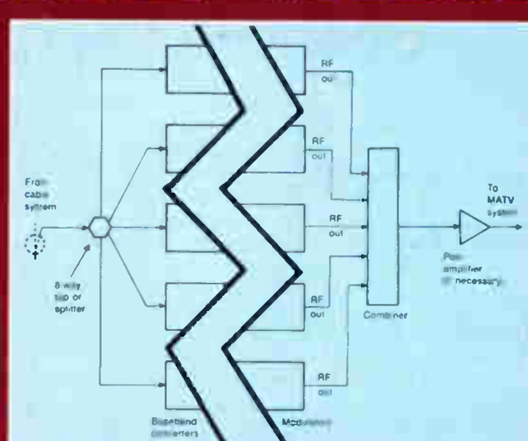
COMMUNICATIONS TECHNOLOGY

Official trade journal of the Society of Cable Television Engineers

Headend planning, setup and maintenance



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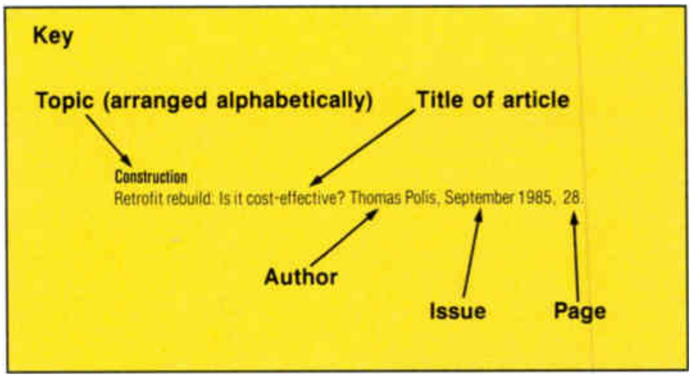

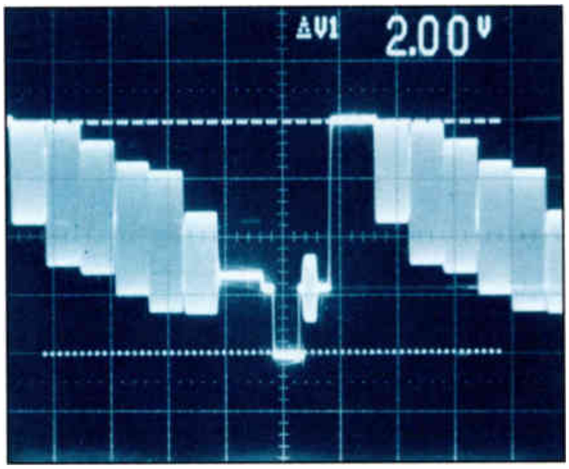

Features

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GENERAL INSTRUMENT

EDITOR'S LETTER

It pays to be prepared

It's still a little early to begin rebuilding or upgrading your cable system, but not too early to think about it. The cable industry presently is standardizing at 550 MHz.

If you're thinking about rebuilding a system to 550 MHz, several factors come into play. According to Ron Hranac, corporate engineer for Jones Intercable, "It goes beyond just having an amplifier with an expanded bandwidth. Not only do we have to consider the performance of the amplifier at that increased channel loading (for example, what effect will the increase have on composite triple beat and carrier-to-noise), but we've got to take a hard look at all of the passive devices in the cable system. That includes the cable, connectors, taps, directional couplers, splitters, power inserters, traps used on subscriber drops, drop cable and even converters."

I also queried Dave Willis, TCI's vice president of engineering, on his views of expanded bandwidth. "While expanded bandwidth provides a lot of channels to select from, it also impacts the quality of service dramatically. The higher the upper frequency, the more inherent problems you have with cable loss, structural return loss of the equipment, signal levels to the home and extra outlets. It creates a lot of problems," Willis stressed, "and definitely impacts the cost of the system. So it ultimately impacts subscriber rates."

Austin Coryell, vice president of engineering for ATC, offered his ideas on the subject. "My personal opinion is that you build a system with equipment that provides what you need for your particular applications. From the chamber tests we've run so far on 550 MHz systems," he explained, "we've found a lot of temperature variations. The manufacturers still have some work to do on temperature compensation, equalization, etc., to maintain a flat response across the whole spectrum from −40 to 140 degrees."

The upside

John Kurpinski, plant manager for Wade Communications Partnership, is an end-user operator currently building a section of Philadelphia at 550 MHz. "The original proposals to build the city were all with dual cable," stated Kurpinski. "The city finally realized that in a major metropolitan build a dual-cable system was very expensive and they didn't need all that channel capacity. It's much cheaper," he added, "to build a 550 MHz single-trunk, single-feeder system. It solves the channel capacity problem and it's much more economical to build."

Finally, I spoke to Keith Weil, manager of products and marketing for Magnavox, which offers a 600 MHz integrated subscriber/institutional system called Isis. "The Isis system allows a cable operator to operate both entertainment and data communications on the same coaxial cable," Weil said. "In many systems you find both a data communications cable and an entertainment cable. It's very costly to construct two cable systems. The data cable," Weil emphasized, "doesn't necessarily mirror the entertainment cable. You might have 1,100 miles of entertainment and 300 miles of data. Our system allows an operator to integrate both onto a single cable. It's a bidirectional system." Magnavox's Isis approach currently is being used in Queens, N.Y.

By utilizing 550 or 600 MHz you will end up with about an 82-channel system. How many channels can you actually load up on an 82-channel system without duplicating a lot of what you are already carrying? Not many.

This is the niche where data comes into play. The more expanded bandwidth you have, the more data can be carried. It's entirely conceivable that an operator can build a 550 or 600 MHz cable system, load it up with 50 or 60 channels, then use the frequency space above that to carry data.

So, be prepared. If you are thinking about rebuilding or upgrading to a 550 MHz system, keep in mind you will need to evaluate your current equipment from A to Z. Presently, passives are being manufactured for expanded bandwidth. These developments also have led to different kinds of cable being developed for lower loss, a main consideration when you use frequencies at 550 and 600 MHz. The result is that you'll be able to offer more, but with more electronics causing more inherent signal degradation, requiring more power, more maintenance and more expense.

The reality is that more may be better as far as service capability to the subscriber, but more is not necessarily better as far as service quality or system economics are concerned.

Just for you

As promised last month, this issue contains "*CT*'s index of articles," which lists all articles and columns run in the magazine since its inception in March 1984 through October 1986. We've categorized and cross-referenced them by topic, and an article may appear in more than one topic category. Also, the articles are listed in reverse chronological order, so the most recent technology and information can be found at the beginning of each topic entry.

All this listing and categorizing took a great deal of work and created at least a dozen gray hairs on our editorial staff. If you have a comment or suggestion about the index, please pass it along. Also, if you see something of interest and wish to find out about back issues, don't hesitate to contact us, we're here to serve.

Toni J. Barnett

COMMUNICATIONS TECHNOLOGY

Official trade journal of the Society of Cable Television Engineers

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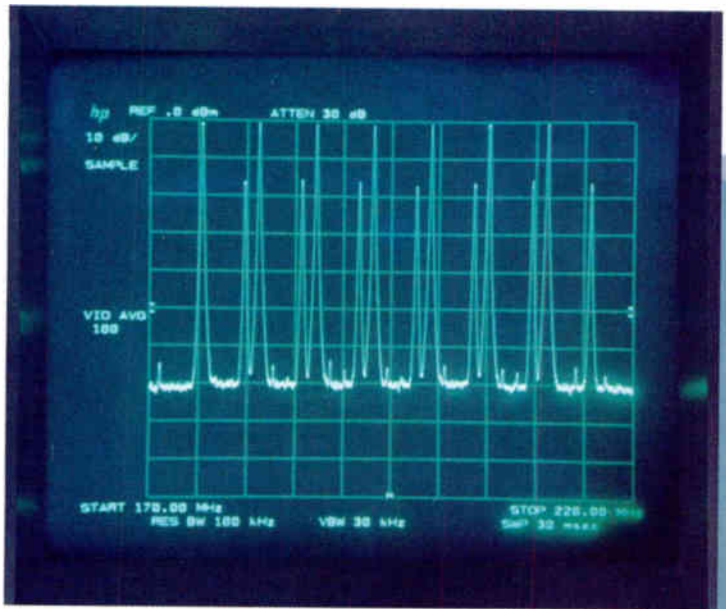

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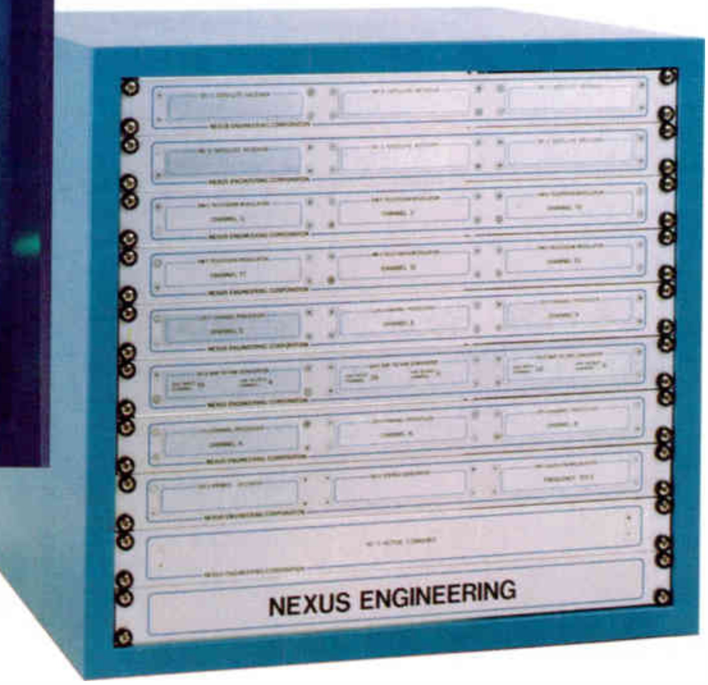

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Composite triple beat:
−60 dBc
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Western Show: 'Right Connections'

ANAHEIM, Calif. — The 18th annual Western Cable Show, to be held Dec. 3-5 at the Anaheim Convention Center, is expecting over 7,000 attendees and 165 exhibitors to provide "the right connections" for the industry. This year's technical sessions once again will be coordinated by the Society of Cable Television Engineers in cooperation with the Western Show.

A brief agenda of the show is as follows:

Tuesday, Dec. 2

3-6 p.m. — Pre-registrants may pick up registration packets at the convention center

Wednesday, Dec. 3

8 a.m. — Registration opens

8:30 a.m.-5 p.m. — Technical sessions

10 a.m.-6 p.m. — Exhibits open

1-2:30 p.m. — Welcome and keynote panel

2:45-4 p.m. — Breakout sessions

4-6 p.m. — Cocktail party in exhibit hall

Thursday, Dec. 4

8 a.m. — Registration opens

8:30 a.m.-5 p.m. — Technical sessions

10 a.m.-6 p.m. — Exhibits open

8:30-9:45 a.m. — Breakout sessions

10-11:15 a.m. — Breakout sessions

11:15 a.m.-12:45 p.m. — Exclusive exhibit hours

12:45-2:15 p.m. — Luncheon

2:30-4 p.m. — Breakout sessions

4-6 p.m. — Exclusive exhibit hours and cocktail party in exhibit hall

Friday, Dec. 5

8 a.m. — Registration opens

10 a.m.-3 p.m. — Exhibits open

8:30-9:45 a.m. — Breakout sessions

10-11:15 a.m. — Breakout sessions

11:15 a.m.-12:15 p.m. — Exclusive exhibit hours

12:15-1:30 p.m. — Luncheon

1:45-3 p.m. — General session

3-4:15 p.m. — Roundtable sessions

A more detailed technical agenda will appear in next month's *CT*.

Jerrold introduces Quadrapower

HATBORO, Pa.—The Jerrold Division of General Instrument Corp. has introduced what it describes as a more efficient method of cable television signal distribution, called Quadrapower. It uses a process whereby two power-doubled ICs are placed parallel in the output stage of the bridger or line extender.

The company says the new technology, which is being placed into use in Jerrold's "X" series bridger amplifiers and line extenders, produces a 5 dB distortion improvement over standard power doubling technology, and a 10 dB improvement over conventional designs. As well, additional unique circuitry allows equipment to run at higher output levels — for a full 550 MHz channel loading — than previously obtainable with feedforward equipment.

Quadrapower components have been ordered for use by American Cablevision of Queens, N.Y.; United of Baltimore; and Comcast in Philadelphia.

S-A, Times Fiber to sign production pact

WALLINGFORD, Conn.—Scientific-Atlanta Inc. and Times Fiber Communications Inc. announced the signing of a letter of intent to combine the engineering, marketing and manufacturing capabilities of both companies for the production and sale of coaxial cable products.

Under the agreement, which is to be concluded this month, Times Fiber will take over S-A's coaxial cable manufacturing facilities in Phoenix, Ariz., and will manufacture coaxial cable products for sale by Scientific-Atlanta. S-A, in turn, will add Times Fiber's full line of RF transmission cable to its CATV product line.

S-A to supply TCI interface product

ATLANTA — Scientific-Atlanta Inc. recently received an order to supply several hundred thousand units of a new on-premises CATV subscriber interface product to Tele-Communications Inc. The product is designed to remove cable electronics from inside subscriber homes and attach it to an outside wall of the house in a tamper-evident enclosure.

The product is said to contain a more secure positive trap technology developed by S-A specifically for this application.

- Compu-Cable Systems Inc. has moved to larger facilities at #6 301 45th St. W., Saskatoon, Saskatchewan, Canada S7L 5Z9, (306) 934-6884.

- Passive Devices Inc. has relocated its office and warehousing to 5120 N.E. 12th Ave., Fort Lauderdale, Fla. 33334, (305) 493-5000.

A day in the life of a chief engineer

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

John Q. Solomon, C.E., arrived at his office earlier than usual, inspired to action by last night's MBA class — dress sharp, inspect your troops at dawn and clear the desk for action! He did remember to put on his new yellow "power" tie matched to his best striped suit, but no breakfast, a grudging sendoff by his grumpy mate, more latecomers than ever at the sign-in sheet, and the sight of his desk buried under its load of unread literature, unanswered mail and incomplete technical proposals, quenched the high from the previous evening.

"Nothing will stop me," he muttered through clenched teeth, and swung into action. A notice was promptly posted on the engineering bulletin board: Lateness will result in the loss of your reserved parking space and the transfer of your car permit to the overflow lot two blocks away.

The desk was attacked with equal vigor. All unanswered correspondences more than a month old were thrown away, his young lab engineer was handed all the unread magazines and told to prepare summaries of the best high-tech articles. All other tasks were assumed by his secretary, who was to reply with one of these three themes: he's out of town, in a conference, or write again with more details.

Finally, by mid-morning, resplendent in his new tie, seated at a clean desk, he was ready to work his MBA magic and amaze his associates with the new John Q. Solomon. The first problem was at hand — where to spend his next vacation? The phone rang and his secretary announced the arrival of Jim High-pressure, the vice president of sales from the Milton Cable TV Supply Co. "He says to tell you he is a Greek bearing gifts." "Show him in," was the reply. "John, have I got a deal for you," enthused Jim. "We just took on a line of new passives made in China at 16 cents hourly and we can fill your orders at half the regular price starting in six months if you cooperate." "What do you mean, cooperate," warily asked John. "We want you and your family to take a first-class trip to China for a couple of weeks to inspect the new plant and consult with their engineers, all of whom are recent Ph.D.s from MIT. There's a little extra bonus of a new dining room table and chairs made of mahogany inlaid with jade! I need a quick OK because Ralph at TTT is dying to go if you say no." "You'll hear from me tomorrow," promised John. (How would you answer?)

