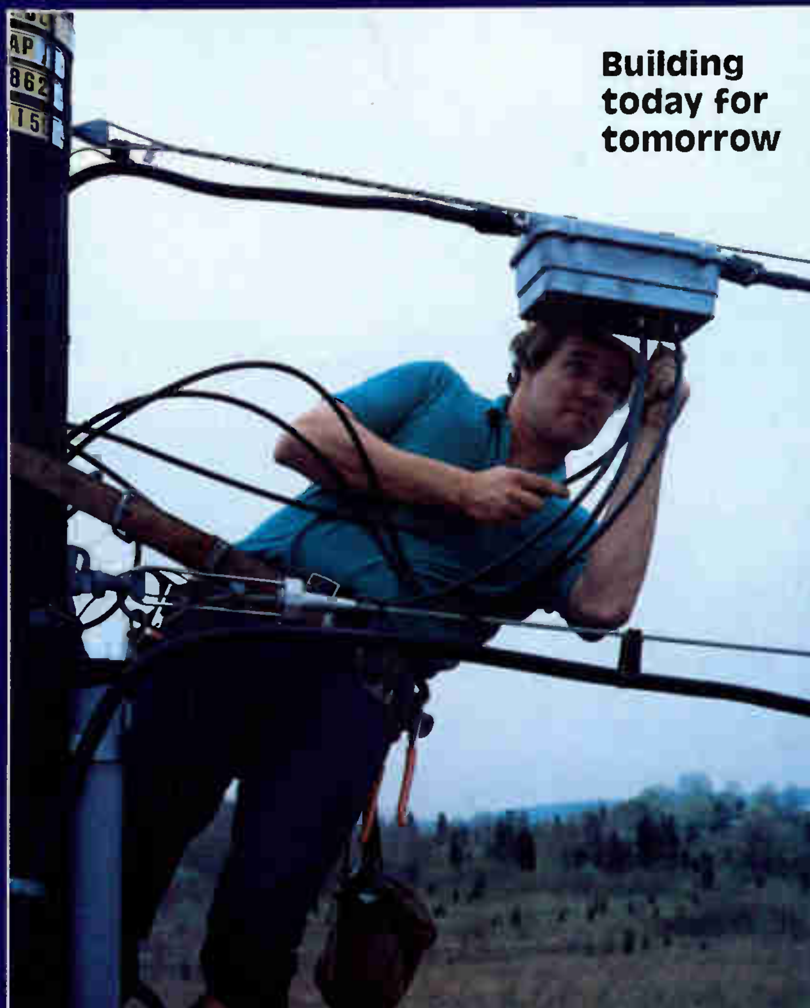
Cable-Tec Expo issue

COMMUNICATIONS TECHNOLOGY

Official trade journal of the Society of Cable Television Engineers



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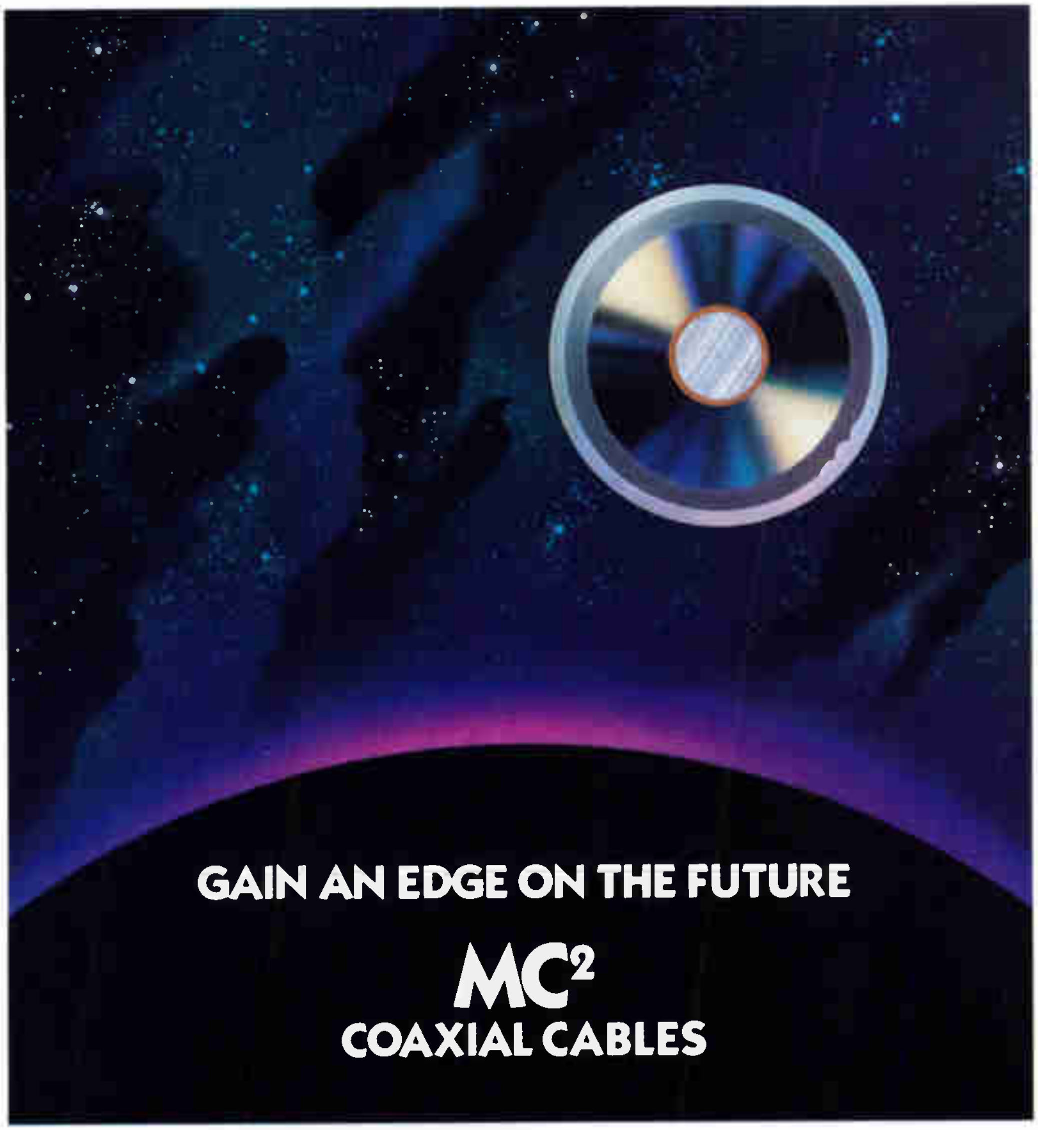
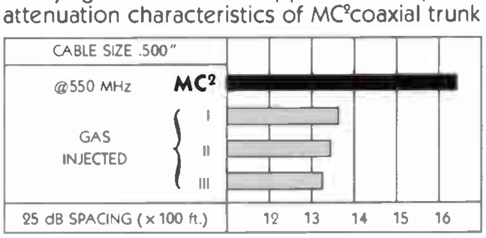


Follow the leader, that's what our competitors are trying to do in order to approach the superior attenuation characteristics of MC² coaxial trunk and feeder cable. But they succeed only by increasing the standard diameters of MC² — our familiar .500" must become .565" or .625"; and our .750" must become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



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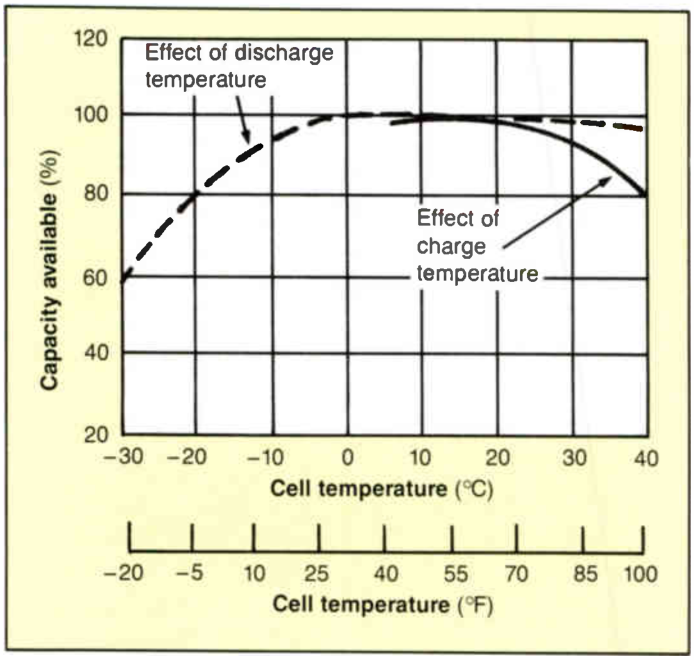

Features

Communications Technology™ (ISSN 0884-2272) is published monthly by Communications Technology Publications Corp., 12200 E. Briarwood Ave., Suite 250, Englewood, Colo. 80112 — or — P.O. Box 3208, Englewood, Colo. 80155, (303) 792-0023. April 1987, Volume 4, Number 2. Office of publication is 12200 E. Briarwood Ave., Suite 250, Englewood, Colo. 80112. Change of address notices should be sent promptly; provide old (or copied) mailing label as well as new address, including ZIP code; allow 6 to 8 weeks for change. Second-class postage paid at Englewood and Denver, Colo. POSTMASTER: Please send address changes to Communications Technology, Box 3208, Englewood, Colo. 80155.

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Your show of shows

Welcome to Orlando! Of all the shows that take place throughout the year, the Cable-Tec Expo is the only one of its kind, aimed directly at the cable TV engineer and technician, where all share the latest in industry technology and techniques. What you learn here you'll be able to take with you and put to use at the office or in the field. That's the beauty of the hands-on kind of experience this expo is.

You may be reading this by the pool or in your hotel room, relaxing after a hard day at the engineering conference or following several expo workshops and exhibits. And, as you sip your drink and wonder when to take in Disney World, you should applaud all the efforts of the Society of Cable Television Engineers, the organization that annually hosts one of the most exciting and informative shows the industry has to offer. At press time, the statistics of this year's expo are impressive: Preregistration is way ahead of last year and the exhibit space already has sold out. Another success.

The ranks of the SCTE have swelled to over 3,300 members strong, a record. And if you—yes, you, Mr. or Ms. Attendee—aren't already a card-carrying member of the SCTE, frankly, I'm surprised. I strongly encourage you to join, not only for your benefit, but for the overall benefit of the industry.

And the winner is. . .

Congratulations to the winner in our essay contest—Dean Owsley of Cardinal Communications. Writing on the subject "How does *Communications Technology* magazine best serve the cable TV engineering community and the SCTE," his entry was chosen from a number of excellent essays. Dean won an expenses-paid trip for four to the expo. (We'll include his winning entry in a future issue of *CT*.) Thanks to everyone who entered.

By the way, if you haven't had a chance to attend one of the expo workshops, there are several interesting ones lined up: "Ku-band technology and TVRO calculations," "A working class on cable system design," "Headend antenna theory and EMI reduction," "Performing measurements on basic test equipment," to name a few. All workshops will run three times on Friday and Saturday mornings.

And let's not forget the SCTE's very own BCT/E Certification Program review courses, as well as testing for Categories I, II, III, IV and VII on the final day of the expo. (For more on the expo, see "News," page 10.)

Quite recently, the board of directors of the Community Antenna Television Association unanimously endorsed the BCT/E Program (see "News," page 10). Endorsements from other organizations are bound to follow.

You may have noticed our presence at the expo, not only with this issue, but with our *CT Daily*. The daily will bring you up to date on the various workshops and action from the exhibit floor. If your company has something of interest to include in the daily, just stop one of our staff at the expo. (Oh, yes, the *CT Daily* is a first for the expo.)

We'll also have a daily for next month's National Show at the Convention Center in Las Vegas, Nev., May 17-20. If your company is unveiling a new product or will have an important announcement to make at the show, be sure to send your press release in to *CT* immediately.

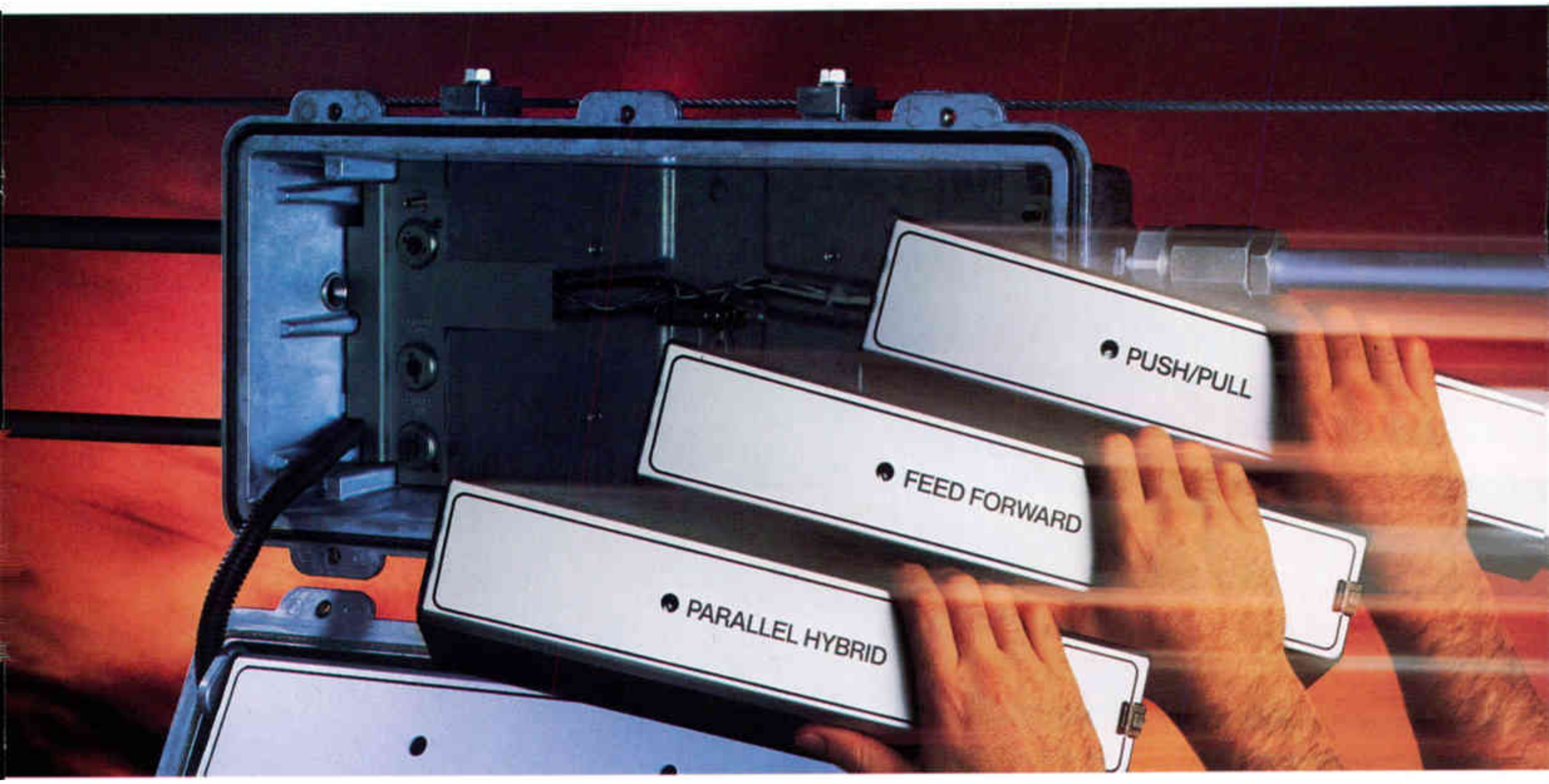
This month, the SCTE welcomes its 32nd and 33rd local meeting groups: the Chesapeake Meeting Group out of Baltimore and the Gateway Meeting Group from St. Louis. All 33 groups are listed, along with their addresses and contact numbers, on page 81. If you happen to live or work in one of the many areas served by the local groups, what are you waiting for? Join, and take advantage of the seminars and other opportunities that await.

Speaking of which, the SCTE is looking for a new director of chapter development. You'll find an ad for this position on page 104. With the number of groups growing all the time, such a director is needed. Hats off to Bill Riker and his staff for addressing this need head on.

This issue of *CT* begins a new column by Dr. Walt Ciciora, vice president of strategy and planning at ATC. What he has to say about where the industry is headed is certain to be thought-provoking. The column appears on page 114.

Well, here's to another eventful and educational expo! Enjoy!

Paul R. Levine



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SCTE announces Expo '87 agenda

EXTON, Pa.—The Society of Cable Television Engineers has announced its official agenda for the 1987 Annual Engineering Conference and Cable-Tec Expo, to be held April 2-5 at the Hyatt Hotel in Orlando, Fla., as follows:

Thursday, April 2 (Annual Engineering Conference)

9:30-10:45 a.m.—"Lightning and grounding," with Dr. Rodney Bent, consultant for NASA

11 a.m.-12 noon—"Consumer interface issues—Making cable compatible," with Robert V.C. Dickinson (Dovetail), Tom Mock (EIA) and Vito Bugliera (Zenith Electronics Corp.)

12-2 p.m.—Membership luncheon; guest speaker Paul Weitz, space shuttle commander

2-3:15 p.m.—"Developing a corporate training program," with Ralph Haimowitz (American Cablesystems) and Roger Keith (Warner Cable Communications), plus roundtable discussion

3:30-5 p.m.—"A technical evaluation of competing technologies—DBS, MMDS, SMATV, VCR," with Sruki Switzer (Cablecasting Ltd.), Andy Bellavia (Zenith Radio Corp.), Jim Clark (Conifer) and Chuck Hewitt (SBCA)

6-8 p.m.—Welcome Reception by the Florida Cable Television Association

Friday, April 3

The following expo workshops each will occur three times during the morning at 8:30-9:30 a.m., 9:45-10:45 a.m. and 11 a.m.-12 noon:

- "Ku-band technology and TVRO calculations," with Paul Heimbach and Virgil Conanan (both of HBO)
- "A working class on cable system design," with Sally Kinsman (Kinsman Design Associates) and George Salvadore (ATC)
- "Headend antenna theory and EMI reduction," with Steven Biro (Biro Engineering)
- "Performing measurements on basic test equipment," with John Shaw (Cable Communications Scientific)
- "Baseband video test equipment measurements and modulator alignment," with Paul Beeman (Viacom Networks) and Ron Hranac (Jones Intercable)
- "Subtleties of sync-suppression scrambling," with James Farmer (Scientific-Atlanta) and Cliff Paul, consultant (RTK)
- Question-and-answer session with FCC engineers Syd Bradfield and John Wong
- BCT/E Certification Category I review course, with Alex Best (Cox Cable Communications)
- BCT/E Certification Category VII review course, with Wendell Bailey (NTCA)

12 noon—Lunch in Exhibit Hall

12-5 p.m.—Exhibit Hall open

7-11 p.m.—Expo Evening at Medieval Times

Saturday, April 4

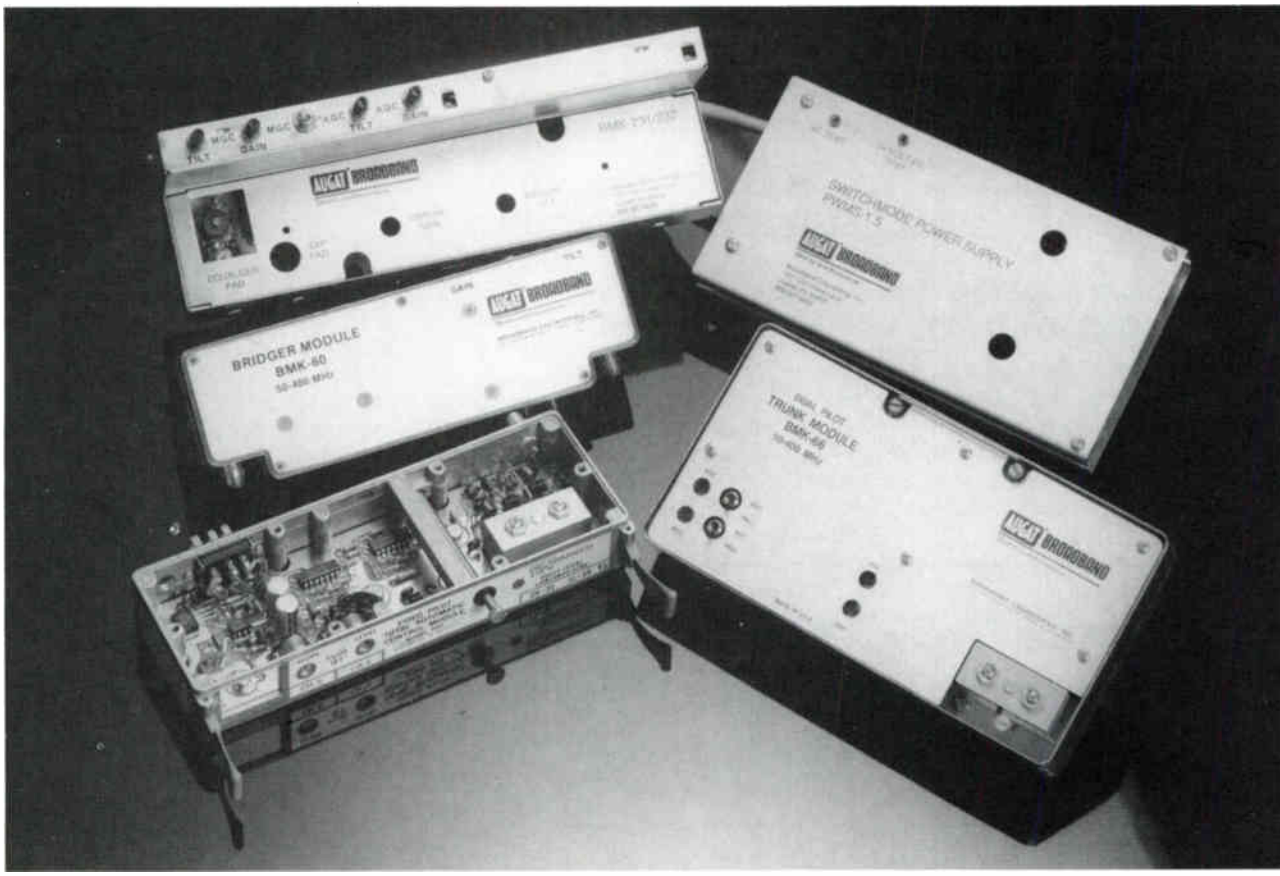
8:30 a.m.-12 noon—Expo workshops offered

BCT/E Program endorsed by CATA

FAIRFAX, Va.—At a recent meeting of its board of directors, the Community Antenna Television Association unanimously voted to endorse the Broadband Cable Technician/Engineer (BCT/E) Certification Program, developed by the Society of Cable Television Engineers. The program was designed to raise the professional status of technicians and engineers by providing standards of competence in broadband communications engineering.

