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Official trade journal of the Society of Cable Television Engineers

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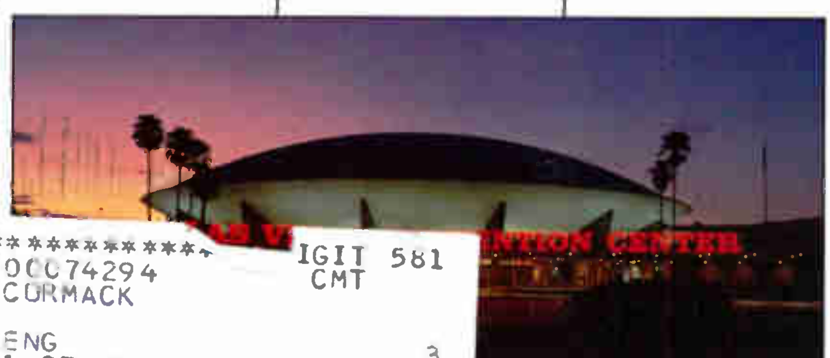

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May 1987

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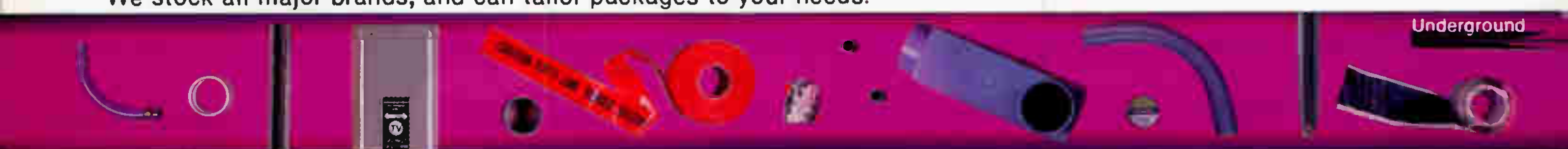

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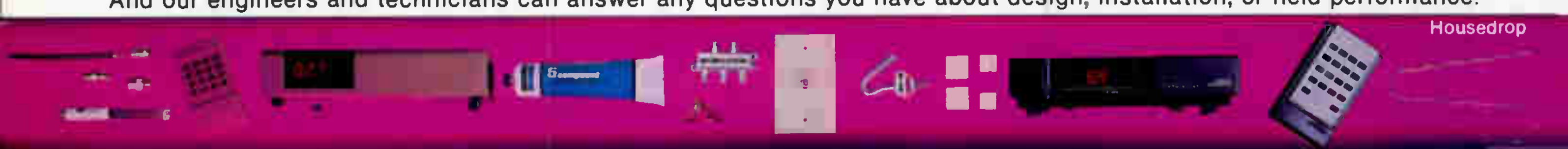

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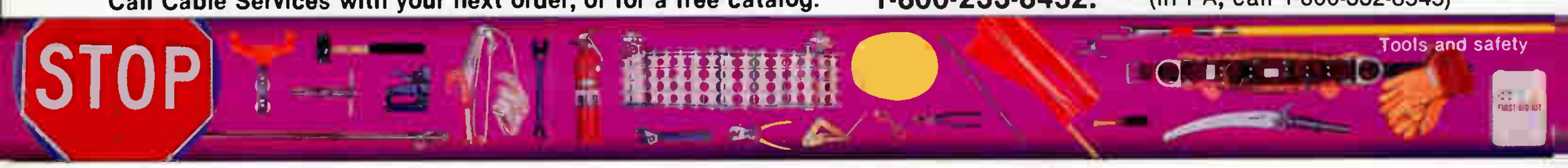

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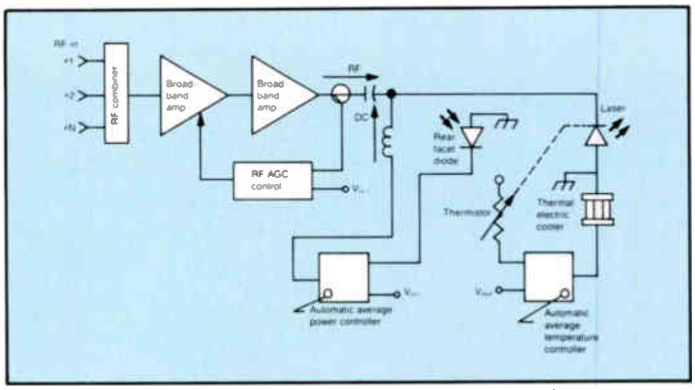

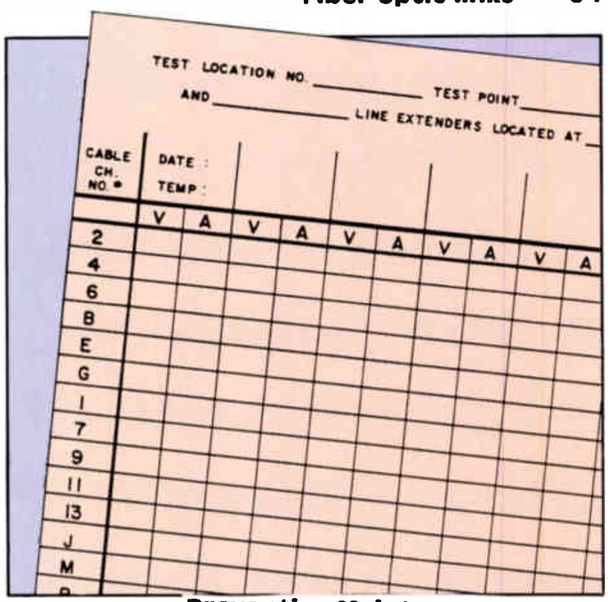

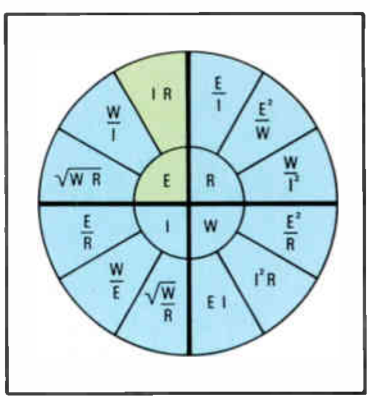

Features

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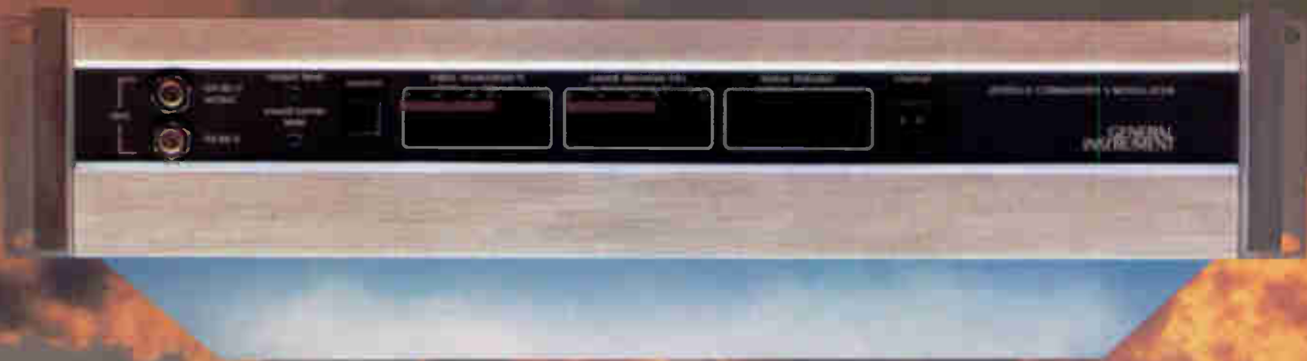

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GENERAL INSTRUMENT

PUBLISHER'S LETTER

Serving your country

I'm no gambler, but I'm putting my money on a terrific NCTA Show May 17-20 at the Convention Center in Las Vegas, Nev. This year's theme is "Cable television serving America," which sums up what this industry is all about. This is the show everyone goes to (or would like to), not just because it's the biggest, but it's where everything comes together. New technologies are demonstrated on the exhibit floor and discussed in seminars, FCC policy issues are debated in question-and-answer sessions, and a myriad of other topics for all facets of the industry are offered.

A complete listing of technical seminars and other events appears in the "News," beginning on page 10. We'll be there in force, as usual, with our *CT Daily*, bringing you up to date on the various technical sessions and exhibit floor action. If your company has something of interest to include in the daily, just stop one of our staff at the show.

It won't be all work and no play. Baby boomers (like me) can enjoy the Welcome Party in the rotunda Sunday, May 17, with entertainment provided by Papa Doo Run Run. Also, the System Awards for Cable Excellence (ACE) will be presented Monday evening at the Hilton. And the gala dinner dance and national awards ceremony will occur Wednesday evening. (But if you're still looking for fun, think "Vegas.")

Overwhelming success

Last month's SCTE Cable-Tec Expo was an overwhelming success. Everything—from the technical sessions to the exhibits to the Expo Evening at Medieval Times—contributed to the excitement and feeling of sensory overload. Congratulations to Bill Riker, the SCTE staff and the Florida Chapter for putting together the best expo to date.

The expo is another indication that the SCTE has been right on target in its direction to provide educational experiences for the industry's engineering community. As the Society's official trade journal, *CT* is proud to be a part of that direction. We'll be providing the expo wrapup in our June issue.

The SCTE's BCT/E Certification Program picked up yet another endorsement last month, from Women In Cable (WIC). On April 1, the WIC national board unanimously voted to endorse the program and stated that it provides valuable professional development for cable technicians and engineers. Meanwhile, the SCTE board of directors gave high praise and an endorsement to WIC's Certificate in Cable Management Program. Three individuals behind the scenes during this chain of events should take a bow: SCTE's Ron Hranac, WIC's Priscilla Walker and *CT*'s Rikki Lee.

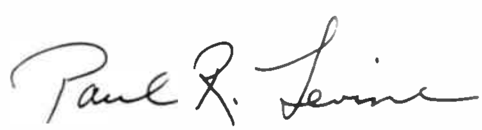
Congratulations also go out to the SCTE's Technical Scholarship Program winners Charles Hutchens of Freedom Cablevision in Sanford, N.C., and David Soldan of Lincoln Cablevision in Lincoln, Neb. Both will receive tuition assistance for a technical correspondence course of their choice selected from the National Cable Television Institute (NCTI).

In this month's *Interval* are the official bylaws of the SCTE, including changes proposed by the national board of directors. SCTE members, please read them carefully and send in your ballot.

Mark your calendars: Next month is the Northeast Cable Television Technical Seminar, to be held at the Roaring Brook Ranch Resort in Lake George, N.Y., June 15-17. The event is co-sponsored by the SCTE and the New York State Cable Television Commission. Topics will include improving customer satisfaction, Ku-band technology and 550 MHz systems. For more information, contact Robert Levy at (518) 474-4992.

I'd personally like to welcome Jim Farmer to our advisory board. Jim is a product development engineer with Scientific-Atlanta and has been in product design at S-A for 18 years.

Finally, we've been busy lately gearing up for our new publication. That's right: We've acquired *CATJ*, the standard for the small independent operator, and *Cable Tech*, NCTI's journal. The two will be combined into one monthly magazine, with its focus directed at the cable technician and installer. Beyond that, folks, our lips are sealed. Except: LOOK FOR IT!



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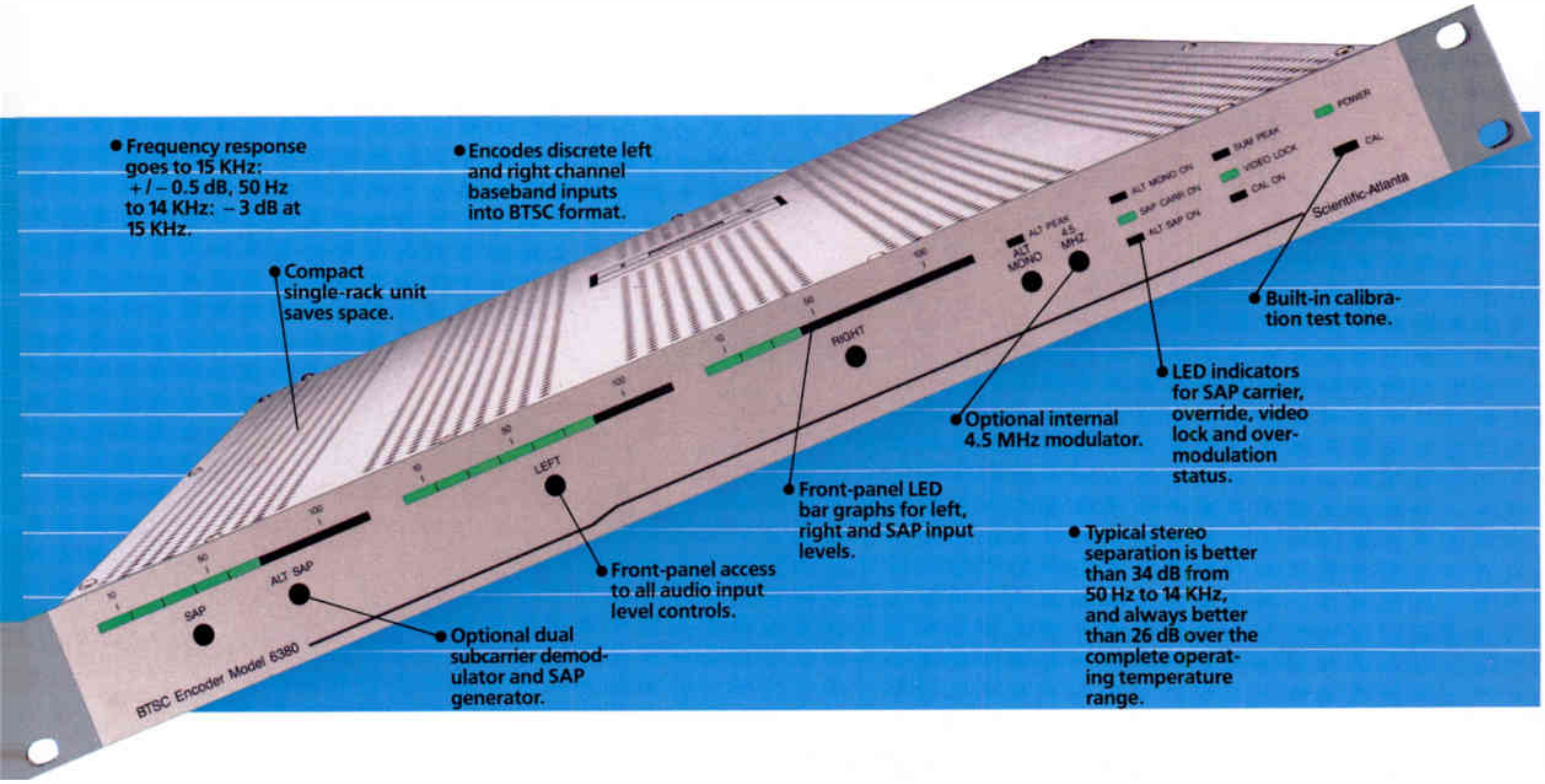

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optic links"; Mircho Davidov (Catel), "Fiber-optic broadband systems—Present and future"; Hermann Gysel (Synchronous), "Properties and systems calculations of optical supertrunks for multichannel TV transmission using analog intensity modulation, single-mode fibers and high-deviation FM"; and R. Scott Stevens (Siecor), "Fiber-optic cable in CATV applications."

• Cable television distribution—Performance and cost solutions

Moderator: Ed Milner (Arlington Cable Partners). *Speakers:* Patrick McDonough (United Cable), "High-frequency/high-density design criteria"; Daniel Smart (British Cable Services), "Innovative aspects of a switched star-cabled distribution system"; Mark Adams (Scientific-Atlanta), "Field experience with feedforward amplifiers"; and Tom Osterman (Alpha Technologies), "Improving power supply efficiency."

3:30-5 p.m.

• "New-tech" signal prospects

Moderator: R. Brian James (NCTA). *Speakers:* William Glenn (New York Institute of Technology), "Compatible high-definition cable transmission technique"; Ben Crutchfield (NAB), "Broadcasting high-definition television"; Craig Todd (Dolby Laboratories), "A compatible in-band digital audio/data delivery system"; and Joseph Roizen (Telegen), "Improving NTSC in a cable television facility."

• Improved plant design and construction: Methods and materials

Moderator: Norman Santos (Oceanic Cablevision). *Speakers:* Steven Biro (Biro Engineering), "Computer assisted design of CATV antenna tower/antenna arrays"; Randall Crenshaw (General Instrument-Comm/Scope Division), "The development of a new super-tough cable jacket"; Jack Gieck (Arnco), "Percol: A polyurethane system to simplify laying of buried cable"; and Thomas Straus (Hughes Aircraft), "Advances in AML transmitter and receiver technology."

Tuesday, May 19
10-11:30 a.m.

• Security considerations: Locking the door to the candy store

Moderator: Ted Hartson (Post-Newsweek Cable). *Speakers:* Anthony Wechselberger (Oak Communications Inc.), "Encryption-based security systems—What makes them different and how well are they working?"; Michael Long (Zenith), "An enhanced RF television scrambling system using phase modulation"; Vito Brugliera (Zenith), "Security considerations for impulse pay-per-view"; and Mark Medress (VideoCipher Division of General Instrument), "VideoCipher II satellite scrambling system."

• Stereo television and cable—One year later

Moderator: Karl Poirier (Triple Crown Electronics). *Speakers:* Kenneth Leffingwell (Wegener Communications), "Mutual effects of BTSC stereo and RF sync-suppression scrambling"; Bill Arnold (Warner Cable), "BTSC stereo—Implementation on normal and scram-

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bled channels"; James Holzgrafe (Oak), "MTS compatibility in encrypted baseband scrambling systems"; Joe Vittorio (General Instrument/Jerrold), "BTSC performance measurement in the lab and field"; and David Sedacca (Scientific-Atlanta), "Practical considerations for BTSC stereo in the CATV plant."

12:30-2 p.m.

- Implementing pay-per-view

Moderator: Nick Hamilton-Piercy (Rogers Cablesystems). *Speakers:* Larry Lehman (Cencom Cable Associates Inc.), "Technical considerations when implementing pay-per-view"; Andrew Ferraro (Request Television), "Satellite delivered tag change system"; David Woodcock (Centel Cable Television Co. of Michigan), "Launching an ANI passing impulse PPV system"; and Nancy Kowalski (General Instrument/Jerrold), "Using impulse technology to implement home shopping."

- Mid-term report card on consumer electronics interface

Moderator: Walter Ciciora (ATC). *Speakers:* Richard Merrell (Zenith), "Multi-control remote transmitter"; James Farmer (Scientific-Atlanta), "A new option in subscriber control"; Wajahat Husain (Scientific-Atlanta), "EIA IS-15 interface compatibility with RF sync-suppressed scrambling"; and Christopher Lewis (Scientific-Atlanta), "Report on the coaxial portion of the EIA homebus standard effort."

3:30-5 p.m.

- Interactive paths and progress

Moderator: Graham Stubbs (Linear Corp.). *Speakers:* Dominick Stasi (Telaction), "Selective electronic home shopping"; Robert Bridge (Alpha Technologies), "A remote status monitoring system for one-way cable plant"; Anthony Aukstikalnis (General Instrument/Jerrold), "The interactive evolution"; and Richard Citta (Zenith), "Performance history in two-way cable plants utilizing a PSK communication system."

- Satellite delivery systems

Moderator: Norman Weinhouse (Norman Weinhouse Associates). *Speakers:* Paul Heimbach (HBO), "Ku-band distribution of television programming for the cable industry"; Andrew Setos, "Cable TV satellite distribution: C- or Ku-Band?"; James McKinney, "FCC's overview on U.S. and international satellite issues."

BCT/E Program endorsed by WIC

CHICAGO—At its April 1 meeting in Washington, D.C., Women In Cable's (WIC) national board unanimously voted to endorse the Broadband Cable Technician/Engineer Certification Program, developed by the Society of Cable Television Engineers. The program was designed to raise the professional status of technicians and engineers by providing standards of competence in broadband communications engineering.

In a prepared statement, WIC said the BCT/E program "provides valuable professional development for (technicians and engineers) . . . in the cable industry. We welcome the opportunity of working with another cable professional society to attain our mutual goal of providing quality educational programs and opportunities for the industry."

On the same day, the SCTE national board voted to endorse WIC's Certificate in Cable Management Program, developed in conjunction with the University of Denver Center for Management Development.

For more information on the BCT/E program, contact (215) 363-6888; for details on the Certificate in Cable Management, contact (303) 871-2927.

FCC releases leakage memo

WASHINGTON, D.C.—The Federal Communications Commission recently issued a public notice on "the excessive levels of radio frequency (RF) energy leaking from cable television systems." According to the statement, the amount and level of leaks found during FCC inspections indicated that "many monitoring and maintenance programs are either inadequate or nonexistent."

Excessive leaks that are detected are required to be documented and repaired by the cable system. Failure to provide an adequate program of regular leakage monitoring and repair may result in a "monetary forfeiture"; leakage detected during an inspection also may result in such a penalty.

The consumer electronics interface mess

By Walter S. Ciciora
Vice President of Strategy and Planning
American Television and Communications Corp

The consumer electronics interface with cable is a mess. How did we get into this situation? What are the options? And is there any hope?

In the past, there was a lot of finger pointing over who was to blame. The cable industry felt that consumer electronics manufacturers created the cable-ready TV just to increase profits without regard for subscribers' needs. They saw cable as uncoordinated and lacking standards; e.g., a product that works fine in one system is a disaster in another.

There were areas where the two industries were in genuine conflict. Some cable operators introduced remote controls as a means of generating new revenue streams. But this practice interfered with the subscribers' ability to use purchased remote controls and with the salability of high-end TV receivers. For the consumer electronics industry, this was a serious matter. To manufacturers, only high-end products have acceptable profit margins; a business could not survive if only low-end products are purchased.

The greatest burden fell on the subscriber. Confusion, frustration and anger were common reactions. The situation appeared hopeless until both industries came to the realization that our subscriber and their customer were one and the same person. If we worked together, both industries and the consumer could benefit. That work has a good beginning but a long way to go before the installed base of problems are resolved.

Loss of convenience

The problem seems to have two fundamental aspects. First, the subscriber often experiences a significant loss of convenience in the use of consumer electronics equipment when connected to cable. Second, the installation and reconfiguration of these products and cable have become very complicated.

The loss of convenience is evident every time cable is used and manifests itself primarily through the remote control. Prior to the cable installation, a remote control was a handy convenience. But when a cable converter is installed, the subscriber has to deal with multiple remotes: one, to turn on the television and tune it to Channel 3; another, to select cable channels. And back to the TV remote to adjust volume or mute the sound.

The VCR in a scrambled cable environment provides the most frustration. With a converter ahead of the VCR, the VCR timer no longer can select the channels to be recorded. Only the channel originally selected on the converter can be recorded without further intervention. A potential solution is the introduction of converters with timers or converter remote controls with built-in timers. As a practical matter, this approach introduces another series of steps that must be executed flawlessly if a successful recording is to be made. Subscribers are not looking for a challenge to their mental abilities as they try to set up their equipment to record a program just before rushing out the door to an unexpected event.

The complication of installation occurs only occasionally. It is first noticed after the initial introduction of cable and then appears each time a new product is added to the home entertainment center or after moving the equipment for cleaning or painting. The complicated installation increases the likelihood of implementation errors that deprive the subscriber of the full functionality of the cable service or the consumer electronics products. This further contributes to the loss of convenience of use.

One of the main problems with the cable-ready TV is that nothing in life is ever really ready. Just as things appear to be almost ready, something changes and the readiness is jeopardized. Recognizing the negative implications of cable-ready, some manufacturers have chosen the term "cable-compatible" instead. But "compatible" is a rubber word that often is stretched to meet the needs of the moment. In the strict sense, "compatible" means that two things—like a cable system and a cable-compatible TV—work together perfectly without loss of functionality on the part of either. Loosely, it means they both run on electricity. Unfortunately, it is used loosely more often than strictly.

Initially, being cable-ready added little cost to a television. As an inexpensive feature on a premium electronic tuner, it only required memory space in the microcomputer that controlled the tuner. The tuner was a big improvement over the old-fashioned mechanical clunker. The extra cost was for the improved tuner, not for the cable-ready feature. Later, as more and more channels were added, a small increment in cost was incurred as another set of tuning diodes was added and more memory was required for the microcomputer. Note that electronically controlled tuning is mandatory for practical tuning of cable channels. (Can you imagine a 105-channel mechanical tuner? An automobile steering wheel would be needed to turn the dial!)

There are only two requirements for a television or VCR to be cable-compatible: First, the channels the subscriber is interested in receiving must be available without the need of having another tuner ahead of the TV set. Second, the TV signals must not be directly picked up off-air by the television's internal circuits. This is called DPU for direct pickup; DPU results in ghosts in the picture. In cable systems with an HRC (harmonically related carrier) frequency plan, objectionable diagonal bars mar the picture.

DPU is not a new phenomena. In fact it is the reason why converters were invented in the first place. The original converters only tuned the 12 off-air channels. They were not intended to extend tuning range, but only offered protection against DPU.

The first requirement for compatibility can be met in several ways. If the cable system uses traps for signal security or if the subscriber simply is not interested in the scrambled channels, a descrambler will not be needed in front of the TV set. Likewise, if a form of descrambler that plugs into the back of the TV set is used, a set-top descrambler will not be required.

The second requirement is met if the subscriber does not live near a TV transmitter, or has a well-shielded receiver. Otherwise, a converter/descrambler is needed ahead of the TV tuner. The remote control becomes almost useless and the subscriber is frustrated.

This definition of cable-compatible is situational. If a subscriber who only had basic now upgrades to HBO in a scrambled system, the formerly cable-ready TV will lose functionality when a set-top descrambler is added. Likewise, if the subscriber moves closer to a TV transmitter, a TV receiver that previously worked satisfactorily may start to exhibit ghosts. A converter may be required to eliminate this problem.

What caused this mess?

Originally there was very little difficulty between cable and consumer electronics products. Both were relatively unsophisticated from a technical perspective. There was little need for the two industries to communicate with each other. Things worked well. But as the technology of the two industries evolved separately, numerous options became available to the designers of both industries. Without standards and vigorous communications between the two industries, designers in both made a variety of choices that were perfectly valid, taken one at a time. The trouble arose when these choices were expected to function together.

Cable's contribution to the mess includes a variety of frequency plans in different cable systems and the use of scrambling. Scrambling is a fundamental technique for restricting access to cable programming and thereby ensuring that it can be sold. It is likely that scrambling will be part of the cable tool kit for the foreseeable future. Nonetheless, it must be recognized that, more than any other factor, scrambling *as done in the past* contributes to the interface mess.

The electronics industry's principal contribution to the problem is the failure to adequately shield the internal circuits of receivers from strong off-air signals. The retail segment of the business added to the difficulties with less than clear advertising. Certain other actions, such as the addition of new features that coincidentally place additional demands on cable systems, are a proper business practice, which for the most part benefit the consumers.

These actions are necessary for survival in this

highly competitive business. Examples include the "picture-in-picture" (PIP) feature, which places a small second image on the screen along with the main picture. It is offered in many of the new digital televisions and VCRs. PIP requires two descramblers when the subscriber wants both the large and the small image to come from scrambled channels. Manufacturers will continue such innovation in the pursuit of a viable market share. Cable will have to be nimble on its feet and accommodate these technical advances.

Perhaps the most important consumer electonics trend has no technical component: It is simply proliferation. As prices continue to erode, more and more televisions and VCRs will be found in the home. If cable service is to maintain its value to subscribers, it must be available on most of the homes' receivers. Otherwise, subscribers will have the sense that, in most cases, they can do without cable. It is not practical to have full converter/descramblers on top of each receiver.

Acknowledging that the root of the problem is the separate evolution of the technologies of the two industries, an important step toward a solution is to build bridges between the industries' engineers. This will facilitate a convergence of the technologies. That is the motivation behind the EIA/NCTA joint engineering committee. The EIA (Electronic Industries Association) represents the manufacturers, while the National Cable Television Association's Engineering Committee represents the technical elements of cable. This joint committee was formed five years ago to provide a forum for engineers who design consumer electronics and engineers who design and operate cable systems. These technologists communicate on important technical issues and increase their understanding of each other's problems and constraints. A secondary purpose is to arrive at technical standards for the design of consumer electronics products and cable systems that will facilitate satisfactory performance.

It must be recognized that these are relatively long-term efforts. The uncoupled technical evolution of the two industries has gone on for quite a number of years. Over 200 million TV sets have been placed in U.S. homes and thousands of cable systems have been built without the benefit of adequate communications. There is no escaping the fact that it will take time to overcome incompatibilities built up over such a long period in such a large installed base of products and cable systems.

The NCTA Engineering Committee recognizes the importance of these long-term efforts. But it is not satisfied that they are adequate. To alleviate (*eliminate* is not likely) the problems in the shorter term, two subcommittees have been formed. The first, under David Large of Gill Cable, has compiled and analyzed a set of connection diagrams to aid cable technicians and subscribers in obtaining the best results from their collection of equipment. This set of diagrams is available from the NCTA Science and Technology department in Washington, D.C. The second subcommittee was formed under Mat Miller of Viacom to take yet another look for potential near-term solutions. This work, which has just begun, is intended to be a creative, brainstorming effort leaving no stone unturned in the search for approaches that may be helpful.

Standards efforts

There are three levels of applicable standards. The most mature standards are in the RS series. RS means "recommended standard." Perhaps the most familiar example is the RS232 standard used with computers and data communications devices. A step along the way to "RS" is "IS," which stands for "interim standard." An IS designation is issued on a trial basis for a year or two. During this period, manufacturers attempt designs in order to more fully understand the consequences of the standard's details. After the trial period, the standard is amended to include learning from the past year and voted upon by the EIA for promotion to RS status. The least mature phase in the development of a standard is the "recommended practice." It is intended to indicate a direction for manufacturers to choose where there may be many reasonable approaches.

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

The channelization standard exemplifies the process of standards creation. Engineers from the two organizations met and educated each

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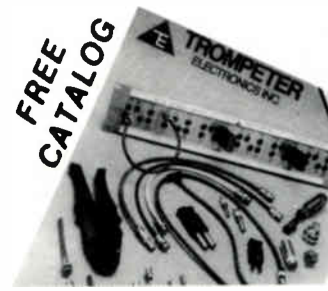

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other on the various methods used to allocate frequencies in the cable spectrum to channel designations. A debate ensued over the pros and cons. Some questions were deferred until more experience was gathered. The interim standard was issued in May 1983. Manufacturers then evolved their product designs towards compliance with IS-6. In late 1986, the committee took up the issue of finalizing IS-6 into a proposal to the EIA for promotion to RS status.

The principal issues remaining were the channelization of the FM band, the order for expanding channel capacity and the method of counting channel capacity. The FM issue centers on the fact that receivers generally have traps (frequency-selective filters) in the FM band to prevent interference with Channel 6 reception when strong FM signals exist in the reception area. This trapping practice is essential for off-air performance; therefore, cable operators must use channels in the FM band accordingly. TV receiver manufacturers likely will strive to develop switchable filters for future products. While not technically practical at present, the need has been highlighted and the consumer electronics industry is now aware.

The order in which channels are added when capacity is expanded and a fair method of indicating capacity to the consumer have been agreed upon. Before the channelization standard, cable companies used numbers and letters to designate channels in a variety of ways. There were a number of equally logical ways of doing this and no mechanism to coordinate between those making the choices. A serious consequence of this situation was that it became impossible for product manufacturers to make receivers that complied to multiple channelization methods. Now, with IS-6, cable practice and consumer electronics design can converge over time to the benefit of the subscriber.

