benefit: Grouping more of his consumed power within the cheaper rate category than commercial users usually receive for exceeding a specified minimum kilowatt hour per month usage.

The ideal, however, is not always easy to achieve. With today's equipment allowing fewer active locations per mile, and with manufacturers placing emphasis on reducing the current drawn per station, the voltage drop of the cable is more likely to be the factor which limits the number of stations fed from a given power supply, not its typical 12- to 14-ampere current capacity.

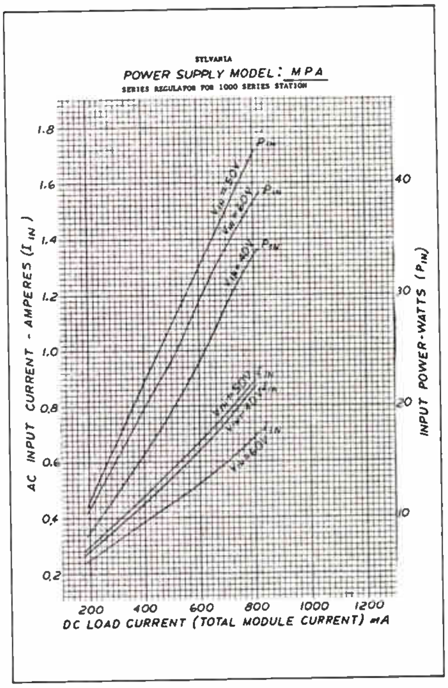
Amplifier stations incorporating SR power supplies have so far proven to be the most efficient in converting the AC voltage supplied by the cable to the DC voltage required by the amplifier. Switching regulator power supplies, however, increase their current demand when their input voltage is reduced, a characteristic which has caused some system designers to run in circles and bay at the moon! In determining the input voltage to a station equipped with the SR power units, the current consumed by the station (as found in the catalog for the operational voltage selected) is multiplied by the loop resistance of the cable. This product,



The current of this amplifier can now be computed, and used to calculate the voltage drop in the cable.

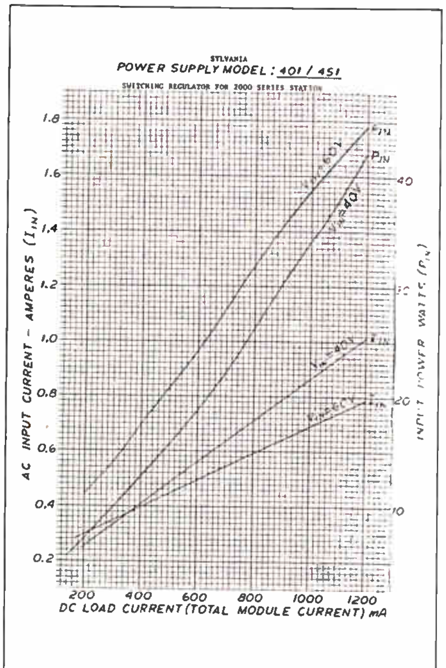
the voltage drop in the cable connecting the amplifier to its source, is then subtracted from the source voltage. The result is the voltage appearing at the input to the station ... except, since it is now lower than the source voltage, the current consumed by the station is really higher, which means the voltage drop in the cable is really greater, which means the input voltage to the amplifier is still lower yet....

To pick the ideal location for a



pole-mounted power supply within a given CATV system design, the designer first requires information (such as the graph in the appendix) which tells him the current drawn by a particular station as a function of its input voltage. Starting at the furthest line extender in the system and working backwards, he may calculate the current drawn by that station (with whatever options it may be asked to accept) at the minimum input voltage permitted for the system. This current is then used to calculate the voltage drop of the cable between this last location and the next upstream location. This voltage drop, when added to the input voltage of the previous station, defines the input voltage to this second furthest amplifier. The current of this amplifier can now be computed, and when added to the current of the preceding amplifier is likewise used to calculate the voltage drop in the cable connected to the next upstream amplifier. At trunk or splitting locations, the sum of all currents must, of course, be used in calculating the voltage drop in the cable upstream from that junction point. This method is continued until the system powering voltage is reached and that's where the first power supply is placed. Of course, the designer has

Of course, the designer has kept a tally of total current and real wattage so far consumed.



kept a tally of total current and real wattage so far consumed and he will more than likely find the aggregate to be less than one-half the power supply's rating. Determination of how many amplifier locations can be properly powered on the upstream side of the newly located power supply is presently done by trial and error, but what is permissable in the way of loading for one side of the supply certainly gives insight into loading the other.

A computer program for the HP 97, patterned after the one written by Frank Himsl and Al Kuolas which appeared in a recent issue of CATJ, is being developed to simplify finding the best location for pole-mounted supplies.

In large CATV systems localized power outages affecting only a few square-block area can disrupt cable reception to all subscribers downstream from the fault. The first entry in the marketplace to alleviate this condition was the pole-mounted stand-by supply, which automatically switches its input to the output of a battery driven inverter upon loss of utility power, maintaining signal carriage to all parts of the system.

These units will accept standard auto batteries and the number of locations requiring battery maintenance and/or inspection average less than one in 7 million of systems with 60-volt operation. These units, when equipped with batteries providing two to four hours of standby time, can be sufficiently large and heavy to preclude acceptance by the utility company for pole-mounting, and this should be checked before purchase. The efficiency of this method is about 40 percent due to the loss in the inverter. ■

Third construction survey confirms nationwide trends

One trend you can't buck in the Lone Star state is the wild pace of cable system sales, CED's most recent cable system survey has found. We doubt there's a state in the nation with as many individual transactions occurring this year. Also, with nearly three-quarters of the nation's systems tallied, a fairly consistent construction trend has emerged. Nationwide, about 20 percent of systems are doing some rebuild of existing plant this year. Also, 34 percent of all systems will be putting up new plant—either line extensions or new franchise wiring. The bulk of the newbuild activity is line extensions, although the mileage is, of course, highly concentrated in the big urban newbuild areas like Philadelphia, Washington, D.C., New York, Chicago and Detroit.

One trend that isn't so strong among systems in this survey is major rebuilds, involving complete wreckout of 100 miles or more of plant. Most of the aerial newbuild activity is 20 miles or fewer per plant. One nationwide constant is underground newbuild activity: about 47 percent of all such activity is concentrated in the 20 miles or fewer category.

Addressability moves, pay-per-view introductions and channel capacity expansions aren't as widespread in this region as in the Northeast, Midwest and Mid-Atlantic regions.

CONSTRUCTION ACTIVITY

SUMMARY:

Miles	Newbuild aerial	Newbuild underground
0-20	129	91
21-50	16	10
51-100	2	0
100+	5	2

Miles	Rebuild aerial	Rebuild underground
0-20	52	49
21-50	22	7
51-100	19	2
100+	17	4

Channel Upgrades
# of systems = 131; 10-34 channels = 69
35-37 channels = 24; 40-47 channels = 8
50-56 channels = 4; 60-80 channels = 5

Currently addressable systems
# of systems = 114
# of subs = 1,032,268

Systems going addressable in 1987
# of systems = 22
Anticipated new subs = 51,302

Pay-per-view
# of systems now offering PPV = 32
Additional systems to offer
PPV in 1987 = 35

Alaska:

Miles	Newbuild aerial	Newbuild underground
0-20	1	0
21-50	0	0
51-100	0	0
100+	0	0

Miles	Rebuild aerial	Rebuild underground
0-20	3	3
21-50	0	0
51-100	0	0
100+	0	0

Channel Upgrades
# of systems = 3; 10-34 channels = 2
35-37 channels = 1; 40-47 channels = 0
50-56 channels = 0; 60-80 channels = 0

Currently addressable systems
# of systems = 0
# of subs = N/A

Systems going addressable in 1987
# of systems = 1
Anticipated new subs = 300

Pay-per-view
# of systems now offering PPV = 0
Additional systems to offer
PPV in 1987 = 0

Arkansas:

Miles	Newbuild aerial	Newbuild underground
0-20	15	8
21-50	1	0
51-100	0	0
100+	0	0

Miles	Rebuild aerial	Rebuild underground
0-20	3	4
21-50	1	2
51-100	2	0
100+	1	0

Channel Upgrades
# of systems = 13; 10-34 channels = 10
35-37 channels = 2; 40-47 channels = 0
50-56 channels = 0; 60-80 channels = 0

Currently addressable systems
# of systems = 10
# of subs = 16,889

Systems going addressable in 1987
# of systems = 1
Anticipated new subs = UKN

Pay-per-view
# of systems now offering PPV = 3
Additional systems to offer
PPV in 1987 = 5

Hawaii:

Miles	Newbuild aerial	Newbuild underground
0-20	1	2
21-50	0	0
51-100	1	0
100+	0	0

Miles	Rebuild aerial	Rebuild underground
0-20	0	1
21-50	0	0
51-100	0	0
100+	0	0

Channel Upgrades
# of systems = 1; 10-34 channels = 1
35-37 channels = 0; 40-47 channels = 0
50-56 channels = 0; 60-80 channels = 0

Currently addressable systems
# of systems = 2
# of subs = 102,123

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construction survey

Systems going addressable in 1987
# of systems = 0
Anticipated new subs = N/A

Pay-per-view
# of systems now offering PPV = 1
Additional systems to offer
PPV in 1987 = 0

Kansas:

Miles	Newbuild aerial	Newbuild underground
0-20	13	10
21-50	1	1
51-100	0	0
100+	0	0

Miles	Rebuild aerial	Rebuild underground
0-20	15	9
21-50	2	0
51-100	3	1
100+	2	0

Channel Upgrades
# of systems = 17; 10-34 channels = 9
35-37 channels = 3; 40-47 channels = 1
50-56 channels = 1; 60-80 channels = 1

Currently addressable systems
# of systems = 11
# of subs = 51,082

Systems going addressable in 1987
# of systems = 2
Anticipated new subs = 9,416

Pay-per-view
# of systems now offering PPV = 1
Additional systems to offer
PPV in 1987 = 0

Mississippi:

Miles	Newbuild aerial	Newbuild underground
0-20	22	9
21-50	2	0
51-100	0	0
100+	0	0

Miles	Rebuild aerial	Rebuild underground
0-20	2	4
21-50	5	0
51-100	1	0
100+	2	1

Channel Upgrades
# of systems = 11; 10-34 channels = 5
35-37 channels = 2; 40-47 channels = 2
50-56 channels = 1; 60-80 channels = 0

Currently addressable systems
# of systems = 13
# of subs = 77,362

Systems going addressable in 1987
# of systems = 2
Anticipated new subs = 8,593

Pay-per-view
# of systems now offering PPV = 3
Additional systems to offer
PPV in 1987 = 5

Missouri:

Miles	Newbuild aerial	Newbuild underground
0-20	19	15
21-50	5	5
51-100	1	0
100+	2	1

Miles	Rebuild aerial	Rebuild underground
0-20	3	3
21-50	3	1
51-100	3	0
100+	0	0

Channel Upgrades
# of systems = 19; 10-34 channels = 12
35-37 channels = 3; 40-47 channels = 1
50-56 channels = 0; 60-80 channels = 0

Currently addressable systems
# of systems = 16
# of subs = 261,505

Systems going addressable in 1987
# of systems = 2
Anticipated new subs = 2,800

Pay-per-view
# of systems now offering PPV = 6
Additional systems to offer
PPV in 1987 = 3

Oklahoma:

Miles	Newbuild aerial	Newbuild underground
0-20	17	20
21-50	2	1
51-100	0	0
100+	0	0

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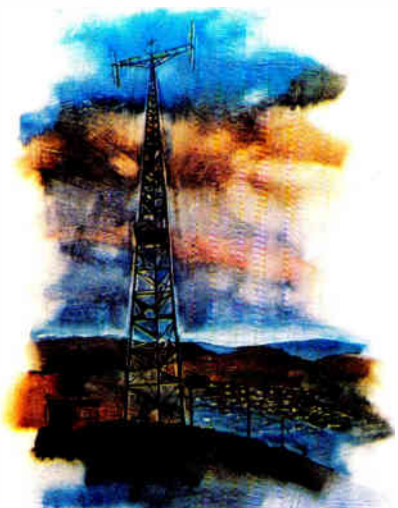

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GENERAL INSTRUMENT

Reader Service Number 31

Miles	Rebuild aerial	Rebuild underground
0-20	8	9
21-50	4	2
51-100	1	1
100+	4	1

Channel Upgrades
# of systems = 15; 10-34 channels = 7
35-37 channels = 4; 40-47 channels = 3
50-56 channels = 1; 60-80 channels = 0

Currently addressable systems
# of systems = 5
# of subs = 9,724

Systems going addressable in 1987
# of systems = 5
Anticipated new subs = 9,500

Pay-per-view
# of systems now offering PPV = 4
Additional systems to offer
PPV in 1987 = 2

Texas:

Miles	Newbuild aerial	Newbuild underground
0-20	41	27
21-50	5	3
51-100	0	0
100+	1	1

Miles	Rebuild aerial	Rebuild underground
0-20	18	16
21-50	7	2
51-100	9	0
100+	8	2

Channel Upgrades
# of systems = 52; 10-34 channels = 23
35-37 channels = 9; 40-47 channels = 1
50-56 channels = 2; 60-80 channels = 4

Currently addressable systems
# of systems = 57
# of subs = 513,583

Systems going addressable in 1987
# of systems = 9
Anticipated new subs = 20,693

Pay-per-view
# of systems now offering PPV = 14
Additional systems to offer
PPV in 1987 = 20

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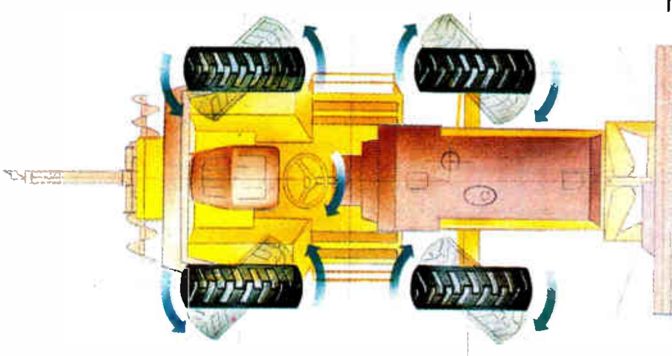

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Optical fiber super-trunking

The time has come: a performance report on a real-world system.

A review of a specific application for video interconnection on single-mode optical fiber over a 13.9-mile path, covering system design, aerial and underground plant construction, terminal equipment selection and operating results. Both digital and analog circuits are used in the system, and the economics and performance of the two approaches are compared. The digital equipment installed transports four video channels on a single-mode fiber using both 1300nm and 1550nm lasers, and the analog system is tested transporting both eight and 12 channels per fiber. To explore the potential of the system, tests are run on a fiber path 27.8 miles (44.7 km) in length. Using actual costs, an updated economic comparison between fiber optic systems and FM video coaxial systems is made.

The conclusion is drawn that analog fiber video transmission systems have been developed to the point where they offer economics and performance generally superior to, and reliability substantially better than, FM video coaxial systems. Both analog and digital fiber systems are shown to be capable of excellent quality video transmission through a path loss of over 25 dB.

The technology to make optical fiber super-trunking a practical, economical option for CATV system interconnection and other video signal transportation applications is here. Such systems are significantly more reliable than other options due to the practicality of very long, totally passive links. In an increasing number of cases, they are actually less expensive than the more traditional alternatives; microwave and FM video on coaxial cable. This paper is intended to document the construction of such a system and to draw conclusions from the performance results and economics which emerged. It is hoped that this will make the optical fiber option more accessible to the CATV industry.

In 1985, this author published a report in the NCTA Technical Papers outlining fiber basics for CATV applications and providing economic and performance comparisons between FM coaxial cable, and analog and digital single-mode fiber optic video transmission systems. The conclusions, based on the information available at that time, indicated clear advantages for each of these three technologies, but indicated that as the optical fiber field continued to mature, the balance would shift in favor of the fiber approaches. That has, to some extent, happened, as will be demonstrated through the experience documented here.

James A. Chiddix, American Television & Communications Inc.

Planning and design

Oceanic Cablevision Inc. currently serves 165,000 cable homes on the Island of Oahu in Hawaii. The acquisition and assimilation of an adjacent cable system made it necessary to provide an interconnection between Oceanic's headend and the new system. Because of local advertising insertions, tape importation of signals not available from satellite, tape-delay of satellite signals, and the lack of high-quality off-air reception due to an intervening mountain range, it was necessary to transport virtually all of Oceanic's signals to this system.

An FM video coaxial trunk existed over part of the route, but it had insufficient channel capacity and was plagued with frequent power outages of long duration in the mountainous rain forests through which it passed. Microwave was not a serious option because of the lack of sites for a route of less than three hops.

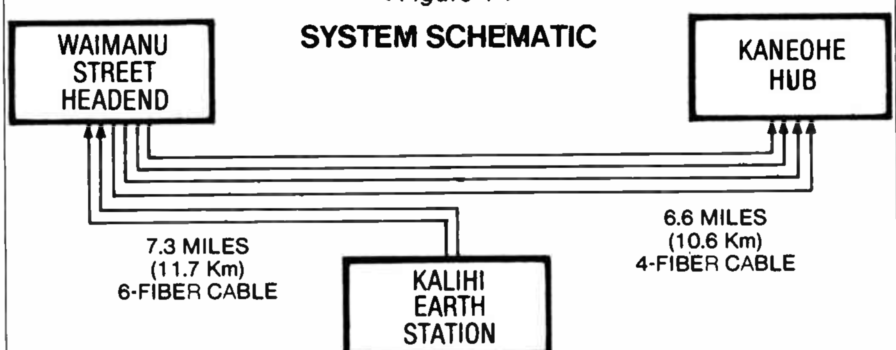
The logical route for this new interconnection passed Oceanic's earth station facilities. An FM coaxial super-trunk had been in use for some years to connect this facility with Oceanic's headend, and that trunk was in need of substantial additional capacity.

These factors combined to make a multiple-fiber single-mode optical trunk attractive to provide highly reliable capacity for transportation of additional signals from the earth station to Oceanic's headend, and of all of Oceanic's channels to the new system. The schematic in Figure 1 demonstrates the configuration of the planned system. Two fibers were to be used to provide additional capacity from the Kalihi earth station to the Waimanu headend, and four fibers to provide signal carriage to Kaneohe, the primary hub of the newly acquired cable system.

The distance to be traversed was 13.9 miles (22.3 km) and a design power budget was created. One necessary element in developing a power budget is a knowledge of the number of splices. Physical locations and underground pulling conditions were taken into account in selecting the splice locations, while keeping fiber reel lengths long. Figures 2 and 3 show the splice locations, and the fiber cable reel lengths which were ordered. Additional footage was ordered on each reel to allow for vertical riser pole runs, and to provide slack to make fusion splicing easier. This extra footage could also be

< *Figure 1* >

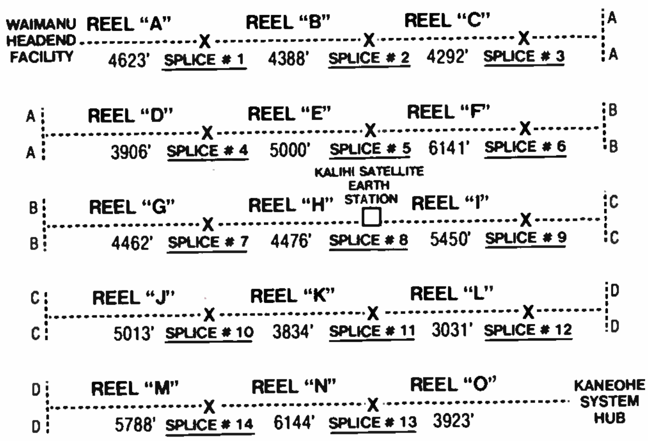
SYSTEM SCHEMATIC



The terminal equipment selected for the first phase of the project was digital.

< *Figure 2* >

SPLICE LOCATION DESIGN



< *Figure 3* >

FIBER ORDERING LIST

REEL USE LOCATION	STRAND LENGTH	REEL #	REEL LENGTH ORDERED	REEL LENGTH RECEIVED
Waimanu Street to Splice #1	4623'	A	4825'	5032'
Splice #1 to Splice #2	4388'	B	4600'	4808'
Splice #2 to Splice #3	4292'	C	4500'	4858'
Splice #3 to Splice #4	3906'	D	4125'	4461'
Splice #4 to Splice #5	5000'	E	5400'	5776'
Splice #5 to Splice #6	6141'	F	6575'	7013'
Slice #6 to Splice #7	4462'	G	4850'	5143'
Splice #7 to Earth Station	4476'	H	4900'	5264'
Earth Station to Splice #9	5450'	I	5650'	5720'
Splice #9 to Splice #10	5013'	J	5200'	5510'
Splice #10 to Splice #11	3834'	K	4100'	4339'
Splice #11 to Splice #12	3031'	L	3250'	3638'
Splice #12 to Splice #13	5788'	M	6000'	6570'
Splice #13 to Splice #14	6144'	N	6400'	7016'
Splice #14 to Kaneohe Hub	3923	O	4300'	4494

pulled through the system to simplify repair splicing, should the system be cut in the future. The fiber order specified reel lengths to a tolerance of -0 percent, +5 percent.

The power budget in Figure 4 reflects relatively conservative design. The budget assumes a splice loss of 0.25 dB per slice; fiber loss of 0.4 dB per kilometer both at 1300nm and 1550nm; connector loss at terminal equipment of 0.5 dB per connector, and a total WDM diplexer loss of 6 dB. The potential for future use of the same fiber at both 1300nm and 1550nm was considered an important factor. A total design path loss of 25 dB, used in evaluating terminal equipment, allowed for a safe operating margin.

The fiber cable to be used was selected on the basis of both cost and availability. Because of the fact that there was substantial demand for single-mode fiber from the telecommunications industry, availability was an especially important factor. A steel strength member was specified, along with loose buffering of the fibers, in pairs, in gel-filled polyethylene tubes. A Kevlar wrapping and an outer polyethylene jacket were specified, but no armor was required since the cable would not be direct-buried at any point. The same cable was specified for both aerial and underground portions of the route.

The cable which was selected cost approximately $1.05 per foot for the six fiber portions and 75 cents per foot for four fibers, which equates to about 60 cents per fiber-meter. The outside diameter of the cable was the same (0.46") in either case, with one buffer tube being replaced with a solid polyethylene cord in the four-fiber cable. The manufacturer selected, Siecor Corp., of Hickory, N.C., agreed to a maximum loss specification of 0.4 dB per kilometer at both 1300nm and 1550nm.

The terminal equipment selected for the first phase of the project (channels which were most urgently required) was digital. Although digital equipment costs were significantly higher than analog, there was digital equipment available which was reasonably competitive, could be delivered quickly, and in which there was a high degree of confidence in performance, based on other installations. This equipment was ordered from Quante Corp., of Santa Clara, Calif.

In the equipment specified, video is converted from analog to digital form with seven-bit encoding (providing 128-step amplitude resolution) and a 9.28 MHz sampling rate, producing a data stream of 65 MBits/sec. Audio is converted using 12-bit encoding (16-bit encoding is optional).

Two video channels and up to eight audio channels (or 16 RS-232 signals) are time division multiplexed (TDM'd) together into a 140 MBit/sec. data stream. As Figure 5 demonstrates, data streams (each including two video channels and associated audio signals) are applied to one 1300nm laser and one 1550nm laser. The outputs of the two lasers are combined optically in a process termed "wavelength division multiplexing" (WDM), and the resulting two optical carriers, containing four video signals, are transported on one single-mode fiber. At the receive end, signals are optically separated, received with PIN-FET detectors and demultiplexed, and the baseband signals recovered. The equipment uses Lasertron lasers and QLT PIN-FET receivers. This entire process involves well understood technology and the equipment has essentially no adjustments.

For the second phase of the project, providing the remainder of channels in the system, there was sufficient time

< *Figure 4* >

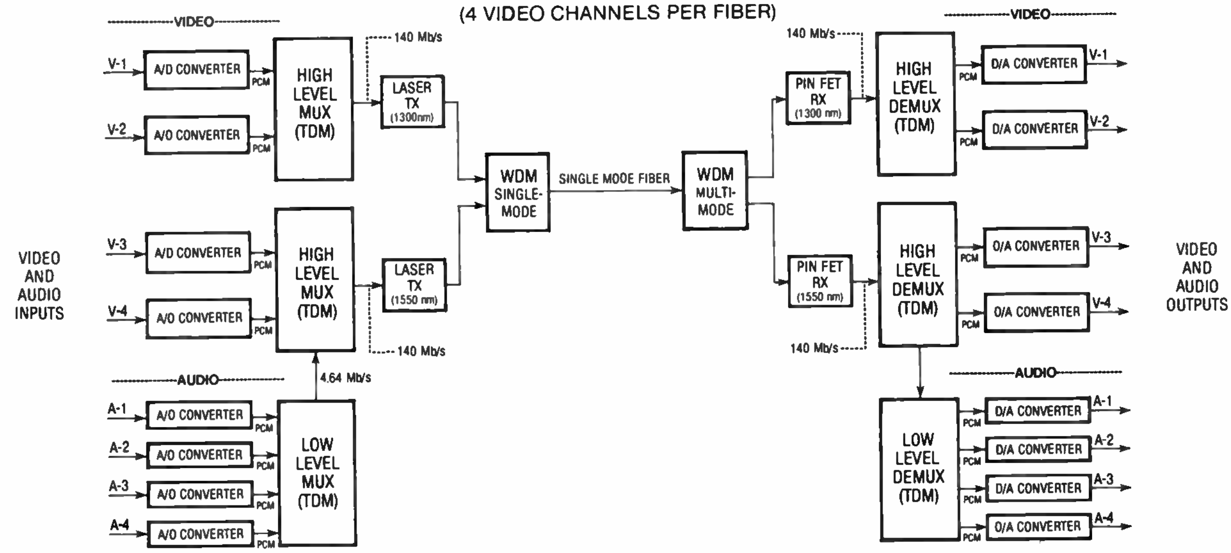
DESIGN POWER BUDGET: Waimanu Street to Kaneohe

	ANALOG (1300 nm)	DIGITAL (1300 nm)	DIGITAL (1550 nm)
Laser Output:	−3 dBm	−3 dBm	−5 dBm
Fiber Loss 22.3 Km @ 0.4 dB/Km	8.9 dB	8.9 dB	8.9 dB
Splice Loss: 14 @ 0.25 Ea.	3.5 dB	3.5 dB	3.5 dB
Conn Loss: 2 @ 0.5 Ea.	1.0 dB	1.0 dB	1.0 dB
WDM Loss: 2 @ 3 Ea.	6.0 dB	6.0 dB	6.0 dB
TOTAL LOSS	19.4 dB	19.4 dB	19.4 dB
POWER INPUT	−22.4 dBm	−22.4 dBm	−22.4 dBm
MIN. RECEIVER INPUT	−28.0 dBm	−34.0 dBm	−34.0 dBm
SYSTEM MARGIN	5.6 dBm	11.6 dBm	9.6 dBm

This entire process involves well understood technology and the equipment has essentially no adjustments.

<Figure 5>

DIGITAL VIDEO FIBER TRANSMISSION SYSTEM
(TDM/WDM)
(4 VIDEO CHANNELS PER FIBER)




Q
R
F

The primary concern with the technology was the potential effect of intermodulation products.

to thoroughly explore analog transmission. Analog transmission was particularly attractive because it involved substantially less expensive terminal equipment, and could, with available equipment, transport significantly more video channels per optical fiber. In addition, frequency-modulated (FM) frequency division multiplexed (FDM) analog video transmission on fiber is theoretically capable of excellent video performance. The primary concern with the technology was the potential effect of intermodulation products between the various FM subcarriers due to non-linearities in both the laser and detector systems. Because of these concerns, a demonstration was arranged by the equipment vendor with the assurance that eight video channels per fiber would be delivered over a 25 dB path within RS250B (medium-haul) video transportation specifications.

The manufacturer chosen was Synchronous Communications Inc., of San Jose, Calif. The equipment specified uses 8 MHz peak deviation frequency-modulated video carriers, and separate frequency-modulated aural carriers. The system uses Hitachi 1300nm lasers and Fujitsu avalanche photo-diode (APD) detectors. Figure 6 shows a block diagram of the system.

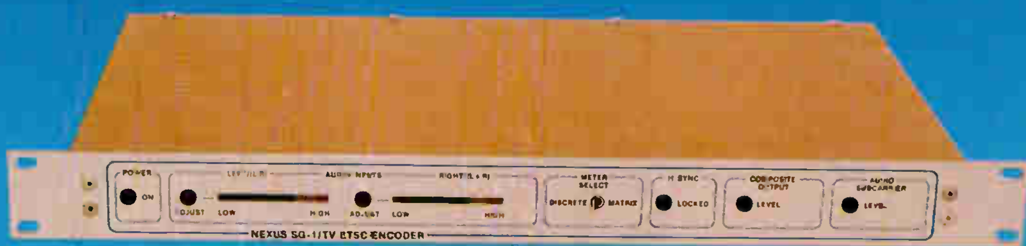
The vendor dealt with intermodulation concerns in two ways. By using very wide deviation FM, a high carrier-to-interference toleration was to be obtained. It was expected that second-order intermodulation products would have a greater effect on this system than third- and higher-order products at the laser operating point selected. A frequency plan was devised whereby the center frequencies of all second-order products would fall precisely between channels. The frequency plan is illustrated in Figure 7. The channels are 40 MHz wide and channel center-frequencies are located at $(N \times 40)$-20 MHz, where N is the channel number. Thus, channel 1 would be at 20 MHz, channel 2 would be at 60 MHz, etc. Channels 1 and 2 were to be devoted to aural carriers, which were to be carried at levels 20 dB lower than the video carriers on the system.

In this frequency plan, all additive and subtractive second-order intermodulation products will have center frequencies between channels. Thus, the additive product of channel 3 (100 MHz) and channel 4 (140 MHz) will fall at 240 MHz, between channel 6 at 220 MHz and channel 7 at 260 MHz. the subtractive product between channel 3 and 4 will fall at 40 MHz, between channels 1 and 2.

The effect of energy falling within a channel is proportional to the distance of the interfering signal from the center frequency of that channel. Much of the power in the second-order intermodulation products would be near their center frequencies, although these

Finally!

AFFORDABLE STEREO



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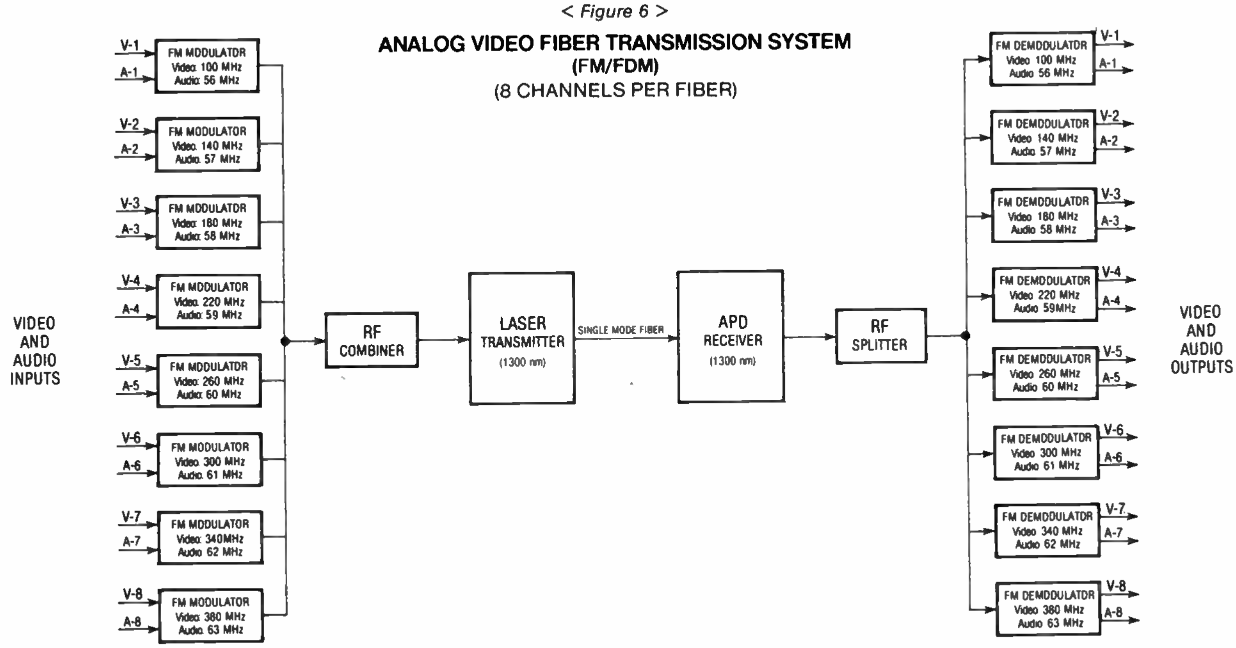
There is a temptation in frequency planning to assume that intermodulation products behave like CW carriers.

< Figure 6 >

ANALOG VIDEO FIBER TRANSMISSION SYSTEM (FM/FDM)

(8 CHANNELS PER FIBER)



products would have a peak deviation of twice the frequency of the fundamentals, and would have energy within both adjacent channels. Figure 8 shows some of these second-order products in the spectrum.

The strength of the intermodulation products would ultimately be a result of the non-linearity of the optical devices used, but it was predicted that through this frequency plan, their effect could be minimized well below the the point of visibility.

There is a temptation in frequency planning to assume that intermodulation products behave like CW carriers. Because they are the product of two or more frequency-modulated carriers, the deviation of the second-order products is twice that of the main carriers, and the peak deviation of higher order products is proportionately higher. While it is desirable to avoid having intermodulation product center frequencies fall in-band, it must be recognized that significant side-band energy will fall there regardless of the frequency plan. Thus, while frequency planning cannot be ignored, it is higher deviation (along with more linear optical devices) which holds the key to high performance FM/FDM fiber transmission systems.