According to Stephen Effros, CATA president, "Our industry is dependent upon excellence and service at the local level. The (BCT/E) program promotes both the development and the recognition of that excellence."

For more information on the BCT/E Program, contact the SCTE national headquarters, 669 Exton Commons, Exton, Pa. 19341, (215) 363-6888.



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three times during the morning (see April 3)

12 noon—Lunch in Exhibit Hall

12-5 p.m.—Exhibit Hall open

Sunday, April 5

8:30 a.m.-12 noon—BCT/E Certification exams on Categories I, II, III, IV and VII

9-11 a.m.—Chapter development meeting: roundtable discussion on how to start up an SCTE meeting group and improve its operations

NCTA Show to offer 'streamlined' panels

WASHINGTON, D.C.—During the National Cable Television Association's Cable '87 show in Las Vegas May 17-20, cable executives will discuss industry developments in seven tracks of panels, including legal, technical and public policy issues. Panels have been "streamlined" to ease conflicts of delegates wishing to attend different sessions.

Legal panels will feature a question-and-answer session with FCC staff, as well as communicating with telephone companies. Technical sessions will include stereo TV, consumer electronics interface and signal security.

A/B switch report supported by industry

WASHINGTON, D.C.—A report filed by the National Cable Television Association to the FCC last December concerning the commission's ruling on mandatory A/B switches has been supported by both cable and broadcasting. In the report, the NCTA also refuted arguments that carriage of non-commercial and other types of stations be maintained in absence of must-carry rules.

In another report to the FCC March 2, the NCTA again stated its position against the FCC's A/B switch and must-carry rules. It urged the commission to adopt signal carriage rules based on a joint industry compromise agreement or, alternatively, to allow an elective approach where cable operators could choose between complying with carriage rules based on the compromise or installing A/B switches.

- Wegener Communications Inc. has relocated its headquarters to Technology Park/Johns Creek, 11350 Technology Circle, Duluth, Ga. 30136, (404) 623-0096.
- Hughes Aircraft's Microwave Products Division is offering customers of its AML local distribution microwave equipment new product warranties on equipment and factory repairs. The warranty period will extend from 12 to 24 months on new products. Also, items that are no longer under warranty and are returned to the factory for repair and/or retuning now will be warranted for 12 months from date of shipment.
- Microdyne Corp. of Ocala, Fla., has contracted to supply and install 27 fully automated satellite receiving systems for the Florida Satellite Network. The turnkey systems will receive programming and videoconferencing for schools and private businesses on a fee-for-service basis.
- Pirelli Optronic Systems, based in Meriden, Conn., has been awarded a contract to provide a fiber-optic supertrunk for Cable News Network in Atlanta. The installation, which was scheduled for March, will provide a link between CNN's main center and its current studios.
- Anixter Bros. of Skokie, Ill., has acquired Delphi Electronics Inc., an electronic wire and cable specialist in Folcroft, Pa. Delphi will continue operating under its own name and will become a distribution center for Anixter products.
- In order to expand its research and manufacturing facilities, Colorado Video Inc. has moved to 5490 Spine Rd., Boulder, Colo. 80306, (303) 530-9580. Its mailing address remains P.O. Box 928, Boulder, Colo. 80306.
- Galaxy Cablevision of Silkeston, Mo., has added a Channel Master Micro-Beam CARS-band 5-watt system to its cable franchises in Shepard, Memorial Point and Onalaska, all in Texas.
- The Communications Group of Spar Aerospace has opened an office at 1745 Jefferson Davis Hwy., Suite 608, Arlington, Va. 22202. The group consists of Comtel and Communications Systems, both of which supply satellite equipment to government and commercial customers.
- Pioneer Communications of America announced an agreement with Cox Cable Communications in Atlanta to provide BA-5000 series one-way addressable converters and M(3) controllers for Cox's system in Cleveland, which passes more than 93,000 homes.
- Zenith Electonics will provide Post-Newsweek Cable with its PM addressable decoders in the MSO's Altus, Okla., system. Also, Cencom Cable Associates will upgrade its Illinois system with Zenith Pay-Master decoders.

You and the trade deficit

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

Bankruptcy is a word that is equally descriptive of the negative financial condition of a governmental body, a corporation or an individual. Briefly, bankruptcy ensues when the reserve capital is exhausted and the expenses exceed the income. In this state, the creditors demand repayment of their loans and seek redress in the courts upon default by the debtor.

Bankruptcy for the sovereign United States of America, while not improbable, would be a many-tiered affair, as compared to the process for the individual, the corporation or the lesser levels of government. Many of our smaller tax-supported communities have spent themselves into insolvency, forcing the next line of command to send in a task force that suspends or dismisses the elected officers, and nurses the ailing body back to fiscal health. With the sole exception of the federal government, everyone else has to live with a balanced budget.

What is so unique about the feds? The power to print currency, the lack of a presidential line veto and a Congress elected, so it seems, solely on their pledges to gift their constituents with federal funds. Among the latest congressional jollies are: the "Clean Water" bill (a wonderful cover-up for evenly awarded pork barrels for everyone), catastrophic illness remedies, homeless shelters and numerous other politically desirous giveaways, unleashing a spasm of spending exceeding even the glory days of the New Deal. Balanced budget? Our Congress is congenitally crippled in voting on austerity.

The road to bankruptcy

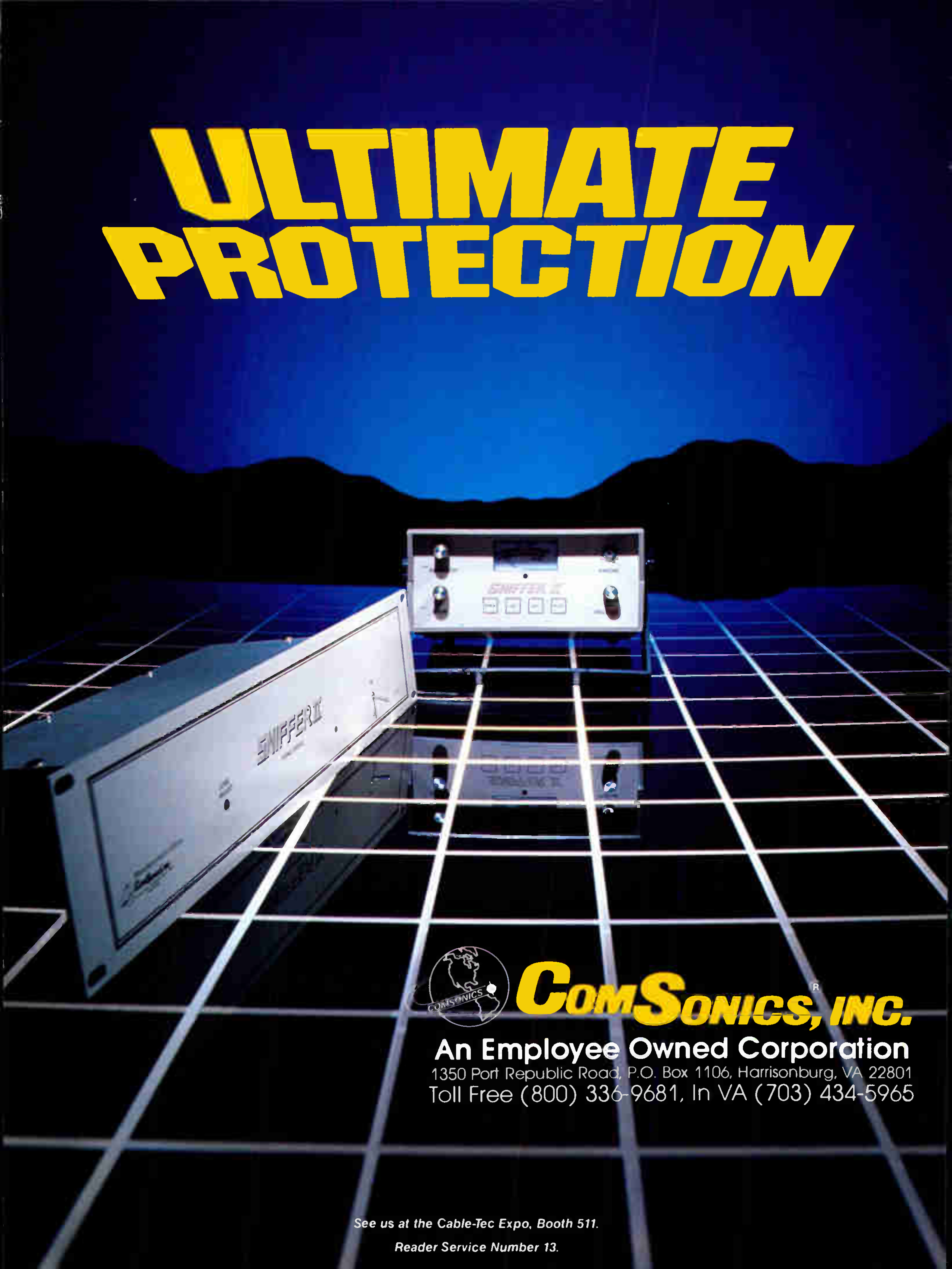
With a $200 billion yearly deficit, the United States is surely on the road to bankruptcy. Why then are inflation and the interest rates so low? Don't ask an economist—an average schoolchild will do. "We still have money in the old sock and we can spend, spend, spend until it is gone!" When will we have sold our desirable real estate, buildings and businesses to the foreign creditors until there is no more to sell? When will our printing presses have mimicked the classic pattern of every other bankrupt country to the point where you'll need wheelbarrows of paper money to buy a quart of milk? Sooner than you think.

Can this juggernaut be derailed? Not by the present elected body of politicians! Like any tale of woe there is more, much more. This time *you* may be as guilty of fostering a deficit as our congressmen. Consider the negative balance-of-trade nightmare. In 1986 we enjoyed (?) a trade deficit amounting to $170 billion. I suspect that this revelation is boring to most of our citizens, except perhaps the 3 million who have lost jobs to foreign workers since 1981 and who may heave a sigh at their reduced living standards. But most of us look to the politicians for an answer to a problem seemingly out of one's realm of influence. Well, this particular deficit is very much subject to correction by your own individual action, and here is why and how:

There are approximately 100 million taxpayers available to repay the $170 billion trade deficit. To make this very personal: If this trade imbalance persists, you are taking on every year a $1,700 debt. Believe me, it is not somebody else's debt—it is yours, and sooner or later you will be dunned by the creditors. Probably your first reaction will be to complain that you did not incur said debt and it is all a mistake and the other guy should be fingered as the spendthrift. However, this year, 3 million of you bought a foreign car, average price about $10,000. As a free person in a free society you decided to buy this superior car, designed by superior engineers, built by superior workers, because you deserve to have the best. Please remember that when you buy the foreign goods you also are supporting their research-and-development engineers who will have the funds to stay ahead of their unfunded American competitors. OK, $10,000 was added by you to the trade deficit. In justice to your fellow taxpayers, you should pay twice for the car, to avoid burdening them with debt for your folly.

Suppose you are an engineer able to specify electronic devices for the company plant. Foreign merchandise is usually 20 percent cheaper, better designed and made, so you say, "Buy—we got the best deal!" But who is going to pay the same sum to take care of the resulting negative trade balance? The 20 percent savings is no longer a bargain!

Thus, every time you make a decision to buy a foreign product, while we suffer from an imbalance of trade, this purchase adds to our debt. Will you pay the piper? You bet you will. Maybe not while we are selling off our net worth, but inevitably the debt will rise like a plague blotting out our sunny skies and carefree lives, and plunging us back into the nightmare years of the Great Depression.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Multiple dwelling units and the urban system

By Robert E. Sturm
Communications Systems Design & Planning

During the last few years, the cable TV industry has redirected its attention and energy from the construction of suburban systems toward large urban systems. The planning, construction and management of urban systems are very different types of projects than have been confronted by cable operators in the past. Urban systems tend to be very sophisticated—and they are very costly to build. One key to the successful completion of an urban system is to bring a large number of subscribers on-line early in the build. With a moderate amount of advance planning, a substantial amount of dwelling units can be passed by the outside plant early in the construction and activation phase of the project.

It is important, from the aspect of revenue, that system operators consider the multiple dwelling units (MDUs) of the system early in the planning stages. Generally, MDUs (apartment buildings, condominiums, townhouses, etc.) comprise a larger share of the potential subscriber base than found in a suburban system. They may represent 45 to 55 percent of the homes passed. In some systems, this number may be even larger. The methods and general concepts in this article have worked well in a number of systems and have brought a large number of subscribers on-line quickly. A system operator may find these procedures useful when implemented.

The first priority in starting the construction of any cable system is to assemble a schedule of key milestones for the construction, activation and marketing of the system. One of the first of these milestones is the commencement of system mapping. The instructions given to the mapper are of extreme importance. In addition to measurement and potential subscriber count accuracy, particular care should be given to the MDUs.

Based upon the demographics of the system, construction managers can isolate the areas within the build that have the highest density or homes passed per mile of outside plant. The demographic information for MDUs typically can be obtained using census data or city records, which should be readily available. Mappers should be instructed to concentrate their efforts from the headend or hub outward to the areas that include the largest number of MDUs.

With the mapping under way and the completed maps returned, the operator now has concrete numbers with which to plan for the next milestones. The mapping will identify potential construction problems, underground construction areas and geographic obstacles such as railroad crossings, freeway crossings and other obstacles that may affect cost-efficient plant construction and marketing. These items are mentioned because of the time frame required for obtaining the necessary authorizations, easements and permits. With the completed routing maps that contain strand and underground continuity along with homes-passed data, the manager can analyze the data contained on the maps and organize and prioritize the areas to be built based upon actual dwelling units passed. The construction manager now can effectively schedule the system design and construction.

An important decision

The decision to consider MDUs as an extension of the outside plant or as a separate entity

Construction schedule for MDU installation

Project__________ Date__________

Month__________

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
1. Advanced planning																															
2. Obtain contract for complex																															
3. Field engineering																															
4. Design system																															
5. Design approval																															
6. Prepare bill of materials																															
7. Notify utilities																															
8. Obtain permits																															
9. Install power supplies (if required)																															
10. Wire building																															
11. Install cable and pedestals																															
12. Splice system																															
13. Activate and balance system																															
14. Inspect work																															
15. Released to marketing																															

is an important one. It has a direct bearing on outside plant cost in terms of system powering and equipment usage. There are a number of construction methods or options available for MDUs. Each method has distinct advantages and disadvantages. The methods outlined as follows are used typically for larger MDUs.

1. *Home-run method*:

The home-run method requires the new cabling of each television location with a dedicated cable back to a subscriber tap port located in a lock box, cable pedestal or phone closet. One of the major advantages of this installation method is that the operator can provide the complete channel line-up to the subscriber and has a point of control located outside of the dwelling unit itself. A major disadvantage is that where a "loop-through" system is installed, the entire building must be wired; a very costly undertaking. Special consideration must be given to construction techniques, control point locations, building permits, floor penetrations and fire-wall penetrations. Access to the individual dwelling units during installation also may present a scheduling problem.

2. *Loop-through method*:

The loop-through method is very popular with MATV (master antenna television) systems. The cable is run from a TV outlet to the next TV outlet in line. Subscriber directional taps or mini-directional couplers are installed at each outlet with the tap side providing the feed to the TV set; the through side is routed to the next outlet. The loop-through method is very popular in hotels, motels and hospitals. An advantage of this method is that it is less expensive to install. A disadvantage is that in older buildings the existing cable and devices may not be technically adequate to pass the full complement of the cable channels, and a break in a cable can "shut-down" more than one subscriber.

'The decision to consider MDUs as an extension of the outside plant or as a separate entity is an important one'

3. *Mini-headend method*:

The mini-headend method is used to deliver a limited number of cable channels into the existing MATV system. This is an ideal solution for bulk billing applications for installations such as hospitals, motels, hotels and apartment buildings. An advantage with this method is that the typical MATV loop-through system can handle the channel loading without replacing the cable. A disadvantage is that not all cable channels may be delivered to the building. A number of channels can be removed selectively from the cable system and injected into the building's existing MATV system.

Each one of these methods requires a different type of feed and signal level from the outside plant. The operator should give careful consideration to the method used to provide services to MDUs.

When the method of service has been selected, the designer then can efficiently provide the proper feed for the complex.

The next milestone to be achieved is the installation and marketing of the multiple dwelling complex. The accompanying sample of a construction and activation schedule can be useful in MDU installations (as well as outside plant construction). This time line can help the construction manager track the progress of each individual complex under construction. It can be incorporated into a personal computer relatively easily; there is a number of existing software packages available that can be adapted for this type of scheduling. The form can be used in scheduling of the outside plant construction as well.

Though advance planning does not contribute to the revenue stream of a cable system, it can affect directly the time frame required to bring revenues on-line. Lack of advanced planning may have a dramatic impact on the successful completion and the profitability of an urban system.

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Reader Service Number 19.

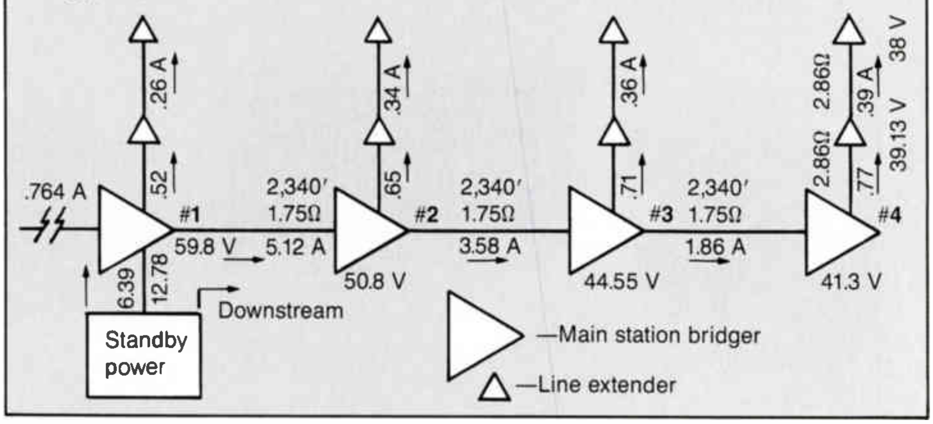
Picture quality related to cable powering

By Charles S. Turner
President, Control Technology Inc.

Over the past several years, many words have been written about the pitfalls of circulating ground currents present in cable systems that span more than one power grid, lightning and other weather-related powering problems, and related grounding. However, for the system engineer really concerned about delivering a quality television product day after day and week after week, an important concern also should be the basic powering of the system.

The public in general is much more sophisticated now than a few years ago when the cable boom began in urban systems. The average consumers, in general, are educated to the point where they know that television programming delivered via cable should be free of

Figure 1



'Incorrect powering of the distribution system can result in the delivery of poor quality signals'

ghosts, lines, background wiggles, sparkles, etc. In other words they know that cable is capable of delivering a nearly perfect picture. They probably do not know that ghosts, lines, sparkles and wiggles are caused by such things as co-channel interference, intermodulation and cross modulation distortion, and power line and terrestrial interference. It is distressing for a cable engineer to hear customers say that they get better quality television from rabbit ears than from the cable.

Incorrect powering

Although many engineers can talk knowledgeably about distortion and interference problems, they may not fully understand that incorrect powering of the distribution system can result in the delivery of poor-quality TV signals to the customer, even when high-quality signals are being transmitted from the headend.

In a modern cable system both the 60 Hz AC powering voltage and RF carriers are multiplexed on the coaxial cable, and the cable attenuates both. Normal training for cable technicians is concentrated on the maintenance of the RF plant with very little time devoted to cable powering. This is related to the fact that correct powering of the cable plant is calculated initially by the plant designer and implemented in the construction phase. However, incorrect powering of distribution amplifiers can result in severe non-linear distortion, regardless of how well the RF aspects of the plant are maintained. This problem is related to the fact that a typical distribution amplifier can operate properly over a range of about 8-10 volts AC once the power pack's transformer tap has been properly selected.