As mentioned previously, there are two requirements for true cable compatibility: 1) the television or VCR must be able to be connected directly to the cable without a converter or descrambler ahead of it, and 2) the internal circuits of the television or VCR must not pick up off-air signals directly. The IS-23 standard is intended to set technical specifications that define what is required for a product to avoid DPU problems in the majority of cable installations. Additionally, IS-23 deals with signal levels, connector types and the allowable level of signals back fed into the cable.

The standard went up for vote at the end of 1986. TV manufacturers found its direct-pickup requirement difficult to achieve. They have asked for further clarification and compelling evidence of the need for such a severe standard. The committee went on hold while this issue received further investigation. The committee will resume its deliberations in the third quarter of this year.

EIA multiport

Perhaps the standard that has the most potential to solve interface problems is the IS-15 decoder interface standard, which also is known as the EIA multiport. The standard is embodied as a 20-pin plug on the back of a TV receiver or VCR that accepts a set-back descrambler. It has been adopted and endorsed at the IS level by both the EIA and the NCTA.

The principal advantage of the multiport is that it makes a truly cable-ready receiver possible in a scrambled environment. Because descrambling is accomplished after the receiver's tuner, the consumer product can be directly connected to cable. The subscriber regains use of the remote control. In the case of a VCR, the timer again becomes useful. It can control channel selection and turn the VCR on and off. An important secondary advantage is a significant reduction in cost to the cable operator. Set-back descramblers will be 40 percent to 60 percent of the cost of set-top units. It becomes practical to provide two units, one for the television and another for the VCR. For the first time, it's possible to watch one scrambled channel while recording a different scrambled channel at an affordable price.

A practical limitation of the EIA multiport is that it requires the subscriber to purchase a new multiport-equipped TV receiver or VCR. This won't happen overnight. Unfortunately, televisions last too long; the typical life is 12 to 14 years. New receivers are bought every seven years, with the old unit put in the basement or donated to one of the kids who grew up with it. Significant penetration will take time. However, subscribers who feel they need a solution can contribute to it by making a purchase. Even that was unavailable just a few years ago.

The situation is dramatically different with VCRs. Since they wear out, VCRs are replaced every three or four years by heavy users. The rotating heads are a critical mechanical element in an otherwise electronic system. They clog and wear, causing expensive repair bills. In many cases, the cost of repair rivals the cost of a new unit. Since the purchase of a VCR more than doubles the trouble with the consumer electronics interface, it is particularly appealing to find that the EIA multiport can bring relief when taken as an option on a new VCR.

The first televisions and VCRs with multiport are expected on the market this year. Descrambler vendors have promised evaluation samples in the beginning of the third quarter of this year, with volume delivery a few months later.

The NCTA Engineering Committee has formed a subcommittee to promote and stimulate the multiport among the MSOs. While there still is a lot of work to be done, progress on this important standard is heartening.

Other interface approaches

If we think further about the previously mentioned requirements for compatibility in the consumer electronics interface, we realize that there are other methods of avoiding another tuner ahead of the television or VCR. These are based on providing a broadband feed into the subscriber's home. Interdiction is applied to the channels the subscriber has not chosen. All other channels are "in the clear." Two methods are currently being pursued actively in the cable industry—a jamming and a trapping method.

Scientific-Atlanta and Paragon Communications, an MSO encompassing many of the former Group W systems, are developing an off-premises technology that jams the channels the subscriber does not want. In addition, the entire service may be turned off at the tap. It is a fully addressable technology. From an interface perspective, its virtue is that no tuners are put in front of the television or VCR. The subscribers' purchased remote controls do their intended jobs and the VCR timer is fully functional. While there are some technical hurdles, they do not seem overwhelming. The principal challenge with this approach is economic. Since the hardware must be installed outside the home of every subscriber, the up-front cost is a serious consideration.

The trapping method is featured by Tele-Communications Inc. in its on-premises approach, which also is being developed in partnership with S-A. Special high-tech positive traps are installed in a tamper-evident cabinet on the side of the house. The positive traps remove jamming carriers inserted at the headend. Additionally, some channels may be negatively trapped. Initially, the approach is not addressable. However, the "hooks" have been installed in the design to allow future upgrading to addressability if the business needs dictate. As with the off-premises approach, the subscriber gets a broadband feed, with authorized channels in the clear. Interfacing is served well by this approach.

In both the on- and off-premises approaches, the consumer-friendly purpose can be frustrated if the consumer electronics product is susceptible to direct pickup. DPU can become a spoiler that requires a converter ahead of the television or VCR in strong signal environments.

Is there any hope?

There is a great deal of hope for alleviation of the consumer electronics interface problem in the reasonably short term and eventual solution in the long term. Greater understanding and communication between the consumer electronics industry and cable will ensure that future designs are much more compatible. More attention to the issues will minimize cable practices that fail to accommodate the realities of the huge installed base of televisions and VCRs.

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Reader Service Number 23.

Retaining consumer friendliness with CATV

By Dave Wachob
Manager, Product Support
Jerrold Subscriber Systems Division, General Instrument Corp.

Anyone who has attempted to interface cable television equipment with today's myriad of consumer electronics understands the frustration associated with this task. What once was a straightforward connection between a descrambling converter and a conventional television now has become a significant challenge—even to those familiar with the technology.

With the rapid growth and acceptance of VCRs and other cable-ready devices the problems must be dealt with effectively if the cable business is to survive and grow.

Subscriber's dilemma

The subscriber who purchases a new cable-ready, stereo-capable, consumer-friendly VCR or television is faced with the immediate problem of how best to interface the device with the cable system for optimum performance. Among the

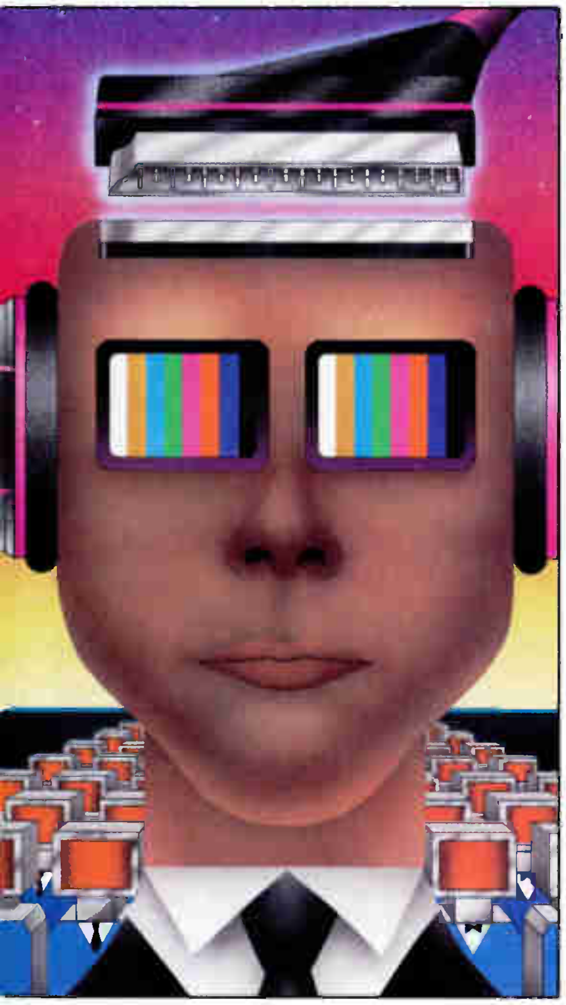


Figure 1: Hookup with VCR in front of converter

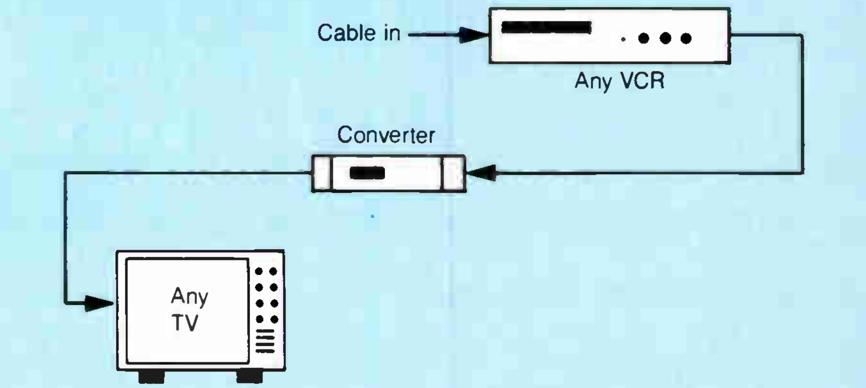


Figure 2: Hookup with converter in front of VCR

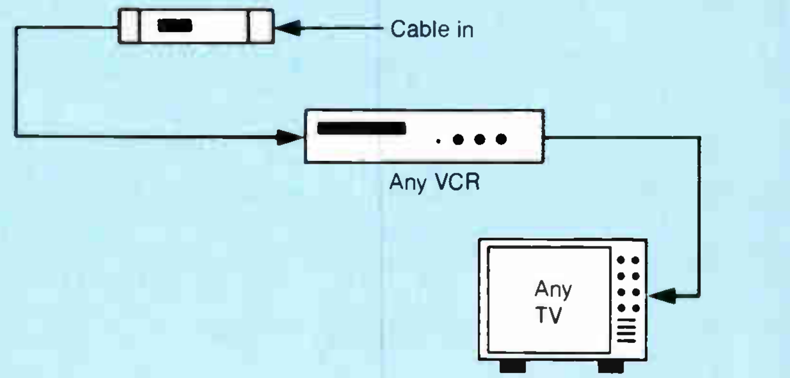
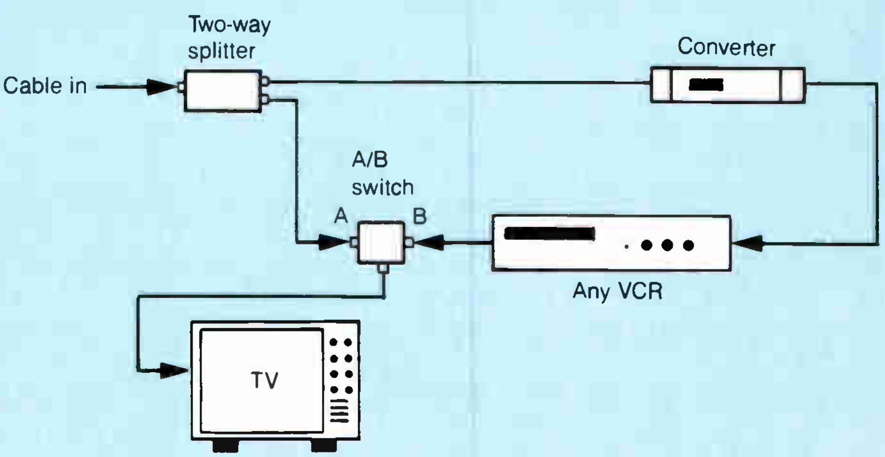


Figure 3: Expanded setup with two-way splitter and A/B switch



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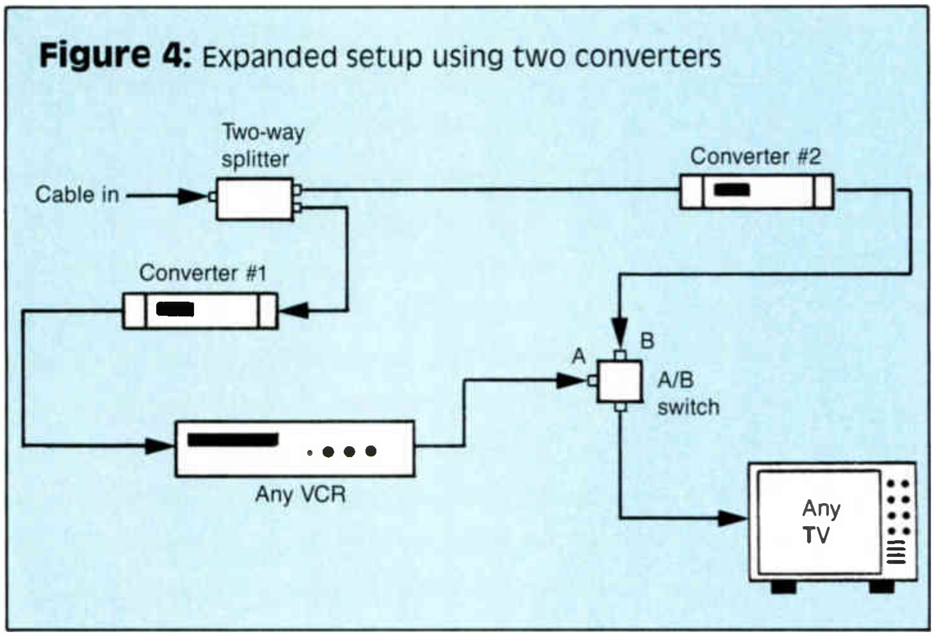

Figure 4: Expanded setup using two converters

items to be considered at this time are personal viewing/recording preferences; the specific hardware to be configured; ease of operation; remote control capabilities; performance trade-offs; and any inherent costs associated with "making it all work together." In addition, whether the system's premium services are trapped or scrambled also has an immediate impact on how the hardware is to be configured.

A wide variety of possibilities exists for connecting subscriber equipment to the existing cable system. In fact, a recent NCTA Engineering Subcommittee on Consumer Interconnection developed 27 possible configurations, without even taking into account baseband or stereo capabilities.

In the interest of time and space, four of the more common basic configurations in use today will be described and critiqued, although many of the same benefits and limitations also are applicable to similar configurations. In addition, some improvements to the basic configurations will be proposed for an "interim solution" in an effort to increase overall consumer friendliness. Finally, some longer-term solutions will be discussed.

'The subscriber who purchases a new cable-ready, stereo-capable, consumer-friendly VCR or TV is faced with (an) immediate problem'

Today's solutions

In its most basic form, the addition of a VCR to a subscriber's cable system can be accomplished in two straightforward approaches, illustrated in Figures 1 and 2.

In Figure 1, the VCR is inserted in front of the converter, which is connected directly to the subscriber's television. This configuration allows the subscriber to independently record a clear channel while viewing a descrambled or different clear channel. This is made possible through the VCR's internal RF splitter, when the VCR is in the "TV" mode. In addition, if the VCR is cable-ready all clear channels selectable by the unit can be recorded. Otherwise, the user is limited to Channels 2 to 13.

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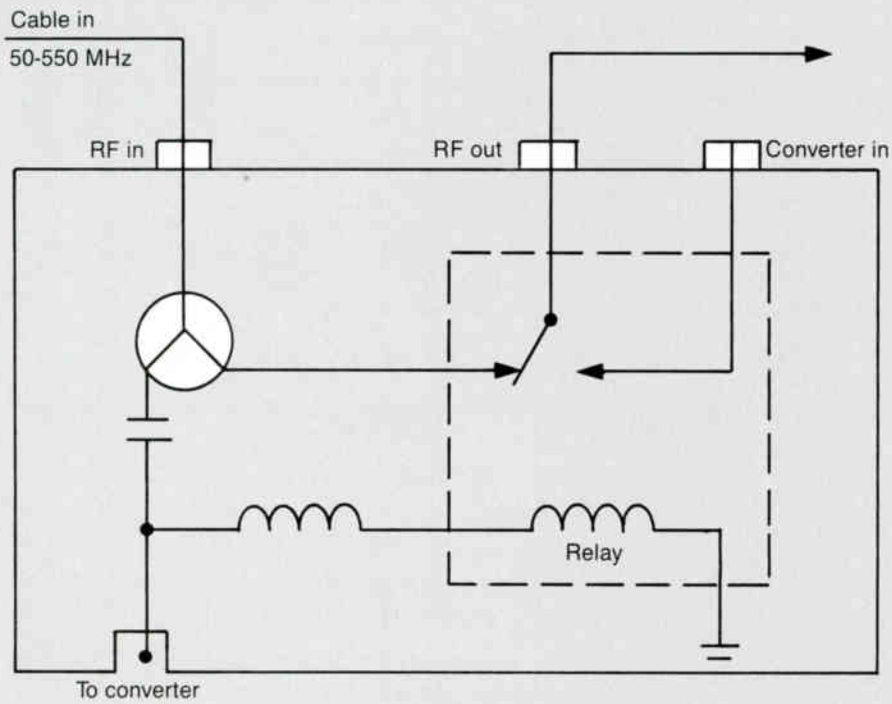
Figure 5: RF bypass option block diagram



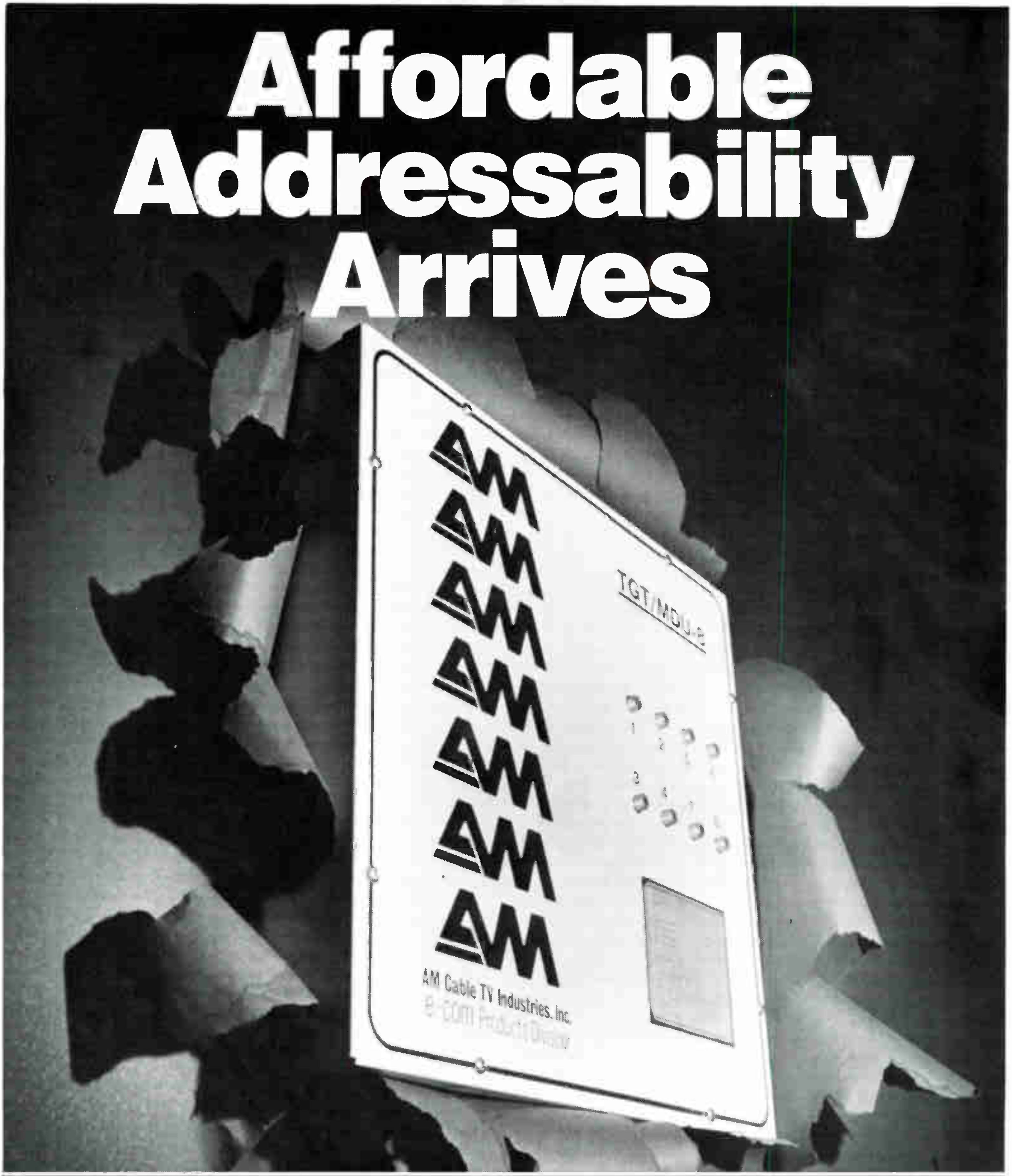
Playback of a prerecorded VCR tape is accomplished by tuning the converter to the output channel of the VCR and tuning the television to the output channel of the converter. For all other recording/viewing scenarios, the appropriate channel is tuned on either the VCR or the converter with the television tuned to the output channel of the converter. Unattended program recording also is possible on all the clear channels that can be selected with the VCR tuner.

Remote control features associated with both the converter and VCR remain functional for both channel tuning and mode selections. For the television, remote channel tuning is no longer applicable, although volume control is still usable if available.

The biggest limitation of this particular configuration is the inability to record a descrambled channel through the converter. This can be overcome, however, by using a baseband converter to loop the converter's baseband outputs back into the VCR's baseband inputs. This approach, in addition to requiring a baseband converter, also requires selecting baseband inputs as the VCR recording source, instead of the usual internal tuner source. Depending on the VCR model, this input is selectable either manually at the VCR or through the remote unit.

In order to record a descrambled channel using a non-baseband converter, the setup in Figure 2 is proposed. Here, the converter is placed in front of the VCR, which in turn is connected to the television. In this approach, all channel tuning is performed through the converter, since only a single channel is output to the VCR or television. As such, only remote tuning through the converter is meaningful.

This approach allows the recording of descrambled and clear channels. The limitation is that only one channel at a time can be recorded or viewed. This also applies to unattended program recording, because no one is present to change the converter channel.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There are exceptions, however. Some of the more advanced converters feature "time-controlled programmability." With this feature subscribers can program converters to change channels in their absence, allowing the VCR access to record any of the converter's authorized channels. Typically, programming is accomplished in a manner similar to VCR programming, by specifying the required time, channel and day information necessary to select the desired program. System "reference time" is supplied either automatically through the headend or input manually to the converter, depending on the particular converter model. This feature greatly enhances the effectiveness of the converter in situations where unattended channel changing is desired.

The configuration shown in Figure 3 expands upon the basic elements illustrated by the first two figures in order to increase and combine the capabilities of the two. In this setup, the incoming cable signal is first split and then fed to both a converter input and one of the inputs of an A/B RF switch. The output of the converter is connected to the input of the VCR, with its output connected to the other input of the A/B switch. The A/B switch output is connected directly to the input of the television.

The net effect of this approach is to allow the subscriber to independently record either a clear or a descrambled channel, while at the same time viewing a clear channel. In the case of a cable-ready TV, the subscriber can view all clear channels tunable on the television, while recording through the converter. For a conventional TV, the subscriber is limited to Channels 2-13. Additionally, the subscriber can view the same descrambled channel that is being recorded through the converter.

The limitation for unattended VCR recording also applies here. Only one converter channel at a time can be recorded unless the converter has the ability to automatically switch channels. Moreover, a new limitation occurs in the case of remote control operation, where the user may have to manually set the A/B switch to the correct viewing position. The extent of this problem is determined by the recording/viewing habits of the subscriber and the desire for truly remote operation. Additionally, there is no remote visual feedback as to the A/B switch position. Channel tuning now is accomplished either via the converter or the television, depending on the selected mode.

While providing more capabilities to the subscriber, there is additional cost associated with the RF splitter and A/B switch required to support these features. There also is an inherent 3 dB minimum loss in the signal level and noise figure associated with the splitter losses. This could become an issue in an area of the distribution network with a marginal signal-to-noise ratio, resulting in degraded picture quality.

The approach in Figure 4 overcomes one of the last remaining obstacles associated with that of Figure 3: the ability to record and watch different descrambled (or clear) channels simultaneously. This is accomplished by using an additional converter connected in the alternate signal path, whose output is connected to the TV through the A/B switch. Now tuning is controlled by individual converters, with the TV staying on one channel (or possibly two, depending on the VCR/converter output channel compatibility).

The same limitations of true remote capability, single unattended channel recording, increased cost and possible signal degradation apply here. Also, the cost increase is substantial because of the second converter. Moreover, the wiring maze can become unsightly and confusing as the number of system components grows. In addition, possible interactions could exist between the remote controls of the two converters. However, the benefits of this fourth approach are substantial due to the complete programming and viewing flexibility that is introduced with a second converter.

Further complicating all of the previously mentioned configurations would be the addition of a separate A/B switch in front of the TV to allow for off-air broadcast reception. What is a complicated problem now could become even worse with the additional hardware and potential misuse by subscribers resulting in increased signal leakage.

In addition, the high signal levels associated with off-air stations increases the A/B switch isolation requirements such that 80 dB minimum would be required in order to prevent local co-channel interference.

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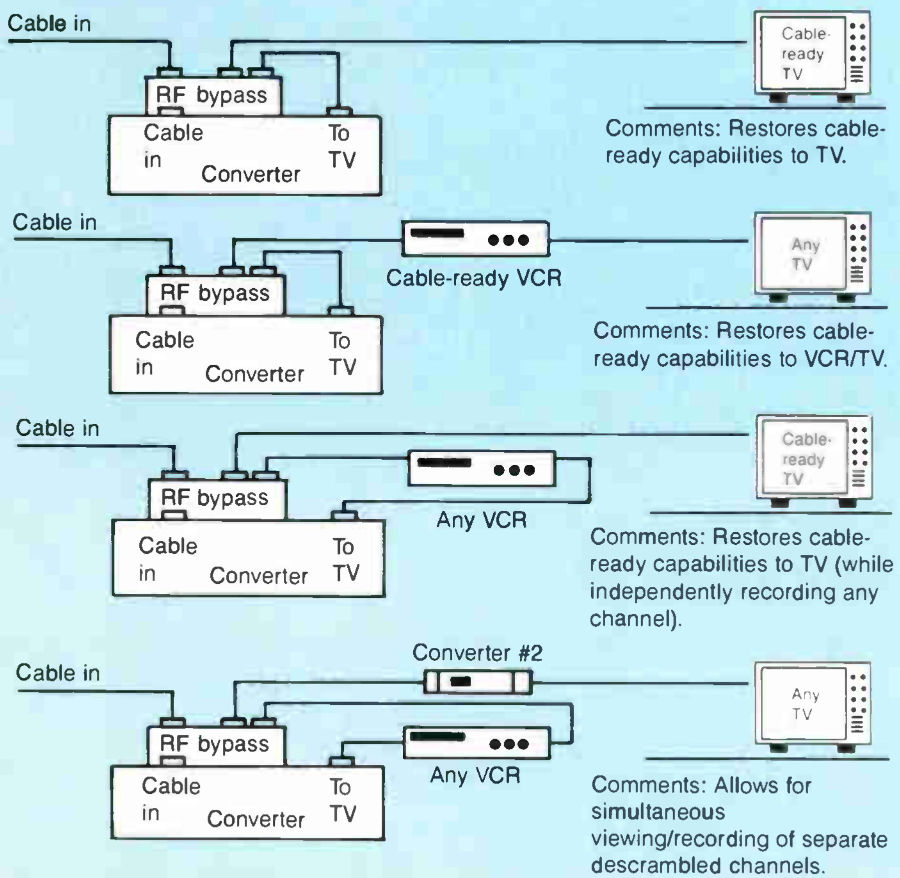
Figure 6: Possible RF bypass option configurations



The interim solution

Building on the capabilities and limitations of the four basic configurations, and the latter two in particular, some improvements can be made to increase consumer friendliness. These enhancements use the A/B control signal built into most of today's converters to handle dual-cable systems. While actual dual systems are in a minority, this control signal and its inherent capabilities can be used to benefit the majority of subscribers and minimize their interface frustration.

The majority of the A/B control signals on today's converters are present either as logical control signals on the RF input connector for an externally powered electronic relay or complete converter-powered A/B relay drives. In the latter instance, no additional relay powering is required and the A/B switch attaches directly to the converter. This is controllable via the converter (or remote unit) A/B control button. In the former, a wall-mounted transformer also may be required to provide the drive capability from the converter control signal. Using this inherent control and drive capability presents two possibilities to resolve the consumer interface issue.

The first, illustrated in Figure 5, combines the splitter, switch and capabilities of the configuration in Figure 3 into a self-contained unit for attachment and powering directly off the converter. This approach, or so-called "RF bypass," allows the converter to be electronically switched in an out of the signal path via the converter or its

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Figure 7: Output A/B switch option block diagram

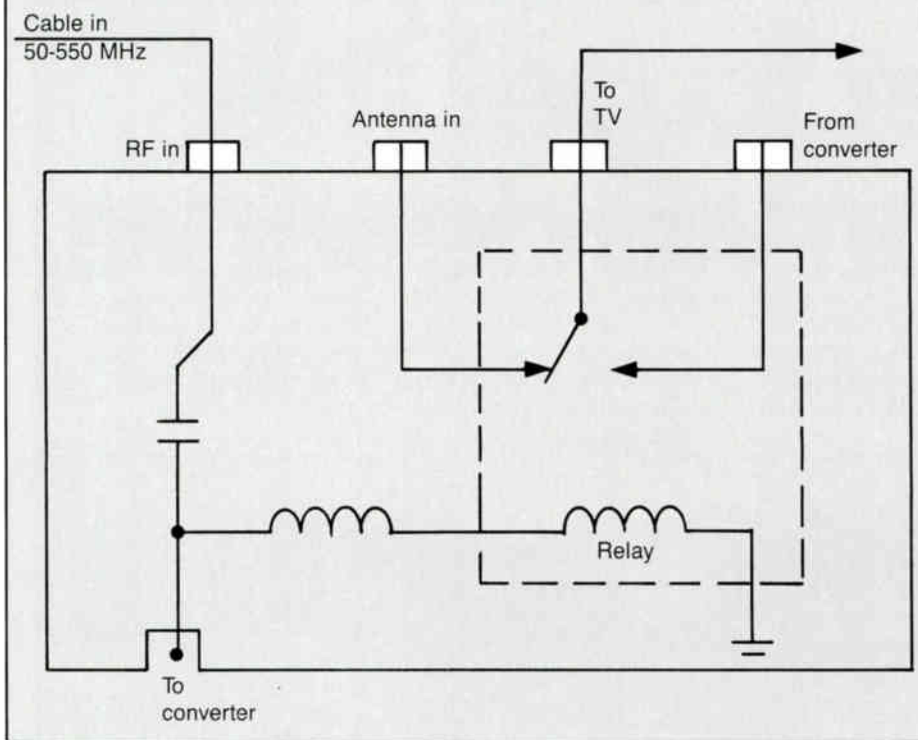
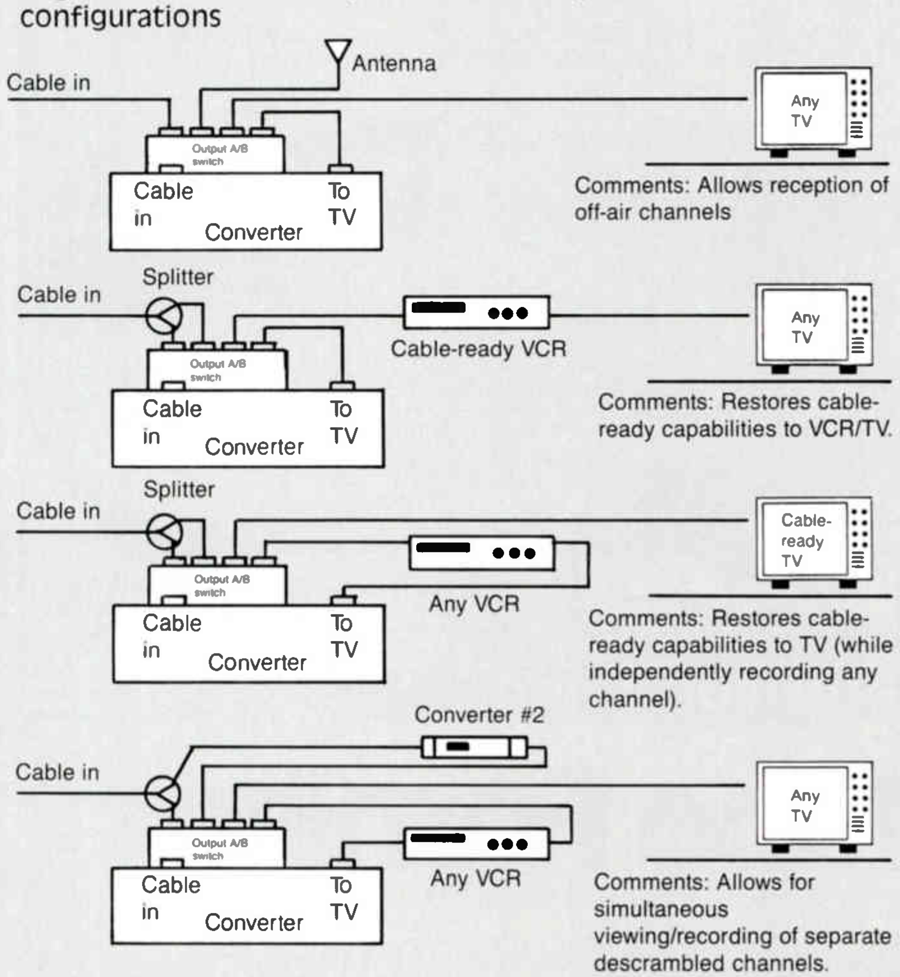


Figure 8: Possible output A/B switch option configurations



remote control using the A/B switch button. This then returns full use of a television's cable-ready capabilities by making the converter transparent to the system when scrambled channels are not involved. Several potential uses are illustrated in Figure 6.