No sooner had Jim departed than the phone rang again. It was Montgomery Morgan III, chief counsel of the firm. "Remember the case of the lineman's electrocution in Wyoming?" "Vaguely," replied John, "that was sometime ago and a long way off. I thought we explained it was negligence on his part." "Well, think again, and you had better be able to prove your words in court, we are being sued for improper training leading to his death and you are going to stand trial. The penalty could be in the millions for the company and a potential six month jail term for you." John mumbled weakly into the phone, "Is the company going to defend me?" "We hope so but our liability insurance was cancelled recently and we may not be covered."

If that wasn't enough, marketing called next. "We have a tough situation in Mountain Top City and you may have to join me there this week." "Not another field trip in the boondocks," groaned John, who never relished visiting the small systems they kept on short rations. "They only have one tech and we have to save him or they will never find another willing to work in that *!*! spot." "What happened?" "Headquarters' surprise audit found he was trading illegal hookups for sex and I'm concerned about subscriber retention and all that." "You're damn right," said John, "this is an emergency only the two of us can handle. Arrange the airline tickets and we'll salvage the tech and the customers. No publicity, not even our families. Right?" "Right."

John called Alice to explain the emergency trip to save a tech but she broke in to deliver her own message: "I hope you remember to bring your tools and test equipment, we're having dinner tonight at my brother's and he wants you to fix the TV you worked on last year. He says you must have done something wrong because it's busted again, and he doesn't want people to think you're a lousy engineer." "Yes, dear." He hung up. That worthless professor of social studies brother-in-law. The only thing that worked around him was his mouth. As for Alice, one of these days, POW! Lucky for her she's married to an engineering type with the lowest divorce rate in the United States.

And John goes to lunch . . .

To be continued . . .

A scramble to scramble: Cable operators on the rack

By Colleen McGuire
Product Manager, Headend Products
Jerrold Division, General Instrument Corp.

The proliferation of backyard TVRO earth stations and SMATV systems during the early '80s caused a dramatic rise in the number of unauthorized pay-channel viewers. As a result, programmers set out to secure satellite signals and protect revenues by scrambling.

Although several scrambling technologies were available, the earliest choice, made by HBO, was the M/A-COM VideoCipher II (VC II). In the time since HBO launched its first tests a little more than a year ago, the VC II has become the de facto standard for satellite TV program scrambling. At least eight major programmers are now using, or actively testing, the system. The VC II system is generally a well-thought-out scrambling system designed to provide for maximum ease of operation.

The biggest concern for a cable operator is the compatibility of VC II with existing equipment. In addition, operators also must wonder whether enough space has been allocated in their headends for the increasing number of descramblers needed. Both concerns easily are addressed.

The VC II scrambling system removes all synchronizing information and inverts the normal video voltage levels, much like typical RF (radio frequency) scrambling systems used in CATV today. Unlike RF scrambling, however, the audio information is digitized and encrypted according to a data encryption standard (DES) algorithm.

This information then is inserted into the horizontal blanking interval of the video waveform. The descrambler is addressed via a system address code also transmitted in the horizontal blanking interval. It is interesting to note that the elimination of the normal audio subcarriers may provide improved carrier-to-noise (C/N) levels as a result of the increased spectrum efficiency.

When HBO and M/A-COM first introduced the VC II system late last year, M/A-COM's technical hotline was flooded with calls about concerns over compatible receivers. As a result, testing was done on many commercial receivers. At this time, most current commercial satellite receivers are compatible and provide the necessary outputs. Several require some modification, either in the field or in the factory. Table 1 provides a listing of those receivers that have been successfully tested by M/A-COM with the VC II system.

Compatibility comes first

In order to operate in a normal CATV system, the VC II descrambler must have satellite receive outputs, including a composite video signal, which is the scrambled waveform unclamped and de-emphasized, and a baseband video input, which is an NTSC standard signal. These two inputs allow the descrambler to operate in both an authorized and bypass mode.

The "authorized" mode indicates that a scrambled VC II waveform is being received with proper authorization information. In this case, the signal must pass through the receiver unclamped and de-emphasized.

Several older satellite receivers did not have this capability and created some confusion during the early months of HBO's scrambling. Receivers often were relocated so that later models, which provided this feature, were placed on scrambled program services.

The "bypass video" mode uses the NTSC standard signal available from the receiver output port, typically labeled "video out" or "baseband video out." Should there be some fault either internally or at the transmit location, the descrambler switches to the bypass mode.

The audio connections of the receiver provide for monaural as well as stereo programming where available. In addition to mono and stereo audio signals, a connection to ground of the language pin — a connection available on the rear panel terminal strip — provides for special applications when a second language program is available. A connection-to-ground will have no effect, however, when stereo services are transmitted. (Typical wiring configurations are shown in Figure 1.)

Although the VC II has a loopthrough feature on its "composite video" input to provide for redundant wiring of the descrambler, it typically is not used. Programmers usually are hesitant to authorize a second descrambler because, without extensive audits, they have no control over where that unit is employed.

Typically, the only adjustment required when installing a VC II descrambler is the "video input" (AGC) gain. With the use of a DC voltmeter, this gain adjustment is achieved via a port available through the rear panel. Complete instructions are provided in the installation instructions.

Figure 1: Typical cable configuration with redundant descrambler

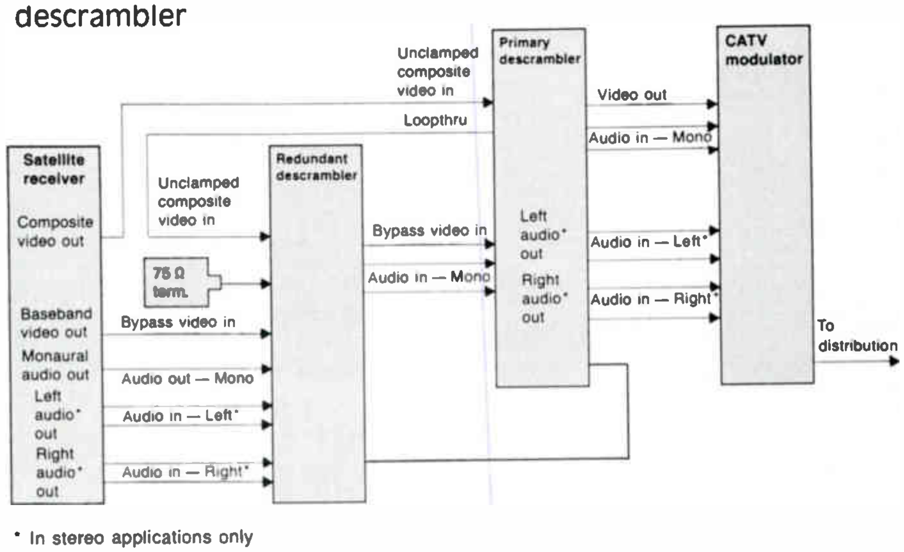
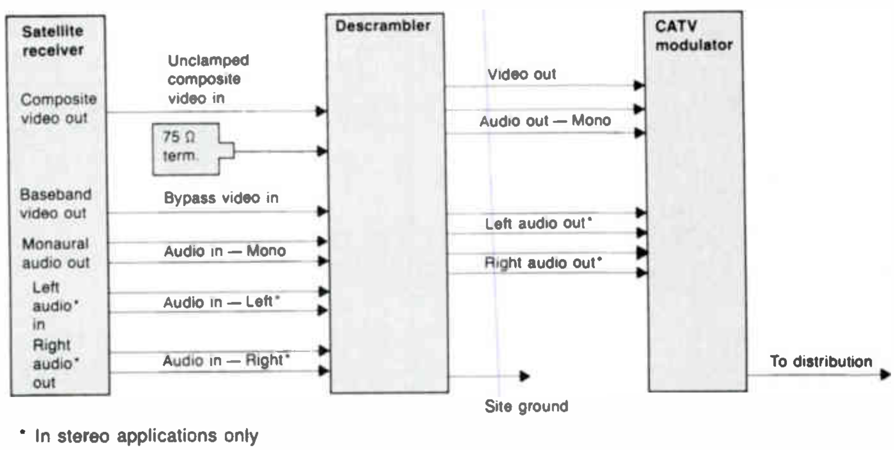


Figure 2: Typical cable configuration with single descrambler



The space problem

Along with receiver compatibility, the physical space requirements may be of concern when incorporating the descrambler into the headend. Rack space is often at a premium for both CATV and SMATV systems. With the advent of such technologies as BTSC stereo encryption, baseband scrambling and ad insertion, headends have become even larger. Where once SMATV operators could put their entire headend in a closet, they now may need to build an addition to house the system.

One VC II descrambler takes a full nine inches of rack space. This same amount of space may, in comparison, have housed up to eight modulators. There is simply no way of getting around the need for more rack space.

In response to this requirement, some cable operators literally have raised the roof. They are building headends with cabinets nine feet tall or taller, as opposed to previous full standard racks that reached roughly six feet. In this way, a limited allocation of floor space may be stretched to accommodate the additional space requirements. In such cases, special care need be taken to ensure the structural integrity of the racks and the proper air flow/temperature.

The good news with respect to the size of the descrambler is that satellite receivers or other rack-mounted equipment may be installed flush with the descrambler because space panels are built into the unit. It was decided during product design that it was much more effective to force proper air flow by providing for this space in unit rather than incorporating an internal fan.

Although VideoCipher II has become the standard in scrambling cable entertainment programming, other systems, such as Jerrold's Star-Lok, Oak's Orion and Scientific-Atlanta's B-Mac are commercially available. None of these scrambling systems are completely compatible with the others. The Oak, S-A and Jerrold systems have been employed in such applications as teleconferencing, data transmissions and private programming services.

To the extent that cable operators become involved with these, or in the emerging pay-per-view services that also use alternate scrambling systems, similar space and compatibility issues may need to be addressed.

Table 1: Compatible satellite receivers

Manufacturer	Model Number
ComTech	RCV-550, RCV-550A
Conifer Corp.	XT 100, XT 200
DX Communications	DSA-643A, DSA-654
Electrohome	S31, E-1, SR-24
Gardiner	GCG-4100, SR-4000
General Instrument	C4R, S412R
Harris	6521, 6522
Hughes	SVR-461, SVR-462, SVR-463
ICM	SR-4650P
ISS	GL-5000*
M/A-COM	VR3, VR3X, VR4, VR4XS, VR3XT
Microdyne	100 DCR/DCR-12, 1100 CSR, *1100 FFC-X1 (S)*, 1100 FCC-X1*, 1100 TVR (X24)*, 1100 TVRM*
Norsat	JR 100, JR 200
Standard Communications	24M, 24S, 24PC, 24SC, Agile Omni
Scientific-Atlanta	6601, 6602, 6603, 6650, 7500, 9530
Triple Crown	TSR-4200, 4000*

*Possible modifications required.

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Reader Service Number 13.

Care and feeding of headends

In the thirty-odd years of cable television, the headend has undergone an amazing metamorphosis. While cable, power supplies and distribution electronics have seen evolutionary improvements to enhance bandwidth, efficiency and noise/distortion performance, headends have sprouted processing and support equipment that could have been foreseen by only the most gifted of the industry's early sages. Even the most basic of today's headends, which are often still on remote mountaintops and pastures, commonly boast two or more TVRO antennas, a multiplicity of off-air receiving antennas and a full complement of baseband and RF processing equipment. This article is aimed primarily toward technicians maintaining such headends by covering some accepted headend (re)construction and maintenance concepts that have proven, in my experience, to enhance reliability and performance.

By Gary Donaldson
Atlanta Regional Engineer, Wometco Cable TV Inc.

It is axiomatic that a headend must be properly situated to be able to work at all. A tower, in a fringe area, that is too short for its ground elevation probably will be inadequate for some or all off-air channels without some extraordinary measures. The same is true of the earth station in a high terrestrial microwave environment or one blocked by physical obstructions. Proper site planning is obviously essential and is usually a compromise between several engineering factors and cost considerations.

For quick and convenient maintenance, the thoughtful planning of the internal layout also is essential, beginning with the anticipation of space requirements for present needs and future growth. How much better off would so many headends be today had their planners foreseen the requirement for VideoCiphers? As in so many instances, "it is better to have it and not need it . . ." Like site planning, though, facility planning is subject to cost and engineering compromises.

The lack of available rack space often comes to haunt headends in the form of cooling difficulties due to stacked equipment. A common guideline is to provide at least one and three-fourths inches (one panel height) of space between equipment in open relay racks and three and one-half inches in enclosed cabinets that have no forced air circulation. Headend expansion often overtakes the capacity of the original air-conditioning. Many of us have discovered that air-conditioning inadequacies have crept up on us in the first hot days of summer when the satellite video receivers begin to drift off frequency.

For redundancy, I favor two moderately sized air-conditioning units (or a single full-sized unit with dual compressors) equipped with low ambient temperature controls to protect them in cooler weather and time-delayed relays to protect the compressor against high-voltage transient surges that are common in the first moments of power restoration after an outage.

What, then, of air-conditioning capacity? Since power consumption can be related to heat, the air-conditioning requirement can be calculated very simply. The mathematics that heating, ventilation and air-conditioning engineers use are:

Btu = watts × 3.41, and
12,500 Btu = 1 ton (of air-moving capacity)

Therefore, simply add the nominal power consumption figures for all of the headend equipment, plus any anticipated load, and multiply by the constant to determine the minimum air-conditioning tonnage. Three to five tons is a common requirement for a 35-channel headend.

Electrical considerations

Particularly in larger headends, it is wise to avoid the situation where one fault could result in the entire headend being shut down due to a single tripped breaker. Therefore, split circuits feeding smaller banks of racks are advisable, with breakers rated at approximately 150 percent of maximum planned load. Many MSOs adhere to the philosophy of incorporating constant-voltage transformers to "smooth out" damaging long rise time high-voltage transients. However, the transformer itself can create havoc if it fails. Bypassing a dead transformer can be very time consuming unless an automatic or manual bypass switch can be activated. Appropriately rated surge protection devices ahead of the transformer are recommended. Several articles have appeared recently on protecting computers and other sensitive equipment.

Inverter-type standby power supplies are quite popular for headends to protect the memories of microprocessor-based character generators and switching equipment. Automatically activated standby generators are very deservedly popular — but a word of caution: Be aware that if natural gas is the fuel of choice, the gas company's commercial customers (which includes CATV operators) will be the first to be shut off in low-pressure situations. Secondary fuel choices are optional with some standby units. Extra standby power capacity is not that much more expensive, so plan to include the headend's lighting and air-conditioning in your standby powering plans.

In headend grounding, one simply cannot overground. From rack to rack, I prefer tinned braided wire rope, #6 gauge soft-drawn copper wire or even wide strips of copper sheet bonded to the AC ground. This in turn is attached to a ground system (by #6 or larger copper wire) that includes 8-foot ground rods (or stacked rods in sandy soil) at the tower legs, all struts of the earth station antennas and the tower antenna downlead bulkhead, all bonded to each other. This system also is bonded for redundancy, back to the ground strip in the AC panel or to the building ground. Standby power supplies, generators and transfer switches also are bonded. This system may not conform to the letter of textbook practice, but I have found that it serves well when followed.

'We no longer can treat the maintenance of the aural portion of our signals with near-reckless abandon'

Equipment layout

The primary considerations in arranging signal processing equipment (including satellite receivers, modulators, demodulators, RF processors, descramblers, encoders, switchers, etc.) are flexibility and maintainability. I have encountered all too many headends that must have been "showcase" pieces of art when brand new, but degenerated into places that even a rat wouldn't call home. All because the original configuration couldn't adapt to change or easy maintenance.