Connections for the system were to be fusion splices except at the terminal points, where final connection to equipment would be through WECO biconical bulkhead connectors. These connectors, while introducing significant loss and adding a certain element of unrepeatability to overall path loss, would provide points for testing and

< Figure 7 >

FREQUENCY PLAN CALCULATIONS

Channel Center Frequencies shown in bold face type
2nd Order Center Frequencies shown in light face type

CH#	FREQ.	2nd ORDER INTERMODULATION COMBINATIONS
1	**20 MHz**	
	40 MHz	2−1, 3−2, 4−3, 5−4, 6−5, 7−6, 8−7, 9−8, 10−9, 11−10, 12−11, 13−12, 14−13
2	**60 MHz**	
	80 MHz	3−1, 4−2, 5−3, 6−4, 7−5, 8−6, 9−7, 10−8 11−9, 12−10, 13−11, 14−12, 1+2
3	**100 MHz**	
	120 MHz	4−1, 5−2, 6−3, 7−4, 8−5, 9−6, 10−7, 11−8, 12−9, 13−10, 14−11, 1+3
4	**140 MHz**	
	160 MHz	5−1, 6−2, 7−3, 8−4, 9−5, 10−6, 11−7, 12−8, 13−9, 14−10, 1+4, 2+3
5	**180 MHz**	
	200 MHz	6−1, 7−2, 8−3, 9−4, 10−5, 11−6, 12−7, 13−8, 14−9, 1+5, 2+4
6	**220 MHz**	
	240 MHz	7−1, 8−2, 9−3, 10−4, 11−5, 12−6, 13−7, 14−8, 1+6, 2+5, 3+4
7	**260 MHz**	
	280 MHz	8−1, 9−2, 10−3, 11−4, 12−5, 13−6, 14−7, 1+7, 2+6, 3+5
8	**300 MHz**	
	320 MHz	9−1, 10−2, 11−3, 12−4, 13−5, 14−6, 1+8, 2+7, 3+6, 4+5
9	**340 MHz**	
	360 MHz	10−1, 11−2, 12−3, 13−4, 14−5, 1+9, 2+8, 3+7, 4+6
10	**380 MHz**	
	400 MHz	11−1, 12−2, 13−3, 14−4, 1+10, 2+9, 3+8, 4+7, 5+6
11	**420 MHz**	
	440 MHz	12−1, 13−2, 14−3, 1+11, 2+10, 3+9, 4+8, 5+7
12	**460 MHz**	
	480 MHz	13−1, 14−2, 1+12, 2+11, 3+10, 4+9, 5+8, 6+7
13	**500 MHz**	
	520 MHz	14−1, 1+13, 2+12, 3+11, 4+10, 5+9, 6+8
14	**540 MHz**	
	560 MHz	1+14, 2+13, 3+12, 4+11, 5+10, 6+9, 7+8

trouble shooting the system. From these points an optical time domain reflectometer (OTDR) could be used to precisely locate any future cable break.

Construction

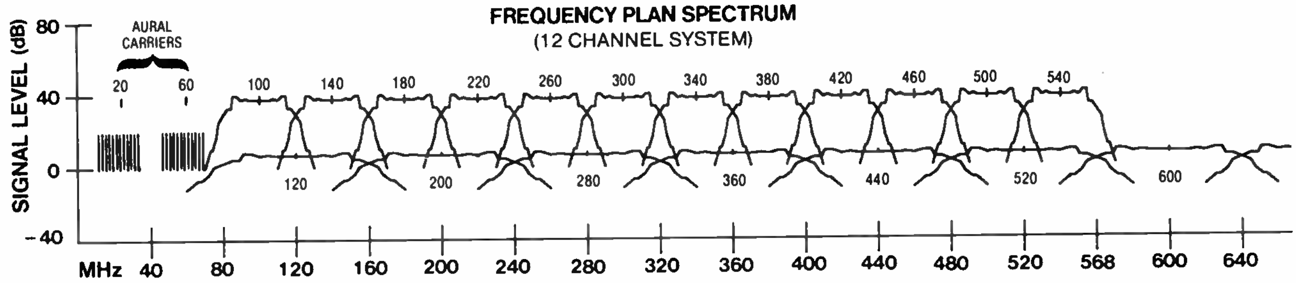
All underground cable runs were located in existing conduits, either those leased from Hawaiian Telephone Co. (a GTE subsidiary) or those owned by Oceanic Cablevision. In addition, most underground fiber cable was located within a "sub-duct" inside the conduit. The sub-duct used was made of polyethylene and had an I.D. of ¾". This system of construction allowed for the placement of the sub-duct prior to fiber pulling, and any problems with conduit congestion and blockage were dealt with in advance. The fiber cable was then pulled through a completely clear path. In addition, should additional cables be pulled through these same conduits in the future, the sub-duct will provide protection for the optical fiber cable. The cost of the sub-duct was approximately 7 cents per foot.

The presence of the sub-duct made low-tension pulling relatively easy; linemen were stationed at various manholes and, with radio coordination,

There were no difficulties with this familiar method of construction or with the fiber cable.

< Figure 8 >

FREQUENCY PLAN SPECTRUM
(12 CHANNEL SYSTEM)



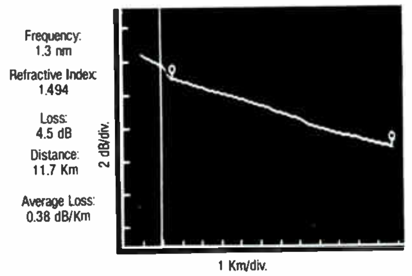
manually pulled the fiber into place. In this way, high pulling tensions were avoided. Once the pulling was complete, sub-duct sections were spliced using heat-shrink tubing.

Because the cable was received on reels up to two kilometers in length, in most instances pulling a span from the center made more sense than pulling the entire length from one end. First, half of the span was pulled into place from the reel. Then, the remaining cable was pulled from the reel into a figure-eight shape on the ground. After all the cable was pulled off the reel, the remainder of the span was pulled from the center, out of the figure-eight. The toughness of the fiber cable, especially when compared to aluminum-sheathed coaxial cable, was dramatically illustrated when one homeowner insisted on driving over the cable because her driveway was partially blocked. There was absolutely no visible or measureable mechanical or optical damage to the cable or any of the fibers that passed through that section.

One portion of aerial plant was built using standard over-lash techniques, with cable being pulled from a reel through rollers hung on an existing strand. There were no difficulties with this familiar method of construction or with the fiber cable that was handled in this way. Another portion of the system involved plant which was primarily aerial, but which followed a rather tortuous path of radical bends and short underground sections in an urban area. In this area, sub-duct was over-lashed to existing strand and coaxial cables, and was passed down riser poles and through underground sections. The fiber cable was then manually pulled as described previously. This construction method, while slightly more expensive than direct over-lash, provided easy pulling of full reel lengths and will provide for greater ease of repair should a section require removal, since the fiber cable can be pulled once again through the subduct.

All fusion splicing and fiber testing was subcontracted to Hawaiian Telephone Co., since they had fusion splicing equipment, an optical time domain reflectometer and trained personnel. This proved to be very satisfactory. All splicing was performed in a closed van. This was made possible by the slack which had been left at each splice location. A laser injection/detection (LID) system was used to couple a small amount of light into each fiber being spliced, and to detect it on the other side of the splice. This allowed optimization of positioning prior to fusing. Underground splices were organized and sealed within a splice housing. In many locations, these splices had to be located below ground level.

<Figure 9>



System performance

Figure 9 shows an optical time domain reflectometer display of one of the 11.7-km fibers from the earth station to the Waimanu Street headend. The total loss is 4.5 dB. Figure 10 shows splice loss in one fiber over the route from Waimanu Street to Kaneohe, as well as the actual fiber loss. It should be noted that the average loss per splice was 0.078 dB rather than the 0.25 dB design specification used. These results are determined by the geometry of the single-mode core within the fiber, as well as the time spent optimizing each splice. These numbers probably could have been improved slightly, but the fact that they were dramatically better than the design specification made this unnecessary.

Figure 11 shows the actual power budget which was obtained in this system. When compared with Figure 4, it is clear that the original design was over-conservative. With experience, more realistic design specifications should emerge.

The system used a Quante digital terminal equipment installed in a rack.

<Figure 10>

FIBER AND SPLICE LOSSES
(22.3 Km / 14 SPLICES)

	AVG. LOSS	MAX. LOSS	TOTAL LOSS
1300 nm FIBER LOSS	0.36 dB/Km	0.4 dB/Km	8.05 dB
1300 nm SPLICE LOSS	0.08 dB/splice	0.34 dB	1.12 dB
1550 nm FIBER LOSS	0.22 dB/Km	0.29 dB/Km	4.91 dB
1550 nm SPLICE LOSS	0.05 dB/splice	0.29 dB	0.69 dB

<Figure 11>

ACTUAL POWER BUDGET: Waimanu Street to Kaneohe

		ANALOG (1300 nm)	DIGITAL (1300 nm)	DIGITAL (1550 nm)
	Laser Output:	−2.8 dBm	−1.9	−6.3
Fiber Loss:	22 3 Km	8.1 dB	8 1 dB	5.0 dB
Splice Loss:	14	1.1 dB	1.1 dB	0.7 dB
Conn Loss:	2	1.0	1.0	1.0
WDM Loss:	2	6.0	6.0	6.0
	TOTAL LOSS	16.2 dB	16.2 dB	12.7 dB
	POWER INPUT	−19.0 dBm	−18.1 dBm	−19.0 dBm
	MIN RECEIVER INPUT	−28.0 dBm	−34.0 dBm	−34.0 dBm
	SYSTEM MARGIN	9.0 dBm	16 0 dBm	15.0 dBm

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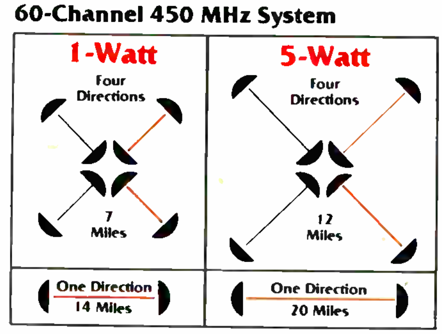

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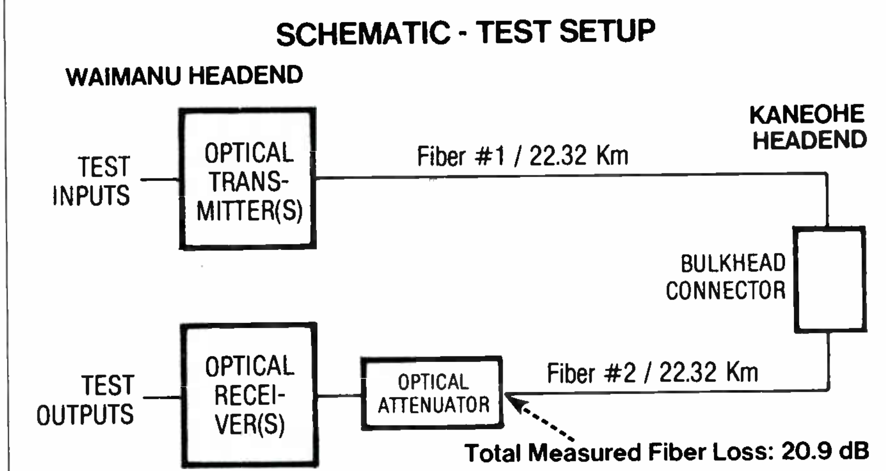
Limiting factors in the technology currently available are the speed of the logic, lasers and detectors.

<Figure 12>



Performance tests for the digital system were performed with a system configuration as shown in Figure 12. Because the path loss was lower than expected, tests were done by connecting two fibers at the Kaneohe hub, and using fibers over and back as the test run. This provided a path loss of 20.9 dB, with connectors, over a total distance of 27.8 miles (44.7 km). Additional attenuation was inserted as shown for threshold measurements. Figure 13 shows the performance of the digital system vs. the major video parameters in the RS250B (medium-haul) specification. Video signal-to-noise measurements in the digital system were performed with a Tektronix model 1430 noise test set, with a measurement limit of 59.5 dB.

It is clear that the system meets most specifications. There are, however, compromises entailed in using 7-bit video encoding rather than the 8-bit encoding usual in broadcasting. While measurements indicated that the video signal-to-noise ratio was 60 dB or better, a certain amount of quantizing noise was apparent in observing certain wave forms. This was, however, below the threshold of perceptability. In the context of overall CATV system performance, this effect is not of great concern.

The measured video signal-to-noise performance of the system did not change measureably as attenuation was added to the path. At an input level of -38 dBm, audio "popping" began to become apparent and, with the rising bit error rate, video impairment became noticeable in the form of missing lines. The system was unusable as soon as these degradations appeared, and -38 dBm was thus considered the effective receiver threshold of the system.

It has been shown that digital systems can carry more than four video channels per fiber through higher speed time division multiplexing, although currently, the cost per channel escalates rapidly. Limiting factors in the technology currently available are the speed of the logic, lasers and detectors. As higher speed logic becomes more economically available (particularly as the Gallium Arsenide logic family matures), it should become practical to carry more digital video signals on a

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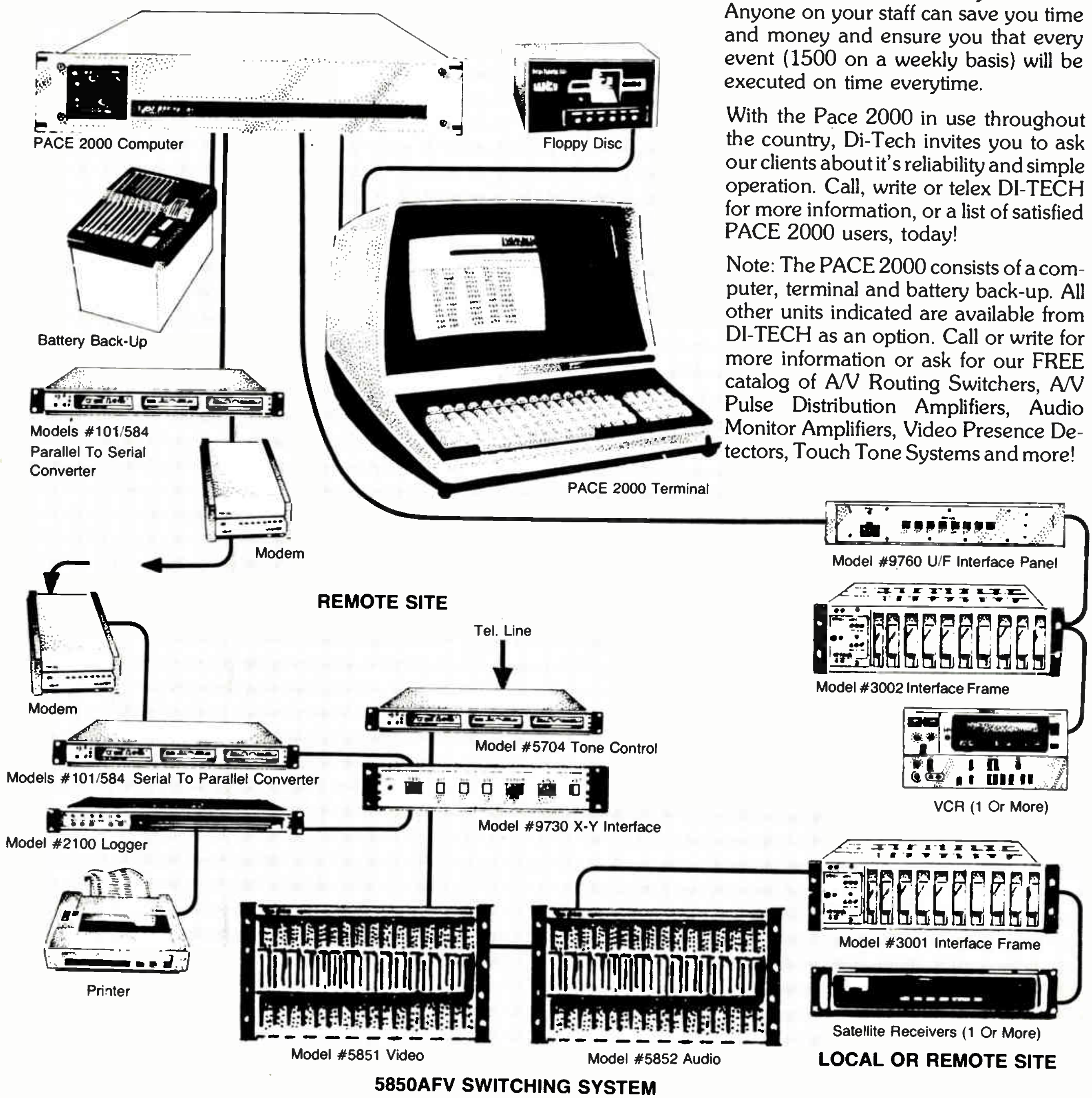

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One critical test was determining the practical noise threshold of the avalanche photo-diode receiver.

<Figure 13>

DIGITAL & ANALOG 20.9 dB LINK PERFORMANCE VS RS 250 B MEDIUM HAUL SPECIFICATIONS

PARAMETER		RS 250 B MED. HAUL		DIGITAL	ANALOG
SHORT TIME WAVE FORM DISTORTION LINE BAR EDGE OVERSHOOT		4 IRE PK-PK		2	2
CHROMA-LUM GAIN INEQUALITY		±.35 dB		0.25	0.2
DIFFERENTIAL GAIN		5%		2.5	4
DIFFERENTIAL PHASE		1.3°		1.3°	0.5°
GAIN FREQUENCY DISTORTION (MULTIBURST)		±4 IRE AT EACH FREQ	5 MHz	−1.5	0
			1.0 MHz	− .5	+1
			2.0 MHz	0	+1
			3.0 MHz	0	0
			3.58 MHz	−2.0	−2
			4.2 MHz	−2.5	−3
CHROMA NON-LINEAR GAIN DISTORTION	Small 20	±.4 IRE		0	0
	Large 80	±1.6 IRE		−0.2	−0.2
CHROMA NON-LINEAR PHASE DISTORTION		2°		1°	0.5°
CHROMA-LUM INTERMODULATION 50 IRE REFERENCE		1 IRE		0	0
FIELD TIME DISTORTION		3 IRE PK-PK		1	0
DYNAMIC GAIN	Line Bar	±3 IRE			0
	Sync	±1.6 IRE			0
SIGNAL TO RANDOM NOISE (WEIGHTED)		60 dB		>59	8 CHS 63.9* 12 CHS 61.5*

*AVERAGE

single fiber using a single laser and detector, within the economic constraints of the CATV industry. It should also become less expensive to use 8-bit video encoding. It is expected that all of these factors will improve the economics of digital optical fiber video transmission, and will provide some improvements in performance as well. The technical performance of the digital system tested, was, however, quite satisfactory for CATV transmission purposes.

The conclusion was drawn that digital technology is presently capable of providing relatively high capacity, high quality video links over long distances. The optical margins available allow for systems with some branching loss. In addition, digital transmission lends itself very well to repeaters, with little compromise in signal quality, making very long-haul transmission practical. The wavelength division multiplexing technique demonstrated here also makes the two-way use of a single fiber a possibility, in a way directly analagous to frequency diplexed RF transmission in present coaxial systems.

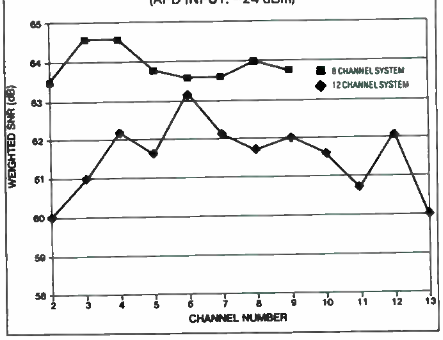
The test methodology of the analog terminal equipment used was the same as illustrated in Figure 11 for the digital equipment, but measurements were also taken as a function of channel loading. Figure 13 shows the performance of this system vs. the RS250B specification, again with 20.9 dB of path loss over 27.8 miles of fiber, and compares with results of the digital system. The system performed very satisfactorily, even when loaded with 12 channels. Video signal-to-noise ratio measurements in the analog system were performed with a Rohde & Schwarz model UPSF2 video noise meter.

Figure 14 shows, more specifically, the change in video signal-to-noise ratio performance as the system loading over the test path was raised from eight channels to 12. The signal-to-noise performance, while remaining satisfactory, decreased as the number of channels was increased, with the resulting reduction in transmit power on each channel (the optical power output of the laser remained constant). These results were very encouraging with regard to carrying a large number of channels on a single fiber over long distances, with a high degree of transparency and reliability. All of these factors directly increase the number of applications where this technology will be economically practical in CATV systems.

One critical test was the determination of the practical noise threshold of the avalanche photo-diode receiver. Figure 15 illustrates the result. While

<Figure 14>

VIDEO S/N RATIO · 8 & 12 CHANNELS
(APD INPUT: −24 dBm)



increased channel loading decreased video SNR performance somewhat, the same practical threshold was observed in terms of APD input, regardless of channel loading, at approximately -34 dBm. These tests were conducted by inserting additional attenuation at the end of the 20.9 dB fiber path. The system as configured, with a laser output of -2.7 dB, has a maximum path loss to threshold of 31.3 dB. This figure is higher than expected and speaks

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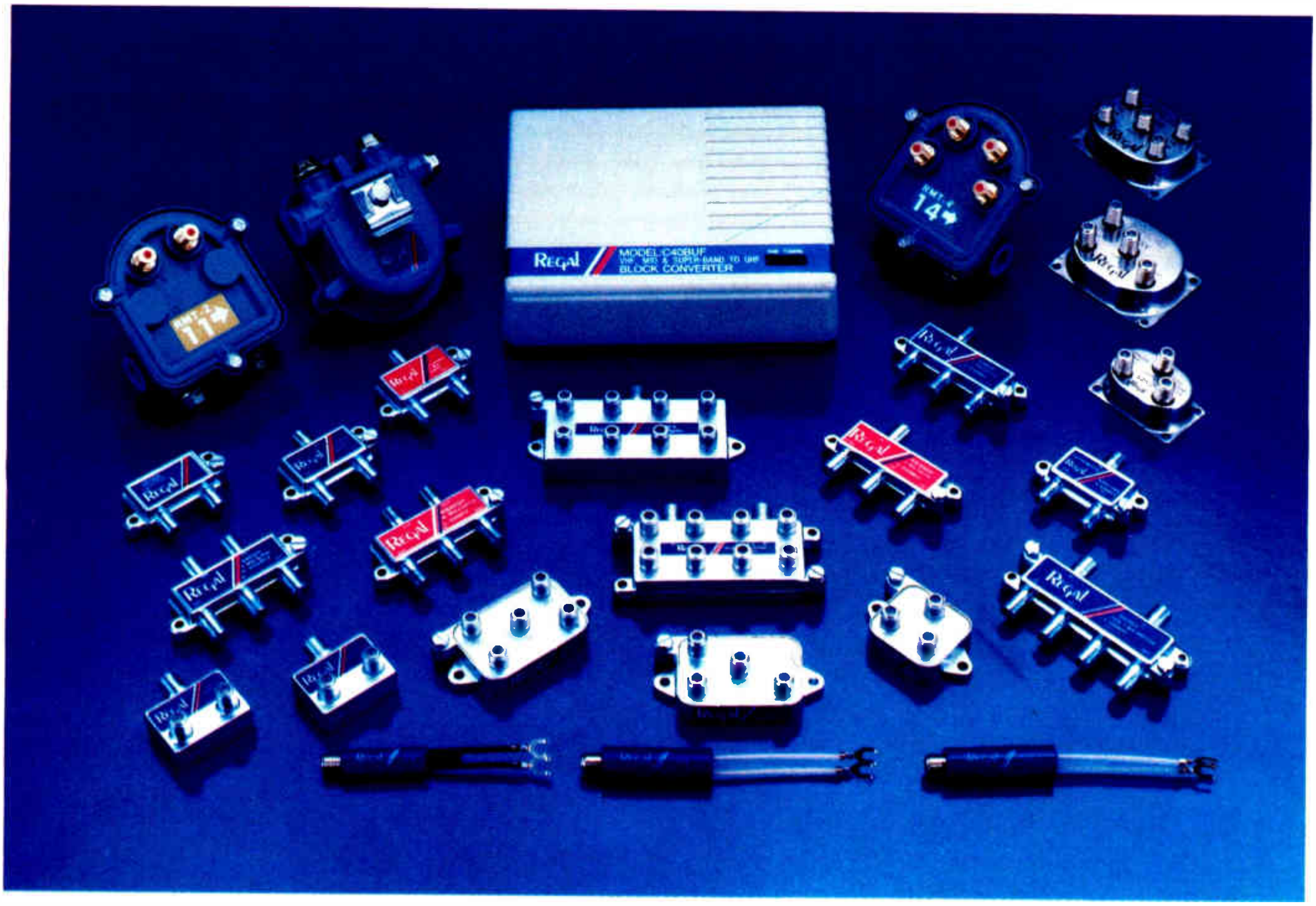

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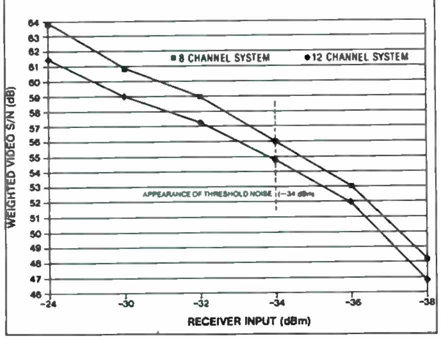
The results of the 12-channel tests leave a question as to what the ultimate limitations of this system are.

well for the performance of the avalanche photo-diode detector, although practical systems must be designed with some operating margin.

Measurement of intermodulation products was of great concern in these tests. Figure 16 shows the RF spectrum of the combined RF signals at the input to the laser transmitter. Figure 17 shows the APD output at the end of the

<Figure 15>

VIDEO S/N RATIO VS APD RECEIVER INPUT

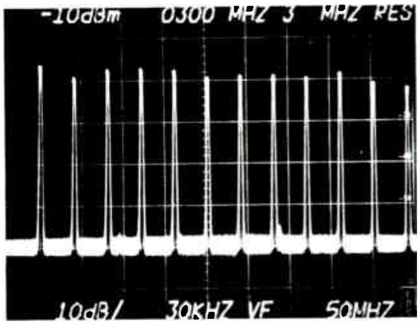


20.9 dB test path with 12 channel loading. The second-order intermodulation product center-frequency peaks can be seen between channels, and are 30 to 35 dB down.

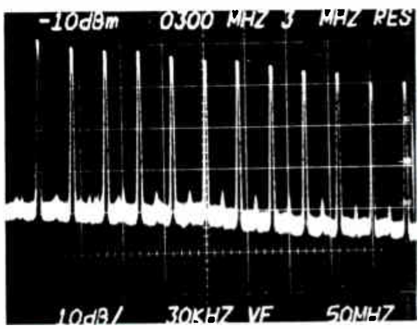
Protection ratio analysis performed by the vendor predicts that this system can tolerate, at the limit of measurable video distortion, 16 MHz deviated interfering carriers which are at least 38 dB down at center frequency, and at least 25 dB down 20 MHz from the center. Figure 19 illustrates this protection ratio curve. It was prepared by measuring the beat distortion on a fixed-frequency 8 MHz peak-deviated video signal, produced by an interfering signal with 16 MHz peak deviation, as a function of the frequency offset of the interfering signal center-frequency. The second-order product center frequency points in Figure 17, which are offset by 20 MHz and are 30 to 35 dB down, should not produce measureable video distortion.

Figure 18 shows the system with one channel removed, so that the effect of third-order (and other odd-order) products, the center frequencies of which fall on-channel, can be observed. The sum of the odd-order products was measured to be 38 to 40 dB down at center-frequency, and should also produce no measureable distortion. This was borne out in the video tests performed.

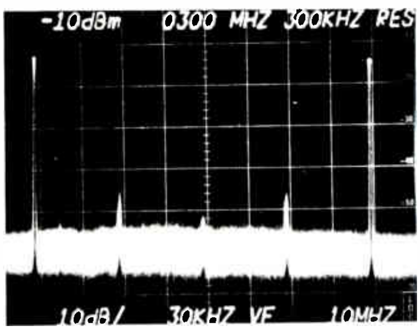
<Figure 16>



<Figure 17>



<Figure 18>

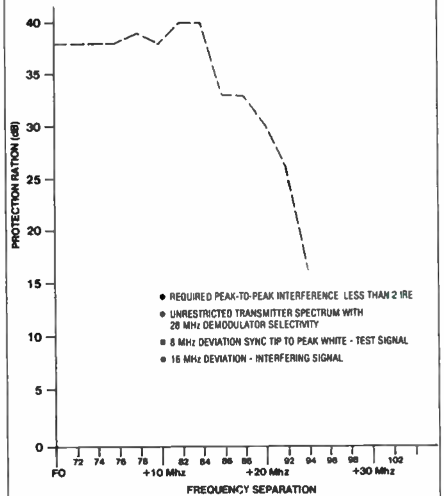


The results of the 12-channel tests leave a question as to what the ultimate limitations of this system are. One, certainly, is bandwidth. Figure 20 illustrates the frequency response characteristics of both the laser and the avalanche photo-diode. It is clear that, while it is theoretically possible to add additional channels to the system, the frequency characteristics of the optical devices will rapidly become a limitation. In addition, ultimate single-mode fiber system bandwidth is a function of the spectral purity of the laser used. This is due to the non-uniform velocity of propagation of light in the fiber as a function of frequency and the resulting dispersion effects over the distance traveled. Thus, if the laser changes frequency as it is amplitude modulated, some dispersion will result in the fiber, and an effective bandwidth limit will be established over a given fiber length. This effect was not a limiting factor in this system, despite its relatively long fiber path. It is assumed that high-purity single-mode lasers currently under development will reduce the impact of this constraint.

In summary, the system measured in the 12-channel, 20.9 dB path loss test configuration seems to provide a

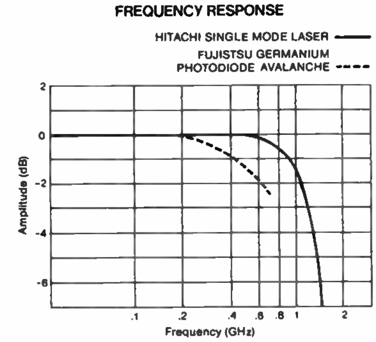
<Figure 19>

PROTECTION RATIO
CARRIER-TO-INTERFERENCE RATIO VS
INTERFERING SIGNAL FREQUENCY SEPARATION



<Figure 20>

FREQUENCY RESPONSE



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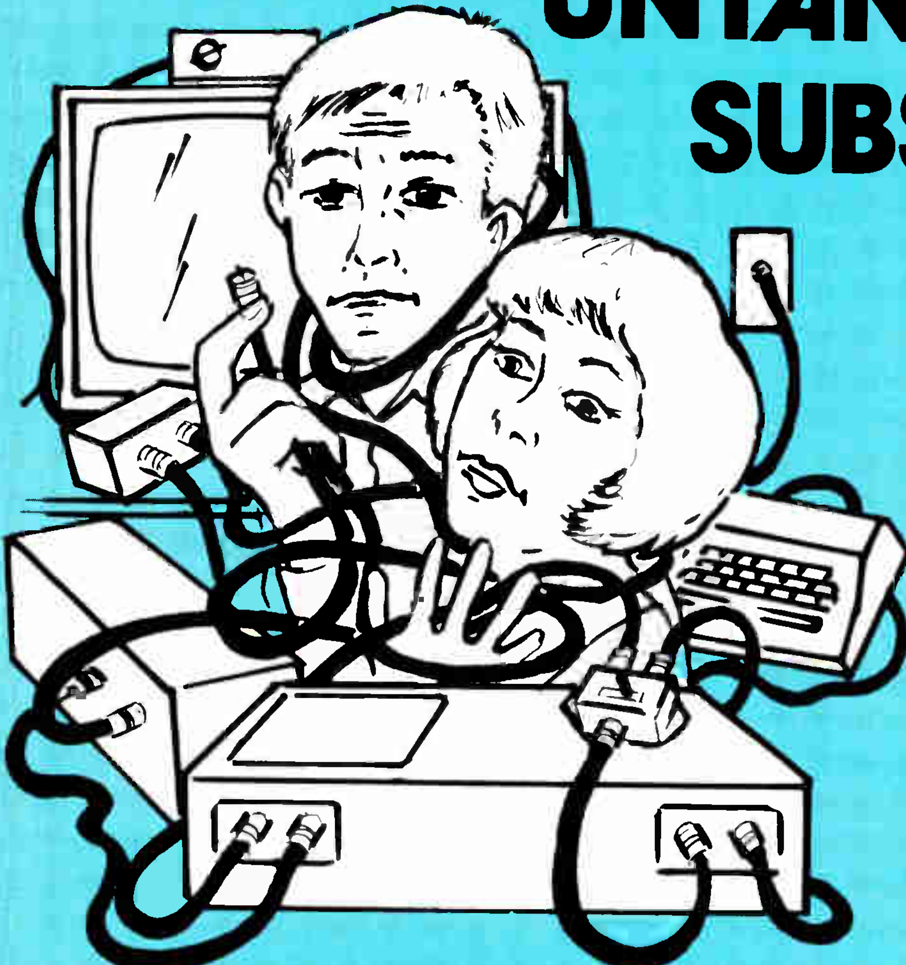

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Featured on the NCTA show cover are various engineers from the industry's supply companies, as well as representatives from the NCTA Engineering Committee and the SCTE Executive Committee. Also present are *CED*'s editorial board members and the *CED* staff. Below are the full names and companies of the people on the cover in alphabetical order. The cover illustration was done by Rob Pudim.