The second potential use for the A/B drive circuitry is shown in Figure 7 and functions as an output A/B switch. This concept builds upon the capabilities described in Figure 4, where a separate input to the television is required for the second converter. Use is not limited to a second converter, however, as illustrated in Figure 8, where several alternate uses are described. Most notable is the first, which would meet the newly adopted FCC A/B switch option requirement.

Both concepts help minimize the wiring maze by reducing the number of necessary device interconnections. Remote control operation also is returned to the subscriber through remote switching of the converter A/B remote control unit. Similarly, a visual indication of the subscriber-selected mode is now available through the converter's A/B mode indicator. For those converters with a built-in A/B drive, either of these devices are field upgradable without opening the converter and can be installed by the subscriber on an as-required basis.

Going forward

In the longer term several approaches to the ultimate solution are under investigation. The primary focus is to remove most, if not all, of the converter electronics from the home and rely on the cable-ready VCR/TV tuning capabilities for channel selection. Two major efforts now under way attack the problem from different directions.

From the front end, several off-premises technologies are undergoing development and evaluation. Pay service authorization is controlled either via external jammers, traps or decoders employing passive, non-addressable technology or active addressable methods. Although the costs have now been removed from the home, penalties associated with outdoor environments have to be considered as well as flexibility for adding impulse capability as the need arises. In addition, as with any new technology, field perfomance has yet to be established under actual operating conditions. For subscribers without full CATV tuning capabilities in the VCRs or televisions, plain converters also would have to be provided to accommodate necessary tuning.

Coming at the problem from the other direction is the IS-15 standardized multiport interface to be included in future VCR and TV products. This interface provides the necessary baseband signals for premium channel descrambling and relies on the VCR or TV tuning capabilities for channel selection. This could ultimately result in a lower cost decoder by removing the necessary tuning hardware. Although several VCR/TV manufacturers have announced that they will have IS-15 hardware available shortly, it may be some time before its acceptance is widespread.

Undeniably VCRs and other cable-ready consumer electronics are a force that must be dealt with in today's cable marketplace. How effective we are at interfacing our systems to the subscriber's electronics may ultimately determine our success or failure as a business.

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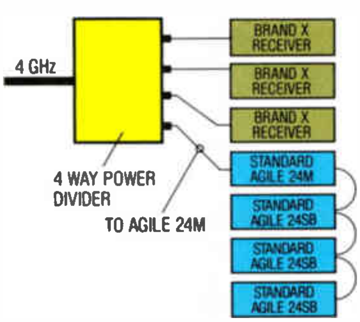

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The VCR interface

By Michael E. Long
Manager, CATV RF Product Engineering
Zenith Electronics Corp

Industry sources estimated that at the beginning of 1986, 28 percent to 30 percent of American homes would have VCRs. This represented a 10 percent increase in VCR market penetration from 1984 to 1985. It also has been reported by some MSOs that nearly 60 percent of their subscribers own VCRs. An A.C. Nielsen study similarly showed that pay-cable subscribers are most likely to own VCRs. Clearly, the home video recorder is an important element to be dealt with in the design and marketing of a cable system. Whether the VCR is a friend or a foe, an opportunity or a problem, depends on how the cable operator reacts.

For existing or potential subscribers, cable TV is regarded as a service for which they pay depending upon its desirability, quality and usefulness. The perceived usefulness of cable is largely based upon its economy, convenience and ease of use. Its desirability stems from providing a greater variety of programming than is available from off-air TV or other alternate entertainment sources. Since cable does provide such programming on various and sometimes conflicting schedules, the subscriber often wishes to record programs on the VCR for later viewing. Here begins the problem.

'The cable operator now must consider the VCR as one of the system parameters and deal with it'

Figure 1: VCR connected before decoder

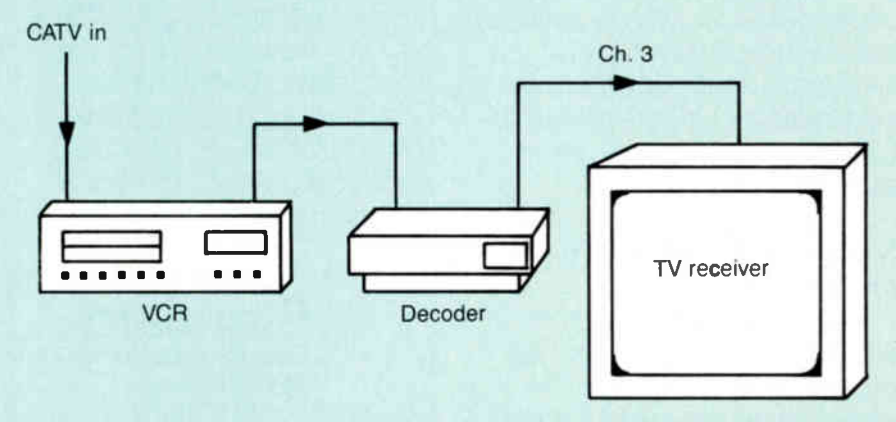
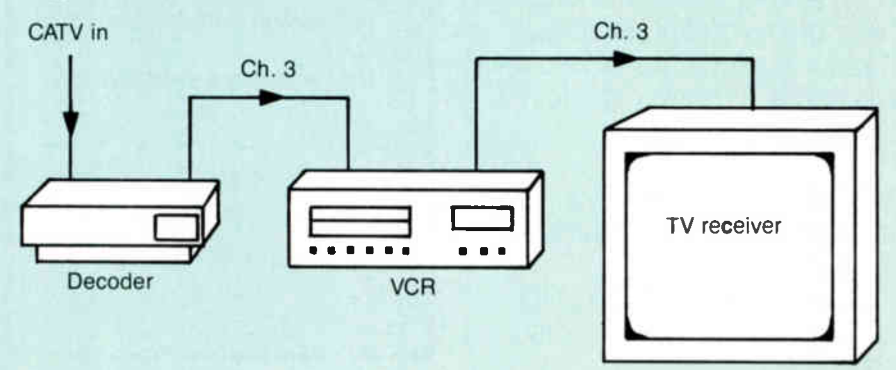


Figure 2: VCR connected after decoder



Faced with the various interconnection possibilities of cable, converter/decoder, VCR and TV receiver, consumers often become frustrated and intimidated by the seemingly complicated arrangement. Once connected, subscribers find that they either cannot record premium (scrambled) programming or are only able to view the program being recorded. It has greatly reduced the usefulness of the VCR's features.

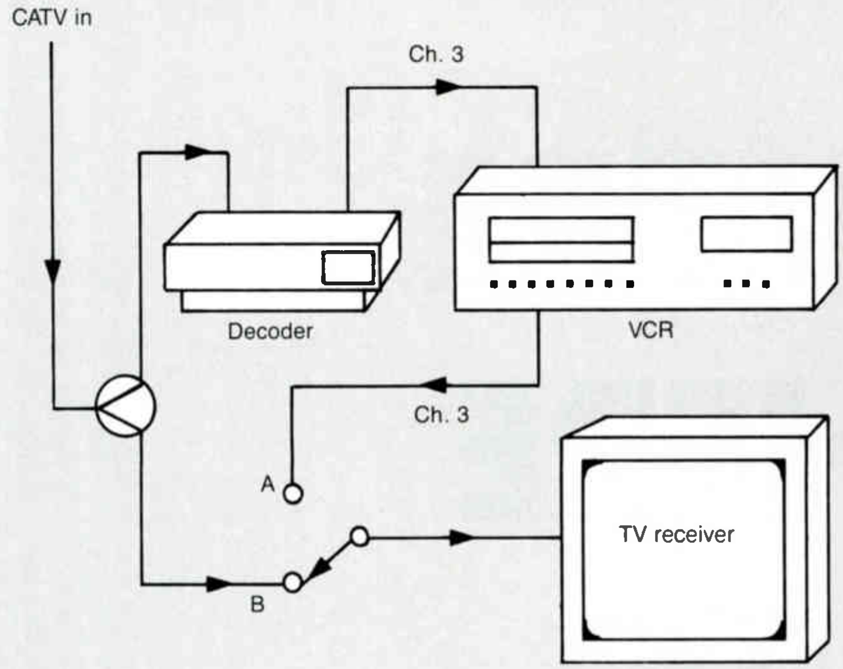
In order to maintain subscriber service satisfaction, the cable operator now must consider the VCR as one of the system parameters and deal with it. A low-cost, easy-to-use VCR interface device must be provided to help subscribers solve their problems. For maximum utility, the ideal device should provide the following functions:

1) simple, easy-to-understand operation
2) maintain MTS stereo compatibility
3) maintain performance quality
4) maintain unattended VCR programmability
5) allow ability to:
   a) view recorded tape
   b) record premium while viewing the same premium channel
   c) record basic while viewing the same basic channel
   d) record basic while viewing other basic channel
   e) record premium while viewing basic channel
   f) record basic while viewing premium channel

Common approaches

It seems that every technically minded individual in the cable industry has thought of a different answer to the CATV/VCR interconnect problem. Some solutions appear simple and

Figure 3: External splitter/switch



others very sophisticated. A common problem is that these devices sometimes are considered from an engineer's point of view and not from the end-user's.

RF switching systems designed to provide for every possibility may be technically elegant and have great appeal to the cable operator's engineering staff but they can be a "headache" for the consumer in installation and use. Even after the device is correctly installed, the subscriber must learn what switch to turn to what position, and what channel to be tuned on both the VCR and TV set for each seemingly simple desired function. Beyond this, the prospect of teaching the use of the device to other family members or an occasional babysitter becomes a monumental task.

Up until now, the two major approaches to the VCR/CATV interconnect problem have been hard-wire interconnect and RF switching.

Hard-wire interconnect:

Figures 1 and 2 show the two possible methods to interconnect a CATV cable, converter/decoder, VCR and TV receiver without extra devices. In Figure 1, the CATV decoder is connected between the VCR and the TV set. This arrangement allows the full use of the VCR's features to record any basic program while viewing any program, basic or premium. The VCR's programmability for unattended channel change is retained but premium programs cannot be recorded, since the signal does not pass through the decoder until after it has passed through the VCR.

In order to record premium programs, the VCR must follow the decoder as shown in Figure 2. This arrangement renders most of the VCR's tuner features useless, however, since the VCR only can receive the output channel of the CATV decoder.

RF switching:

An alternate approach, designed to recover some of the VCR features lost in the hard-wire interconnection, is shown in Figure 3. This system uses an external splitter and RF A/B switch ar-

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Figure 4: View/record switching

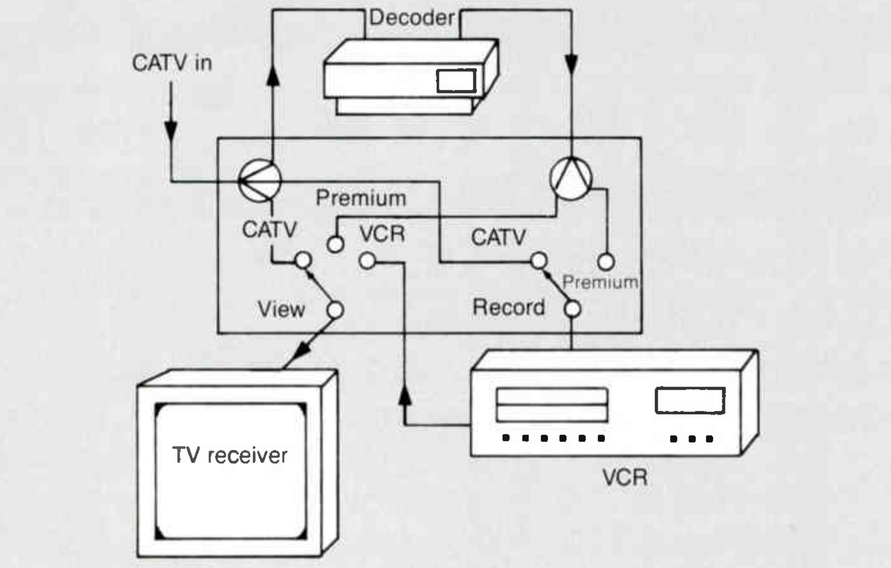


Figure 5: Ganged RF switches

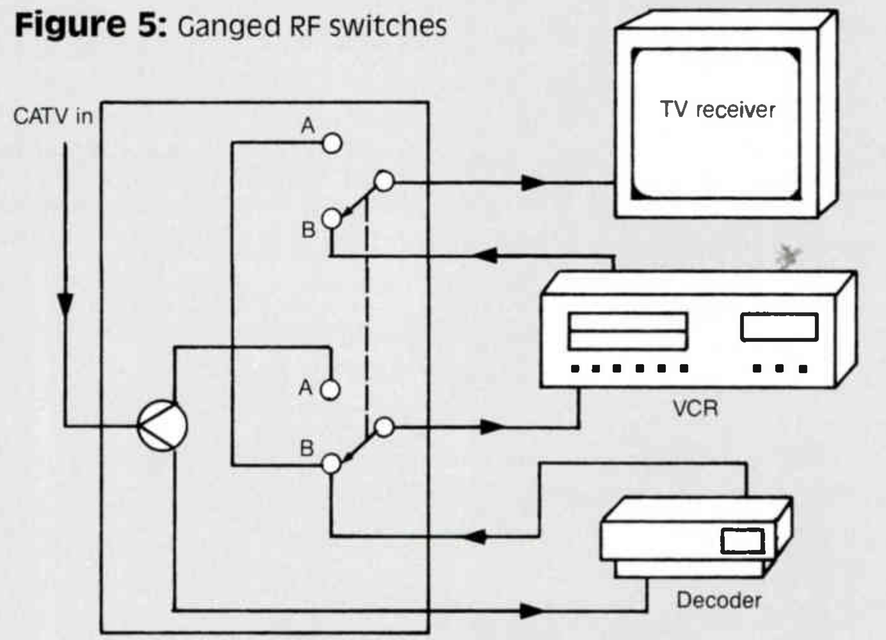
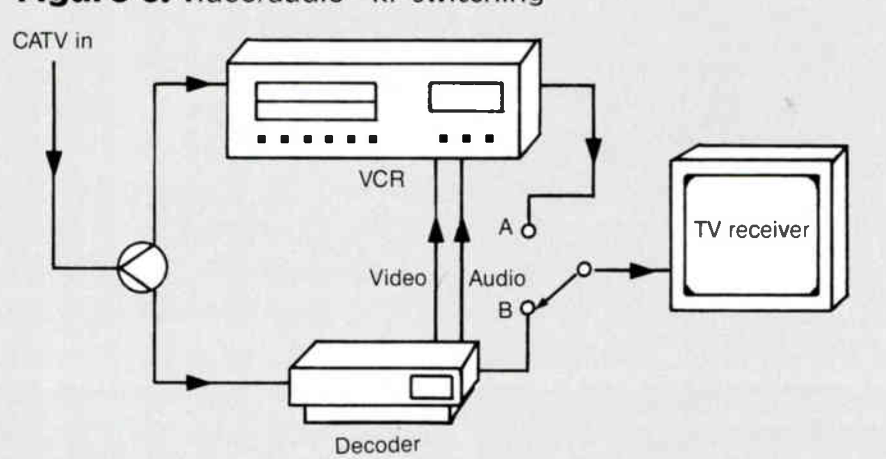


Figure 6: Video/audio—RF switching



ranged in such a way that while any program (basic or premium) is being recorded, any basic program can be viewed. The VCR, however, still is only capable of receiving the CATV decoder's output channel and is incapable of programmable channel change. Operation of the system now begins to become complicated due to the addition of the manually operated A/B switch.

As an attempt to recover more of the functionality of the VCR, an RF switching product incorporating multiple ports, switches and splitters can be used. Figure 4 describes a typical product incorporating two separate switches, one for viewing (three positions: CATV, premium, VCR) and one for recording (two positions: CATV, premium). Although this approach does seem to provide for all of the most desired options, it does not allow a programmable unattended VCR to record a premium program followed sequentially by recording a basic program since the VCR has no control over the switching. Additionally, the manual switching is more complicated and might tend to intimidate many high tech-shy subscribers.

In an effort to simplify the switching device operation, the RF switches could be ganged together as shown in Figure 5. This arrangement is designed to reduce the possible switch positions, and consequently the number of decisions the user must make.

This example shows a product with only two positions. Position A allows the viewing of any basic or premium program through the use of the CATV decoder tuner, while recording any basic program through the VCR tuner. Position B allows the viewing of the VCR output or any basic or premium channel tuned by the CATV decoder tuner, while recording the same program being viewed. A third switch position could be added, with only a small increase in complexity of operation to further allow the recording of a premium program while viewing a basic program.

Even though these solutions appear to simplify operation, switch position and channel selection decisions still have to be made depending upon what the subscriber desires to do. In some switch positions, checking what the VCR is recording is impossible, since switching to the "VCR view" mode disconnects the desired signal from the VCR input. Similarly, care must be taken not to change switch positions for viewing alternate programming while VCR recording is in progress.

Figure 6 shows a novel approach using both a two-position RF switch device and the video/audio outputs of a baseband CATV decoder through the VCR's built-in tuner/auxiliary input selector. Some new VCRs even allow the unattended selection of tuner or auxiliary inputs as part of the multi-event programming. With such a VCR, this system allows for all of the desired functions. In operation, however, it is not as simple as it looks. Although there is apparently only one two-position RF switch to be concerned with, there are two more two-position switches in the VCR (TV/VCR switch and tuner/auxiliary switch) that must be manipulated.

Alternate approaches

RF switching systems have one common drawback—the complicated installation and

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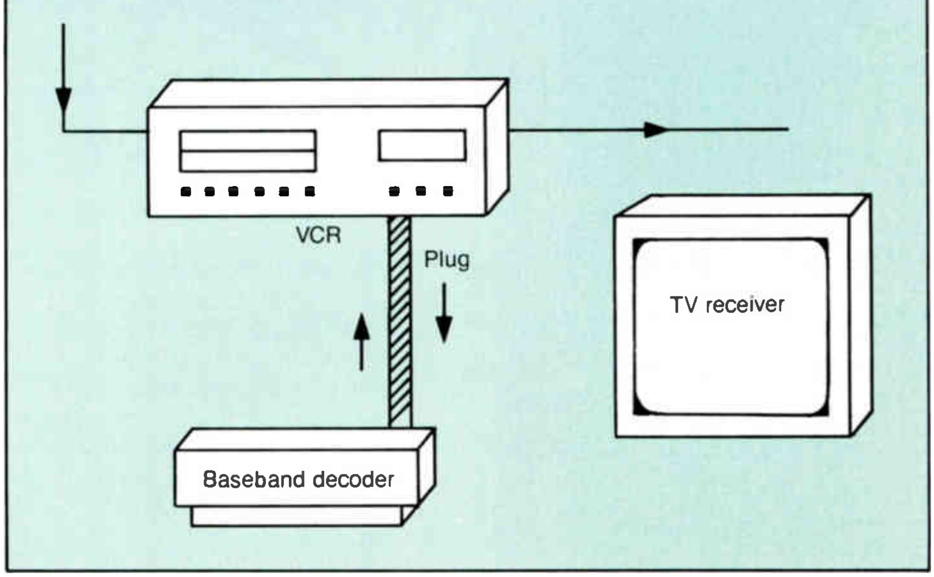
Figure 7: Baseband system



various switch positions make them difficult to use. What really is necessary is a system that does not require the subscribers to think about what they are trying to do.

In an effort to provide the most user-utility, while providing simplicity of operation, two alternate approaches to the VCR/CATV interconnection problem are suggested: the VCR "afterburner" baseband decoder and RF frequency multiplexing.

The afterburner approach is so named because the premium program descrambling is performed *after* the subscriber receiving equipment's tuner-IF and demodulation stages. The system depends upon baseband scrambling techniques, in-band addressing data and home equipment capable of being adapted.

Figure 7 shows a VCR equipped with a Zenith Base-Tac decoder. (All Zenith VCRs since 1984 have been adaptable to a Base-Tac decoder through a field installable Redi-Plug. Similarly, a VCR designed with a Cenelec connector for the NTSC television receiver baseband audio/video interface standard could be used.) The plug on the back of the VCR contains all of the necessary interconnects in a single, multi-wire cable between the VCR and the Base-Tac pay TV decoder.

In this approach there is no CATV converter (only the baseband decoder), no splitter and no RF switches to be concerned with. The CATV RF signals can be connected directly to the VCR and from the VCR to the TV receiver as in a normal setup. The VCR tunes and demodulates the encoded channel into a baseband signal. The encoded video and addressing data then are routed to the external baseband decoder through the plug. The decoder, if previously addressed and authorized for the tuned program, will decode the signal and return it to the VCR.

Channel selection for the VCR is accomplished through its own tuner, manually or via its programmable VCR timer. The VCR and TV receiver operate normally without complicated switching and retain all of their features, including BTSC stereo compatibility.

Since the "afterburner" system relies upon baseband scrambling and adaptable home equipment, it may not be a univerally acceptable solution to the CATV/VCR problem at this time. A more general approach is needed to deal with the variety of equipment now in use. Thus, a VCR interface was conceived by Zenith that does not require manual or automatic switching but supplies all of the functions normally associated with

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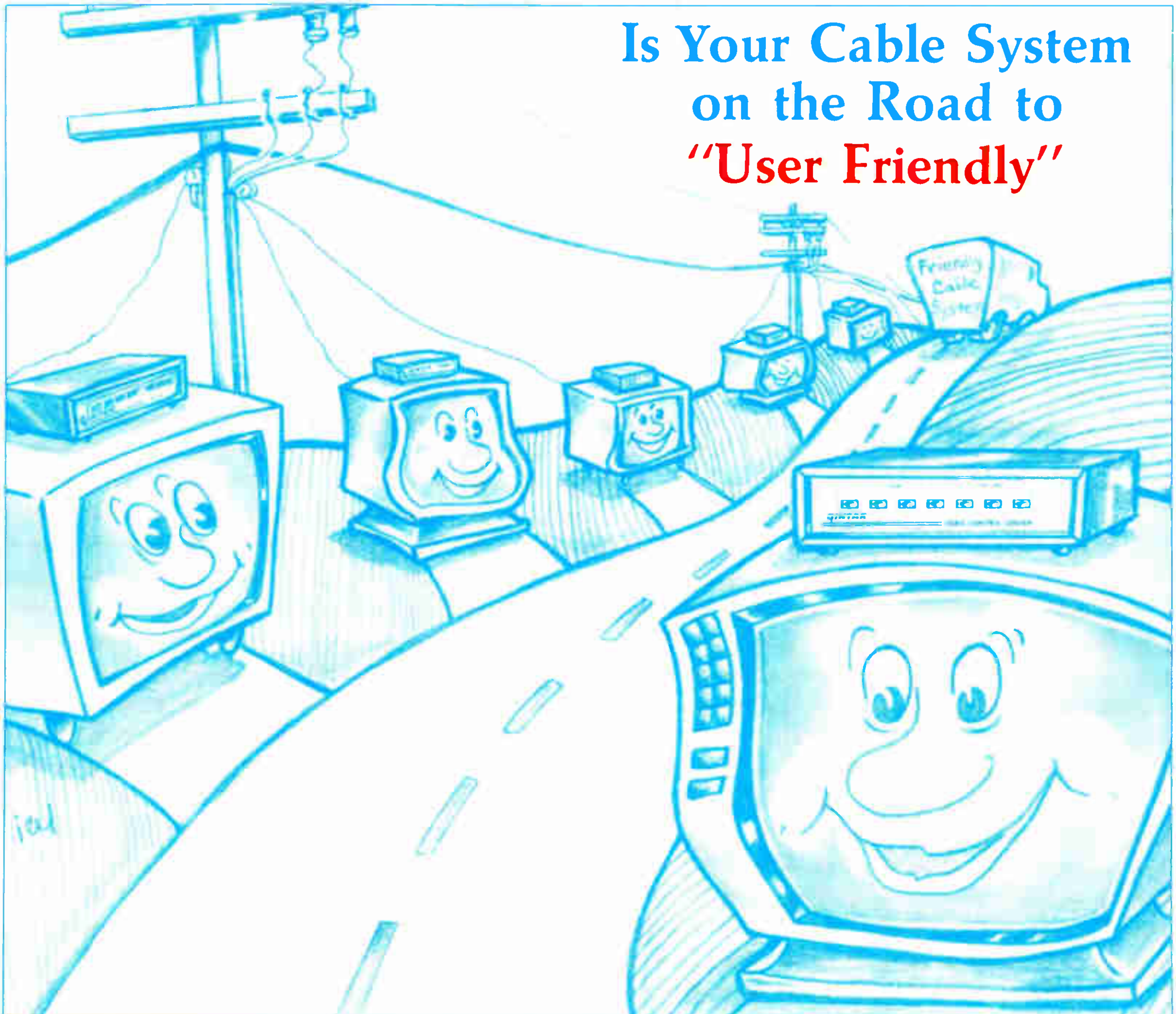

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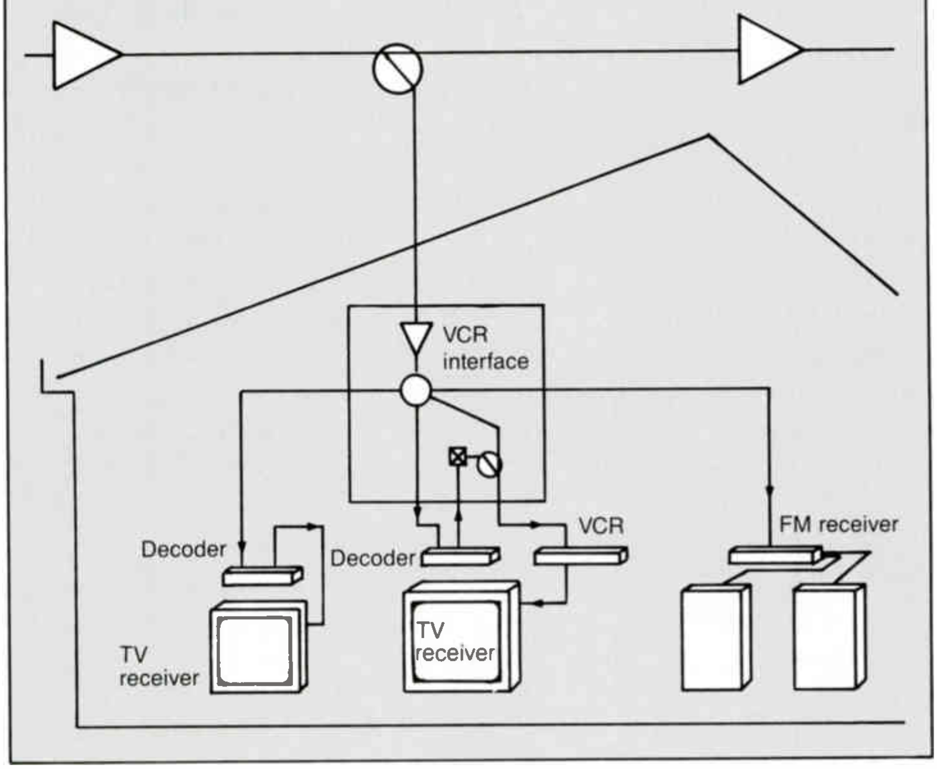
Figure 8: Universal VCR interface



such switchers.

The application block diagram of the system is shown in Figure 8. With this approach, instead of switch/time multiplexing the RF signals through a difficult to learn switching system, the signals are frequency multiplexed. The incoming cable signals are amplified (to compensate for later losses) and split four ways: to a secondary RF output, to the input of the primary pay TV decoder, to an FM receiver output and to a signal combiner. The Channel 2 or 3 pay TV decoder RF output is fed to an upconverter (mixer/local oscillator) where it is converted to a channel not used on the CATV system. This decoded and upconverted channel now is recombined with all the signals on the cable system in the signal combiner and passed on to the subscriber's VCR and TV receiver.

With this arrangement, the subscriber operates the VCR and television normally, in the same familiar fashion as without a CATV converter. No confusing RF switching is necessary. No extra thought is necessary to perform the desired viewing and recording functions. Once connected, the VCR interface does not have to be worried about; it can be left out of sight.

Channel selection for viewing or recording is accomplished with the television's and/or the VCR's tuner. With the TV set or VCR tuned to the decoded upconverted channel, channel selection is performed through the CATV converter/decoder. Viewing of one channel while recording another is now possible, as well as unattended, programmed VCR channel switching from premium to basic. By interconnecting several TV sets or VCRs, a subscriber could be viewing a premium program and recording a basic program, while others in the home are viewing or recording other basic programs.

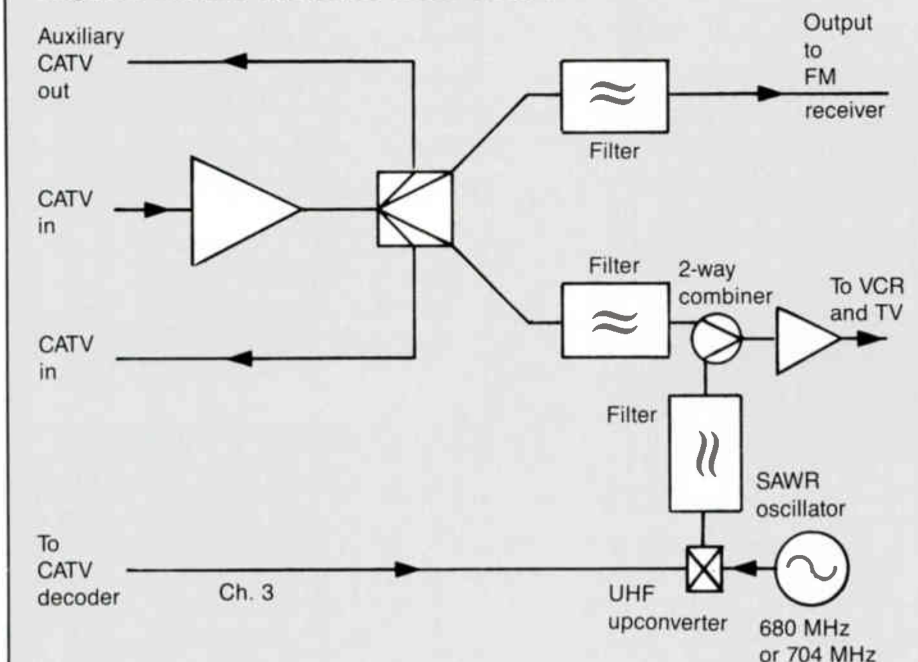
A major decision is the choice made for the upconverted output channel. For economical mass-production, a common, standardized output channel must be selected. Ideally an unused CATV band channel would be chosen, but due to the lack of standardized channel usage among cable systems, a common channel cannot be identified.