In my view, the type of headend that represents the zenith of inflexibility is one where the satellite receivers and the modulators they feed are paired together. Imagine the scenarios: A program service moves from Satcom to Galaxy, requiring the receiver's RF cable to be rerouted to a different bay. If the service scrambles or requires switching, video, audio and composite video leads must be rerouted to the deciphering or switching equipment before being routed back to the modulator. If the channel assignment is changed, either the modulator is out of the original channel sequence or the arrangement of the satellite receivers must be changed to retain the sequence. In all probability, the neat arrangement of the original wiring would be compromised.

The antithesis of that inflexible arrangement would be a headend with positions for all current and future equipment already laid out and with all RF, video, audio and composite video lines permanently in place, whether in immediate use or not. All satellite receivers and other baseband

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Reader Service Number 15.

sources would be grouped together, as would the processors and modulators, in their channel order.

The satellite receivers would not necessarily have to be arranged in any particular sequence. In fact, as long as the equipment is homogenous (no mixing of, say, LNA and LNB receivers), there would be no need to group the receivers in any particular order. All that is necessary for a flexible arrangement is that the horizontal and vertical RF feeds from all earth stations converge to one spot and are all power divided as needed. On a nearby panel can be bulkhead connectors (F-81s for LNB/LNC systems and female N connectors for LNA systems) that correspond to the RF inputs of all the satellite receivers. A short jumper between power divider and bulkhead connector completes the connection. If a satellite-delivered program service switches birds, simply move that receiver's jumper to a different port.

I recommend the same concept for the interconnection of baseband sources and modulators. In other words, all video and audio lines converge to one spot, arranged in order corresponding to their grouping as sources: satellite receivers, character generators, etc. Opposite this group is a similar set of video and audio lines, arranged in order of their associated modulator's channel assignment. All that is required to complete the connection between the two are video and audio jumpers. Complete flexibility: The entire program arrangement could be changed in short order, simply by rearranging the jumpers. If commercial insertion or other switching is necessary, it then is simple to divert the signals right from that spot to the switcher and back again. Video/audio patch panels are available commercially, but if cost is a consideration, the same can be accomplished with F-81s — or preferably female/female BNCs — and double-terminal barrier strips for the audio (three terminals per line) mounted on panels. Patching inevitably consumes rack space, but the advantages in flexibility are well worth it.

Satellite signal descrambling has made it all the more uncertain how to plan new headends or to rebuild old ones. The only safe route is to assume deciphering on all satellite services. Unfortunately, safe is not always immediately practical. I recommend planning for descramblers in a bank of racks between the modulators and the video/audio patching system. A permanent patching system in each rack for all composite video, video and audio lines would simplify the interconnection of receivers and descramblers, requiring only the rerouting of the interconnecting wiring.

Use of the more reliable BNC-type connector rather than Fs is recommended throughout. BNC-to-F adaptors only complicate matters. When a BNC is called for, use the proper connector rather than a half-breed. Several connector manufacturers now offer solderless crimp-on BNCs that are inexpensive, especially considering the improved reliability.

All the operational flexibility suggested in headend construction to this point is, of course, absolutely meaningless if there is no means to identify all of the wiring. Therefore, all cables should be marked by some permanent logical code at their source and terminus by labels. Markable Ty-rap labels are strongly recommended.

Baseband performance and testing

Ideally, if all the performance and reliability possible were built into a headend, there would be no need for performance monitoring after the initial setup. Ideal situations seldom exist on this planet, so some consideration should be given toward convenient performance monitoring and maintenance.

Video testing is fundamental in modern headends, whether on a mountaintop or the top of a highrise. The quality of a video signal can be subjectively determined by scrutiny of a video monitor. Rack-mounted receiver/monitors are among the most useful pieces of test equipment available. They provide convenient facilities to check video, audio and RF signal quality, act as a universal demodulator and, with pulse-cross option, allow easy scrutiny of the horizontal and vertical blanking intervals. The most convenient use of a monitor occurs when it is paired with a video switcher, through which all video lines are wired before proceeding to their modulators. Without interrupting the signal path, a press of the appropriate switch allows the monitoring of any video signal in the headend.

The television waveform monitor (WFM) soon may find itself indispensible in all headends. There is now available a portable (and relatively inexpensive) digital meter that will give a quick indication of video voltage level, but the waveform monitor remains unchallenged for versatility. All quality WFMs have two inputs, A and B. I recommend that the A input be used for video source testing by looping the signal to be tested (from the switcher, satellite receiver, VTR, etc.) through the WFM to the TV monitor where it is terminated with 75 ohms. *Be very careful to avoid multiple terminations.* The WFM's B input can be connected to the receiver/monitor's demodulated video output for monitoring off-air or combined headend signal quality. In this case, a 75-ohm terminator is required on the WFM's video loopthrough.

Lower-end video waveform monitors are now available with line select options to allow close scrutiny of several VBI (vertical blanking interval) lines containing the vertical interval test signals (VITS). Though a full discussion of video baseband testing is beyond the scope of this article, I will point out that this utility greatly simplifies analysis of virtually all common video distortions. For instance, a broadcaster's transmission of the multiburst VITS waveform can be used to determine fairly accurately that channel's in-channel frequency response of the headend, from antenna to the combining network, assuming a flat response for the test demodulator.

The primary purpose of the waveform monitor remains that of verifying the amplitude of the video signal, which of course should be maintained consistently through the headend at 1 volt (140 IRE units) peak-to-peak across 75 ohms. All video processors are designed to handle video at that nominal level, this being particularly true with scrambling encoders. Any baseband switching will require matching levels to that standard.

A calibrated instrument such as a WFM or an oscilloscope is obligatory for precision alignment of gated sync-suppression encoders. Pulse-cross television monitors are very handy for such work, but since they lack a calibrated graticule (so far), they qualify as just adequate. The instruments also allow easier appreciation of the proximity of the VBI back-porch guard band to the color burst signal. If the manufacturer of your scrambling system can provide you with a calibrated descrambler, try to obtain one. Otherwise, it is possible that your encoder alignment could be to a standard different to what the factory uses to align its production descramblers.

We are beginning to find that we no longer can treat the maintenance of the aural portion of our signals with near-reckless abandon. Up until the present, we have been content merely to provide an adequate audio level to the modulator to allow deviation of the carrier by 25 kHz, set it and forget it. Consumer video equipment is becoming more demanding of audio high fidelity. We now will have to pay more attention to the quality of the signal rather than just its amplitude. This means first paying a bit more attention to the maintenance of audio modulation to provide optimum audio signal-to-noise and distortion to the receiver.

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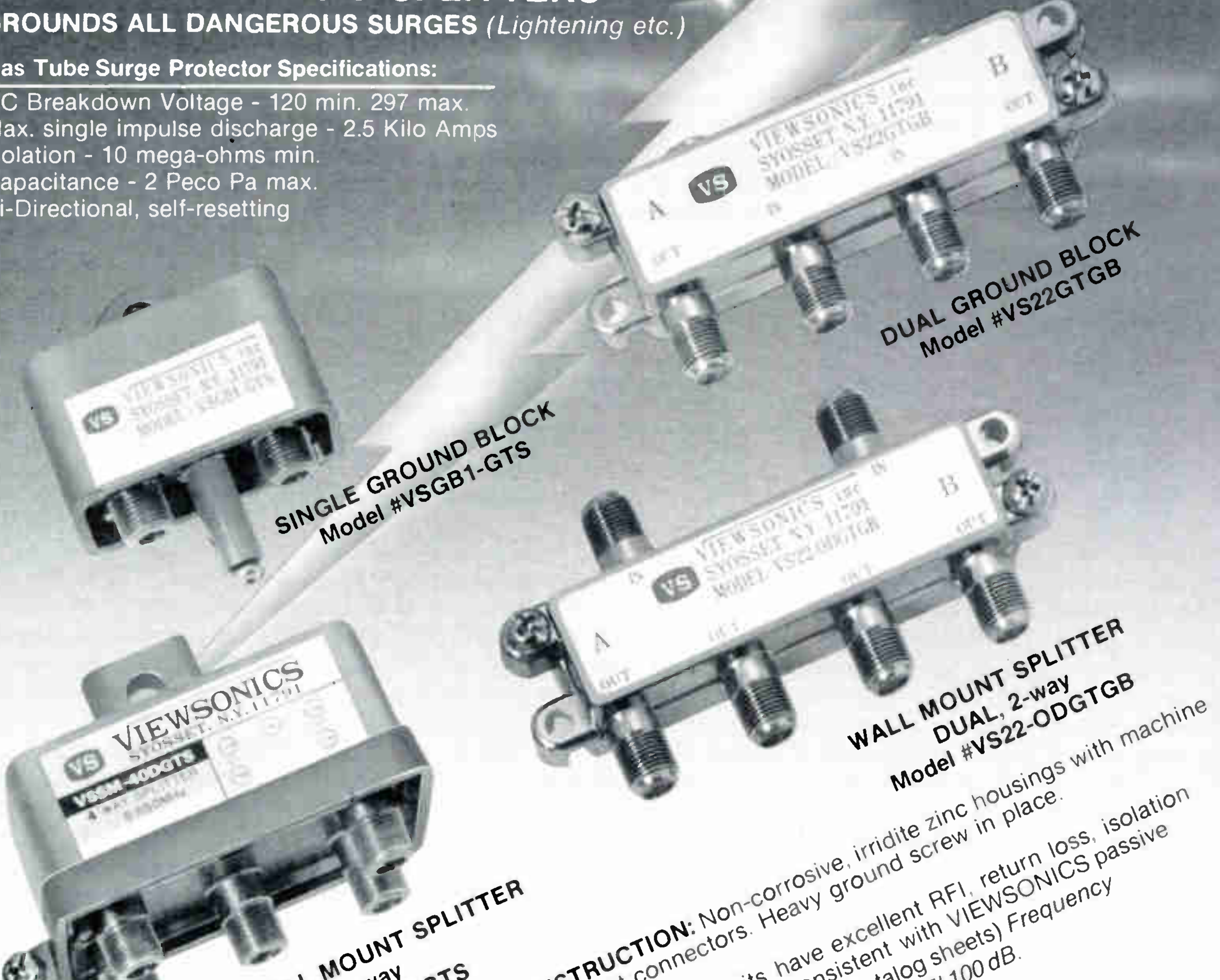

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Subscribers seem perturbed when encountering wildly varying audio volume as they scan through their channels. In many headends, the only visual facility to check audio modulation levels is the little flickering overdeviation lamp. The illumination of this lamp is, as far as I can tell, a fairly accurate indicator of overdeviation, but it tells precious little about *under*deviation. Meters generally give a more reliable indication of modulation, but beware of inconsistencies. Match the audio modulation of the headend as carefully as possible by ear to that of the off-air broadcast standards. If my ear is trustworthy, I find that the meters on some equipment peak well below the 25 kHz mark when set this way.

With the increasing popularity of commercial insertion and other locally originated programming requiring baseband switching, the matching of audio levels becomes very important. As with the video switcher/waveform monitor combination, an audio switcher paired with a VU or other appropriate meter would simplify this task as well improving accuracy.

IF and RF performance and testing

Carrier frequency accuracy is among the most important parameters in headend maintenance, considering the more stringent tolerances specified by the FCC on new aeronautical band channels. The old standard called for a ±25 kHz tolerance of the video carrier from its nominal frequency assignment. The new standard demands a mere ±5 kHz tolerance from the new offset assignments (usually 12.5 or 25.0 kHz, depending on band, from the old channel nominal frequency assignment). Older equipment may have difficulty in maintaining this tougher standard. The 4.5 MHz ±1 kHz tolerance of visual/aural intercarrier frequency remains unchanged.

An accurately calibrated frequency counter is indispensible in today's headend. Models are now available that tune to the carrier of interest, are very tolerant of modulation and give direct readouts of intercarrier frequency. I recommend maintenance of at least a quarterly, if not a monthly, log of frequency readings, particularly for new aeronautical band channels.

The maintenance of processors and modulators at intermediate frequency (IF) in newer headends is thankfully easy — it almost can be forgotten about. Occasionally, equipment will develop faults at or before their IF sections that require diagnosis and correction. For this reason, it is handy, if possible, to have a test demodulator with an accessible IF loop available to insert the suspicious IF signal for analysis. Problems with processors and modulators can be virtually circumvented today due to the availability of tunable modulators, RF (including UHF)-to-IF and IF-to-RF converters (often with the new FCC aeronautical frequency offsets).

Maintenance of the headend at RF remains the most consistent task of the headend technician, as it is here that the performance of the first, and therefore subsequent, amplifiers is affected. A primary consideration when adjusting the level of a headend output converter is that manufacturers design their equipment to be most effective within a certain range of output levels, usually 55 dBmV ±5 dB. Therefore, the RF outputs of the processors and modulators should be padded, if necessary, to remain within this window. The RF input levels to processors and/or demodulators should be logged and checked periodically to track potential deterioration, as should all IF and RF output levels.

Expanded bandwidth headends often consume excess equipment output level in combining losses, making it impossible to maintain optimum equipment and/or headend output levels. I am a firm believer in the philosophy of maintaining headend levels the same as those for trunk. To recover this lost signal, it often is necessary to pad and place the first amplifier(s) in the headend itself. Many engineers do this as a matter of course, as it allows easy access to the most important single amplifier in the system without measurably impacting overall system performance.

Checking, adjusting and logging visual and aural RF carrier levels can be a tedious task, but should be done regularly, preferably weekly, as the performance of the entire system depends on it. Naturally, monitoring of levels should be done with a recently calibrated instrument. If set with a signal level meter, I recommend use of the same meter with which the trunk is balanced (with the same test probe, if applicable).

There can be no more important — and versatile — instrument available to the technician than a quality spectrum analyzer. Many of us have to do without one at least part of the time, or make do with the instruments available. The economy-class analyzers do have considerable utility, however. Properly calibrated, they can make short work of carrier level adjustments, particularly the visual/aural (V/A) carrier ratio. Errors in setting the 15 dB V/A ratio on scrambled channels (those superimposing AM on the aural carrier in particular) can be largely avoided by use of an analyzer.