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Berlin, Kathy—*CED*
Best, Alex—Cox Cable
Bias, Frank—Viacom (retired)
Blonder, Ike—Blonder Tongue Laboratories
Borchert, Marshall—Riser-Bond
Bostick, Glyn—Microwave Filter Co.
Bradfield, Syd—Federal Communications Commission
Brown, Roger—*CED*
Burke, Ed—Channell Commercial Corp.
Camino, Lesley—*CED*
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Corvo, Lou—General Instrument
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Dattner, Bob—*CED* Board
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Fenwick, George—Katek
Filmer, Don—Norsat
Fox, Steve—Wegener Communications
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Hanchett, Charles—Cable Link
Hayashi, Mike—Pioneer Communications
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Hesler, Joe—Eagle Comtronics
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Huffman, Chris—M/A-COM Cable Home Group
Ingram, Martin—Telewire Supply Corp.
James, Brian—NCTA
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Killion, Bill—Channel-matic
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White, Steve—Oak Communications
Wilkenloh, Frederic—Times Fiber
Wilkes, Brian—Rainbow Satellite Communications
Wilson, Cathy—*CED*
Windle, Steve—Wavetek Indiana
Wise, Chuck—Broadband Engineering
Wong, John—Federal Communications Commission
Wonn, James—C-COR Electronics

Connecting Cable Systems to Subscribers' TVs and VCRs — Guidelines For The Cable Television Industry

Part II and III

by the NCTA Engineering Committee's Subcommittee on Consumer Interconnection

Chairman: David Large

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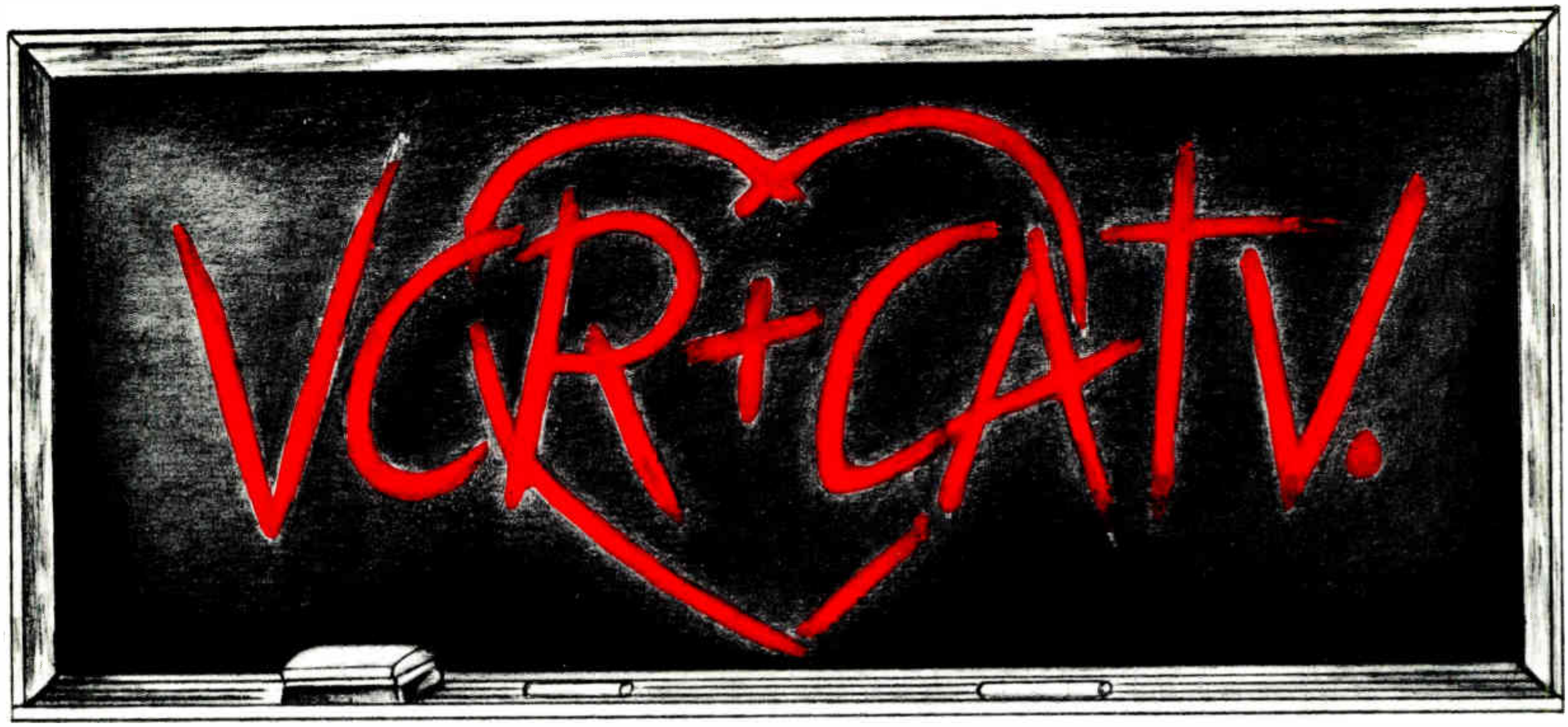

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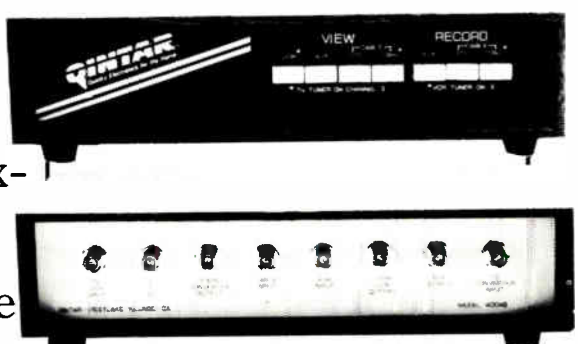

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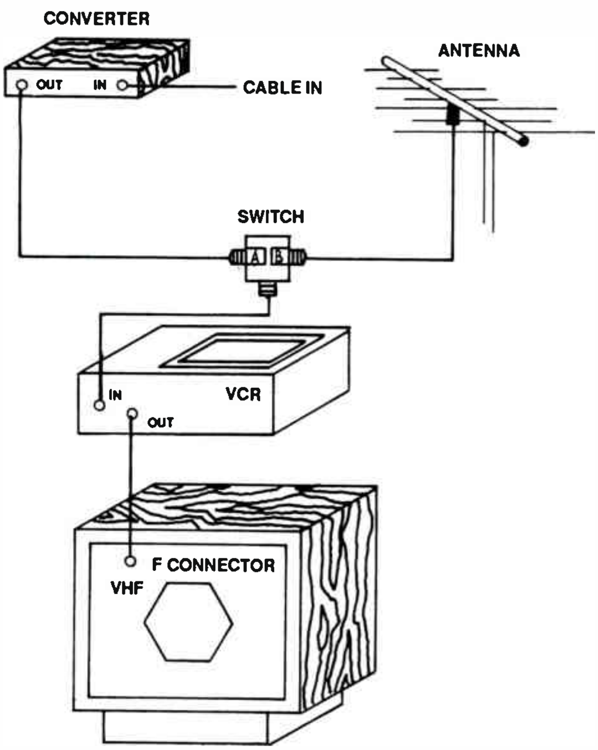
ILLUSTRATION # 15



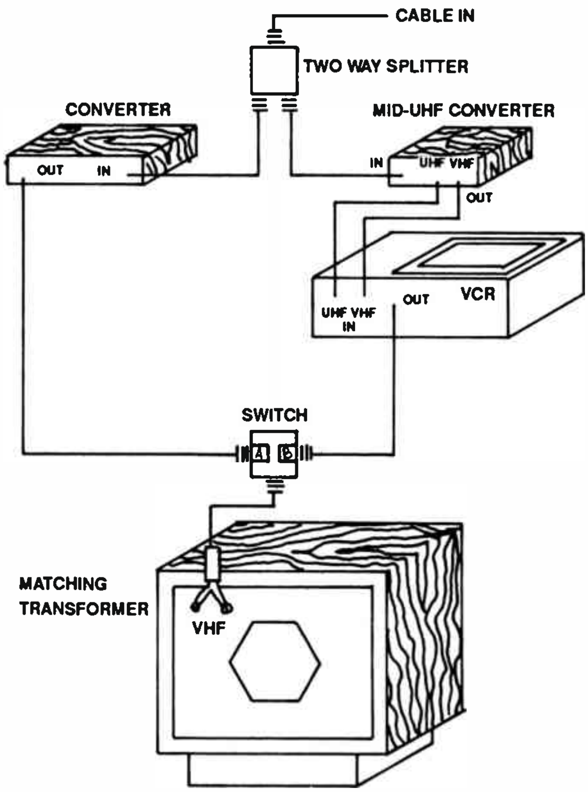
Allows:
- recording of ANY CABLE CHANNEL, while viewing THE SAME CABLE CHANNEL
- recording of any off-air channel, while viewing any off-air channel

Also allows (for OFF-AIR CHANNELS ONLY):
- timed, multi-channel, multi-event recording (i.e. ability to program VCR to record a movie on channel 5 at 6 p.m., and then a second program on channel 26 at 8 p.m.)
- channel selection by the TV remote control
- channel selection by the VCR remote control

Precludes (for CABLE CHANNELS):
- timed, multi-channel, multi-event recording, use of TV or VCR remotes

NECESSARY DROP LEVEL: 0dBmV

ILLUSTRATION # 16



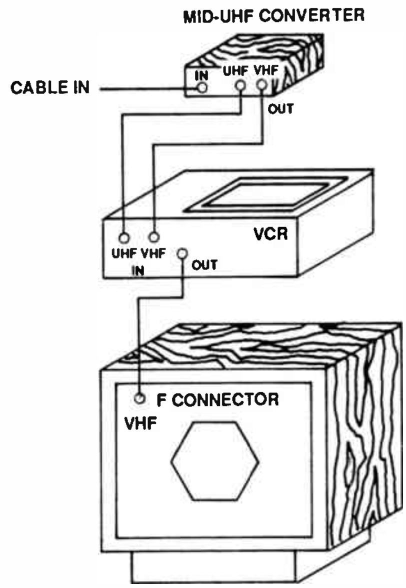
Allows:
- recording of ONLY NON-SCRAMBLED channels, while viewing ANY channel

Also allows (except when using the converter):
- timed, multi-channel, multi-event recording (i.e. ability to program the VCR to record a movie on channel 5 at 6 p.m., and then a second program on channel 26 at 8 p.m.)
- full use of the TV remote control
- full use of the VCR remote control

NOTE: allows for viewing of all channels on a non-cable ready TV

NECESSARY DROP LEVEL: +3.5dBmV

ILLUSTRATION # 17

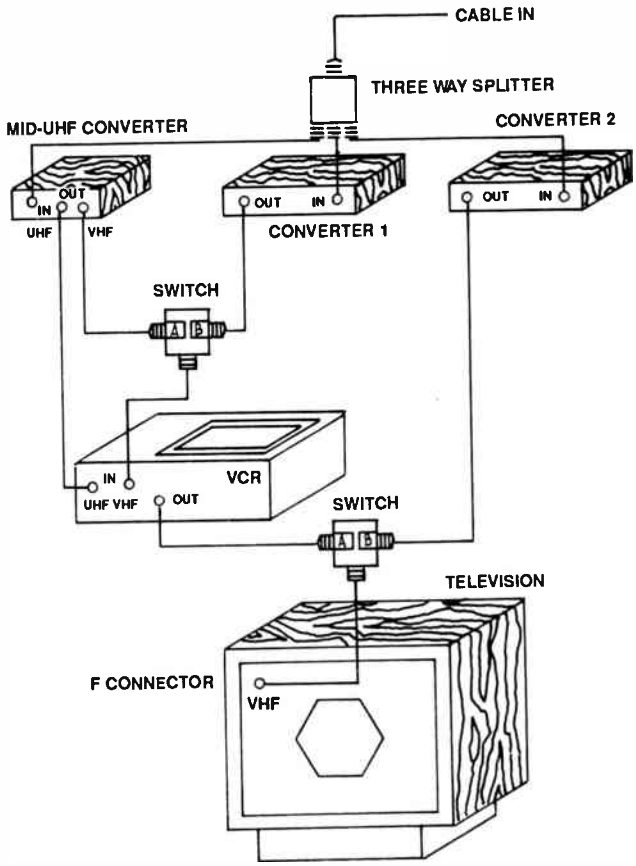


Allows:
- recording of NON-SCRAMBLED channels, while viewing ONLY NON-SCRAMBLED channels
- timed, multi-channel, multi-event recording (i.e. ability to program VCR to record a movie on channel 5 at 6 p.m., and then a second program on channel 26 at 8 p.m.)
- full use of the TV remote control
- full use of by the VCR remote control

Note: This illustration is useful if the non-cable compatible VCR has a remoe control but the TV doesn't. Illustration #25 is superior for VCRs with bypass circuitry

NECESSARY DROP LEVEL: +5dBmV

ILLUSTRATION # 18



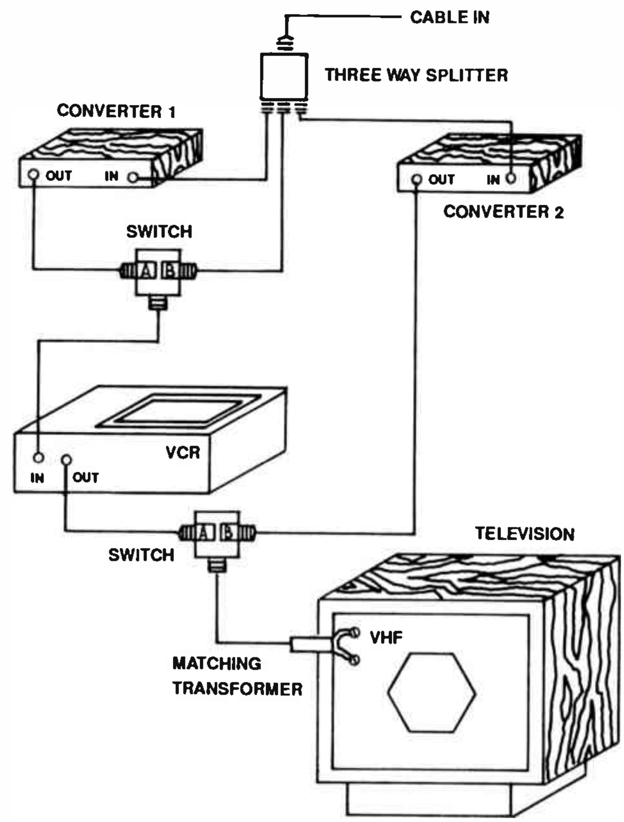
Allows:
- recording of ANY channel, while viewing ANY channel
- timed, multi-channel, multi-event recording (i.e. ability to program VCR to record a movie on channel 5 at 6 p.m., and then a second program on channel 26 at 8 p.m.) of NON-SCRAMBLED CHANNELS ONLY

Precludes:
- channel selection by the TV remote control
- channel selection by the VCR remote control

Note: use of converter remote control will affect both converters simultaneously

NECESSARY DROP LEVEL: +7dBmV

ILLUSTRATION # 19

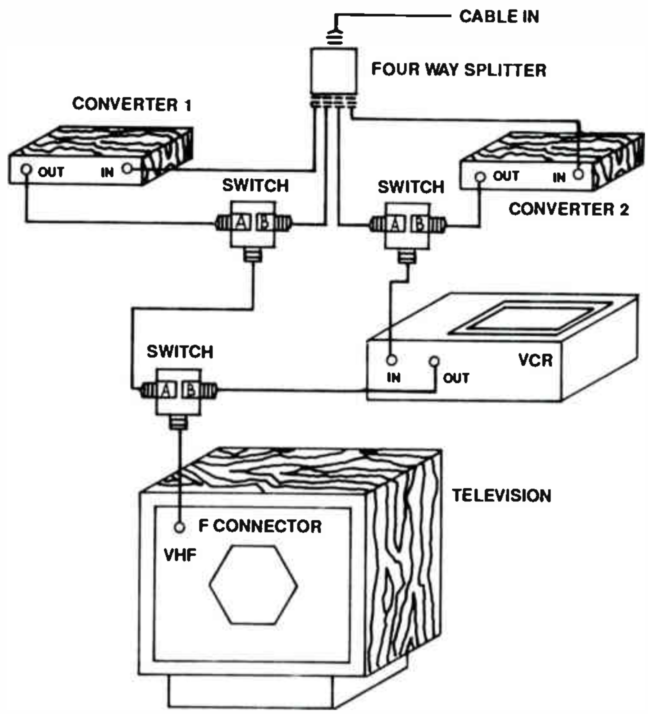


Allows:
• recording of ANY channel, while viewing ANY channel

Allows (when VCR in non-converter, bypass mode):
• timed, multi-channel, multi-event recording (i.e. ability to program VCR to record a movie on channel 5 at 6 p.m., and then a second program on channel 26 at 8 p.m.) (NON-SCRAMBLED CHANNELS ONLY)
• channel selection by the TV remote control
• channel selection by the VCR remote control

Precludes (on scrambled channels):
• timed multi-channel, multi-event recording, use of TV or VCR remotes
Note: use of converter remote control will affect both converters simultaneously
NECESSARY DROP LEVEL: +7dBmV

ILLUSTRATION # 20

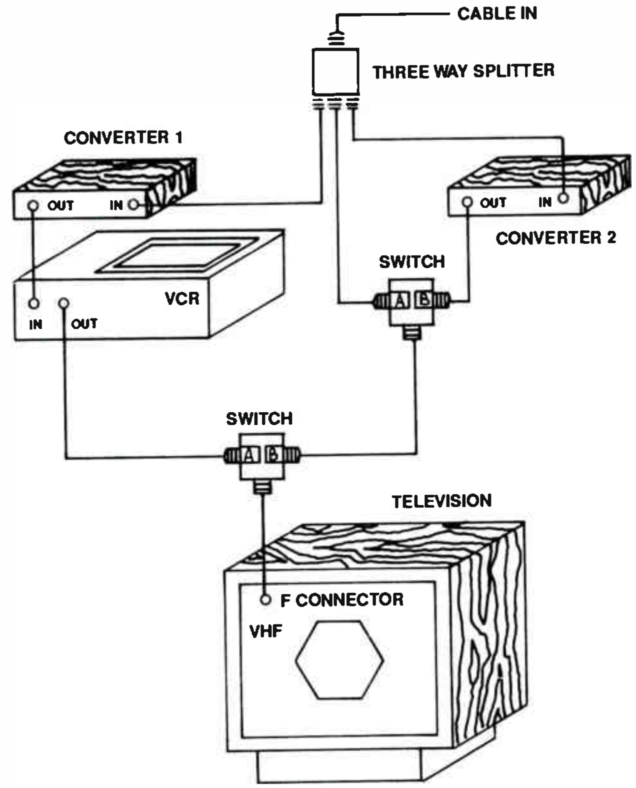


Allows:
• recording of ANY channel, while viewing ANY channel

Also allows (for NON-SCRAMBLED CHANNELS ONLY):
• timed, multi-channel, multi-event recording (i.e. ability to program VCR to record a movie on channel 5 at 6 p.m., and then a second program on channel 26 at 8 p.m.)
• full use of the TV remote control
• full use of the VCR remote control

Precludes:
• timed multi-channel, multi-event recording, use of TV or VCR remote control on SCRAMBLED CHANNELS
Note: converter's remote control will affect both converters simultaneously
NECESSARY DROP LEVEL: +7dBmV

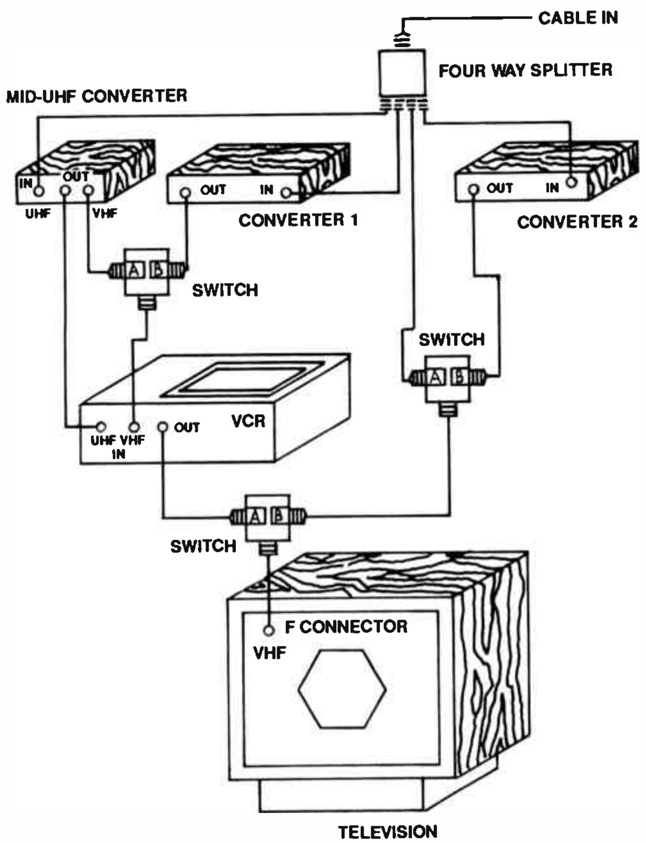
ILLUSTRATION # 21



Allows:
• recording of ANY channel, while viewing ANy channel
• full use of the TV remote control

Precludes:
• timed, multi-channel, multi-event recording (i.e. ability to program VCR to record a movie on channel 5 at 6 p.m., and then a second program on channel 26 at 8 p.m.)
• use of TV remote control for SCRAMBLED CHANNELS
• channel selection by the VCR remote control
Note: converter's remote control will affect both converters simultaneously
NECESSARY DROP LEVEL: +7dBmV

ILLUSTRATION # 22

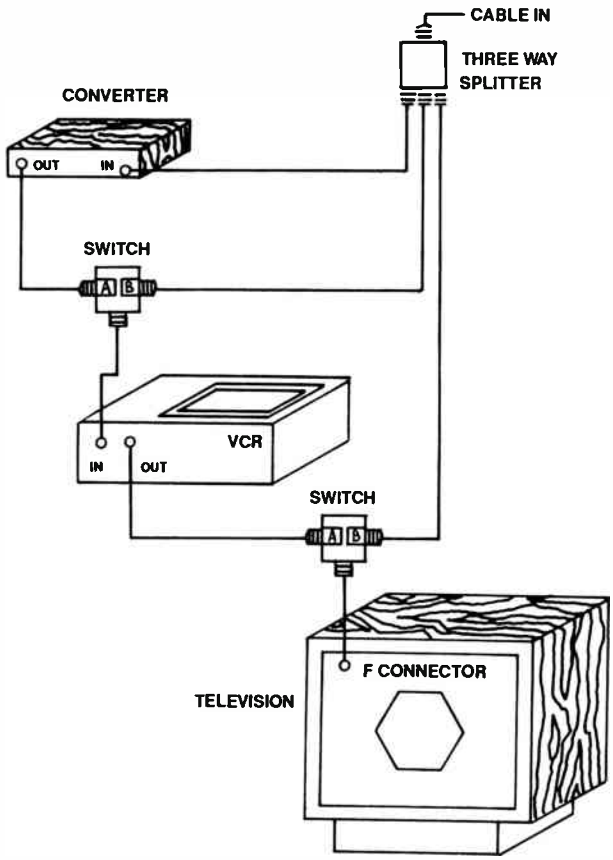


Allows:
• recording of ANY channel, while viewing ANY channel

Also allows (for NON-SCRAMBLED CHANNELS ONLY):
• timed, multi-channel, multi-event recording (i.e. ability to program VCR to record a movie on channel 5 at 6 p.m., and then a second program on channel 26 at 8 p.m.)
• full use of the TV remote control
• full use of by the VCR remote control

Precludes:
• timed multi-channel recording, use of the TV or VCR remote control on SCRAMBLED CHANNELS
Note: converter's remote control will affect both converters simultaneously
NECESSARY DROP LEVEL: +7dBmV

ILLUSTRATION # 23



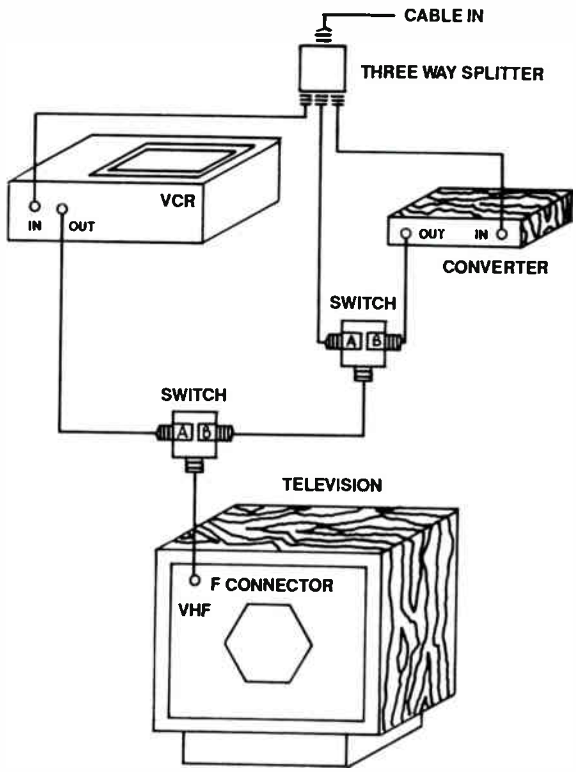
Allows:
- recording of ANY channel, while viewing A NON-SCRAMBLED channel

Also allows (for NON-SCRAMBLED CHANNELS ONLY):
- timed, multi-channel recording (i.e. can program VCR to record a movie on channel 5 at 6 p.m., and then a second program on channel 26 at 8 p.m.)
- full use of the TV remote control
- full use of the VCR remote control

Precludes:
- timed multi-channel recording, use of TV or VCR remote control for SCRAMBLED CHANNELS

NECESSARY DROP LEVEL: +7dBmV

ILLUSTRATION # 24



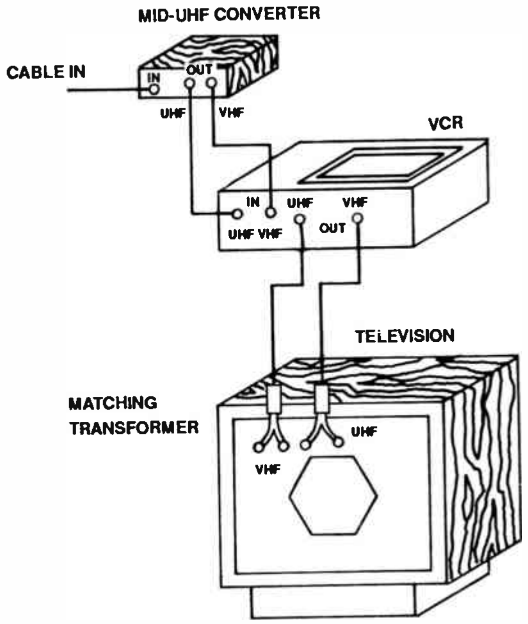
Allows:
- recording of A NON-SCRAMBLED channel, while viewing ANY channel

Also allows (for NON-SCRAMBLED CHANNELS ONLY):
- timed, multi-channel recording (i.e. ability to program VCR to record a movie on channel 5 at 6 p.m., and then a second program on channel 26 at 8 p.m.)
- full use of the TV remote control
- full use of the VCR remote control

Precludes:
- timed multi-channel, multi-event recording, use of TV or VCR remote control for SCRAMBLED CHANNELS
- recording of scrambled channels

NECESSARY DROP LEVEL: +7dBmV

ILLUSTRATION # 25



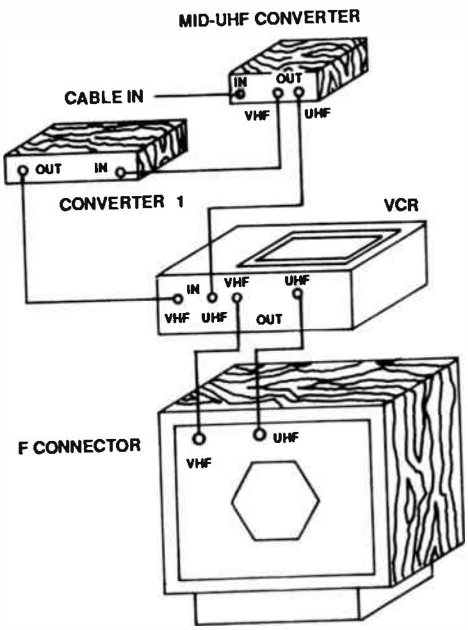
Allows:
- recording of NON-SCRAMBLED channel, while viewing A NON-SCRAMBLED channel

Also allows (for NON-SCRAMBLED CHANNELS ONLY):
- timed, multi-channel, multi-event recording (i.e. ability to program VCR to record a movie on channel 5 at 6 p.m., and then a second program on channel 26 at 8 p.m.)
- full use of the TV remote control
- full use of the VCR remote control

Precludes:
- recording of scrambled channel while viewing a scrambled channel
- timed multi-channel, multi-event recording, use of TV or VCR remote control on SCRAMBLED CHANNELS

NECESSARY DROP LEVEL: +3.5dBmV

ILLUSTRATION # 26



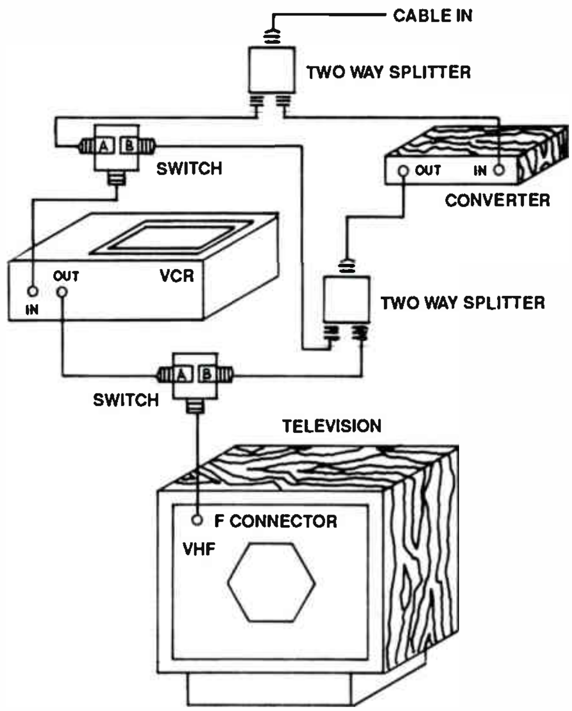
Allows:
- recording of ANY channel, while viewing A NON-SCRAMBLED channel

Also allows (for NON-SCRAMBLED CHANNELS ONLY):
- timed, multi-channel, multi-event recording (i.e. ability to program VCR to record a movie on channel 5 at 6 p.m., and then a second program on channel 26 at 8 p.m.)
- full use of the TV remote control
- full use of the VCR remote control

Precludes:
- timed multi-channel, multi-event recording, use of TV or VCR remote control on SCRAMBLED CHANNELS

NECESSARY DROP LEVEL: +0dBmV

ILLUSTRATION # 27



Allows:
- recording of ANY channel, while viewing THE SAME channel
- recording of ANY channel, while viewing a NON-SCRAMBLED channel
- recording of a NON-SCRAMBLED channel, while viewing ANY channel

Also allows (for NON-SCRAMBLED CHANNELS ONLY):
- timed, multi-channel, multi-event recording (i.e. ability to program VCR to record a movie on channel 5 at 6 p.m., and then a second program on channel 26 at 8 p.m.)
- full use of the TV remote control
- full use of the VCR remote control

Precludes:
- timed multi-channel, multi-event recording, use of TV or VCR remote control on SCRAMBLED CHANNELS

NECESSARY DROP LEVEL: +7dBmV

Chapter Three-Ingress/Egress Discussion

Analysis of Ingress/Egress Issues in the Home:

Ingress and egress can be found at any device between the cable drop and the viewer, including the TV receiver itself. Ingress, also known as direct pickup or DPU, can be defined as any undesirable signal induced on the cable from an electro-magnetic environment outside the cable system. Egress is defined as any signal originating within the cable being radiated to the outside environment from the cable or any device connected to it.

Ingress

Ingress is not limited to the near proximity of TV transmitting sites, it has been observed more than 50 miles from the source of the signal. Sources of ingress can be many, but high power TV transmitting stations, amateur radio and private and public safety land mobile radio operations are the most common sources of ingress. Field intensities in excess of 1 volt/meter have been recorded within two miles of TV stations. Cable channels 2-13 and 18-21 are most often affected. Early TV receivers offered virtually no protection from ingress; this led cable operators to use converters to overcome the effects of DPU.

More recently, TV receiver manufacturers began offering "cable-ready" receivers for sale; these are distinguished by the ability to tune the unique cable channels in the mid and super bands. While the 300 Ohm twinlead, used between the antenna terminals and the tuner in earlier sets, was often replaced by F-fittings and coaxial cable, the shielding was often not adequate to operate satisfactorily in most urban environments.

A test to measure the amount of ingress has been developed. All connections are removed from the device to be tested. A signal level meter is connected to the input connector of the device. The level of ingress can be measured directly on the signal level meter while the tuner on the device under test is operated over all channels. The highest level observed should be recorded; the relative impairment can be determined by taking the ratio of signal on the cable to the level recorded from the meter. For example, if the signal from the cable is 0 dBmV and the level recorded from the meter is -30 dBmV, the Carrier-to-Ingress ratio is 30 dB. If the interfering signal is another TV signal, the interference should be suppressed at least 45-50 dB; if the interfering signal occupies a narrow band of frequencies, such as from a two-way radio, the interference should be suppressed at least 55-60 dB.

Measurements like those just described have been made on 1984 and 1985 model TV receivers, VCRs and CATV converters. The ambient field intensity ranged from 133 mV/m to 1.2 V/m. Ingress on the TV receivers ranged from -44 dBmV to -2 dBmV, VCRs ranged from -30 dBmV to -20 dBmV and CATV converters ranged from -46 dBmV to -32 dBmV. In spite of the foregoing, experience has shown VCRs are more likely to experience ingress as a result of their poorer shielding integrity. Older receiving equipment, especially that employing 300 Ohm twinlead for the antenna connection, experiences ingress to a much greater degree. Levels from nearby transmitters have been recorded as high as +50 dBmV on some equipment. FM tuners which have built-in antennas, or are coupled to the power line for an antenna, are especially prone to high levels of ingress. When connected to a cable system, this equipment causes back-feeding of the signals into the cable system. The EIA/NCTA Joint Engineering Committee Interface Working Group is expected to issue an interim standard which will increase the field intensity in which TV receiving equipment is to operate satisfactorily from 100 mV/m to 1 V/m.

In some instances, ingress in the home has been so severe that not only is the affected subscriber's viewing disrupted, but signals are back-fed into the cable distribution system. In these cases, everyone downstream from the affected subscriber also experiences the effects of ingress. In these cases, the operator will often try to use a converter as an isolation device to prevent back-feeding; where this is not practical, special amplifiers which exhibit good back-front isolation can be installed in the line to reduce or eliminate back-feeding.

CATV operators selecting components for installation between the subscriber tap and the TV receiver should take care to select products with adequate protection from the effects of ingress. In addition to the usual care in choosing cable and connectors, the operator should also take care in selecting A-B switches, two-way splitters, VCR switch units and converters.

Ingress can occur from standard broadcast radio stations operating in the 550-1620 Khz band. This ingress can be exacerbated when CATV distribution and drop cable shields act like long wire antennas increasing signal intensity at the connected devices. Interference has been observed in both TV sets and VCRs. Although this type of interference is hard to eliminate, its effects can be minimized by good local grounds at the affected equipment.