Figure 1 illustrates what might be considered a portion of a typical cable distribution system, with the effects of tap insertion loss ignored for simplicity. This sketch only illustrates the amplifiers powered on the downstream portion of the distribution system. For the purpose of the illustration the upstream portion can be considered identical. The power consumption is about 45 watts for the trunk station and about 15 watts for the line extender. Even though the standby supply provides approximately 60 volts to the first amplifier (59.8 volts), the voltage level at the last line extender is only 38 volts, due to IR losses in the cable. One of the more popular amplifiers is provided with three tap settings corresponding to three input voltage ranges: 1) high, 52 to 60 volts; 2) medium, 44 to 52 volts; and 3) low, 36 to 44 volts. Again referring to Figure 1, the voltage tap settings should be as follows:

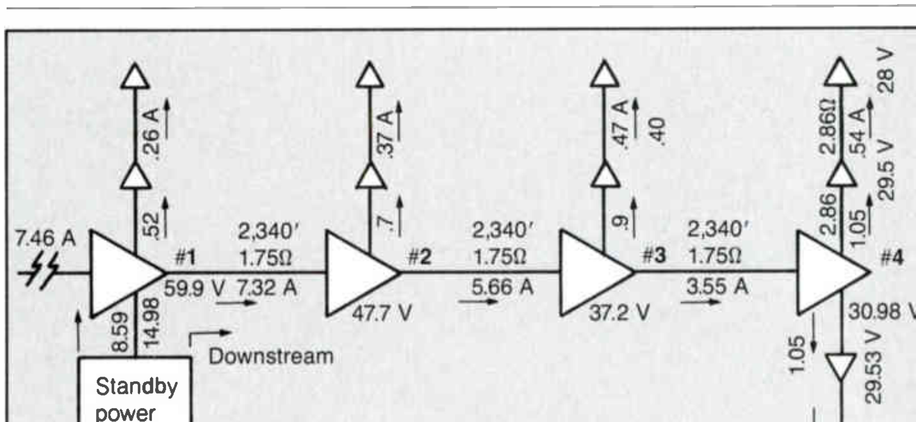


Figure 2

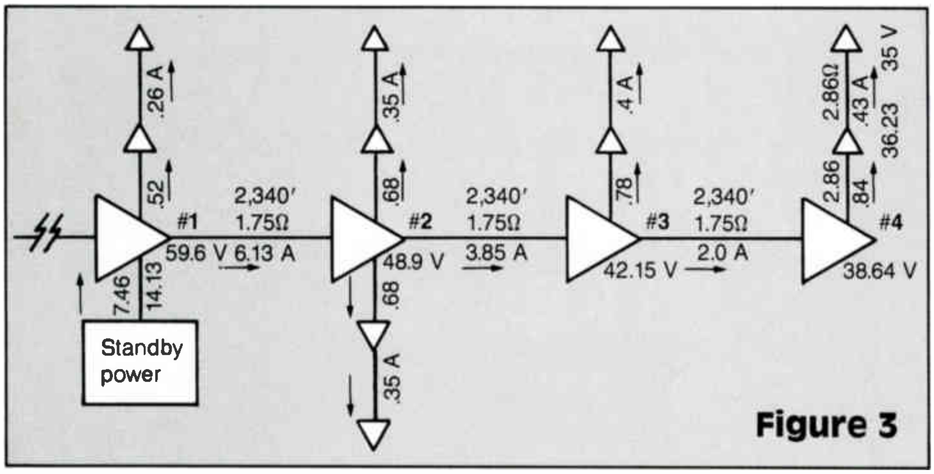


Figure 3

- Amplifier #1: actual voltage, 59.8 volts; range, 52–60 volts; correct setting, high.
- Amplifier #2: actual voltage, 50.8 volts; range, 44–52 volts; correct setting, medium.
- Amplifier #3: actual voltage, 44.5 volts; range, 44–52 volts; correct setting, medium.
- Amplifier #4: actual voltage, 41.3 volts; range, 36–44 volts; correct setting, low.

Incorrect range settings generally will result in the introduction of non-linear distortion of the amp it powers and a corresponding reduction in picture quality downstream. Poor picture quality will become increasingly noticeable in long amplifier cascades.

It is very important that all AC voltage measurements be made with a true RMS (root mean square) reading voltmeter. Most voltmeters are designed to read correctly on sine wave voltage only and will read about 10 percent high on the quasi-square wave voltage utilized in cable power supplies.

Once the cable plant is powered correctly, concern in this direction should be minimal. However, any changes to the cable plant affecting the placement or quantity of active devices will change powering requirements. In Figure 2, if a system has switching regulator power supplies and another distribution leg with two line extenders were added to the last trunk amplifier the current will increase more than the amount required by these additions. This occurs because as the voltage drops to a power pack, its current goes up. The resulting power requirement theoretically would increase by 34 percent; 16 percent would be directly attributable to the increased load and 18 percent due to the increased IR losses in the cable. The resulting IR losses would totally unbalance the system powering, as follows:

- Amplifier #1: actual voltage, 59.9 volts; previous setting, high; correct setting, high.
- Amplifier #2: actual voltage, 47.1 volts; previous setting, medium; correct setting, medium.
- Amplifier #3: actual voltage, 37.2 volts; previous setting, medium; correct setting, low.
- Amplifier #4: actual voltage, 31.0 volts; previous setting, low; correct setting, below-acceptable range.

According to this, amplifiers #3 and #4 now are powered incorrectly, resulting in some level of non-linear distortion being introduced. The powering for #3 could be corrected by moving the voltage setting from medium to low. Unfortunately, the powering of #4 cannot be corrected without either adding another power supply or redistributing the load to another existing power supply. Since #4 currently is being presented with only 31 volts (see Figure 4), the probable effect is a serious distortion problem, which will increasingly manifest itself further downstream.

Because of the effects of IR losses in the cable, the addition of two line extenders to amp #4 (illustrated by Figure 2) is much more severe than the same construction attached to amplifier #2 (Figure 3). In this example, the power plug on


CONTENTS C-COR Engineer
THIS END UP

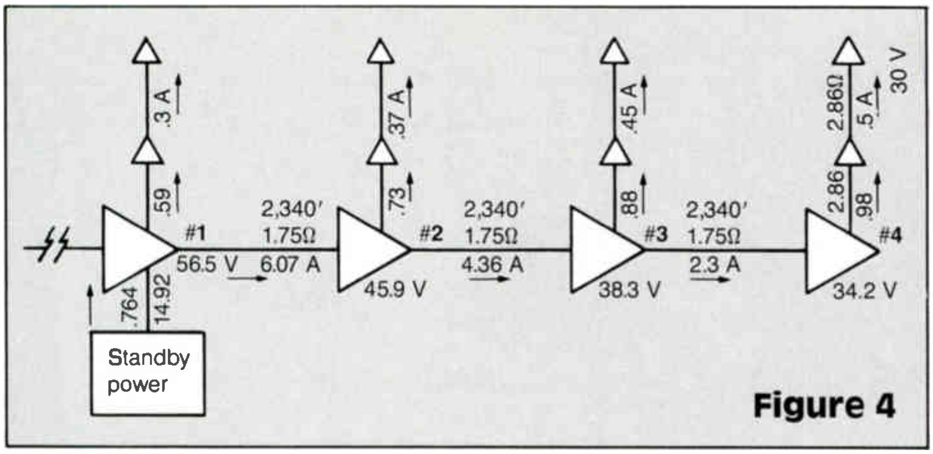


Figure 4

#3 needs to be moved to the low position, and #4 also will operate satisfactorily in the low position.

Magnified by distance

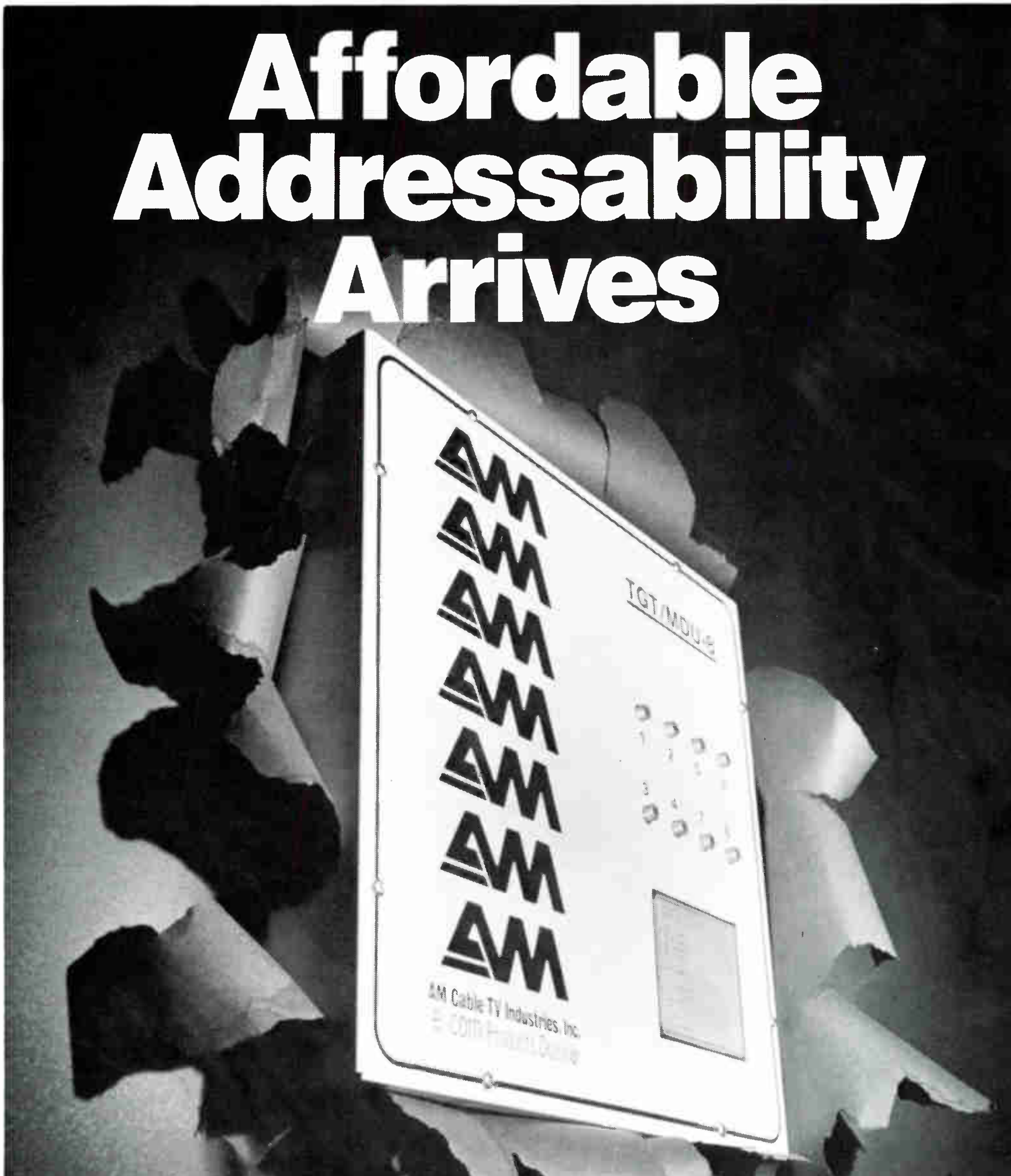
Since the effects of adding loads are magnified by distance from the power supply, one can surmise that variations in power supply voltage also is magnified by distance (also due to IR losses). Figure 4 illustrates that a fully implemented system is affected strongly by changes in the voltage at the power supply. The most significant application of this phenomenon is when standby power supplies are used that are not tightly regulated in the standby mode.

A typical non-regulated supply will exhibit a change in output voltage of 15 percent or more from no load to full load. This translates to about 9 to 10 volts in a 60-volt unit. Manufacturers usually design inverters (standby sections) so that the output voltage "brackets" the mean or desired voltage, thereby establishing that the output voltage is correct at 50 percent of full load (e.g., 65 volts at no load, 60 volts at one-half load, and 55 volts at full load). The output voltage also will decline linearly with discharging batteries. For instance, batteries declining from 37 volts at the beginning of a standby cycle to 31.5 volts at the end of the standby cycle (low voltage cut-off)—a decrease of 15 percent—will cause a similar decline in the inverter output voltage, or about 9 volts in a 60-volt supply.

Therefore, it follows that at only one load and battery condition will the output voltage be the same in the standby mode as in the primary mode in the examples shown. This condition virtually ensures that the system will experience a decline in the quality of video and audio information carried on the cable when the system is required to operate in the standby mode. The effect on digital data carried on the cable can be devastating. Since the effects of load and declining battery voltage are cumulative, it is easy to see that the output voltage of the power supply can decline by as much as 25 percent during an extended power outage, or as much as 15 volts. Because of the multiplying effect of IR losses, many amplifiers essentially would be inoperative during much of an extended standby cycle.

The overall effects of poor or no regulation probably are less apparent than one might normally conclude, probably due to the fact that: 1) most power outages are of short duration (10 minutes or less) and 2) many systems have older-style amplifiers equipped with series pass regulators, instead of the newer and more efficient switching regulators in their internal power supplies. The older-series pass regulators become more efficient with lower input voltage and therefore minimize the multiplying effect of IR losses. With modern amplifiers, unregulated standby supplies also may provide less standby time as a function of the higher current requirements due to the drop in AC voltage.

When all of the powering factors in a cable system are considered thoroughly and carefully, the system engineer should conclude that proper powering of the cable distribution system is a major factor in the quality of the product delivered to the cable customer.


Affordable Addressability Arrives
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Refurbished equipment: A cost-saving alternative

By Jerry Quinn
NCS Industries Inc

The idea of recycling used cable television equipment certainly is not a new one. At various times over the last decade small and large operators alike have turned to refurbished equipment due to shortages and/or slow deliveries by the manufacturers and lower price considerations.

However, we now are faced with a completely new situation. Equipment has a life span set by the technology of the day. Some products were obsolete in two years, others in five years. No longer is the add-on heat sink and interstage circuitry varying from one amplifier to another, but with the advent of the hybrid gain blocks cable distribution amplifiers are almost ageless. The mean time before failure typically is eight to 12 years. The current equipment is consistently of high quality due to the good basic design of yesterday.

'(Equipment) can be purchased, remanufactured and returned to service at 30 to 50 percent of its new replacement cost'

The used equipment available today is as varied as the industry that produced it. Care must be taken to select only equipment that can ef-

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Reader Service Number 27.

fectively give a second life of service by a manufacturer that has well-established tenure in the cable industry.

Equipment that is available today averages between five to 12 years in service. It can be purchased, remanufactured and returned to service at 30 to 50 percent of its new replacement cost.

Some rural and mid-sized systems traditionally have utilized refurbished gear for one very basic reason—cost. The typical rural system does not have a sufficient subscriber base and cash flow to purchase all new plant. Sometimes there can be as little as five to 10 homes per mile. These clever system operators have found many areas in which to save money, such as with headend and satellite equipment, and trunk and distribution electronics.

In the recent past, larger multiple system operators have begun to re-evaluate the removal of older equipment and its subsequent use. Although it is not state of the art, the equipment is far from being obsolete. These operators are removing the older vintage electronics and upgrading their smaller plants and headends, saving thousands of dollars.

Building confidence

To ensure confidence in using refurbished electronics, the gear should have a thorough going over before it is delivered to the user. On trunk and distribution equipment the housings should be cleaned (glass beaded), hardware checked and replaced where necessary, and all mechanical aspects should be tested before being sent out (for water leakage, etc.) All amplifiers, modules, connector chassis and cables should be cleaned and checked mechanically. After this all the modules must be tested independently before being assembled as a station for testing and alignment. Sweep response, return loss and distortion tests must be performed as well as a final picture test. Power supply voltage, current limit and hum modulation must be tested. Also, automatic slope and gain controls must be checked. Channel alignment must be verified and actual signal level tracking also must be done.

Satellite receivers and channel processors and modulators also are available in increasingly greater amounts. Receivers are sometimes obsolete due to non-standard downconversion schemes at the dish. Other system engineers have found better performance from a block downconversion at the satellite dish. This is causing some abandonment of 3.7 GHz to 4.2 GHz input receivers. However, these still can perform very well; in fact, they sometimes can outperform new production models. Satellite receivers must be properly aligned at the 4 GHz frequency band, the intermediate frequency and at the demodulator level. The receiver performance should be verified by using satellite delivered signals, and should be checked for compatibility with any descrambling equipment that might be used.

It seems that new programs and channel realignments are having an effect on headend modulator and processor change outs. Because of this, systems might want to consider channel changing or trading up older equipment to comply with the FCC rules.

This brings up the refurbishing of modulators. A modulator should be aligned and set for the correct offset frequency, and set up for encoders (when capable). As well, align and test the differential phase and gain, and the IF circuitry, including appropriate traps. Allow equipment to burn in for at least 48 hours. After 48 hours verify the alignment, stability, frequency, flatness, etc., adherence to manufacturer's specifications, and aesthetics.

Testing of processors should be performed similarly, with the addition of the phase-lock test of the incoming channel with the output channel when they are at the same frequency.

Dealing in used equipment can be a money-saving dream or it can be a nightmare. Be cautious! If you use an outside source, verify that the person or company with whom purchases will be made has an established track record in the industry and backs up the sale with warranty service. Your source should be able to supply all the gear and accessories required, including pads, equalizers and fuses or circuit breakers. Another consideration is whether the refurbished equipment is compatible with current products. This can be important for spares and if extensions are a future possibility. Many used products are directly compatible with new and even will fit in the same housings and chassis. Make sure your vendor has the technical competence, cable product knowledge, and service and sales backup support to help you to choose the best equipment at the best possible savings, with the least amount of service problems.

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Reader Service Number 29.

Two-way data on entertainment cable

'Poor splices, kinked and bad cable, marginal installation and bad grounding . . . can cripple the return path'

By Tony Goggin

A man in Phoenix, Ariz., sits down to his computer at the office. He needs the daily stock report hot from Wall Street. Using a service that his company has leased from the local cable system, he types in a few quick commands and has it instantly. Next, he needs to compare it with a Minnesota university professor's predictions from a year ago. Another moment later, it's in front of him. He types up an analysis over coffee and a doughnut, and sends it from his computer to his supervisor downstairs. Then he requests the daily news from the "Fictional Electronic Times" (just another couple of keystrokes away) and has it before he can get a coffee refill.

Sure, we can do similar things today with computer services like CompuServe and The Source. However, busy signals frequently get in the way, and a typical long distance phone call to access a university computer can run $10 to $20 during peak hours with no guarantee on data quality. As well, retrieving large amounts of data is tedious and slow. Is there a better way to make this process faster and cheaper? Is it possible to have even more sources of information available via your computer than ever before?

The answer to these questions is an overwhelming yes! Better yet, the service can be provided by local cable companies with equipment that is ready to be used today. This area of two-way data communications can have a tremendous potential as a fresh source of revenue for local cable systems.

Where are we now?

Although the technology for two-way cable service has been around for nearly six years, equipment is just becoming reasonably priced. As a quick overview, two-way technology can be used in many different ways. One application is for pay-per-view ordering. Another type of two-way communications is an offshoot of the preceding one except that it is data oriented. Customers have a remote-control unit that they use to send control signals to a computer at the headend via an upstream path installed in the cable system. Upon request, the customer begins receiving teletext data and can interact with electronic information services like Associated Press, Comp-U-Card and Electronic Media Services (an example of this is the Request service offered by Group W Cable in Buena Park, Calif.).

A third use for a return path in the cable network is true two-way data communication between computers. A modem at one end converts computer data to a CATV signal and sends it to the headend. At the headend, the data signal then is sent back downstream over the entire network. Each modem sending a signal out has an address assigned to it, and a modem receiving the downstream signals can be tuned to that address and receive its data.

Two-way data communication on an entertainment cable network has some very exciting possibilities. At present, the fastest telephone communication rates for conventional dial-up telephone modems average 120 to 240 characters per second, with some very expensive modems peaking at 960 characters per second. On the other hand, even a typical two-way cable system can handle data transmission rates up to a quarter of a million characters per second. For example, while transmitting a complete copy of *The Wall Street Journal* by conventional means would take nearly 2½ hours, the same issue would take just under 10 seconds with an entertainment cable-based modem system. This means that anyone needing an extremely high-speed communication service would benefit from a two-way cable capability.

The "office of the future" is just one area that can benefit from two-way systems. Reducing the size and complexity of computer systems at hospitals by connecting them to a main computer and eliminating most of the local computers is another possibility. Banks, which handle large volumes of data every day, could speed up their transfers and reduce the amount of computer time that they tie up. Traffic lights could be controlled very easily from a central location, and installing a new traffic light only would require a hook-up to the local cable network. Also, schools and universities can be linked together to exchange information and effectively increase the

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Costs, problems and difficulties

The concepts behind two-way cable data are not difficult to understand, though carrying blueprints through to the finished product is a little more difficult.

First, if your system is not already set up to handle two-way data transmission then the cost of installing a return path for upstream signals can be considerable. Special amplifiers and diplex filters have to be installed along the entire data path from the customer back to the headend. Many times, older existing cable systems have to be completely rebuilt.

Upstream signals are especially susceptible to system ingress and other distortion products. Poor splices, kinked and bad cable, marginal installation and bad grounding that normally would not affect downstream performance can cripple the return path, making it unsuitable for modem communication. The cost for upgrading a cable system to two-way capability varies greatly from system to system depending on the existing signal quality of the system and how much upgrading has to be done.