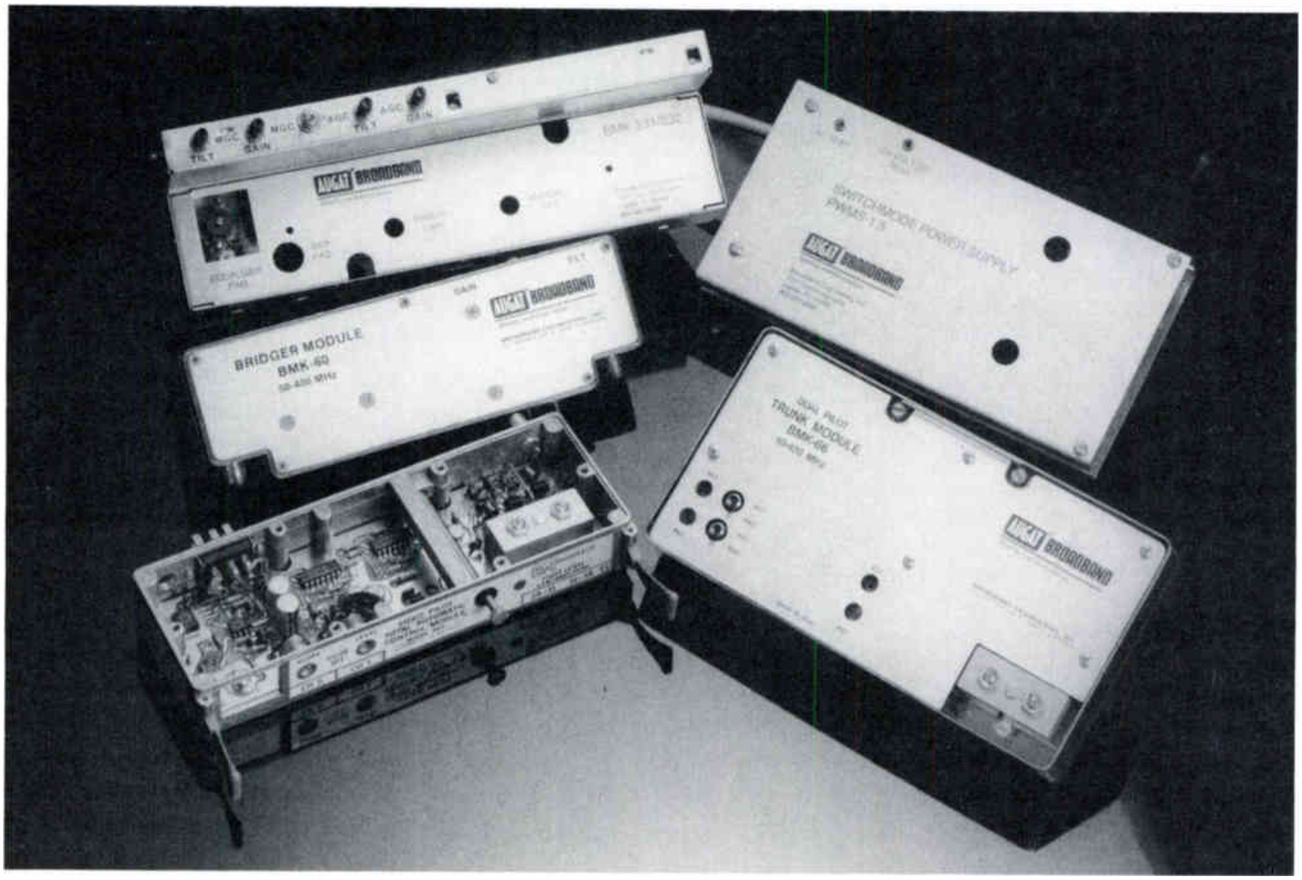
Spurious beats from the headend often can be diagnosed with the least expensive spectrum analyzers, but they typically lack the dynamic range and versatility that switchable IF bandwidths provide in the "Cadillac" models. To my knowledge, there remains no more effective instrument to diagnose and measure off-air cochannel distortion than a quality analyzer. Good and indifferent analyzers also are very effective in peaking satellite antenna OMTs (orthogonal-mode transducers) for minimum cross-polarization isolation.

A high-performance spectrum analyzer also is one of the most useful tools for accurately setting video modulation. After verifying a proper 1-volt video input to the modulator, tune to its visual carrier (even at IF, if more convenient), set the frequency span/division to 0 kHz, the resolution bandwidth to 300 kHz or higher and switch the vertical scale to "linear." Finally, adjust the input attenuation to raise the video waveform display to the top graticule. Adjust the video modulation to bring the peak white flag (assuming a white reference is present) down to the seventh of the eight horizontal graticules (7/8ths = .875 or 87.5 percent). This procedure removes all dependency on questionable meters, displays and blinking lights. The only caution — and this is valid regardless of procedure — be careful not to set modulation too high if a white reference test signal is not present.

Performance documentation

A preventive maintenance program loses virtually all of its effectiveness if proper documentation is not maintained for comparison and analysis. This is true of headends, distribution plant, power supplies or the family car. For instance, the so-called "C/N" meter on many satellite video receivers is not as worthless as many people believe. Once initially set, it can provide insight into the long-term performance of the receiving system — providing that records are maintained indicating its reading at regular intervals.

Conscientious technicians and engineers realize that by logging readings of baseband, RF and IF levels, etc., they provide the tools to improve their system's performance. By logging inspections of the tower, its lighting and downguys; the grounding and bonding of headend, tower and earth stations; and the maintenance of the air-conditioning, etc., not only do they have the data to improve performance and reliability — they cover their asses with paper!



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Reader Service Number 18.

Headend balance and alignment techniques

By Michael L. Wolcott
Senior Field Engineer Scientific Atlanta

One of the major selling points any cable system operator can offer to potential customers is superior quality pictures or other signals. To accomplish this, the cable technician must integrate many different components with varying characteristics. All these players must be kept happy for the total system to perform correctly. Or, as someone once said, "The quality of the headend determines the quality of the entire system."

Many of the adjustments described in this article would apply equally to any manufacturer's equipment, although control locations may vary. Most measurements can be made with common test equipment. Other tests must be made with more specialized equipment to be accurate. Also, any test equipment should be reliable and calibrated to a known standard. Additionally, it is assumed that all headend equipment is operating on its proper output frequencies for video and audio carriers.

To do a complete headend examination, you will need: 1) an oscilloscope with a minimum bandwidth of 10 MHz; 2) a field strength meter or visual signal meter; and 3) a spectrum analyzer. The spectrum analyzer should have a calibrated time base, log/linear selection, and calibrated stepped bandwidth and frequency span per division.

Satellite receivers

Setting levels on satellite receivers in the headend is a good place to start. It is assumed that the earth station antenna is properly pointed and any terrestrial interference filters are adjusted properly. The receiver should be tuned to the desired transponder and adjusted while the desired service is on the air and not scrambled. (Beware! Shared services on the same transponder can and do have different video levels and quality of transmission.)

Set up the scope as shown in Figure 1. If you connect the receiver's video output directly to the scope as shown in Setup A, then you will adjust the video output for a 2 volt, peak-to-peak display. The scope's time base should be set to 10 microseconds per division and the "volts/division" control should be set to 0.5. Adjust the receiver output control for a four vertical division display, top to bottom.

If you use the terminated input setup as shown in "Setup B," then a 1 volt, peak-to-peak signal is desired. The scope's time base still will be 10 microseconds per division, but the volts per division should be set to 0.2. Adjust the receiver for a five vertical division display.

Modulators

Next, modulator levels should be set (see Figure 2). Using the field strength meter, adjust the output RF control for a 55 dBmV video carrier signal, measured at the RF output port of the modulator. If your modulator has a test port, it is usually –20 dB or –30 dB from the actual output level. This port may be used, but be sure you make the appropriate correction when reading the meter. The modulator output also must be terminated. Adjust the audio carrier to its proper level, typically 15 dB below the video level, or 40 dBmV. When all modulators have been set, disregard any imbalance of system levels at the composite trunk output for the moment.

The National Television Standards Committee (NTSC) and the FCC have defined the reference white level in a transmitted TV picture as 87.5 percent modulation. Anything over this could cause problems. The spectrum analyzer is the most accurate method of setting modulation depth. Do not take any manufacturer's "white clip" light or overmodulation in-

Figure 1: Setting satellite receiver levels

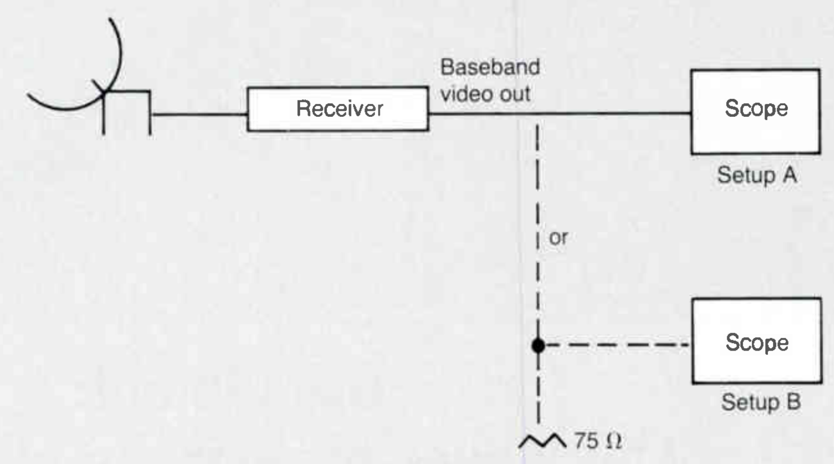


Figure 2: Adjusting modulator levels

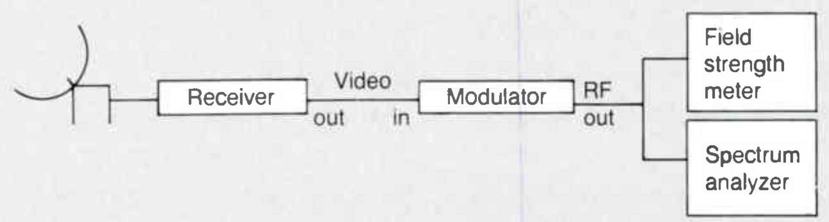
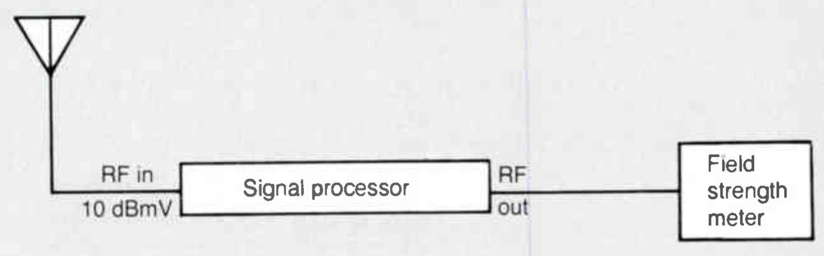
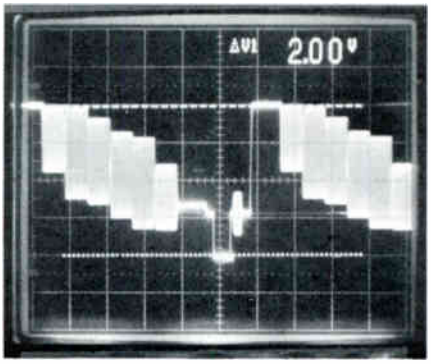
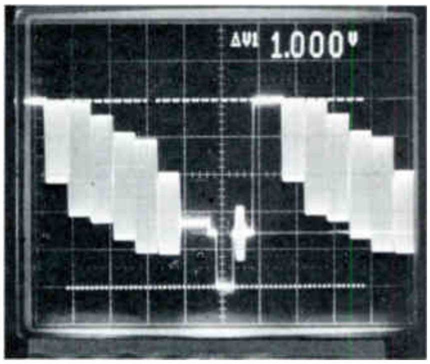


Figure 3: Balancing the signal processor





Color bars as viewed with an unterminated scope input. Scope time/division = 10 μs, volts/division = 0.5 volts.



Color bars as viewed with a terminated scope input. Scope time/division = 10 μs, volts/division = 0.2 volts.

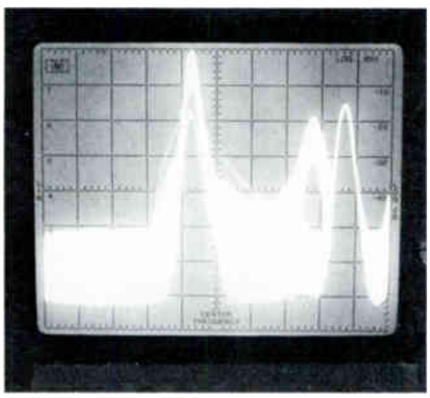
dicator as gospel. Also, if you have any scrambled channels, these measurements *must* be made in the unscramble or bypass mode. Any measurements made in the scramble mode will be incorrect. This also is true when any system signal strength measurements are made.

When using a spectrum analyzer to set depth of modulation, be sure the analyzer is capable of zero scan per division horizontally, has calibrated vertical divisions of 1 or 2 dB and 10 dB per division, has a variable stepped time base, and a stepped bandwidth selector with a bandwidth of at least 300 kHz.

To do the measurement, preset the analyzer's controls as follows:

Time base	0.2 μs
Resolution	300 kHz
Frequency span/division	1 MHz
Log/linear	10 dB log

Center tune the desired video carrier. Set the video carrier eight divisions from the bottom line using the reference level and vernier controls. Switch the frequency span/division to zero. Change the log/linear switch to linear. Use the fine-tuning control for maximum signal and the reference level and vernier controls to set the top of the signal to the reference line.



Spectrum analyzer display showing video carrier, color subcarrier and audio carrier (10 dB/log, 1 MHz/division, 300 kHz bandwidth).

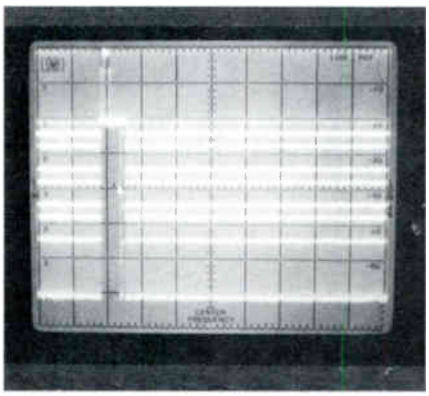
Adjust the modulation depth control on the modulator for a display on the analyzer of seven divisions (counting from the top).

Nothing is more annoying to a subscriber than to change channels and find that the sound is either louder or softer than the volume of the previous channel. Sound carrier overdeviation also can create problems for adjacent video signals.

However strange it may sound, the human ear actually is the best test equipment. Set the modulator's audio deviation control to mid-range. Tune your TV or converter to an off-air station and make mental note of the sound level. Switch the TV or converter to the modulator you are testing. Adjust the audio output control of the receiver feeding that modulator so that the sound strength equals that of the reference station. You may use the modulator's audio overdeviation indicator as a guide, but the ear should have the final say in the matter.

Signal processors

Signal processors are the next units to balance. It is assumed that all off-air antennas are properly pointed, have good downleads and connectors, preamplifiers (if any) are in good working order, and any necessary splitters are installed. Using the field strength meter, or other suitable device, measure the level of the off-air signal at the RF input of the processor (Figure 3). Most processors are designed for the optimum input to be 10 dBmV. Use an in-line attenuator to pad the input signal to this level. If the input signal is less than 0 dBmV, a preamplifier on that channel may be required.



Spectrum analyzer display for depth of modulation. Each major division equals 12.5 percent (linear mode, 0 span/division, 300 kHz bandwidth).

Next, measure the RF output and adjust the video carrier for a 55 dBmV level. Adjust the sound carrier control for a 40 dBmV level (15 dB below video). Disregard for now any variation of the system levels at the composite trunk output. Be certain all modulator and processor input and output connections have been restored to their normal positions. All RF outputs should be at 55 dBmV for video and 40 dBmV for audio (measured at the RF output ports).

Determine your system design levels. Headend levels should be set flat (i.e., the levels of the lowest channel, highest channel and all channels between should be equal) if the first system amplifier is at the headend or spaced a short distance from it. If the first amplifier(s) is/are 15 to 22 dB away, the system levels should be set using the design tilt. Typical levels would be 31 dBmV flat or 31/28 dBmV with a 3 dB tilt, measured at the composite trunk output. Adjust these readings as necessary for the loss of any system test point you may use.

With the field strength meter, look at each video carrier of the system. If necessary, use an in-line attenuator to get the video carrier of the modulator or processor to within ± 3 dB of the desired system level for that channel. Make the final adjustment to exact system level using the unit's RF output control.

It may be necessary to return to your processors. If they have a standby carrier control and/or an automatic gain control (AGC)/manual control, now is the time to adjust these.