Egress

Egress can result from inadequate shielding, either from equipment provided by the cable operator or from subscriber-owned equipment. In general, emissions from CATV systems must be limited to 20 μV/m at three meters. Any operator using channels in the aeronautical bands (108-137 MHz and 225-400 MHz) is required to monitor all portions of the cable system annually; any egress in excess of 20 μV/m must be identified and corrected. Under certain conditions and after 1990, operators must monitor all portions of the system on a quarterly basis.

The FCC Rules assign responsibility for egress from cable systems and subscriber-owned equipment connected to it as follows:

> 76.617 Responsibility for receiver-generated interference
> Interference generated by a radio or television receiver shall be the responsibility of the receiver

operator in accordance with the provisions of Part 15, Subpart C, of this chapter: Provided, however, that the operator of a cable television system to which the receiver is connected shall be responsible for the suppression of receiver-generated interference that is distributed by the system when the interfering signals are introduced into the system at the receiver.

Even though the subscriber might be responsible for correcting problems with subscriber-owned equipment, the cable operator is faced with the often difficult task of isolating the source of egress. If the cause of the egress is inadequate shielding in a TV receiver or VCR, the owner is often precluded from using the equipment as it was intended; e.g. a "cable-ready" TV receiver or VCR that cannot be connected directly to the cable. Generally, as ambient signal levels increase, ingress will become a problem before egress will. This is true because taps and splitters used by the cable industry have inherent isolation, usually at least 20 dB. Therefore, DPU will become visible on a customer's TV set before it gets high enough to affect the neighbors. Systems will sometimes provide converters to some but not all subscribers. Those subscriber's TV sets not using a converter are usually connected directly to the cable. In cases where shielding in the TV sets is poor, cable signals radiated by the TV receivers can and do cause interference to licensed radio services such as amateur radio operators, fire, police and forestry services. CATV maintenance personnel need to be especially vigilant to find and control or eliminate this type of egress. If necessary, the offending drop should be disconnected until the egress can be eliminated.

It should be apparent many people are affected by ingress and egress; the cable operator experiences increased operating costs and deteriorated signal quality. If the offending equipment is relatively new, the dealer often experiences the wrath of a dissatisfied customer. The biggest loser of all is the cable customer who suffers from impaired service, often after paying a premium for special "cable-ready" equipment. If the cooperative efforts of the EIA and NCTA are successful, designers of new equipment will be cognizant of the cable environment and include shielding to make their products immune to the effects of the electro-magnetic environment.

Following, on the next page, is a document which is suitable for use by field personnel who are faced with problem solving when equipment is connected directly to the CATV system. A complete treatment of all problems encountered would be voluminous, so this will only serve as a guide. It does not treat every possible situation which might be encountered.

Technical Guidelines for Direct Connection to Customer Owned Equipment: Introduction

Surveys have shown the number of cable-ready television sets have increased exponentially in recent years; we estimate about one-third of our customers now own a receiver capable to tuning most or all of our non-scrambled channels. These sets are selling at a rate of 10 million per year. So we expect the number of customers desiring to connect directly to the cable will increase substantially in the next few years. Concurrently, the number of VCRs sold has increased remarkably. CATV converters and converter/descramblers are a barrier to using the features of these consumer devices. We desire to accommodate and aid our customers in using their own equipment to tune CATV channels whenever possible; at the same time the CATV operator can reduce his investment in owning and maintaining converters.

However, in accommodating direct connections to the cable we must establish policies and procedures to protect the quality of the service we provide. These guidelines are intended to protect the customer and the CATV network from service problems and picture impairment which could be caused by the direct connection of inadequately shielded equipment.

While a converter/descrambler or a descrambler will continue to be necessary for anyone receiving scrambled signals, use of plain converters can be reduced and perhaps eliminated in the future. Based on survey data, we believe one-third of our basic customers may not require a converter to receive our service.

Unfortunately, only a few of the cable-ready television receivers and VCRs are completely satisfactory for direct connection to the cable system. While more present day consumer products designated as "cable-ready" can tune most or all CATV channels, few, if any, have adequate shielding for signal ingress and egress. Egress can result in re-radiation of CATV signals in excess of FCC limits. (Section II, chapter one contains definitions and a general discussion of these mechanisms.)

The most common problem results from signals from television stations and mobile radios entering the equipment and disrupting customer viewing. The phenomenon is known as ingress or Direct Pick Up (DPU). Disruption can take two forms: echoes and other interference and/or beats in the connected television set or VCR. This can have an impact on the owner of the equipment. The more disturbing effects occur when DPU is so intense so as to feed DPU back into the cable system from poorly shielded equipment. Not only can this impair reception for the equipment owner, but for every other customer downstream from that location. Diagnosis and elimination of this "back fed" DPU can be very difficult and time consuming, especially if there is more than one location where DPU is being introduced on the system.

It is the purpose of these guidelines to establish procedures to prevent DPU from impairing the viewing for the customer where the direct connection is made, and to prevent DPU from direct connections from back feeding into the cable system.

Many of these situations already exist and the number can be expected to increase as sales of cable compatible television receivers and VCRs continue.

Installation and Maintenance of Basic Service

A. Identification and Prevention of Back Feeding

(1) Discussion

Most CATV passive devices have at least 20 dB isolation between any two ports; this is depicted on Figures 1 and 2.

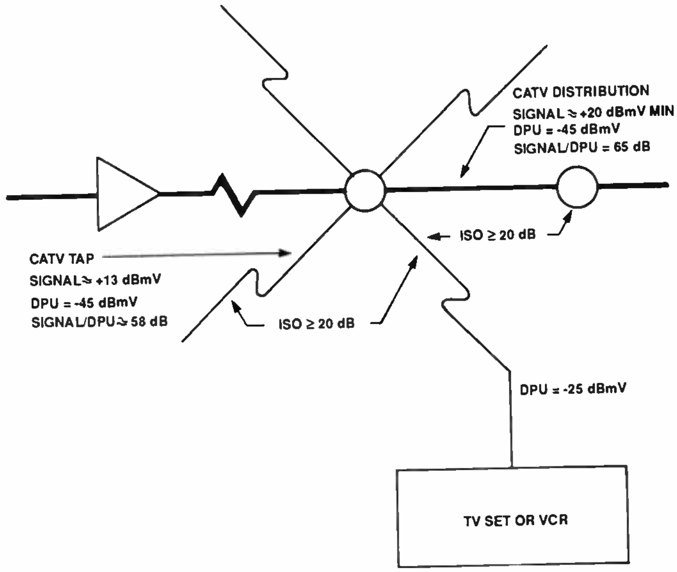


FIGURE 1

TYPICAL TAP ISOLATION

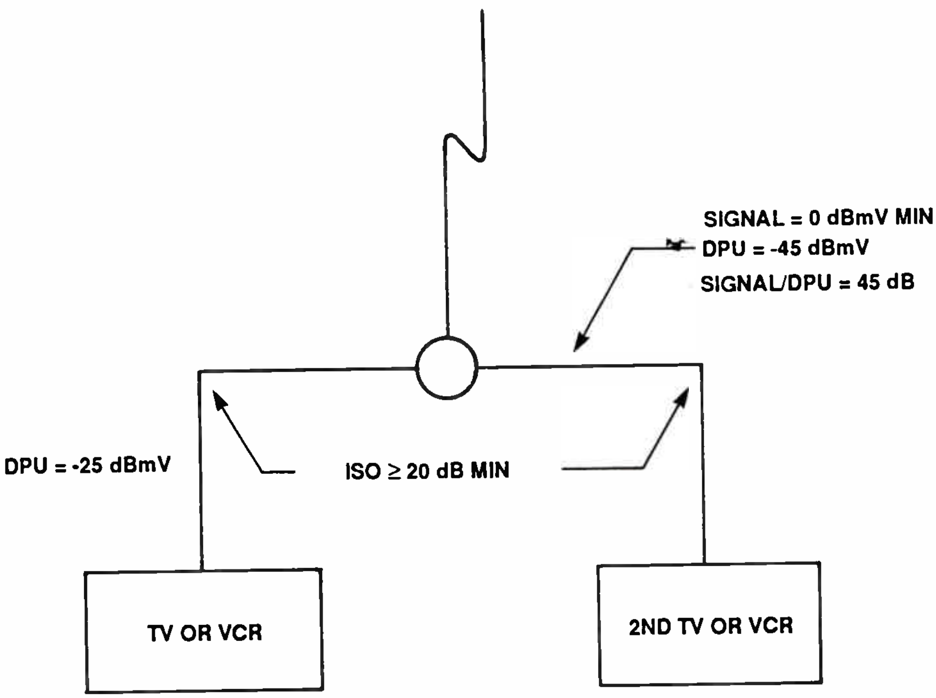


FIGURE 2

TYPICAL SPLITTER ISOLATION

DPU from television stations, which is manifested as a sync bar or echo in the picture, should be suppressed at least 45-50 dB if DPU is not to produce visible echoing. If the passive components provide a minimum of 20 dB isolation, then DPU levels from television sets and VCRs should be less than -25 dBmV. This assumes drop levels are 0 dBmV. Beats caused by other services such as land mobile radios and television stations off frequency from cable channels should be suppressed 50-55 dB if they are not to cause visible beats in the picture. In these cases, levels at receiver and VCR connectors must be less than -30 to -35 dBmV if they are not to cause harmful back feeding.

When DPU at the antenna terminals exceeds the limit, a converter or isolation amplifier is needed to reduce the amplitude of the DPU signal back fed into the CATV system. The amplifier has modest forward gain (approximately 10 dB), but has at least 45 dB attenuation from the output port to the input port. It should be understood, the isolation amplifier only protects the CATV network from back feeding, it will have minimal or no effect in reducing echoing in the receiver or VCR; if echoing is present as a result of DPU in the VCR or receiver, only a converter will eliminate the phenomenon.

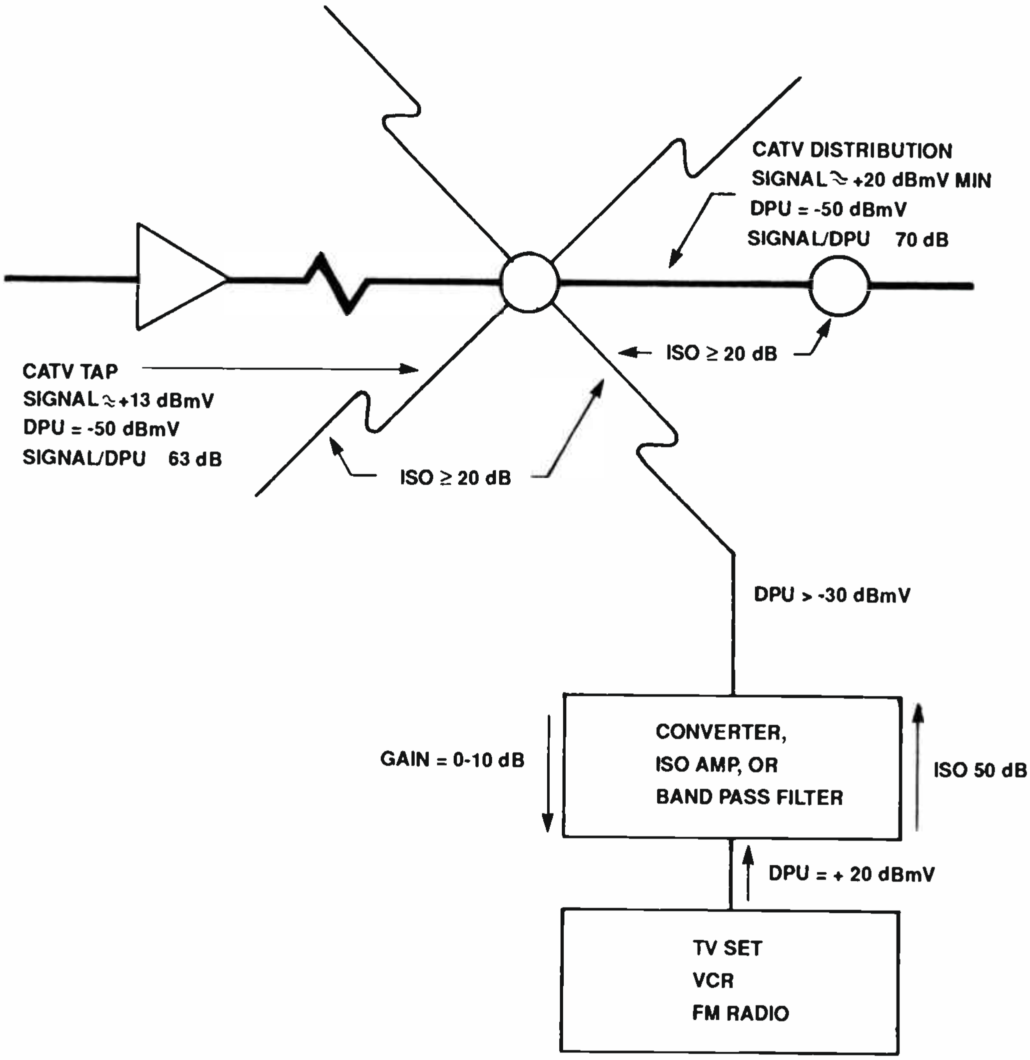


FIGURE 3

ISOLATION AMPLIFIER OR CONVERTER FOR ISOLATION

Although a complete discussion of locating and curing back feed problems in the distribution plant is beyond the scope of this document, it should be mentioned that single sources on a given trunk or distribution cable can be difficult to locate and isolate, multiple sources of back feeding can be very difficult to isolate. Technicians will necessarily have to use television sets to observe and clear sources of back feeding. As more customers begin direct connection, the number of back feeding incidents can be expected to increase substantially.

(2)Diagnosis

- Remove all cable connections, and connect a SLM to the input terminal of the television receiver to be connected directly to the system. Keep the test lead as short as possible and do not use push on connectors.
- Measure the amplitude of all local VHF off-air channels and note highest level.
- If a VCR is also to be connected directly to the cable, measure levels at the input terminal on it also.
- If the measured level exceeds -25 dBmV on any channel(s), the direct connection to the CATV system should not be made; a converter or isolation amplifier must be connected between the customer's equipment and the CATV system.
- Repeat the procedure for each outlet not using a converter. If an amplifier is installed, the preferred location is on the input side of any splitters that may be installed. With an amplifier located at the splitter input, it would be possible to connect equipment directly to any outlet without installing additional amplifiers. If the splitter is installed in a location where an amplifier connected to its input would be exposed to the elements, then the amplifier should be installed between the splitter output and the television set. This will necessitate the use of a separate amplifier for each outlet. If the need is demonstrated, we will begin development of a weather tight version which can be cable powered that could be installed before the splitters. This will necessarily include concurrent development of a power passing splitter.

B. Identification and Elimination of DPU in Television Receivers and VCRs

(1) Discussion

This phenomenon will be the one most often encounetered since the inherent isolation of the system passives provide at least 20 dB of protection to other equipment connected to the cable. Measurements have shown the worst victims of DPU in present day equipment will be VCRs. Standards to raise the shielding of television receivers and VCRs are being promulgated by the EIA and NCTA. As they are placed in practice, we hope to see improvement in television receiver and VCR performance.

Unlike VHF broadcast television signals, which are ubiquitous, amateur radio and mobile service signals tend to be localized to an area in the near vicinity of the transmitter. Isolation of signals from mobile radios can be made by observing the picture when the offending unit is transmitting. This is almost impossible when the offending transmitter is in a vehicle. While DPU from television stations should be suppressed at least 45-50 dB below the television carrier, other types of interference need to be suppressed at least 55-60 dB.

(2)Diagnosis

- Disconnect all inputs from television receivers under test and terminate input connector if possible.
- Tune the receiver's channel selector to each local VHF channel and look for the presence of a picture.
- If a picture is observed on any channel, remove the terminator, connect the cable directly to the television receiver and look for a sync bar, echo or co-channel in the picture.
- If no sync bar, echo or co-channel is present, then the cable can be connected to the television receiver; if an echo is observed, proceed to the next step.
- Measure the drop level; if it is less than +5 dBmV, then connect an isolation amplifier between the drop and the television receiver. This is to prevent overloading of the amplifier and/or the television receiver.
- Look for a sync bar, echo or co-channel in the picture. If it is still present, it will be necessary to use a converter.
- If a VCR is also connected, the preceding test should be repeated with the VCR output connected to the television receiver and the VCR input terminated.

C. Other Connected Devices

(1)Discussion

Other types of equipment connected to the cable system can also cause DPU problems. Often equipment designers are not cognizant of potential DPU problems from inadequate shielding. FM receivers, burglar alarm equipment, modems, VCR switch boxes, computers and games are examples of equipment which is often connected directly to the cable that can cause problems.

Some of this equipment subjects CATV service personnel to two types of problems: DPU and the associated back feeding, and egress. In many instances, device shielding is so poor, emissions from the device exceed the 20 μV/m at 3 meters limit established by the FCC. While Part 76.617 of the Rules holds the customer responsible for emissions from most or all customer owned equipment, cable maintenance personnel are faced with the difficult task of finding and isolating the offending equipment.

Use of special band pass filters and/or isolation amplifiers can help reduce or eliminate back feeding to other outlets on the same dwelling and the cable distribution plant. With their inherent 10 dB gain, use of isolation amplifiers can make the signal leakage problem worse.

If this if found to be the case, consideration should be given to installing attenuator pads to reduce levels to the offending device, however care should be taken to keep levels well above the minimum needed for reliable operation of the equipment.

(2)Diagnosis

If the equipment to be connected is to be used with a television receiver or VCR (such as A-B switches, VCR switches or games) use the procedures described in chapter two.

If the equipment to be connected is used for other services, such as FM radio or data receivers (like X*PRESS), the procedures should be as follows:

- Disconnect all inputs from the equipment to be measured and connect a SLM to the input connector. Keep the test lead as short as possible and do not use push-on connectors.
- Measure the amplitude of all local VHF off-air channels and measure the highest level.
- If the highest level exceeds -25 dBmV on any channel, direct connection to the cable system should not be made; an isolation amplifier should be connected between signal splitter or tap and the equipment to be connected. If the equipment is an FM receiver or will receive signals in the FM band, then an isolating bandpass filter can be used to reduce or eliminate back-feeding.
- If the recorded levels exceed -25 dBmV, then the potential for harmful back-feeding exists. If the recorded levels exceed the -25 dBmV limit by only a small amount, television receivers served by the same splitter or tap should be checked for a sync bar, echo or co-channel. If it is observed, then the equipment being measured should not be connected to the cable system.
- Alternatively, an isolation amplifier with 60 dB or more isolation could be tried if they are available.

D. General Discussion

As the use of cable-ready receivers, VCRs and other ancillary equipment increases, we can expect to experience a corresponding increase in related service requests. Effective training of all personnel in dealing with related problems can be beneficial to both the cable company and the customer. The cable company can enjoy reduced costs while the customer can get the most benefit from the cable service and the equipment to be purchased.

It is best for everyone if problems can be handled by the telephone whenever possible. Therefore, the importance of training office personnel cannot be over-estimated. Examples of questions which might be used by CSRs to diagnose and isolate problems are shown below:

- Did you buy a VCR and connect it?
- Did you move your television receiver to a different location in the room?
- Have you connected an FM receiver to the cable?
- Have you installed any splitters or cable from a source other than the CATV operator?
- Did you connect a different television receiver to the cable?
- Is the isolation amplifier plugged in?

The details of a CSR training program are beyond the scope of this policy; they will require the cooperative efforts of everyone involved to be effective.

Very Important: Every location not using a converter needs to be identified in the billing system. This will help prevent future service calls and will help CSRs identify problems resulting from direct connections.

In the future, consumer equipment will be designed and manufactured with cable in mind. Then CATV customers can use all their features without the resultant degradation in service quality being experienced now. Hopefully, this document will help during this transitional period.

Appendix A-Summary of Scope and Progress of other Industry Groups

RF Cable Interface and Decoder Interface Working Groups: Introduction

Standards committee progress is often painfully slow. To a newcomer, especially someone accustomed to the "fast lane," this activity can be quite frustrating. There are several points to be made about this. Firstly, if cable interface and decoder interface standards were easy to achieve, they would have been agreed to a long time ago. There has been pressure for an extended period of time. Secondly, the issues being settled are delicate points involving trade-offs which impact the economics and performance of two industries. These two industries have a history short on cooperation and long on confrontation. Fortunately, the trend toward cooperation is on the up swing.

At first blush, it would seem difficult to find two industries with more reason to cooperate than the Cable Television Industry and the Consumer Electronics Industry. Better pictures should enhance satisfaction in cable service and better choice should increase the desire for quality images. Most of the difficulties to date have been due to a lack of information and misunderstanding. Open, honest, and frank contacts should be helpful to all.

Structure

In 1982, the National Cable Television Association, NCTA, and the Electronic Industries Association, EIA, formed a Joint Engineering Committee to discuss technical issues which impact both industries. The first order of business of that committee was to create a channelization standard for frequency assignment. After considerable debate, the committee recommended the plan which became an EIA Interim Standard for one year. It has recently emerged from this probationary phase to become an official recommended standard.

It is important to note that these standards are voluntary standards. Neither the NCTA nor the EIA have enforcement powers. Adherence to the standard depends on the good faith of the companies involved.

After the channelization standard, two Working Groups were formed to consider an RF cable interface standard and a decoder interface standard. Shortly after formation of the Decoder Interface Working Group, it was discovered that the EIA R-4 Group had its own decoder interface group. Seeing little point in duplication of effort, the Joint Committee decoder working group disbanded.

Attitudes

An important reason for the successes of the Joint Committee has been a change of attitude on the part of the participants. In the past, cable/consumer electronics relations were marked with finger pointing and name calling.

Very important technical trade-offs were the focus of arguments which had significant economic impact. This behavior has been replaced with a realization of the importance of customer satisfaction. The customer/subscriber must be satisfied if the two industries are to prosper. It is pointless to try to shift blame. The customer/subscriber demands satisfaction from both industries.

A significant step in the right direction has been the relaxation of what has been called the "70 dB syndrome." In the past, the cable industry has tended to demand that any potentially harmful phenomenon be suppressed by 70 dB. The consumer electronics industry has become offended by this approach since this degree of suppression is difficult to measure for most parameters and impossible to achieve in practice. The result has been near zero progress.

The "70 dB syndrome" has been replaced with a much more reasoned discussion of actual problems. A phased approach has been recommended which sets achievable targets, timed to cover frequencies ranges as they are implemented in the cable practice over time. When a cable representative believes there is a need for a specification which the manufacturers feel can't be presently achieved, a tutorial is included. This motivates the manufacturers to strive for solution in future designs.

The defensive guards have been lowered and technical people are listening to one another in open dialog. People are trying to understand each others problems and accommodate.

Occasionally, a new member joins the committee and makes moves in the old ways. The committee brings the newcomer in line and progress resumes.

The RF Cable Interface, IS-23, Working Group

The RF Cable Interface Working Group's major concern is the Cable Compatible Consumer Product, such as the Cable-Ready TV. The committee very quickly got over the issues of connector type, impedance, and signal levels. A more serious problem has been Direct Pick Up (DPU) of broadcast signals.

The committee has taken voluntarily committed receivers and measured them in a T.E.M. (Transverse Electro-Magnetic) cell. The tests were funded by the EIA, and each participating manufacturer received data on his products. A non branded table of data was supplied for committee use. Sets ranged in performance from satisfactory behavior to sets with considerably lower levels of tolerance. Manufacturers have been carefully considering the art of radiation immunity as it applies to their products. Progress has been made.

The most significant aspect of this work is a ten-times increase in the direct pick up specification. Under this proposal, a complying product must not show noticeable degradation of performance in the presence of broadcast electromagnetic fields having a strength of one volt per meter. The previous specification came from the Canadian standard and was based on one-tenth of a volt per meter. It is expected that the proposal will cover 80 percent to 90 percent of all cable DPU problems. The remainder will require a converter to completely solve the problem.

It is important to realize that the TV receiver manufacturers have taken on a significantly greater burden with this new standard. This level of performance will be difficult to achieve. However, the customer/subscriber will benefit. This achievement demonstrates that two industries can work together to resolve difficult issues when a cooperative approach is employed.

Cable converter product has also been measured in T.E.M. cells. These tests were funded by cable volunteers and the NCTA. The goal was to understand techniques for implementing the converter's seemingly better performance.

A recurring problem in this committee work is the separation of performance standards from interference standards. It is felt that the regulation of performance is best left to the marketplace. However, the control of interference is a bona fide standards matter. Four kinds of interference have been considered in order of increasing severity:

1. Interference with the product's own performance
2. Interference with other products in the same home
3. Interference with other subscriber's reception
4. Interference with other users of the electromagnetic spectrum, such as aircraft navigation and communications radio.

The Long Term Future

The logical conclusion for the trends in CATV home terminals is for subscriber ownership. This is the best outcome for nearly all concerned. The subscriber has his favorite hardware relationship: ownership. Unlike his European cousin, the US TV receiver user has historically preferred ownership to rental. The same should apply to the decoder hardware. This will especially be the case if he can own the tuner, remote control, and other convenience features as part of the bargain. These later goals are achieved by having the descrambler come after the TV receiver's tuner. There are two ways of accomplishing this. One way has a "decoder interface plug" on the back of the TV receiver (or VCR, etc.) into which the subscriber owned (or leased) descrambler fits. The second method is to build the decoder directly into the receiver by the receiver manufacturer. The latter will happen if there is a de facto or actual decoder standard which would permit free movement from cable system to cable system. If this is not achieved for whatever reason, then plug-in, re-sell, or swap devices will be required.

The principal entity which is disturbed by this approach is the manufacturer of home terminals who doesn't also make TV receivers. He sees more than half of his "value added" eliminated. But from the bigger picture, the waste and inefficiency of having a tuner, remote control circuits, and related components in the home terminal, only to have them duplicated in the TV receiver, is undesirable.

From the cable operator's point of view, the program protection method must ensure that subscribers cannot defeat the system and receive the programming for free. Another interested party in all this is the programming producers. If they believe their product can be stolen, they will not make it available to the cable operator. The cable operator realizes that the would-be pirate has nearly unlimited time and resources at his disposal. The system which meets this test will be robust indeed. Once this assurance is obtained, the cable operator will gladly give up the capital requirements caused by the need to supply the descramblers. The money would be better invested in more programming, service-enhancing facilities, or home terminals that provide new services to subscribers.

The Decoder Interface, IS-15, Working Group

The Decoder Interface Working Group is not a Joint Committee effort, rather it is entirely an EIA activity. In spite of this, there has been significant friendly dialog between the two industries. Cable participation in this committee work has been welcomed. Specifically, there have been cable industry contributions to the design and testing of the interface plug.

The Interface Plug is also called the Cenelec 20 pin plug. Even with twenty pins, the committee wished it had more! Composite video in and out is provided. RGB inputs are optional. A data line pair to communicate logical instructions such as EIA Home Bus signals, has been provided. At some day in the future, it will be possible to connect consumer electronics products to a master home system. Fast-blank for text insertion and decoder restored sync input pins are provided. Devices with the interface plug are intended to be optionally "daisy chained." That is, devices may be designed in such a manner as to be connected in series, allowing interaction between devices and an extension of product into an easy to use, consumer friendly system.

The most serious and controversial issue regarding the interface plug is automatic gain control (AGC) design philosophy. AGC has two modes of operation with strongly conflicting demands, acquisition and stable operation. The circuit time constants must be different for these two modes. Additionally, the AGC time constants of the cable converter and television receiver must be significantly different so one is dominated by the other. If the two time constants are close together in value, oscillations may result. The problem is that some receiver manufacturers are using long time constants while others have decided upon short time constants. An important difficulty to appreciate is the fact that in scrambled mode, most systems suppress horizontal sync pulses. For decades, television AGC design philosophy has depended on finding and accurately measuring sync pulse parameters. The two processes are in fundamental conflict. Without sync pulses, there is a tendency for the amplifiers to increase gain and saturate. This crushes the signal and ensures that sync pulses will never be found. This "lock-out" condition is a disaster which must be avoided. It is most complicated in systems which suppress sync pulses in the vertical interval as well. This phenomenon is extremely non-linear and not well understood. Some engineers insist that there is no theoretical basis for these systems to ever work! They claim that each time the system achieves synchronization and decoding, a fortunate electrical accident has occurred!

One serious complication is the fact that AGC expertise in television receivers is a scarce resource. There are probably less than twenty experts in the entire world. The subject is very complex with almost no published technical literature. An engineer becomes an expert in this field through years of apprenticeship to an existing expert. A second complication is that competitive performance between manufacturers' products is largely determined by AGC characteristics. To someone who appreciates this, the committee interactions take on a whole new dimension. There is the careful guarding of secrets, the pained release of just enough information to make the interface plug system work, but the anxiety that too much may have been revealed to a competitor.

The Decoder Interface Working Group has had three field tests in ATC's cable systems in Denver, CO. Several TV receiver manufacturers and several decoder manufacturers participated with varying, but basically very good, results. The level of success exceeded expectations and re-energized the committee. At least one receiver manufacturer's engineers formed a strong alliance with a decoder manufacturer's engineers. Extensive cooperation and mutual sharing of information has resulted in a raising of the potential for success of these two companies. At least one other manufacturer took a very unfriendly, parochial approach in the first test which offended the other participants. This has caused embarrassment to others at that company who have worked long and hard at trying to establish a record of cooperation and leadership. By the second test, this was corrected.

The best indication of the success of the field tests has been the lively interchange that took place afterwards, resulting in significant improvements in the proposed standard. The most interesting improvement is the proposal of an AGC time constant control pin which would yield control of the time constant to the decoder.

Current tests have concentrated on base band scrambling schemes because the interface plug connections do not include RF signals.

Committee agreement on the interim standard was achieved by mid-April 1986. The parent group approval process is essentially complete.

Upon completion of the Base Band Decoder Interface, the committee will turn its attention to two more issues: a) practical details of implementation of the standard and, b) potential of the standard to include an IF (Intermediate Frequency) connection.

Practical issues include the facilitation of testing of designs. To that end, the New Technologies department of ATC volunteered to host tests. Decoder manufacturers will supply encoders and decoders and Television receiver manufacturers will provide TV sets. Engineers will be welcome to use the laboratory to make measurements and conduct experiments. Confidentiality will be preserved by proper attention to ethical practices. Another practical issue is the promotion and promulgation of the standard. For that purpose the EIA and selected manufacturers had a hospitality suite at the International Conference on Consumer Electronics (ICCE) in Chicago June 4 through 6, 1986. ATC helped in equipping that suite. The ICCE is the principal technical conference for consumer electronics design engineers. Similar hospitality suites are contemplated for upcoming cable shows. Strategies for generating cable support of the Interface Standard are under consideration.

Both the EIA and the NCTA recognize that most of the scrambling systems displayed are not base band. The next order of business is to strategize a way of accommodating RF scrambling at IF. This may be done on a separate plug, or the signals may be descrambled at base band. Whether the return will also be at IF or through the base band plug at base band, will be determined by the committee. This work is expected to take no more than an additional six months, perhaps less because the issues are less complicated than the previous problems.

First availability to TV receivers incorporating the interface plug will likely be in late 1986.

The Committee Process

The committee has a life cycle of its own. At first there is a small group of attendees trying to make it happen. Slowly the group expands until so many attend that it is difficult to get anything done. After several months, those low on patience cease to attend. Decision-making picks up. Then some dramatic event such as a field trial takes place. Once again, attendance soars. A new danger to progress takes place. New members attend for the first time. They start questioning the fundamental philosophy. Old ground is revisited. The skillful chairman must maintain progress, yet not turn off the new attendees. The new attendees will have their say in the final standards approval process. They must not be alienated. As the committee reaches the end of its work, two forces come to conflict. Those who have put in years of work want to bring it to a close. Others who have been alerted to the committee's work by the expected issue of a new standard become alarmed. They see all kinds of threats to their interests and, of course, better ways to do the job, usually using advanced technology which wasn't available when the committee started its work. The committee chairman must manage these forces or total grid lock will result.

Another practical difficulty with committee work is the fact that the most likely contributors are industry experts and industry decision-makers. By definition, these individuals are very busy and in demand by their company's engineering departments and by other committees. Getting the right people involved is critical to success. Occasionally, a company's management's view of committee work is too parochial. Important contributors are denied permission to attend, or are not supported in this activity.

An important element of the committee process, is the mutual education of the two participating industries. Committee work is an excellent means of communication between experts in the cable and the consumer electronics industries. Well before an agreement on standards is reached, the TV receiver design experts are applying what they have learned from the committee work and are anticipating the new standard. This process makes timely introduction of product, based on the new standard, possible.

While it will be years before a significant penetration of product built around these standards takes place, those customers with an urgent need or desire will be able to purchase products in the second half of 1986. Thus, a timely impact will be made even though extensive use of the standard will take many years.

Thanks go to the EIA and the NCTA for their leadership in these issues. Special thanks to the EIA for sponsoring the meetings and to Tom Mock, of the EIA, in particular. The task would have been much more difficult, if not impossible, without his time and energy. And, of course, thanks to the committee participants for their participation and time away from home.

Conclusion

Progress is being made on two fronts, the RF cable interface and the decoder interface. Progress is slow and painful but essential if the customer/subscriber is to be provided with the maximum utility potential of the technology. These are long term solutions. But they will never arrive without heavy investment of energy and time in current committee work.

Consumer Electronics Bus Committee:

Introduction

The Consumer Electronics Bus Committee (CEBC) was formed by the Electronic Industries Association's Engineering Policy Council to recommend voluntary standards for what has been popularly called the Home Bus.

The Committee chose not use that name, but used the Consumer Electronics Bus (CEB) instead, because past use of the name Home Bus has inferred a purely digital environment. The standards under development now are for multiple media, some of which will use mixtures of analog and digital techniques.

The media for which standards are under development are:

1. The Power Line Bus (PLBUS).
2. The Wired Bus (WIBUS).
3. Infrared media for use in a single room (SRBUS).
4. Low Power RF (RFBUS).

At the heart of the CEBC standards development effort are a number of basic requirements:

1. From the consumer's point of view, extreme "ease of use" is required.
2. Future expansion for unknown uses built in.
3. Commonality of language across the media.

The methodology of the CEBC is to focus on systems and techniques proposed by member companies. Where there are no proposals forthcoming, consultants are used to gain a particular goal agreed upon by the Subcommittee responsible for it.

The Single Room Bus

The original single focus of this Subcommittee was the problem of proliferation of remote control systems: all using infrared media, not standardized, (and in some cases) not compatible. It was felt that further development of the Remote Control marketplace would be inhibited by further increase in the number of hand-held controllers as more products became remotely accessible. This original target we called the "Unified Remote Control System."