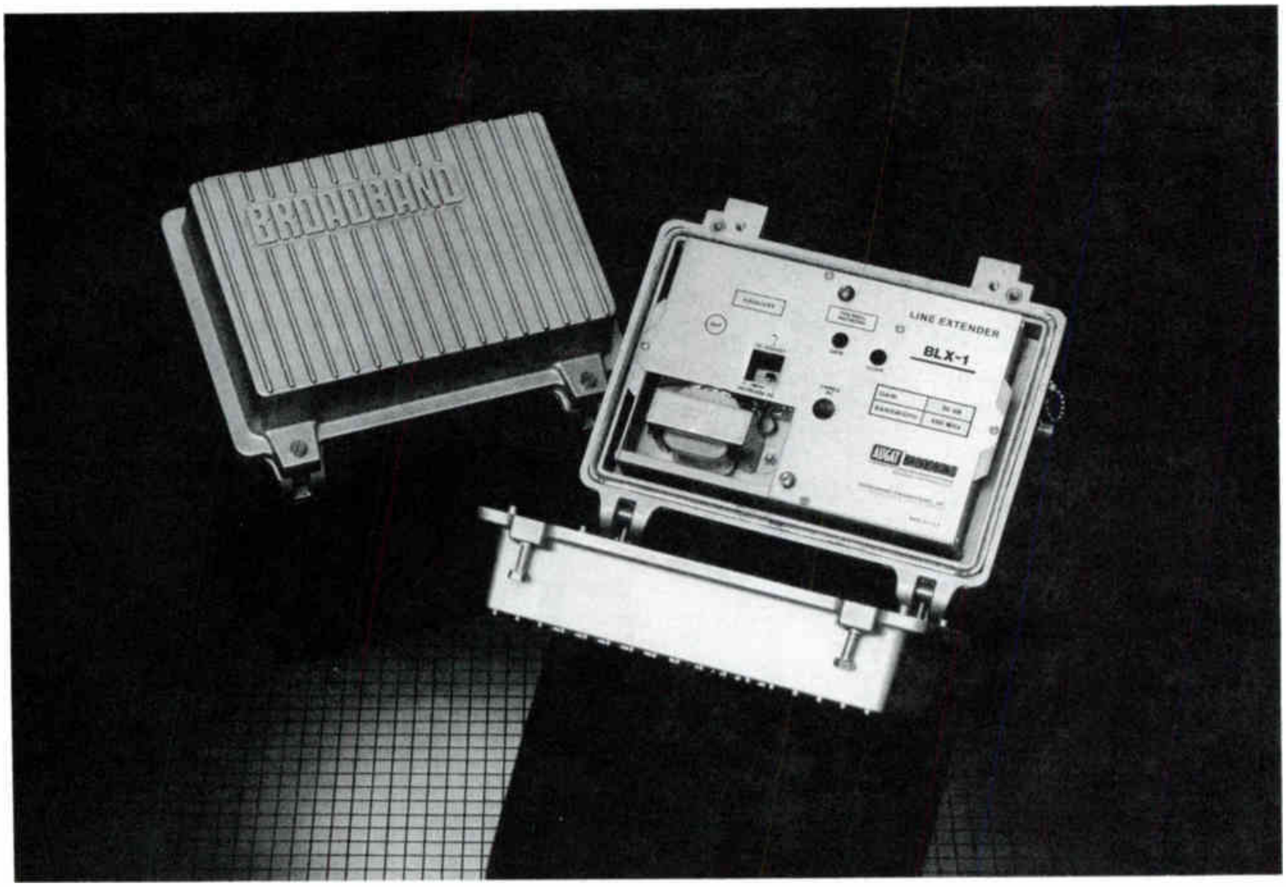
Next, maintenance also becomes more critical. If the entertainment cable service is out for a short period of time, customers become a little irate but are not likely to suffer greatly. If the data service is severed, then banks can't transmit accounting and bookkeeping information, library systems go down, corporations can't send payroll and traffic lights malfunction. Thus, some amount of redundancy should be introduced as a protection against catastrophic outages. As well, status monitoring becomes more important as an early warning against possible failures. Customer problems have to be dealt with immediately, making data transmission repairs a priority over standard entertainment service. In many instances, 24-hour service must be available seven days per week.

Also, marketing becomes a problem. Telecommunications managers have to decide why they should give up a perfectly good (if a little slow) dial-up telephone data service for a cable communication network that hasn't had a chance to prove itself. A company practically has to breathe service to convince new subscribers that faster *is* better and more economical.

Last, letting a data system occupy entertainment channels becomes a problem. Each data channel can carry between 100 to 200 subcarriers, or 100 to 200 users per channel. In order to effectively provide service to a wide area, as many as 12 channels may need to be devoted to data communications. This means frugal use of channels and careful selection of equipment and cable quality to maximize the number of subcarriers per channel. An arrangement has to be designed to provide the most entertainment on the fewest possible channels.

Solutions?

Yes, there are ways to economically provide two-way data service to willing customers. Obviously, the first step is a careful market analysis



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Reader Service Number 34.

to determine the number of potential customers. A telephone survey of schools, institutions, universities, city and county government offices, military offices, hospitals and larger corporations would provide a good idea of the attitudes on a faster cable-based communication system.

Next, after a need has been determined for an area, the approach to upgrading the network to two-way capability has to be decided. Upstream amplifiers and filters don't have to be added to the entire system. Only the service to an area where a customer is located need be upgraded. However, that upgrade has to extend all of the way to the headend. There are two different ways to go about doing this. If a network is old and is going to be rebuilt soon anyway, it is possible to design the new system with plug-in capability for two-way data communication at a later date. When the need is called for, the proper equipment just has to be popped into place and checked out, and it's ready to go. The other way is an "upgrade as needed" method: just upgrade existing equipment until two-way data quality can be achieved in an area.

After the initial return path has been installed and maintenance procedures become more of a routine, then the cost per drop is reduced. This will make two-way service more appealing to potential customers and it will improve revenue for cable networks. When all of the kinks are worked out in the upstream path, it becomes an efficient and easy system to maintain.

A common way to reduce problems caused by return system noise is to install bridger gate controls (BGCs). BGCs are switches in the bridger that can be activated and deactivated from a computer at the headend, selectively disconnecting sections of the return path from the rest of the system. This keeps the noise from the disconnected area from reaching the headend. The computer polls each BGC, retrieves the data from the modems in its area, then deactivates it and carries on to the next BGC, all in a fraction of a second. As a byproduct, the BGCs can be used to locate noisy feeder lines. Equipment at the headend can be set up to monitor noise from the system when each BGC is activated. If a sudden increase in noise or interference occurs, then troubleshooters more easily can identify the area to work in, plus have a better estimate of the magnitude of the problem.

If you have enough channels to provide both data and entertainment on the same cable system, then there is a definite possibility for providing two-way data service. If maintenance can keep customers satisfied, then the doubts of the reliability of cable data communication can be lifted. A whole lot of "ifs," but a whole lot of possibilities as well. The field of two-way cable technology, while not unexplored, remains an area for cable companies to provide more services for their customers and, in turn, acquire a new and profitable market.

Twenty years ago, the development of the laser was remarked as a "solution looking for a problem to solve." Communication at a quarter of a million characters per second on a CATV network can be thought of in the same light (pun intended). After all, the office of the future may be just a few amplifiers away.

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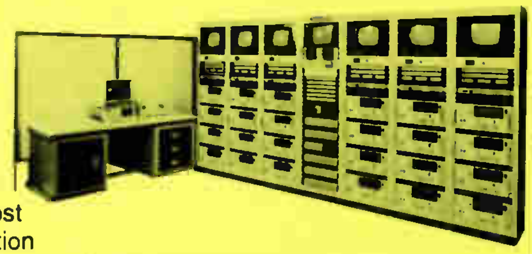


This is the system everyone thinks of when someone asks, "What is the most widely used random access ad insertion system?"

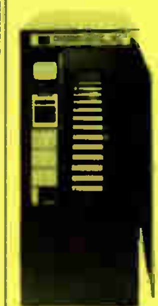
The fact is that there are more SPOTMATIC systems in use today than any other type of ad insertion system. The reasons are simple: high quality, proven reliability, unparalleled factory support, and an unmatched array of features.

- Completely modular for easy expansion as system grows
- Interfaces with optional Ad Manager™ billing and traffic software
- Expandable to 32 channels with 32 VCR's inserting ads
- Full random access or random pod operation
- Front-panel keyboard or optional personal computer control
- Complete turnkey packages available
- Quick delivery
- Broadcast quality vertical interval switching
- Automatic logging with advertiser-sorted printout
- Automatic bypass of malfunctioning VCR
- Automatic return to satellite in event of VCR or power failure

Channelmatic, Inc., 821 Tavern Rd., Alpine, CA 92001. Or phone (800)231-1618 or (619)445-2691.

Reader Service Number 114.

BROADCASTER I™ PROGRAMMABLE VIDEOCASSETTE CHANGER



Access 15 cassettes to play in any order

- **Uses one Sony VP-5000 series 3/4" VCR**
- **Easy to program, stores up to a full week's schedule**
- **Highly reliable mechanism uses no belts, chains, gears**
- **Suitable for broadcast, cable, industrial, educational, and government installations for any multiple-tape playback requirement**

Channelmatic, Inc. 821 Tavern Rd, Alpine, CA 92001 (800)231-1618 or (619)445-2691

Reader Service Number 115.

ADCART 2•2™

Like two systems for the price of one

A new concept in ad insertion allows low cost fully random access ad playback with one through four VCR's on one channel, two VCRs on each of two channels, or four VCRs shared between two channels. Features full stereo audio capability, preview bus, computer-adjusted audio levels, user-friendly CRT terminal interface for easy scheduling, advanced audio and video switching circuitry, front panel status display, and unlimited system expansion capability. Traffic and billing software available. Contact CHANNELMATIC, INC., 821 Tavern Rd., Alpine, CA 92001 (800)231-1618 or (619)445-2691

Reader Service Number 116.

FREE CATALOG

Write for our brand new catalog of television and cable system equipment. Everything from automatic ad insertion to playback systems to audio and video switching to signal processing and control.

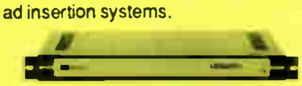
Complete product line listing with photos, block diagrams, and comprehensive descriptions and specifications. Enough detail to spec out your own custom system. Catalog will become a valuable reference. And it's yours just for the asking. Write, call, or circle the bingo number. But do it soon.

Channelmatic, Inc. 821 Tavern Rd. Alpine, CA 92001 (800)231-1618 or (619)445-2691

Reader Service Number 117.

ARE YOU THROWING MONEY AWAY?

Losing verification data is just the same as throwing money away, and who in their right mind would do that. Make sure when you run somebody's ad you get paid for it. The LOGMATIC™ and LOGMATIC JR.™ logging and verification systems always get their data when used in a system with SPOTMATIC JR. and LI'L MONEYMAKER low-cost ad insertion systems.



LOGMATIC

LOGMATIC JR.

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

Call or write for more information. You don't have to lose money for unverified spots. Channelmatic, Inc. 821 Tavern Rd. Alpine, CA 92001. (800)231-1618 or (619)445-2691.

Reader Service Number 118.

NETWORK SHARE SWITCHER

- Inserts ads into four networks from one ad source.
- Inserts ads one network at a time on a first come, first served basis.
- Four Digital DTMF cue tone decoders.
- Four preroll delay timers one for each network.
- Composit sync out put to facilitate vertical interval switching.
- Cue tone decoder disable switches.
- Power fail relay bypass.
- Inputs and outputs for controlling ad insertion devices.

NSS-4A NETWORK SHARE SWITCHER

CHANNELMATIC, INC. 821 Tavern Rd. Alpine, CA 92001 (800)231-1618 or (619)445-2691

Reader Service Number 119.

LIKE GETTING YOUR MONEY FOR NOTHING AND YOUR CHECKS FOR FREE

Make Money the Easy Way — Put either SPOTMATIC JR.™ or LI'L MONEYMAKER™ to work for you now. They are the lowest-cost tools you can use to automatically insert local ads into cable TV programming. You have one unit controlling one VCR to put ads on one channel. Equipment overhead is very low.

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

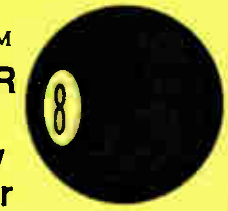
The SPOTMATIC JR. has a built-in printer for verification records; however, both the LI'L MONEYMAKER and SPOTMATIC JR. inserters connect easily to a LOGMATIC™ logging and verification system. With optional software, this enables computerized data retrieval and automated billing and report generation.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

Channelmatic, Inc.
821 Tavern Rd., Alpine, CA 92001
(800)231-1618 or (619)445-2691

Reader Service Number 120.

Does the high cost of monitor switchers have you behind the eightball? Then you need to

PUT AN EIGHTBALL™ UNDER YOUR MONITOR— 8x1 Very Low Cost Switcher

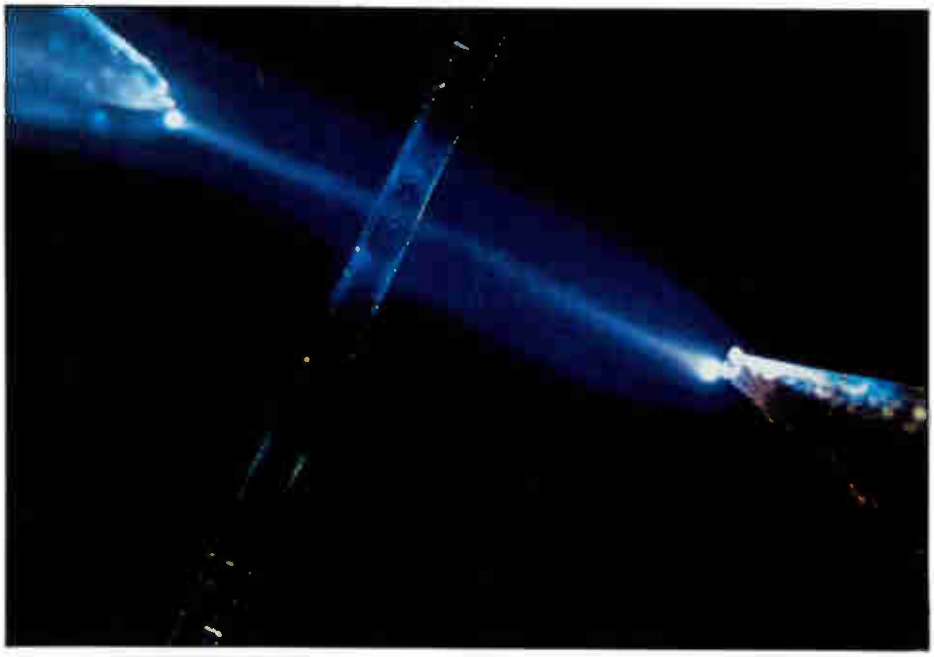


It is an integrated circuit-based monitor switcher featuring broadcast quality stereo audio and video switching. Lighted momentary contact pushbuttons are field-legendable. Its cost is far less than any other comparable unit on the market. Write or call for information today.

CHANNELMATIC, INC. 821 Tavern Rd. Alpine, CA 92001 (800)231-1618 or (619)445-2691

Reader Service Number 121.

Fiber-optic cable design and selection



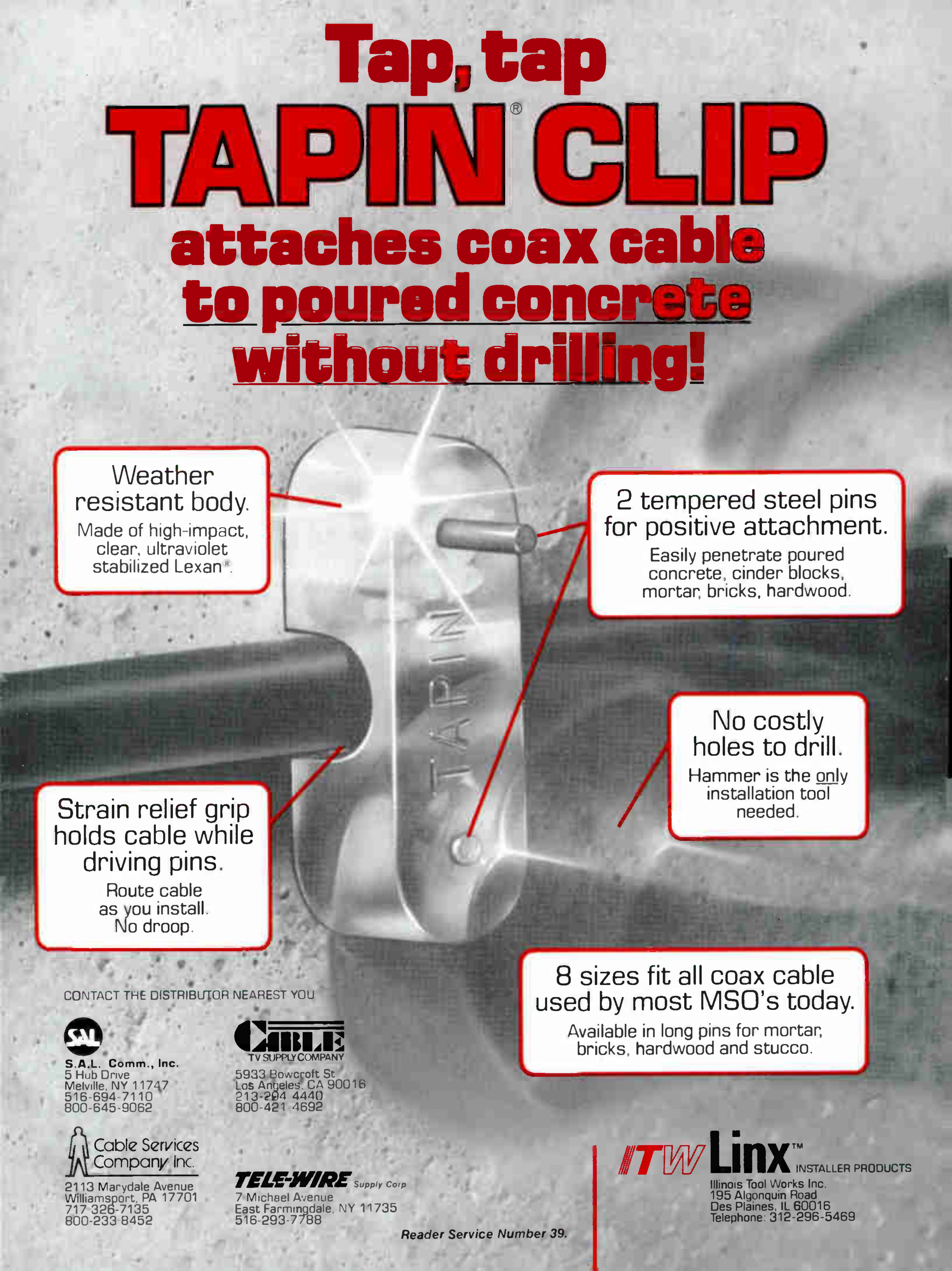
Courtesy Siecor Corp

The electric arc of a fusion splicing machine heats the intersection of two fibers to the point where they flow together to form a single integral piece.

R. Scott Stevens
Sales Engineer, Siecor Corp

The fiber-optic transmission system is no longer the futuristic revolution in the telecommunications industry; rather, it has become a standard means for transmitting all types of information whether it be voice, data or video. Commercial applications started back in 1976 and during its 10-year history fiber optics has been taken from the blackboard through the field trials to a point where it has become one of the most reliable, simple and cost-effective transmission systems available. These attributes have allowed fiber optics to penetrate all areas of networking: long haul systems, subscriber loops, local area networks, computer communications, customer premise and CATV.

The CATV industry is one of the last groups to fully utilize the capabilities of fiber optics. In part, the dismal performance of the early mutimode CATV systems may have disillusioned some to fiber's benefits. Essentially, multimode systems were the wrong application for CATV requirements. (There are exceptions, i.e., short distance, low bandwidth.) The multimode fiber was too limited in its ability to carry information.


Tap, tap
TAPIN® CLIP
attaches coax cable to poured concrete without drilling!
Weather resistant body.
Made of high-impact, clear, ultraviolet stabilized Lexan®.
2 tempered steel pins for positive attachment.
Easily penetrate poured concrete, cinder blocks, mortar, bricks, hardwood.
TAPIN
No costly holes to drill.
Hammer is the only installation tool needed.
Strain relief grip holds cable while driving pins.
Route cable as you install. No droop.
8 sizes fit all coax cable used by most MSO's today.
Available in long pins for mortar, bricks, hardwood and stucco.
CONTACT THE DISTRIBUTOR NEAREST YOU
S.A.L. Comm., Inc.
5 Hub Drive
Melville, NY 11747
516-694-7110
800-645-9062
CABLE TV SUPPLY COMPANY
5933 Bowcroft St
Los Angeles, CA 90016
213-204 4440
800-421 4692
Cable Services Company Inc.
2113 Marydale Avenue
Williamsport, PA 17701
717 326-7135
800-233 8452
TELE-WIRE Supply Corp
7 Michael Avenue
East Farmingdale, NY 11735
516-293-7788
Reader Service Number 39.
ITW Linx™ INSTALLER PRODUCTS
Illinois Tool Works Inc.
195 Algonquin Road
Des Plaines, IL 60016
Telephone: 312-296-5469

Courtesy Siecor Corp.

Cross section of a fiber-optic cable

In single-mode systems the fiber has virtually unlimited bandwidth making it ideal for CATV. However, until about two years ago the single-mode electronics were not sufficiently developed to make it a cost-effective option for the main trunking. Now the electronics manufacturers can pack more than 12 broadcast-quality channels on a single fiber (using FM analog, not digital) allowing many CATV operators to capitalize on fiber's advantages. With the technical barriers removed, fiber optics successfully competes with coaxial and microwave on cost and performance for point-to-point systems.