Switch the AGC/manual switch to manual. Adjust the manual gain control to equal the desired system level. Return the AGC/manual switch to AGC. Finally, remove the processor's RF input signal and adjust the standby carrier level control to equal the manual and AGC system output level. Reconnect the processor's input signal. Any FM broadcast signals you carry should be equal in level to the Channel 6 audio carrier level. Pad or amplify as necessary.

Now that you have the headend balanced and well-integrated, you may need to tweak the system amplifiers somewhat. Once done, however, you can take pride in your system's signal leaving the headend. You now have balanced video/audio carrier ratios for each unit, have uniform modulation depth and audio deviation, and most important, have assured yourself that RF carrier levels are uniform for all headend channels.

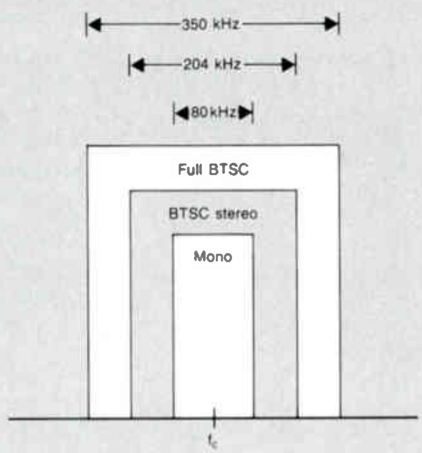
Audio considerations in the headend

By W.J.J. Hoge
Learning Industries

Now that subscribers are buying compact disc players and stereo TV sets, there is a greater demand for good audio quality on cable TV systems. More attention now must be paid to properly maintaining the audio gear in the system. Also, the non-audio equipment that affects the system's audio performance must be kept adjusted to prevent signal degradation.

In the headend, a number of problems can arise if planning and/or maintenance are neglected. Figure 1 shows the occupied bandwidths for a mono TV audio signal, a BTSC signal with stereo only and a BTSC signal with all extra subchannels present. If the IF filters in the heterodyne processor used for the channel have insufficient bandwidth to pass all of the signal, rather nasty things happen. In the best case, part of the signal simply disappears. In the worst case, the distorted signal delivered to the receiver will cause cross talk between the various subchannels. Fortunately, the filters in most processor IFs are "sloppy" enough to work with BTSC. If a demod/remod headend is used, most of the potential difficulties discussed next must be dealt with.

Figure 1: Occupied bandwidth



'There is no technical reason to maintain high average aural modulation'

Audio and the TV modulator

To begin with, be very careful in setting up the aural deviation. The expandor in the receiver will not properly track the compressor in the stereo generator unless the deviation for unity gain in the noise reduction system is properly calibrated. Tweaking the deviation away from the calibration point will result in poor separation. If the stereo generator is properly aligned, the relative levels of the pilot, the L+R subchannel, and the L−R subchannel should be correct. An accurate method, such as Bessel Null, should be used to set the deviation of the aural subcarrier. Once the deviation is adjusted, any further gain changes to make up for program level variation should be done ahead of the stereo generator.

The loudness wars of rock radio are well-known. The "conventional wisdom" is that the loudest signal gets the most listeners. In television, however, most stations in a market try to maintain about the same loudness level. In this case, the conventional wisdom is that a station that is much louder than the rest is considered annoying by the viewers. There is no technical reason to maintain high average aural modulation. The video will be unviewably noisy long before noise becomes an audio problem.

After the equipment is properly aligned, the operational checks are very simple. Here are a couple of tips you can use for quick system checks:

1) If the ratio between the pilot level and the peak program deviation is correct, and if the deviation level is properly set in the modulator, then (with no program modulation) the first sidebands of the pilot signal will be approximately 16 dB below the aural carrier. If you use a spectrum analyzer to look at the aural carrier with no program modulation and these sidebands are at some other level, something is out of whack.

2) Feed one channel only with a 1 kHz sine wave at the peak program level; then, adjust the input gain so that the L+R, L−R and pilot signals add up to a composite signal about 6 dB below full modulation. If you feed the same signal to the other channel and the gain is balanced, you'll get the same result. Now, if you feed the same signal to both channels, you still should have a signal about 6 dB below full modulation. Why? Because the L−R component disappears when both inputs are equal.

The video portion of the signal is handled no differently than you should be handling it now. However, improper operation of the visual portion of the modulator can cause jamming of the BTSC signal. The visual carrier in a TV signal is amplitude modulated. Synchronizing pulses represent maximum modulation, approaching 100 percent, while white signals produce negative-going modulation, approaching 0 percent.

Video modulation greater than 100 percent will result in carrier cutoff during that portion of the video exceeding 100 percent negative modulation. This will produce "splatter" consisting of signal components that can extend beyond the normal visual transmitter passband. Video splatter can produce interfering signals in the aural passband, which can result in a raspy buzzing sound in the receiver occuring at a 30 or 60 Hz rate (the frame or field rate).

Receivers with intercarrier aural detectors are especially sensitive to such interference. This is because the sound detector in such a receiver relies on the presence of both the visual and aural carriers to produce a beat signal at 4.5 MHz for use by the sound detector. If one of the signals disappears, the sound detector produces either noise or no output at all. The resulting output from the receiver with an overmodulated visual carrier is an extraneous sound ranging from a slight, high-pitched rasp to an obnoxious, loud buzzing.

Chrominance information generally does not cause a problem if it exceeds 100 percent negative modulation. These high-frequency signals do not affect the detector in the same way as lower frequency luminance signals. In any event, high chroma levels are rare and do not cause buzz problems unless they become excessive. This does not normally occur with studio scenes, but high chroma levels do occur with color bars, special effects, character generators, etc.

Maximum luminance should be held to no more than 87.5 percent negative modulation. It may be necessary to use video processing or stabilizing amplifiers at the visual input to the modulator. These devices contain peak white clippers and sometimes automatic gain controls. White clippers should be set to limit luminance levels to 87.5 percent negative modulation. If a peak chrominance level control is provided, it should be set to limit chrominance modulation levels to 95-100 percent. Vertical interval signals, such as VIR, VITS, teletext or captioning signals, also may cause buzz. Such signals must be band-limited before they are mixed with the video. That is, they must not contain any signal components that fall in the spectrum near the aural subcarrier. Furthermore, these signals cannot be allowed to cause overmodulation of the visual carrier. This means that data signal levels must be limited to 70 IRE units or less. Some addressable set-top converter systems transmit data to the subscriber's box at levels as high as 85 IRE units. This can cause interference.

BTSC transmission is more susceptible to interference from signals in the 200 kHz band around the aural subcarrier than is monophonic transmission. Spectral overflow from the visual carrier can be minimized by avoiding overmodulation.

However, some video sources — such as character generators — have video signal components well beyond 4.5 MHz. In these cases, we have spectral overflow at the source; such sources *must* have their signals band-limited. A video low-pass filter should be installed on the output of all such sources. Such a filter not only must have appropriate amplitude response, it also must have excellent group delay characteristics. Otherwise, the video will be distorted.

The ear knows

Good audio quality doesn't stop at the headend. Of course, the audio equipment located there must be routinely maintained, but the performance of the system's video and other gear can strongly affect the quality of the sound heard by a subscriber. Thus, good audio requires proper operation and maintenance of the entire system.

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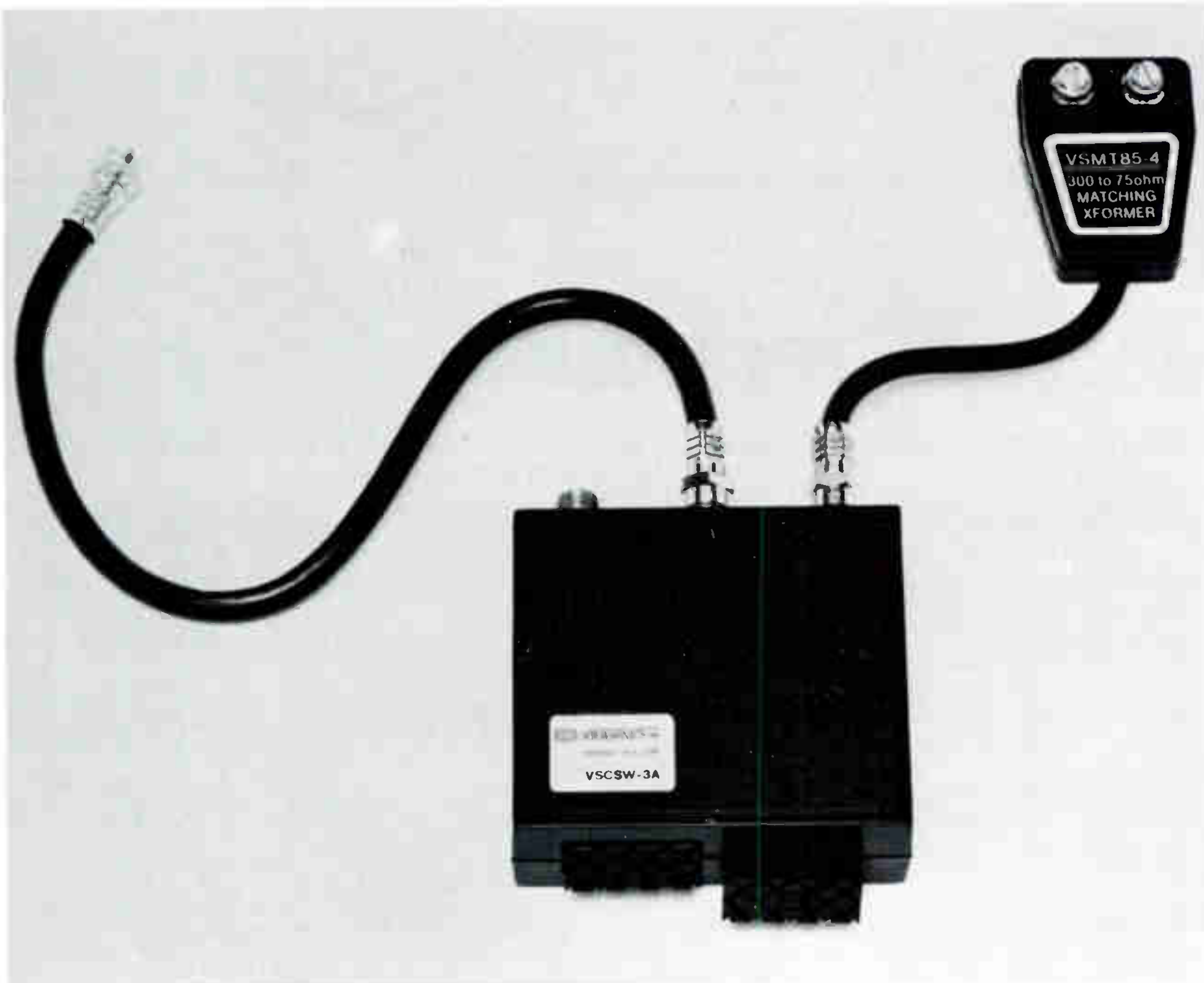

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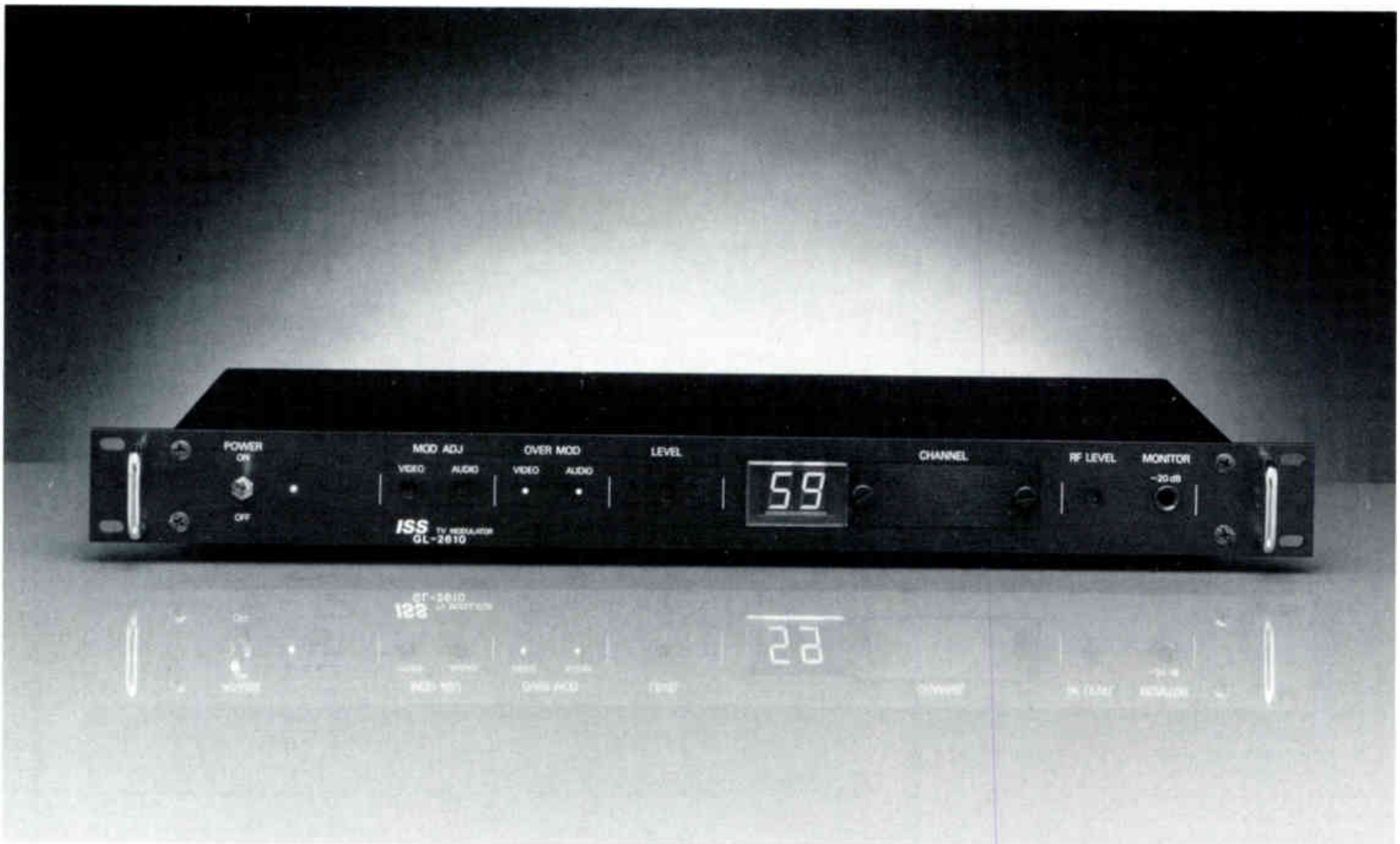

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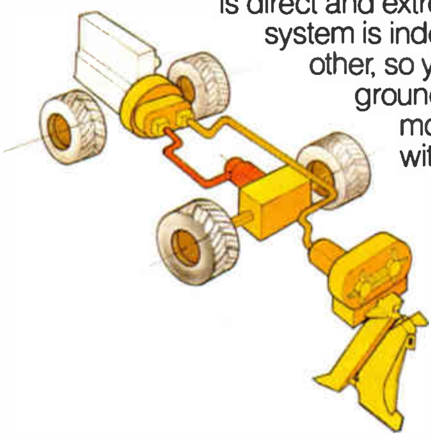

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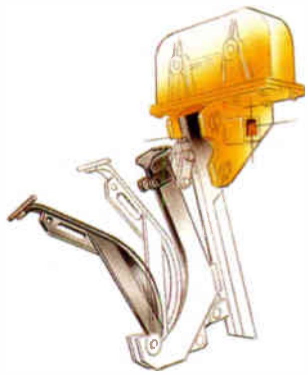

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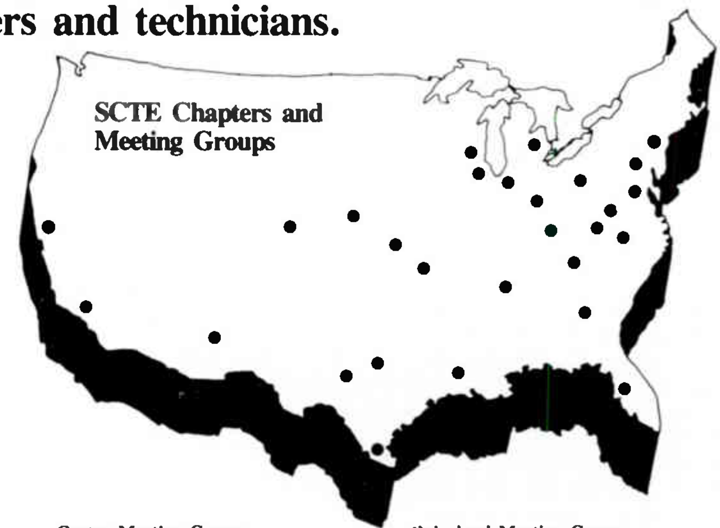

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Customer service, Wes De Vall, March 1984, 50.