An alternate method is to upconvert to a UHF channel. This serves a dual purpose: It provides a guaranteed unused channel for use and it becomes useful with older non-CATV compatible televisions and VCRs.

Figure 9 shows a detailed block diagram of the VCR interface. A SAW resonator oscillator (for stability) is used to upconvert the decoder output channel to a UHF output frequency. Two models are made available depending upon the UHF output channel required in the user's area. A 680 MHz oscillator is used for upconversion from Channel 3 (VHF) to Channel 59 (UHF). Similarly, a 704 MHz oscillator is used to upconvert from Channel 3 (VHF) to Channel 63 (UHF). In either case, the converted decoder output signal is summed with the CATV RF spectrum for delivery to the subscriber's VCR and TV.

In application, the television and VCR are placed in the "TV" mode (as opposed to the "CATV" mode) to select VHF basic channels or UHF CATV programs (as tuned through the CATV decoder). Viewing or recording other CATV channels while the CATV decoder is otherwise being used requires switching the television or VCR to their "CATV" modes.

Figure 9: VCR interface block diagram



Acknowledgements: The author would like to thank Vito Brugliera and George Green for their help and encouragement in the preparation of this paper, and to George Hoeltje, Mike Nakanishi and Andrew Babchak for their development of the VCR interface from an idea to a working product.

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2. "Proposal: Wideband Cable Feed Including Descrambled Premium Channel," David Large, NCTA Consumer Interconnect Subcommittee, Aug. 21, 1985.

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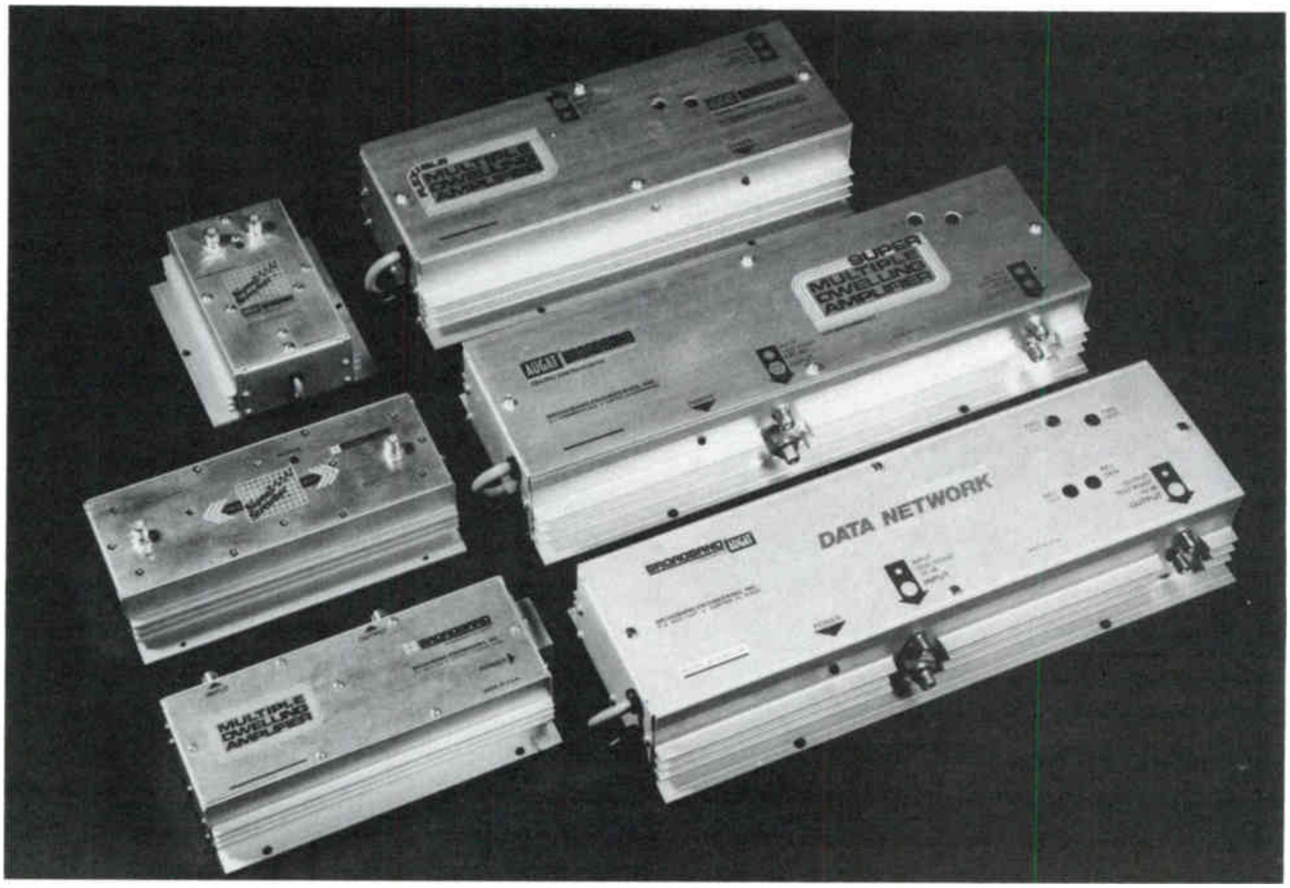

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Implementing BTSC stereo in the headend

Several cable systems have begun delivering programming to their subscribers in BTSC stereo. Within a few years, most cable systems will add BTSC stereo to their video channels. One problem, however, is that BTSC is a new technology. There is confusion among cable engineers concerning both what the technology entails and how to successfully implement stereo in the headend. This article will define the BTSC signal and discuss ways to add the stereo encoding equipment to your headend. You will find that with proper planning, BTSC is easy to interface with your existing equipment and will be a positive addition to your programming.

By Steve Fox
Manager, Customer Applications
Wegener Communications Inc

When the BTSC concept was initially developed, several design constraints were taken into account: The stereo signal could not disrupt monaural audio reception in subscriber television sets; the stereo signal had to fit within the 6 MHz video bandwidth; and the system needed to deliver quality sufficient to gain consumer acceptance. The system eventually accepted and endorsed by the FCC and the NCTA meets these criteria.

Figure 2: BTSC and FM stereo from a subcarrier audio demodulator

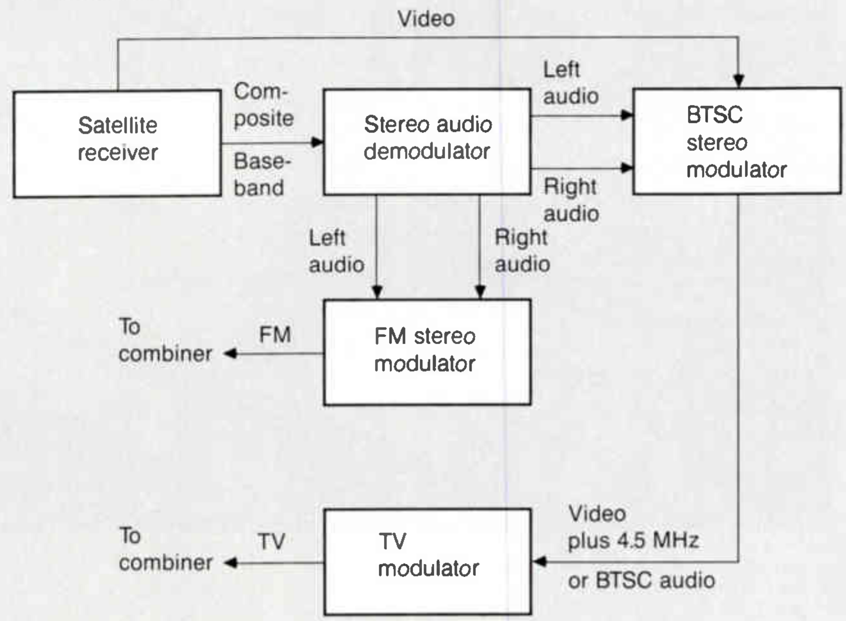
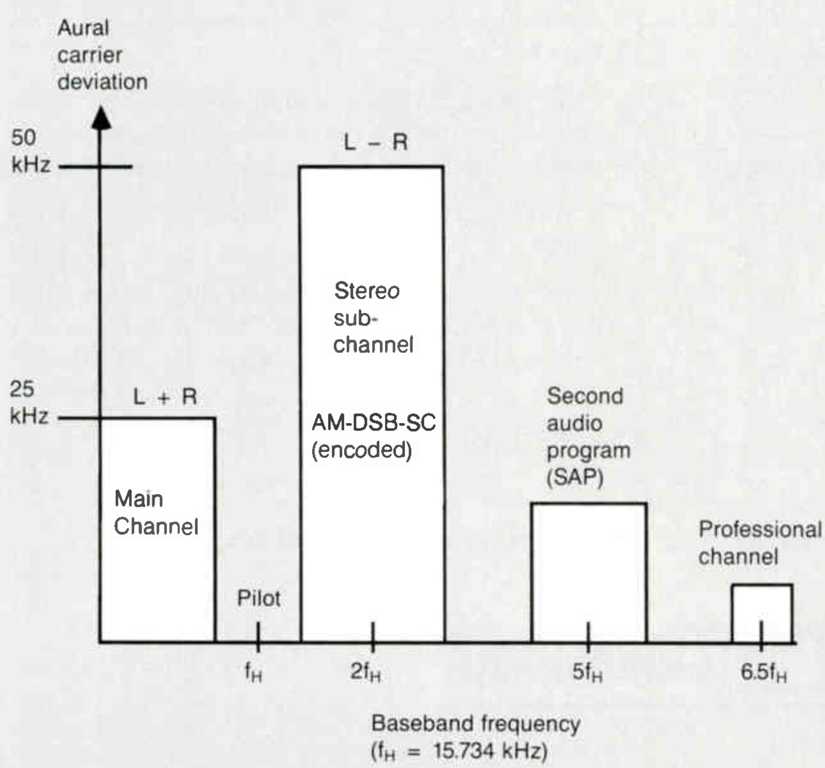


Figure 1: BTSC baseband signal



First, let's look at the BTSC baseband signal shown in Figure 1. The BTSC signal is made up of five components: L+R or monaural, the pilot, L−R or the stereo subchannel, second audio program (SAP), and the professional channel (PC).

The *L+R* subchannel is identical to the monaural baseband audio signal delivered in monaural-only programming. The signal has 75 μs pre-emphasis, 25 kHz peak deviation and a useable audio bandwidth of about 50 Hz to 15 kHz.

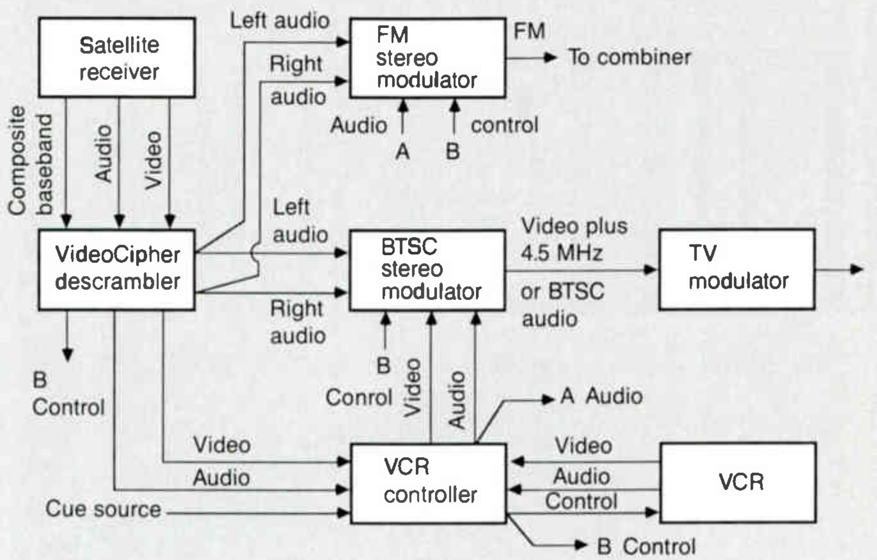
The *pilot carrier* is used as a synchronizing frequency for the L−R subchannel and to illuminate the "stereo" LED on subscriber stereo decoders. Peak deviation is 5 kHz and center frequency is 15.734 kHz, the same as horizontal sync.

The *L−R* (or stereo) subchannel is an AM double sideband suppressed carrier with dbx compression, 50 kHz peak deviation, and 50 Hz to 15 kHz useable audio response. Total peak deviation for L+R, pilot and L−R combined is 55 kHz.

SAP is a monaural signal that is similar in usage to an FM broadcast SCA. Also dbx compressed, SAP has a 50 Hz to 10 kHz audio response and 15 kHz peak deviation. This signal is intended for alternate language audio (no doubt other uses also will be found that are undefined at this time). Probably, most cable systems will not use the SAP carrier.

PC may be used as a voice or a low-speed FSK data channel and will find use in broadcast televi-

Figure 3: BTSC and FM stereo from a descrambler (full-time scrambling) with local commercial insertion



sion stations. Total BTSC signal bandwidth with all carriers, including SAP, exceeds 100 kHz and peak deviation is 73 kHz. (These specifications will take on greater significance when we discuss interfacing the BTSC encoder with TV modulators.) It should be noted that as SAP and PC are added to the BTSC stereo signal, the potential for signal degradation increases. Therefore, these signals should not be added to your system unless needed.

Next, let's look at the equipment required at the headend to generate BTSC stereo. Three signals drive the BTSC encoder: left audio, right audio and baseband video. Audio sources include satellite and microwave subcarrier demodulators and the VideoCipher descrambler. Video is derived from the descrambler or from a satellite or microwave receiver and is used to generate a reference pilot for the subscriber BTSC decoder. Note in Figure 1 that all signals above L+R are centered at multiples of the 15.734 kHz pilot frequency, another reason for the video input to the BTSC encoder. For this reason, a clean baseband video source must be used, not the output of a headend scrambler. The final component is the BTSC encoder itself.

The nomenclature "BTSC" is very important. Another commonly used term, "MTS" or multichannel television sound, is properly defined as stereo transmission on the video channel by some undefined method. "BTSC" is the specific method of stereo transmission endorsed by the FCC and the NCTA, and *is* the industry standard. Consumer receiving equipment conforms to the standard or, in other words, are BTSC decoding devices. The point here is that BTSC encoders—but not necessarily all MTS encoders—will operate successfully with consumer decoders and should be used in the headend.

To further complicate the issue, the terms BTSC and MTS sometimes are used interchangeably to denote a true BTSC system. True BTSC encoders provide quantified, measurable performance standards because they themselves conform to the industry standard. Non-BTSC stereo

(Continued on page 70)

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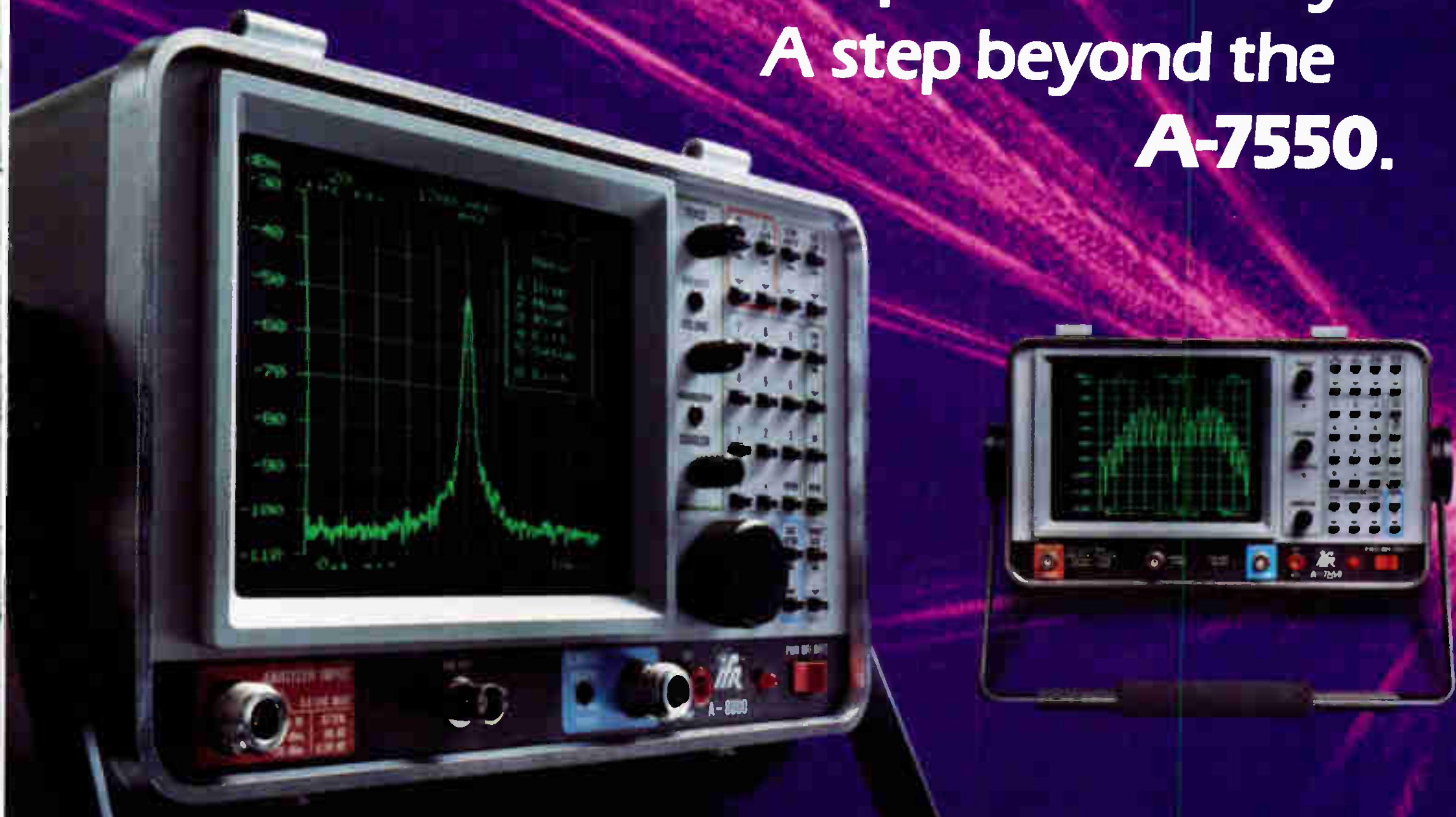

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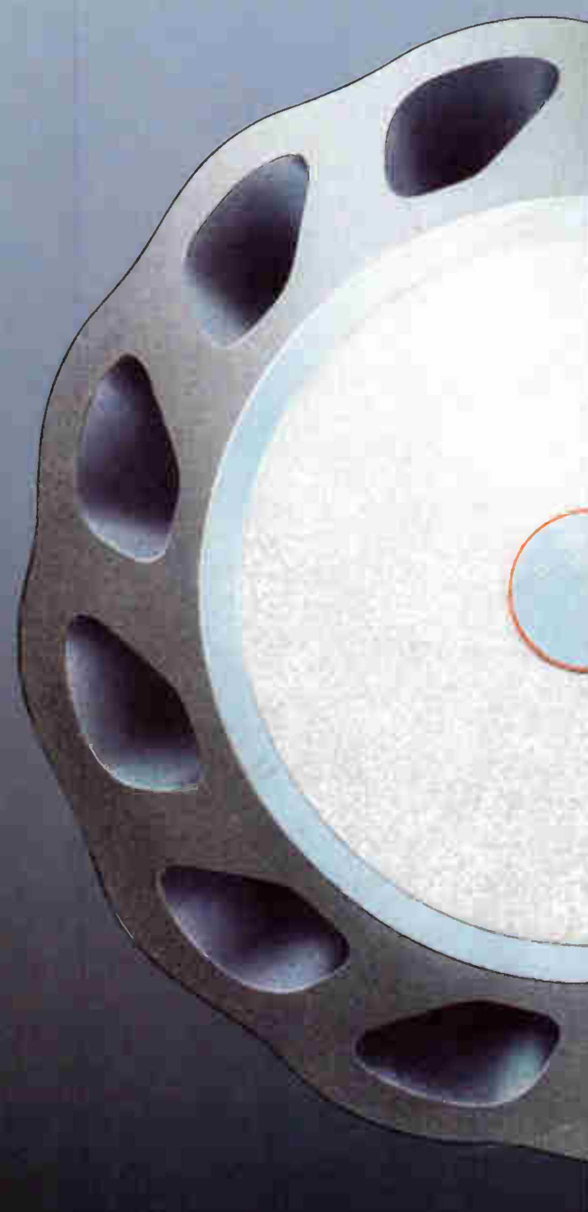

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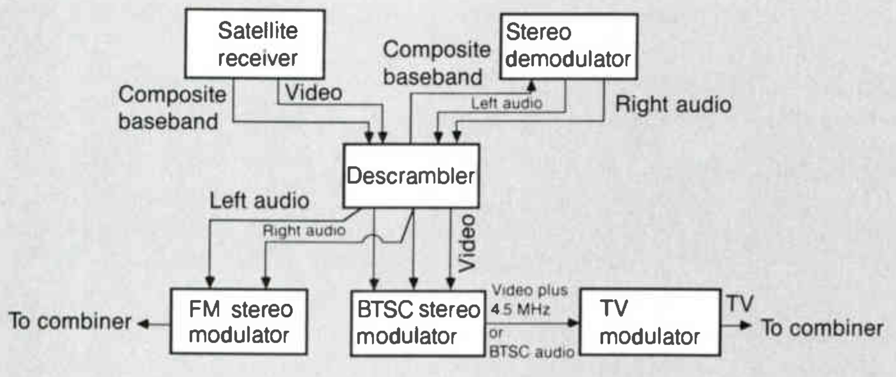
Figure 4: BTSC and FM stereo from a descrambler and subcarrier demodulator (part-time scrambling)



(Continued from page 54)

encoding systems, although less expensive, do provide a simulation of stereo, but their outputs do not accurately resemble the stereo relationship provided by the programmer. It should be noted that the use of non-BTSC stereo encoding devices is illegal for off-air television broadcasters, but not for cable operators. What cable operators must do, therefore, is to make sure they know what components they really are purchasing.

System configurations

BTSC stereo can be implemented in the cable headend in several configurations for a variety of applications. These include: TV stereo only or simultaneous TV stereo/FM stereo generation, with or without local commercial insertion, and with subcarrier demodulators or the VideoCipher descrambler as the baseband audio source. To further complicate matters, configurations differ for part-time or full-time network scrambling. Four typical systems will be discussed here. (Reasons for retaining your FM stereo delivery will be discussed later in this article.)

Figure 2 is a diagram of a system generating both BTSC and FM stereo. A satellite receiver is used for the video source, while a subcarrier demodulator provides left and right baseband audio. In this and in all other examples, the same baseband audio source drives both the FM and the BTSC modulators (the modulators typically will have high impedance inputs, eliminating loading problems). A descrambler easily can be substituted for the stereo demodulator in full-time scrambled systems to provide the baseband audio and video signals.

In Figure 3, the descrambler is used to supply these signals. This system is identical to the one in Figure 2 except local commercial insertion also is utilized. A network cue (contact closure or DTMF) provides switching commands to the VCR controller to switch between network and commercial (advertising) program sources. During network operation, stereo audio is input to the BTSC and FM modulators directly from the descrambler, while video is routed through the VCR controller. During commercial operation, the VCR containing taped commercial programming is switched on simultaneously with auxiliary audio inputs on both the BTSC and FM modulators by the VCR controller. Thus, commercial audio at the auxiliary inputs in switched in, while network audio is switched out, and commercials run on both the BTSC and FM systems. At the end of the commercial interval, a second network cue stops the commercial insertion process and the systems switch back to normal network operation.

Prior to beginning full-time scrambling, programmers first implement a testing period during which the network is scrambled only part time. For networks that provide stereo audio subcarriers prior to the implementation of scrambling, additional complexity is added to the headend puzzle.

Figure 4 is a block diagram of a combined BTSC and FM stereo configuration during part-time scrambling by the network. During scrambling, video and audio baseband signals are provided by the VideoCipher and the stereo subcarriers are not transmitted over the satellite by the programmer. When scrambling ceases, however, the baseband signals no longer are provided directly by the descrambler. The stereo subcarriers again are transmitted by the programmer and a subcarrier demodulator is required at the cable headend. Left and right audio is routed through the bypass audio inputs of the descrambler to its output terminals. Video is routed through the bypass video input from the satellite receiver to the descrambler output. When the network is transmitting unscrambled, the VideoCipher will *not* provide baseband audio or video outputs unless these signals are provided at the bypass inputs from external sources.

Although the configuration in Figure 5 appears complex, it is simply a compilation of the previous ones. For cable headends locally inserting commercials on networks scrambled part time, the commercial insertion process remains identical to that shown in Figure 3. Again, both the descrambler and subcarrier demodulator are required to maintain stereo audio inputs to the BTSC and FM modulators. When the network switches between scrambling and non-scrambled transmission, no disruption in the delivery of stereo audio to the subscriber will occur.

When inserting commercials at the headend, care must be taken in selecting the appropriate BTSC and FM modulators. While most cable systems insert commercials in monaural, the trend is moving in the direction of stereo. Not all modulators have commercial insertion interfaces and of those that do, some are monaural only, while others can process both monaural and stereo commercial audio. The caution here is to make sure you select the proper equipment for your present and future system requirements.

Interfacing to your TV modulator

The primary installation issue not yet discussed is interfacing the BTSC stereo generation system to your TV modulator. This interface is critical to successful implementation of BTSC. The way you interface will depend on the particular TV modulators you have, headend scrambling and other factors. There are four ways to interface this equipment. Three are considered the "standard" interface methods and will be discussed here. The fourth method is at 41.25 MHz.

The baseband audio interface is shown in Figure 6. In this case, the audio is encoded into the BTSC format and output to the audio inputs of the TV modulator. Baseband video is looped through the BTSC modulator to the TV modulator video input. When this interface is utilized, the TV modulator must be able to process the extended bandwidth and deviation of the BTSC signal. Often, this means modifying the aural processing section of the TV modulator, either at the factory or in the field, or replacing it altogether with a BTSC-compatible unit. Also, the audio pre-emphasis circuit in the TV modulator must be disabled, since 75 μs pre-emphasis already is provided in the BTSC encoding process.

The adjustment of the audio modulation level of the TV modulator is critical to stereo separation. For example, a misadjustment of as little as 1 dB will limit theoretical *maximum* separation to 25 dB. Some BTSC modulator manufacturers provide a "calibration tone" feature to aid in setting the audio modulation level. This provides a rough setting and generally is designed to work accurately only with specific TV modulators. The result may or may not be adequate stereo separation. If this interface is used, the setting of the audio modulation level of the TV modulator should be rechecked frequently.

The preferred interface from the standpoint of simplicity and hardware consideration is 4.5 MHz. There are two ways to provide a 4.5 MHz interface; the method selected will be determined by the inputs available on your TV modulator.

In Figure 7, both video and BTSC audio are combined and modulated onto a 4.5 MHz carrier by the BTSC modulator. The resulting composite video signal then is input to the TV modulator. This is the easiest interface to make but has one drawback: Some TV modulators can produce interaction between the video and audio signals when the composite video interface is used. This interaction could be insignificant or could result in buzz on the audio and/or video degradation. The degree of interaction, if any, is dependent on the particular TV modulator used and on signal injection levels.

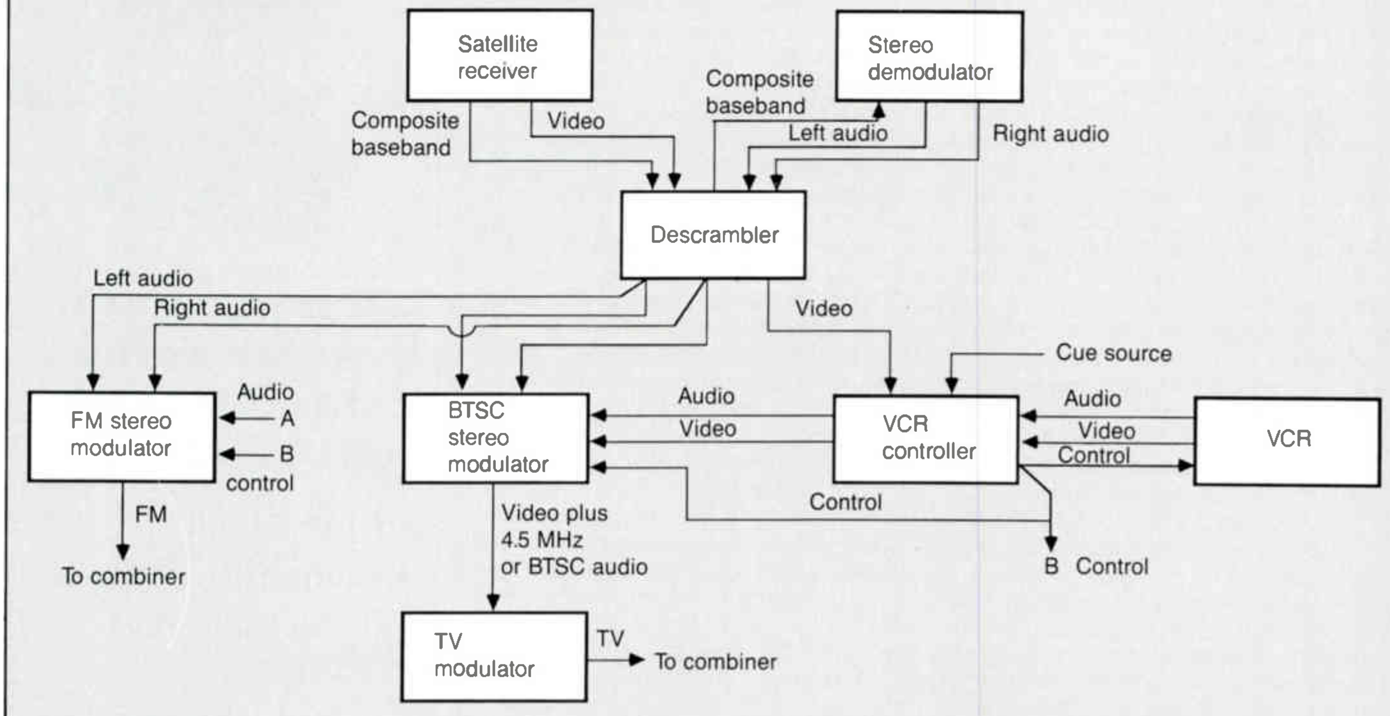
The way to eliminate potential signal interaction is shown in Figure 8. In this example, BTSC audio is modulated at 4.5 MHz and output to the TV modulator. Baseband video is looped through the BTSC modulator and is input to the TV modulator separately. This is the preferred method of interface from a technical point of view. Many TV modulators that do not have provisions for separate inputs can be modified easily and inexpensively in the field. With careful attention to levels, however, this modification may be unnecessary.

One obvious advantage of interfacing at 4.5 MHz is that the aural section of the TV modulator is completely bypassed, meaning that no aural modification or TV modulator replacement is necessary. Another advantage is that no adjustments other than input and output levels are required, and no periodic adjustments are needed. All critical deviation adjustments are factory set. If you decide to interface at 4.5 MHz, keep in mind that not all BTSC modulator manufacturers offer this output. Of those who do, some provide a 4.5 MHz output as standard, others as options. The ability to combine video onto the 4.5 MHz carrier also may be an option or may be unavailable. Again, keep your system requirements in mind when selecting your headend equipment.