A straightforward task

Fiber-optic cable selection can be a very involved technical issue. Fortunately, most reputable cable manufacturers already have encountered most situations, and for them it should be a straightforward task in providing the proper cable. CATV engineers, however, must provide certain information and should be aware of the key technical issues. In particular, they should have an understanding of the following:

Representative cable prices

	0.5 dB/km	0.4 dB/km
4-fiber	$1.96/cable meter	$2.12/c-m
12-fiber	$4.20/c-m	$4.68/c-m
24-fiber	$7.20/c-m	$8.16/c-m

- number of fibers,
- environment in which the cable is to be placed,
- fiber and cable specifications, and
- reel lengths required.

The number of fibers required can be worked out with the electronics vendor. Normally, 10 to 12 broadcast-quality video channels are transmitted per fiber (one direction or bi-directionally). There is a trade-off between the number of channels and the signal quality: The more channels squeezed on a fiber the lower the signal-to-noise ratio will be. Given the number of current channels, the expected future requirements (which may include voice and data

How to buy, sell and repair converters.

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

All makes, all models.

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

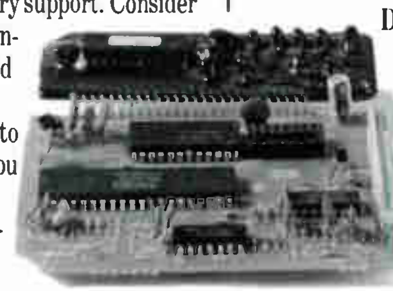
needs than anyone in the business. PTS/Katek buys all makes, all models and sells only to authorized cable systems. If it's not in stock, PTS/Katek knows where to find it.

New Jerrold equipment in stock

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

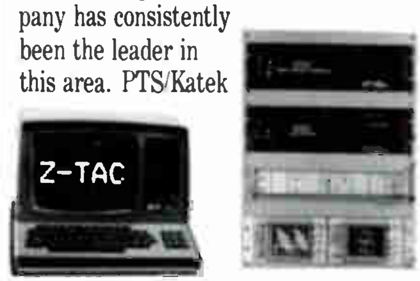
All repair is not the same.

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



Writing the book on addressable repair.

New chapters are being written on addressable repair every month. One company has consistently been the leader in this area. PTS/Katek repairs more addressable than all repair companies combined.



Do it yourself.

If you have an existing in house repair program, you'll find it economical to sub-contract sophisticated repair such as tuners, RF, IF, and decoder modules. Talk to PTS/Katek.

Call toll free today.

Talk to the converter specialists. If you want to know more about buying, selling or repairing converters call 1-800-441-2371.

PTSKatek™
The Converter Specialists

Bloomington, IN Arvada, CO Detroit, MI Indianapolis, IN Jacksonville, FL Jupiter, FL Longview, TX
Newbury Park, CA Norfolk, VA North Highlands, CA Pittsburgh, PA Westfield, MA Yeadon, PA

as well as video) and the acceptable signal quality, it is straightforward mathematics to determine how many fibers are needed.

There are three standard environments—aerially on poles, underground in ducts and direct buried in the ground—that fiber-optic cables are placed. (Two other less common placements—underwater and on high-voltage towers—require more in-depth engineering and pricing considerations.) Cable used in ductwork is the simplest and least expensive design. It is designed with a single polyethylene jacket. Aerial cable is often the exact same cable design when lightning and high voltage are not concerned. (Most standard cable designs incorporate some metallic element that can carry induced currents and cause an arc-over.) If lightning is a major concern the cable can be constructed of all dielectric materials to offer maximum protection. The substituted dielectric materials are slightly more expensive. Buried cable is the most rugged. It is constructed with steel tape armoring sandwiched between two jackets of polyethylene. The armored cable should be rated for vibratory plow-in and should offer rodent resistance.

Fiber specifications are important in assuring that the system will work when the electronics are switched on. Single-mode fiber's main variable is the attenuation specification. It generally can vary from 0.4 dB/km to 0.7 dB/km at 1,300 nm laser or LED operation. The lower the attenuation the further the span length be-

Wave division multiplexing

Information in a fiber-optic system is transmitted by light. The light source, whether LED or laser, operates at a specific wavelength that, for single-mode systems, is nominally 1,310 nm. The 1,310 nm wavelength was chosen because 1) it is above the cutoff wavelength of 1,270 nm (the point where a single-mode fiber would gain the unwanted characteristics of multimode), 2) it is a local minimum for attenuation, 3) it is in the zero dispersion range of a fiber and 4) it is economical to produce lasers and LEDs that operate at this range.

In reality, for a laser or LED, the wavelength output may vary 20 nm about 1,310 nm due to manufacturing specifications or operational drift. At the other end of the system, the receiver is designed to detect a broad range of wavelengths in order to account for such variations.

One of the powerful characteristics of fiber-optic light guides is that two or more separate wavelengths (i.e., 1,300 nm, 1,328 nm, 1,267 nm, etc.) can be multiplexed and transmitted on the same fiber without causing signal interference. For each wavelength utilized there is a proportional increase in the information carrying capacity, i.e., doubled if two wavelengths are used and tripled if three are used. The ability to multiplex different wavelengths (called *wave division multiplexing* or WDM) in theory gives a fiber system unlimited information carrying capacity.

As what normally happens, what looks great on the drawing board does not translate readily into practical applications. One problem is the availability of usable wavelengths. As noted, most optical components in production operate over the range 1,290 to 1,330. Since the detectors cannot distinguish the difference between 1,294 nm and 1,312 nm, it would be useless to try to utilize any more than one wavelength in this region until narrower spectral width lasers and detectors are developed. This forces the user to look at a wavelength range either below or above 1,290-1,330. The single-mode cutoff wavelength at 1,270 nm prevents one from going lower and the OH– attenuation peak prevents the use of wavelengths directly above. The next attenuation minimum occurs at the mid-1,500s, which is where manufacturers have worked to develop optical components.

WDM systems using 1,310 and 1,550 are commercially available and already are being used for cable TV. However, for initial systems applications, it is normally cheaper to use a second fiber, transmitter and receiver than to install WDM. The WDM equipment tends to be relatively expensive. Where WDM becomes effective is in the upgrading of an existing fiber system that has reached its capacity limit.

tween electronics. As a calibration, a 0.5 dB/km attenuation should allow transmission to reach over 30 km unrepeated. Fiber should be specified either as a maximum attenuation on the reel or in the case of a systems approach, as a maximum attenuation end-to-end. In either case, verification of attenuation of each fiber should be made by the supplier just prior to shipping. In addition, all fiber should meet or exceed the 1,300 nm spec when operating at 1,500 nm, which will allow for future upgrading using wave division multiplexing (see sidebar).

Other key specs associated with the fiber (with typical values) are as follows:

1) Dispersion—maximum 3.5 psec/nm-km at 1,300 nm and typically 17.0 at 1,550 nm.

'Fiber-optic cable has a little bit of a Dr. Jekyll/Mr. Hyde complex'

2) Cutoff wavelength—1,200 ± 70 nm.
3) Refractive index difference—0.3 ± .04 percent.
4) Mode field diameter—10.0 ± 1 micron.
5) Core concentricity—less than or equal to 1 micron.
6) Zero dispersion range—1,310 ± 15 nm.

The cable specifications are important in assessing the quality of the product. Fiber-optic cable has a little bit of a Dr. Jekyll/Mr. Hyde complex. On the one hand the glass fiber is inherently a fragile material easily damaged. On the other hand, if packaged properly, the cable as a unit can take a beating while withstanding environmental extremes and still have a lifetime of well over 20 years. The key is to make sure the manufacturing process is done correctly.

While there are variations on cable design, the following descriptions are based on the time-proven, loose-tube design.

Buffering—the fibers are housed in a color-coded loose tube(s), which are filled with an inert waterproof compound. (Avoid tight buffered cable in the outdoor environment.)

Stranding—the buffer tubes are stranded around a steel (overcoated with polyethylene) or dielectric central member. The stranded unit should be lashed with a polyester binder to maintain the integrity. The central member provides anti-buckling strength, but little tensile strength.

Interstitial fluid—the cable core should be filled with an inert waterproof compound to prevent moisture ingress.

Tensile strength—a synthetic strength member (e.g., Kevlar) should be incorporated around the central core providing at least a 2,700 N (600-pound) pull rating.

Jacket—the cable jacket should be ultraviolet-resistant polyethylene and marked permanently with the manufacturer's name and cumulative meter markings.

Temperature performance—minus 40 to plus 70 degrees Celsius with no increase in attenuation at 1,300 nm.

Fiber guarantee—100 percent of the fibers should be working. Some manufacturers who lack precise control of the manufacturing process put in spare fibers to cover those that will be broken during the run. Not only does this indicate poor process control, but it will create an administrative headache in trying to track the good fibers once the cable reaches the field (especially during emergency restoration when time is critical).

Fiber-optic cable is manufactured in standard reel lengths, typically in 2 km through 6 km in increments of 1 km. A few manufacturers can produce continuous reels up to 12 km. If non-standard lengths are needed, the cable can be cut to order. However, this involves leftover cable that may or may not be usable, and therefore a surcharge frequently is added based on the unused portion.

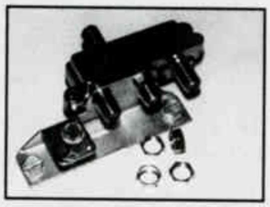
Once the preceding parameters have been determined, the price of the cable can be developed. Pricing normally is based on a cable design suitable for duct installation (least expensive design). It is given on a per cable meter basis with fiber count and attenuation grade as the main variables. Different cable criteria such as an all-dielectric design or steel tape armoring involve price increases that can be incorporated into the per cable meter price or stated in terms of a price addition. The accompanying table reflects some representative cable prices. ■

New Products from Sachs Communications Inc.

The SC18 series Saxxon Clips that are ever so popular have just had their price reduced at the MSO level. This reduction is mainly due to the mechanization of the assembly process of these clips using the new "robot". This has the capacity of doubling the production output of the product. Presently, the clips are available in three sizes: 6mm for RG59 cables; 7mm for RG6 cables and 8mm for Quad cables. The company now also produces these clips painted in black.

The new SC28 series identification tags from Sachs are made of special MG10 aluminum alloy, which permits the installer to scribe/write any information that may be required. There are three variants in the series: 3¼" long, 7" long and 7" prestamped, with a company name or logo, for example, as desired by the custumer. There is no additional charge for prestamping except a small initial stamp preparation charge. **The SC29 series** I.D. Flags are for identifying coax cables but at 1" length, are much smaller than the SC28. These are available in plain MG10 aluminum alloy for scribing on or painted alloy, in literally any colour desired.

Other new items: To add drops to an existing clamp, Sachs is now producing the **SC03EK** kit to attach to a previously installed SC03E Span Clamp. This saves the time of a second installation and saves on hardware costs as well. **The SC23 series** tap brackets come in two inch or four inch heights with vertical or plain type clamps and with or without common grounding. **The SC24** series tap brackets are for wall mounting situations of taps such as in appartments. The two types are for taps facing down or taps facing out.



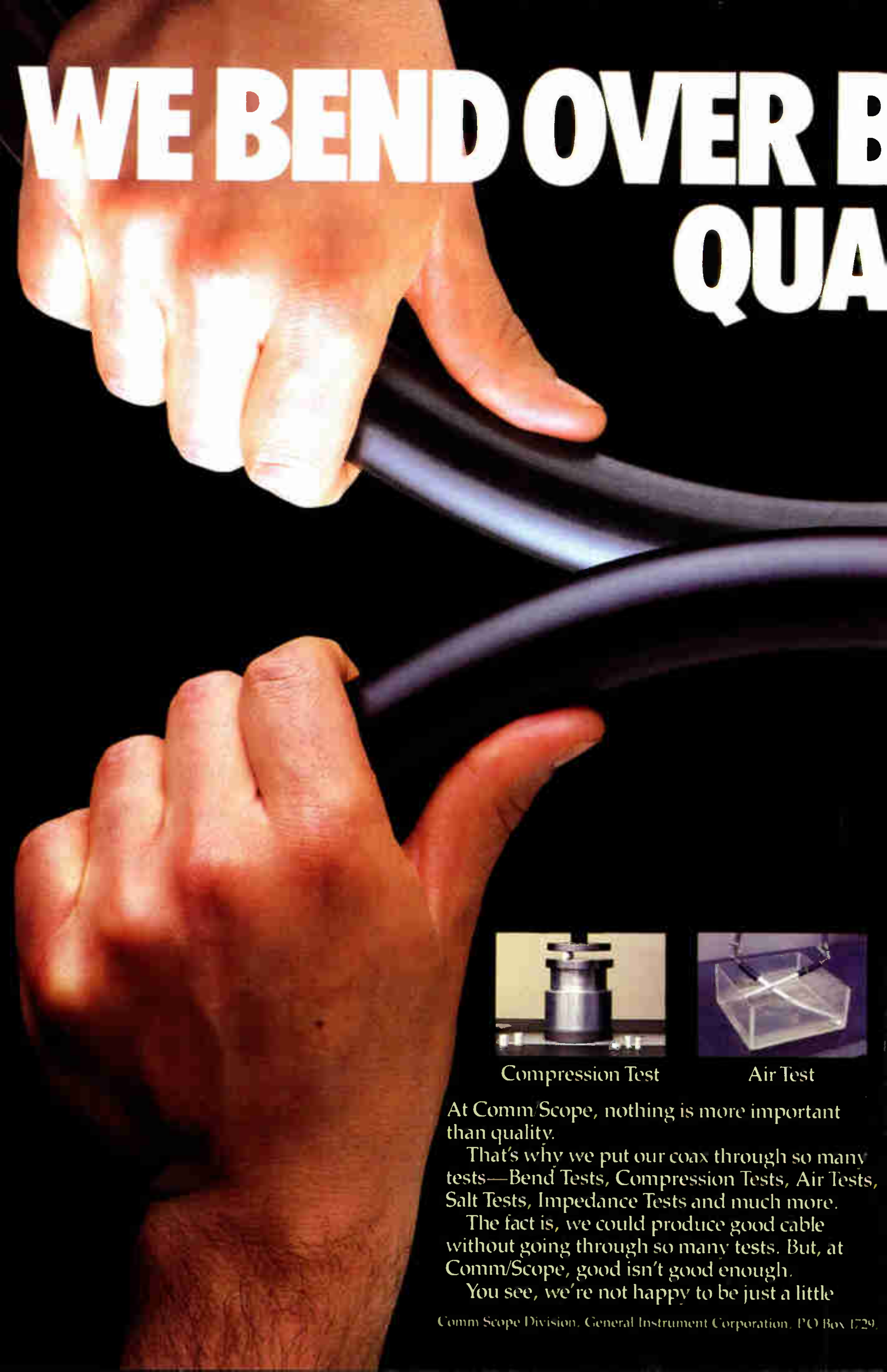
The SC12 & SC12D series of ground brackets and the SC13 ground straps are now UL Listed. The SC12D - S81 includes one F81 connector, permitting a second one to be added later on. It also permits the addition of a splitter whenever required using the **SC09 Splitter Ring Nut.**

The SC22 series Ground Connectors are available for #4 or #6 wire, copper or cadmium plated, to attach to copper pipes or various fixtures.

The SC26 House Hook is for messenger applications. It has an oval head, where the messenger is wrapped, thus eliminating the need for other hooks.

Contact Sachs Communications Inc.
30 West Service Rd.,
Champlain, N.Y.
12919-9703
1-800-361-3685,

Reader Service Number 45.


WE BEND OVER B
QUA
Compression Test
Air Test
At Comm/Scope, nothing is more important than quality.
That's why we put our coax through so many tests—Bend Tests, Compression Tests, Air Tests, Salt Tests, Impedance Tests and much more.
The fact is, we could produce good cable without going through so many tests. But, at Comm/Scope, good isn't good enough.
You see, we're not happy to be just a little
Comm/Scope Division, General Instrument Corporation, P.O. Box 1729,

ACKWARDS FOR
LITY.

Salt Chamber Test

Impedance Test

better than everyone else. We want to make sure they don't even come close.

For more information on how we bend over backwards to bring you quality products, first rate service and on-time deliveries with our own carriers, just call 800/982-1708 or 800/222-6808 in NC.

COMM/SCOPE. WITH YOU ALL THE WAY.

Hickory, NC 28603, 800 982-1708 (800 222-6808 in NC), Telex: 802-166

GENERAL
INSTRUMENT

Reader Service Number 47.

Figure 1: Deviation of loss over frequency range

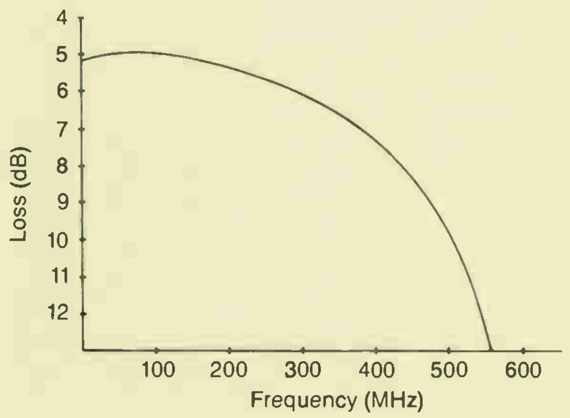
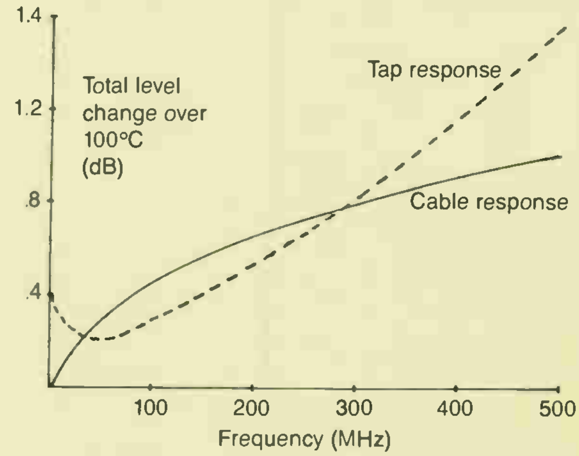


Figure 2: Thermal behavior of taps and cable



Computer-aided design in a tapped trunk environment

The increasing diversity of CATV plant presents opportunity as well as liability for system designers. As they explore the frontier for new sources of revenue, they are challenged by a departure from the familiar demographics of the large urban areas where the population density is fairly homogeneous. They are faced with lower densities and increasing costs with less revenue potential. There usually is less technical expertise available to cope with system maintenance, but there certainly is no lack of desire for access to the media.

Tapped trunk designs, which unify the previously segregated functions of trunk and distribution, are frequently the best method of serving these needs. However, there are a few special problems involved in extracting the economy and performance potential. The added design complexity of the tapped trunk cascade, together with the iterative nature of the system design process, strongly implies computer analysis so long as there is a high degree of certainty in the methodology of prediction.

By Bob Romerein and Dan Kolis
Lindsay Specialty Products Ltd

No doubt everyone is familiar with the view from an airplane window. The countryside bears a resemblance to a microscopic view of cellular material with scattered nodes of activity con-

Figure 3: Computer-aided design program

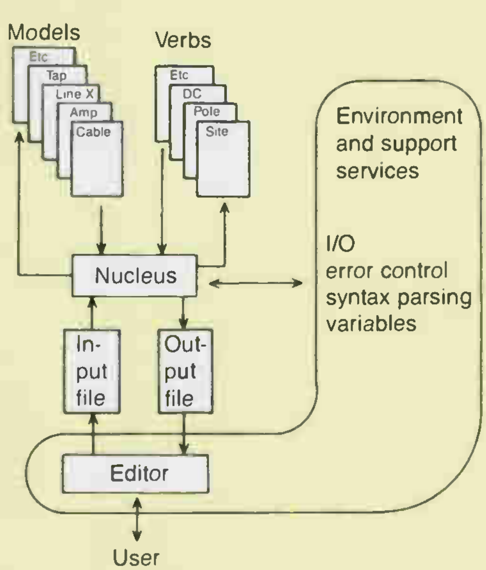
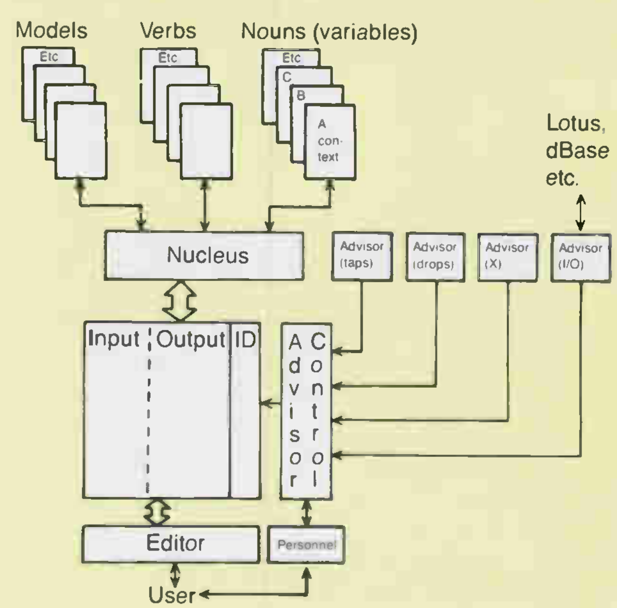


Figure 4: Optimum design of computer program



Salt Chamber Test

Impedance Test

better than everyone else. We want to make sure they don't even come close.

For more information on how we bend over backwards to bring you quality products, first rate service and on-time deliveries with our own carriers, just call 800/982-1708 or 800/222-6808 in NC.

COMM/SCOPE. WITH YOU ALL THE WAY.

Hickory, NC 28603, 800 982-1708 (800 222-6808 in NC), Telex: 802-166

GENERAL INSTRUMENT

Reader Service Number 47.