Technical IQ—A necessity, Henry Kalina, March 1984, 50.

Training personnel, Roger Seefeldt, March 1984, 50.

Technical handbook

Chapter I: Decibels and dBmV, Ken Simons, April 1984, 44.

Chapter II: The combination of voltage, current or power, Ken Simons, May 1984, 58.

Chapter III: Random noise in CATV systems, Ken Simons, June 1984, 46.

Chapter IV: The fundamentals of distortion in CATV amplifiers, Ken Simons, July 1984, 56.

Chapter V: A mathematical analysis of distortion as it occurs in CATV amplifiers, Ken Simons, August 1984, 35.

Chapter VII: The arithmetic of cascaded trunk-line amplifier systems, Ken Simons, September 1984, 14.

Chapter VIII: Measuring noise, cross-modulation and hum modulation, Ken Simons, October 1984, 50.

Chapter IX: Reducing the effects of reflection in CATV feeders, Ken Simons, November 1984, 64.

Chapter X: Sweep testing of coaxial cable, Ken Simons, December 1984, 42.

Teletext

Successful implementation of CATV teletext, Gary W. Stanton, June 1984, 33.

Terrestrial interference

Frequency coordination or interference suppression?, Glyn Bostick and Patricia Tagg, July 1985, 66.

Tests and measurements

Broadband LAN performance testing, Part I, Steve Windle, September 1986, 59.

(Continued on page 71)

AGC amplifier

Leaming Industries has introduced its Model AGC622 audio automatic gain control amplifier. The product is designed to maintain average program levels within a reasonable range without reducing the dynamic range. It includes a gated-gain compressor and a peak limiter.

The amplifier contains two pairs of left and right inputs (A and B) that may be selected by remote or local control. The stereo synthesizer may be activated by selection of input B (A remains true stereo) or the synthesizer may be enabled or defeated full time by internal programming jumper jacks.

For more information, contact Leaming Industries, 180 McCormick Ave., Costa Mesa, Calif. 92626, (714) 979-4511; or circle #97 on the reader service card.

Fiber-optic meters

Biddle Instruments has announced its Megger fiber-optic power meters for measuring at wavelengths of 850, 1,300 and 1,550 nanometers. A single-scale power meter directly measures power in dBm emerging from either end of an optical fiber link or from any accessible point to display attenuation, splice and connector losses. A three-scale power meter measures optical power levels in dBm, dBr and microwatts.

Both instruments measure optical fibers up to 1 millimeter diameter. They are claimed to be ideal for measuring and identifying good and faulty optical fiber cable on computers, process control equipment, high-voltage monitoring circuits and local area networks. All instruments are battery-powered and feature high-impact plastic cases and LCD digital readout.

For additional information, contact Biddle Instruments, 510 Township Line Rd., Blue Bell, Pa. 19422, (215) 646-9200; or circle #98 on the reader service card.

Cable wrap

A new line of expandable plastic cable harnesses in compact payout boxes is available from M.M. Newman Corp. The Heli-Tube spirally cut cable wrap comes packaged in coiled lengths of 50, 100 and 250 feet. According to Newman, the cable wrap cannot roll and unravel. Materials include clear polyethylene, UV-resistant black polyethylene, fire-resistant white or black rulan, black nylon, nylon and Teflon.

For more details, contact M.M. Newman Corp., P.O. Box 615, Marblehead, Mass. 01945, (617) 631-7100, or circle #85 on the reader service card.

Fiber-optic locator

Radiodetection's fiber-optic cable location system consists of a special purpose transmitter and a high sensitivity receiver. The transmitter is installed conductively in a regeneration station and transmits a low-frequency signal to the next regeneration station. (Maximum distance achieved to date is 60 miles.)

According to the company, lightning protection is not compromised and systems where each splice is grounded also can be accommodated. The cable is given a unique identity by use of an audible pulse code. The locator system also is adaptable for use on systems other than fiber-optic cables.

For more details, contact Radiodetection Corp., P.O. Box 623, Ridgewood, N.J. 07451, (800) 524-1739; or circle #95 on the reader service card.

Jumper cables

Pico Macom Inc. has announced its Model J30-MFF super-shielded, high-flex mini jumper cables. They are designed for 75 ohms to match all RF components and have a .165-inch O.D. that is said to allow neater routing and tying. According to the company, the product is applicable to multi-cable installations where flexibility is required. The high-quality foil and copper braid overlay provide shielding required by CATV.

For more details, contact Pico Macom Inc., 12500 Foothill Blvd., Lakeview Terrace, Calif. 91342, (800) 421-6511; or circle #88 on the reader service card.

Cable designator

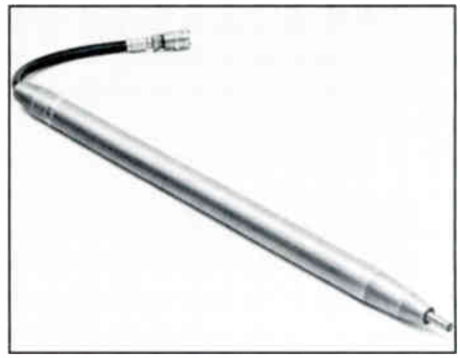
Riser-Bond Instruments has announced its Model 525 cable designator, used for identifying individual cables in a common bundle. The product is said to be able to transmit through taps and splitters, enabling the operator to identify individual cables already in place with all components installed. The test set consists of one receiver and multiple transmitters, allowing the technician to identify up to 10 cables at a time.

For additional information, contact Riser-Bond Instruments, P.O. Box 188, Aurora, Neb. 68818, (402) 694-5201; or circle #92 on the reader service card.

Wire markers

Panduit Corp. has announced its new line of self-adhesive wire markers for use in harsh environments, elevated temperatures or in oily, dirty areas. Aluminum foil markers are said to be resistant to heat, oil, solvents and abrasion; they can be used over a temperature range of −40°F to 900°F (−40°C to 480°C). Acetate cloth markers are used in varnish dip or baking cycles; they do not discolor and they retain legibility after exposure to high temperature. Polyester laminate markers are used in machine tool applications; they offer abrasion resistance and are protected against oil, solvents and dirt.

For further information, contact Panduit Corp., 17301 Ridgeland Ave., Tinley Park, Ill. 60477-0981, (312) 532-1800; or circle #84 on the reader service card.



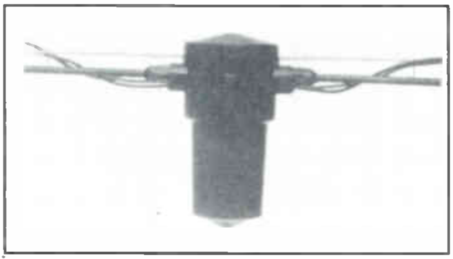
Piercing tool

Allied Steel & Tractor recently introduced its Model 502 Hole-Hog underground piercing tool, designed for laying cable in areas where space is limited. A small, shallow entry pit is needed to launch the tool, which, according to Allied, works best in compressible soils and can operate at depths of 18 inches. With a 2-inch diameter and 40-inch length, the tool is said to form a smooth, compact tunnel at a rate of 4 feet per minute.

For further information, contact Allied Steel & Tractor Products Inc., 5800 Harper Rd., Solon, Ohio 44139, (216) 248-2600; or circle #100 on the reader service card.

Aerial tap enclosure

The Tap Cap aerial enclosure from CableTek is designed to protect taps, traps and fittings from acid rain, salt spray and moisture. According to the company, it protects service from theft better than locking terminators or trap sleeves. Left-hand thread tamperproof screws, along with UV-stabilized outdoor material, make the enclosure secure. All four-way and most eight-way taps fit inside, and the length allows for up to two traps per port.



For more information, contact CableTek Center Products Inc., 850 Taylor St., Elyria, Ohio 44035, (800) 562-9378; or circle #91 on the reader service card.

Cable booster

Reliable Communications' serial cable booster is said to double the usable length of an RS232-C cable by actively receiving and transmitting 12 of the most common signal lines of the RS232-C interface. According to the company, when the cable booster is placed in the center of the cable length and environmental conditions are similar over its entire length, the signal-to-noise ratio will be halved. The unit is data rate and data format transparent, and can be powered from the interface or by detachable power supplies.

For more information, contact Reliable Communications Inc., 10280 Imperial Ave., Cupertino, Calif. 95014, (408) 996-0230; or circle #90 on the reader service card.

Bit error test set

The Digital Instruments Division of Tau-tron Inc. has announced the introduction of its BERTS-1150, a bit error rate test set that addresses digital bit rates up to 1,150 MBPS. It performs total error count, automatic and manual error rate, and clock frequency.

For more information, contact Tau-tron Inc., 10 Lyberty Way, Westford, Mass. 01886, (617) 692-5100; or circle #94 on the reader service card.

Reference guide

Howard W. Sams has published *Digital Communications,* a 448-page guide devoted to communications technologies. Developed as a reference source, it focuses on technological advances in videoconferencing, fiber optics, satellite communications, electronic mail systems, computer-based messaging and other fields.

For more details, contact Howard W. Sams & Co., 4300 W. 62nd St., Indianapolis, Ind. 46268, (317) 298-5409; or circle #93 on the reader service card.

Signal generator

Gaslight Video is offering its Model 8601 NTSC signal generator, which produces composite video output with either full-field color bars or black burst. These two options are selectable from the front panel. Switching between the two signals takes place during the vertical interval.

According to the company, the product is designed for use in small studios or industrial editing rooms where switching from one signal to the other must be easily achieved. The generator is 1¾ inches high and shipped ready for rack mounting or tabletop use. It provides full-time 4-volt composite sync in phase with the composite video output.

For further information, contact Gaslight Video, 281 N. Park Lane, Orange, Calif. 92667, (714) 771-3148; or circle #89 on the reader service card.

Demodulator

Nexus has developed a narrow-band subcarrier demodulator, Model SD-5/N, with extremely low power consumption and inexpensive crystal frequency control, according to the company. The unit accepts two high- or low-level narrow deviation audio subcarriers from the audio subcarrier output of a satellite receiver. The demodulator input sensitivity is said to be internally adjustable to operate with a wide range of receivers.

The product has four output connections for maximum versatility. A loopthrough subcarrier connection provides all associated transponder subcarrier signals for additional audio applications. It is crystal controlled between 5 and 8 MHz and produces two monaural baseband signals.

For more information, contact Nexus Engineering Corp., 7000 Lougheed Hwy., Burnaby, B.C., Canada V5A 4K4, (604) 420-5322; or circle #96 on the reader service card.

Polyurethane to the rescue

By Jack Williamson

A liquid polyurethane developed for rapid repair of bomb-damaged runways may provide a quick solution to the cost and difficulties of burying conduit and small-diameter cable.

Estimates of potential cost reductions compared to conventional trench installation indicated "a savings from 30 to 60 percent in labor costs alone," according to Dan Pike, vice president of engineering, with Prime Cable TV in Austin, Texas.

Prime is the managing partner of Community Cable TV in Las Vegas, Nev., where experimentation with the product and technique is under way, preliminary to winning city and county approvals.

The field testing is being conducted by Simpson & Sons, Las Vegas contractors. Carl Simpson, president and owner of the firm, became interested in the product after reading about its use by the California State Department of Transportation for the emergency repair of asphalt and concrete pavements. (Approval of the product as a pavement patching system also is pending state highway department tests in Ohio, Indiana and Kentucky.)

Compared to conventional cable installation requiring a trench eight inches wide and 18 inches deep, filled with sand and slurry and capped with an asphalt patch, the procedure using the polyurethane material is simplicity itself:

1) A slot two or three inches wide and perhaps six inches deep is cut in the pavement;

2) the cable is placed at the bottom;

3) the slot is filled with aggregate or chips of the paving material that was cut out;

4) the aggregate is flooded with the two component liquid polyurethane.

The material gels in approximately two minutes and can support traffic in less than a half hour.

Called Percol, the product is the creation of ARNCO, a South Gate, Calif., company specializing in the development of liquid urethane products across a wide market area. ARNCO Vice President John Disher describes the material as "a two-component, low-viscosity system that penetrates the aggregate and surrounds the cable. It sets up in a time frame allowing its use on slopes, without excessive runoff, and it can be applied in varying environmental conditions."

Initial development work, as a rapid runway-repair product, was conducted in conjunction with the U.S. Air Force. As a highway emergency patching material, it is produced in two

Model of a cutaway section of street pavement with TV cable encapsulated by the polyurethane product Percol.

forms, one rigid, intended to reconstitute fractured portland cement paving, the other somewhat flexible, to absorb movement between one slab and another. It is the flexible version being studied with the most interest in Las Vegas.

"We put Percol and compacted-asphalt samples in a 60,000-pound press for about two minutes," Simpson reports, "and the asphalt stayed down, about half its initial thickness. The Percol came back to just about its original state."

Tests in an aggregate-filled cut, six inches deep, showed the polyurethane percolating four or five inches to either side below the asphalt. "You drop in a two-inch conduit," Simpson said, "and fill up the top four inches with aggregate and Percol, and with a cut that narrow, you could run a train across it without hurting your conduit."

He pointed out the added advantages of reduced lane-closure times in crossing major intersections. "By the time you get into the second lane, it sets up so quick, you could be running traffic over the first lane. It's a fantastic product."

Disher said ARNCO recommends using washed pea gravel for aggregate, "although we haven't seen the results Carl Simpson reports with asphalt chips, which would be less expensive."

Though for small applications the material can be mixed and poured from a bucket. ARNCO is designing installation equipment incorporating a plural component, gravity-purge, motionless mixer.

Simpson acknowledged that with the cable buried only four to six inches deep, it was subject to being uprooted by periodic pavement repair procedures. "It's going to get ripped up anyway, even if it's down 18 inches and, with the shallower cut, you could replace the cable three times for what the deeper trench would cost you the first time."

"Cable TV is a business," Pike said, "just like any other business. We have to be ever so vigilant for better techniques that will reduce costs and yet still fall in the range of good engineering practice. That's what this is all about."

Jack Williamson is a free-lance writer based in Riverside, Calif.