Headend scramblers and alternative RF delivery systems

Over the past several months, Wegener Communications has conducted a series of tests to determine the mutual effects of BTSC stereo encoding and headend scrambling. Numerical

Figure 5: BTSC and FM stereo from a descrambler and subcarrier demodulator (part-time scrambling) with local commercial insertion



results of the testing will be presented in a paper at the 1987 NCTA convention, so several general comments will be made here. Scrambling systems from a number of manufacturers were evaluated. In all cases, some degradation in stereo separation occurred during the scrambling process, but in no case did separation fail to meet or exceed levels comparable to off-air transmission. Nor did the BTSC process interfere with descrambler operation on the scramblers evaluated. Some problems did become evident, however.

With sine wave sync suppression scrambling, some audio components were evident in the video. The audio/video interaction was reduced to virtually imperceptible levels by interfacing to the TV modulator with 4.5 MHz BTSC audio and separate baseband video, as discussed previously. This scrambling system had very little effect on stereo separation. From an operational point of view, sine wave sync suppression scrambling is the most challenging, but with careful engineering it can work well with the BTSC stereo system.

Gated sync suppression scrambling caused no visible video degradation, but sync-buzz was evident in the audio. Further testing showed the buzz to be scrambling-related rather than BTSC-related. The noise effect was minimized by proper adjustment of the depth of video modulation, audio input levels and scrambler setup.

The effects of FM trunking on BTSC stereo is another area of concern to cable operators, and an evaluation of these systems is currently being undertaken at Wegener Communications. At this time, some general statements can be made. First, no significant audio or video degradation has been found in subjective testing. Stereo separation is affected, but again separation exceeds that expected from off-air stereo at the subscriber system.

Several factors need to be taken into account when implementing BTSC over an FM trunk. Video deviation must be set correctly on the FM modulator. The FM demodulator output level and TV modulator video level adjustments will interact. Both must be set to the proper depth of video modulation to minimize sync-buzz and should be set a little below 100 percent. BTSC interfacing is, of course, at 4.5 MHz.

Microwave delivery systems can be configured in a variety of ways but, again, some general statements can be made. If possible, encode the stereo audio into BTSC and transmit the signal with video at 4.5 MHz over the microwave link. If the audio is to be delivered separately from the video, transmit separate left and right narrowband subcarriers over the link. At the microwave receive site, demodulate the subcarriers into baseband left and right audio, then encode into BTSC. Either of these methods of transmission will result in a quality stereo signal. Transmitting encoded BTSC audio as a single multiplexed subcarrier apart from video, however, will likely produce increased noise and greater susceptibility to path fades, and is not a recommended method of transmission over the microwave link, especially in multiple hop systems.

Off-air television stations generally are processed at the cable headend by a heterodyne processor. In most cases, the heterodyne processor will pass BTSC without modification. However, some older systems may require filter modifications to pass the extended bandwidth of the BTSC stereo signal. If you are not sure, check with the manufacturer.

BTSC signal quality and testing

A high-quality BTSC encoder will deliver separation in the 50 Hz to 14 kHz audio passband of about 32 to 45 dB, measured at the baseband audio output. A 4.5 MHz modulation will degrade the separation by no more than a few dB. Distortion of less than 1 percent, frequency response of ±1 dB or better throughout a 50 Hz to 14 kHz audio range, and signal-to-noise greater than 60 dB all indicate a quality BTSC modulator. The encoder itself should cause no perceptible video degradation (remember, video is one of the inputs to the BTSC modulator). If the BTSC modulator is supplied with an auxiliary input for local commercial insertion, there should be no reduction in performance when this interface is used. Again, a stereo local commercial insertion interface is recommended.

In the BTSC encoding process, gain or phase tracking errors between the L+R and L−R subchannels will cause rapid loss of separation. All adjustments to components on the BTSC modulator are precisely set by the manufacturer and no attempts should be made by the cable technician to alter these settings. The only adjustments available to the cable system are left and right audio input level and, if needed, 4.5 MHz output level. (The output level is normally factory set and probably won't need readjustment.)

If the BTSC modulator is equipped with LED level meters for setting the input levels, no test equipment is needed. The 4.5 MHz output level can be verified with a spectrum analyzer, if desired. Rough separation measurements can be made with an oscilloscope. If precise measurements of BTSC operation are desired, quality test systems are available from several manufacturers. (We use the Modulation Sciences Model SRD 1 and Belar BTSC reference monitor.)

A brief look at cable converters also is in order. Generally, an RF converter will pass the BTSC signal intact without problem. Baseband systems can provide problems, however. Baseband converters that pass BTSC stereo typically will do so only with the volume control turned up. Many older baseband converters will not pass the entire BTSC signal without modification. Converter manufacturers are addressing potential problems and offer various solutions to make their products compatible with BTSC. If you have questions about your system, contact the manufacturer.

Subscriber issues

BTSC stereo delivery provides one obvious advantage to the cable subscriber. With FM stereo delivery, the cable is split in the home and one splitter output is connected to the antenna input of an FM receiver. When changing television channels, the subscriber also must change the station the FM receiver is tuned to in order to receive stereo for the new TV channel. Although this is inconvenient, if the FM receiver and TV are located in different rooms, the subscriber likely won't take advantage of FM stereo at all. BTSC stereo, on the other hand, is transmitted along with video on the television channel. The stereo audio tracks with video whenever the television channel is changed, and no splitters or significant additional wiring is required to install the stereo decoding equipment.

Some cable subscribers will prefer to receive FM stereo rather than investing in new BTSC stereo receiving equipment, however. The cable operator should consider delivering one or both stereo methods on each channel appropriate for subscribers' needs, especially if an FM delivery system is already in place on some of the cable channels.

How does the subscriber receive BTSC stereo? One way is to purchase a stereo television. Television manufacturers are now building stereo decoders into low-, mid- and high-end sets. Estimates indicate that more than half the new televisions sold in 1987 will be BTSC-capable and that they will cost little or no more than monaural versions.

Stereo televisions fall into three catagories. The true stereo television contains BTSC decoding circuitry, a stereo amplifier and stereo speakers, either attached or detachable. The "stereo-ready" television may contain a BTSC decoder but requires interface with external components such as an amplifier and/or speakers to complete the stereo system. More often, stereo-ready TVs provide a wide-band baseband (multiplexed) BTSC or a 4.5 MHz output to interface with an external stereo decoder. Still other "stereo-capable" televisions will demodulate the 4.5 MHz carrier and output a multiplexed BTSC audio signal. An external adapter is required to decode this signal into left and right audio.

The stereo adaptor is the second method of BTSC stereo reception, and one that is relatively inexpensive. Generally, a stereo adaptor will accept the Channel 2, 3 or 4 output from a cable converter (or the multiplexed audio output from

Reader Service Number 52.

Figure 6: Baseband audio interface

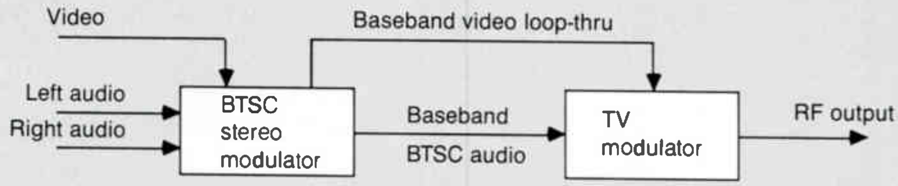


Figure 7: 4.5 MHz composite video interface

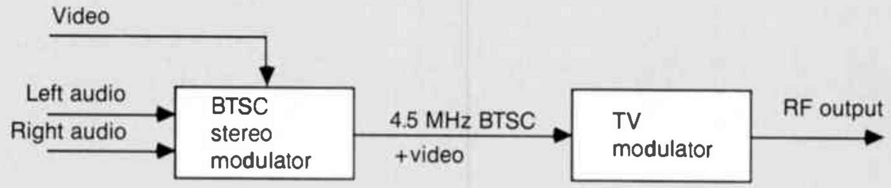
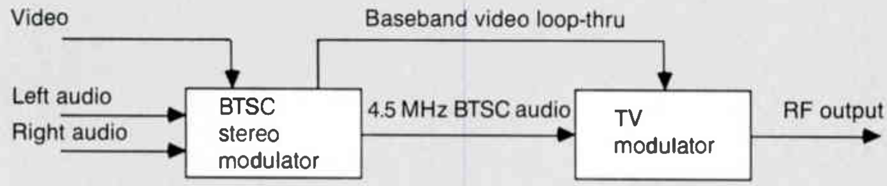


Figure 8: 4.5 MHz BTSC and separate baseband video interface



a stereo-capable television), decode the BTSC stereo into left and right audio, and output the video channel to the television. Some adaptors include a stereo amplifier and speaker connections, while others interface with the auxiliary input of an external amplifier. As well, some include a variable RF tuner for off-air BTSC reception.

Essentially, the BTSC stereo adaptor will turn an existing monaural television into a stereo television—the difference being that the decoder is external rather than internal. Separation and other performance specifications will vary from good to poor and care in selection is therefore important. The same can be said, of course, for stereo televisions.

A third method of decoding BTSC is with a stereo VCR. The VCR must contain a BTSC decoder to operate with the stereo system. As with adaptors and stereo televisions, BTSC decoders in VCRs vary in quality.

Installing the subscriber BTSC system is simple and can be accomplished easily by most subscribers. However, a subscriber may call the local cable system for assistance. It is to your advantage to provide this help; however, keep in mind that the BTSC system usually is subscriber-owned. You may want to charge for house calls.

BTSC and FM stereo performance at the subscriber drop are generally equivalent. BTSC convenience to the subscriber is superior to FM. In regards to performance, however, if subscribers accept the quality of FM stereo, they will certainly be pleased with the quality of BTSC.

Opportunity knocks

The BTSC stereo delivery system now is used by over 1,000 off-air television stations. Subscribers are purchasing systems to receive BTSC stereo, creating an opportunity for cable systems to provide an important new service to their subscribers and to increase penetration on channels delivered in stereo. This means added revenue to the cable system.

At some point, most cable systems will take a hard look at providing BTSC stereo, and many will decide to implement BTSC on several channels. It is to your advantage to understand BTSC stereo technology, the short- and long-term capabilities needed in your particular system, and the equipment available to satisfy your specific requirements. As well, it is to your advantage to share your knowledge with your subscribers, encouraging them to add BTSC stereo in their homes.

Although the BTSC system is complex, the critical factors are taken care of by the major encoder manufacturers. What remains is a straightforward delivery system that, with proper engineering at the cable system, can be installed and maintained easily. ■

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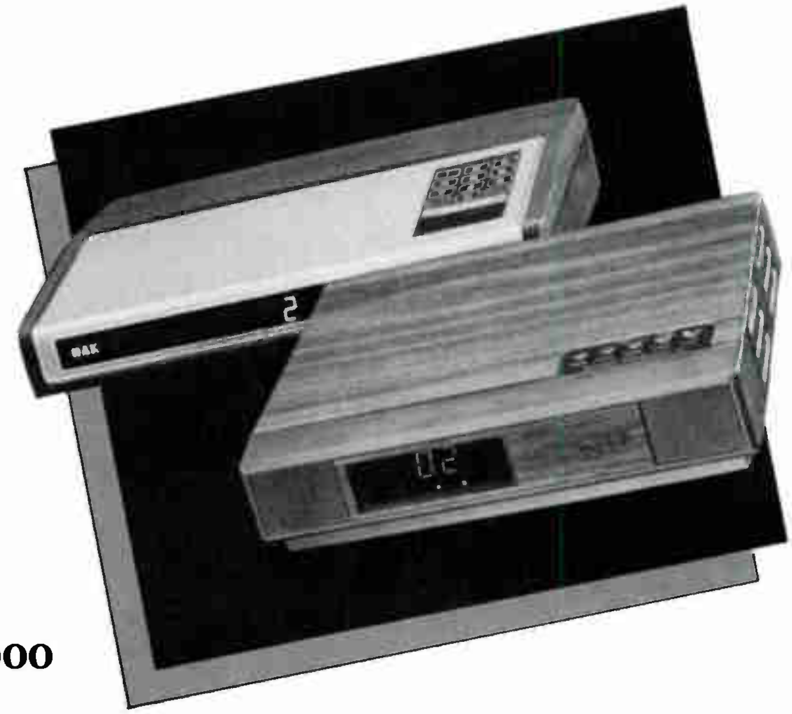

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Reader Service Number 53.

Transportation of stereo signals over FMLs

By Luis A. Rovira
Senior Engineer, Broadband Communications Division
Scientific-Atlanta Inc

Amplitude-modulated links (AMLs) and frequency-modulated links (FMLs) are used routinely in CATV systems to transport signals between hubs, satellite receiving stations and headends. When used properly this equipment is nearly transparent to video and audio signals. Care should be taken, however, when adapting existing systems to carry BTSC stereo. FMLs in particular can cause significant degradation of the stereo signal if improperly used.

Typically, the FM transmission systems used in CATV frequency-modulate one VHF carrier with video information and a separate VHF carrier with audio information. In upgrading such a system all that is necessary is to add one more carrier for a second audio channel. One carrier then is assigned to the left audio channel and the second to the right. Encoding of the audio into the BTSC format can be done after the link, with the encoder and modulator co-located. All the performance specified for the FM link is preserved.

In systems that are near or at capacity it is tempting to avoid adding the extra channels. Some stereo encoders have built-in 4.5 MHz subcarrier modulators and provide a video plus audio subcarrier at their outputs. It would seem a simple matter to connect such an output directly to the video input of the FM link and avoid the separate audio channels altogether. Unfortunately the results could be quite marginal.

Video clamps

In sending video over FM links some sort of DC restoration may be used to avoid field-time distortions. Video clamps normally act to restore the sync tips to a constant DC voltage. Although all clamp circuits use active components, some are more "active" than others. These circuits detect the presence of the sync and then trigger active devices to saturate and clamp the signal path to some stiffly held voltage. Unfortunately, any subcarrier present in the signal also is effectively "shorted" to this voltage for the duration of the clamping period. This produces an amplitude modulation of the subcarrier at the horizontal frequency (f_H) that can approach 100 percent.

Any subsequent AM-to-FM conversion in the signal path or the consumers' receivers will then cause a discrete carrier at f_H that will add vectorially to the existing pilot. The resultant pilot will have a phase that is different from the phase of the original pilot. This phase error will cause the synchronous subcarrier detector to add a phase error to the recovered difference signal and thus seriously degrade stereo separation. Buzz also can be added to the audio due to inadequate AM rejection in the receiver's FM demodulator.

Bandwidth considerations

Because the video channels normally are intended to carry only video, frequency response usually is specified only to 4.2 MHz. Though not necessarily present, the user should beware of sharp low-pass filters or transmission zeros in the signal path at frequencies above 4.2 MHz. Before combining video with a 4.5 MHz subcarrier in any system, low-pass filtering of the video may be required to prevent spectral overflow of the video from interfering with the audio carrier.

A less obvious problem is that of overmodulation. FM links normally have bandpass filters at the output of the transmitter in order to protect adjacent channels. Selectivity also is provided in the receivers in order to reject adjacent channels. The bandwidth of these filters, along with the linear deviation range of voltage-controlled oscillators (VCOs), normally limit the deviation of the video carrier. With this upper limit in mind, manufacturers usually deviate as much as possible to preserve video signal-to-noise ratio.

If a user then adds a subcarrier to the video signal without reducing the modulation sensitivity of the VCO, two things happen: Deviation is increased by the added peak voltage of the video plus subcarrier (usually .1 V p-p), and the highest modulating frequency increases from 4.2 MHz to about 4.6 MHz (stereo plus SAP). The resulting increase in bandwidth can exceed the bandwidth of the channel resulting in increased distortion of the audio and video.

Signal-to-noise ratio

The transmission of video plus audio subcarriers as a frequency-modulated carrier is not without precedent in the CATV signal chain. Satellite delivery of signals normally is done this way, so much already is known about the technical tradeoffs involved. Early on it was discovered that a better signal-to-noise ratio (S/N) could be obtained by using multiple audio subcarriers as opposed to one multiplexed subcarrier. The same consideration applies to an FM video plus multiplexed subcarrier signal.

It cannot be denied that it is possible to transmit BTSC stereo as a 4.5 MHz subcarrier added to video over an FM link. By disabling active clamps, checking frequency response, filtering any spectral overflow and reducing deviation the BTSC signal should survive, though bruised with a marginal S/N. The problem is that the FM link is only a small part of a complex distribution system, of which no single component should be so marginal. By contrast, transmission of separate left and right audio information over individual channels of an FM link is an excellent way to transport stereo and entirely avoid any degradation attributed to the FM link.

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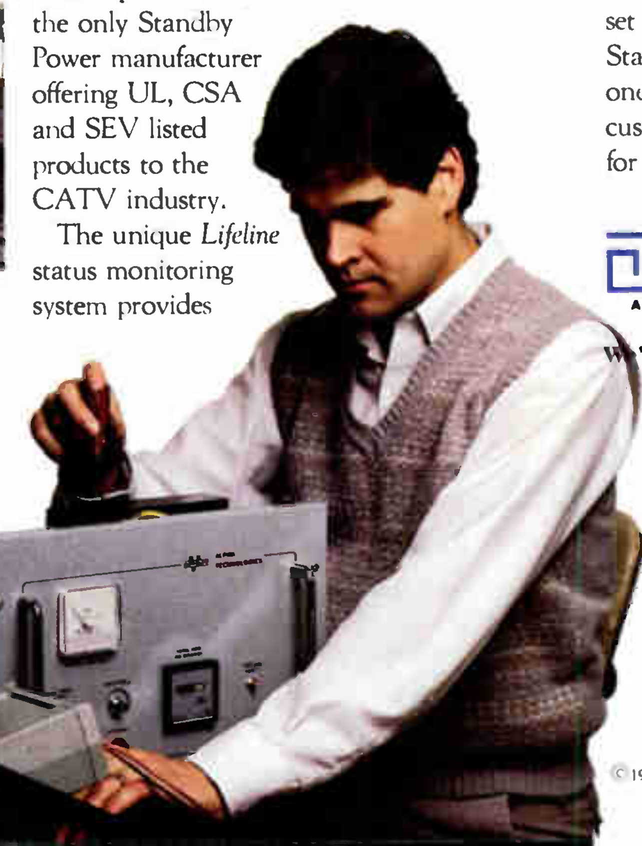

Reader Service Number 55.

Leakage—A multifaceted problem

Although this article originally was presented at the Society of Cable Television Engineers' 1977 reliability conference, much of the content and many of the concerns offered are as real today as they were 10 years ago. Bob Dickinson is currently president of Dovetail Systems Corp.

By Robert V.C. Dickinson

The subject of CATV leakage is timely for examination at this reliability conference. In the CATV business we operate our "closed systems" in an environment where the number and magnitude of external RF sources is constantly increasing. This represents an increasing threat to high-quality CATV system operation. In addition, we are being challenged by over-the-air users of the same spectrum with the charge that we are not operating "closed systems" but that we are leaking and the power radiated may be detrimental to those services. We will examine the situation in a broad manner, focus on some current major problems, and look at ways in which we can improve our system integrity and thereby promote higher CATV quality while reducing any threat to other parallel services.

The cable industry has been in existence for over 25 years and has grown from rather rudimentary beginnings to an industry representing over 3,500 systems and perhaps 14 million subscribers. Review of the beginnings of the industry would indicate various approaches to controlled TV transmission including crude but effective technical implementations. Open wire systems have brought TV to some where there was no other way. A lot of braided shield trunk cable has been employed. Many thousands of pressure taps have dotted the scene for years and are still in existence in many systems. As the industry developed it became clear that cable systems that allowed outside radio frequency energy to leak in had potential major problems. The intermodulation distortions (beats and cross mod) were known and controllable factors; however, a CB transmitter operated close to the leaky system could degrade or obliterate the signal on several channels in large portions of the cable system. Since the CB population has grown with leaps and bounds, this problem continues to increase rather than decrease.

For protection of other services the FCC, as part of 76.605 on technical standards, contributed rules governing permissible system radiation and required its measurement (76.601 & 76.609[h]) on an annual basis. This requirement turned out to be a very technical, rigorous one, which, if universally adhered to, would reduce system radiation to a very low level in most cases. The full force of this regulation was restrained by the infrequent measurements required so that its full impact has not been fully felt by most. The testing requirement, once per year, is normally implemented by measuring three arbitrary points. If these three points pass, well and good. If one or more show excessive leakage it is repaired and the test repeated. The data is recorded for "public inspection" and the whole matter is forgotten for one year and the remainder of the system goes untested and unrepaired. The result has been less than universal recognition and control of system egress and ingress.

Many people in the industry, however, have seen beyond the simple requirement of taking the required data once per year. It has been apparent to some that sooner or later this regulation will be seriously enforced. Probably more important, leakage out of a system, which would lead to violation of this regulation, invites ingress and results in service calls, dissatisfied customers, and all that goes with it. As a result various techniques have been developed and are in use for more comprehensive leakage checking.

Early in the game leakage was monitored by listening for signals in the FM band. A signal on a non-off-the-air frequency was monitored in the service vehicles using a standard FM receiver tuned to the prescribed frequency. Detection of this signal obviously indicated leakage from the cable system. Experience as to location of responses, signal level and the like provided a way of monitoring systems during routine travel throughout the system. The results were improved preventive maintenance and subsequent reduction of ingress. The location of many illegal hookups made up for some of the effort expended in keeping a "tighter" system.

Mid-State Electronics now markets their Cuckoo device, which produces a signal in the FM band. The signal level may be stepped and the modulation may be warbled for identification. By noting how may steps can be heard at a given location an estimate of the leakage intensity can be made.

Another device along these lines is manufactured by ComSonics and is called The Sniffer. Rather than a wide-band FM signal, a narrow-band AM signal is used with a peculiar, identifiable modulation. The Sniffer has a fixed-tuned receiver and employs a probe-type head rather than a standard FM receiving antenna. The receiver sensitivity can be varied. When the signal is heard the leak may be located by probing with the head and constantly reducing the sensitivity until the exact point of leakage is located. Similar equipment is in wide use in Canada.

The onset of concern for more serious monitoring has shown that standard cable connectors may be tight when they are installed but may develop leakage over a period of time. This effect is caused by deformation of the outer shield within the connector reducing the area of contact and hence the integrity. Manufacturers over the past several years have developed an "RFI" connector that is designed to prevent this deformation and maintain connector integrity. The main principle of these connectors is the insertion of a mandrill (often stainless steel) under the end of the cable sheath where it is clamped within the connector. This prevents deformation and maintains contact. Other improvements are included in connectors by various manufacturers but the basic long-term stability and integrity of the connectors have been greatly improved.

Concerns begin to grow

As early as 1971 the Federal Aviation Administration became concerned that the growing CATV industry might become a source of radiation that could interfere with aircraft navigation and community services. This was a serious concern since it deals with "safety of life" and enormous financial investments, commitments and liabilities. The Office of Telecommunications Policy, U.S. Department of Commerce, through the Institute of Telecommunications Sciences at Boulder, Colo., has issued four studies relating to this field. Two of these were sponsored by the Department of Commerce and two by the Federal Aviation Administration. The titles are as follows:

OT 74-39—*Electromagnetic Compatibility of Simulated CATV Signals and Aircraft Navigation Receivers* (USDC)

OT 75-73—*Radiating Aerial Coaxial Cable Measurements* (FAA)

OT 75-75—*Flight Tests Measuring Compatibility of Simulated CATV and VOR Signals* (FAA)

OT 75-192—*Electromagnetic Fields of a Dielectric Coated Coaxial Cable with an Interrupted Shield* (USDC)

The titles indicate much of the content of the investigations. These studies were concerned largely with possible interference to navigation aids rather than voice communication channels. The results, summarized in a few words, are that CATV systems can leak, particularly under conditions of catastrophic failure (broken or badly damaged cables in high-level circuits) in a manner that can cause malfunction of aircraft navigational services. The conditions that are required to cause such interference demand very precise control of frequencies specifically related to the navigational aids in question.

When these rumblings were received by the industry more study was undertaken and numerous cable operators made the decision to avoid the use of frequencies where interference might be caused. With the limited knowledge available the likelihood of interference seemed to be very small; however, should there be an aircraft accident in the vicinity of a cable system

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carrying signals in the navigation spectrum the political ramifications could be disastrous. Lawsuits might result and the burden of the proof could well be upon some cable operator rather than on the FAA or FCC.

For these reasons many operators abandoned the use of Channels A-1 and A-2, which were sometimes employed for special services. The frequency range from 108 to 136 MHz includes Channels A-2, A-1, A, B and part of C; however, only the frequencies from 108 to 118 MHz contain the navigation aids that were the major area of concern. The frequencies from 118 to 136 MHz carry aircraft communications channels. In any event many people were becoming concerned about this possible problem. Those in the FAA were interested in shutting off any possible interference and many in the cable industry were trying to determine ways of eliminating any possible interference even if leakage were to occur.

The Harrisburg incident

Early in April 1976 an episode began that was apparently "the straw that broke the camel's back." In Harrisburg, Pa., a rather large (over 30,000 subscribers) and an older system (built around 1966 with pressure taps throughout) became the goat for the industry. The story goes this way. The FAA assigned a new approach control frequency for the area. The frequency chosen was 118.25 MHz. As soon as this frequency was commissioned, pilots began to complain that there were whistles on the channel showing up between transmissions. These whistles were quite annoying. The FAA began to search for the problem and spent some time without success. The FAA then called in the local FCC field bureau, which also started looking. Eventually the local cable company was called. It admitted using a 118.25 MHz pilot carrier, but stated correctly that the pilot had no modulation. For this reason it was overlooked for some time until in desperation the FCC asked that the CATV pilot be turned off. The interference vanished with the pilot.

Further investigation showed that there were four sections in the system each operating an independent 118.25 MHz pilot. Since these pilots were not from a common source their frequencies, although crystal-controlled, were somewhat different. The reception of two or more by an aircraft receiver produced audio beats. These beats had been erroneously attributed to modulation on a single source. With the discovery that it was cable system leakage causing the difficulty the cable company immediately removed the pilots. The AGC amplifiers ran wide open for a few days while they were reconfigured to operate on Channel 5 visual carrier. The problem was solved in this manner and the cable system continued to leak without any other known problem. This particular system is now being rebuilt; however, it is a large one and will take some time to accomplish.

The discovery of this situation was all that was needed to swing the FAA into action to lobby for elimination of CATV usage of frequencies parallel to "safety of life services." These frequencies included the 108 to 118 MHz navigational aids band; 118 to 136 MHz aircraft communications band; 121.5 MHz, an aircraft emergency frequency; the 156.8 MHz marine emergency frequency; 243.0 MHz (second harmonic of 121.5), another aircraft emergency frequency; and the band 225 to 400 MHz for aircraft navigation and communications frequencies covering many commercial and military usages. Heavy pressure began to be exerted in this area resulting in high-level government requesting that the FCC remove all of these frequencies from the cable CATV spectrum. A summation of the results of such a move indicates that there would be only 19 channels that could be used for CATV carriage. Obviously the impact of such a ruling would be a disaster for the CATV industry.

Looking for the solution

As these pressures were building, various elements of the industry, coordinated by Delmer Ports of the National Cable Television Association, began to plan their strategy. Industry representatives continued liaison with the FCC, FAA, Office of Telecommunications Policy and others to come to some sort of a reasonable solution for this problem. As these informal discussions proceeded the FCC felt obliged to issue a notice of proposed rule making (Docket 21006) putting forth the various alternatives available to control the situation. The Interference Subcommittee of the NCTA Engineering Advisory Committee under the leadership of Frank Bias of Tele-Vue Systems, has spent much time in preparing comments for the notice of

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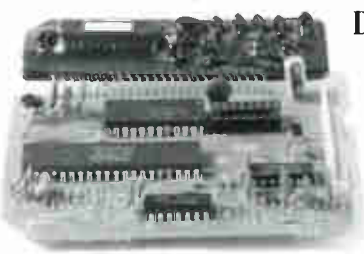

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proposed rule making. Since this notice was issued in late November a number of meetings have been held and hundreds of hours (not to mention thousands of dollars of transcontinental airline fares) have been spent by committee members preparing comments. Comments were originally due on Jan. 17, 1977, but at the request of NCTA and others, has been postponed until March 3, 1977. The notice of proposed rule making addressed two questions:

1) How can it be assured that cable television systems operating on frequencies used by air navigation systems and aeronautical and marine emergency radio services do not cause harmful interference to those safety-of-life services?

2) What frequency channeling plan or plans should be used by cable television systems for equipment compatibility, for prevention of interference to over-the-air services, and for other purposes?

The NCTA response focuses on question #1. Some of the proposals presented by NCTA will have impact on question #2. The position has been taken that a general frequency plan cannot be established at this time and that only those frequency provisions affecting question #1 should be considered in this rule making.

The scope of the FCC's proposal is summarized in its paragraph I.3 as follows:

"a) To adopt a frequency channeling plan for the delivery of television signals to cable television subscribers. This frequency channeling plan may include the so-called mid-band and super-band channels as well as the standard television broadcast channels. Alternatively the channeling plan may prohibit operation in whole or in part on the frequency band used for navigation and safety purposes.

"b) To require the use of the proposed frequency channeling plan for all Class 1 and Class 2 cable television channels and for some Class 3 and Class 4 channels as well.

"c) To adopt standard designations for those channels not used in over-the-air service.

"d) To modify our requirement for monitoring cable television systems for possible signal leakage.

"e) To adopt rules specifying the conditions under which a cable television system that is found to be causing harmful interference to authorized radio services may be required to cease operation and specify the conditions under which operation may be resumed.

"f) To adopt restrictions on cable carriage and signals within certain air traffic control and safety services bands."

The docket goes on to discuss these various areas. A number of possible avenues of action are outlined including frequency offsets and power restrictions in lieu of vacating the frequencies. Increased monitoring and perhaps revisions of allowable leakage levels are mentioned as well as institution of a system providing for partial or total cable system shutdown if interference is detected.

Some of the measures proposed would be very difficult for the cable industry. NCTA takes the position that certain protective measures are in order but that they need not nearly be as stringent as the FCC has proposed. Before looking at possible responses to Docket 21006, let us look at the actual problems involved.

The interference problems

The navigation aids in question are the VOR and instrument landing systems. The VOR (VHF Omni-Range) is a system whereby aircrafts can select a radial to or from the navigation aid station and fly that radial by centering an indicator pointer. Technically the system utilizes a carrier frequency onto which is amplitude modulated a 9,960 Hz subcarrier. The subcarrier in turn is frequency modulated $\pm$480 Hz with a 30 Hz reference signal. The entire transmitting antenna is mechanically or electrically rotated at the 30 Hz reference frequency to produce a spatial modulation of the entire signal. The aircraft receiver detects the 30 Hz reference on the FM subcarrier and compares it with the 30 Hz spatial amplitude modulation and determines the bearing of the aircraft relative to the station by the phase difference between the two signals.

In order to cause harmful interference a relatively strong signal must be located within 2 or 3 Hz of either 30 Hz sideband. Virtually phase-lock conditions must be maintained to cause an offset error. The general case

of a high-level signal less than 3 Hz from these sidebands will produce a swinging indication of the pointer or loss of flag so that the pilot would know that a problem was present and disregard the resulting navigational information. Calculations of possible CATV leakage and its effect upon VOR circuits indicate that the probability of interference even under conditions of catastrophic leaks is very small.

The instrument landing system (ILS) is composed of two parts. The localizer tells the pilot which side of the flight path he is on in a horizontal plane and the glide slope gives the same information in the vertical plane. The glide slope system provides a path at a fairly low angle (in the vicinity of 2.5° above horizontal) to the landing point on the runway.