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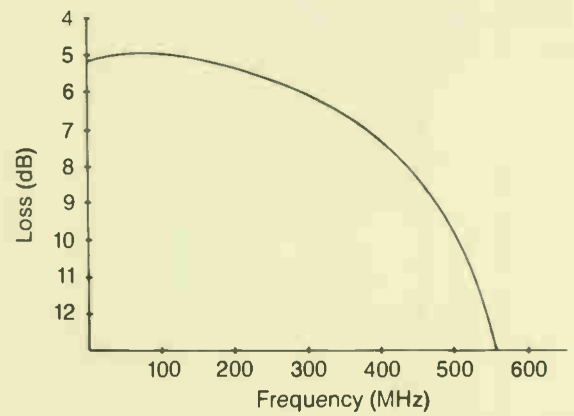

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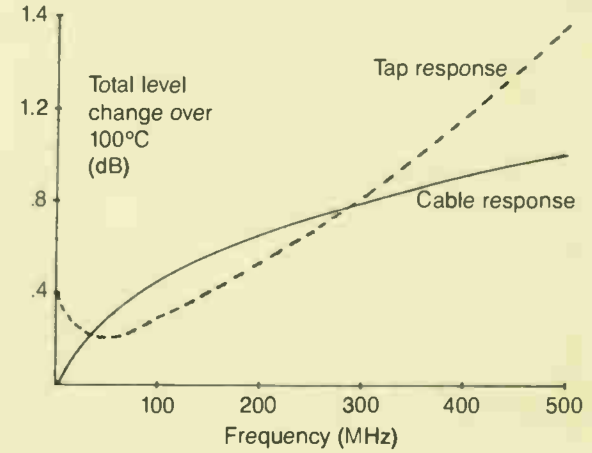

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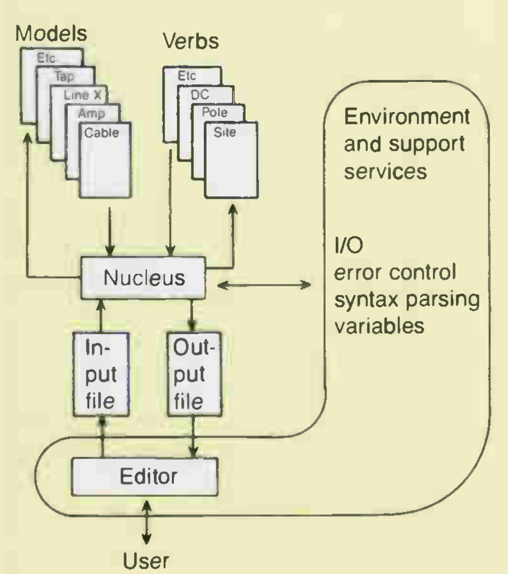
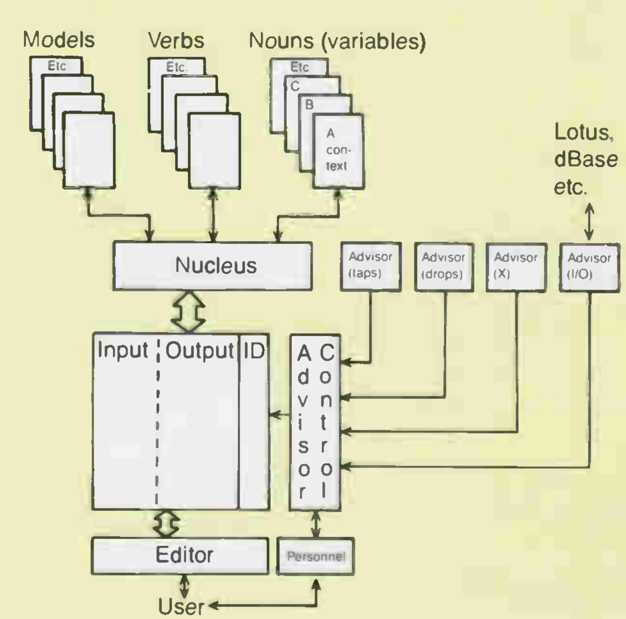


Figure 4: Optimum design of computer program



'The existence of a truly superb cable design program for general use would benefit cable operators to a significant degree'

nected by a network of arteries. The density patterns are irregular. Many of the arteries have smaller nodes randomly distributed along their length. This visualization is helpful in establishing a sensitivity to the lack of generality in the design. Rural systems are a string of special cases.

The Rural Electrification Administration (REA) has studied rural demographics carefully in an effort to assess the technical and economic considerations of these marginal applications. The basic design philosophy that it has found to be economically appropriate in delivering acceptable quality signals in these areas is to combine the conventional concepts of trunk and feeder plant. Noise and distortion are distributed equally throughout the system by adopting one transmission level that is typically halfway between conservative trunk levels and high-powered feeder levels. Subscriber taps also are allowed to exist on the primary signal path.

The system design concept that has evolved from studies of this nature has come to be known as *tapped trunk*. The benefits of this approach are, first of all, a substantial reduction in the amount of cable necessary, since backfeed situations virtually are eliminated. While backfeed is often a very useful tactic in dense urban areas, it becomes a burden in cable costs when the distance between subscribers increases.

Other savings are realized in the inevitable reduction in amplifiers as well. There is less cable loss to overcome, and the amplifier spacing is increased due to the higher transmission levels.

For example, in a conservative tapped trunk redesign of a trunk and feeder system built outside of Orillia, Ontario, we uncovered a savings of 16 percent in cable material costs. We also discovered a cost savings of over 30 percent in amplifiers; however, this effect seems to be a measure of the economy of distributed simplicity as opposed to concentrated complexity in amplifier design, rather than simply a reduction in amplifier numbers. It is true too that maintenance becomes easier with identical amplifiers set at identical levels. Even the cable can be made uniform in the smaller systems. Uniformity is intrinsically cheaper and can be especially attractive when the access to skilled technical personnel is scarce.

The tapped trunk concept is not essentially new. Back in the early days of cable technology, when the notions of hardware methodology were similar to plumbing, there was a nasty device called a "pressure tap." Basically, this was a type-F connector that actually penetrated the main coax. A simple resistive attenuator inside the connector tapped off a portion of the signal for each subscriber. However, it ignored the parameters of isolation and return loss, so the problems encountered with reflections—not to mention the damage to the cable—were discouraging.

In retrospect, it seems likely that the tapped trunk concept was abandoned along with the pressure tap, and the two have remained linked in the minds of many of those who have by now ascended to positions of authority in the cable industry. Resistance to the belief that the tapped trunk is even worth considering seems to be couched in a blanket distrust of the integrity of subscriber taps in general.

Modern directional taps

The state-of-the-art multitap is produced in high volume and marketed much like a commodity. Its function is taken virtually for granted. Performance specifications tend to be used as marketing tools rather than design criteria. Yet, there seems to be a cloud of uncertainty about its presence in the primary signal path.

The design process involved in manufacturing a series of taps is a mixture of science and black art. There are seven parameters to optimize simultaneously and, even though most of them have a common link with the characteristic impedance, the outcome is a matter of destiny. The insertion loss is the most significant consideration with respect to its effect in cascade. It still is referred to as flat loss, which is quite reasonable in a 220 MHz world.

But this assumption is no longer valid as bandwidths increase. While there are slight variations in the signature with each tap value, the overall effect is a build-up in level in the mid-band followed by a gradually increasing rolloff in the hyper-band. Any effort to design out this effect to preserve the simplifying assumption that the insertion loss still should be flat inevitably will have to sacrifice some other parameter. However, it is unlikely that tapped trunk systems will be loaded beyond 300 MHz anyway. (The basic premise of the design philosophy is economy in marginal applications, and there are escalating headend and maintenance costs as the channel loading increases.)

So, within this perspective, the deviation from the flat loss assumption will be easily manageable with simple mop-up techniques. Idiosyncratic variations from tap to tap will tend to cancel randomly, and cable loss betweeen taps will limit the build-up of reflections.

Figure 1 is a wide bandwidth view of a cascade of five multitaps typical of the values found in a tapped trunk cascade. The deviation from ideal flat loss is apparent by drawing a straight line through any two points on the curve that represent the upper and lower frequencies of a given bandwidth. It also is apparent that as the bandwidth becomes wider the deviation becomes greater.

Changes in the thermal environment have an impact on everything, including taps. The concept of flat loss is eroded further by the findings of a study of insertion loss vs. temperature during a recent multitap design program at Lindsay. It was found that the variation in the insertion loss of a cascade of taps is frequency dependent. Unlike cable, the variation is not a given percentage of the loss. Each tap, regardless of its insertion loss, has roughly the same variation, which is a function of temperature and frequency only. The effect over wide bandwidths is to accentuate the deviation from the ideal flat loss mentioned earlier. The thermal equation predicting the thermal response of a span of cable containing a given number of taps should be modified to include the equivalent cable contribution due to tap behavior. The contribution appears to be significant enough to be considered in system design calculations.

Figure 2 shows the thermal behavior of a cascade of five taps compared to the thermal behavior of a length of cable. The cascade was found to exhibit a level change of 0.8 dB at 300 MHz over a temperature change of 100°C. A 4 dB length of cable will produce the same level change, so we can say that each tap is comparable to one-fifth of this piece of cable. In other words, it has an equivalent cable length of 0.8 dB regardless of the tap value. The actual thermal change contributed by each tap at 300 MHz was found to be 0.16 dB.

Another concern to those uninitiated to the tapped trunk environment seems to be the intrinsic reliability of the tap in the system. There undoubtedly are vast quantities of data available in the maintenance records of cable systems around the world. We examined the maintenance log of our system in Lindsay, Ontario, to get some idea of the maintenance liability of introducing taps into the main line. We serve about 5,600 subscribers through 64 miles of cable. The evidence uncovered in the log indicated that over the last five years seven of the 1,150 taps failed. This represents a 0.12 percent failure rate per year.

Failures in connectors also were of interest since the tapped trunk architecture imposes a greater liability on the main signal line with a greater number of connectors. This accounted for eight failures out of a total of about 3,300 connectors, or 0.05 percent per year. Interviews with service personnel indicated a belief that the reliability of each connection rested heavily on the workmanship involved in the installation. This, then, seems to be a local variable to be assessed on an individual basis.

Reality check

The REA has provided excellent documentation on the performance of an actual tapped trunk system, showing how well the calculated system parameters correlate with actual measured results. Its studies have identified several of the frontiers of experience with the tapped trunk concept, and have demonstrated that performance and cost estimates in this domain can be made with a reasonable level of confidence. For example, cascades of 40 amplifiers supporting 150 passives in series are conceivable for bandwidths up to 300 MHz. The distortions arising from reflections in a system this size are expected to be visually undetectable, based on extensive video tests conducted at the tapped trunk system in Edinburg, Va. Group delay in a one-way system of this size is on the order of 200 nanoseconds negative on Channel 2 and about 120 nanoseconds negative on Channel 13.

Unfortunately, the program of rural cable television development at the REA was truncated by a federal policy decision shortly after the Edinburg study, so the continuity of development in this field has been fragmented somewhat. Undoubtedly, the frontiers will be pushed back further as greater risks are taken to exploit the potential cost savings of tapped trunk designs. William Grant, who headed the REA development program, estimates savings on the order of 20 percent over the conventional trunk and feeder approach.

When given the opportunity to make several small system design proposals, we were struck immediately by the diversity of the population density. Tapped trunk design seemed to be appropriate for part of each project; however, there were areas of higher density where the technique was clumsy and placed an unnecessary burden on the integrity of the trunk. We felt compelled to develop a computer-aided design tool that would be driven not by simplifying assumptions, but by a sensitivity to the demographics, the hardware and the costs.

The program we designed supports many capabilities meaningful in exploring tapped trunk cable plant. Some of these tasks include:

1) Capturing strand and demographic information into an accurate, maintainable data base.

Table 1: Computer program verbs

CABLE? = N	: ft. of special cable
CABLE5 = N	: ft. of .500 cable
CABLE7 = N	: ft. of .750 cable
TAP	: calc. tap value
DC? = N	: specify coupler
AMP = N	: specify amplifier
NOTE = T	: remark
GAINON	: normal amp placement
GAINOFF	: no amp placement
FL = N	: specify flat loss
REPORTLOSS	: loss summation
REPORTBUMPS	: bumps summation
RESETLOSS	: loss reference pt.
RESETBUMPS	: bumps reference pt.
A. T = N	: assignment
SETCABLE? = N	: specify cable

2) Allowing speculation as to modes of service to that region.
3) Examining this speculation from a number of facets such as costs, RF degradations, temperature, etc.
4) Generating bills of material and other documents meaningful to technical and financial professionals.
5) Modeling suboptimum device performance to study how this affects cable systems.

The program was authored on an Apple computer and written in BASIC under the CP/M operating system and Microsoft BASIC. This choice was not optimum but did not function as a constraint.

The eventual bounds of a program's capability are determined by initial premises that later become limitations. In exploring other computer-aided methods in use in the cable industry, we became aware of approaches that are intrinsically suboptimum. The most common (and painful) tactic was a preoccupation with the visual representation of the cable plant. Conspicuous by its absence in the foregoing list of objectives is rendering of the final design as a drawing. A bent to automating the drafting side of the design process is a problem that may have begun as an ill-directed cost control measure. Casual analysis of the costs to design a plant may show drafting as a significant, if not outstanding, cost. This is true only if the instantaneous costs are evaluated. Costs occurring downstream in unnecessary cable, line extenders and labor during construction, as well as the long-term burden of unnecessary actives, must be comprehended fully. Ensuring that our software effort would not encounter a limitation before it reached its goals was difficult. We utilized a combination of techniques to maintain generality in the core of the program early in the authoring process. It sometimes is said, "Every complex system that works began as a simple system that works." This certainly is true in software development in general and this program in particular.

The program, diagrammed in Figure 3, is composed of a small nucleus of code that refers to a library of models of the devices under study. The emphasis here is on "small" and "devices under study"; we were careful to leave these pieces of the program totally free of non-essential complexity. The support services, such as text control and syntax parsing (turning the program into a custom programming language of sorts) are very large in comparison. This portioning of the program to isolate the model is very important. It allows the researcher to consider a particular model in isolation, change it and see how this affects the cable design.

Another important black box inside the program is the verb dictionary; in the context of computer languages this precise kind of dictionary is called a *lexicon*. The function of the lexicon is to specify what must be done upon encountering each word in the directions. What "must be done" is specified as a series of transformations, which are specified as models. The things they are done to are the elements of the environment, which are any entities that have both names and values. Of course, what knits these black boxes together is the nucleus. The nucleus is simple, but calls up black boxes of significant complexity. The overriding concern of the nucleus is as simple as its structure; from its perspective the conclusions are byproducts of reading through the directions looking for the special verb called "END."

The content of the lexicon and transformations in the models characterize precisely what the output file will contain. No other portion of the program will affect the environmental values. Thus improvements in input/output, editing or other subsystems will not affect the calculations and/or results.

The first pass of the program had a repertoire of seven verbs. This was barely adequate to perform a tapped trunk design requested for a small site in Hawaii. By the time we were ready to attempt a system of non-trivial size, the lexicon contained more than 20 verbs. Table 1 contains some of the verbs and how they are evoked in the current implementation. Many of the additions do not direct the cable plant design, but produce condensed reports of one kind or another. Examples of this are the pseudofamily of "report" commands, which show how loss was accumulated (useful in deciding on the relative merit of AGC vs. thermals), and "bumps" from non-flat loss devices. Procedurally it appears that the commands and/or verbs do fall into categories, such as "reports," "resets," "assignments," "devices," etc. This adds a linguistic uniformity useful as a memory aid for the researcher but has no impact on the machine's implementation. All verbs point to the lexicon, which directs the models to change the environment. There are no exceptions and the verbs do not directly modify or reference each other in any way.

Inadequacies and extensions

A significant flaw in the first implementation was its inability to elegantly handle how branches of the system interrelate. This was the primary drawback of authoring this program in a non-recursive language such as BASIC. The only approach to this important aspect is to model the system as a large linked list that should be memory resident. This implies an implementation in Pascal, Lisp, C, Snobol or even Ada. It implies a fairly large memory as well.

It probably is possible to do such a wholistic analysis on the most powerful of personal computers with the addition of lots of extra memory. Another inadequacy of our implementation, also stemming from the language, was how slowly the most complete version ran. Waiting for an end-to-end analysis for the Orillia plant was an ordeal. However, the exhaustive nature of the analysis generates a pleasant certainty that the design is valid.

As is always the case with technology, our effort supplied us with a few answers and generated a multitude of questions; most importantly, what would be the general shape for an optimum program? We have pondered this thought and will present some further directions. In some ways it is similar to what we have written but is substantially more open-ended. Figure 4 may be helpful in visualizing these principal points:

1) The central nucleus should be highly interactive. Primarily this means clarity and speed are of the highest priority.

2) The source files should be amenable by software entities just as if these changes were done by the researcher/designer. The concept of "in" and "out" should be softened to meld both into one entity with two "flavors." When decisions on what to do are made, the entity that made them should initial the entry. The concept here is that input files transform into conclusions in a stepwise fashion.

3) The environment variables should be more contained and multiple values for a given variable should be allowed to exist depending on context. An example of how to utilize this function is that a branch, when explored, would seem a self-supporting system independent of the whole. Also, variations of the entire design can exist for comparative purposes.

4) Entities called *advisors* could inspect in real time any value or event occuring. These entities could be activated or deactivated with ease. Expansion of the program's power would be done by adding advisors. Some might be large. Examples of potential advisor specialties are represented by their names: tap placer, amp placer, drop placer, constructor, maintainer, debumper, reliability watcher, reverse watcher, etc.

5) Considering all the variations of reports that may be required is a mind-numbing task. What all "pure" reports have in common is that they are passive. That is, they look at but do not change the design. An advisor could be charged with interfacing with external spreadsheet programs. An example of an appropriate use for

(Continued on page 64)

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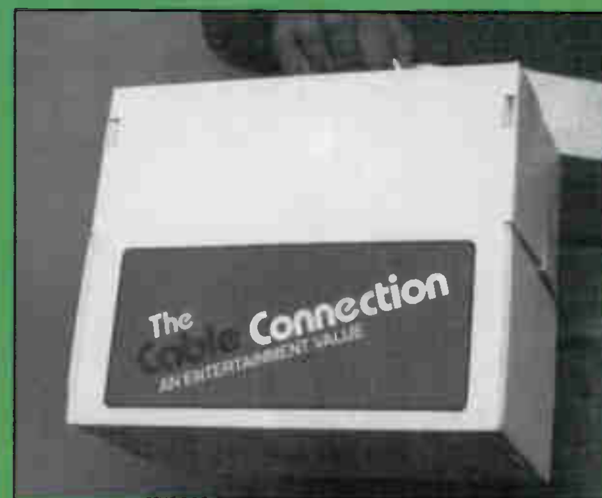
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(Continued from page 52)

such a function would be to move bills of materials and labor estimates directly from the program into accounting tuned spreadsheets such as Lotus 1-2-3. This would allow economic planning vs. time estimates to transpire without reprocessing this information. Also, summaries of all different systems could be merged into regional-type reports for comparative analysis and/or presentation. Using intermediary languages such as dBase II for this would allow merging with addresses, pay TV records, outage history make-ready directives and a mass of other knowledge useful in other aspects of the cable operation.

6) An intrinsic method of marking boundaries into the source file should exist. In text, for example, paragraphs, sentences and punctuations put words into context. The analogs in a cable system are street names and regional demarcations such as "North Ward." These should be supported elegantly.

There is no doubt that this agenda is extensive. It is fortunate that writing the initial portions, such as the nucleus, is not significantly constrained by future inclusion of more complex functions. Any effort to write code of this sort is a major project and the architecture of the program should be documented and understood in significant detail before any work begins.

The existence of a truly superb cable design program for general use would benefit cable operators to a significant degree. It would be of particular value in tapped trunk, where the interconnectivity of the plant is a particular opportunity for clever methods and careful, clear logic to yield savings.

How likely is such a program to exist in the near future? This is a difficult question that we cannot answer. However, there are some encouraging trends. First, there is an increasing awareness that designs in circulation can and should be improved; this is clear from our external communication with our customers as well as recent articles about suboptimum designs. Second, the general trend of literacy is benefiting the cable industry. A recent program that may be available commercially has been written based on a linked-list model. It is written in Pascal and is fast and clear. Hopefully, those responsible for design in the cable industry can encourage more programs of this caliber to be authored and made available. (Those interested in this particular effort, can contact Frank Himsl of CableNet in Oakville, Ontario.)

An embryonic level

Both tapped trunk and extended accuracy of computer modeling in cable environments are at an embryonic level of development. This leaves the system operator/designer in a difficult position; in order to achieve savings some exposure to risk must be tolerated. We had hoped to define where and when tapped trunk was appropriate and be able to state this with relative certainty.

We believe our effort yielded results between certain success and total failure. On one hand we can state with certainty that the reliability of taps and connectors has reached a satisfactory level to consider tapped trunk systems and that effects of temperature and signature in concert generate tolerable distortions of the passbands at frequencies up to 300 MHz. The commonly held belief that the normal distribution of tap values have signatures that do not generate summed massive distortions is borne to be true using computer, manual and experimental analysis. We also can state that in the isolated cases of two particular cities tapped trunk resulted in a 20 percent savings in material costs alone.

The existence of a successful system built by the REA proves a system with 18 amplifiers and 74 passives in line can work. Extrapolating the REA experience and combining that with our studies, it would not be difficult to support the claim that a system of twice that size is viable. No intrinsic barrier to construction of the 400 tap system (Orillia) seems apparent, especially considering the slight branchedness imparted there to be conservative. The actual length of this tapped trunk cascade was only 17 amplifiers deep. The REA projected the upper limit of tapped trunk technology to be about 40 amplifiers with between 100 and 200 passives.