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parental control, the TZ-PC120 lets your subscribers lock out the sensitive channels they don't want their children to see, without affecting the remaining channels. And thanks to our innovative *Stored Charge Non-Volatile Memory,* parental control channels and other memory functions will not be affected by a power outage. There's also an 18-button infrared remote control. It's compact, controls every function and comes complete with Panasonic batteries.

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The new addressable PC-200 converter.

When it comes to your headend, the new PC-200 addressable converter

can help give you a head start. Downloadable features include channel map, channel authorization, clear parental control, initial activation and emergency alert.

The PC-200 also features 68 channels, a full-function infrared remote control, electronic parental control, favorite-channel recall and two-speed scan.

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For more information, contact Panasonic Industrial Company, Video Communications Division, One Panasonic Way, Secaucus, NJ 07094. Or call:

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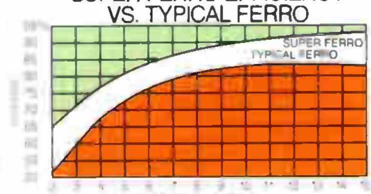

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Wavetek Report 3: LAN Leakage

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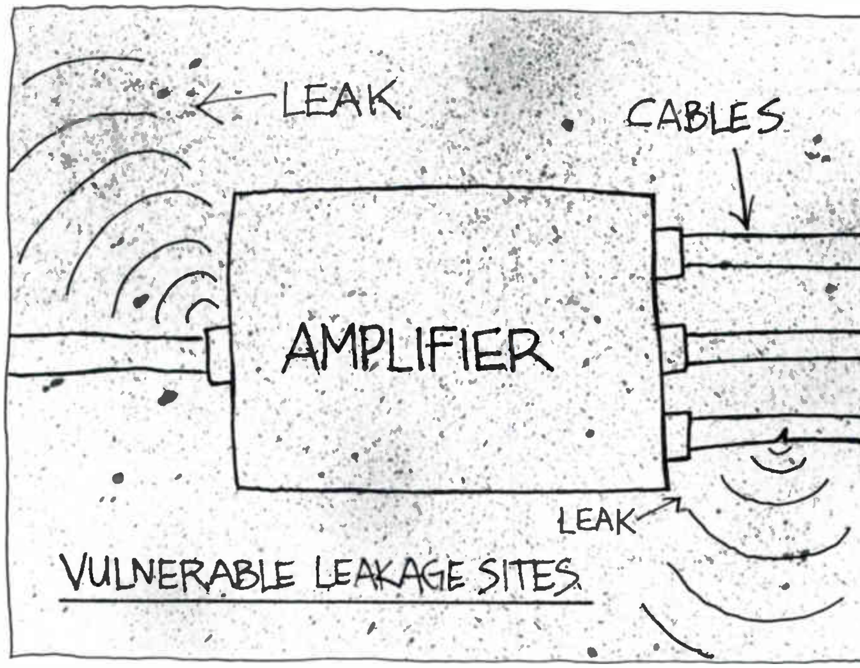

No matter how well it's maintained, every Local Area Network is susceptible to leakage. Yours included.

It's a subtle problem. Often unnoticed. Or unnoticeable. Perhaps even overlooked.

But leakage is serious, nonetheless. With equally serious consequences.

Ingress, in. Egress, out.
The causes are simple. The diagnosis, however, isn't.

Leakage occurs because of a breakdown at any of the vulnerable points. A loose cable. A corroded fitting. A nick in the cable. Usually, something minor enough that won't take the system down.

Which is precisely why leakage goes undetected.

LAN leakage comes in two forms.

Ingress, where data seeps into your system from outside. Or *egress,* where your system is, in effect, broadcasting data that may interfere with airborne or other frequencies.

Big Brother is watching.
Egress leakage has the potential to be the more severe because it often affects off-air, shared frequency services.

Your data leaking out threatens airline communications. It threatens military communications. It threatens emergency communications.

The problem is real. Leakage is a very sensitive issue. One that is attracting more than casual attention from the likes of the FCC and FAA.

Already, the FCC has formulated rules to address CATV leakage. Can LAN be far behind?

If LAN operators don't police themselves now, they'll face potentially severe government regulations and fines. Both very costly.

The threat is real, too.

Good in, garbage out.
Ingress leakage, while not as potentially dangerous as egress, can be costly in its own right.

It threatens the integrity of the system you were hired to maintain. RF energy from outside sources, such as CB radios or other high level sources, seeps into your spectrum. It doesn't belong. It's unwanted. It messes things up.

Transmission error rate increases. System reliability decreases.

User complaints soar.

All of a sudden you've got a problem for which, because of its subtlety, you can't quickly get to the source and correct.

The cure: routine testing.
The best way to prevent leakage is to adopt a program of routine leakage testing.

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Reader Service Number 42.

The interface control point

By Robert E. Sturm
President, Communication Systems Design & Planning Inc

As the types and sophistication of cable television systems for urban areas are changing at a rapid rate, it is difficult for management and engineering operations to plan for all contingencies in a new system or one that is to be rebuilt. A particular area that is difficult to accurately forecast a budget for is the actual cost associated with school district access to the system. This type of access is not a revenue producer and as a result not a great deal of advance planning is spent on it.

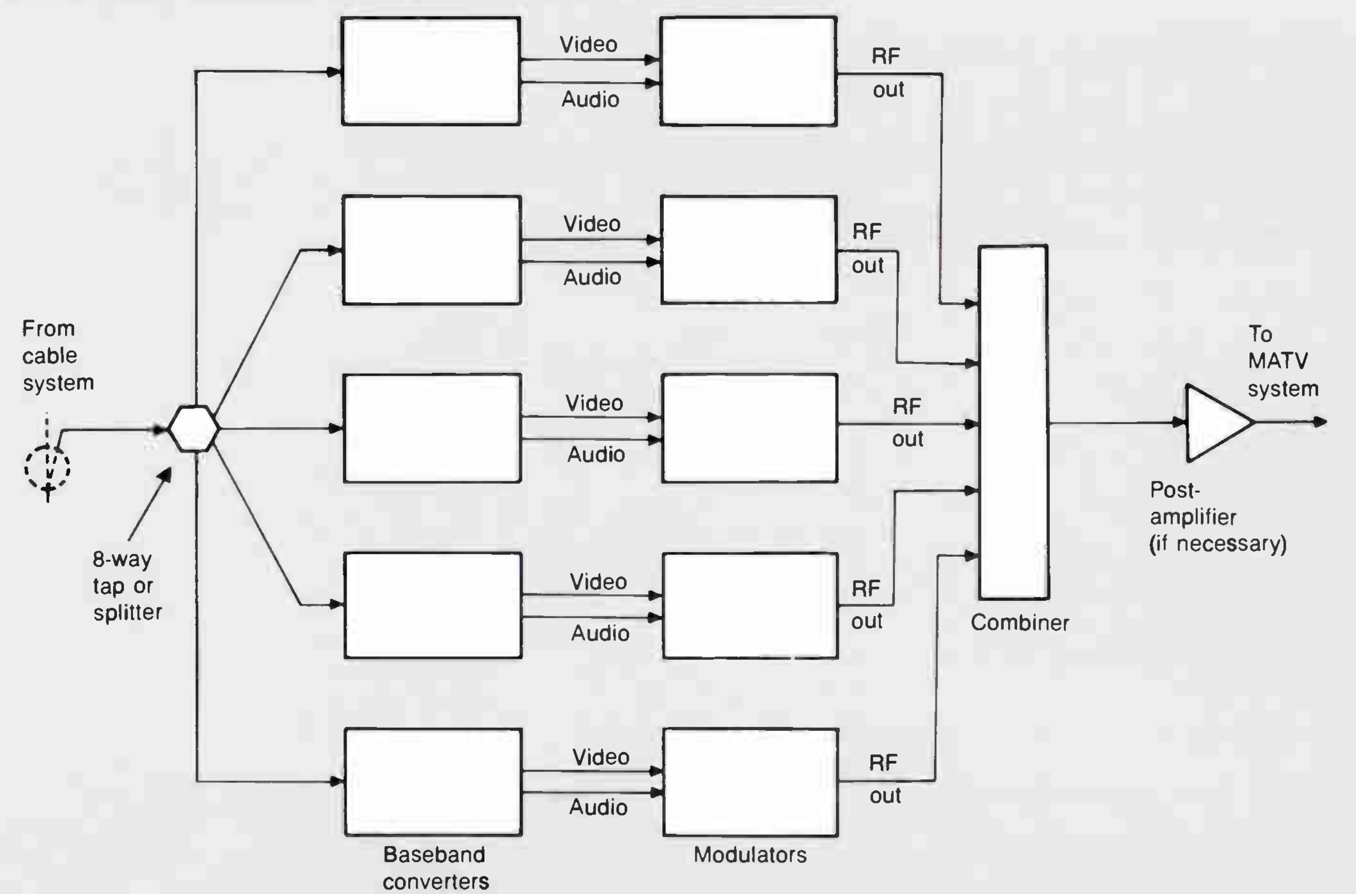
During the franchising or refranchising negotiation process, a number of municipalities have come to expect cable operators to provide service to schools as part of their franchise. Urban systems typically contain a large number of schools. How cable service is provided to schools and classrooms can be very time consuming and costly for the system operator.

The three key factors in the cost of delivering cable television to school classrooms are: 1) wiring of the various outlets, 2) converter costs

Table 1: Cost estimate to provide/maintain traditional service to a school

I. Materials	
One 8-way tap @ $15	$ 15
Five Baseband converters @ $120 each	600
Five VHF modulators @ $350 each	1,750
One Combiner @ $250	250
One Post-Amplifier @ $300	300
Rack and connectors	300
	$ 3,215
II. Labor	
Installation and balancing, 24 hours @ $35/hour	$ 840
III. System maintenance	
10 years, four trouble calls per year @ $35/a call	1,400
Total	$5,455

Figure 1: Typical five-channel cable interface control point



Note: Unused tap port may be used for return injection to cable system.

'How cable service is provided to schools... can be very time consuming and costly'

and 3) installation labor. It is reasonable to assume that a high school in an urban area can contain approximately 60 classrooms, an auditorium, a library, administrative offices and lounge areas for the school staff. There possibly may be as many as 20 televisions that are rotated among the various classrooms via audio/visual carts. Each cart typically will contain a videotape player as well. The auditorium may contain additional sets for student viewing of videotapes, classes that are provided via closed-circuit television or viewing of other major events. Each one of these sets may require a set-top converter to receive cable television programming.

The cabling of 60 outlets plus the additional unique outlets can be a very expensive task and in most instances will require the use of coaxial cable certified for use in a ceiling air return type of environment (i.e., plenum cable). The converters that must be supplied are an additional cost to the internal system. Maintenance of the internal system over the franchise life also may prove more costly than projected. Table 1 is a reasonable cost estimate to provide and maintain cable television in the school model as previously outlined.

Controlling the approach

As Table 1 illustrates, providing cable service to schools can be a very expensive project, not to mention time consuming. Rather than rewiring a building and providing converters for each TV receiver, another method that cable operators may wish to explore is an interface control point approach. This concept has worked well in a number of major urban school applications and if designed correctly offers the school a great deal of flexibility for audio/visual applications.

The cable interface control point utilizes a school's existing master antenna television (MATV) wiring and also eliminates the need for a set-top converter with each television receiver. The control point can be designed for the internal cablecasting of up to 12 channels while still allowing the school access to all cable programming that it has been authorized to receive by the operator. It has been our experience that a five-channel interface control point (Figure 1) is cost-effective for most applications.

The input to the cable interface is provided from a standard directional tap. The tap port outputs provide the inputs to a demodulating device (a set-top converter with a baseband output is a very cost-effective device for this application). The baseband output of the demodulating device then is fed into a modulator for a standard television channel (Channels 2 through 13). The outputs of the modulators then are combined and fed into the school's exisitng MATV wiring. There also may be additional time required to troubleshoot the existing system (the bulk of which is spent tightening up loose connectors).

With the cable interface concept, the building still has access to all of its authorized programming, but only five different cable channels are available at any one time. The school's audio/visual operator only has to change the channel at the set-top converter to acquire a different incoming cable channel for distribution in the school.

An additional channel for building-originated programming also can be added at nominal costs to the school. The school no longer is required to supply a videotape player or videodisc player with each audio/visual cart. Special programming now can be originated at one location within the building and distributed to the classrooms through the cable interface point. The addition of this localized channel may prove to be a revenue source for the cable operator.

There are many fine manufacturers of low-cost components for this type of cable interface. The type of equipment used in this application does not have to meet stringent cable television headend specifications or quality. The system is not transporting 60 television channels to large numbers of subscribers. The interface control point needs only to deliver five channels of marketable quality television to a limited amount of television receivers. Table 2 is an estimate of the cost to build a five-channel cable interface control point.

Table 2: Cost estimate using five-channel headend to provide/maintain service to a school

I. Materials to install drops:	
A. Cable (plenum) 6,000 feet @ $450/1,000 feet	$ 2,700
B. Passive devices	60
C. Active electronics	600
D. Connectors	75
E. Possible power supply	250
F. Miscellaneous installations	
1. Conduits	70
2. Electrical boxes and wall plates	210
3. Fasteners	50
4. Special connectors	50
5. Special molding 1,000 feet @ .35/foot	350
II. Labor to install internal system:	
A. 60 outlets in classrooms @ $35/outlet	2,100
B. 10 special outlets (auditorium, administrative offices, gymnasium, etc.) @ $35/outlet	350
III. Set-top converters	
A. 30 units @ $60/outlet	1,800
IV. System maintenance	
A. 10 years, four trouble calls per year @ $35/call	1,400
Total	$10,065

The use of cable interface control points is not limited to schools or public buildings. Cable managers may want to consider this method for delivering a limited amount of programming to hotels, motels, convention centers and other meeting halls. Once the interface is in place, it is relatively easy to add teleconferencing capability to an internal system, which then may be connected with the major cable system. This inexpensive teleconferencing ability can add to the revenue stream and profitability of the cable television system.

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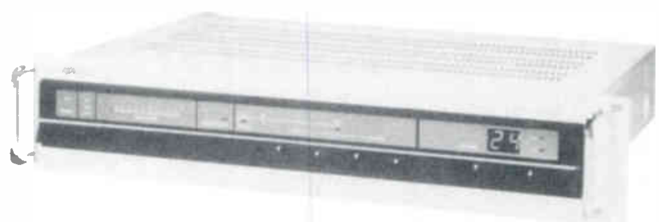

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CALENDAR

November

Nov. 11-13: Jerrold technical seminar, Hatboro, Pa. Contact Joan Thielen, (215) 674-4800.

Nov. 12-14: Magnavox CATV training seminar, Orlando, Fla. Contact Amy Costello, (800) 448-5171.

Nov. 14: Wavetek system sweeping seminar, the Wavetek factory, Beech Grove, Ind. Contact Steve Windle, (317) 788-5980.

Nov. 17: Waters Information Services' data broadcasting technology seminar, Viacom Conference and Training Center, New York. Contact (607) 772-8086.

Nov. 17-19: Magnavox CATV training seminar, Orlando, Fla. Contact Amy Costello, (800) 448-5171.

Nov. 18-20: MIRA Corp.'s product safety seminar, Cincinnati Radisson Inn, Cincinnati, Ohio. Contact (513) 434-7127.

Nov. 18: SCTE Ohio Valley Meeting Group seminar on TV stereo technology, Ramada Inn, Columbus, Ohio. Contact Bob Heim, (419) 627-0800.

Nov. 18-20: Texscan CATV instrumentation training program, Indianapolis, Ind. Contact David Lyle, (317) 545-4196.

Nov. 18-20: Online International's Localnet '86, Moscone Center, San Francisco. Contact: (212) 279-8890.