The localizer signal is in the range of 108.1 and 111.9 MHz. This signal is amplitude modulated at 150 Hz on the right side of the runway and 90 Hz on the left side. On course is the vertical plane indicated by equally detected modulation between the two sides. Localizer course width is about 5° for full indication left to right. This represents a span of approximately 5,300 feet at a distance of 10 nautical miles from the transmitter. The glide scope is very similar to the localizer except that it operates in the frequency range of 328.6 to 336.4 MHz. On the upper pattern lobe 90 Hz modulation is used and 150 Hz on the lower. The glide slope path is only about 1° wide or 1,060 feet at 10 nautical miles. The width of this path at touchdown is only a few feet, hence is a very effective guidance system. Both localizer and glide slope indications are usually portrayed on a "cross pointer" indicator. The pilot flies both indications to center both pointers in the inner circle of the indicator.

Interference with the localizer or ILS system requires the same type of frequency stability and precision as the VOR with the interfering frequency located approximately at the frequency of the modulation sideband(s). Here again the figures show that the possibility of interference by CATV leakage although not zero, is very, very small.

Interference with the communications channels, as in Harrisburg, is a somewhat different story. Interference to communications circuits generally requires a considerably higher signal level; however, any frequency within the received bandwidth of the AM communications receiver will be accepted and can be a source of interference. When the levels are very low, the squelch on the aircraft receiver will not trip hence the radiation will go unnoticed. If the signal levels are higher, the squelch will be tripped and assuming only one unmodulated signal exists, the only effect will be to cause a hiss or rushing sound rather than dead silence, as when there is no transmission being received. Signals of this level will be overridden by the communications signal from the higher power air traffic control (ATC) transmitter and will not be heard. It is difficult to configure an interference situation where the leakage from a cable system, even at maximum power level, can override the power from the ATC transmitter. The only case where this might happen is at great distances from the ATC transmitter and very close to the cable system. In this event the duration of such interference to a passing airplane would be quite brief. The FAA has built in restrictions, such as "minimum enroute altitudes," which do much toward avoiding this situation.

There are a number of other considerations that bear upon the whole subject. For instance, over the past 25 years of CATV operation the Harrisburg incident has been the only reported complaint of interference to any of the aircraft navigation or communications services from CATV sources. Over the same period of time there has been an excess of 6,000 complaints from other radiating sources. Other radiating sources include millions upon millions of FM and TV receivers governed by Part 15 of the FCC regulations, which allows 28 dB more signal leakage at these frequencies than the current FCC cable leakage spec. Harmonics and spurious outputs from AM, FM and TV broadcast transmitters are a major potential source of interference and result in certain local frequencies being unusable for air navigation and communications services.

The NCTA responds

With all of the preceding in mind, certain conclusions have been reached and five major points are being used as the basis of the NCTA comments on the proposed rule making. They are as follows:

1) Each cable system will maintain at its operating office a list of carrier frequencies currently in use on the cable system. This will facilitate loca-

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tion of interference when it occurs. A simple phone call from the complaining activity can establish whether the cable system carries any frequencies that could cause interference. If so, action can be immediately initiated to confirm or disprove the allegation and correct any possible problem.

2) Each cable system that is in a prescribed geographical relationship to specific navigational aids in the 108 to 118 MHz air navigation band will operate with a minimum character offset of 25 kHz from the local navaid frequency. The results of the Boulder studies would indicate that such an offset would absolutely preclude interference under any conceivable cable system failure mode.

3) Each cable television system that operates carriers in the frequency range of 118-174 or 216-300 MHz shall offset appropriate carriers a minimum of 50 kHz from the emergency frequencies of 121.5, 156.8 and 243.0 MHz. These are the aircraft and marine distress frequencies where, under emergency conditions, power and frequency stability of the emergency transmitters may be marginal. This proposal is designed to give maximum protection to these frequencies.

4) NCTA does not feel that adequate standards governing leakage from cable television systems can be established at this time. The levels needed to protect voice communications to aircraft have not been established. There is desirability for leakage monitoring but sufficient reliable field data is not available to relate the current practice to the levels necessary. NCTA proposes and will cooperate fully with FCC/FAA and others in responsible programs of data collection looking toward the development of suitable techniques and standards.

5) NCTA feels that the features of a frequency plan that can reduce the probability of interference (namely acknowledge a frequency in use and frequency offset from those of crucial safety services) have been incorporated in the recommendations, therefore a total frequency allocation plan need not be imposed or agreed upon now for the purpose of controlling interference. It is NCTA's opinion that the desirability of any form of frequency plan for other purposes should be addressed in a separate form and a separate proceeding.

These proposals cover only the frequencies below 300 MHz since little, if any, use of the frequencies above is now being made. NCTA will advise the industry of the proper precautions to be taken when frequencies above 300, particularly those in the glide scope range of 328.6 to 335.4, are planned.

This brief summary given is a general idea of the steps being taken by NCTA on behalf of the industry to present comments on Docket 21006. The comments themselves are substantial and are a matter of public record. When and what the FCC will rule is still unclear. Liaison with FCC, FAA and others is continuing through NCTA and industry representation. Whatever the outcome, the basics of the situation will to some greater or lesser degree fall upon the industry for future implementation.

What to do

The question is really: What can we do to 1) avoid possible interference problems and 2) improve our system operation by reduction of both ingress and egress in the cable system?

First of all it is obvious that for everybody's benefit more comprehensive techniques and systems must be developed for maintaining system RF integrity. Devices such as The Sniffer and the Cuckoo seem to be workable approaches available today. Surely other monitoring systems will appear as the need increases. In this writer's opinion there is no substitute for continuous monitoring by service vehicles on routine travel through the system. The direct benefits in location of illegals, reduction of CB interference, and the like will pay for much of the investment and time required.

Construction and maintenance practices also are important. There are a number of specific system problems that lead to leakage. The "wedding ring" crack, which generally occurs in connection with expansion loops, finally circles the cable and eventually completely fractures. Since the separation of the crack depends a great deal upon temperature, the amount of leakage varies from day to day. Larger expansion loops may be the answer. Proper lashing is important. At times, lashing cable has been known to wear through the cable sheath. Squirrels chewing the aluminum on the top side is a problem in many of the southern states and

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a difficult one to find. The same goes for pinholes caused by lightning. The pinholes usually occur between the messenger and the cable and allow leakage at that point.

The largest single problem is the deformation of the cable in a "non-RFI" connector. The right solution for this is to use only RFI connectors in construction. In older installations, patch kits have been devised. Proper installation of these patches is essential.

Amplifier housings need good RFI braid around the covers. The covers must be installed with a torque wrench for proper pressure. F connectors remain a principal source of problems in modern systems. F connectors should employ long sleeves and hex crimps or equivalent, which supply evenly distributed pressure around the fitting. Poorly designed ground blocks with no through ferrule produce poor RF integrity due to corrosion. Damaged baluns, broken drop cable and the like are also sources of RF leakage.

It is felt that the industry's first reaction should be to take this problem seriously. This serious attitude should result in the implementation of continuous monitoring techniques and upgraded construction practices as soon as possible. A firm decision "to do it" is the crucial step.

The other end of the story is that if by chance extremely stringent regulation is imposed, much of the cable plant now in operation may be condemned. Therefore, it certainly behooves us to upgrade our construction practices ASAP to keep such problems (and rebuilds) to a minimum. Whether regulations are that stringent or not, one would expect to see a fairly complete cleanup of cable plants within the next five to 10 years and the sooner the better for all concerned.

In summary, the cable industry is now in the midst of a multifaceted problem (if you care to refer to your taps as "spigots" you might call it a multi-faucetted problem), which affects our quality of service and may affect safety of life services. We do have problems and pressures, however, we do have some answers. We must "tighten up" our CATV plants and keep them tight under a good monitoring program. For this we can expect better quality, high customer satisfaction, and perhaps even more penetration and approval of better rate structures.

CLI: Accumulating the data

By Bruce Catter
Fund Engineer Manager, Jones Intercable Inc.

Over the past year and a half, Jones Intercable has completed ground-based cumulative leakage index (CLI) testing on 73 systems in the manner prescribed by the FCC. To date, six of those systems have completed their second test. Those tests have yielded some very interesting data. Before discussing the results and my observations, let's take a brief look at the philosophy behind CLI.

Cumulative leakage index is a way of determining and assessing the signal leakage integrity of cable plant. Signal leakage from a cable system represents an interference to over-the-air users of common frequencies and can affect the safety of aeronautical and emergency service users. Breaking down the phrase "cumulative leakage index" may give us a better understanding of the underlying theme behind the test.

The word *cumulative* suggests something that is made up of accumulated parts, something additive. In fact, the test is aimed at assessing the cable plant's potential of interfering with the communications and navigation systems of aircraft passing through the airspace above. Leakage overlies the system in a "lumpy umbrella" shape. The level of interference is made up of the cumulative or accumulated effect of all of the leaks in the plant, not just one or two big leaks (although the larger leaks are obviously major contributors).

The next word in the phrase is *leakage*, which simply refers to a breach in the plant's mechanical integrity that allows RF energy to escape its closed medium and to travel paths other than intended. The most common source of leakage you will find anywhere, in any system, is the "F" connector.

Next up is *index*, which indicates measure. The index that the FCC will use is 64. That number was established through testing to determine the level of RF interference at specific altitudes that actually would interfere with aircraft operation in the vicinity. Testers eliminated leaks of less than 50 μV/m (properly measured on the ground at 10 feet, etc.) as potential problems for aircraft, although these leaks still must be dealt with. If one follows the test procedures outlined by the FCC, applies the data to the CLI formula, and comes up with a number less then 64, one can be reasonably assured that the cable plant tested will not interfere with aircraft communication and navigation systems.

Thus CLI is a test designed to assess the overall signal leakage integrity of a given cable plant at a given "instant" in time. The test takes all leaks of a certain minimum level into account and yields a "figure of merit." The potential for that plant to cause harmful interference is measured against an index of 64. In order to truly assess signal leakage integrity at a given point in time, the test must be conducted as quickly as possible; ideally all facets of the test would be conducted instantaneously.

Why do CLI testing?

Why on earth would anyone want to conduct such a test? To just arrive at a figure of merit, one must parade past at least 75 percent of the total plant, including the known worst areas, stop and measure the leaks found with a dipole antenna and signal level meter, and do it very quickly. Then the data must be analyzed and input into a formula, and finally a "CLI" can be calculated. Now that you have your CLI number, what good is it? Without follow-up not much, but just as the signal level meter and sweep system are useful tools, so too is CLI testing. The cable industry became self-regulating with regard to signal quality and now should deal aggressively with the signal leakage issue, if only in the interest of professionalism. Since the test identifies sources of signal leakage (egress), it identifies sources of RF and moisture ingress as well. Fixing these breaches in plant mechanical integrity smoothes out the frequency response of the system and improves picture quality. That keeps subscribers happy—which keeps them connected to the system and their money coming in.

Repairing the leaks also will reduce service calls—a basic non-revenue producing activity—and help to shift maintenance efforts into a preventive mode and away from a reactive one. Operating the plant in a preventive maintenance mode not only demonstrates a professional approach to conducting business, it lengthens the life of the plant. This in turn can ward off rebuilds and help to preserve the value of the asset.

Data obtained from the CLI test also can be a useful way to help determine the need for rebuild activity and to secure the necessary funds during the budgeting process. The list of good reasons for conducting CLI tests goes on and on. Basically, the test identifies problem areas that can directly affect picture quality in a cable system. The reasoning behind CLI testing also revolves around a safety issue that we all should be conscious of and concerned about as professionals.

Remember, too, that the test for signal leakage conducted for years in conjunction with the annual proof-of-performance test has, for the most part, consisted of throwing up a dipole antenna at the three widely separated test points (including the longest cascade) and measuring for leakage. I suggest that we have not been conducting *thorough* signal leakage tests. (Some people do quite well with routine monitoring, however, there is a difference between routine monitoring and testing.)

Results

The results described here represent data collected from 73 cable systems that conducted full CLI tests in the manner prescribed by the FCC. The technical demographics of these systems vary widely. Results are offered only to give an idea of what to expect. Keep the location, age, mechanical condition and electrical make-up of your system in mind when drawing parallels.

The following numbers resulted from "full CLI tests" consisting of driving/walking out the plant, measuring the leaks found with a dipole antenna and signal level meter, entering the data into a computer and calculating figure of merit, and returning later to repair all of the leaks found (including those less than 50 μV/m). All labor and materials are included.

- Only 70 percent of systems tested passed with a figure of merit of 64 or less on the first test.
- Average leaks per mile:

very leaky plant = 4.0 or more
moderate = 1.1
very quiet plant = 0.3 or less

- Cost of test equipment varies according to size of plant and type of equipment selected. Test costs ranged from nothing to an approximate 9 percent increase to the total cost of the project.
- The total repair cost per leak varies a great deal with percentage of backyard easement (systems with 75 percent or more of their plant in backyard easement should increase these costs by approximately 10 percent), number of leaks found, quantity and type of materials used, etc. A rough figure of $59 per leak was derived from our tests, which yields an approximate budgetary cost per mile of:

very leaky plant = $236/mile or more
moderate = $64.90/mile
very quiet plant = $17.70/mile

Observations

One of the most interesting observations arising from the tests concerns systems that still use pressure taps and/or non-RFI sleeve connectors. I would have expected that these systems would be prone to more signal leakage and would yield higher figures of merit. But that is not the case. We have found that as long as diligent preventive maintenance is performed, older plants do not leak any worse than newer ones. In fact, if a newer system was the victim of poor construction techniques, it may leak worse and cost more to maintain. For this reason, it is a good idea to conduct a quick, abbreviated CLI on all new extensions. One is then able to point out craftsmanship difficulties to those building the plant before too much time has passed.

We have found that the second pass-through (testing conducted annually) does not necessarily turn up fewer leaks. The first pass identifies the largest leaks, some of which are masking smaller ones. The figure of merit does come down, but at least two passes are necessary to bring the number of leaks down significantly.

Conducting a CLI test and repairing any leaks found on 100 percent of the system (the only approach I recommend) *does* improve delivered picture quality and reduce service calls. The degree of impact depends on the severity of the problem that existed in the first place. For example, one average 10,000-subscriber system performed 340 service calls a month before conducting a CLI test and repairing the leaks found: 340 calls × $35 per call = $11,900. After completing the work, the system's call dropped to around 300 per month, representing a savings of $1,400 per month or $16,800 per year.

The cost for this particular system to conduct the CLI testing was only $2,000 because all of the plant is accessible from the road. Testing was paid for in about a month and a half. Almost every one of the service calls saved probably would have dealt with ingress as evidenced by the decrease in that category of call. Most important, the system shifted those repairs from a reactive maintenance activity to a preventive effort and made immediate improvement in delivered picture quality.

As might be expected, somewhere between 80 and 90 percent of the leaks found are drop-related and the vast majority of those are caused by "F" connector problems, primarily looseness.

Before we started the testing on a companywide scale, I anticipated that chief technicians might wind up spending a great deal of time calculating CLI from their test results. To expedite the process, I developed a macro-driven, Lotus-based computer program that handles the calculations and serves as a signal leakage log as well. It has proven to be a useful tool. (Jones Intercable will make this program available, along with the accompanying documentation, at no charge. To receive it send a formatted 3½" or 5¼" disk and a self-addressed, postage-paid mailer to: Bruce Catter, Jones Intercable, 9697 E. Mineral Ave., Englewood, Colo. 80112.)

Jones Intercable has conducted these tests for a year and a half and we have learned that there is no time to spare. The FCC deadline for submission of results indicating that the cable system has been tested in accordance with the rules—*and has passed*—is July 1990. I believe that the best reasons for conducting signal leakage testing have nothing to do with pressure from the FCC, but rather stem from our industry's concern for professionalism and public safety.

At the outset, the cumulative leakage index test was viewed as an onerous, expensive, labor-intensive task—and it is. CLI testing can create a scheduling problem because of the typically heavy, temporary manpower requirement. However, the benefits far outweigh the obstacles. The real burden is in educating operations management on the value of shifting reactive maintenance activities to preventive ones.

Figure 3: RF analog optical receiver

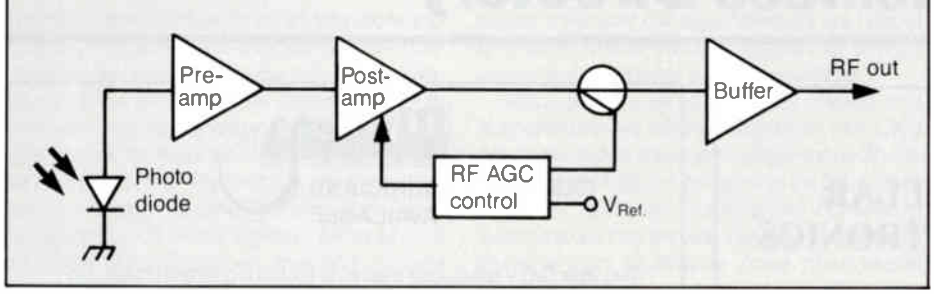
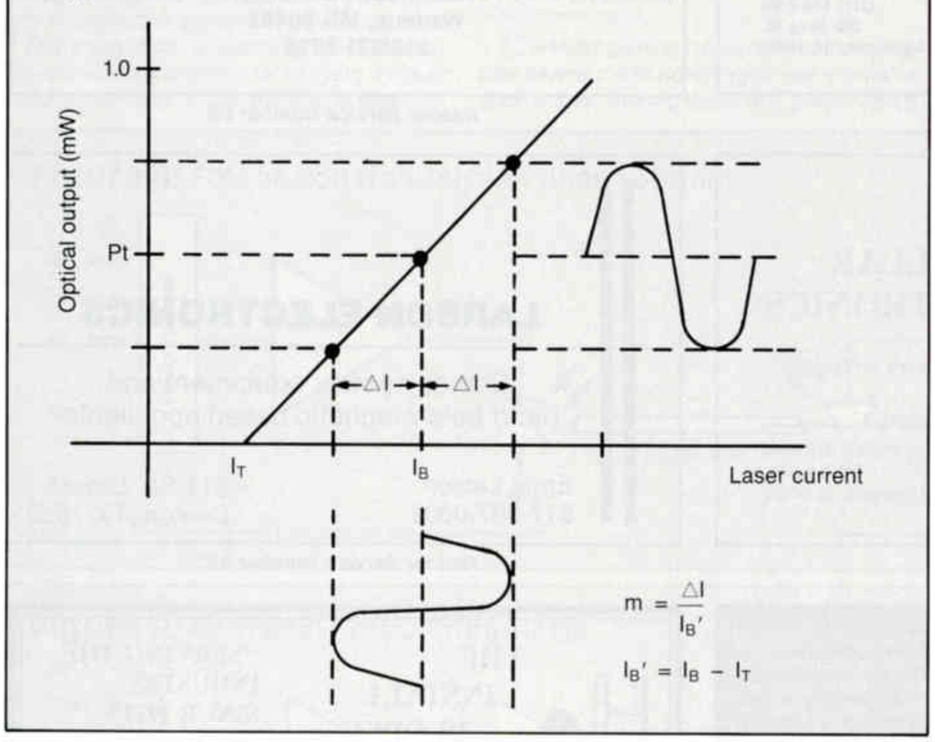


Figure 4: Laser LI curve



fiber. If a fiber cable is broken, there are no sparks to cause fires or explosions and no chance of electrical shock.

Small size and weight: A single conductor fiber-optic cable weighs about nine pounds per 1,000 feet. A comparable coaxial cable weighs 80 pounds per 1,000 feet. Thus, weight-conscious designs can save precious pounds without a sacrifice in signal capacity.

Security: Electronics "bugging" depends on electromagnetic monitoring; fiber-optic systems are immune to this technique. They must be physically tapped to extract information, which decreases signal levels and is readily detected.

FDM analog system

A block diagram for an FDM (frequency division multiplexed) analog transmission fiber-optic link is illustrated in Figure 1. The major system components are: 1) the optical transmitter, 2) fiber-optic cable and 3) the optical receiver.

1) *Optical transmitter*

An optical transmitter accepts the individual RF FDM analog inputs and provides the signal conditioning necessary to drive the semiconductor laser diode. Figure 2 shows the major optical transmitter functional components. First, an RF combiner sums the multiple analog inputs that are to be transmitted. The RF levels for each carrier should be equalized prior to the optical transmitter. Otherwise, optimum noise and distortion performance for each carrier will not be achieved. However, a slope compensation stage may be provided after the combiner stage to adjust for normal cable slope effects.

Broadband amplifiers with AGC (automatic gain control) provide the necessary signal level to drive the laser diode. The RF drive level to the laser must be controlled precisely to realize the optimum system noise and distortion performance.

A DC bias is applied to the laser to provide a linear operating point. This bias current will determine the average optical output power out of the laser diode, which is typically 0.5 mW for single-mode 1,300 nm lasers.

Laser power is sensitive to changes in temperature and laser aging. To preserve a constant average optical output power, two control circuits are commonly provided in the laser transmitter: a laser temperature controller and an automatic optical power controller.

A photodiode monitors the rear facet of the laser as a sample of the transmitted optical power and uses this information to control the laser DC bias current. Thus, if the laser average optical power changes due to time or temperature, the laser bias is adjusted automatically to maintain constant average optical power.

Laser life is adversely affected by operating at higher temperatures. Temperature control is accomplished by using a thermistor to monitor the laser temperature. A control circuit then drives a TEC (thermal electric cooler) to which the laser heatsink is mounted to maintain the laser at a constant temperature, typically 20°C.

2) *Fiber cable*

Single-mode 1,300 nm fiber cable is preferred for multichannel analog systems. This fiber has a core diameter of only 9 μm with an overall cladding/buffer diameter of 950 μm (typical). These fibers may be assembled into various cable assemblies that provide multiple fibers, strain relief and jacket options.

Fiber cable is available in lengths up to several kilometers per reel. For distances greater than several kilometers, the fibers typically are fusion-spliced to minimize path insertion losses. Single-mode fusion splices have typical optical losses of only a few tenths of a dB. Single-mode connectors have typical losses of 0.5 dB. The optical transmitter and receiver normally are connectorized for convenience in servicing equipment.

3) *Optical receiver*

The primary function of an analog optical receiver is to reconvert the light power into an RF signal with a minimum contribution of noise and distortion. A block diagram is shown in Figure 3. The optical detector commonly employed for 1,300 nm analog applications is either an InGaAs pindiode or a Ge avalanche photodiode. The major distinction between them is that the avalanche diode has gain available (approximately 10), whereas the pindiode does not.

The photodiode current drives a transimpedance preamp that provides high input sensitivity and transforms the diode current into a voltage at its output. These preamps are available as DIP-packaged devices with fiber pigtails attached.

A post-amplifier (with AGC) follows the preamp to provide sufficient gain to obtain unity system gain for the entire FO link. AGC is utilized to maintain a constant output level independent of optical input power that may change due to fiber resplicing, fiber loss vs. temperature, etc.

System perfomance parameters

We now will discuss how several key system parameters are affected by the respective fiber-optic system components. The parameters to be considered are carrier-to-noise, bandwidth and distortion.

1) *Carrier-to-noise (C/N)*

Carrier-to-noise obtained at the end of the FO system ultimately will determine the baseband (video) signal to noise performance. C/N is preferred over system signal-to-noise (S/N) as an FO link parameter, since the output of an optical receiver is an RF carrier.

Also, analog video can be transmitted via VSB-AM, FM or other modulation techniques. For a given C/N ratio, the resultant video S/N ratio is

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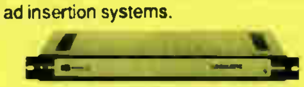
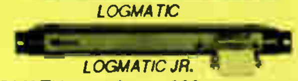


LOGMATIC



LOGMATIC JR.

The LOGMATIC contains a 4000-event memory and interfaces to an 80-column printer or to a PC for data retrieval. The LOGMATIC JR. has a built-in 20-column printer and real-time clock. It prints the event record as the event occurs. Both loggers feature automatic operation, and they record insertions on four channels.

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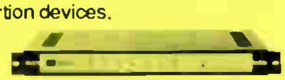

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Switching occurs during the vertical interval for broadcast quality transitions. Once the system is programmed by the operator, it operates automatically.

The SPOTMATIC JR. has a built-in printer for verification records; however, both the LI'L MONEYMAKER and SPOTMATIC JR. Inserters connect easily to a LOGMATIC™ logging and verification system. With optional software, this enables computerized data retrieval and automated billing and report generation. Write now to see just how little it takes to get into automatic ad insertion.

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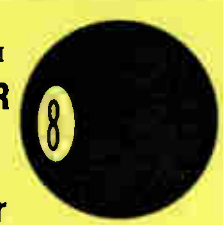

It is an integrated circuit-based monitor switcher featuring broadcast quality stereo audio and video switching. Lighted momentary contact pushbuttons are field-legendable. Its cost is far less than any other comparable unit on the market. Write or call for information today.

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a function of the modulation approach. Wideband FM provides higher S/N ratios at the sacrifice of utilizing greater channel bandwidths.

The optical transmitter will have an impact on C/N in two ways: 1) setting of a particular modulation depth and 2) inherent laser source noise.

For an analog system, a time-varying signal, S(t), is used to directly modulate the optical source about a bias current point (I_B) as shown in the laser LI curve (Figure 4). With no signal input, the optical output power is Pt. When the signal S(t) is applied, the optical output power, P(t), is:

$$P(t) = Pt\,[1 + m\,s(t)] \qquad \textbf{(1)}$$

Where m is the modulation depth defined by:

$$m = \frac{\Delta I}{I_B'} \qquad \textbf{(2)}$$

$$I_B' = I_B - I_T$$

Where I_T = laser threshold current

The parameter ΔI is the RF variation in current about the bias point. To prevent distortions in the output signal, the modulation must be confined to the linear region of the curve. Furthermore, if ΔI is greater than I_B', the lower portion of the signal gets cut off and severe distortion results. Typical m values for analog applications are .25 to .50.

A higher modulation index (m) will provide a higher RF C/N ratio since the received RF carrier is proportional to m. Thus, a direct tradeoff exists between system distortion and noise performance as contributed by the optical transmitter.

Inherent laser source noise defines the maximum achievable C/N obtainable from a laser transmitter. Minute fluctuations in optical emission are exhibited when biased above threshold. This noise phenomenon is referred to as *relative intensity noise* (RIN). The intensity noise is neither thermal nor strictly shot noise in nature. It is the response of the laser to modulation by intrinsic shot noise that results from the granular nature light and electricity. Typical values of laser C/N due to RIN are −120 to −140 dB/Hz.

The optical loss budget analysis is the conventional approach used for determining the maximum optical path loss. A loss budget compares the optical power transmitted with the minimum optical power at the receiver to provide the required C/N ratio out of the receiver. The difference between these two quantities is the optical loss budget allowable for the total path loss. A typical analysis is shown as follows:

Power launched (Tx)	−3.0 dBm
Fiber loss	20.0 dB
Splice loss	2.0
Connector loss	1.0 dB
Received optical power (Rx)	−26 dBm
Received sensitivity (Rx) (minimum power allowable to provide required C/N)	−30 dBm
System margin	4 dB

One might ask how the C/N performance of the system will change as a function of optical input power. The answer depends on whether the system noise performance is receiver limited, quantum noise limited or laser source noise limited. The C/N present at the output of an optical receiver employing a pin-diode is:

$$C/N = \frac{(1/2N^2)(m \times R_o \times Pt)^2}{\underset{\text{(source + quantum + receiver)}}{(RIN\,R_o^2\,Pt^2\,B) + 2q(R_o\,Pt + I_d)B + (4K_b\,T_B/R_{eq})Ft}} \qquad \textbf{(3)}$$

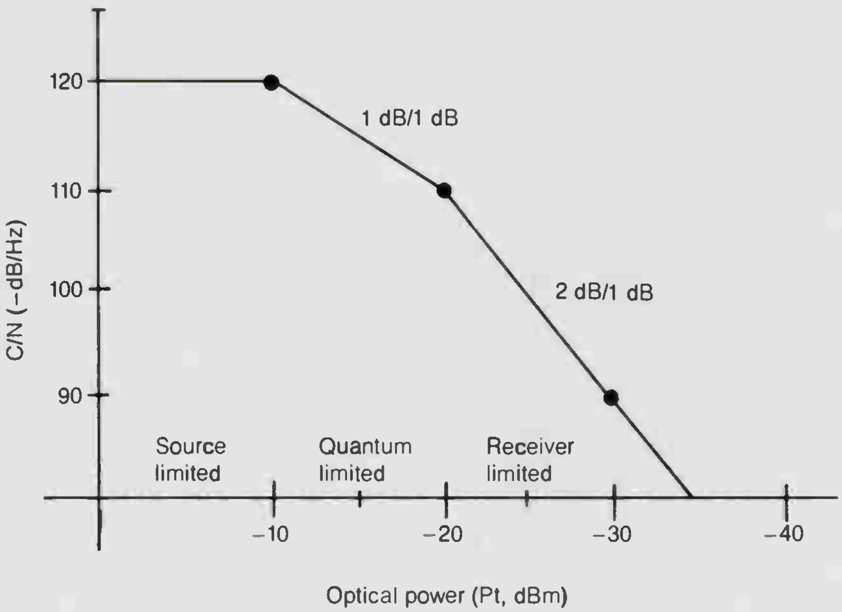
where:

R_O = diode responsivity
m = modulation depth
Pt = average optical power received
q = electron charge
K = Boltzmann's constant
I_d = diode dark current
B = bandwidth of receiver
T = temperature (°K)
R_{eq} = equivalent resistance of photodiode load and amplifier
Ft = noise factor of preamplifier
RIN = source relative intensity noise
N = number of FDM channels

When the optical power incident on the photodiode is low the receiver circuit noise term dominates the system noise, so that

$$C/N = \frac{(1/2N^2)(m \times R_o \times Pt)^2}{(4K_b\,T_B/R_{eq})Ft} \qquad \textbf{(4)}$$

Figure 5: C/N vs. received optical power



Here, C/N is directly proportional to the square of the average optical power. Thus, for each 1 dB change in optical power received, the C/N ratio will change by 2 dB. For larger optical signals incident on the photodiode, the quantum noise associated with the signal detection process dominates (assuming I_d negligible), so that

$$C/N = \frac{(1/2N^2)(m^2 \times R_o \times Pt)}{(2qB)} \quad \textbf{(5)}$$

Since the C/N ratio in this case is independent of circuit noise, it represents the fundamental or quantum limit for analog receiver sensitivity. In this optical power range the C/N ratio will change 1 dB for each 1 dB change in receiver optical power. For very high optical power levels the C/N ratio may be limited by the laser source.

$$C/N = \frac{(1/2N^2)(m^2)}{(RIN \times B)} \quad \textbf{(6)}$$

Thus, the C/N ratio is constant at the maximum obtainable from the laser transmitter. Figure 5 illustrates an example of C/N obtainable at the receiver output as a function of optical input power when these noise sources are present.

2) *Bandwidth limitations*

Laser transmitters have available modulation bandwidths of at least several GHz. Typically the transmitter circuitry will limit the upper bandwidth rather than the semiconductor laser diode. However, linearity constraints will tend to limit full utilization of the available bandwidth in analog FDM systems.