It is our hope that the contours between pure tapped trunk, moderation of trunk and feeder with tapped trunk, and classical design will become clearer as systems in the safe regions of design philosophy are constructed. Experimental knowledge of this type then can be used to tune the computer model, which, in turn, decreases the likelihood of experimental systems becoming liabilities.

We indeed are fortunate to have an opportunity to work with an informed and well-managed system operator and soon may embark on such a multi-faceted, multi-site project. It is encouraging to be part of an exploration linking the efforts of the design, manufacturing, operations and finance phases of the cable industry into a cooperative unit. Perhaps the experiment in corporate communication is as meaningful to the cable industry as the technological and economic advances under study.

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Acknowledgements: Special thanks to Barry Harper and Lynn Taylor of Lindsay Cable for their assistance in providing data relative to their system. Thanks also to Don Sterling and Ken Lynes of Lindsay Specialty Products for their advice and cooperation in making this study possible.

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Reader Service Number 56.

Headend alignment procedures

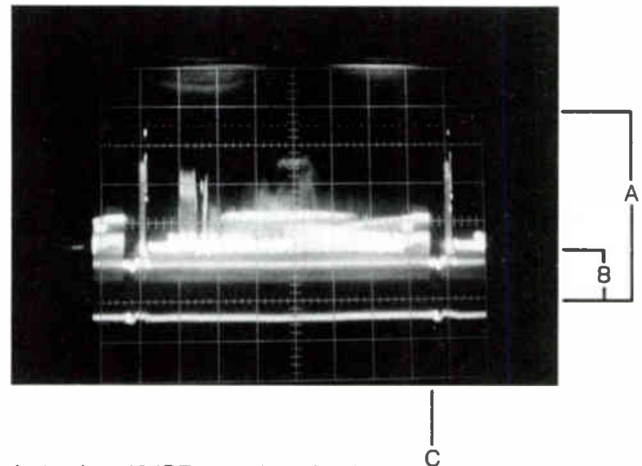
Good headend setup starts at the receivers. This is the point at which you have some control of the signal that is sent via the satellite. These receivers are the lifeblood of your cable system and if not adjusted correctly can cause a fair amount of problems with converters, decoders and customers' TV sets. The setup of your receivers is to keep the video output—this is the part of our service that the customer is paying for—within the standards required by the equipment to produce a usable picture for the customer. The purpose of this article is to run through a complete headend alignment.

By Chris Radicke
Electronics Technician, Republic Cable

The first step in headend alignment is to check the output of the receivers, using an oscilloscope or waveform monitor. At the output of the receiver you want to have 1 volt of video. This measurement should be from sync tips to peak white (Figure 1), or sync tips to the highest point of the VITS (vertical interval test signal), as shown in Figure 2.

Place the oscilloscope in the DC-coupled mode, and place the volts per division at 0.2. With the volts per division at 0.2, five divisions equal 1 volt. On the display there are two dotted lines five divisions apart. Having the scope DC-coupled will allow easy positioning of displayed signal. Next, position the sync lines on the lower dotted line. This lets you know that the displayed signal is within the two dotted lines and also allows you to see the sync to blanking level. The difference between the sync to blanking level will be .3 volts (1½ divisions). This is a good thing to remember when there is not a VITS to use and if you are not sure that the white level present is peak white. If a VITS is present, then the highest peak white to be available would be in the VITS signal.

Figure 1



A. 1 volt—140 IRE	2 μs time/cm
B. 3 volts—40 IRE	.2 volt/cm
C. Vertical interval	DC clamp

Remember that some services now are scrambled. In this case you might tune to another transponder and check the output of the receiver. Normally this will leave the video output within two-tenths of a volt. If you need to tune to another transponder, do not forget that the customers also are watching. After completing this you would need to check the AGC

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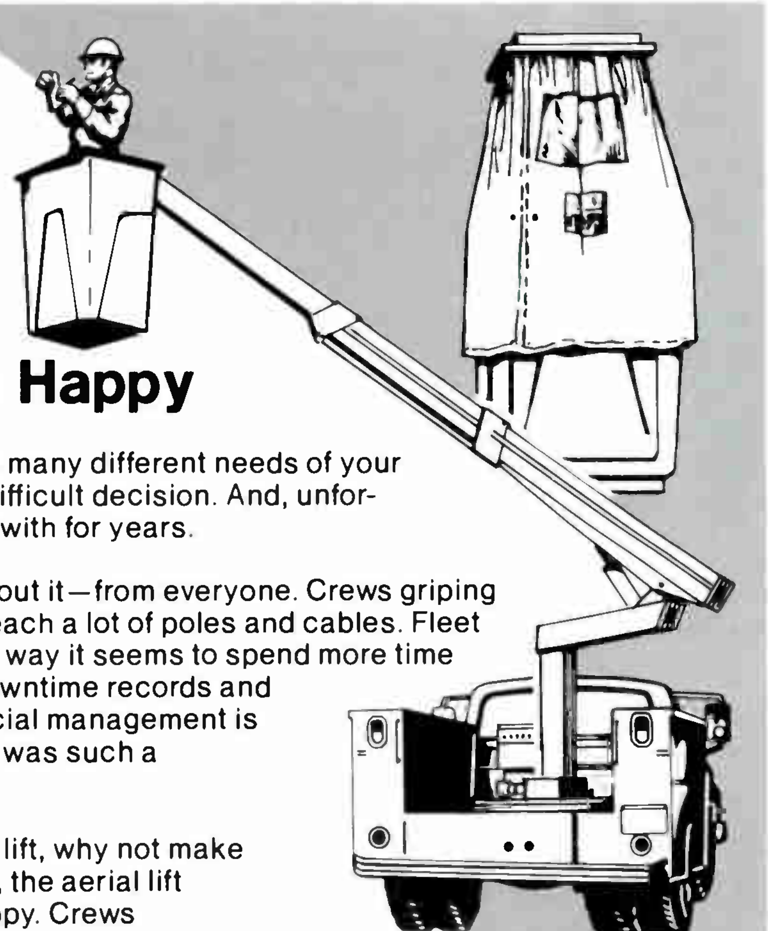

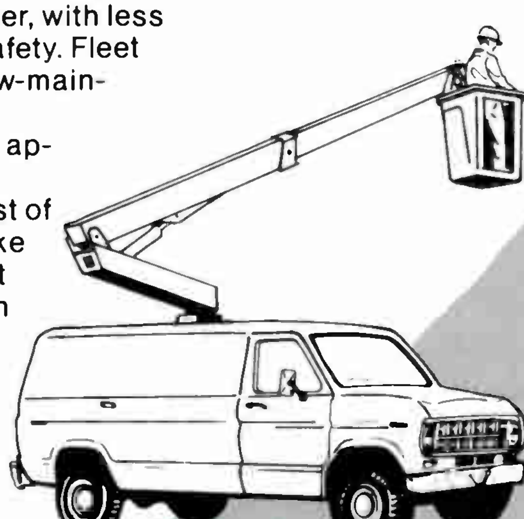

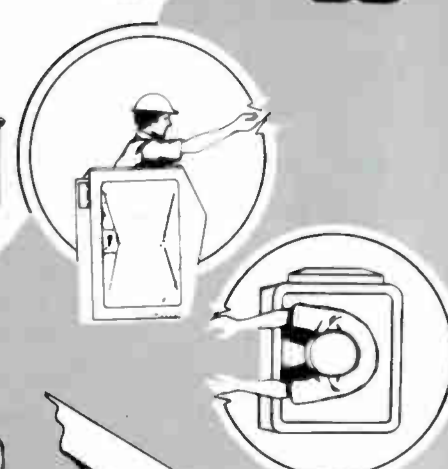

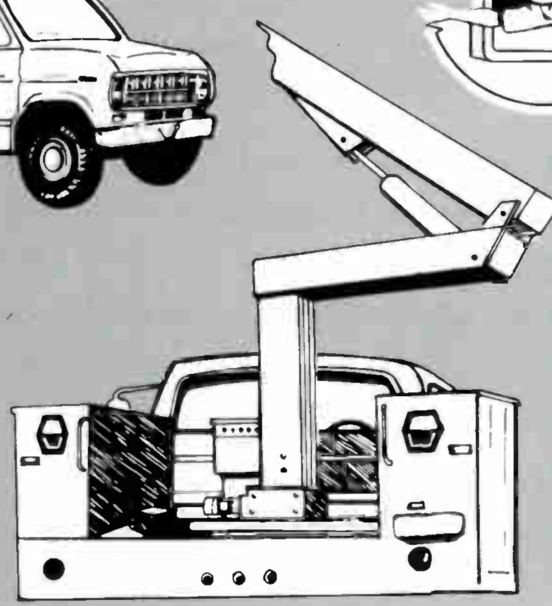

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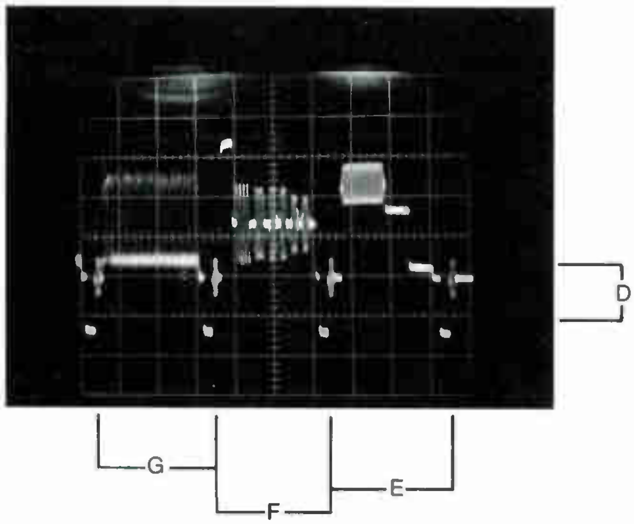
Figure 2



D. Sync (40 IRE)—(0.3 volts)
E. VIRS
F. Multi-burst
G. Teletext data

2 μs time/cm
.2 volts/cm
DC clamp

(automatic gain control) voltage at the VideoCipher II. This voltage is to be set at 4 volts $\pm$.2 of a volt.

After setting the video level you should check the video input at your encoder system. This usually is done by removing the loop-thru terminator (Figure 3) at the input of the encoder unit. At this point you also would be looking for 1 volt sync to peak white. Always remember that when us-

Figure 3: Checking video input at encoder

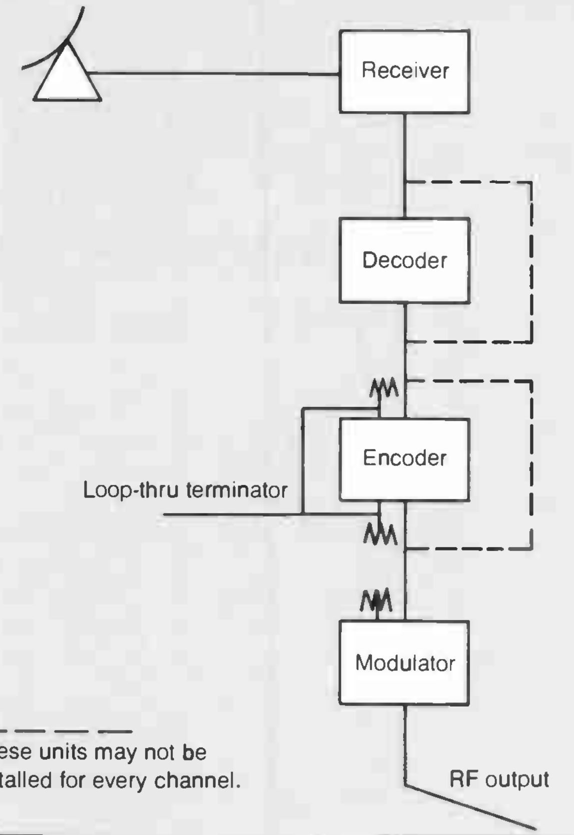


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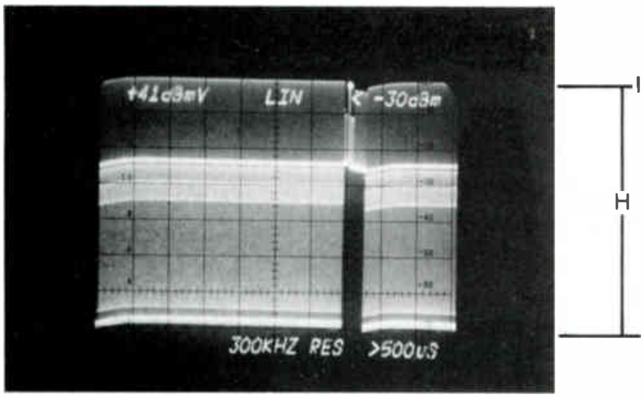
Figure 4



H. 87.5% modulation = 7 divisions
I. Sync tips on reference line

Time base .5 μs
Resolution 300 kHz
Frequency span/division

ing an oscilloscope to have a 75-ohm termination, unless otherwise noted.

After checking to make sure that you have 1 volt of video at the input, replace any terminations that you might have removed. Next, look at the output of the encoder. Most units will give a specified test point and procedure for alignment while scrambled. After completing correct scrambler adjustments you are ready to move on to the next step.

Setting depth of modulation

The depth of modulation is done correctly using a spectrum analyzer. Tune to the desired carrier and then switch to zero-span on the analyzer. This will allow you to look at the video information being applied. Using a Tektronics 7L12 spectrum analyzer, "zero-span your carrier" by using the frequency span per division control. Now put the unit into 2 dB per division mode. Next, peak the displayed signal using the fine tuning control. You are trying to put the sync tips at the reference line (Figure 4). At this point it may be necessary to add or remove attenuation using the preamp. If you cannot line up the sync tips with your reference line, use the variable gain control to do so. Now switch to the linear mode. The sync tips should be approximately two divisions in amplitude. The amplitude of the entire display never should exceed seven divisions. Note that a major graticule division is 12.5 percent modulation and each minor division is 2.5 percent modulation. Seven major divisions equal 87.5 percent modulation. A vertical interval should be present during this measurement.

This is a very accurate method but is dependent on peak white available in the applied video. Ideally, an NTSC television signal generator should be used as the video source for this adjustment. If a video generator is used, then reapply program video and check to see that the sync to blanking levels are approximately equal. This should ensure correct modulation depth when switching back to program video. A VITS signal also can be used as a reference when adjusting modulation depth. After setting depth of modulation you are ready to set the audio deviation.

Audio deviation is set correctly using a known frequency audio signal at a known dBm level by applying this signal to the modulator audio inputs. Using a spectrum analyzer, check to see that the maximum audio carrier deviation is 25 kHz. However, the most common method is the comparison method: Tune your converter to a local channel and try to match this level by ear. If you cannot match the level then you need to increase or decrease your audio output at the receiver's audio adjustment.

The next step is to set the carrier level on each of the modulators and/or processors. This can be done with either a spectrum analyzer or SLM (signal level meter). One note of caution: If you are going to use a spectrum analyzer to obtain your correct level, keep in mind that the rest of your SLMs will read a slightly lower level due to peak detection circuitry in the SLM. This problem will be even worse on the scrambled or video-inverted channels. After setting the video carrier, set the audio carrier. This level normally is −15 dBmV from the video carrier level.

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Cross modulation: Its specification and significance

Cross modulation is a familiar term in the CATV industry. Hybrid manufacturers and equipment suppliers specify cross modulation performance. The Scientific-Atlanta system design group estimates that about half of its customers specify end-of-line cross modulation performance, yet their experience indicates there is a lack of consistency in its specification and measurement. More important, there is often a gross overspecification of system requirements due to a lack of knowledge of the relationship between the specification and visual disturbance in a TV picture.

By Mark Adams and Rezin Pidgeon
Scientific-Atlanta Inc.

Cross modulation originally was defined by the National Cable Television Association[1] as: XM(dB) = 20log (a/b). Where *a* is the peak-to-peak voltage of the undesired modulation envelope, and *b* is the peak voltage of the unmodulated video carrier.

The basic measurement procedure also was outlined in that document. Accordingly, all carriers except the channel under test are square wave modulated at 15.75 kHz and the amplitude modulation (a) impressed on the CW (continuous wave) carrier under test is measured relative to that for a 100 percent modulated carrier. To achieve high sensitivity for this measurement and discrimination against composite triple beat (CTB) and other noise, cross modulation is generally measured using a spectrum analyzer or field strength meter to linearly detect the envelope and a selective level meter tuned to 15.75 kHz to measure the cross modulation component. This procedure is still the one in use by hybrid amplifier manufacturers for specifying equipment performance.

The NCTA method measures AM cross modulation (amplitude modulation of the desired carrier) in agreement with the NCTA definition. AM cross modulation is simply the result of amplifier non-linearity causing amplifier compression when the interfering carriers are switched on. However, cross modulation also can exist as phase cross modulation due to amplifier phase shifts and non-linearities. Also, at higher frequencies non-linear transistor junction capacities become significant contributors.[2]

The development of hybrid amplifiers for 450-550 MHz employed a new generation of transistor die that resulted in improved CTB and noise figure performance, but also resulted in less AM-to-PM (phase modulation) conversion of cross modulation at higher frequencies; the NCTA cross mod specification became worse than that of its predecessors. A plot of AM and PM cross mod is given in Figure 1, which illustrates how AM and PM cross mod typically vary with frequency. AM cross mod predominates at the lower frequencies; PM predominates at higher frequencies.

Figure 1: AM and PM cross modulation of amplifier cascade

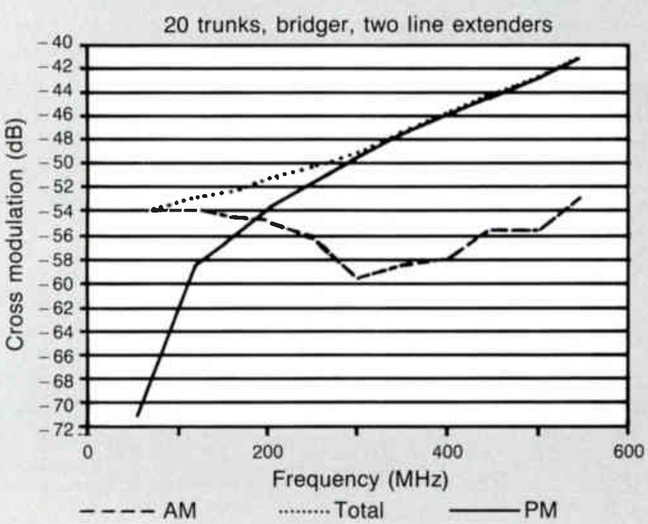


Table 1: System performance for barely perceptible cross mod

Signal level (dBmV)	49.5
CTB (dB)	-39
Cross mod (dB)	
AM	-31
PM	-40.5
Total	-30.5

To allay fears of the higher cross mod specification, tests were conducted at Scientific-Atlanta with TRW engineers in 1982 using the new 5000 series transistor-die hybrids.[3] It was demonstrated that even in an HRC phase-locked system and at the lower channels where CTB is a minimum, performance seemed to be limited by CTB, not cross mod. Cross modulation on Channel 2 measured −32 dB by the NCTA procedure; the composite triple beat plus second-order beat (measured not phase-locked) was eliminated by the bypass test,[4] the visual distortion appeared about the same. This is not too different from results of the test described later.

Cross modulation also is measured in the frequency domain by measuring the sideband level of the line frequency (15.75 kHz) cross mod sidebands. For 100 percent square wave modulation the first order sidebands are 10 dB below peak (unmodulated) carrier level. Thus, 10 dB is added to the first sidebands to obtain the equivalent NCTA measurement. Note that for agreement with the NCTA definition, cross modulation ratio is the level of the cross modulation sidebands relative to those sidebands for 100 percent modulation, which are 10 dB below the unmodulated carrier level.

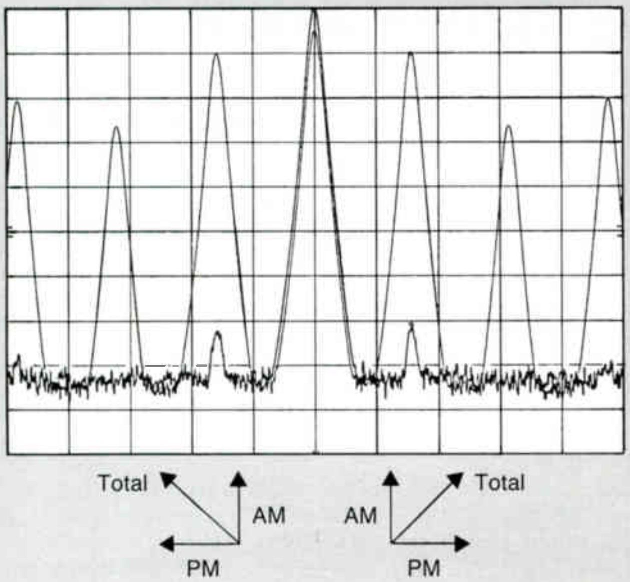
For PM cross modulation the sidebands appear the same as for AM cross mod, and one cannot be distinguished from the other by a spectrum analyzer display. The sideband level measurement gives the total AM and PM cross mod added on a power basis. A cross modulation spectrum is shown in Figure 2.