Nov. 19: SCTE Rocky Mountain Chapter meeting on long-haul microwave and fiber optics, ATC National Training Center, Denver. Contact Joe Thomas, (303) 978-9770.

Nov. 19: SCTE Great Lakes Meeting Group seminar on signal level meters and spectrum analyzers, Hazel Park Community Center, Hazel Park, Mich. Contact John Danekind, (313) 589-2926.

Nov. 19-21: Institute for Advanced Technology seminar on local area networks, Galleria Park, San Francisco. Contact (415) 781-3060.

Nov. 20: SCTE Southern California Meeting Group seminar on system powering, powering supply designs and maintenance, Airport Hyatt, Los Angeles. Contact Joe Girard, (213) 969-0230.

Nov. 21: SCTE Heart of America Meeting Group election of officers and "CATV Technology Briefs," Holiday Inn Sports Complex, Kansas City, Mo. Contact Wendell Woody, (816) 474-4289.

Nov. 22: SCTE Tip-O-Tex Meeting Group BCT/E review course on Category IV — Distribution Systems, Alice National Bank, Alice, Texas. Contact Arnold Cisneros, (512) 425-9111.

Planning ahead

Dec. 3-5: Western Show, Convention Center, Anaheim, Calif.

Feb. 18-20: Texas Show, Convention Center, San Antonio, Texas.

April 2-5: Cable-Tec Expo '87, Hyatt Hotel, Orlando, Fla.

May 17-20: NCTA annual convention, Convention Center, Las Vegas, Nev.

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.

December

Dec. 1-5: George Washington University course on optical fiber communications, Broadmoor Hotel, Colorado Springs, Colo. Contact (202) 676-6106 or (800) 424-9773.

Dec. 3-5: Western Show, Convention Center, Anaheim, Calif. Contact (415) 428-2225.

Dec. 9-11: Center for Personal Development seminar on fiber-optic communications, Arizona State University, Tempe, Ariz. Contact (602) 965-1740.

Dec. 10: SCTE Delaware Valley Chapter meeting on engineering management, professionalism and ethics with BCT/E exam on transportation systems. Williamson Restaurant, Horsham, Pa. Contact Bev Zane, (215) 674-4800.

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

Dec. 12: Wavetek system sweeping seminar, the Wavetek factory, Beech Grove, Ind. Contact Steve Windle, (317) 788-5980.

Broadband LAN performance testing

This is the second in a series concerning test procedures for local area networks (LANs). In September, frequency response testing was covered; this month, testing for carrier-to-noise and hum modulation is explained.

By Steve Windle
Applications Engineer, Wavetek Indiana Inc.

Carrier-to-noise (C/N) and hum modulation are two sources of interference with data communication. As the C/N ratio becomes smaller, communication becomes more difficult. When there is hum modulation, the demodulated signal can be distorted. Following the test procedures described and with the proper test equipment, these forms of distortion easily can be measured and trouble identified.

Carrier-to-noise

C/N is a form of distortion that can inhibit the error-free transmission of data on the broadband LAN. The degree to which the C/N ratio affects communication is a function of the receiving device (instead of a TV, a modem is used). If the C/N ratio is too low, the modem on the receiving end of the transmission may have trouble distinguishing the modulation from the system noise. Each line amplifier used to compensate for system losses adds a fixed amount of noise to the desired signal. If the unity-gain concept of operation for line amplifiers is adhered to, this noise level may be predicted readily.

For the cascade noise figure:

$$NL = NF + 10 \log N$$

where:
NL = cascade noise figure in dB
NF = noise figure of the amplifiers in dB relative to a 4 MHz bandwidth
N = number of identically operated amplifiers with the same noise figure

Simple mathematics shows that the noise level will increase 3 dB each time the number of amplifiers is doubled — a useful troubleshooting rule.

The C/N test is a measurement of a carrier at its desired transmission level, relative to the noise power contributed by the line amplification equipment. This relative value is a component of, but not the total contributor to, the signal-to-noise ratio of the received carrier.

Test equipment and procedure

The test instrumentation needed to measure C/N ideally will have built-in corrections for reading the noise amplitude. One of the corrections is for the difference between the bandwidth (BW) of the measuring device and the measurement standard. The standard for measurement is 4 MHz, related to the bandwidth of a video receiver, but the resolution bandwidth of the measurement device is typically 300 MHz. As the resolution bandwidth of the measuring device is increased or decreased, the amount of noise power detected will increase or decrease accordingly. To compensate for this disparity of bandwidths the following equation can be used:

'The test instrumentation needed to measure C/N ideally will have built-in corrections for reading the noise amplitude'

$$\text{C/N at specified BW} = \text{C/N at measured BW} - 10 \log \frac{\text{specified BW (Hz)}}{\text{measured BW (Hz)}}$$

Another compensation is required for the test instrument's intermediate frequency (IF) filter bandwidth characteristics. In theory, the measurement considers an IF filter with a perfectly rectangular shape, but the real IF filter has a more "haystack" shape. This difference in shape will affect the noise measurement, making a correction necessary.

Peak detector errors also can cause a noise measurement error, since the detector will not provide the true root mean square (RMS) value of the average noise. This, too, makes a compensation necessary.

To measure the C/N ratio on the system, inject test carriers at system levels near the low and high ends of the operational spectrum. With a signal meter or spectrum analyzer, read and record the received carrier level. Remove the carrier or tune the test instrument off frequency. Read the level of noise remaining.

Most Wavetek instruments have built-in compensation for noise measurement errors. When using other test equipment, refer to the operating manual or application note to secure the corrected noise level. The operating manual will give corrections for bandwidth conversions, impulse noise figures and the peak-to-effective noise level.

To verify that the system noise is sufficiently higher than the instrument noise, increase the input attenuation by 1 dB. The displayed noise level should decrease by 1 dB and the C/N relationship should remain constant. If this relationship changes, preamplification and preselection will be needed to perform the test.

The corrected noise level then should be subtracted from the reference carrier level to calculate the measurement value in dB. This process should be repeated at each test frequency. Results of the test should be compared to design specification for compliance.

Keep in mind that the C/N ratio will change 3 dB per doubling of the amplifier cascade in the outbound direction, when the amps have identical input levels and noise figures.

Hum modulation

Hum modulation is defined as the low-frequency modulation of a carrier when passing through an active or passive component of a transmission system. This problem is typically traceable to power supply filter failures in line amplifiers yielding a 120 Hz ripple modulation source (or 60 Hz halfwave rectification in passive devices due to improper solder connections or oxidized connectors). Excessive amounts of hum modulation can increase bit error rates due to demodulation distortion of the data carrier.

The simplest way to test for hum modulation is to use a signal level meter equipped with hum detection circuitry. To perform the test using such a meter, inject a continuous wave (CW) carrier at system levels at the headend. This carrier should be tested to make sure it is free of hum from the instrument that produces it. Proceed to the remote test point and connect the meter to the system. Tune the instrument to the test carrier and select hum function on the meter. Percentage of hum modulation will be displayed on the meter movement.

If the signal level meter doesn't have the hum measurement function, the hum test can be performed (with a more involved procedure) using the detected video output. Connect the scope vertical to the SLM video output with a shielded lead or coaxial cable. The scope case should be isolated from ground to avoid stray hum loops. Set the scope for line sync. Tune the meter to the frequency of the CW test carrier. Disconnect the signal from the RF input of the SLM and align the scope trace with the bottom graticule line of the display. Connect the RF signal to the input and adjust the scope vertical sensitivity so the average deflection of the test signal is aligned with the top graticule line. This calibrates the scope so the unmodulated level corresponds to 10 divisions and the percent modulation equals five times the peak-to-peak variation of the signal. The hum modulation must be relatively severe to be readable with this method (a peak-to-peak variation of 10 divisions would be 50 percent modulation, one division would be 5 percent).

When the hum test provision is available in the test equipment, hum modulation is a quick and easy test to perform and should be incorporated into normal preventative maintenance testing procedures. The acceptance criteria should specify the maximum value of hum allowed on the system.

Next in the broadband LAN performance testing series we will cover intermodulation: cause, effect and measurement.

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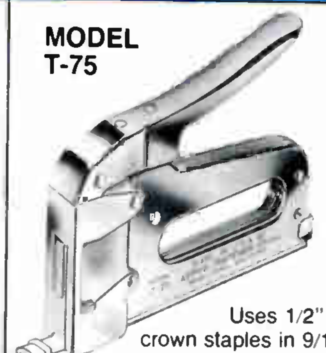

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Converting dBW to watts

By Ron Hranac and Bruce Catter
Jones Intercable Inc.

Conversions between dBW and watts are common in satellite communications. The magic of the decibel provides yet another way to deal with the sometimes unwieldy mathematics in cable television engineering.

The following chart is provided to aid this conversion. The formulas from which the chart was derived are presented on the next page, along with sample problems.

dBW to watts

(reference dBW = 1 watt across 50 ohms)

dBW	watts	dBW	watts	dBW	watts	dBW	watts
−60	0.000001	−30	0.001	0	1	30	1,000
−59	0.00000126	−29	0.00125893	1	1.2589254	31	1,258.9254
−58	0.00000158	−28	0.00158493	2	1.5848932	32	1,584.8932
−57	0.00000199	−27	0.00199526	3	1.9952623	33	1,995.2623
−56	0.00000251	−26	0.00251189	4	2.5118864	34	2,511.8864
−55	0.00000316	−25	0.00316228	5	3.1622777	35	3,162.2777
−54	0.00000398	−24	0.00398107	6	3.9810717	36	3,981.0717
−53	0.00000501	−23	0.00501107	7	5.0118723	37	5,011.8723
−52	0.00000631	−22	0.00630957	8	6.3095734	38	6,309.5734
−51	0.00000794	−21	0.00794328	9	7.9432823	39	7,943.2823
−50	0.00001	−20	0.01	10	10	40	10,000
−49	0.00001259	−19	0.01258925	11	12.589254	41	12,589.254
−48	0.00001585	−18	0.01584893	12	15.848932	42	15,848.932
−47	0.00001995	−17	0.01995262	13	19.952623	43	19,952.623
−46	0.00002512	−16	0.02511886	14	25.118864	44	25,118.864
−45	0.00003162	−15	0.03162278	15	31.622777	45	31,622.777
−44	0.00003981	−14	0.03981072	16	39.810717	46	39,810.717
−43	0.00005012	−13	0.05011872	17	50.118723	47	50,118.723
−42	0.00006310	−12	0.06309573	18	63.095734	48	63,095.734
−41	0.00007943	−11	0.07943282	19	79.432823	49	79,432.823
−40	0.0001	−10	0.1	20	100	50	100,000
−39	0.00012589	− 9	0.12589254	21	125.89254	51	125,892.54
−38	0.00015849	− 8	0.15848932	22	158.48932	52	158,489.32
−37	0.00019953	− 7	0.19952623	23	199.52623	53	199,526.23
−36	0.00025119	− 6	0.25118864	24	251.18864	54	251,188.64
−35	0.00031623	− 5	0.31622777	25	316.22777	55	316,227.77
−34	0.00039811	− 4	0.39810717	26	398.10717	56	398,107.17
−33	0.00050119	− 3	0.50118723	27	501.18723	57	501,187.23
−32	0.00063096	− 2	0.63095734	28	630.95734	58	630,957.34
−31	0.00079433	− 1	0.79432823	29	794.32823	59	794,328.23
						60	1,000,000

Formulas

To convert watts to dBW:

$$dBW = 10\log_{10}(watts)$$

To convert dBW to watts:

$$watts = 10^{\frac{dBW}{10}}$$

Examples

Problem:
A satellite's footprint EIRP (effective isotropic radiated power) in the southern United States is 32.4 dBW. What is its EIRP in watts?

Solution:
Use the formula

$$\begin{aligned} watts &= 10^{\frac{dBW}{10}} \\ &= 10^{\frac{32.4}{10}} \\ &= 10^{3.24} \\ &= 1{,}737.8 \text{ watts} \end{aligned}$$

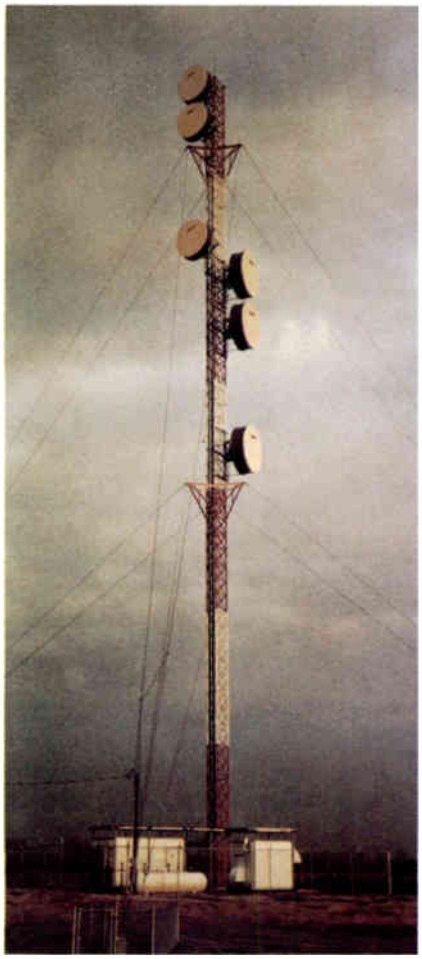
Problem:
An uplink facility uses a 1,000 watt high-power amplifier (HPA) for the final amplifier stage before transmitting to the satellite. Assuming 7 dB of waveguide loss between the HPA and the antenna, and an antenna with 50 dB of gain, what is the uplink's effective radiated power in dBW and watts?

Solution:
First, convert the 1,000 watt HPA output to dBW, using the formula

$$\begin{aligned} dBW &= 10\log_{10}(watts) \\ &= 10\log_{10}(1{,}000) \\ &= 10\,(3) \\ &= 30 \text{ dBW} \end{aligned}$$

Subtracting the 7 dB waveguide loss from the HPA output yields 23 dBW at the input to the antenna. Adding the antenna's 50 dB gain increases this power level to 73 dBW, the uplink's effective radiated power. To convert 73 dBW to watts, use the formula

$$\begin{aligned} watts &= 10^{\frac{dBW}{10}} \\ &= 10^{\frac{73}{10}} \\ &= 10^{7.3} \\ &= 19{,}952{,}623 \text{ watts} \end{aligned}$$



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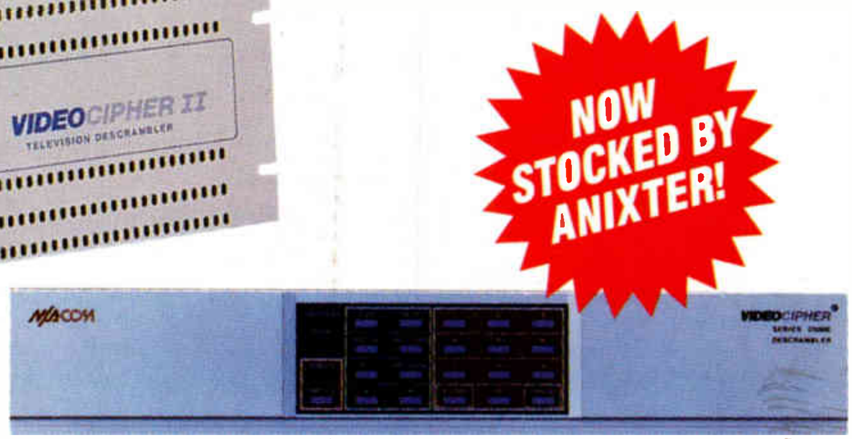

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