Single-mode 1,300 nm fiber has bandwidths above 10 GHz/km available. The electrical 3 dB bandwidth for a single-mode fiber is

$$f(3\ dB) = (.35)/(M \times \Delta\lambda \times L) \quad \textbf{(7)}$$

where:

M = material dispersion (ps/nm × km)
$\Delta\lambda$ = optical spectral width (nm)
L = fiber length (km)

For 1,300 nm single-mode fiber:

M = 3.5 (ps/nm × km)

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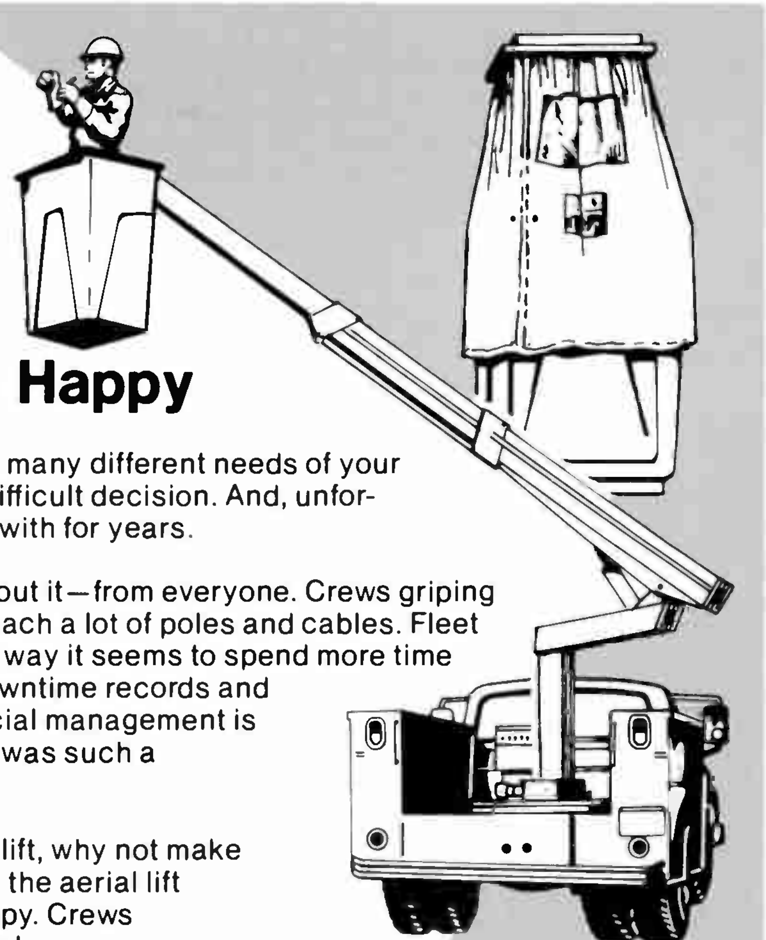

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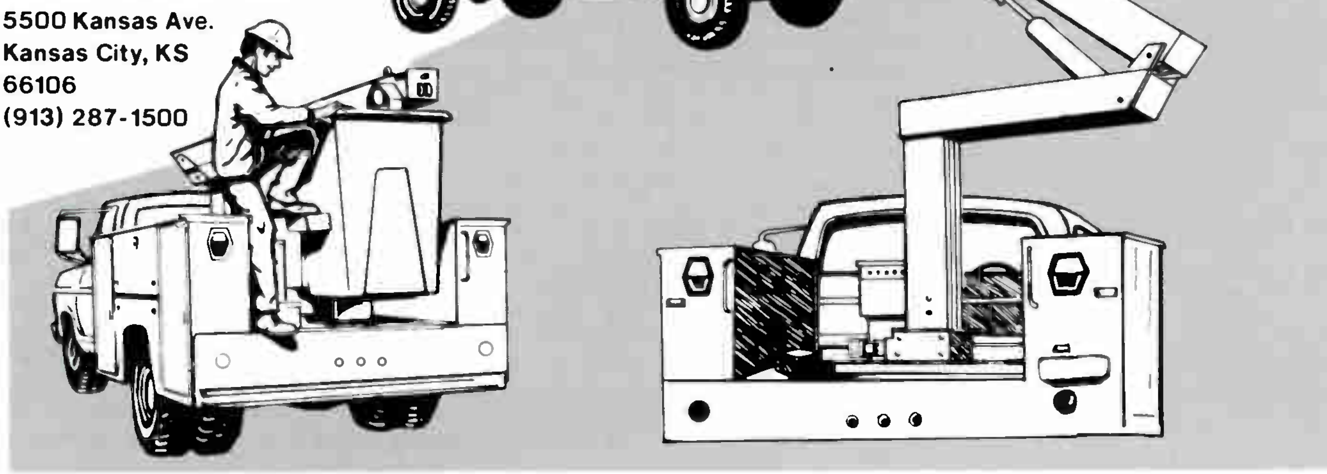

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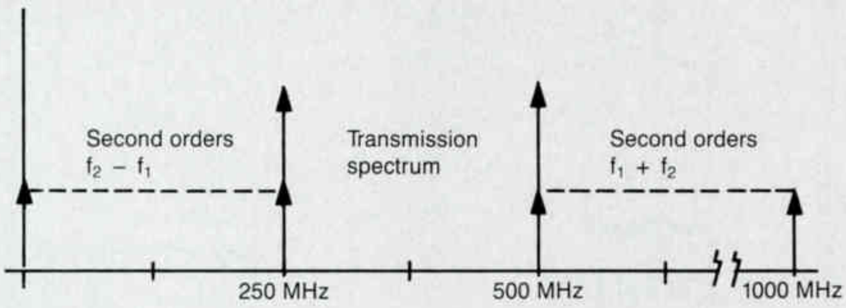
Figure 6: Spectrum plan to avoid second orders



Thus, for a 10 km path with a single-mode laser ($\Delta\lambda$= 1 nm)

f(3 dB) = 10 GHz

High-sensitivity receivers require that bandwidths be limited. As seen from the expression for C/N ratio (Formula 3), all the noise terms are directly proportional to bandwidth. For this reason the optical receiver will intentionally limit the bandwidth to only that required for the particular transmission requirement.

High-sensitivity receivers also require high input resistances, as can be seen by the C/N expression in Formula 3. Higher bandwidths are difficult to maintain at higher resistance levels, due to real and parasitic capacitances present in the optical receiver circuitry. Very wide-band (>1 GHz) receivers typically utilize 50-ohm photodiode, preamp and post-amp stages that will provide lower receiver sensitivities due to the 50-ohm thermal noise source at the preamp input.

3) *Distortion*

The limiting distortions in an analog FDM system are second- and third-order intermodulation. Second-order intermods are defined as $f_1 \pm f_2$ products. Third-order intermods are defined as $f_1 \pm f_2 \pm f_3$ products.

The laser diode normally will be the distortion-limiting component in a fiber-optic link. Typical values of distortion for a single-mode laser operating at a 50 percent modulation depth are: Second order, 30-45 dB; and third order, 45-60 dB.

The spread in values indicates that not all lasers have good linearity. Some lasers even may have abrupt discontinuities (kinks) in their LI curves, which disqualifies them completely for use in analog systems.

Circuit linearization techniques for lasers have not proven successful to date. A scheme that measures the non-linearity and corrects it in real time, such as feedback or feedforward, can be helpful here. However, at this time, careful specification criteria and selection of lasers for linear analog performance are an absolute requirement to obtain high-performance analog FO links.

The linearity of fiber-optic receivers are generally quite good since they operate at relatively low signal levels. Pin photodiodes have good linearity over several orders of magnitude. Well-designed preamps and post-amplifier electronics will not contribute significantly to system distortions.

At very high optical powers present at the receiver input, it may be necessary to utilize an optical and/or electrical AGC. Fixed optical attenuators also may be used at the receiver input when the high levels are a permanent condition.

With prior knowledge of the distortion performance available in a FO link, a system designer can minimize some of the possible limitations. For example, since second orders are the strongest distortions, a frequency transmission spectrum that eliminates second orders from falling in desired channels can be selected. Limiting

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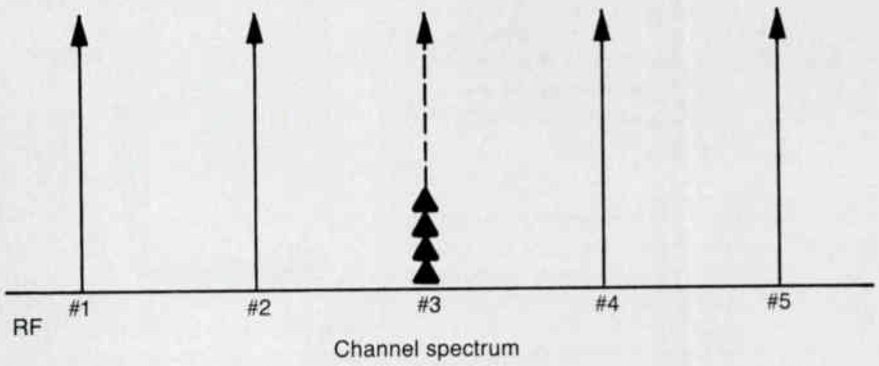
Figure 7: Beat stacking for five-channel system



the transmission bandwidth to the highest octave region will cause all the second orders to fall above or below the desired transmission spectrum (Figure 6). Without the second-order limitation, third orders will be the limiting distortion mechanism.

As the number of channels increase above three and are equally spaced, it is important to realize that there will be intermod or beat stacking. That is, several individual beats will exist at or near the same frequency. This is commonly referred to as *composite triple beats* (CTB). The result of beat stacking tends to be additive on a power basis (assuming the individual carriers are not phase-locked). Figure 7 illustrates this situation for five RF carriers. The cumulative effect of stacking can be estimated using the expression:

$$CTB = -d3 + 10\log(N)$$

where:

$-d3$ = distortion level of a single third-order intermod (three tone)

N = number of stacked beats (equal levels)

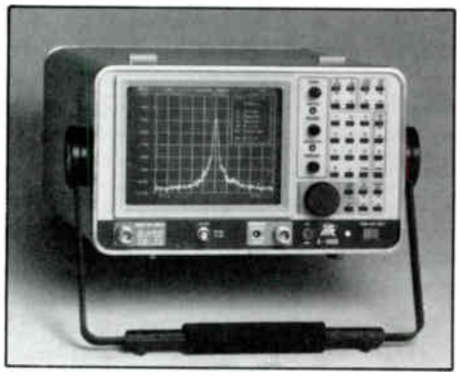
The largest number of beats will fall in the center channel for a symmetrically spaced spectrum. For the five-channel spectrum shown in Figure 7, there will be four (three-tone) third-order beats stacked in the center of the channel spectrum. Thus, the worst case third-order distortion would be 6 dB worse than that contributed by a single third-order distortion. Two-tone, third-order distortions also will be present with multiple carriers. However, they will have individual distortions that are 6 dB below a three-tone third-order product and thus tend to be a negligible contribution as the number of channels increases. These extrapolations are useful since many linearity tests are performed using a limited number of carriers.

Systems applications

Analog FDM fiber-optic transmission systems have been used successfully to carry up to 16 channels of video on a fiber link with performance approaching RS-250B (short haul). The most common modulation technique employed is wide-band FM (>7 MHz deviation). Wide-band FM modulation provides a signal-to-noise ratio improvement of over 20 dB compared to standard AM transmission. FM signals also have a high tolerance to intermod distortion. Whereas AM channels require channel distortion levels greater than −57 dB below the RF carrier, FM will operate with distortion levels of −40 dB.

VSB-AM fiber-optic transmission systems have successfully carried four to eight channels of video up to 12 km. Performance levels are comparable to CATV standards. However, the cost per channel for an AM system is significantly lower than for video FM.

This article was presented at the RF Technology Expo '87.



Spectrum analyzer

IFR Systems is offering its Model A-8000 spectrum analyzer. Its synthesized RF section covers a frequency range of 10 kHz to 2.6 GHz with a time base accuracy of ±0.5 PPM. Scan width can be selected from 1 kHz to 200 MHz/division plus zero scan and full scan. Resolution bandwidths vary from 300 Hz to 3 MHz and sweep times can be selected from 5 milliseconds to 10 seconds/division.

A 10 dB, 2 dB or linear scale can be selected on the vertical raster scan display and the log mode can be scaled in dBm, dBV, dBμV, dBmV and dBμW. There is 60 dB of internal attenuation and 65 dB of IF gain available to permit a displayed measurement range of −120 to 30 dBm. Two video filters, 300 Hz or 30 kHz, also can be selected, as well as an average mode.

For more information, contact IFR Systems Inc., 10200 W. York St., Wichita, Kan. 67215-8935. (316) 522-4981; or circle #125 on the reader service card.

Water removal

The Water Guard dessicating packets from Oil Maintenance Technology are said to remove moisture and condensate that accumulates in amplifier boxes or other closed areas and reduce the maintenance costs due to water problems. Packets are available in several sizes; custom packets can be made to fit specific needs.

For further details, contact Oil Maintenance Technology Inc., P.O. Box 1079, Channelview, Texas 77530, (713) 452-5732; or circle #123 on the reader service card.

Remote controls

R.L. Drake is introducing a new line of programmable remote controls that allow the user to operate up to three different remote controlled products from one module. The remote has a 30-foot range and only can be used with infrared (not ultrasonic) products.

To program the unit, the user flips the "learn" switch and places the module against the component's remote. The function desired is pressed on both remotes; the Drake unit flashes a light

to indicate it has learned the function. According to the company, the 41-function module can operate even the most sophisticated consumer electronics components.

For more details, contact R.L. Drake Co., P.O. Box 112, Miamisburg, Ohio 45342, (513) 866-2421; or circle #133 on the reader service card.

Feedforward amp

Hughes Aircraft's Microwave Products Division announced its new feedforward power amplifier, designed to extend the range of its AML microwave line extender. The AML-FFA-160 is able to transmit up to 60 channels and provide the full benefits of feedforward distortion cancellation at CARS-band microwave frequencies.

The 12.7-13.2 GHz microwave amp uses standard AML GaAs FET solid-state technology in a feedforward configuration. Housed in a separate temperature-controlled outdoor housing, it provides the AML-OLE-111 microwave line extender with up to 10 dB more output capability without further degrading the noise and distortion performance.

For more details, contact Hughes Aircraft Co., Microwave Products Division, P.O. Box 2940, Torrance, Calif. 90509-2940, (213) 517-6233; or circle #135 on the reader service card.

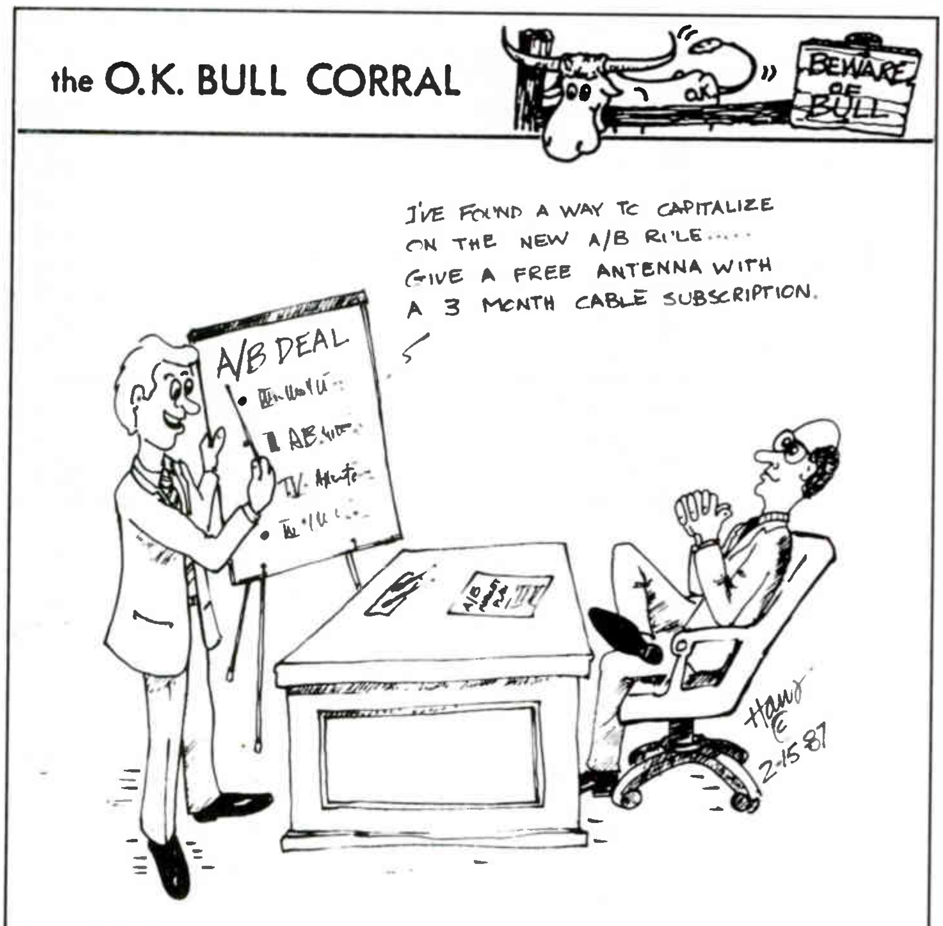
Steel molding

CableReady Inc. has introduced a two-inch version of its Guardian galvanized steel molding. The new size has a 45 RG-6 capacity and is constructed of 26-gauge galvanized steel like the company's one-inch molding, which has an 18 RG-6 capacity. Both sizes are said to be vandal- and weather-resistant. They offer security key reentry for fast and easy upgrades. A 15-year warranty on each size also is offered.

For more information, contact CableReady Inc., 6820 N. Broadway, Suite E, Denver, Colo. 80221, (303) 428-9141; or circle #136 on the reader service card.

F connectors

Gilbert Engineering is offering its new color-identified F connectors to be used in conjunction with color-identified drop cable produced by major cable manufacturers. The color ring on each connector identifies its size and is designed for easy installation and proper gripping of matching color drop cables. The connectors were produced originally to meet TCI specifica-



Courtesy Parallex

tions, but now are standard catalog items available for general use.

For further information, contact Gilbert Engineering, P.O. Box 23189, Phoenix, Ariz. 85063-3189, (602) 245-1050; or circle #137 on the reader service card.

Signal level meter

Sadelco's new Super 600 Special signal level meter shares many of the internal features of the regular Super 600, but now has a user-replaceable F connector on the front panel. The meter comes equipped with individual band illumination and a microammeter for improved night vision. An AFC control also is mounted on the front panel. The NiCad battery supply with auto shutoff includes deep discharge protection.

For more information, contact Sadelco Inc., 75 W. Forest Ave., Englewood, N.J. 07631, (201) 569-3323; or circle #141 on the reader service card.

DBS antenna

Matsushita Electric, together with Comsat Corp., has introduced a new flat Ku-band satellite antenna suitable for direct broadcast satellite (DBS) and fixed satellite service (FSS). Unlike a parabolic dish antenna that reflects microwaves off its surface and collects them, the flat antenna receives microwaves directly.

The antenna is said to be highly portable and easily installed; its flat surface is resistant to problems associated with snow and wind, and can be colored or printed to order. The antenna comes in three sizes (1.2 foot square, 1.3 by 2.4 feet, and 2.4 foot square). It is available in left/right circular polarization and dual types.

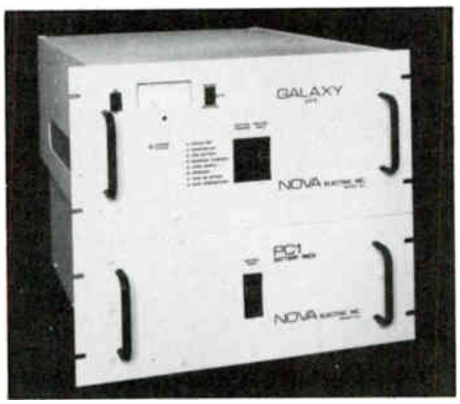
For complete details, contact Matsushita Electric Works, 10400 N. Tantau Ave., Cupertino, Calif. 95014, (408) 446-5010; or circle #128 on the reader service card.

Cable cement

Silaprene M5038, part of a new line of cable splicing cement from Uniroyal Plastics, is said to provide a secure and flexible bond for splicing high-voltage wires as well as other electrical cables. Its reclaim rubber base is quick drying and offers adhesion to rubber, non-porous metals and plastics surfaces.

The product is available in black and can be applied by spray gun or brush. Joining the spliced surfaces and applying pressure establishes a bond and ensures full contact. The dried adhesive can be reactivated with petroleum naphtha.

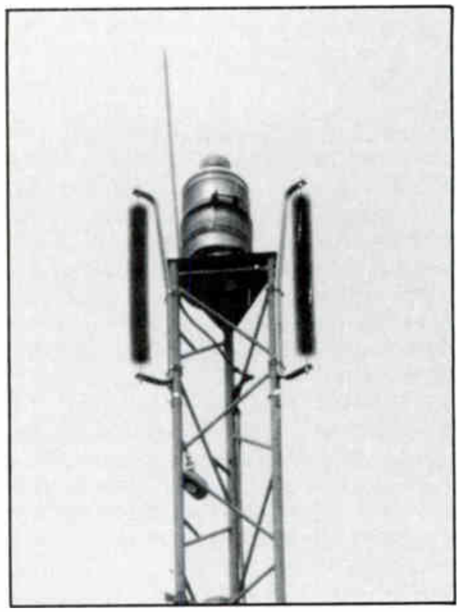
For more details, contact Uniroyal Plastics Co. Inc., P.O. Box 2000, Mishawaka, Ind. 46544-1399, (800) 336-1973; or circle #126 on the reader service card.



Power supply

Nova Electric is offering its Galaxy 5000, a small 5 kVA uninterruptible power system. The module stands 8¾ inches high; its 7-inch battery pack provides up to 10 minutes of operation at full load. According to Nova, the product employs reliable state-of-the-art transistor technology. Only two printed circuit cards are used to provide all necessary signal processing and control to the system's battery charger, inverter and solid-state transfer switch.

For more details, contact Nova Electric Inc., 263 Hillside Ave., Nutley, N.J. 07110, (201) 661-3434; or circle #131 on the reader service card.



Lightning guard

Lightning Prevention Systems is offering its Model ALS-3000, designed to prevent lightning from striking any structure it is mounted on. It is said to remove the attractive charge from the protected structure and render it virtually "invisible" to lightning. The system arrays combine a total of over 40,000 dissipating points to neutralize over 30,000 square feet of surrounding ground area.

For more information, contact Lightning Prevention Systems, 204B Cross Keys Rd., Berlin, N.J. 08009, (609) 767-7209; or circle #121 on the reader service card.

Practical considerations for rebuilds

The need for additional channels continues to be a motivating force in the cable industry. New services, the repositioning of basic, pay-per-view, home shopping and so on, all force the operator to look for methods to add channels to existing systems. This article will attempt to review some of the important considerations involved in rebuild decisions.

By Patrick K. McDonough
Corporate Chief Engineer, United Cable Television Corp

When to do a rebuild is just as important as how it should be done. The timing depends on a number of factors. Often this decision is made by default, as in the case of a franchise nearing expiration. Usually, some type of upgrade is required to keep the franchise and to respond to competitive forces within a geographical area. Refranchise timing is tracked by most MSOs and, in conjunction with marketing, technical or revenue considerations, is the most common reason for rebuilding or upgrading a system.

The need to refranchise is not the only reason to consider upgrading a plant. Sometimes the opportunity for significant revenue increases will be recognized by a marketing group and the need for additional channels to accomplish this goal will be the decisive factor in the rebuild decision. At other times, the ongoing costs to maintain and operate an older plant will be motivation to rebuild. Forces of nature, such as tornadoes or floods, also will bring on the need for rebuilds. The annual budget review is the logical time to consider most rebuild requirements within an MSO, since there usually is a concentration of management, marketing and technical personnel gathered together who have both the expertise and authority to make these decisions.

A myriad of possibilities

Once the decision has been made that a rebuild is necessary, the next step is to determine *what* exactly is required. This can be an area of confusion and conflicting demands for the engineer who is given this reponsibility. There are a myriad of possibilities to consider, and it must be stressed that there is no one right answer to the question of how to upgrade that will fit every circumstance.

Up to this point the terms *rebuild* and *upgrade* have been used interchangeably but a distinction should be made. A rebuild, as used here, involves the total replacement of the existing cable plant. An upgrade, on the other hand, is the partial replacement of equipment and/or cable to extend the life or bandwidth of a system. Obviously the differences in cost between these two similar approaches are a significant part of the decision-making process. In practice the operator quite often will find that a combination of both approaches is the best solution to any problems.

In making the decision to rebuild or upgrade, the engineer must consider a broad base of information. One of the first and most important factors is why the need to rebuild exists in each particular case. If an 8-year-old plant needs to add six more channels for new services, this probably can be accomplished through some type of upgrade. If, on the other hand, a 15-year-old system built on the Pacific coast needs to add the same six channels, the system more likely will need to be rebuilt.

On-site inspection of the system is needed to resolve most of these questions. What is the condition of the cable and electronics? Can any of the existing gear be salvaged? Importantly, what is the condition of strand and other support hardware? Can this be reused? Is underground cable in conduit or direct buried? Can existing conduit, vaults and pedestals be used in the new plant? What is the condition of the drop wire and installation passives and can they pass the new bandwidth? Significantly, this last question often is overlooked, even though it is of prime importance. The answers to all of these and many more questions must be determined before final planning can begin.

At this point it has been determined that a rebuild or upgrade is necessary and approximately what needs to be done. The next steps concern *how* the project will be completed. This is the nuts-and-bolts part of the process, the activities that most people associate with a rebuild.

First, accurate as-builts and/or strand maps of the existing system must be developed. As-built maps are required in an upgrade situation, while good strand maps, with or without as-built information, are needed in rebuild projects. Maps should detail the information needed to determine cable routing, include all MDU and future construction areas, show bridges, lakes and other obstructions, and indicate specifically any existing plant areas that can be included in the new system without modification.

Design criteria and instructions should be developed next. Some of this may have been completed in the analysis phase of the project but design now should be refined. This includes the call-out of system operating specifications, forward and reverse levels, bandwidth, and cable and passive device attenuations. Special instructions, such as the need to maintain the same amplifier locations, also should be included. Mapping and design can and should begin well in advance of the actual construction effort. The design, whether done by phase or power supply area, should generate accurate BOMs (bill of materials) for project costing, material orders and project control.

'First, accurate as-builts and/or strand maps of the existing system must be developed'

Good contracts

The next logical step will be deciding *who* does the work, how they will be supervised, setting up reporting procedures and so on. A good contract, written by qualified attorneys, is a must. It should be specific in detailing the work functions, unit prices, time frames and responsibilities of all concerned parties. Items such as retainage, reports, payment for confirmed production, performance bonds and warranties should be included.

Some MSOs have the capability of providing such construction services from within the organization. On some projects, such as the drop-in upgrade of a smaller system, local system personnel may be able to handle the work themselves. A formal contract in these cases is not required, but care should be taken to make sure that system technicians receive the proper training prior to undertaking such a project.

Whether a contractor is used or not, the crews must be supervised by one person with overall responsibility for the project. The size of the construction management team will depend on the scope of the project. Construction management may vary from a single supervisor to a fairly large group consisting of various specialists such as make-ready engineers, underground locators, etc. Cost control, warehousing and materials handling should not be overlooked in determining the construction team size.

From this point on, it is a matter of relying on the people put in place to bring the project to a successful conclusion. Naturally, the rebuild should be monitored via the reporting system to identify and correct problems before they become too serious. When the project is done, the entire system should be proofed just as a new-build plant would be. This is the final assurance that the newly rebuilt system will achieve the goals for which it was designed.

In summary, the steps taken toward implementing a rebuild or upgrade project should follow a logical pattern. Using *when*, *what*, *how* and *who* as a framework is the beginning of just such a logical approach. The better organized a project like this is, the more control the operator can have over the results. The end product will prove to be worth the effort.

THE LITTLE FARMER & THE GIANTS

A MODERN CABLE FABLE

Once upon a time, in a not-so-far-off land, the grain the people used to make their daily bread was grown by four huge giants–and one small independent farmer. For years, all five grain producers co-existed peacefully, in an atmosphere of healthy competition.

But then one day, the four giants entered into a battle for control of the grain market. When the battle ended and the dust cleared, only two giants were left. And, of course, the little independent farmer.

Then a strange thing happened. Overnight, the competitive situation changed. And the people began to worry. "Now that there are only two giants," one person said, "what's to stop them from charging higher prices for their grain?" "If they do, we won't be able to make as much bread as before," cried another.

But the little farmer overheard the people talking. And he cleared his throat and took a step forward. "My friends," he said, "you're forgetting about me." "You," snorted a man at the front of the crowd, "what can you

do against such giants?" "I can do just what I've always done," the farmer replied, "supply the finest grain and the best service in the land–at a very competitive price. As long as I'm around the giants can't take complete control of the grain industry–if you'll all think of me and include me in your business."

There was a general chorus of "that's right," "we didn't think about the little farmer." And so, after the farmer pledged to maintain his independence and to remain in the land for many years to come, the people went back to baking their bread, greatly relieved. And they all lived happily, and competitively, ever after.

CAPSCAN

A Burnup & Sims Cable Products Group Company

The moral of this tale is that variety & competition in almost every industry are good for the consumer. Like the farmer, we at Capscan, the only full service, independent coaxial cable company remaining in the U.S.–promise to maintain our autonomy. And to continue providing the best quality products and service in the business. We invite you to call us for a competitive bid on your next project.

See us at the NCTA Show, Booth 1642.

Reader Service Number 90.

Building a system history

By Peter Rumble
Training Coordinator, McCaw Cablevision

Do unexplained subscriber complaints and mysterious outages have your service team running aimlessly all over town "putting out fires?" Are some system amplifiers behaving like unruly brats, demanding your attention and throwing costly tantrums? Do portions of the plant seem to run flawlessly until the technician leaves the area or goes home at the end of the day? Are you wishing the cable system would leave you alone for just two minutes so you could get some work done?

If the answer to any of these questions is "yes," it's possible that you simply may be unaware of the plant conditions causing these headaches. A preventive maintenance program can bring some relief.

Creating and maintaining a system log can provide the technician with an indispensable troubleshooting tool. With adequate documentation, changes in plant conditions can be detected that otherwise would go unnoticed. Compiling information on selected plant parameters generates a history that, when reviewed, assists in identifying design oversights and construction errors.

Amplifier maintenance history log

Date	No*	Amp Location	Tech.	Problem	Resolution

System trunk data log

TRUNK AMP NO ________ LOCATION: ________

AMP TYPE: ________ AGC ____ MGC ____ PAD ____ EQ ____

PWR: IN OUT THRU SELF AC VOLTAGE ____ XFORMER TAP ____

DC REG VOLT ______

CABLE SIZE/TYPE: IN ________ OUT ________

CALCULATED INPUT AT DESIGN FREQ: ________ dBmV

SLM LEVELS DATE: ____ TEMP °F: ____

CHAN																	
IN																	
OUT																	

BRIDGER FUSES: Port 1 ____ 2 ____ 3 ____ 4 ____

SWEEP WIDTH: ____ MHz to ____ MHz DATE ____ TEMP °F ____

Insert Sweep Picture Here

Specification: $\frac{N}{10}+1$ Peak to Valley; N = Trunk Amp# from headend

End-of-line check

TEST LOCATION NO ______ TEST POINT ________ AFTER ____ TRK STA

AND ______ LINE EXTENDERS LOCATED AT ________

CABLE CH NO *	DATE TEMP															
	V	A	V	A	V	A	V	A	V	A	V	A	V	A	V	A
2																
4																
6																
8																
E																
G																
I																
7																
9																
11																
13																
J																
M																
P																
R																
T																
W																
D.C																

	LB	HB	LB	HB	LB	HB	LB	HB	LB	HB	LB	HB	LB	HB	LB	HB
C/N																
% HUM																

NOTES

1 BLANK CHANNEL SPACES PROVIDED ARE FOR SAMPLE CARRIERS IN THE AERONAUTICAL / NAVIGATIONAL RADIO BANDS OR FOR SUB-LOW CHANNELS T-7 TO T-10

2 DC : FM DATA CARRIER LEVELS ON ADDRESSABLE SYSTEMS

3 LB : LOWBAND HB : HIGHBAND

4 % HUM READINGS TO BE RECORDED AS PEAK TO PEAK VALUE

'Determine what records will be most useful to your operation and include them in your preventive maintenance program'

By periodically analyzing records of field equipment readings, trends and patterns can be spotted. Symptoms of plant deterioration often are exhibited as departures from the documented amplitudes of RF and AC signals, amplifier DC voltages and picture quality indicators like C/N (carrier-to-noise) and hum. The locations of faulty power supplies, corroded or loose coax connectors, cracked cable shields, improperly installed line components and other causes of picture degradation can be pinpointed by observing subtle changes in recorded data.