Upon consideration of the capability of the IR media, we realized that the SRBUS Standard must include the capability of remotely addressing the WIBUS and PLBUS, as well as for use as a Single Room LAN for unattended wireless communication between pieces of equipment within the room.

We were forced into these expansions because it was clear that the probability was very high that infrared would be used for these applications: the CEB standard would quickly become obsolete if we did not roll those obvious applications into it.

We also came to the conclusion that the new SRBUS Standard *must* be defined in a way that precluded interference by existing products. After all, it would be very difficult for the Chief Engineer of a manufacturing concern to make a decision to go to the new CEB Standard if it had demonstrable performance problems at the outset. At the same time, we have a strong bias toward establishing the standard in such a way that we minimize interference by the CEB to existing equipment.

The concept of a number of separate systems, using the IR media, operating more or less simultaneously in the room led to the definition of "Consumer Service Levels." These are descriptions of performance levels as seen by the consumer, not OSI levels.

Level 1:

Single, shared, one-way control channel services. User feedback or verification of control operation is only present in the form of the visible and/or audible response of equipment responding to user commands. Access to other CEB bus types may only be realized through active two-way "gateways" and not "bridges."

Level 2:

Single, shared two-way control channel services. User demand or quasi continous driven control signaling is provided with channel provisions to allow multiple Level 2 devices to be operated within the same room. Two-way operation is assumed to be primarily used to validate communications and resolve channel contention and collisions. Level 2 will enable use of the SRBUS as a bridge with other CEB media and the use of repeater-like functions.

Level 3:

Dedicated, independent multiple audio channels. Compact-Disk-equivalent performance is supported from multiple sources or channels to multiple receiving devices tuned or enabled to receive a selected stereo audio pair. As a secondary application consideration the channels may be configurable as either one or two-way data channels to permit use as a limited speed LAN between devices operating at speeds beyond the capabilities of PLBUS. Note that the maximum speed of the bus is limited to that required to support its primary multiple channel audio application.

Level 4:

High speed data communications. In recognition of the potential of future optical data bandwidths an open ended provision is intended for unspecified data applications. The only available example at present is hard disk data.

Level 5:

Wideband signal communications. An optical wideband wireless link is intended to extend the reach of future SRBUS concepts to include video and/or WIBUS communications.

Note that Level 1 defines a simple, one-way Unified Remote Control System. LEVELS 2-5 define a two-way approach.

At this point, the Subcommittee faced a choice: we could focus on quickly defining the Unified Remote Control standard so that industry could start using it. But the risk of developing the Level 1 language and protocol and then later finding it to be incompatible with other levels was too high. Therefore, the Committee decided to use a top-down approach, and take the time to develop a unified command and addressing language for the whole home. The language then used by any one particular level of the SRBUS would be a hierarchical subset of the CEB language.

Development Strategy

The command and addressing language is being developed by a working group existing within the Technical Steering Committee (the top level Committee of the CEBC). Therefore, the strategy presently being pursued by the SRBUS Subcommittee is that of implementation in a way that guarantees coexistence with existing systems.

We are presently focusing on Levels 1 and 2, and pursuing two implementation strategies. In order of preference, they are:

1. Staying at 900 nm (the wavelength used by almost all production systems now) and guaranteeing non-interference by receiver design and coding techniques.
2. Move away from 900 nm to the 850-800 nm range and separate the systems by optical filtering.

The reasoning for the order of preference is one of simplicity: staying at 900 nm means minimal change for those businesses already in production, and the coding techniques can be achieved through enhancing the capability of the microprocessor systems already used in most manufacturer's designs.

To stay at 900 nm and to be able to perform reliably in the presence of transmissions from older systems, the CEB/SRBUS system must very carefully define optical receiver techniques to ensure that good quality signals are presented to the decoding sections of the receiver. It is expected that wide dynamic signal latitude will be required. It is not expected to be an overly difficult task.

Present Status

At the present time, no company has come forth with a proposed system for achieving Level 1 and Level 2 system implementation. Upon retrospect, this seems reasonable since no company has been contemplating such global standards for the home simultaneously with the remote control system.

Therefore, the Subcommittee has decided to use the services of a consultant. The task of the consultant would be to evaluate the approaches recommended by the Subcommittee and make their own recommendations as to how best to implement a realizable system whose performance is consistent with the goals of the Subcommittee.

The consultant will then construct breadboards to demonstrate feasibility of the standard and for demonstration to the Member companies of the Subcommittee.

Schedule and our Plans

At the time of the writing of this paper, a number of consultant candidates are being evaluated. By the time of presentation, the chosen consultant will be at work on the task described above. We then expect that breadboards will be available toward the end of 1986 for evaluation by member companies and subsequent alterations should some objections be encountered.

Human Interface

Using the CEB Unified Remote Control System to control a number of pieces of equipment probably presents no problems for firms already in the business. A number of products are already in the marketplace using remote control systems that can address many different pieces of consumer entertainment equipment.

The real challenge will be to those firms who decide to design and sell wireless remote access to the PLBUS and WIBUS. In doing so, they will be able to create a wireless hand-held remote control system which can address the entire home. The challenges in the area of good human factors design will be large, even if the addressing space is limited to a small number of devices. Making consumers comfortable with actuating and controlling lights, VCRs, etc. which are out of sight will take well-thought-out, carefully executed algorithms and devices.

Indeed, the area seems to be large enough to appear to support entire companies: a number of small firms are moving into the Home Control area, specializing in human interfacing.

Proliferating more and more different, and conflicting, hand-held systems is a human interface problem of a different (but just as severe) type. Almost all of the Consumer Electronics Industry has participated in developing new markets in which the consumer became confused and irritated: we've watched the new businesses stumble, and sometimes stall.

The CEB SRBUS standards provide a method of avoiding the proliferation problem. They can substantially reduce the complexity, on the consumers part, of operating a wide variety of remote control equipment made by various manufacturers. Strong acceptance and conformance to the coming CEB Standard can make the marketplace growth rate much quicker and its path much less thorny.

Chapter One-Integrated Switching Systems

Discussion

The confusion and mess of A-B switch configurations has led to the design of numerous integrated RF switching networks. Typically such devices contain several splitters and multiposition switches and may contain integral amplifiers to overcome splitting losses. While they have the disadvantage of some lack of flexibility, their use reduces much of the necessary cabling and results in clearly labeled functions for the customer.

Unfortunately, many of the devices on the market (particularly those available through retail electronics and hi-fi stores) are inadequate with regard to functionality, switching isolation, through loss and/or shielding. In their defense, many were designed more for the interconnection of other video equipment (video disk players, video games, multiple VCRs, etc) than for cable installations. Only recently have devices been introduced which were designed with the requirements of cable operators in mind.

This section contains a discussion of the various options available to the designer of such equipment and closes with a model specification for one possible configuration. The NCTA is not in the business of equipment procurement and thus the specification is not intended to be complete, nor to focus on features other than those necessary for minimum operation. Such factors as mechanical configuration, additional input or output ports, AC power switching, etc. are more properly considerations of market assessment. The subcommittee is indebted to George Hart of Cablesystems Engineering for many of the provisions in the model specification.

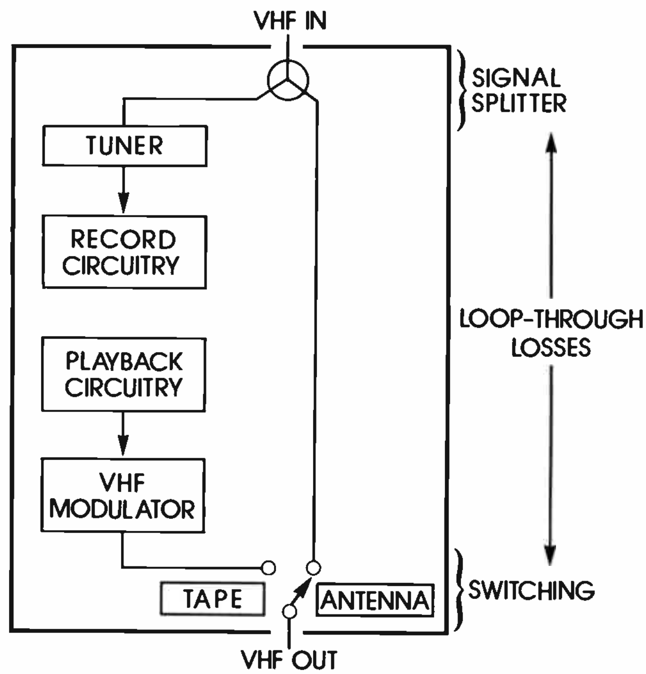
Configuration Options:

Most useful switching devices will contain certain features in common-namely the ability to select several sources for viewing or taping and to view pre-recorded tapes without cable changes. Beyond that, however, there are choices to be made in amplification, feeds to descramblers, FM outlets and non-RF features.

Splitters vs. VCR Feedthrough. A device which only provides switched outputs for VCR and television set may be built without any splitter loss if desired, although some control logic is required. This is done by feeding each input to an armature port on both the VCR select switch and the television select switch. Provided the physical distance between the switches is kept very short and the switch arms present an open circuit when non-selected, this can be done without the use of splitters.

The logic is set up so that independent selection may be made of RF source for the television and VCR unless both select the same source. In that case, the television is connected to the output of the VCR instead of its selected source. Provided that the VCR is internally switched to its bypass mode, the television will receive the same source as the VCR. By preventing both selector switches from activating the same input port, double termination of sources is avoided. The Zenith "Video Organizer" is an example of a commercial product using this technique.

This configuration involves two compromises: first, the savings in signal loss is more theoretical than real and second, it may be more confusing to the subscriber. The problem with the signal loss savings is that many VCR's are quite lossy in their signal bypass path, which contains a splitter and switch of its own as shown in the diagram below. Although the EIA/NCTA interface specification calls for a 5 dB maximum loss recommendation for future designs, a few models of currently installed VCRs may have losses in excess of 10 dB.



VCR Signal Flow Diagram

The potential customer confusion stems from the need to switch the recorder between tape mode for playback and (sometimes) to bypass mode for viewing non-recorded material *in addition to* selecting sources of the RF switching box.

Descrambler Output Port(s). One requirement which is unique to cable installations using scrambling is the necessity of a signal feed to the descrambler. With some addressable descramblers, in fact, a full-time cable feed is necessary not only for receipt of new authorizations, but to keep the unit from totally deauthorizing. Descramblers built for use in dual-cable systems generally also contain internal A-B switches and thus need inputs from both cables. The inclusion of such output ports is one of the factors that distinquishes switching units intended for the cable market from simple video source selectors.

FM Receiver Port. A second port that is sometimes provided is a full-time feed intended for use by an FM receiver. If such a port is considered, the egress and ingress implications outlined in Section I, chapter three should be carefully considered. As a minimum, it is recommended that the FM port be fed through a bandpass filter. If addressable devices or other terminal equipment that use signals in the area above 108 MHz are in use, then the filter should be designed to have minimum through-loss in that region. Similarly, the principal aircraft frequencies are located immediately above the FM band as are many leakage detector signals, so the sharpness of the upper cutoff is of interest. A low-gain, high-isolation amplifier in series with that port can reduce the effects of strong local TV signal ingress.

AC Powering Considerations. Configurations which use active signal switches or amplification will require line power of some kind. While this may seem a mundane consideration by itself, it may not be so when combined with the requirements of other equipment. A customer with a converter, VCR and television set may have already used all available outlets within reach. As a cost-savings measure, some manufacturers of switching networks may choose to use wall-mounted transformers ("calculator power supplies") as those may be independently UL approved, saving both time and money in bringing the new product to market. Unfortunately, many such transformers not only use one outlet, but may cover additional outlets as well. Also, there is no possibility with such a unit of providing an accessory AC outlet on the back so that the total number of receptacles in use is the same. Finally, consideration should be given to the reliability and durability of the light duty low-voltage cords and plugs used to connect the transformer to the switching unit.

Amplification. Given that most switching networks involve signal splitting to feed multiple receivers and that low signal levels limit attainable noise performance as explained above, the obvious answer is to provide amplification in the switching network. If such amplification is provided, careful consideration must be paid to its placement within the network and electrical characteristics.

Wherever the gain stage is placed, it becomes part of the cable system's distribution network. Unlike trunk amplifiers, however, it operates without well-determined input and output levels, owing to the variation in drop levels within a system. Thus, it must provide:

- Acceptable distortion characteristics when the network is supplied with the highest expected drop signal level.
- Acceptable noise performance when the network is supplied with the lowest expected drop signal level.
- Sufficiently flat frequency response that the range of signal levels does not exceed either the NCTA or EIA limits when connected to a typical drop.

Fundamental to the design is the question of whether the gain is to be placed at the input ports or output ports. If the gain is placed after the splitting and switching, then the distortion characteristics are easier to meet as the levels are lower, however, the passive losses add directly to the noise figure and, unless the inherent noise figure of the amplifier is significantly lower than the customer's video equipment, nothing is gained.

Placing the amplifier ahead of the splitters requires it to handle somewhat higher signal levels, but allows optimizing noise performance. It is important that such amplifiers have a gain not significantly higher than the passive network losses. This keeps the output level within reasonable range for distortion reasons and keeps the amplified signals from leaking into the non-amplified signals due to the finite isolation of the switching. Preamplification also requires that the switching devices handle somewhat higher signal levels which may be important to some active switching technologies.

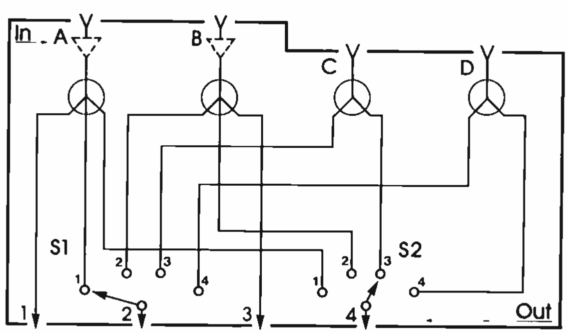
The addition of an active amplifier stage also is of concern to system lightning/surge protection via the cable input port. Low noise figure high-performance amplifiers are inherently sensitive to lightning surges and require special consideration in the design of an amplified switcher product. Such may not be the case with direct cable inputs to converters depending on whether the converters use an input amplifier.

Model Specification-Converter/VCR Switching Network:

Description:

An RF routing and switching device capable of routing signals from four sources to two switched and two fixed output ports. Two of the input ports are "wideband ports" and two are "low-band ports." The two fixed output ports are permanently fed from the wideband input ports.

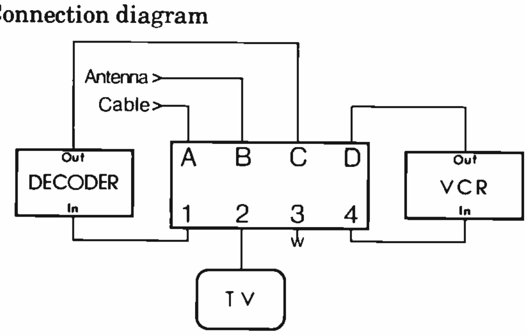
Functional schematic:



Applications:

B. Single cable with decoder, VCR, and antenna or external source

1) Connection diagram



2) Labels

A	Cable Input	**Switch 1**	View
B	Antenna (or ext)	Pos 1	Cable
C	From Decoder output	Pos 2	Antenna
D	From VCR Output	Pos 3	Premium
1	Cable to Decoder	Pos 4	Tape
2	To TV Set	**Switch 2**	**Record**
3	(not used)	Pos 1	Cable
4	To VCR Input	Pos 2	Antenna
		Pos 3	Premium
		Pos 4	(not used)

Applications:

(3) Features

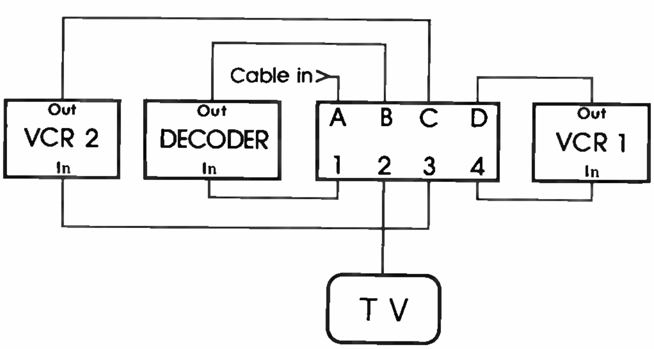
- Allows use of antenna, playback VCR, video disk, MDS or STV decoder, computer, etc.
- Allows "cable-ready" tuners to access all non-scrambled program material with independent TV and VCR channel selection.
- Allows VCR to use timed recording functions on all non-scrambled channels or single premium channel.

(4) Limitations

- Doesn't allow simultaneous access to more than one scrambled channel.
- Doesn't allow unattended recording of both scrambled and clear channels.
- If external input is antenna, requires high isolation switching due to ingress/egress requirements and variation in signal level. Also high input levels from antenna may cause distortions.

D. Single cable with decoder and dual VCRs

1) Connection diagram



2) Labels

A	Cable Input	**Switch 1**	**View**
B	From Decoder Output	Pos 1	Cable
C	From VCR #2 Output	Pos 2	Premium
D	From VCR #1 Output	Pos 3	Tape 2
1	Cable to Decoder	Pos 4	Tape 1
2	To TV Set	**Switch 2**	**Tape #1 Record**
3	To VCR #2 Input	Pos 1	Cable
4	To VCR #1 Input	Pos 2	Premium
		Pos 3	Tape #2
		Pos 4	(not used)

(3) Features

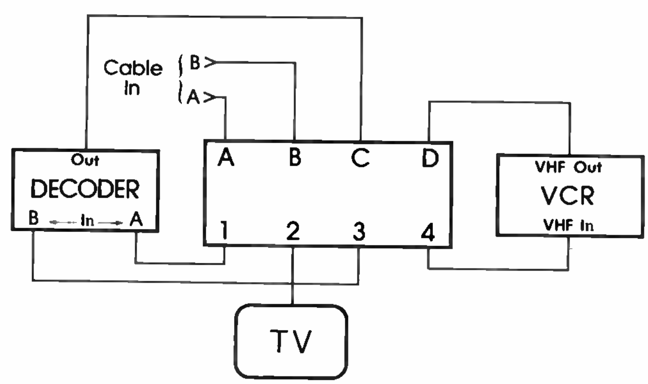
- Allows integration of two VCR's with controls for tape duplication.
- Tape 2 may be used to record a clear or scrambled channel from decoder while Tape 1 is recording the same channel or any other unscrambled cable channel.
- As an alternative, Tape 2 may be used as playback only and output #3 used as feed to 2nd TV set.

(4) Limitations

- Cannot copy from Tape 1 to Tape 2.
- Same limitations as other configurations with respect to use of remote controls or timers for manipulation of switcher controls or descrambler tuning.
- Tape 2 input limited to Converter/Descrambler output.

A. Dual cable with decoder and VCR

1) Connection diagram



2) Labels

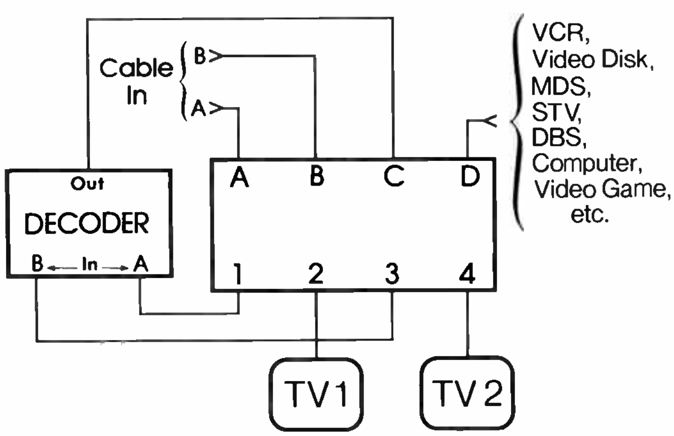
A	Cable A	**Switch 1**	**View**
B	Cable B	Pos 1	Cable A
C	From Decoder Output	Pos 2	Cable B
D	From VCR Output	Pos 3	Premium
1	Cable A To Decoder	Pos 4	Tape
2	To TV Set	**Switch 2**	**Record**
3	Cable B To Decoder	Pos 1	Cable A
4	To VCR Input	Pos 2	Cable B
		Pos 3	Premium
		Pos 4	(not used)

(3) Features
- Independent access by TV and VCR to A Cable, B Cable and Decoder output. Allows use of built-in tuners for independent selection of non-scrambled channels. • Restores utility of remote control and timed tuning functions of TV and VCR for channel selections within a single cable.
- Allows recording or viewing of scrambled or clear material or tape playback without changing any cables.

(4) Limitations
- Cannot record one scrambled channel while viewing another.
- Cannot do timed recording sequences that require cable selection or decoder channel selection.
- Cannot use wireless remote controls for cable selection.

C. Dual cable with decoder, two television sets and external input

1) Connection diagram



2) Labels

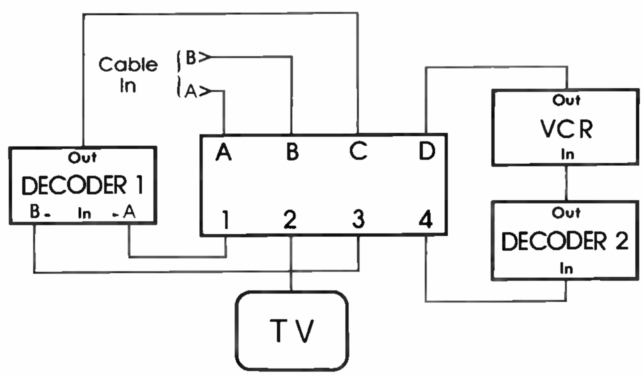
A	Cable A Input	**Switch 1**	**TV #1**
B	Cable B Input	Pos 1	Cable A
C	From Decoder Output	Pos 2	Cable B
D	From Auxiliary	Pos 3	Premium
1	Cable A To Decoder	Pos 4	Auxiliary
2	To TV Set #1	**Switch 2**	**TV #2**
3	Cable B To Decoder	Pos 1	Cable A
4	To TV Set #2	Pos 2	Cable B
		Pos 3	Premium
		Pos 4	Auxiliary

(3) Features
- Allows either of two TV sets to access both non-scrambled and scrambled programming with a single descrambler, although still limited to one scrambled selection at a time.
- Allows integration of other video sources into home video connection.

(4) Limitations
- Access to only a single scrambled channel at a time.
- Cable and function selection for remote TV set not convenient because of location of selector box.

E. Dual cable, dual decoders and VCR

1) Connection diagram



2) Labels

A	Cable A Input	**Switch 1**	**View**
B	Cable B Input	Pos 1	Cable A
C	TV Decoder Output	Pos 2	Cable B
D	From VCR Output	Pos 3	Premium
1	Cable A To TV Decoder	Pos 4	Tape
2	To TV Set	**Switch 2**	**Record**
3	Cable B To TV Decoder	Pos 1	Cable A
4	To VCR Input	Pos 2	Cable B
		Pos 3	(not used)
		Pos 4	(not used)

(3) Features

- Allows for simultaneous access to two scrambled channels.

(4) Limitations

- Requires cost of two descramblers to be amortized.
- Wireless remote controls may not be usable on both descramblers because of interaction.
- Timed recording functions of VCR involving more than one channel will not work as VCR's tuner is fixed on decoder output channel.
- On addressable systems, decoder #2 will not receive authorization data if Record switch is left in position 3 or 4.

Note: Addition of a second decoder to any of the above application diagrams ahead of the VCR will work in much the same way.

Electrical specifications:

(unused ports terminated in 75 ohms)

Bandwidth

A and B Inputs:
54-450 MHz
(Note: two-way systems will require that the lower limit be 5 MHz (in the reverse direction) while the upper limit can be expected to increase with the development in cable technology to 550 MHz or higher).

C and D Inputs:
54-74 MHz

Switching isolation

(on-off insertion loss ratio)
54-74 MHz:
75 dB
(Note: if applications are contemplated in which one port will be used for roof-top antenna inputs, this should be increased to 80 dB minimum, through 216 MHz. If the cable system upper frequency limit extends above 470 MHz, the same consideration will apply to potential UHF station interference.)

74-450 MHz
65 dB
(Note: this specification assumes that dual cable systems have opposing channels RF phaselocked).

Input terminal isolation

A and B ports to each other:
70 dB, 54-450 MHz
(Note: if applications are contemplated in which one port will be used for roof-top antenna inputs, this should be increased to 80 dB minimum up to 216 MHz. The same considerations discussed under switching isolation above apply here for systems whose upper frequency range overlaps the UHF broadcast frequencies.)

All combinations of input
Ports from each other:
75 dB, 54-74 MHz
(Note: this specification is included so that impedance mismatches of various sources do not degrade the effective switching isolation.

Amplification

Although the functional schematic above shows three-way splitters on the wideband input ports, an analysis of the suggested applications shows that, except for (C), only two of the three outputs are actually used at any one time. Thus, with sufficient switching flexibility and some control logic, it would be possible to achieve the same result using only two-way splitters. In that case, the losses could be kept to 4 dB or so and the complications of active amplifiers avoided. If amplifiers are used, they should be placed as shown in the functional diagram at the beginning of this section. Unless provisions are made for return paths, of course, such amplifiers would preclude use in a two-way system.

Gain and distortion

Net Gain:
The net gain, considering amplification, splitting and switching shall be in the range of -4 to +3 dB (0 nominal) from 54-450 MHz from A or B inputs to any selected output and -4 dB maximum from the C and D inputs to any selected output over the frequency range 54-74 MHz. The frequency response shall be flat within 4 dB in each case.

Crossmodulation Ratio:
›58 dB for 60 carriers synchronously modulated with a 15 KHz square wave at +14 dBmV input level at A or B input ports.

Carrier to Second or Third Order Beat Ratio:
›58 dB for 60 CW carriers at +14 dBmV input level at A or B input ports.

Carrier to Composite Triple Beat Ratio:
›60 dB for 60 CW carriers (standard frequency assignments) at +14 dBmV input level at A or B input ports.
Note: As with the upper frequency limit discussed above, the number of simultaneous carriers that must be handled while producing an acceptable level of distortion products can be expected to increase as the technology of cable distribution changes.

Carrier to Hum Ratio:
›50 dB for an input level of -6 dBmV over an AC range of 97 to 132 volts (if applicable).

Shielding

Egress:
Shall meet FCC Part 76.605 (a)(12) leakage limits with the outputs terminated for input signals of +15 dBmV applied

to A or B inputs.
Ingress:
When operated in an external ambient RF field of strength 1.0 V/m at any frequency from 54-450 MHz, the signal level measured at the A or B input ports shall be less than -35 dBmV when all other ports are terminated. The level measured at any other port shall be less than -55 dBmV when all other ports are terminated.
Note: This number is higher than that specified in the EIA/NCTA interface document (paragraph 2.1.1) dealing with signal transmitted back to the cable system, but is consistent with paragraph 2.1.2 dealing with performance degradation.

Chapter Two—Accessories to Aid Compatibility

Discussion

In general, use of the various switching networks discussed in earlier chapters results in improved capabilities for the customer, but at an increase in cost and operating confusion. Also, any of the schemes presented have the built-in problem that the cable converter is not controllable by the VCR's timer. Finally, there is the problem of too many separate remote control handunits: television, VCR, converter(s), FM tuner and video or audio disk players. Presented below are some approaches to solving these residual problems.

Timers

The problem of time-sequence recording on different channels has been approached in several ways. Oak and Zenith, for instance, have made available optional handheld remote units with built-in timers for their converters while another vendor has introduced a "generic" controller/timer unit. These units perform the same functions as the normal remote but can be programmed to do several channel changes over a period of time. Thus, a VCR which is connected to a converter output could be programmed to record several events (all on the converter output channel), then the converter's remote timer programmed to select the proper input channels for the recording.

The advantages of putting the timer functions in a separate remote unit are that it allows the operator to offer timing as an option without the costs of handling two types of descramblers and that it offers backwards compatibility with existing converters. The downside is that the remote must be left pointed at the IR receiver in the converter and any missed command could ruin the entire recording sequence (particularly a toggled command, such as ON/OFF).

Other manufacturers, for instance Jerrold, Pioneer and Tocom, are choosing to eliminate the uncertainty of the command path from the remote by offering the timer as an internal converter option.

From the standpoint of the customer, the question is whether the additional capability is worth the cost and operating confusion. Each time a recording is made two separate timers, with different controls and logic, must be set up.

Multi-Function Remote Controls

A remote control option that is designed to reduce duplication and messiness is the multi-function remote control. An early example on the market is a unit by General Electric that is capable of duplicating the functions of up to four wireless remote units by any manufacturer. It is programmed using a built-in IR receiver which receives and stores control sequences from the units it will replace in service. Assuming that the controls are clearly labeled for the various functions and that the control codes for the various video appliances do not interfere with each other, it could save clutter in the home. An alternate design would include plug-in "personality" modules for each of the units to be controlled. Both approaches could represent either a potential loss of remote control revenue for the cable operator or a new market potential depending on whether the cable operator is the only source for such devices in his area.

One operator has suggested a much lower cost way to accomplish a similiar objective. He offers his customers a plexiglas "pad" to which two or three remotes can be attached using Velcro fasteners. The other side is used for a tuning guide.

Chapter Three—Hardware Modifications

Discussion

While external switching networks can return some of the utility of VCRs and remote controllable television sets, they cannot solve all the problems and those that are solved are at the cost of hardware and operating complexity. Further improvements require either modifications to the designs of converters or specially designed hardware. Several ideas are presented here with the intent of stimulating discussions in the industry leading to innovative long-term improvements.

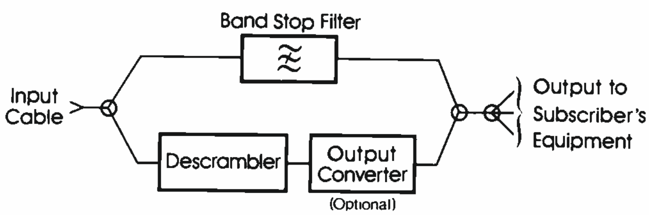
Proposal I: Wideband Cable Feed Including Premium Services

Description

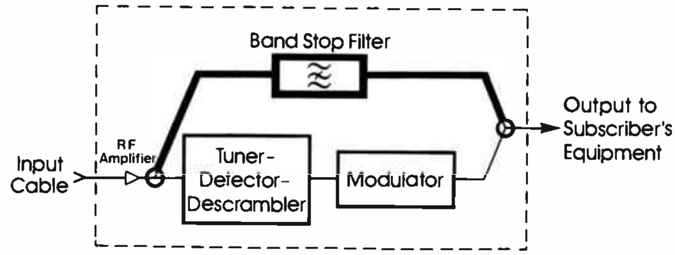
Under this proposal the input cable feed is split, one input line used for the descrambler input and the other fed to an output combiner. The descrambler output is recombined with the broadband input so that the output of the network would contain all clear channels plus one selected descrambled premium channel. Thus, normal television sets and VCR's could access services on standard television channels, extended tuning range devices could access all non-scrambled services and a selected premium service.

Such a device would allow access to premium services by second sets and VCRs without losing independent tuning capability, although simultaneous access to multiple premium services would still be denied. It has the advantage that no additional wiring or switching functions are required.

Functional schematic:



combiner would be required. The diagram below shows a baseband converter modified to put the added circuitry (shown in dark lines) completely within the device.



Detailed Discussion:

Key to implementation of this method is the choice made for the output channel. Either a blank channel must be allocated in the distribution system to allow for the reinsertion of the decoded signal, or a filter would have to be used to "create" such a channel. In that case, the cleared channel should contain programming of little or no worth in its as-received state, such as an encoded premium signal or space-filler character generator. A filter of some sort will likely be necessary in any case to avoid recombining distribution system noise with the converter output, though the requirements are not as stringent in that case. Since single channel filters which do not affect adjacent channels are very expensive to fabricate, it would be preferable to think in terms of removing one channel and degrading considerably each adjacent as well. Several frequency ranges suggest themselves:

- Channels above the maximum for the distribution system in question, but within the tuning range of "cable ready" sets are a possibility for older systems. In that case, the band-stop filter could be replaced with a low-pass filter at a significant cost savings.
- If several scrambled channels are grouped together, then there is no loss of utility in trapping out center channels of the group. There may even be a useful increase in security because of denying access to other scrambled services for pirate descramblers.
- Aircraft channels which had conflicts under the old signal leakage rules and which could not be activated without losing grandfathering privileges could be used since the converter output power levels are quite low.

Upon examining possible applications of this proposal, it becomes obvious that a significant cost savings could be realized if converters were available with bridged input connectors having little loss (or even slight gain) and also if converters were available with outputs on arbitrary channels so as to avoid any output channel conversion requirements. In such a case, little more than a two-way

Advantages:

- Fully simultaneous access to all non-scrambled services and any selected premium service is available for both television set and VCR and (potentially) additional sets as well.
- No additional user-operated controls and complexity are created in a single-cable installation and only one switch in a dual situation (compared to a simple descrambler connection).
- For the special case of single premium service installations, a potentially lower cost configuration results if descrambler tuner, remote control and other features are eliminated and this cost more than exceeds the cost of the filter required.

Disadvantages:

- Simultaneous access to only one premium channel is provided. Generalizing this system for additional channels requires either additional splitting and combining with attendent amplification problems, or series connection of networks. In any case, devices would have to be available with a variety of input and output channels for various permutations.
- Restraints may be placed on channel arrangement in the system so as to leave blank channels or adjacent "rejectable" channels.
- The lack of standardization of channel usage among cable systems will result in demand for many models of such a device, affecting economies of scale in manufacturing.
- Splitter losses may very well be such that amplification will be required, either integral to a modified descrambler or externally. In either case, there is a cost impact. If the amplification is external, then there are problems with an additional power cord behind the TV set.
- A lower cost single-service device forgoes one of the principal advantages of addressability, namely the easy changing of service levels.

An Alternate Configuration:

One possible realization of this technique is to put the output of the descrambler in the UHF television band and not recombine it with the remainder of the signals. The two outputs of the network can then either be connected directly to the UHF and VHF inputs on a television set or looped through the VCR and then to a television set. Zenith currently markets an external network based on this technique except that the UHF output is recombined with the direct cable signals.

Advantages:

- This approach eliminates both the filter and recombining network, thus saving cost. Also, additional amplification is generally not necessary as only one splitter is in the line.
- Modified descramblers or external networks could be standardized since one standard UHF channel could be used unless more than one descrambler were used for simultaneous access to additional scrambled services.