Once identified, actions can be taken to repair trouble spots before unplanned outages or subscriber complaints result. Plant rework can be scheduled on your own terms within reasonable time constraints and in favorable weather. This yields higher quality workmanship than can be obtained under the pressure of an outage during prime viewing hours.

Accurate records eliminate guesswork in troubleshooting. Documentation reduces errors that can result from relying on memory. Evidence is established that calculated design values were met, amplifier station configuration and type were verified, and desired frequency response was attained. This history can aid the sweep technician in duplicating past response when equipment changes are made. The maintenance technician can benefit by consulting the log for specific AC voltage readings when troubleshooting powering problems.

Kinds of records

Because no two cable systems are exactly alike, you will need to determine what records will be most useful to your operation and include them in your preventive maintenance program. Additional logs might include histories on standby power supplies, battery maintenance, headend equipment, tower lighting and specialized mini-systems for large commercial accounts like schools, motels and shopping centers.

The system logs are intended to be permanent records and therefore should not be taken to the field. A loose-leaf notebook will allow pages to be removed, copied for reference and replaced. A binder facilitates the addition of updated pages and new data sheets for future builds. The logs should be established during the first proof of the cable system and updated whenever periodic balancing or response sweeping is performed on any trunk line.

At the front of each log, include a current copy of your preventive maintenance (PM) plan. It clearly should define:

- The company's commitment to and philosophies on PM.
- The limits of all plant parameters and technical specifications.
- The frequency of data collection for each log.
- Personnel accountable for reports and reviews of PM logs.
- The procedures and test equipment required for measurements.
- The technicians currently qualified to perform the tests.

Establish a separate log book for each set of records. The system size and complexity usually dictates the amount of material to be organized and compiled.

Headend test-point log

Product reliability and quality begin at the headend. Monitor the stability and performance of the headend and ensure the system input is optimum. For plant maintenance purposes, record the RF levels of each video and audio carrier on the system and include a photo of the swept response as measured at the headend test point.

Sound engineering practices require that technicians responsible for trunk-line maintenance individually record these levels using the signal level meter assigned to them for daily use. Meter serial number and date of measurement should be included as a permanent part of the log. If doubts about calibration, accuracy or stability arise, this reference can be used for comparisons.

Enter the values of AC voltages used in system powering, if applicable. Levels of test and data carriers, return signals and other inputs also should be included.

System trunk data log

Document the actual field values listed for each trunk amplifier in the cable plant from the headend to the end of the cascade. Recording the information essentially forces the technician to proof the system, amplifier by amplifier. Proper pad, equalizer, powering mode, voltages and operating levels are verified. Unnecessary bridger leg fuses are removed, the operation of AGC/ASC (automatic gain/slope control) circuitry is checked, and an examination of the station is made for mechanical integrity. Although not in the log, the conditions of straps, spacers, hardware, lashing wire, shrink boots and clearance should be noted and corrected, if possible. As technicians work their way through to the end of the system, problems will be discovered and corrected. An invaluable system history will be generated in the process.

The parameters included are considered as the suggested minimum indicators of trunk station performance. Input/output channels selected should include system pilots, highest and lowest video carrier frequencies, one other carrier in each band and any other carriers of interest. A space is provided to attach the latest frequency response pictures, documenting that the desired peak-to-valley output has been attained for that station. Ideally, all trunk stations should be swept twice yearly, recorded and entered into the log.

Dedicate a section of the system log to each trunk line and identify each cascade using a numbering scheme or name describing its destination. As the completed data sheets are returned from the field, they are reviewed before entering into the log. Those items not meeting standards, or with disparities between calculated design and actual field values, can indicate potential field problems. These can be noted and looked at again later. Examples might include cable equalization problems, standing waves, attenuation discrepancies or borderline voltage readings. Although these conditions may not drastically affect picture quality, they must be corrected to ensure peak system performance and reliability.

Trunk amplifier maintenance history

The purpose of this record is to prevent "repeated maintenance," that is, treating the symptoms and not the causes of signal problems over and over again. For example, it's possible for more than one technician to change a bridger module in the same location in a given week to correct a rash of complaint calls. Each was led to believe that the old module was the cause of the distortions in the feeder line, without the knowledge that it was replaced only hours ago. Yet each time it was exchanged, the problem cleared!

Technicians usually are too busy to discuss with one another the what, why, where and when of each module they change. By recording each problem and resolution for a particular amplifier location, the field technician or supervisor reviewing the log can see what has occurred. After repeated module changes, it should be evident that the amplifier was not causing the problem, but merely reproducing it. The informed technician now can look for the real cause of the customer's poor reception.

File this record along with the corresponding system trunk data sheet for each amplifier station. This way, pages easily can be located and identified. Review work orders and maintenance reports daily as they return from the field, and make the proper log entries.

End-of-line checks

The end-of-line checks are used to monitor the performance of the system on a "whole picture" approach. A new perspective on how the cable plant is operating is realized by weekly comparisons of this record. Variations in headend stability, poor amplifier response, AGC failure and gradual increases in video distortions often can be detected only by reviewing this log.

At several test-point locations, video and audio carrier levels, C/N and hum are measured carefully and recorded. Ambient temperature also is rated, providing a reference for tracking proper AGC action. The RF carrier levels of every cable channel are not necessary for this check. Scrambled channels, system pilots, data streams, unmodulated test signals and other carriers of interest in plant operation should be considered. Regularly monitoring signal power level in the restricted bands verifies compliance with FCC limits.

A check of picture quality with a known good portable television set is recommended on every channel, if possible. As a backup, sweep response viewed at the end-of-line can detect spikes, suckouts, rolloffs and other abnormalities that might have developed since the last visit.

Finding and correcting the cause of an out-of-spec weekly reading on hum, for instance, could save your staff valuable time. Visiting three or four households, diagnosing the problem and then going out in the field to troubleshoot it is wasted effort.

Intermittent scrambling in just one part of town easily might be corrected. A search for the source of low RF levels at the end-of-line test point soon reveals a radial crack in the trunk line that is located and repaired.

The test points chosen for the end-of-line checks will be used to monitor selected plant parameters. Establish several test points throughout the system on all major trunk lines. Include the ends of the longest cascades and the trunk lines feeding the areas of highest subscriber density. Also consider those portions of the town that routinely generate the majority of complaint calls.

The number of test points is not as important as the amount of coverage provided. Try to establish a minimum number that will provide an adequate representation of overall plant operation. A good cross section, of course, will be dependent on plant miles, but five to 15 locations can be logged weekly with little manpower.

The accessibility of the test points is proportional to the continued success of the program and the probability of obtaining reliable, accurate information on a regular basis. Data collection points located in backyard easements, on narrow bridges or around heavily traveled highway intersections are to be avoided.

It will be necessary to assume that the bridger output is representative of the trunk that feeds it. At the trunk bridger location chosen, obtain test signals by either:

A) Directional coupler or low-value tap cut into an unused bridger port. For accurate C/N measurements, it is desirable that at least 30 dBmV be available at the test point; or

B) Subscriber tap-off points presently in the feeder line. This will provide adequate levels for all portions of the maintenance check except C/N in most systems. These readings will need to be taken where appropriate levels can be obtained.

Install a good quality drop wire from the signal source down the pole to a suitable height. The drop wire can be protected by installing it in PVC conduit or by covering it with pole moulding. Routing the drop close to existing pole mouldings or risers will maintain cosmetic appearances and minimize personnel climbing hazards. Guard against corrosion and possible RF leakage by "weatherizing" the connectors and providing a means to terminate the drop when not in use.

The recommended frequency of data collection for the end-of-line check is weekly on all system test points. For scheduling purposes, stagger the readings so that all locations are not due the same day.

Why bother?

Today's cable consumer demands the same reliability and quality available from other home entertainment alternatives. Preventive maintenance can extend plant life, decrease replacement costs, increase operational efficiency and be the determining factor in the monthly decision to renew service.

The success of any PM program requires a continuous commitment at every level of the organization. This knowledge must be understood in the corporate office as well as in the field. A lapse in dedication by any member of the team results in a loss of momentum. The program will falter and eventually may fail.

Resistance to PM programs will prompt responses like "we're too busy" or "we don't have the manpower." This indicates a situation in which the cable system is managing the staff. Implement a planned and organized program using a system of routine testing and accurate documentation to regain control of the plant and stay on top of it. ■

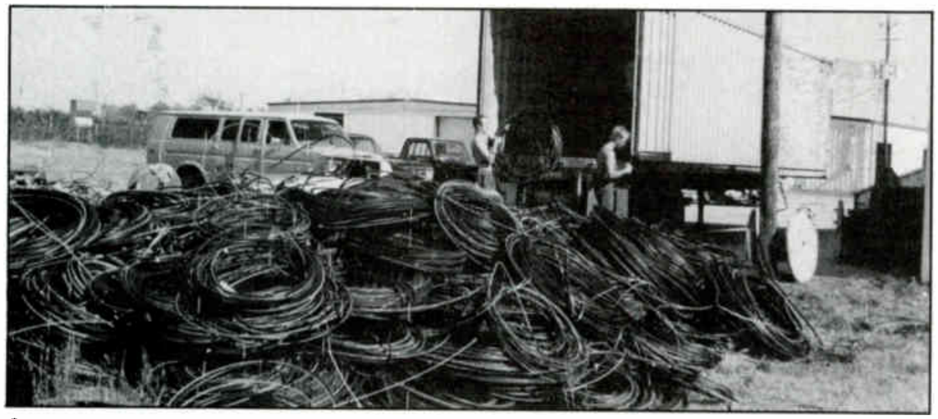
Salvageable revenues

By Tom Wood Jr.
Resource Recovery Systems

Lost revenue. . .a popular topic with any business interested in making a profit. Within the cable TV industry this subject lately has become synonymous with that of signal theft at the subscriber level. Unfortunately, another pertinent area of the industry, that of the system construction phase, has been virtually ignored recently.

Though perhaps not as glamorous a topic as signal theft, there exists no other phase of a cable system's operation as potentially wasteful and costly as construction. Millions of dollars are spent on equipment and materials, the distribution and utilization of which are essential to the very success of the system. Yet one routinely finds little or no coordination between the system's construction engineering personnel, its construction contractors and a reputable salvage contractor. This lack of preplanning usually results in unexpected accumulations of partial reels of unusable coaxial cable as well as, in the case of rebuild systems, unwanted miles of wreck-out piled high at a headend or a contractor's yard.

'In some parts of the country, landfills do not accept scrap reels and cable'



Scrap coaxial cable can be a good source of recyclable materials. Here, wreck-out is being unloaded at a salvage contractor's facilities.

With landfill and dumpster fees soaring into the hundreds of dollars—not to mention rising labor costs—these accumulations of scrap can pose an expensive and time-consuming problem to the MSO as well as its contractors. Proper coordination between engineering, construction and purchasing can of course minimize some of these problems. Custom purchasing based upon the system's needs (if your largest aerial span is 1,600 feet, don't buy 2,200-foot reels of coax), as well as close supervision and control of the materials used, are essential. A certain percentage of material, however, always will be unusable and should be disposed of in a cost-effective manner.

The obvious solution is to sell these materials. A system should plan in advance of construction, however, to find a salvage contractor who will provide the best overall program to deal with reels as well as the cable and electronics. While there are a number of companies that will clean up your waste materials and haul them away, not all are prepared to pay for the privilege of doing so. This is particularly true when those firms are unaccustomed to the type and volume of scrap generated by a new or rebuild cable TV system.

Recyclable resources

Scrap is made of critical natural resources needed to build future systems. Landfills are not the place for these recyclable resources. In some parts of the country, landfills do not accept scrap reels and cable.

To ensure prompt and dependable services, as well as maximum dollar return, cable system operators only should deal with reputable recycling firms. This entails not only solicitation of the best scrap price but, more importantly, investigation of the firm's past reputation within the industry. A history of previous service with certain scrap contractors should be available between an MSO's corporate office and its various systems around the country. This is particularly useful when dealing with a nationwide recycling organization, of which there are few.

A scrap contractor should be attuned to the needs of his clients and even can help minimize waste. Accurate monitoring of incoming scrap payments can help pinpoint those areas where excessive and unacceptable percentages of scrap are being generated. The bottom line is that cable operators should be as concerned with their potential losses from system waste as from signal theft—both are lost revenue.

Affordable Masterpiece

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

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

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

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

MODELS: SVT-20 SVT-40

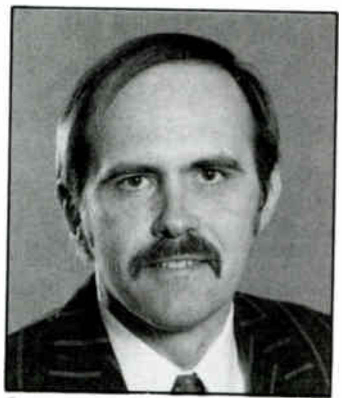
Features:

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

Specifications:

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

See us at the NCTA Show, Booth 1939.
Reader Service Number 71.



Coslo

Dennis Coslo has been named production manager at **Broadband Networks Inc**. He will be responsible for the company's manufacturing operations. Before joining the company, Coslo was assistant vice president of manufacturing at Penn Tran Corp. Contact: P.O. Box 8071, State College, Pa. 16803, (814) 237-4073.

Stephen Hattrup has been named vice president and treasurer for **American Television and Communications Corp**. Prior to this, he was corporate vice president of financial planning.

Earl Langenberg and **David Pangrac** have been named directors of engineering and technology. Prior to this, Langenberg was vice president of engineering for Rogers Cablesystems. Pangrac previously was vice president of engineering for ATC's Kansas City Division.

Also, **Timothy Evard** has been named director of marketing, strategy and planning. He previously was vice president of marketing for the Tampa Bay Division of Paragon Communications.

Finally, **Raleigh Stelle III** has been named standards engineer for ATC. Prior to this, he was vice president of marketing and a director for Texscan Corp. in Phoenix, Ariz. Contact: 160 Inverness Dr. West, Englewood, Colo. 80112, (303) 799-1200.

Advanced Protection Technologies announced **Thomas Norling** as vice president of research and development. His responsibilities include establishing an electronic research facility for communications and power transmission protection. Norling previously held positions at ITT and General Cable Co. Contact: 14088 Icot Blvd., Clearwater, Fla. 33520, (813) 535-6339.

Zenith Electronics Corp. elected **Robert Hansen** to the new position of president of its Consumer Products Group. He will continue as a corporate executive vice president.

Howard Graham has been named corporate vice president of finance and chief financial officer at Zenith. He had been vice president of finance services since 1983.

Finally, **John Taylor** has been named director of corporate public relations and communications. Prior to this, he was Zenith's manager of this department. Contact: 1000 Milwaukee Ave., Glenview, Ill. 60025, (312) 391-8181.

International Cablecasting Technologies appointed **W. Thomas Oliver** as its president and chief operating officer. He previously was senior vice president of Home Box Office. Contact: 9033 Wilshire Blvd., Penthouse, Beverly Hills, Calif. 90211, (213) 276-4660.

American Cablesystems of New York named **Phil Ripa** as its new director of engineering. Previously, he was project engineer for the MSO's Cambridge, Mass., system. Contact: 55 Tozer Rd., Beverly, Mass. 01915, (617) 921-0080.

Panasonic named **Robert Chalfant** planning manager of its Planning and Market Development Division. He will be responsible for coordinating efforts on behalf of Panasonic's parent company, Matsushita Electric Corp. of America, to strengthen industrial sales in the United States. Previously, Chalfant was marketing manager for Panasonic's Cable Television Products Group. Contact: 1 Panasonic Way, Secaucus, N.J. 07094, (201) 348-7183.

Bob Holladay has been named director of marketing for **CableBus Systems Corp**. He will be responsible for all sales and marketing activities, as well as contributing to corporate planning and development. Prior to this, Holladay was special projects manager for Delta Engineering. Contact: 7869 S.W. Nimbus Ave., Beaverton, Ore. 97005, (503) 643-3329.

Holladay

Signal Vision Inc. announced the appointment of **Michael Soloman** to the position of regional sales representative for the northern California, Washington and Oregon territories. Prior to this, he was regional sales manager for RMS Electronics. Contact: 3 Wrigley, Irvine, Calif. 92718, (714) 586-3196.

G. Bickley Remmey has joined the **Jerrold Division** of General Instrument Corp. as manager of sales support/administration. Prior to this, he was Northeast regional sales manager for Texscan Corp. Contact: 2200 Byberry Rd., Hatboro, Pa. 19040, (215) 674-4800.

Ward

Brian Ward has been appointed director of marketing for **Triple Crown Electronics**. Prior to this, he was sales manager for Electrohome Electronics. Contact: 4560 Fieldgate Dr., Mississauga, Ontario L4W 3W6 Canada, (416) 629-1111.

CATV applications of Ohm's law

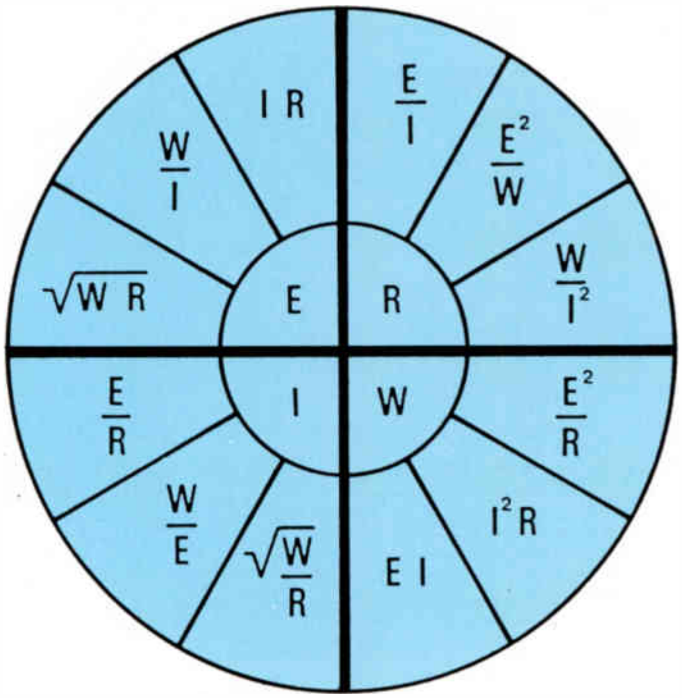
By Ron Hranac and Bruce Catter
Jones Intercable Inc.

The relationship between voltage, current and resistance is known as *Ohm's law*. The current flowing in a circuit is directly proportional to the applied voltage and inversely proportional to the resistance, which is shown by the mathematical formula

$$I = \frac{E}{R}$$

The following diagram illustrates conversions between common units of electrical measurement as they relate to Ohm's law.

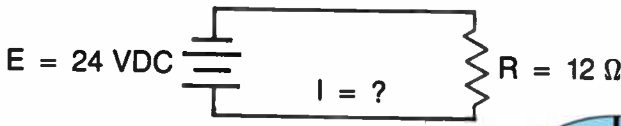
Ohm's law



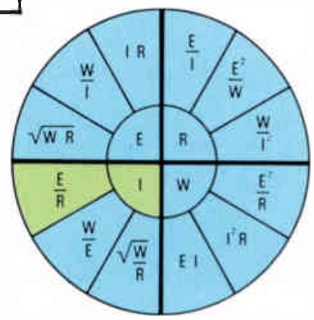
E = Voltage
I = Current
R = Resistance
W = Power

Example 1

Problem: How much current (I) is flowing through the following circuit?



Unknown: Current (I)



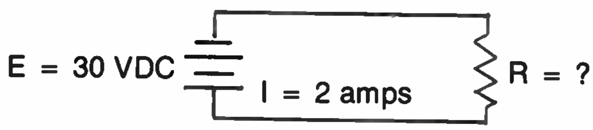
From the chart: $I = \frac{E}{R}$

$I = \frac{24}{12}$

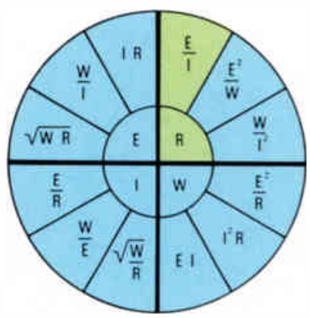
$I = 2$ amps

Example 2

Problem: What is the value of the resistor in the following circuit?



Unknown: Resistance (R)



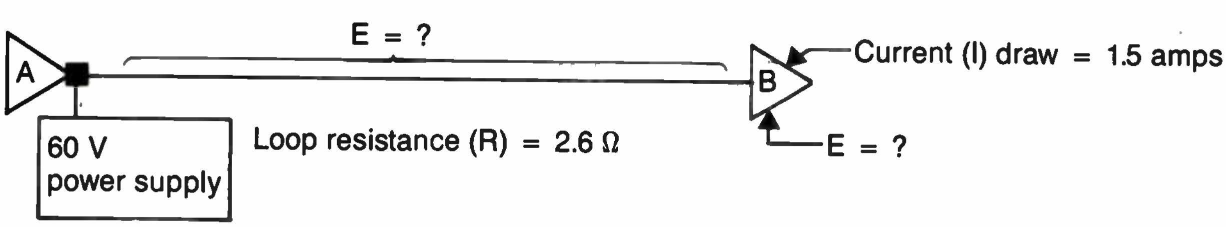
From the chart: $R = \frac{E}{I}$

$R = \frac{30}{2}$

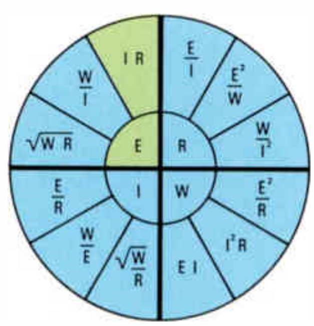
$R = 15$ ohms

Example 3

Problem: 1) What is the voltage drop in the span of cable shown below? 2) What is the AC voltage at amplifier B?



Unknown: Voltage (E) drop in cable



1) From the chart: $E = IR$

$E = (1.5)(2.6)$

$E = 3.9$ VAC

2) AC voltage at amp B = 60 V − 3.9 V

= 56.1 VAC

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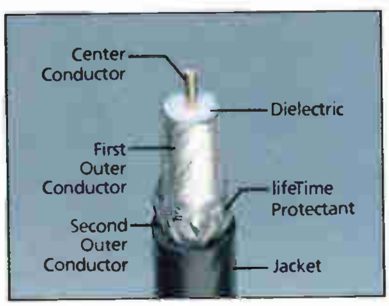
Enhance your drop cable investment by specifying the exclusive lifeTime™ cable from Times Fiber Communications. For as little as an additional 18¢ per subscriber*, lifeTime can "insure" maximum protection and offer 20–30% longer cable life.

lifeTime provides increased coverage against moisture – one of the major causes of premature cable failure, signal leakage and damaging corrosion. Let your customers become the beneficiaries of clear reception, decreased incidence of flashing and reduced subscriber outages.

lifeTime cable diminishes the need for expensive sealed connectors. Decreased frequency of connector replacement and the connector compatibility of this cable should dramatically reduce labor and maintenance costs.



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Reader Service Number 103.

May

May 4-6: Canadian Cable Show, Convention Center, Montreal, Canada. Contact (613) 232-2631.

May 12-14: Maryland/Delaware/D.C. Cable Television Association annual spring meeting, Annapolis Hotel, Annapolis, Md. Contact Susan Hollis, (301) 268-2721.

May 14: SCTE Central Indiana Meeting Group seminar on BCT/E Category IV–Distribution Systems, Indianapolis Motor Speedway, Indianapolis. Contact Rick Cole, (317) 841-3692.

May 17-20: NCTA Show, Convention Center, Las Vegas. Contact (202) 775-3550.

May 18-21: Trellis Communications seminar on designing and installing fiber-optic networks, Trellis Training Center, Salem, N.H. Contact (603) 898-3434.

May 26: SCTE Satellite Tele-Seminar Program, "RF Field Strength Measurement Principles and Practices," 12-1 p.m. ET on Transponder 7 of Satcom IIIR. Contact (215) 363-6888.

June

June 1-5: Information Gatekeepers' European Fiber Optic Communications and Local Area Networks Exposition, European World Trade and Convention Center, Basel, Switzerland. Contact Renee Farrington, (617) 232-3111.

June 2-4: Online International's CableSat 87 exhibition and conference, Metropole Hotel, Brighton, England. Contact Pam Howard, 01-868-4466.

June 3: SCTE Rocky Mountain Chapter review on Category IV–Distribution Systems and BCT/E testing. Contact Joe Thomas, (303) 978-9770.

June 7-9: Space and Telecomm Inc.'s annual symposium, Albert Thomas Convention Center, Houston. Contact (713) 225-1950.

June 10-12: Institute for Advanced Technology seminar on local area networks, IAT Training Center, Washington, D.C. Contact (800) 638-6590.

June 15-17: Northeast Cable Television technical seminar, Roaring Brook Ranch Resort, Lake George, N.Y. Contact Bob Levy, (518) 474-1324.

June 15-17: Online International's Localnet East exhibition and conference, Hilton Hotel, New York. Contact Carol Peters, (212) 279-8890.

June 15-19: Information Gatekeepers' ISDN/Broadband Networks for the Future, Merchandise Mart and Westin Peachtree Plaza, Atlanta. Contact Renee Farrington, (617) 232-3111.

June 16-18: Jerrold technical seminar on applying problem-solving technology, Chicago. Contact Jerry McGlinchey, (215) 674-4800.

June 19: SCTE Heart of America Meeting Group seminar on BCT/E Category II—Video and Audio Signals and Systems, Holiday Inn Sports Complex, Kansas City, Mo. Contact Wendell Woody, (816) 474-4289.

June 22-25: Trellis Communications seminar on designing and installing fiber-optic networks, Trellis Training Center, Salem, N.H. Contact (603) 898-3434.

June 23-25: C-COR Electronics technical seminar, St. Louis. Contact Tammy Kauffman, (800) 233-2267 or (814) 238-2461.

Planning ahead

July 20-22: New England Show, Dunfey's Hyannis Hotel, Hyannis, Mass.

Aug. 30-Sept. 1: Eastern Show, Merchandise Mart, Atlanta.

Sept. 21-23: Great Lakes Expo, Indianapolis Convention Center/ Hoosier Dome, Indianapolis.

Oct. 6-8: Atlantic Show, Convention Center, Atlantic City, N.J.

Oct. 18-22: Mid-America CATV Show, Hyatt Regency at Crown Center, Kansas City, Mo.

Dec. 14-16: Western Show, Convention Center, Anaheim, Calif.

AD INDEX

Competing for quality

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

Cable technologists long have appreciated the strategic importance of signal quality; it always has been a part of good service. Now as we become more attuned to competition, signal quality takes on even greater importance—a strategic importance.

There are a number of aspects to signal quality. We can argue for hours over subtle differences between images. But one thing that defies argument is an outage. Outage control is the "necessary but not sufficient" fundamental condition for good signal quality. Once we have outages under control, we can turn our attention to the other aspects of signal quality.

Human perception has difficulty with absolute judgments of video quality. An isolated TV receiver's picture can be acceptable even when it is badly out of adjustment. But relative comparisons are remarkably easy. Even subtle differences are noticeable when many screens are side by side. Color differences between TV receivers are striking when viewed on the showroom floor of a TV dealer. Yet almost any one of the sets seen by itself would be acceptable. So an important principle is that we must be very careful of situations in which the subscriber might be able to make comparisons.

There are three types of comparisons to be concerned about: 1) time-sequenced, 2) side-by-side and 3) to other images. Time-sequenced comparisons are the ones most likely to happen in the home, while side-by-side are salesroom floor situations. Comparisons to other images are the least likely evaluations made by subscribers. Video professionals can be expected to use 35mm film or movie theater images as standards.

The A/B switch

Consider some of the ways in which cable subscribers may have an opportunity for comparisons in time sequence. A current hot topic involves A/B switches. If subscribers use an A/B switch to choose between off-air and cable reception, it is important that they not experience noticeably poorer signal quality on cable. The greatest vulnerabilities occur where the off-air signals are strong and ghost-free. (A *ghost* is a delayed and transformed version of the original image.) Cable signals likewise must be noise- and ghost-free.

There is an unfortunate vulnerability with off-air comparisons. If the off-air signals are very strong and the TV receiver's immunity to direct pick-up (DPU) is inadequate, cable performance may *appear* to be inferior when, in fact, it is the TV receiver's fault. DPU is the susceptibility to interfering signals directly picked up off-air by the receiver's internal circuits because of inadequate shielding. Where local signals are carried "on channel," this interference appears on the screen as leaving ghosted images. In cable systems operating on a harmonically related carrier (HRC) frequency plan, annoying beats between the broadcast carrier and the cable signal carrier result in diagonal bars in the picture. A solution is to add a converter. But this has negative consumer electronics interface consequences.

An extremely damaging situation occurs when we invite a comparison by having an outage. If subscribers see a better picture when they switch to the external antenna, we have shot ourselves in the foot. Subscribers, already irritated over the outage, just may be pushed over the edge, resulting in the loss of subscriptions.

'If subscribers see a better picture when they switch to the external antenna, we have shot ourselves in the foot'

The best opportunity to shine is when the off-air signals are inferior. Good antennas, even ghost-canceling configurations of antennas, can ensure a quality picture at the headend. Good cable practice can deliver it to the home. It would be a mistake not to take advantage of such opportunities to do better than the alternative.

A bothersome side-by-side comparison involves direct broadcast satellite (DBS). The nature of the DBS signal is that it is free of ghosts and very likely to be free of cross modulation products. It is an FM signal, unlike cable's AM. Signal-to-noise can be controlled by the size of the dish and the quality of the low-noise converter. A point of vulnerability is the showroom floor of the TVRO dealer. With a cable feed and a signal from a large dish, the dealer can make comparisons that can be slanted in the TVRO's favor. This also can cost cable a lost subscription. It is important to ensure that cable headend satellite signals are of first quality. Modern consumer-grade TVROs have the potential to produce better pictures than old earth stations that have been maintained poorly.

The most troublesome situation involves the VCR. The number of cable subscribers exposed to this comparison far exceeds any other. When subscribers rent videotapes, they sometimes experience "better video." The nature of the "better" carries important messages for cable practice. Present rental videotapes actually have *less* resolution than broadcast or cable video. Their signal-to-random-noise ratio is not all that different from cable or broadcast video. But they have very little coherent interference. Coherent interference on cable results in identifiable images or patterns in the picture. The interference may be a ghost picked up by the headend antenna.

Another alternative is co-channel interference, the simultaneous reception of two different video images. Cross modulation overlays an image from another channel on the viewed image. Sometimes all that can be recognized from the other channel is the vertical and horizontal blanking bars slowly rolling through the desired image.

Finally, there is a wide range of beats resulting in non-image patterns on the screen: diagonal bars, herringbone patterns or just the appearance of looking at the TV receiver through a screen door. None of these are present in the rental tape, which is popped into the VCR for Friday night viewing.

The really bad news about VCRs is that "you ain't seen nothing yet." "Super VHS" is about to make its appearance in the United States. It will put video on the subscriber's screen that will "knock your socks off." But that's a subject for next month's column. See you then.