Disadvantages:

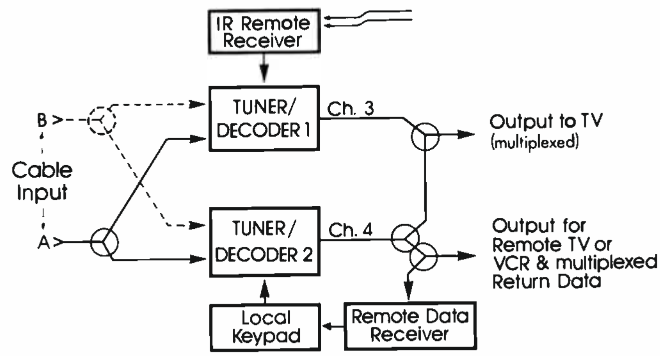
- Consumer video equipment is not standardized as to whether the VHF and UHF inputs use separate or a single input connector so recombining may not always be avoidable.
- Many extended tuning range VCR's and TV's do not have simultaneous access to cable mid- and super-band channels and UHF channels. Generally there is a relatively inaccessable switch which changes tuning modes. Certainly, for that equipment, the user gains less convenience by this technique.

Proposal II: Dual Channel Premium Decoder

Description:

This is a proposal for a dual-channel integrated decoder. It overcomes one fundamental limitation of all the proposals above presented in allowing simultaneous access to more than one scrambled channel. Since both decoders are included in a single package, the problem of insuring that both units stay in a single residence is solved. Also, certain economies are realized by elimination of some features, common power supplies, etc. The two descrambled outputs are available either separately or multiplexed on a single cable.

Functional schematic:



Detailed Discussion:

The proposed dual decoder is more than just two decoders in a single package. One of the decoders will be controlled by a local IR receiver from a wireless remote control unit. The second will be controllable either by the local keypad or by control signals multiplexed on its output RF line. Potentially a remote IR receiver or keypad of simple design could place keystroke data on this line that would duplicate the signals from the local keypad. This tuning arrangement would allow current package designs to be used since many incorporate both keypad and remote command entry. From a functional standpoint, it also makes sense since the second decoder is either used for a remote television which needs to access the tuning commands remotely or it is used with a VCR, in which case the local keypad would be preferable to a wireless remote anyway.

The second difference between this configuration and two individual decoders is that each has a modulator on a different channel. The RF MULTIPLEX output allows for both outputs to be on a single cable which is advantageous for VCR hookups. The output levels are set somewhat higher than for a normal converter to allow for the combining and the expected cascade of VCR and TV on the main output.

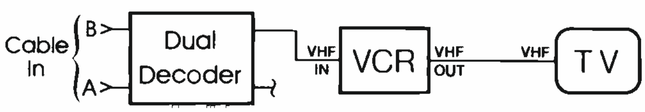
Finally, even though the hardware savings over two individual units may be minimal, the very fact of their inseparability and a single telemetry receiver means that one of the units cannot find its way to another subscriber. This means that an operator can comfortably charge lower second outlet rates for the dual unit knowing that he has some protection against theft of services.

While the provision for an external remote control input adds some cost, it should be minimal and, in the long term, may coincide with requirements for such capability, depending on the direction of the EIA HOME BUS effort or the National Association of Home Builders (NAHB) SMART HOUSE project. Finally, it opens the possibility for direct control of tuning by the VCR timer via a signal transmitted out the VCR's input port, given a cooperative effort by the manufacturers involved.

Applications:

A. Standard VCR/Television connection:

1) Connection diagram

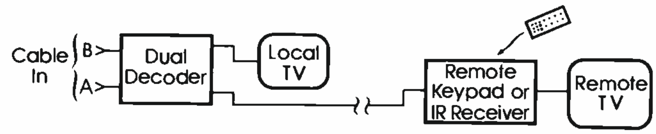


2. Features
- Independent selection of programming for VCR and television, including simultaneous access to multiple premium services.
- Simple wiring, simple installation, no level matching problems.
- Allows use of converter's wireless remote for control of one channel (television watching) and manual selection of another channel (recording).
- Increased security over separate converters.

3. Limitations
- Use of IR remote mandatory for one channel.
- Relatively high cost compared to simple switching systems.
- Prevents use of built-in remote controls and extended tuning ranges in customer's equipment.
- Will not allow timed recording sequence which require channel changes unless a timed channel change mechanism is also built into one of the decoders.
- Possibility of degraded reception due to use of two output channels, one of which may be used locally for off-air reception. Also, the degradation caused by the signal processing within the converter.

B. Second television outlet:

1) Connection diagram

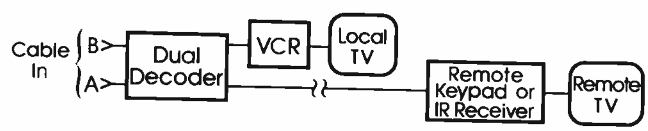


2. Features
- Allows two television sets to access separate premium programming without requiring separate descramblers, so lower second set rates are possible.
- May allow full wireless remote control for both sets.

3. Limitations
- With remote control on second set, the hardware cost may be more than the cost of two descramblers.
- If separate enabled levels or parental control are required, the cost will be higher.

C. Combination installation

1) Connection diagram



2. Features

A straight combination of the above allows for VCR plus second set installation with minimum complexity. It is limited to simultaneous access to two channels, whether scrambled or not, however any combination of two channels is possible.

Proposal III: Master-Slave Descramblers

Description:

The above proposal attempts to solve the problem of simultaneous access to multiple premium services by packaging two descramblers in a single package and providing both single and multiplexed outputs. An alternate proposal was presented by Tony Chen-tung Li of Oak Industries at the NCTA 1985 National Convention. Oak's proposal is to modify tdescrambtlers to optionally allow an alternate telemetry input from the normal distribution cable signal. The first descrambler in a home serves as a master unit and transmits control signals to the secondary units.

The advantages of such a scheme are:

- Less descrambler modification than the dual unit described above.
- It can be generalized to more than one slave unit.
- Each descrambler can be located at the video equipment served, thus simplifying channel selection for remote units.
- Secondary units, as above, cannot be used at other residences without wired connections.

The principal disadvantage is the added circuitry to provide for either master or slave operation of each unit with its associated cost. An additional factor may be the unique splitter configuration required.

Multiple Home Terminal Units:
Subscriber Convenience—Security Risk

James R. Cherry, Director, Product Design Engineering
Tony Chen-tung Li, Manager, Product Design Engineering

Oak Communications Inc.
16516 Via Esprillo
Rancho Bernardo, California

Abstract

The need of the subscriber to simultaneously operate multipe TV sets and/or VCRs from his cable service has led to significant use of multiple home terminal units (HTU). If a subscriber pays a lower fee for a secondary HTU that is authorized to receive the same premium service as his primary unit, a risk exists that the unit will be sublet to a neighbor. For addressable cable systems using out-of-band data carriers, a master/slave configuration is proposed as a solution to the problem of subletting secondary units. The master/slave consists of two HTUs: The master used with the primary set and the slave used with the secondary sets. The slave unit does not function unless its address-control channel is protected by a master HTU. Thus, if the slave unit is used in a neighbor's home without its master, the secondary, or slave, unit will not function. Both master and slave HTUs can still respond with all addressable features. The uniqueness of the scheme lies in the selective blocking, by the master unit, of deauthorize commands directed at all slave HTUs. A high level of security is maintained without the requirement for complex, handshaking duplex data communications between the two HTUs.

Introduction

The HTU converts any cable channel to a channel that can be received by the standard TV receiver or recorder (typically channel 3 or 4) and it descrambles premium channels for which it is authorized.

If a subscriber desires to utilize a cable channel which is outside of the usable band in his TV receiver or recorder, or which is scrambled, he must do so through an HTU. For simultaneous use of multiple TV receivers or recorders to receive different cable channels, one HTU per video device must be used. Thus, we find some subscribers utilizing multiple HTUs for the convenience of operating second sets and VCRs.

In systems where a substantially lower fee is charged for premium services received on a subscriber's second or subsequent HTU, a significant security risk is incurred. The lower second-set fee can be the result of franchise agreement mandate or system policy.

Assuming that additional HTUs provided to a subscriber are identical to the initial unit, then they can be used on any outlet in the system to receive the service for which they are authorized. Thus, one subscriber can pay a nominal fee for a second HTU authorized to receive the same premium service as his primary unit, and sublet this unit to a neighbor, thereby circumventing the normal premium service fee.

The security risk is strongly a function of the subscriber cost differential between initial and subsequent HTUs. Also, it is a function of the social norms in the area covered by the franchise.

For addressable cable systems capable of out-of-band data transmission, a solution to the risk brought on by low-priced second sets is a system in which the HTU provided as a secondary set will only operate in the presence of a primary set . . . a master/slave arrangement.

The master/slave solution

Three approaches to master/slave configurations will be described: 1) master-to-slave control channel, 2) separate master-to-slave control line, and 3) control channel interruption.

1) Master-to-slave control channel

Figure 1 shows a functional block diagram of the master-to-slave control channel configuration. The control channel is assumed to be 10.7 MHz in this example.

Master HTU. The master HTU has been designed to retransmit the control channel back onto the input cable at 10.7 MHz. The master HTU is controlled by the standard control channel at 104.7 MHz.* The 10.7-MHz channel is interrupted whenever the master HTU receives an inhibit command from the headend via the standard control channel. The inhibit command is sent to all master HTUs in the system as a group. The duration of the 10.7-MHz channel interruption is of sufficient duration to disrupt the following message which is directed to only slave HTUs. The 10.7-MHz channel operates continuously as long as the master HTU is powered.

---

* 104.7 MHz is one of the FSK control data channel frequencies used in Oak systems. This data channel transmits a continuous stream of 64-bit message packets addressed to individual HTUs or groups of HTUs.

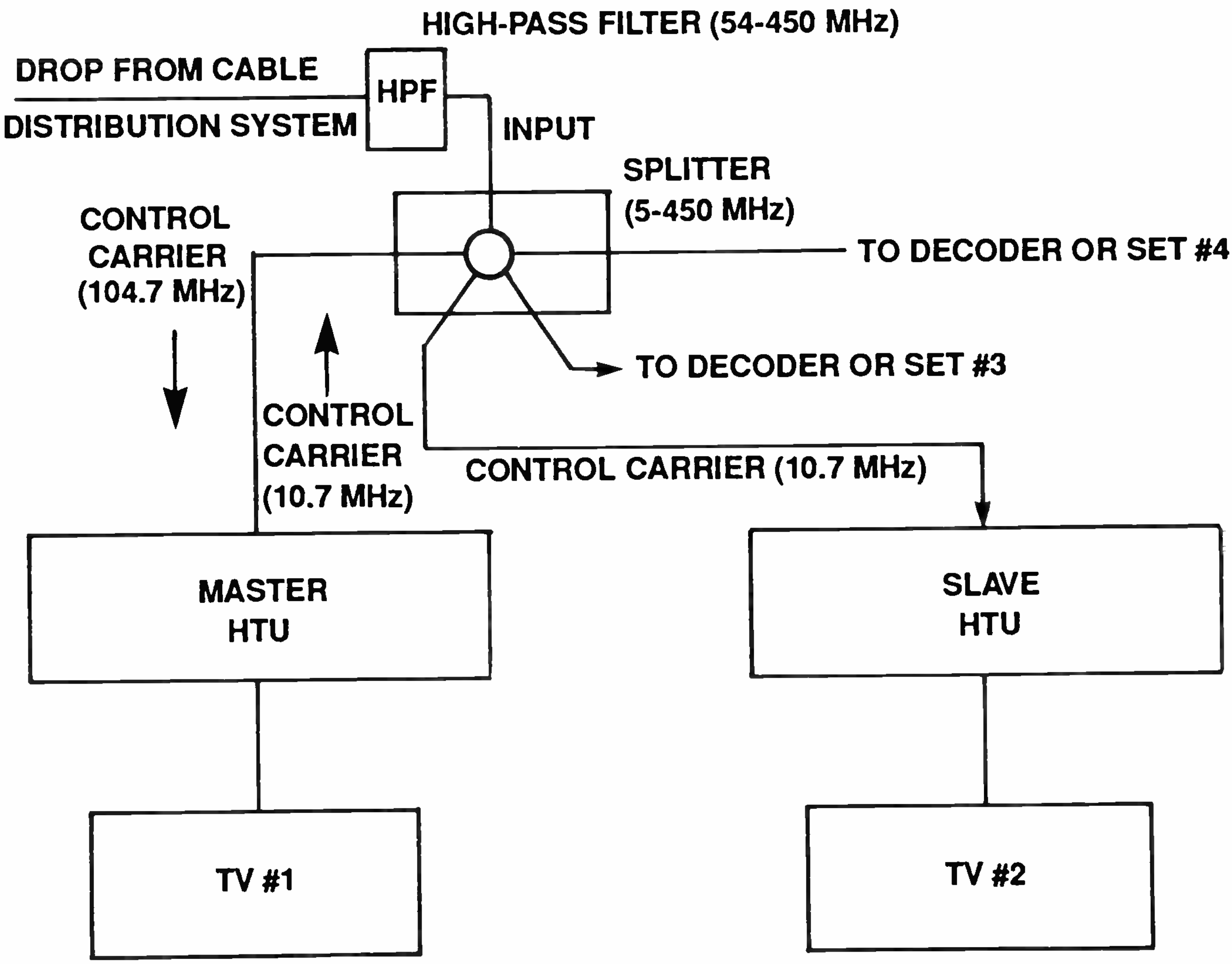


Figure 1. Master-to-slave control channel

Slave HTU. The slave HTU is designed to receive the 10.7 MHz-control signal retransmitted by the master HTU. The slave decoder can be addressed and controlled by the headend, provided that the control signal is received via the master HTU, which retransmits the 104.7-MHz control data at 10.7 MHz.

Periodically, deauthorize messages are sent to all slave HTUs as a group, preceded by an inhibit command sent to all master HTUs. If the slave decoder is receiving its 10.7-MHz control channel via a master HTU, the deauthorize signal will have been inhibited and the slave will continue to function normally. If the slave is connected to the control channel by an independent converter, (i.e. without the master being present), then it becomes deauthorized following reception of the first deauthorize message.

Both slave and master HTUs are manufactured identically and shipped as master HTUs. At installation a message from the headend is sent via the standard control channel that will configure designated HTUs as slaves. Slaves thereafter respond to only 10.7-MHz control.

Splitter. The splitter is standard, except for the requirement to pass the 10.7 MHz signal. The 10.7-MHz control signal is retransmitted from the master HTU to the splitter. The 10.7-MHz signal passes through the splitter to its input port and is reflected from the high-pass filter in that line. It is then, in turn, passed to the other output ports.

High-pass filter. A high-pass filter is used to block the 10.7-MHz signal from entering the system by reflecting the signal back into the splitter.

2) Separate master-to-slave control line

Figure 2 shows a functional block diagram of the separate master-to-slave control line configuration. This system operates on the same inhibit/deauthorize principle described in the master-to-slave control channel configuration.

Master HTU. The master HTU has been designed to transmit a control signal to the slave HTUs that will disable the slave's control channel during a deauthorize message that follows an inhibit message. As in the master-to-slave control channel scheme, an inhibit signal is put on the control line by a master HTU whenever an inhibit command is received from the headend via the standard control channel. The inhibit command is sent to all master HTUs in the system as a group. The duration of the inhibit signal on the control line is of sufficient duration to disrupt the following message which is directed to slave HTUs. The control line inhibit function operates as long as the master HTU is powered.

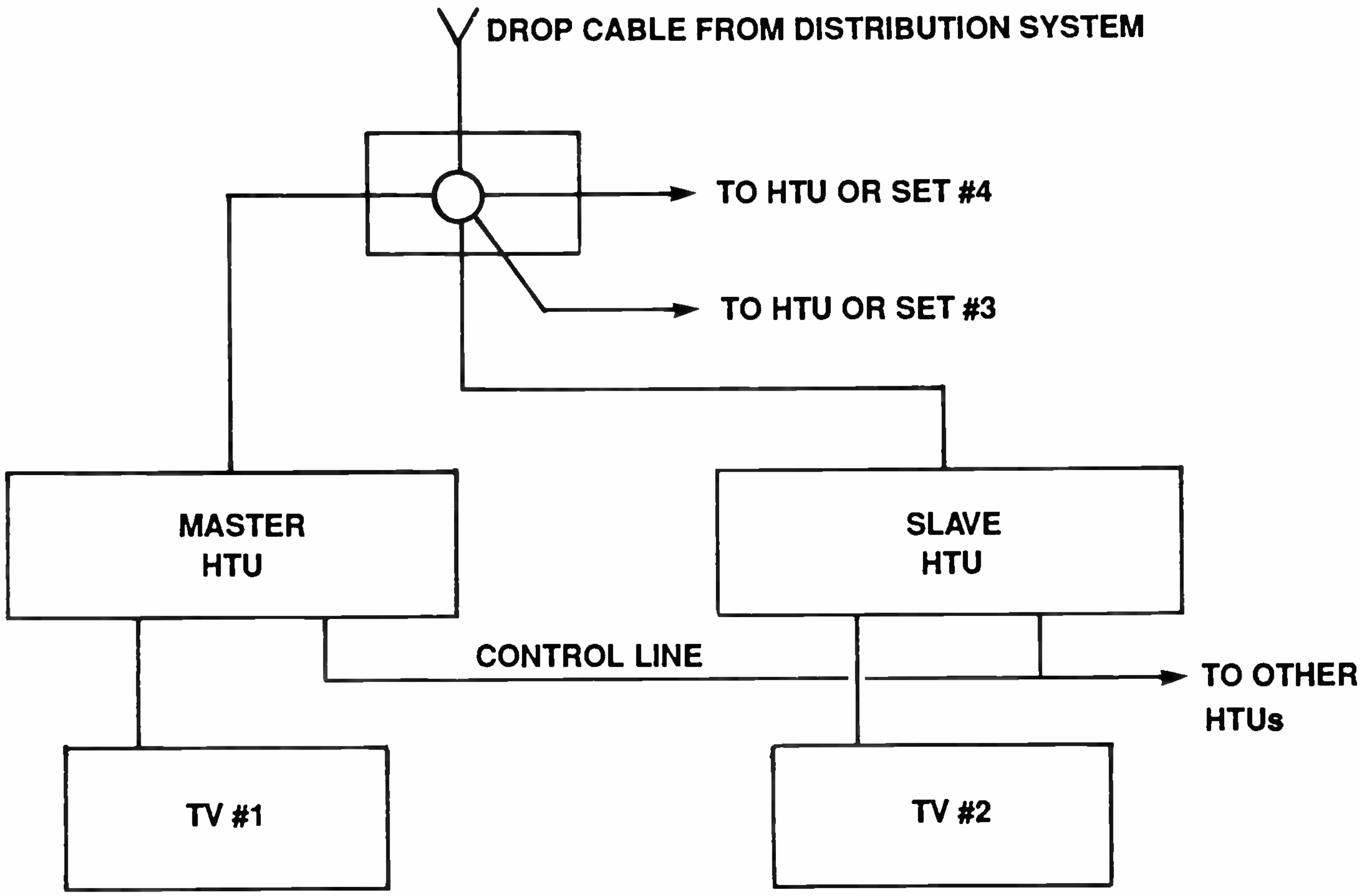


Figure 2. Separate master-to-slave control line

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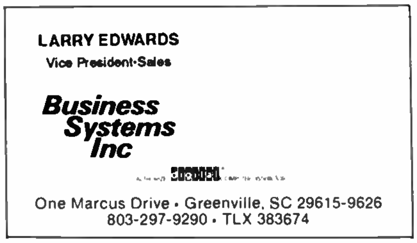
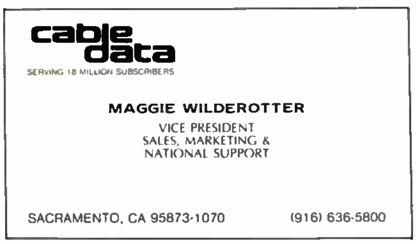
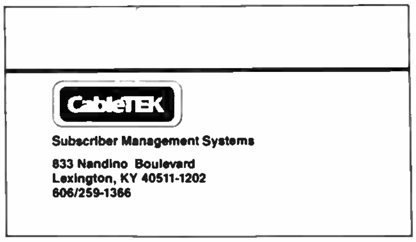
Billing callbook



Business Systems Inc.
One Marcus Drive
Greenville, S.C. 29615
(803) 297-9290, (800) 424-0101 (national), (702) 369-6667 (West regional office)
PERSONNEL: Earl Blasi, president; William Cox, vice president; Russ Bosko, vice president; Larry Edwards, vice president.
DESCRIPTION: In-house, real-time computerized billing and management system featuring an interface to addressable converters and taps. Also, standalone pay-per-view automation system including complete ANI interface capabilities.



CableData
Sacramento, Calif. 95873-1070
(916) 636-5800
PERSONNEL: Maggie Wilderotter, vice president sales, marketing and national support; Bob Crowley, director of sales; Nancy Frank, director of marketing.
DESCRIPTION: Presently serving 20.5 million subscribers, CableData offers on-line subscriber management and billing services for cable systems of 0-350,000 subscribers. DDP System using Tandem computers for complete system operations including order entry, dispatch, check-in, inventory control, routing and scheduling etc., addressability and pay-per-view software, as well as audio response unit (ARU) interfaces, PEP Unit, PEP (Phone Entry Processor) for automatic phone functions, TNT Workstations for IBM PC compatible software for data manipulation and analysis. New computer system, QuickData, and application software QBS (QuickData Business System) for cable systems of all sizes. Custom logos and message statements available on customers statements.



CableTEK
833 Nandino Blvd.
Lexington, Ky. 40511
(606) 259-1366
PERSONNEL: Robert Noren, senior vice president; Norman Johnson, vice president, sales.
DESCRIPTION: CableTEK, presently serving more than 7 million on-line and remote subscribers, offers a large variety of information systems: On-line, on-site for systems serving between 5,000 and 250,000+ subscribers; on-line, remote for 5,000 to 100,000+ subs; multi-terminal PC for 1,000 to 15,000 subs; and batch remote for 100 to 20,000+ subs. CableTEK is also the exclusive dealer for Melita audio response units for both inbound and outbound calls. The company's newest product, the Portable Terminal, allows you to take your billing computer into the field.

Computer Utilities of the Ozarks
103 Industrial Park Road
Suite C
Harrison, Ark. 72601
(501) 741-1616
PERSONNEL: Herb Lair, president; John Bartlow, vice president customer support; Jerry Criner, vice president systems engineering; Lynn Armstrong, vice president project manager.
DESCRIPTION: Management information and accounting system for in-house, on-line computer systems to provide billing, work order processing, marketing, converter inventory, addressable interface, franchise summaries, location information and inquiries. System operates on IBM micro- and minicomputers and PC compatibles with multi-user and database capabilities.

Creative Management Systems
Corporate Headquarters:
213 Washington Street
Toms River, N.J. 08754
(201) 341-6165
PERSONNEL: Morris "Mac" Adler, president; Alan Meyer, executive vice president; Ron Samuel, vice president customer service; Rich Alfonso, vice president research and development.
REGIONAL LOCATIONS AND PERSONNEL: 1750 Montgomery Street, San Francisco, Calif. 94111, (415) 954-8550, Gilbert Jacobs, vice president sales and marketing, John Jonopulos, Western region manager, Gina Marucci, sales promotion/advertising; Park 80 West, Plaza II, Suite 200, Saddlebrook, N.J. 07662, (201) 843-4889, George McGuire, Eastern region manager; Corporate Plaza, Suite 5, 11212 Davenport Street, Omaha, Neb. 68154, (402) 330-6610, Bob Hall, regional sales; Forum VI, Suite 636-H, 3200 Northline Ave., Greensboro, N.C. 27408, (919) 299-3544, Lee Mixson, regional sales.
DESCRIPTION: In operation since 1971, CMS products service over 125 cable operators serving over 2½ million subscribers. CMS offers System 1, an on-line subscriber management and billing system that operates in the cable office on the IBM System/36 family of computers. It includes order processing, customer service, billing and accounts receivable, scheduling and dispatch, service call, equipment inventory, addressability, pay-per-view, marketing and financial analysis, and report writer. Integrated accounts receivable and general ledger are options. CMS offers complete turn-

key installation. System 1 has true cycle billing capabilities with first, last and change of service bills prepared daily. Statement, coupon and postcard bills are available and can be printed on site. CMS offers a statement printing and mailing service through Dyatron Corporation as an option.

First Data Resources Inc.
Cable System Services
Jay A. Oxton
President
(402) 399-7071
Office Address
10825 Farnam Drive
Omaha, NE 68154
Mailing Address
7301 Pacific Street
Omaha, NE 68114-5497

First Data Resources
7301 Pacific Street C-46
Omaha, Neb. 68114
(402) 399-7035
PERSONNEL: Jay Oxten, president.
DESCRIPTION: Serving 4.5 million subscribers, FDR offers mainframe-based, full-function management and billing services and PC-based, on-line, standalone systems. The cable system services division of First Data Resources provides the industry with a complete range of CATV office management and billing systems, from PC-based on-line systems to the most advanced mainframe system in the industry, backed by a responsive customer service organization. Whether your system has 20 subscribers or 200,000, First Data has a solution tailored to your needs at an affordable price.

Snowden Bunch
President
EHLEN SOFTWARE PRODUCTS, INC.
6094 Appletree, Suite 9
Memphis, TN 38115
901/795-0955

Information Systems Planners Inc.
6094 Apple Tree
Suite 9
Memphis, Tenn. 38115
(901) 795-8314
PERSONNEL: Snowden Bunch, president; Bruce Gronich, vice president.
DESCRIPTION: ISP offers "CABILL," an on-site computer billing system for operators serving 1,000 to 100,000 subscribers. ISP also promotes AT&T products, canned software, modified software and entire systems designed for markets where packages have not yet been developed. ISP has a staff of nine devoted to producing user satisfying systems. ISP developed CABILL, a marketable product designed for the cable television industry. ISP plans to develop other packages that would be marketable to certain specific industries.

KMP COMPUTER SYSTEMS
A Division of First Data Resources Inc.
135 LONGVIEW DRIVE
LOS ALAMOS, NEW MEXICO 87544
505/672-1600
ELDON C. PEQUETTE
CABLESTAR™ CATV Billing & Management Systems

KMP Computer Systems
2075 Trinity, Suite 100
Los Alamos, N.M. 87544
(505) 661-7700
PERSONNEL: Eldon Pequette, president.
DESCRIPTION: Serving more than 250 cable systems nationwide, KMP Computer Systems provides PC-based billing services and management information systems for CATV operators with 20 to 20,000 subscribers, both addressable and non-addressable. Software packages are available for your existing IBM or compatible PC, as well as turnkey systems for operators that may require hardware. KMP's "Cablestar" software gives you a full-function on-line system that can run on a single PC or can be networked to multiple PCs as your workstation requirements grow. Software design is portable, allowing for hardware upgrades without software obsolesence.

Toner Cable
computer systems, Inc.
Karen M. Toner
Software Applications & Support Manager
969 Horsham Road
Horsham, PA 19044
(215) 675-2053
Toll Free: 800-523-5947 ◻ PA Only: 800-492-2512

Toner Cable Computer Systems
969 Horsham Road
Horsham, Pa. 19044
(800) 523-5947
(800) 492-2512 (Pa. only)
(215) 675-2053
PERSONNEL: Robert Toner, president; Steve Deasey, sales; Karen Toner, sales.
DESCRIPTION: Toner's standalone computer system, with more than 200 systems sold, is a turnkey cable billing and subscriber management computer system providing the following: Subscriber billing (monthly, cycle, coupon, annual, etc.); accounts receivable; management reports; marketing reports; custom report generator; work order programs; service call programs; addressable interfaces; OCR (optical character) scanning for ease of payment entry, etc.

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First Data Resources, Inc.
Cable System Services Division
(402) 399-7545
Cable Marketing Department, 7301 Pacific Street, Omaha, Nebraska 68114

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Commercial insertion systems must be flexible

Texscan study reveals changes inevitable as advertising programs mature.

An analysis was made of 100 cable TV commercial insertion systems to determine patterns of use which could guide Texscan and its customers to select features and functions which can best meet specific commercial insertion requirements.

These patterns were established in detail, and the general summary of factors presented in this report pinpoint two conclusions:

1) There is great diversity in the mix of features and functions purchased by cable operators, and

2) The majority of systems will proceed through an evolution of significant changes—probably within the first year or two of operation—as local advertising programs mature.

The purpose of this report is to isolate the principal features of a commercial insertion system that control its architecture. The findings are that patterns of use can be quantified, but they are subject to periodic change. The conclusion is: Stress the importance of creating a flexible hardware and software path for this inexorable change in the future.

Definition of survey parameters

An analysis was made of 100 cable systems which purchased automated commercial insertion systems within the last 18 months. These 100 systems control 343 channels of ad insertion, an average of 3.4 channels per system.

The systems range in size from single-channel, locally controlled installations to networks with more than 50 channels in multiple markets programmed by a central computer.

The systems have been in operation long enough to establish a history of changes made in system architecture to upgrade or expand in concert with the rapid learning curve in commercial insertion operations.

Five major features of a commercial insertion system

I. Spot selection method
A) Random sequential
B) Semi random access
C) Full random access

II. System control
A) Local
B) Remote

III. Computer software level
A) Standard affidavit
B) Store-and-sort reports
C) Full traffic and billing

IV. Networking
A) Markets in the region
B) Multiple regions with multiple markets

V. Program playback automation
A) Single channel
B) Multiple channel

All of these architectural features of a commercial insertion system have

Example system featuring matrix chart

Upgrade from basic four channel to four channel networking system

	Basic four channels	Expanded system	Your system
I. Spot selection			
A. Random sequential	X		
B. Semi-random access			
C. Full random access		X	
II. Control			
A. Local	X	X	
B. Remote		X	
III. Software			
A. Standard	X		
B. PC store and sort			
C. Traffic and billing		X	
IV. Networking		X	
V. Automatic program playback			
A.			
B.			
VI. Expansion			
A. More channels			
B. More markets		X	

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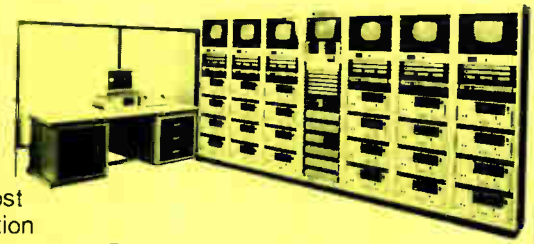

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LOGMATIC JR.

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- Power fail relay bypass.
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An analysis was made of 100 systems which purchased automated commercial insertion systems recently.

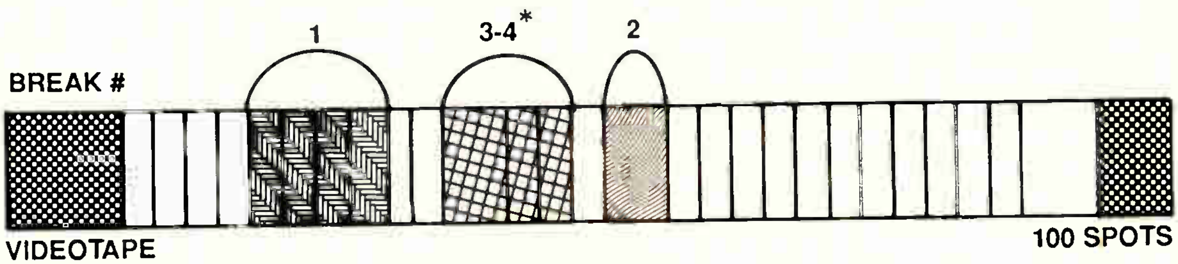


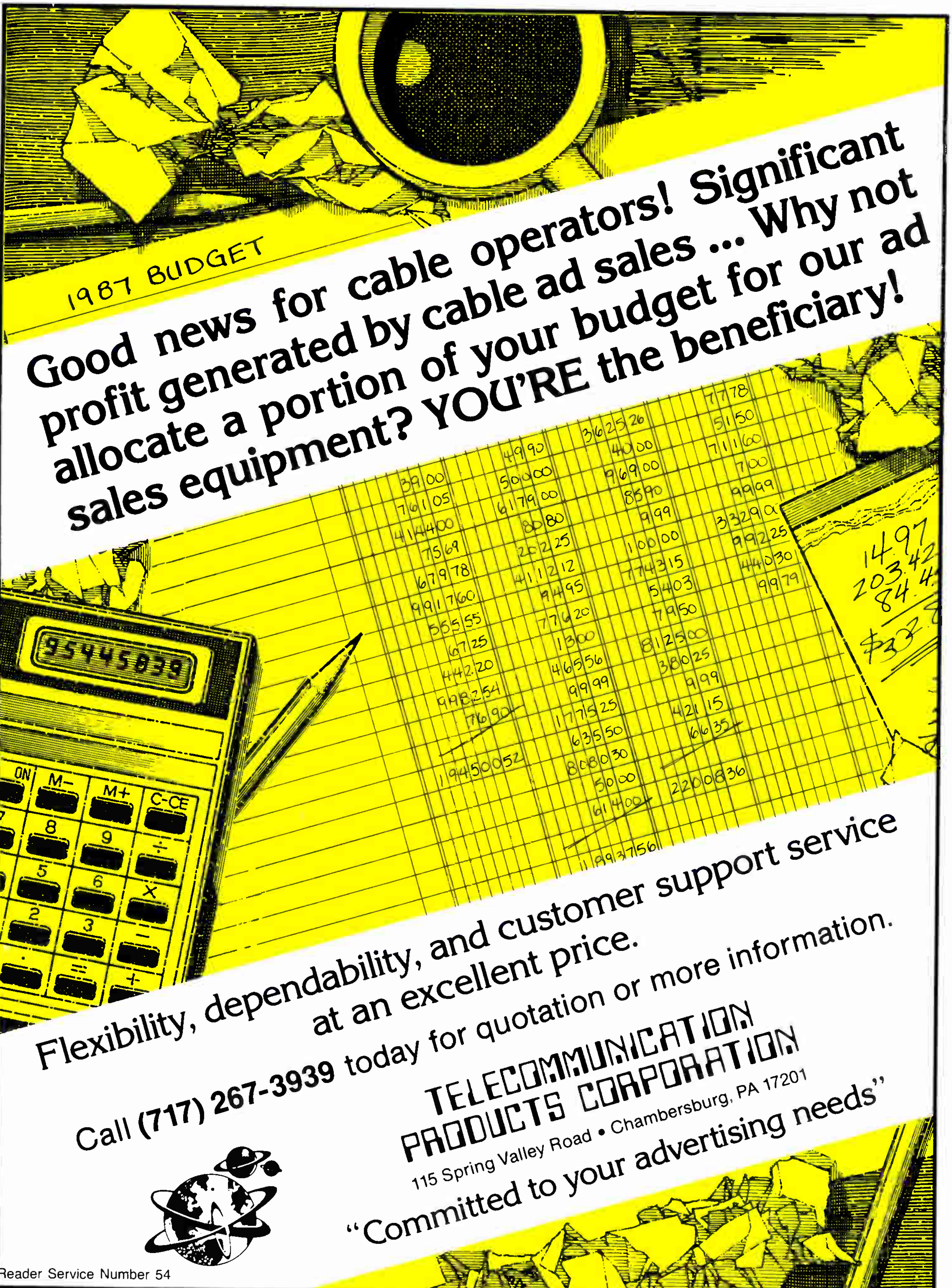
FIGURE 1

DEPICTION OF VIDEOTAPE FORMAT FOR RANDOM SEQUENTIAL INSERTION

CHANNEL	BREAK NUMBER	BREAK LENGTH	SPOT NUMBER	SPOT LENGTH
CNN	1	2 Min	5	30 Sec.
			6	30 Sec.
			7	30 Sec.
			8	30 Sec.
	2	1 Min	38	30 Sec.
			39	30 Sec.

CHANNEL	BREAK NUMBER	BREAK LENGTH	SPOT NUMBER	SPOT LENGTH
CNN	3	2 Min	12	60 Sec.
			13	30 Sec.
			14	30 Sec.
	4*	1 Min	12	60 Sec.

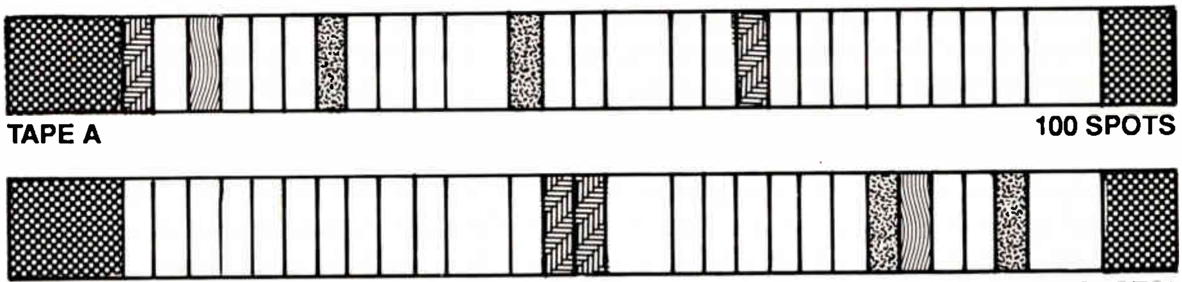
*Same as first spot in break 3.



Reader Service Number 54

An operator should be able to progress to any feature and level without discarding any part of the system.

DEPICTION OF VIDEOTAPE FORMAT FOR SEMI-RANDOM ACCESS INSERTION



TAPE A — 100 SPOTS

TAPE B — 100 SPOTS*

FIGURE 2

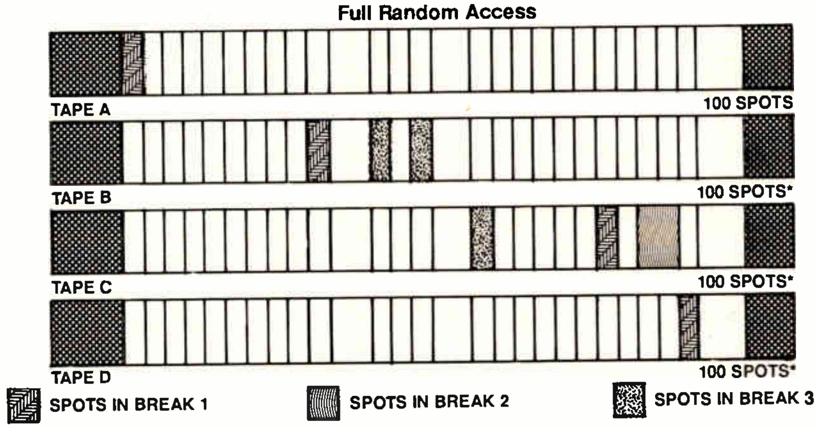
SPOTS IN BREAK 1 — SPOTS IN BREAK 2 — SPOTS IN BREAK 3

CHANNEL	BREAK NUMBER	BREAK LENGTH	SPOT NUMBER TAPE A	SPOT NUMBER TAPE B	SPOT LENGTH
CNN	1	2 Min	A-1		30 Sec.
				B-26	30 Sec.
				B-27	30 Sec.
			A-32		30 Sec.
	2	1 Min		B-88	30 Sec.

CHANNEL	BREAK NUMBER	BREAK LENGTH	SPOT NUMBER TAPE A	SPOT NUMBER TAPE B	SPOT LENGTH
CNN			A-3		30 Sec.
	3	2 Min	A-21		30 Sec.
				B-87	30 Sec.
			A-13		30 Sec.
				B-96	30 Sec.

* Spots on Tape B may be the same as or different than those on Tape A.
Capacity for spots on this channel is 100 full random access for 1 minute breaks, 200 for semi-random access on all breaks.

The terms 'random sequential' and 'random pod' are not always synonomous.



CHANNEL	BREAK NUMBER	BREAK LENGTH	SPOT NUMBER A	B	C	D	SPOT LENGTH
CNN	1	2 Min	A-1				30 Sec
				B-26			30 Sec
					C-75		30 Sec
						D-100	30 Sec
	2	1 Min			C-80		60 Sec

CHANNEL	BREAK NUMBER	BREAK LENGTH	SPOT NUMBER A	B	C	D	SPOT LENGTH
CNN	3	2 Min		B-30			30 Sec
						D-1	30 Sec
				B-28			30 Sec
					C-44		30 Sec

*Each tape can be the same or as different as the other tapes; the capacity for spots on this channel is 100 full random access, 400 semi-random access.

Reader Service Number 56

We classify computer software programs into three levels: standard, PC store-and-sort and full traffic billing.

several levels of sophistication. Axiom: An operator should be able to progress to any combination of features and levels without discarding any part of the system.

Definition of terms

I. Spot selection method.

Prior to each advertising break, one or more spots are cued up for automatic insertion to take place after the next satellite cue signal or programmed clock time. There are three basic methods of selecting spots which will show on the next break:

A) Random sequential.
A group of spots are shown consecutively in the order in which they were placed on the tape. Although spots must be shown in sequence during the break, any group of sequential spots may be used for the next break.

This is sometimes referred to as "random pod," meaning that the several spots shown in the break form a "pod" of spots.

The terms "random sequential" and "random pod" are not always synonomous. Some systems require that the "pod" be recorded on the tape as an inviolate group, others allow the recording of all spots back-to-back so the sequence of spots can begin anywhere on the tape.

B) Semi-random access.
A channel or group of channels such as CNN, ESPN, etc., may be subject to VCR controllers which have fewer VCRs than the number needed to cue up all of the spots necessary for the break ahead of time. For example, a two-VCR controller must show four spots on CNN during the two-minute, top-of-the-hour break. It can cue up the first two spots ahead of time, but it must search for the next two spots during the break. There is a physical limitation to the amount of time one machine can search while the other is showing a 30- or 60-second spot; therefore, the system must select the next spot within a range of nine spots in either direction during 30 seconds or 35 spots during a 60-second interval.

Because the last two spots cannot be selected totally at random, this spot selection method is deemed semi-random access.

C) Full random access.
This spot selection mode permits the operator to play any spot sold on that channel during any break, in any order, at any programmed time.

II. System control

A) Local control.
Each satellite channel's VCR controller must be scheduled by an input terminal. The terminal and printer must also receive data from the controller for purposes of verification logging, status monitoring and print programs. If this terminal is directly connected to the VCR controller in the same building, it is locally controlled.

B) Remote control.
If the terminal is remoted over

Some marketing organizations are connecting cable systems from several surrounding states into multi-regional networks.

telephone lines or coaxial cable for all scheduling, logging, monitoring, printing and override functions, it is under remote control.

III. Level of computer software

We classify computer software programs into three levels: Standard, PC store-and-sort and full traffic billing.

A) Standard.
Standard computer software for scheduling spots, status monitoring, logging, tape marking, printing and actual spot insertion is in the firmware PROMs in the controller. This software prints running verification logs, provides a few days of log storage and prints sorted client affidavit reports automatically daily. All that is needed to access the system is a "dumb" terminal.

B) PC storage-and-sort.

Many operators require a computer and software system which can store all monthly verification log information through automatic retrieval, and then convert this data into a series of customer-designed monthly reports for affidavits and special client information "cuts." This normally requires the addition of a PC with hard disk to handle this larger volume of stored data.

The PC also provides a "smart terminal" for programmed auto dial functions and an interface to other computer programs such as optional traffic and billing.

C) Full traffic and billing.
Traffic and billing programs are constantly being improved in the industry. They provide such services as spot inventory reports, automatic channel scheduling from contract data entry, affidavits, invoicing and many special reports. Traffic and billing software requires the power of an IBM PC AT computer.

IV. Networking

An increasing number of cable TV operators' commercial insertion systems are being linked to a central station which schedules and manages several systems in the same regional advertising market. Some marketing organizations, either MSO or independent, are even connecting cable systems from several surrounding states into multi-regional networks. We define a network as two or more cable commercial insertion systems connected to a central computer which electronically manages them. ■

Commercial insertion article provided by Texscan Corp.

Record numbers flock to Cable-Tec Expo

The SCTE found its place in the sun in Orlando, where record numbers of attendees and exhibitors flocked to the eleventh annual Engineering Conference and the fifth annual Cable-Tec Expo April 2 through 5.

Under sunny skies but cool temperatures, more than 1,100 attendees were registered, up from 850 who attended last year's Expo in Phoenix. The Hyatt Orlando's exhibit hall was filled to overflowing by 98 exhibitors who came showing their latest generations of hardware and services. "The high turnout came as a pleasant surprise to us," said Bill Riker, SCTE executive vice president.

Although the big winner was the SCTE, which now boasts more than 3,300 active members, the Society itself recognized a number of people for their contributions to the industry during the luncheon portion of the Engineering Conference. Named 1986's Member of the Year by the SCTE board was Rex Porter of Times Fiber Communications. A charter member of the SCTE, Porter was given the award based on his continuing support and dedication to SCTE's goals and for his $2,500 contribution to the scholarship fund.

Six members of the Board of Directors were elected by the membership in January. The entire Board consists of: Region 1, Bob Vogel, Hanford Cablevision; region 2, Ron Hranac, Jones Intercable; region 3, Bill Kohrt, M/A-COM; region 4, Gerald Marnell, Douglas Communications Corp.; region 5, Mike Aloisi, Showtime/TMC; region 6, Gary Selwitz, Warner Cable Communications; at-large, Richard Covell, Jerrold; Len Ecker, consultant; John Kurpinski; Bob Luff, Jones Intercable; and Dave Willis, TCI.

Prior to the membership meeting, the Board elected its officers for the coming year. They are: President, Bob Luff; Eastern vice president, Mike Aloisi; Western vice president, Richard Covell; secretary, Ron Hranac; and treasurer, Bob Vogel.

SCTE President Bob Luff bestowed the President's Award to *Communications Technology* magazine for the publication's support and promotion of the Society.

Other winners of special merit included Paul Beeman of Viacom Networks, who conducted 16 full-day technical seminars to various chapters and meeting groups over the past year. Also, Expo conference chairman Ralph Haimowitz of American Cablesystems was given a plaque in honor of his work organizing this year's event.

In recognition of their exemplary

Sandwiched in between all the good news was a warning on consumer interface issues.

performance in their respective fields, Outstanding Achievement Awards were presented to the following individuals by Jim Stilwell, chairman of the technical awards committee: John Green, chief technician, United Artists Cablesystems; William Riley, regional engineer, American Cablesystems Corp.; Dana Rappold, outside planning manager, American Cablesystems of Massachusetts; Garry Bowman, chief engineer, United Artists Cablesystems; Jack Trower, corporate engineer, Wehco Cablevision; Ron Boyer, applications engineer, Microsat South East; Wendell Woody, field sales representative, CATEL Communications; Jason Barstow, chief technician, Group W Cable; Pete Daly, service manager, Rollins Cablevision; and Toni Barnett, vice president of editorial, *Communications Technology*.

Seven members were elevated to Senior Member status, including: Steve Bell of Video Cable Systems Inc.; Walt Ciciora with ATC; Gary Donaldson, Wometco Cable Television Inc.; Larry Massaglia, Gilbert Engineering; Jon Ridley, Jerrold; Gary Selwitz, Warner Cable Communications; and Mike Smith, also from Warner.

Charles Hutchens, chief technician for Freedom Cablevision in Sanford, N.C., and David Soldan, lead technician for Lincoln Cablevision in Lincoln, Neb., were named scholarship award winners for the months of March and April. Awards are presented to individuals who show the greatest potential for advancement in the industry. Both will receive tuition assistance for an NCTI technical correspondence course of their choice.

Indicative of the Society's rapid growth over the past year, five more meeting groups were elevated to full chapter status. Included was the Cactus Chapter from Phoenix, the North Central Texas Chapter from Dallas, the Razorback Chapter from Jonesboro, Ark., the Tip-O-Tex Chapter from Alice, Texas, and the West Texas Chapter from Big Spring, Texas. Meanwhile, the Chatahoochee Chapter, representing the Atlanta area, was presented a plaque for its participation on the jointly sponsored Engineering and Technical Management Seminar held in January.

Sandwiched in between all the good news, however, was a loud warning sounded by panelists discussing consumer interface issues. New VCR product introductions, already announced and slated for later this year, that promise significantly improved picture resolution, may begin a slow rumble that will surely turn into a cacophony of complaints if the industry doesn't do all it can to deliver clean signals.

"It used to be that the VCR was the

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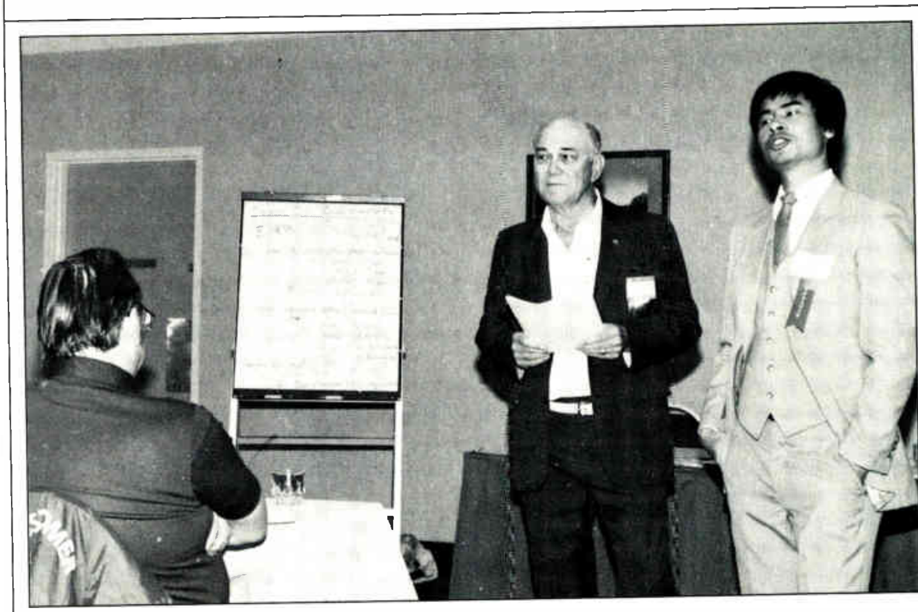
Reader Service Number 65

Television receiver manufacturers are developing more sophisticated, more intelligent sets every year.



Cliff Paul (left), consultant, and John Wong, engineering advisor at the FCC, lead a question-and-answer session. Consisting of an informal test covering CARS microwave, aeronautical frequency usage and the recent A/B switch ruling, attendees discussed policies, procedures and rules associated with receiving and maintaining FCC approval to operate.

stepchild of the industry," said panelist Tom Mock, a staff engineer with the consumer electronics group of the Electronic Industries Association. "Now, however, it's going to set the pace." Similar warnings were expressed by Wendell Bailey, NCTA vice president, science and technology and Vito Brugliera, vice president of marketing and product planning for Zenith cable products.

At issue is the number of lines of resolution consumers will have available to them. According to Mock, if consumers own a new TV set that is capable of delivering between 400 and 500 lines, the new Super VHS will bring 440 lines of resolution while ED (extended definition) Beta will deliver about 500 lines to viewers' eyes. The newer 8 mm video format will probably soon follow with an enhanced product soon, added Mock. The resolution numbers compare very favorably to off-air broadcast and cable, which typically offer about 325 lines and 250 lines, respectively, said Brugliera.

What does it all mean? It could be trouble, because subscribers will be able to directly compare the pictures offered by their VCRs against those offered by cable. And if the new recorders offer resolution that is twice as good as cable, it could be a very long winter for operators and their engineers. "The comparison (between cable pictures and VCR pictures) will not be favorable (to cable)," said Sruki Switzer, consulting engineer, during a later session. "In the past, people didn't know any better. Now they will."

And it doesn't stop there. Television receiver manufacturers are developing more sophisticated, more intelligent sets every year, said Brugliera. The most widespread trend is in audio, now that 90 percent of the nation's population has access to broadcast stereo. The increased frequency range possible in the sets is forcing cable operators to deliver stereo, and that isn't necessarily easy. The biggest key to delivering good stereo audio is maintaining the proper separation levels, said Brugliera.

Tuning functions and on-screen display of information are also becoming more sophisticated. Tuners utilize microprocessors with intelligence, can tune up to 178 channels and often eliminate the need for a set-top converter. On-screen displays of channel,

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Reader Service Number 67

The 1988 Cable-Tec Expo will be held in San Francisco June 16 through 19.

time, type of audio received (stereo or mono), bass and treble adjustments and a host of other fields are being built into top-end sets, said the Zenith executive, and operators need to be aware of these trends.

Meanwhile, Bailey iterated the need for Multiport, the baseband decoder device standard accepted by the EIA. Although it will supplant set-top decoders, which is seen as a boon to both operators and consumers, it will also eliminate remote revenues, often a substantial sum of money, he said.

For the first time, the nine Expo workshops were each offered in two formats, one for engineers and one for technicians. Sally Kinsman, president of Kinsman Design Associates, and George Salvador, manager of design and drafting for ATC, instructed attendees on cable system design. Basic concepts such as cable attenuation, and tap and splitter selection were covered, and included the actual design of a small feeder leg.

Steven Biro, president of Biro Engineering, discussed the elimination of interference with antennas and antenna arrays. He discussed how to design various arrays to protect signals from interference, how to choose the best type of antenna, and told attendees to do an on-site survey before building a tower, adding, "If you get interference, move it."

Performing measurements on basic test equipment was covered by John Shaw, president of Cable Communications Scientific, and Terry Bush, technical support specialist at Wavetek. Their sessions covered which equipment to use to determine system signal response and RF signal analysis, what the equipment does, how to hook them up and how to interpret the results.

Scientific-Atlanta's Principal Engineer Jim Farmer looked at the subleties of sync suppression scrambling. Utilizing a slide show, he showed attendees how to set carrier and modulation levels on scrambled signals, how to set up a scrambler and how to spot problems with scrambling systems.

BCT/E review courses on signal processing centers and engineering management and professionalism were conducted by Alex Best and Wendell Bailey, respectively.

The 1988 Cable-Tec Expo will be held in San Francisco June 16 through 19, announced Riker. After receiving a dozen ideas on where to hold the event, the field was subsequently narrowed down to five choices. The Board settled on San Francisco because the Expo had never been held in the Northwest, facilities were available to house the entire program and significant savings on room rates was sucessfully negotiated.

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Reader Service Number 87

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Providing back-up to broadband LANs

Learning how to avoid network failures could save thousands of dollars.

Local area networks utilizing broadband communications continue to gain acceptance primarily due to the continued demand for MAP (Manufacturing Automation Protocol). These networks are typically a combination of video and data, and exchange over this media may consist of manufacturing process control data. Failure of the network could represent thousands of dollars of productivity lost for every minute of disruption. Reliability is essential. For this reason, measures must be taken to offer a back-up in case of network outages.

Unpredictable sources of disruption

Interruptions in service in a broadband LAN can be caused by any number of sources. The primary failure modes include the following:

1) Cable and connector discontinuities
2) AC power supplies (60 VAC)
3) DC power supplies (24 VDC typically)
4) Broadband hybrid amplifiers

The above active electronics, 2, 3, and 4, have a destructive enemy in the form of surges or transients. Fluctuations on the power grid, grounding inconsistencies (sheath currents), and lightning can all be origins of dangerous surges. The network amplifiers (DC power supplies included) are typically well protected by means of spark gaps or other devices, but an occasional failure can indeed occur and result in costly loss of communications. Various forms of redundancy are used to guard against any break in signal integrity if such amplifier failure occurs.

Redundancy as a solution

Power back-up

Standby power supplies have been used as a standard measure to protect the system from temporary loss of primary power. Batteries are switched on and off to produce a square wave 60V AC waveform in the event of loss of input power. Status monitoring systems are available which permit regular maintenance (and exercise) of these batteries and will sound an immediate alert if anything goes wrong. It is now possible to monitor the electrolyte level remotely in addition to making actual measurements on the AC and DC voltages.

However, this protects the network against "down time" only in the case of power loss. It will not keep the network active for failures in the cable, connectors, DC power supply or the hybrid amplifiers.

Amplifiers

If one considers an RF amplifier as a black box with a certain vulnerability to surge, there are several levels of redundancy which can be used to protect it. The first level is to offer a passive bypass from input to output in the case of any detected failure within the amplifier housing. RF relays are typically inserted at the input and output paths of the main amplifier (see figure 1).

These switches route the RF signal past the amplifier that has failed, thus maintaining signal continuity. However, when in this bypass mode, the signal quality is compromised. The advantage to this technique is that data communications, in many cases, are quite tolerant of noisy environments and will survive if two-way continuity is available. The quality of the signal is indeed seriously degraded and there are obvious risks. RF relays by definition degrade the reliability of the amplifier station by themselves.

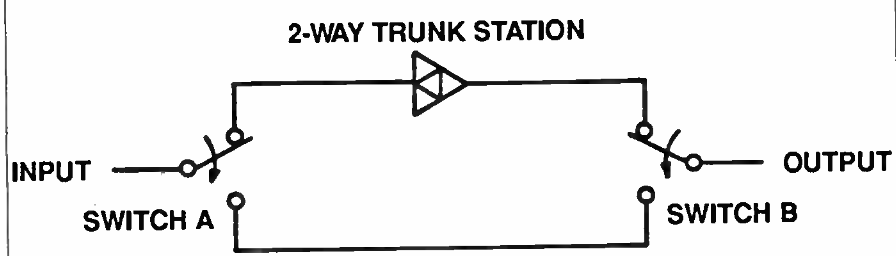
The next highest level of redundancy is to offer a lower cost amplifier which can be switched in when some failure is detected (see figure 2). This approach offers a significant advantage in that although the amplifier gain and signature may be compromised somewhat, the signal quality is probably more than adequate to maintain good two-way communications.

The best implementation of this approach might be to keep the redundant amplifier in a "cold" state so that its power supply, RF inputs, and electronics are shielded from the very source of failure (i.e. surges) which damaged the main amplifier. The second advantage to keeping the back-up amplifier turned off is to avoid added heat build-up in the housing which shortens the life of the electronic equipment. This technique can be implemented

Lee Thompson and Dale Lutz, Scientific-Atlanta

FIGURE 1

PASSIVE REDUNDANCY SWITCH



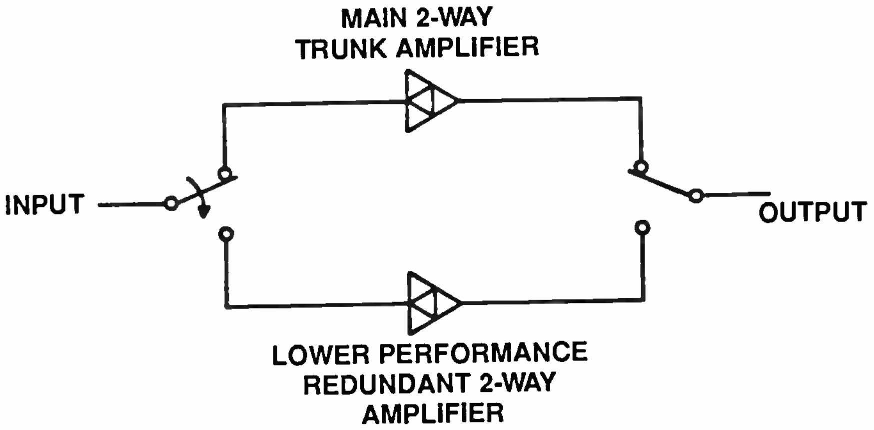
Advantages
1) Data communications can be maintained if one or two stations fail.
2) Can be constructed internally or externally to trunk station. (i.e. can be added at a later date.)

Disadvantages
1) MTBF degraded by inserting RF relays in system.
2) Signal quality is degraded when activated.
3) Relays (if external) must be capable of switching AC power as well as RF.

The next level of redundancy is to offer a lower cost amplifier which can be switched in when failure is detected.

FIGURE 2

SWITCHED ACTIVE REDUNDANCY

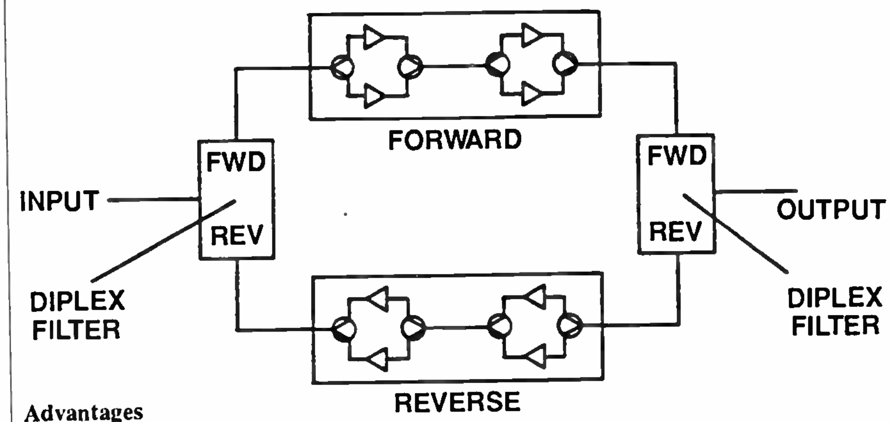


Advantages
1) Fully redundant amplifier modules.
2) Individual amplifiers can be removed without interrupting service.
3) Can be accomplished internally or externally to main trunk housing.

Disdvantages
1) MTBF degraded by inserting RF relays in the system.
2) Redundant amplifier may be susceptible to the same surges which could cause the main trunk to fail.

FIGURE 3

INTERNAL REDUNDANT FWD/REV TRUNK AMPLIFIER HYBRIDS



Advantages
1) Minimizes non-critical circuit redundancy.
2) All redundancy contained in trunk housing.

Disadvantages
1) Removal of module severes service.
2) Redundant hybrid exposed to same conditions as primary hybrid.
3) Level drops by roughly 6 dB in the event of either amplifier failure.

How to buy, sell and repair converters.

Managing your converter inventories for profit may require turning old converters to cash, purchasing new and used equipment as well as repairing existing inventories.

All makes, all models.

Where do you look for the buyers and sellers of each converter make and model? Service reps at PTS/Katek talk to more system managers everyday about converter

needs than anyone in the business. PTS/Katek buys all makes, all models and sells only to authorized cable systems. If it's not in stock, PTS/Katek knows where to find it.

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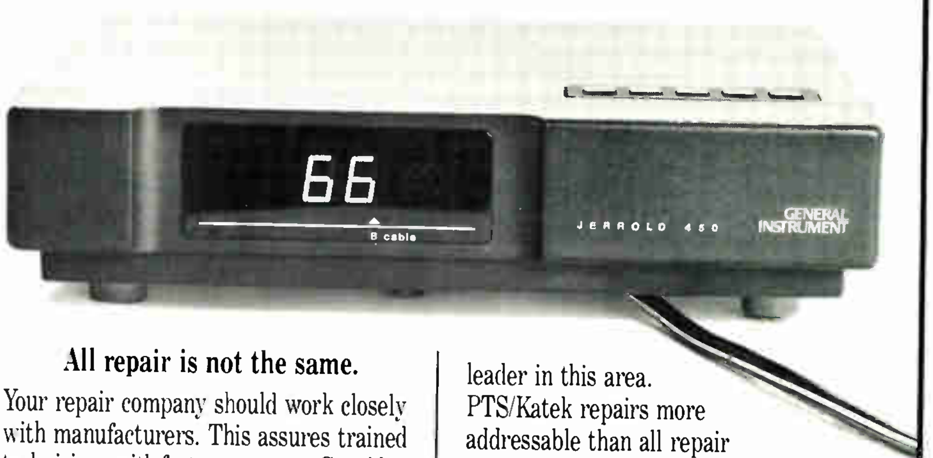
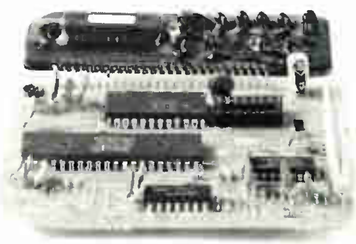
Many distributors only want your big orders and work from manufacturers' inventories. PTS/Katek has one of the largest private inventories. Plus they ship every in stock order, large or small, within 24 hours.



All repair is not the same.

Your repair company should work closely with manufacturers. This assures trained technicians with factory support. Consider parts availability, turn-around, warranty, and quality in addition to price. It's important to know the company you ship your converters to will be in business tomorrow.



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It might be argued that a great solution to redundancy would be to offer two amplifiers in parallel.

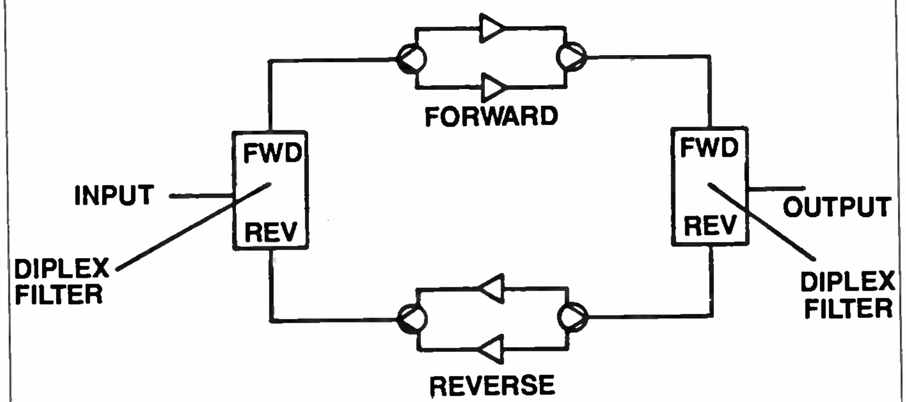
within the integral housing, or, in fact, can be accomplished externally as well by switching a less expensive amplifier across the primary in the event of signal loss.

While this is a more desirable technique than "station by-pass," in both cases an RF switch must be utilized. Once again, these switches degrade the amplifier reliability.

It might be argued that a great solution to redundancy would be to

FIGURE 4

INTERNAL REDUNDANT FWD/REV TRUNK AMPLIFIER

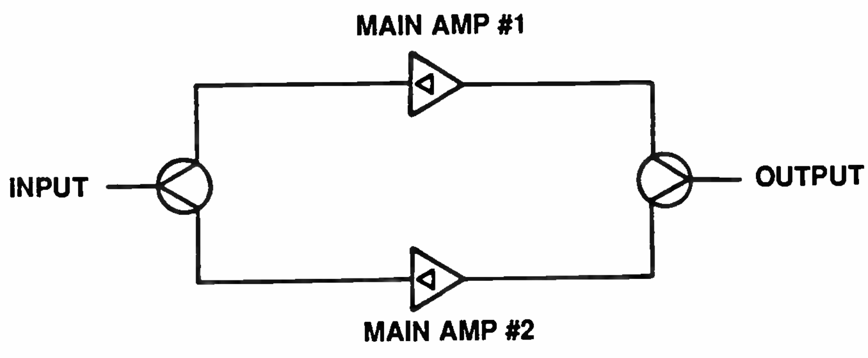


Advantages
1) Minimizes non-critical circuit redundancy.
2) All redundancy contained in trunk housing.

Disadvantages
1) Removal of module severes service.
2) Redundant hybrid exposed to same conditions as primary hybrid.
3) Level drops by roughly 6 dB in the event of either amplifier failure.

FIGURE 5

EXTERNAL COMBINED AMPLIFIERS



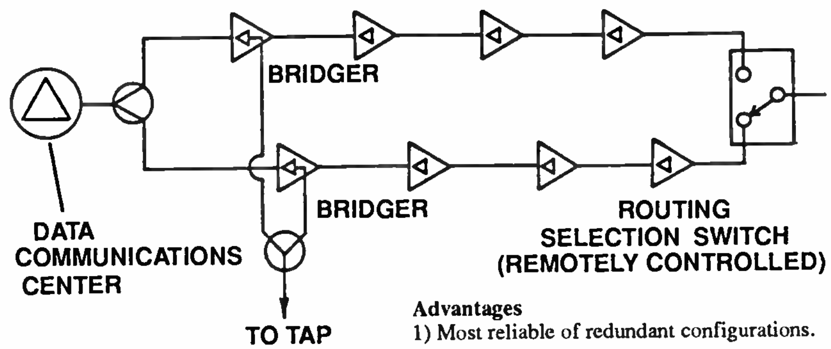
Advantages
1) Fully redundant amplifiers.
2) Amplifiers can be monitored separately.

Disadvantages
1) Both amplifiers exposed to same conditions which might generate a failure.
2) Level drops by roughly 6 dB in the event of failure by either amp.

To ensure constant communications over the LAN, redundancy is a necessity.

FIGURE 6

DIVERSE ROUTING REDUNDANCY



Advantages
1) Most reliable of redundant configurations.

Disadvantages
Costly (amplifiers and cables).

offer two amplifiers in parallel, "on" continuously within the same housing. The two amplifiers have a splitting device on the input and output, enabling both to be active simultaneously (see figures 3, 4 and 5). In the case of a failure between one *or* the other hybrid amplifier, the result would be negligible since the other gain path is still active and a level change of roughly 6 dB is the only output variation.

This method is subject to one weakness. Both amplifiers are now subject to the same surges and perhaps operate off the same power supply or transformer. In addition, heat becomes an issue as both amplifiers in the normal state continue to consume power.

With any of the above solutions, there is still a serious weak link. That weak link is the cable and mechanical connections of the system. The mechanical problems are at a lower severity level in an indoor controlled environment, however, they can and do exist. A case can be made, particularly in critical data situations, that the only acceptable solution is "true" redundancy (see figure 6). True redundancy can be characterized by a separate path located some distance from the primary path to avoid construction accidents. This is an appropriate solution to the main signal path (i.e. trunk) to ensure integrity.

A logical necessity to this approach, as in any other technique, is a flexible and powerful monitoring system. Routine testing and trend analysis can be used diagnostically to predict problems and trigger preventive maintenance prior to network outages. Interrogation of key amplifier nodes and external test equipment is also quite possible.

Conclusion

Little data has been accumulated on LAN-type environments, but in CATV systems statistics show that the most vulnerable part of the system is the cable and mechanical connections. The amplifiers themselves have a relatively long Mean-Time-Between-Failure (MTBF). To ensure constant communications over the LAN, redundancy is a necessity. The insertion of RF switches in the amplifier does obtain this redundancy, however, with a certain risk factor, as these switches will, by definition, further degrade amplifier MTBF.

True redundancy consisting of separate and distinct cable paths, combined with effective status monitoring, is the preferred solution to the problem of reliable communication in a LAN. ■

Once you've defined your terms, hard choices become obvious.

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\kən-ˈvər-tər\n: a device for adapting a television receiver to receive channels for which it was not originally designed.

SIGMA \ˈsig-mə\n: an advanced 550-MHz, baseband home terminal unit manufactured by Oak Communications Inc. Provides true encryption-based signal security; available features include IPPV,* all-channel secure MTS-stereo capability, secure master/slave configuration, on-board settop timer and programmable RCU timer for VCR compatibility, dual-cable inputs with automatic switching between A and B cables, and baseband outputs (audio, video).

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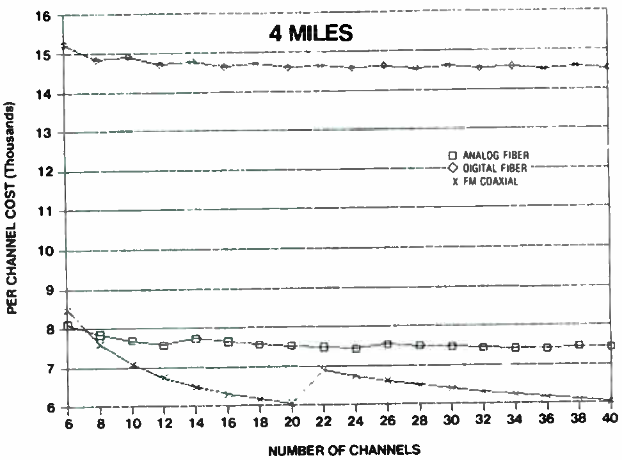
Reader Service Number 78

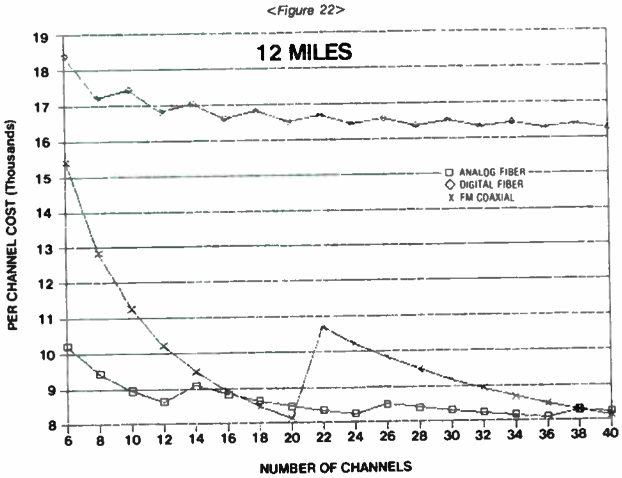
Ultimate single-mode fiber system bandwidth is a function of the spectral purity of the laser used.

Continued from page 52

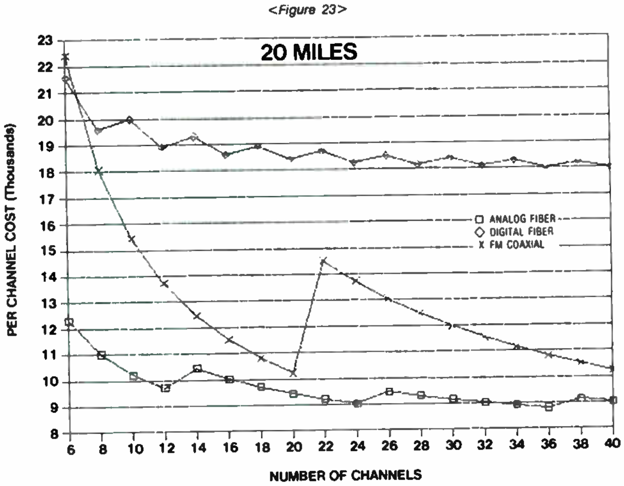
<Figure 21>



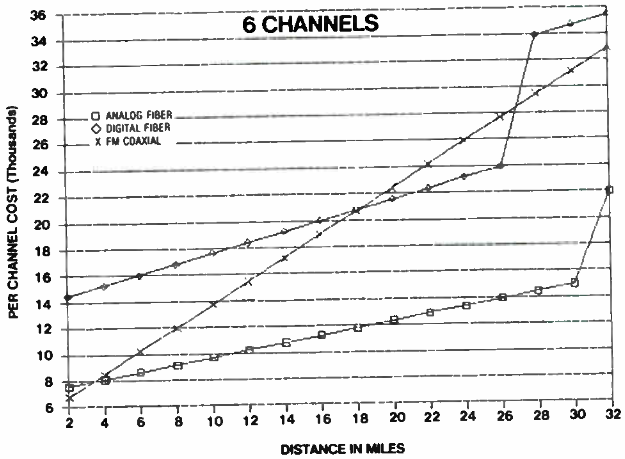
<Figure 22>



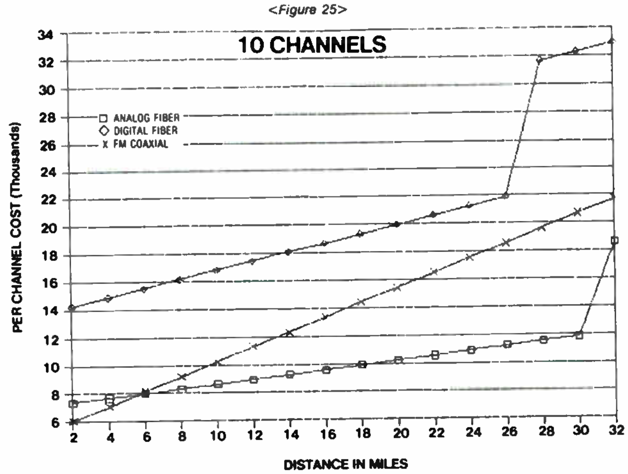
<Figure 23>



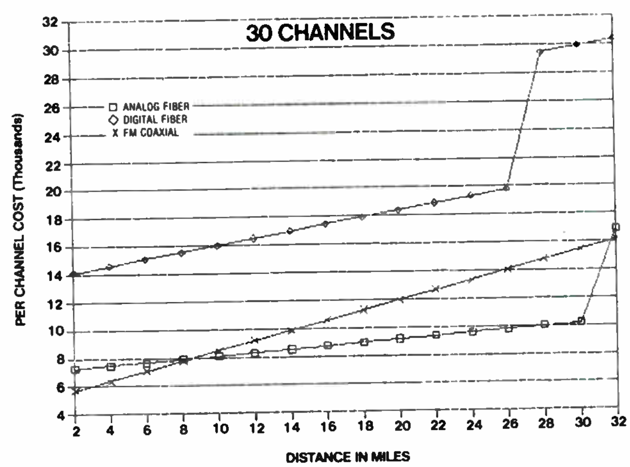
<Figure 24>

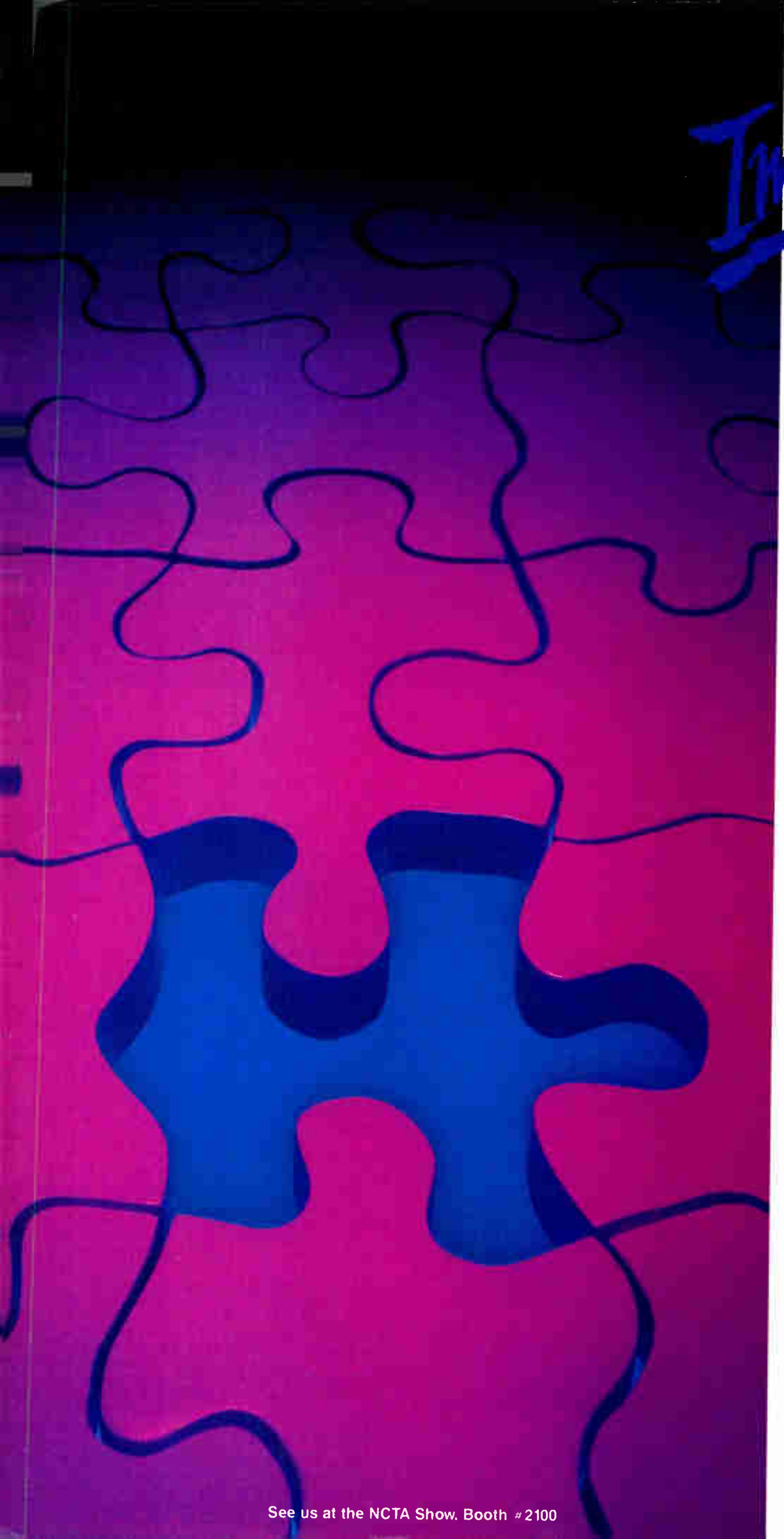


<Figure 25>



<Figure 26>





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GENERAL INSTRUMENT

Reader Service Number 79

good balance between potential performance limitations contributed by even/odd-order intermodulation products, optical device frequency response and noise performance. The ability to carry 12 channels 30 miles or more on a single-mode fiber with relatively inexpensive terminal equipment opens many possibilities for CATV applications. When the distances that must be traversed are not so great, the relatively large power budget available may be used for branching of the system to feed a number of hubs from a single transmission point, or for the insertion loss contributed by WDM diplex filters inserted to add additional transmission capability at 1550nm (in either the forward or reverse direction). It appears probable that the CATV industry is on the verge of rapidly accelerating use of this technology because of the convergence of performance and economics.

System economics

The following are updated cost assumptions made for systems which utilize FM video on coaxial cable, and the digital and analog fiber optic transmission systems installed and tested at

FM, FDM ANALOG SIGNALS ON FIBER:	
TERMINAL EQUIPMENT COST PER CHANNEL	$7050.00
FIBER COST:	
Single Fiber	$0.30 per/ft.
2 Fibers	$0.45 per/ft.
3 Fibers	$0.60 per/ft.
4 Fibers	$0.75 per/ft.
5 Fibers	$0.90 per/ft.
6 Fibers	$1.05 per/ft.
7 Fibers	$1.20 per/ft.
8 Fibers	$1 35 per/ft.
CHANNEL CAPACITY	12 CH/FIBER
DISTANCE BETWEEN REPEATERS	30 MILES
REPEATER COST PER CHANNEL	$6500.00
TDM, WDM DIGITAL SIGNALS OF FIBER:	
(FIBER COST SAME AS ABOVE)	
EQUIPMENT COST PER CHANNEL	$13645.00
CHANNEL CAPACITY	4 CH/FIBER
DISTANCE BETWEEN REPEATERS	26 MILES
REPEATER COST PER CHANNEL	$9175.00
FM SIGNALS ON COAXIAL CABLE:	
CABLE, AMPLIFIERS & POWER SUPPLIES	$0.66 per/ft.
PRESENT VALUE OF MAINT & POWER... (10 years, 12% annual discount rate)	$0.33 per/ft.
TERMINAL EQUIPMENT PER CHANNEL	$5000.00
CHANNEL CAPACITY PER TRUNK	20 CHANNELS

Oceanic Cablevision. There will, of course, be variations with each specific application.

The graphs in Figures 21 through 26 illustrate economic trade-offs under a variety of conditions between the three systems, based on the assumptions presented above and assuming equal labor, duct and strand costs for all three systems. Total cost per channel is plotted against a variety of distances and channel loadings. Breakpoints occur where a second cable is added to the coax system for additional channels, where additional fibers and lasers are added to fiber systems, and at distances where fiber repeaters are required.

It is clear that digital technology, based on the assumptions above, is attractive primarily in very long-haul applications where repeatability becomes critical. It is this technology, however, which may have the most potential for dramatic capacity increase and cost decrease in the next few years.

FM video on coaxial cable and FM, FDM video on single-mode fiber show much more closely comparable economics. While each application must be analyzed individually, it is clear that analog video transmission on fiber is often the least expensive alternative, particularly when the present value of the significantly higher ongoing operating costs of a coaxial system, with its amplifiers and power supplies, is included (as it is here).

There is an additional factor which is difficult to represent in either performance or cost comparisons between coaxial and fiber systems. That is the significantly greater reliability exhibited by fiber systems (with their smaller, tougher cable, and passive nature) over long distances. The vulnerability to amplifier, power supply and power utility failures which are inherent in FM coaxial systems are almost entirely avoided. This factor is of greater importance as the CATV industry moves into an era of increasing competition and demand for service quality from subscribers.

The analog fiber optic system marks the emergence of a second generation of fiber transmission technology which is economically applicable to the CATV industry. Digital transmission on fiber has a place today and may become a competitive alternative as digital components make advances in increasing speed and decreasing costs. Analog systems appear to be capable of performance and economics which will make them very useful for some time to come.

While FM video on coaxial cable remains a well understood, viable alternative in some applications, the number of those applications is decreasing dramatically. For point-to-point transmission of video and other CATV system signals, analog transmission via fiber is an option which simply must be considered. ■

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Reader Service Number 81

Single-channel negative traps

Augat/LRC Electronics

The VT-X single channel cylinder rejection traps from LRC Electronics operate within channels 2 through 6 and (A-2) through I. The trap's PC board is molded with hard plastic, and the units are temperature stable from -40 to +140 degrees. HRC, PRIME, IRC and other offsets are available for the VT-X line, which also features a blocking capacitor and RF shielding. A notch depth of -60 dB is provided for all channels; a special notch of 65 dB is available.

For more information, contact LRC Electronics at (607) 739-3844.

Eagle Comtronics

Eagle traps are available at standard, HRC, IRC, inverted, European and special frequencies. Made in the U.S., standard features include: a single PC board for improved ground continuity, a blocking capacitor to discourage theft, permanent channel identification, extended high frequency response and temperature compensation. The thick wall brass housing is anti-corrosion nickel plated and will withstand a half ton of pull. Eagle traps also feature two O-rings sealing the main body, a sealed pin, metal or plastic shields, and urethane potting to resist shocks and increase stability.

The ETN line of traps from Eagle provides a high-frequency loss of -0.5 dB at 500 MHz and -1.0 dB at 525 to 600 MHz. The ETN-2 through ETN-13 for channels 2-6, A-2, A-1, A-I, and 7-13 offer a notch depth of -75 dB; ETN-J through ETN-W for channels J-W offer a notch depth of -70 dB.

For more information, contact Eagle Comtronics Inc. at (800) 448-7474 or (315) 622-3402.

Gamco Industries

Security traps from Gamco are completely encapsulated to prevent moisture absorption and to absorb shock. The traps feature a soldered linear ground pad, a sealed connector and pin, and power protection on the center conductor. The traps' thick wall brass housing will withstand a half ton of pull. Gamco traps are temperature compensated from -40 to +140 degrees and operate to a bandwidth of 450 MHz. Return loss on the traps is 16 dB.

Gamco traps are available with the optional Terma lok security system—a built-in, patented theft-deterrent locking mechanism.

The single channel traps from Gamco are available in either a three- or four-pole configuration. Gamco's three-pole 605/606 series of traps for the low-, mid-, high-and superbands provides a rejection depth of -60 dB. The four-pole 617/618 series, also for low-, mid-, high- and superbands, provides rejection depth of -75 dB.

For more information, contact Gamco Industries Inc. at (800) 221-1367 or (201) 381-0700.

Intercept

Intercept's single channel notch filters are completely filled to prevent moisture absorption and sealed at both ends to prevent moisture from penetrating into the trap. The double press fit of the outer cover to the inner housing assures positive contact for maximum resistance to RF leakage. All metal parts of the Intercept trap line are machined from solid brass which is nickel plated for durability and corrosion resistance. A PVC boot on the tap connection seals tight against the tap port and prevents thread corrosion. Weather-tight O-rings seal the outer sleeve. All Intercept traps will withstand temperatures from -40 to +140 degrees and pressure on the port up to 100 PSI.

For more information, contact Intercept Corp. at (800) 526-0623 or (201) 471-2212.

Microwave Filter

The Series 5KV standard video pay TV traps from Microwave Filter provide a video notch loss of 70 dB. In addition, a 50-dB bandwidth maintains video suppression under extreme temperature swings from -40 to +140 degrees. The units are available for standard, HRC, inverted and offset channels.

Microwave's traps are moistureproof-tested to withstand forced air at 100 PSI without leakage. In addition, the units are designed to withstand 25 in-pounds of torque without connector rotation or damage, and permit less than one microvolt per meter of leakage at a distance of 10 feet from the trap. Shock testing equivalent to a 15-foot drop onto asphalt is also performed on Microwave traps.

For more information, contact Microwave Filter at (800) 448-1666 or collect at (315) 437-3953.

Northeast Filter Co.

The PermaTrap series from Northeast Filter offers a rejection depth of 65 dB. The units are temperature stable and feature a non-removable crimped sleeve and rubber seal on the connector and male pin. Completely urethane-filled, the PermaTraps also offer a passband range in the lowband of 450 MHz minimum; passband range for all other bands is 600 MHz minimum. Designed to be completely shockproof, these traps include moisture cure adhesive sealant to provide superior sleeve seal.

For more information, contact Northeast Filter Co. Inc. at (315) 437-7377 or 7378.

Continued on page 136

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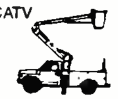

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BUSINESS DIRECTORY

All metal components of the ARCOM trap are made of nickel-plated brass.

Continued from page 130

Northern CATV Sales

The line of ARCOM urethane traps from Northern CATV Sales is urethane potted to prevent moisture ingress and drifting caused by water absorption. ARCOM traps are moisture sealed at the pin end and around the tab and feature O-rings sealing both ends. ARCOM traps are also pressure tested at 100 psi and the design features metal-to-metal contact between the outer and inner case to eliminate RF radiation problems.

All metal components of the ARCOM trap are made of nickel-plated brass in a tamperproof rolled case to prevent subscriber retuning.

Features of the ARCOM line of traps include: staked and soldered copper-coated steel center conductor, positive interlocking modules, recess in male "F" connector, 360-degree solder of PC shield to case, soldered interconnection, self-threading screw retainer and temperature compensated design.

For more information, contact Northern CATV Sales Inc., (800) 448-1655 or collect at (315) 463-8433.

Pico Products

Pico's single channel notch filters are machined of thick wall brass and then nickel-plated for corrosion resistance. All circuitry is completely potted to inhibit moisture absorption and to stabilize circuitry. Neoprene O-rings between housing walls, at the male end, prevent moisture migration; and all lines are tested for 20-foot drop shock resistance. Thermo rubber weather seals form over the tap shoulder to prevent moisture migration by way of the threads. This also reduces broken tap ports. Machined and interlocked connectors facilitate threading onto the tap.

Pico's NF Series of three-pole single-channel notch filters provide rejection between -55 dB and -70 dB, with -60 dB nominal. The SNF Series Super traps feature four poles and offer rejection from -60 dB to -80 dB, with -70 dB nominal.

For more information, contact Pico Products Inc. at (800) 822-7420 or (315) 451-7700.

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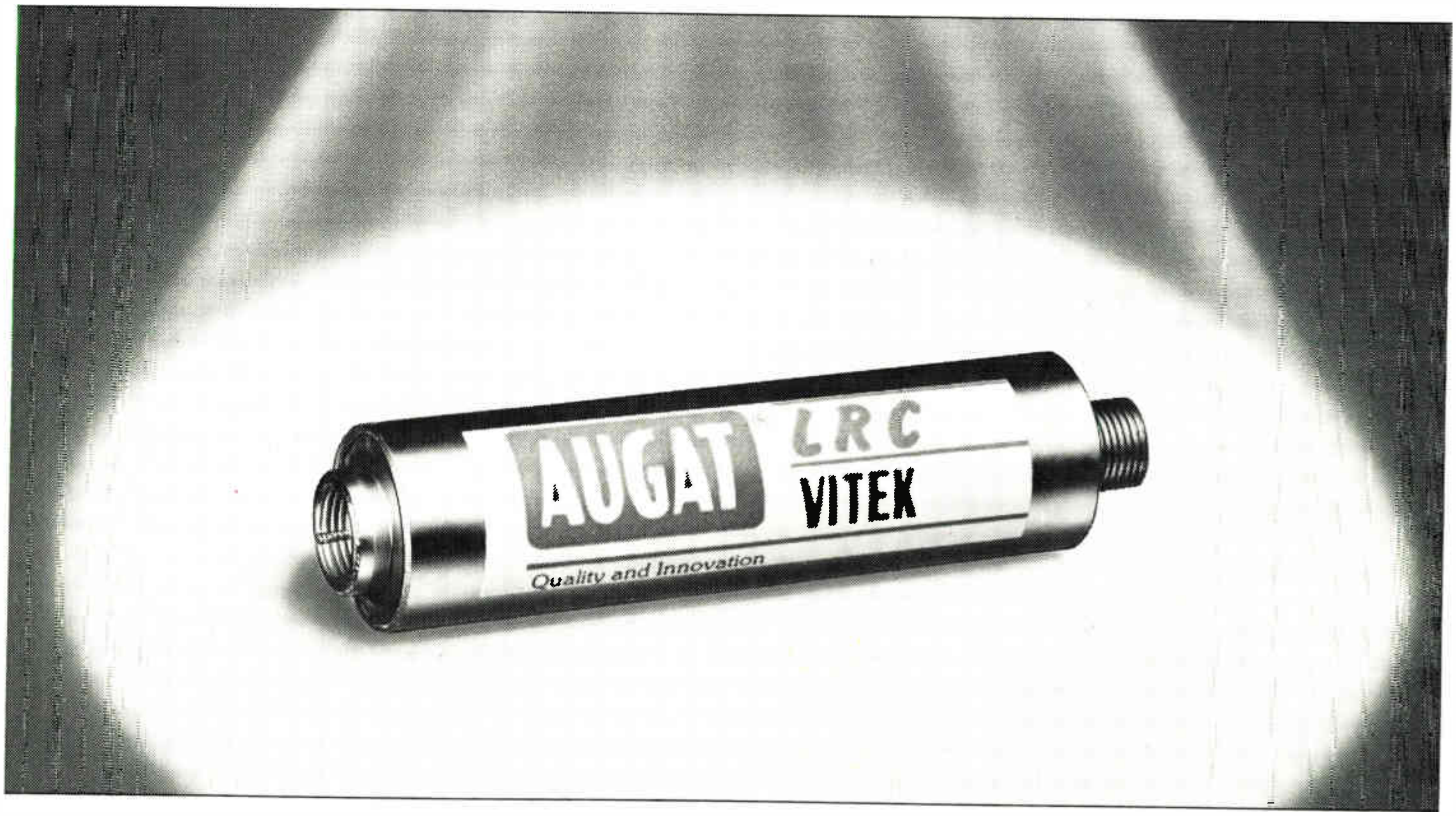
THE SHOW STOPPER.



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Multiport's limitations drawing interest from manufacturers and MSOs

Interest in **EIA's Multiport** is apparently beginning to percolate among the manufacturers and MSOs because people are beginning to discover some of the things it *won't* do. Missing from the baseband interface standard is the ability to impulse order a pay-per-view event and channel mapping.

Because Multiport was designed as a set-back device and performs no tuning functions, there is no effective way to push a button and receive PPV programs. For systems using technology other than ANI, that's possibly a significant problem, according to Nick Worth, vice president of engineering at TeleCable and a Multiport advocate.

Two remedies immediately spring to Worth's mind, but it's unclear which solution will shake out. The unit could be returned to the top of the TV, outfitted with an infrared receiver and consumers could be issued universal remote controls. The drawback to that approach is obvious—operators would again be forced to add capital to the home and a key aesthetic advantage would be lost.

The second option is to redefine the standard and include provisions for standard IR coding. However, that process would be lengthy and would result in the alteration of a standard that has already taken a long time to complete. However, unless ANI becomes the dominant technology to provide PPV, it's a problem that will become increasingly critical as Multiport catches on with consumers.

On the other hand, the inability to provide for channel mapping (an expedient way of redefining channel numbers via the converter) is more easily solved. Systems presently using converter channel mapping will have to physically alter their headends to put the programming on their proper channels. In many large metropolitan locations, channel mapping was a quick way to avoid direct pickup problems associated with strong off-air signals, but it is clear that with the advent of Multiport and the growing sales of cable-ready TVs, channel mapping was bound to lose favor with cable operators.

Pico Products has been tapped by TCI to provide a negative active trap for the MSO's "on-premise" cable connection concept. The giant MSO has placed an order for 50,000 of the traps, a scaled-down, re-engineered version of its OTAS off-premise active trap developed about five years ago, for its Miami, Fla., system. The traps, which will have to meet strict specifications supplied by TCI, can be used to control up to six levels of programming (which led them to be dubbed "6-pack"). The traps use an oscillator to effectively destroy the undesired signals to prevent subscribers from receiving unauthorized services.

In addition to the Miami system, TCI has ordered 150,000 additional traps for use in its other locations around the country, according to Pico officials. TCI is expected to use the Pico traps for highly penetrated pay services while reserving the positive trap, under development by S-A, for low-penetration pays and The Disney Channel.

Remember the addressability/scrambling/VCR pickle that Denver's Mile Hi cable system found itself in (*CED*, Feb. '87, p. 36)? Well, they've taken some steps that they think will help them climb out of the box they're in. First, the basic services will no longer be scrambled. Of the eight pay services offered, some will be trapped and some will continue to be scrambled.

What this all means is that customers with cable-capable TVs who subscribe to the basic service and a trapped premium service will no longer need a converter. And if they have a cable-compatible VCR, the unit's functions are completely restored. Those customers who receive trapped services only, don't plan on purchasing PPV events and don't have a cable-capable set will be issued a plain, non-addressable Jerrold or Panasonic box, according to John Dawson, vice president of engineering.

The change was slated to begin during the first week of April. Crews were to be sent out to install traps where needed throughout the 55,000-subscriber system. The whole exercise is an attempt to be more friendly with the growing number of cable-compatible TVs and VCRs out there. And, of course, the bottom line is to increase penetration, now at 26 percent.

Tele-Wire Supply Corp. has been bought by **Anixter**. Anixter has been on an aggressive acquisition spree lately, and had planned on taking market share from other suppliers in CATV for some time. No surprise there. What is a surprise is Tele-Wire's dramatic growth over the past year. We understand the company now has overtaken Cable TV Supply for the number two position among CATV suppliers.

Jerrold has developed a 600 MHz full feature tap with improved insertion loss performance in the 300-400 MHz range. The FFT-H series replaces the FFT-F, FFT-G and SPT series. The taps are two-, four- and eight-way interchangeable and are backward compatible to existing taps. The price of the taps increased about 12 percent over last year because of increased material costs, said Jerrold officials.

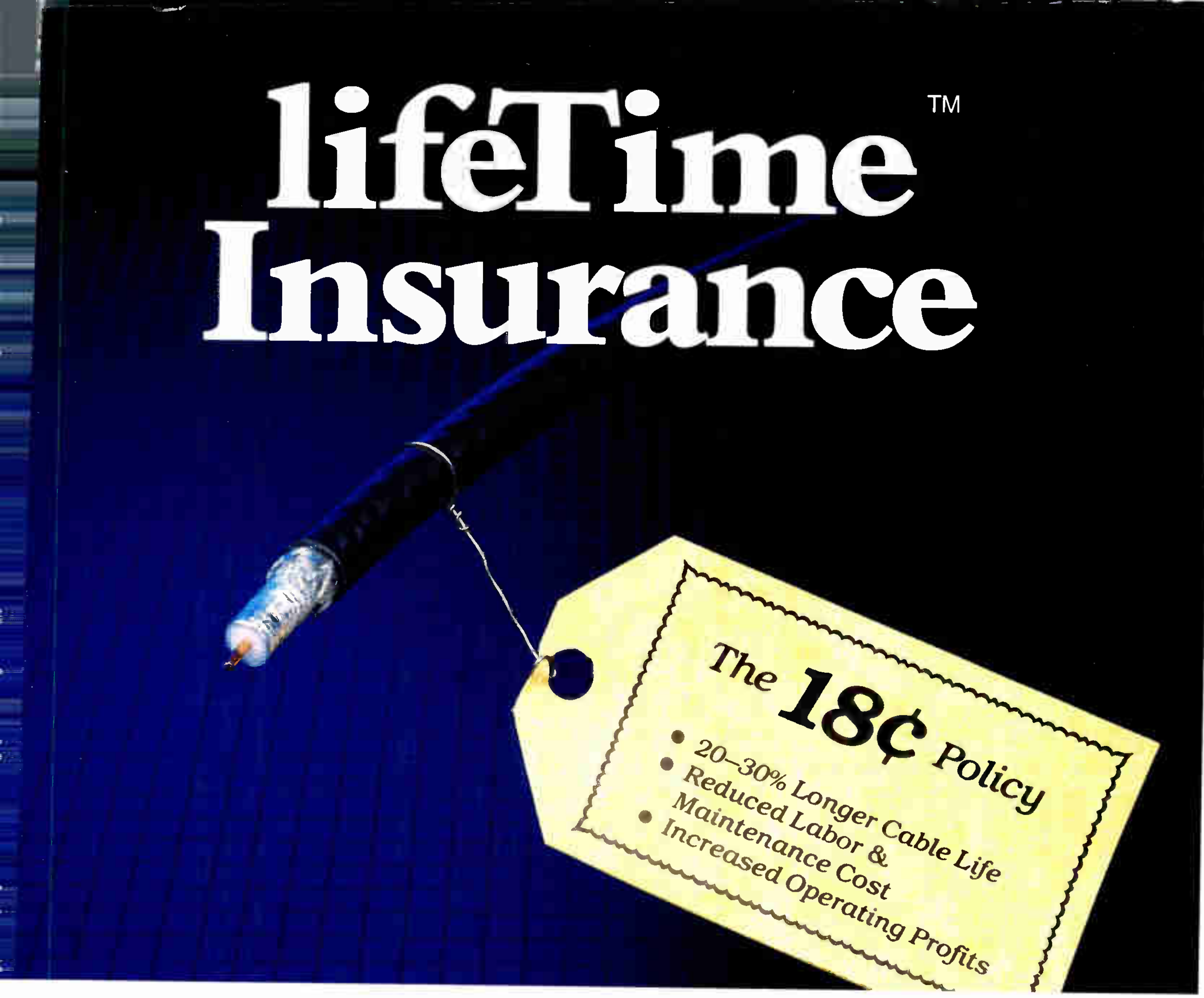
GI's **VideoCipher** division has introduced a lower-priced version of its integrated home satellite receiver/descrambler. The new VC II 2400R, with optional power supply, sells for $1,050 and comes complete with wireless remote control, two methods of parental control, programming for 24 C-band and 32 Ku-band channels, a programmable antenna positioner and digital stereo audio.

Reader Service number 110

An FM deviation meter designed to measure audio deviation in cable and SMATV systems has been developed by **FM Systems**. The ADM-1 measures the peak deviation of actual program audio as well as test tones and holds the highest peak deviation reading until it's reset. The meter reads up to 199.9 KHz deviation in positive peak, negative peak and peak-to-peak deviation. Accuracy is listed at ±0.5 percent when measuring audio at ±25 KHz. Distortion in the modulator can be detected by measuring the difference between positive and negative deviation when modulating with a sine-wave.

Reader Service number 111

—Roger Brown



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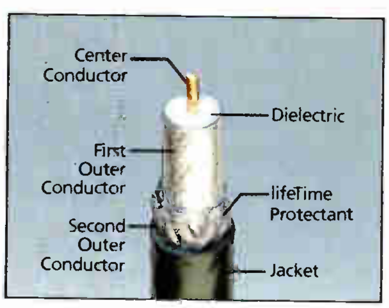

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