Also illustrated in Figure 2 are phasor diagrams showing the addition of the AM and PM components. Because these components are in quadrature the sum should be the same for upper and lower sidebands. Many measurements made at Scientific-Atlanta verify that upper and lower sideband levels are nearly the same. To measure AM and PM cross mod separately, AM cross mod can be measured by the common practice referred to earlier using a spectrum analyzer or field strength meter to detect the signal and a selective level meter to measure the 15.75 kHz component. The spectrum analysis gives the total AM plus PM cross mod. Thus these two measurements can be subtracted (on a power basis) to obtain PM cross mod.

The spectrum analysis method can be employed to examine cross modulation on an operating CATV system (if the carrier for the channel under test can be temporarily unmodulated). Another possible advantage of this method is that in an HRC phase-locked system it will show sidebands (which in effect are the same as cross mod sidebands) due to modulation of carrier beats. The carrier for the channel under test would be turned off for this test eliminating cross modulation as the source of unwanted sidebands.

Cross mod by the sideband method also is outlined in the Hewlett-Packard *Cable Television Systems Measurement Handbook*.[5] This also

Figure 2: Spectrum analyzer display of cross modulation sidebands



is basically the procedure established by Canadian Broadcast Procedure 23 for evaluation and proof of performance of CATV systems.[6] Naturally, results of these measurements will be quite different from those made by the NCTA procedure since it is based on 100 percent square wave modulation of all carriers. These other procedures reference cross modulation sidebands to the CW carrier level and are not necessarily measured under the condition of 100 percent square wave modulation of the interference. A further discussion of these measurements and how they relate to each other and to distortion in a TV picture is given in the following section.

Cross modulation interference test

The relationship of cross modulation distortion and its effects on a TV picture in a high-capacity CATV system are difficult to quantify partly because of the difficulty in isolating cross modulation from CTB and other distortions. Experiments for this have been devised, however, and the results of one are reported in this section. Figure 3 shows the setup used to measure the level of cross modulation for subjective levels of interference to TV pictures or test patterns.

In this experiment 28 independent video sources (including three scrambled channels) modulated a HRC phase-locked headend system. The system was loaded to 330 MHz; there were 42 channels in all, 14 of which were duplicated. The headend output was connected to a cascade of twelve 550 MHz push-pull hybrid trunk amplifiers. The output of the cascade was viewed on a Mitsubishi TV receiver and the corresponding levels of distortion were measured.

The procedure used to observe cross modulation without the destructive effects of CTB was to offset the channel being observed, Channel 3, to the standard frequency and then to turn off the channel above it. Since for HRC all carrier beats including second-order beats are at multiples of 6 MHz, these beats are at the band edges of Channel 3 and thus do not interfere significantly with the signal being observed. At system levels high enough to produce visible cross modulation, beats between sound carriers and picture carriers became quite significant; therefore all sound carriers were turned off. The spectrum within the video bandwidth was relatively clean. There were some spurious signals, probably due to luminance-chrominance carrier beats, but those were more than 60 dB below the video carrier. The TV picture was clean except when levels were elevated further to produce high distortion in the picture.

In this experiment TV programs and test patterns were observed and the operating level that produced barely perceptible cross modulation was determined. Cross mod was most noticeable on a flat field approximately 7.5-20 IRE, so data was taken for that condition. Results are summarized in Table 1.

Data was measured by driving the cascade from a Matrix multicarrier generator (standard frequency plan). Cross modulation was measured with a Hewlett-Packard 8901A modulation analyzer calibrated for agreement with the NCTA definition. Cross modulation also was gauged by measuring the 15 kHz sideband levels and by using a spectrum analyzer and wave analyzer to measure the AM component as in the NCTA procedure. Results agreed within 1 or 2 dB.

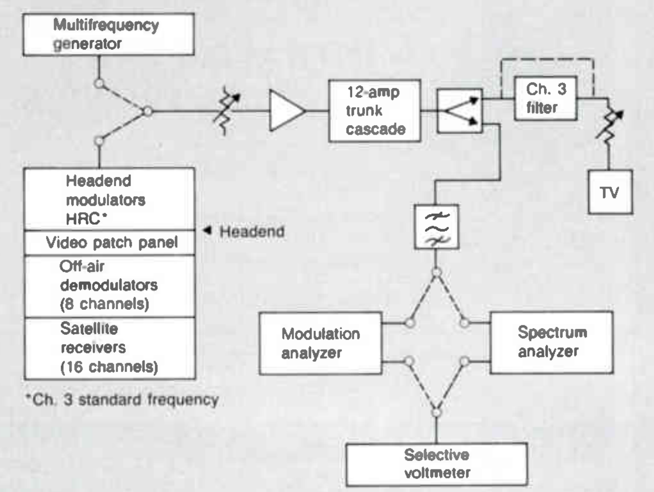
Figure 4 is the spectrum that resulted when all channels were 100 percent synchronously modulated as in the NCTA procedure; Figure 5 is for the system loaded with TV channels. With video modulation the sidebands varied around −65 dB with large fluctuations due to the random nature of the video signals. Figure 5 was recorded with the spectrum analyzer operating in the peak hold mode for one minute to capture transients peaks. Recordings made this way were more consistent and easier to compare.

As noted, there was a large difference in sideband levels between synchronous square wave modulation and video modulation—a reduction from −40 dB to an average of approximately −65 dB or a peak of about −58 dB. This large reduction is caused by: 1) a single TV channel interferes less than if it were 100 percent square wave modulated at or near the line frequency, and 2) TV signals are generally uncorrelated, and uncorrelated signals add on a power basis, whereas for synchronous modulation the cross modulation components add on a voltage basis.

If we assume for simplicity that all carriers are equal amplitude and amplifier distortion is third-order and independent of frequency, synchronous cross modulation will be proportional to the number of channels. For random TV modulation, cross mod will be proportional to the square root of the number of channels. Thus, the difference is proportional to $\sqrt{N}$ (N is the number of interfering channels), which in our case is 42, or 16 dB. This $\sqrt{N}$ relationship was borne out in earlier experiments[7] in which cross modulation was simulated and its effect measured for 1-24 independent program sources. (A review of Figure 3B of Reference 7 shows the departure from $\sqrt{N}$ to be less than about 2 dB for 2-24 channels.)

In order to correlate results obtained using square wave modulation of a carrier with results obtained with interfering video carriers, it was necessary to correlate the power at the major spectral points of the square wave modulated signal with the corresponding energy in the modulated video signal. Since interference is determined by the square of the amplitude of the interfering carrier, an experiment was devised to compare a squared (baseband) video signal with a squared baseband square wave.

Figure 3: Cross modulation test setup



*Ch. 3 standard frequency

In the experiment baseband video and baseband square waves were squared using a four-quadrant multiplier IC, and the energy in a 1 kHz bandwidth at line frequency was measured. It was found that the average level of the video signal so processed was 10 dB below the correspond-

(Continued on page 104)

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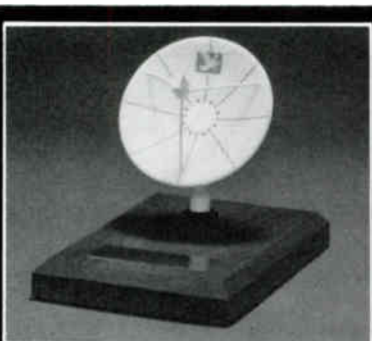

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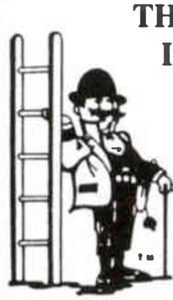

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Third-generation spectrum analyzers and CATV testing

By Tom Babb, Owen Brown and John Cecil
Hewlett-Packard Co

To maintain cable TV system performance, operators must spend a good deal of their time testing equipment. One instrument that has gained wide popularity among engineers and technicians for this testing is the spectrum analyzer. Over the years, spectrum analyzer design has kept pace with other technologies, offering enhancements that do much more than just measure the frequency spectrum. For example, new microprocessor tools resident in third-generation analyzers reduce the time it takes to perform several basic CATV tests and thus free operators for other matters.

A spectrum analyzer (Figure 1) is a superheterodyne receiver whose tuned frequency is swept over a selectable frequency range, normally called the *span*. The spectrum analyzer uses a swept local oscillator to mix the radio frequency (RF) input signals and translate them into an intermediate frequency (IF). These signals are resolved by IF filters, thus separating complex real-time signals into their individual frequency components. For example, the CATV channel contains a video carrier, modulation sidebands and an audio carrier. These all are displayed as separate signals on a spectrum analyzer.

The resolved signal also passes through IF amplifiers to a detector, which measures individual signal amplitudes. This allows the CRT to present a display of frequency vs. peak amplitudes.

Microprocessor bells and whistles

Over the years, designers have added features to this basic spectrum analyzer model that address specific markets or that simplify the general process of taking measurements. This work has been facilitated greatly by advances in microprocessors. The computing power of microprocessors can be used to sharpen the spectrum analyzer's measurement capabilities in several important ways.

Microprocessors can be used to improve frequency response. At the factory or service center, the analyzer's amplitude response over the frequency range can be stored in the microprocessor's memory. The microprocessor then can compensate for any amplitude variations in making spectrum measurements.

In a similar fashion, the microprocessor can reduce non-linearity in the screen display by adjusting it for any irregularities over its amplitude range. Another task that the microprocessor improves is compensating for inaccuracies when alternating between different ranges of resolution bandwidth, IF gain, input attenuation and display scales.

Because a microprocessor continuously checks the instrument's operation, it can warn operators if the spectrum analyzer is in need of service, and it can help the technician troubleshoot and calibrate the instrument. In fact, in some cases, the microprocessor is used by the analyzer for self-calibration at the push of the button.

These microprocessor-based enhancements are embedded in firmware, not in additional hardware, for the spectrum analyzer. Along with improvements in measurement capability, the microprocessors supply operators with tools such as CRT display markers. A marker can directly provide frequency and amplitude values, in numerical form, of any signal located at any spot on the screen. An operator simply positions the marker on the signal, rather than manually aligning the signal with amplitude and frequency reference lines. This saves a tremendous amount of test time

Reader Service Number 69.

Figure 1: Spectrum analyzer block diagram

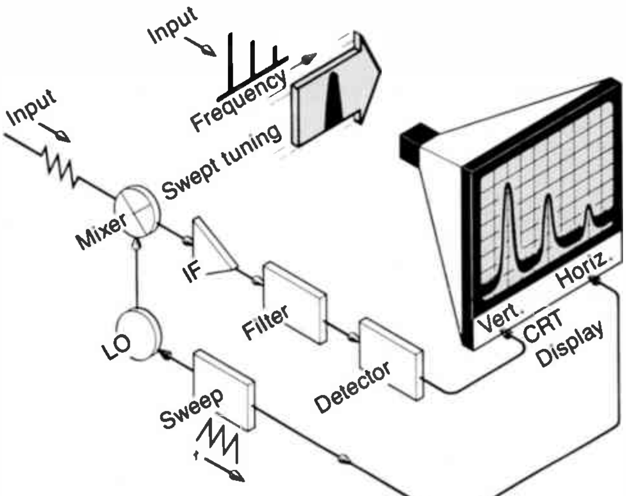
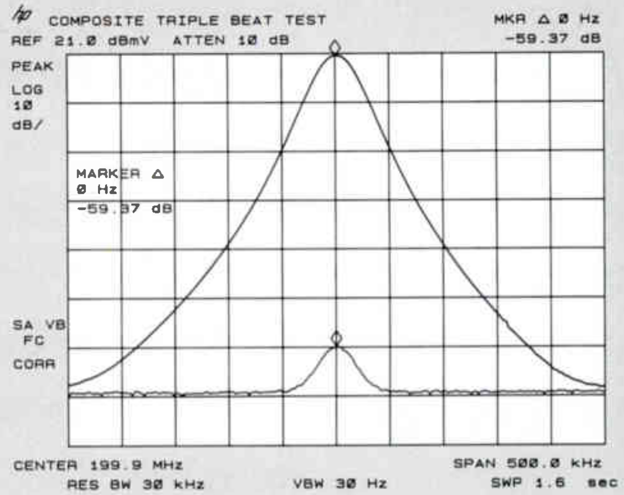


Figure 2: Composite triple beat test



and reduces measurement inaccuracies.

In addition, for any frequency range displayed, markers can identify and order signals according to their amplitudes with a peak search function. A delta marker function provides users with automatic measurement of the amplitude and frequency differences between signals. And a peak-to-minimum measurement provides a test for carrier-to-noise ratio.

Maximum amplitude excursions and frequency extremes of a signal, caused by either FM or AM, can be stored in the microprocessor's memory using a maximum hold function. Then, markers can be used to measure peak deviation of FM signals and percent modulation of AM signals.

One limitation of a basic spectrum analyzer in displaying AM modulation lies in the narrowness of the resolution of the IF filters. For example, modulation frequencies less then 1 kHz cannot be viewed by a spectrum analyzer that has a minimum IF filter bandwidth of 1 kHz. This is a serious limitiation for CATV operators in making 60 Hz and 120 Hz hum measurements. Microprocessor-based spectrum analyzers with a fast Fourier transform (FFT) embedded in their firmware provide users with a way of measuring low-frequency AM modulation.

The FFT is a mathematical routine that converts time domain information into frequency domain information. Because resolution is no longer limited by the IF bandwidth, modulation frequencies in the subhertz range can be resolved. Measurement time is reduced because wider bandwidths

Figure 3: Cross modulation testing at 15.7 kHz

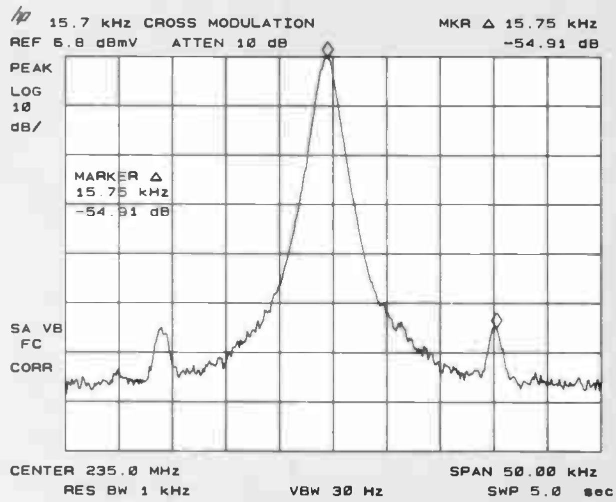
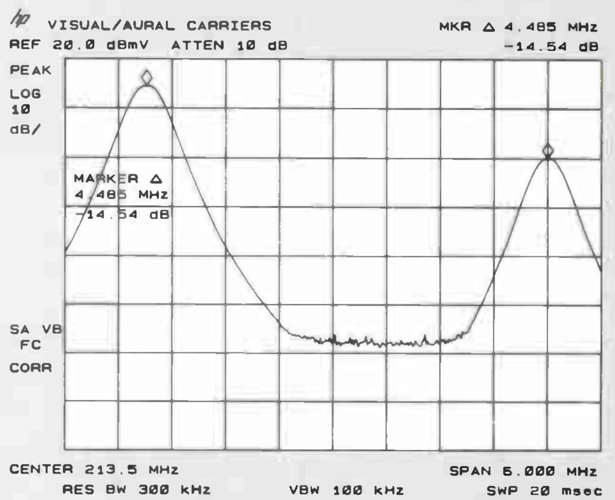


Figure 4: Visual/aural carriers testing



now can be used. The only limit to using FFT techniques lies in the sweep time necessary to take a measurement. The sweep-time range of the spectrum analyzer is related to the frequency range of the modulation that the FFT can measure.

Along with microprocessor enhancements, a general trend in test equipment design has been toward portability, and this holds true for spectrum analyzers. Component integration has allowed vast decreases in PC-board dimensions, and mechanical design techniques have led to sturdier instruments. Operators now can take precision test equipment such as spectrum analyzers into the field.

With the advent of computerized controllers, analyzers can be operated over instrument buses to do automatic measurements. The analyzers also can download traces directly to plotters and printers without the controller. Equally valuable is their ability to store traces in field-portable computers. The stored traces can be printed or plotted later back at the office.

Addressing CATV measurement needs

The added capabilities that microprocessors have brought to spectrum analyzers directly affect the CATV test process. Testing to preserve picture quality is important not only at the headend but also in the field at system taps. Intermodulation or composite triple beat tests are done by measuring the amplitude of the carrier, turning the carrier off and looking

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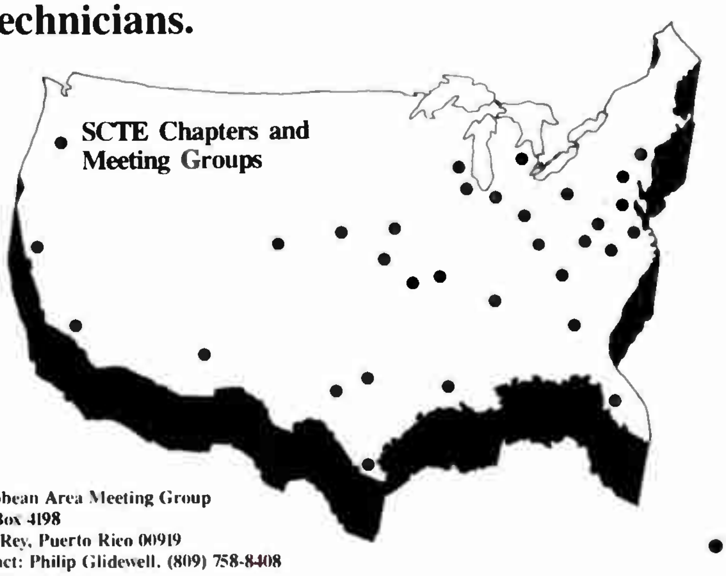

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Figure 5: Carrier-to-noise testing

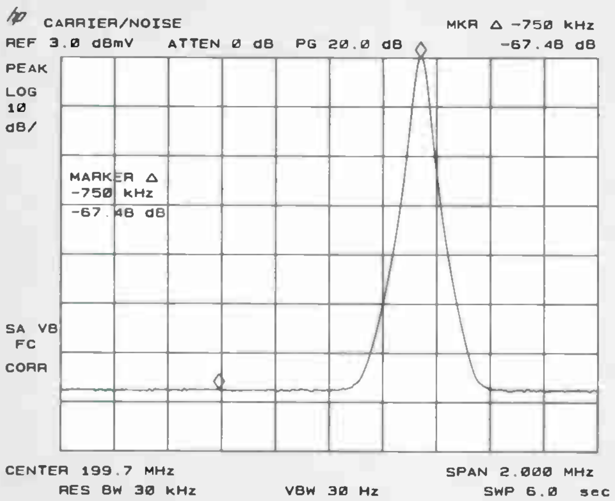
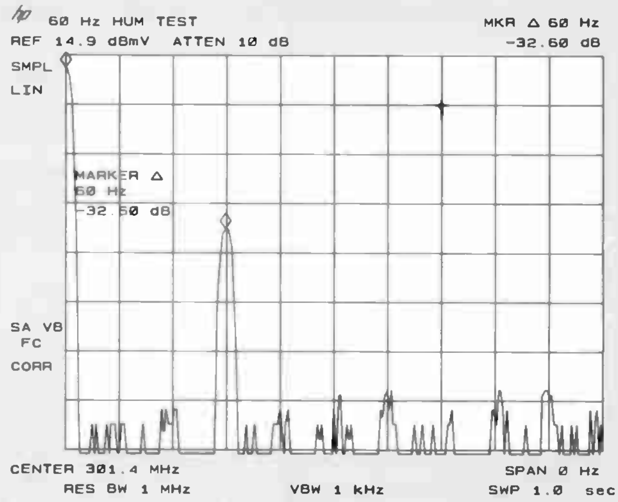


Figure 6: 60 Hz hum testing



at what is left. This can be accomplished with selective level meters or more often with spectrum analyzers (see Figure 2).

Of the features previously noted, markers are most useful for speeding up this test. With them, you no longer need to remember the carrier level nor to count down divisions. Peak search and delta marker functions speed up measurements and eliminate guesswork in interpreting the CRT traces.

Cross modulation also causes distortion products (Figure 3), but in this case an operator looks for an AM sideband. A technician with a manual spectrum analyzer would tune to the visual carrier and then look 50 dB down, 15.7 kHz away from the unmodulated carrier. This requires going to an IF bandwidth of 1 kHz and a video bandwidth of 30 Hz in a 50 kHz span, resulting in a five-second sweep. The FFT function, together with the markers, provides an easier, faster solution, and the measurement can be done in about one second.

Using FFT, the instrument is set to a sweep time of 20 milliseconds, a bandwidth of 1 MHz and a span of zero for time domain display. The FFT button is pressed to get a low-frequency display showing the 15.7 kHz modulation, and then markers are used for fast, accurate measurements.

The visual carrier level and its level relative to the audio carrier and to adjacent channel carriers can be measured easily with markers. The peak search function places the marker on the carrier, and the delta marker along with "next right" and "next left" move the second marker to the other carriers. If the carriers are being modulated, the maximum hold function allows the markers to find the peak power of the carriers (Figure 4).

The carrier-to-noise ratio of a system often is found by going to span of about 2 MHz and bandwidth of 30 kHz, measuring the amplitude of the unmodulated visual carrier, and calculating the difference between that amplitude and the average noise floor of the system displayed by the spectrum analyzer (Figure 5). Preselector filters and a preamplifier often must be used for this test. The measurement must be correlated to a 4 MHz noise bandwidth per FCC specification, so a correction factor of 23 dB is subtracted from the difference.

This measurement is speeded up considerably by using analyzers with marker functions and other dedicated function keys. Once the span and bandwidth are set, these analyzers find the peak carrier level and minimum noise level almost instantaneously. In most cases, however, a correction factor still must be used.

Currently, most hum measurements caused by the AC power line are done with selective level meters, but this test also can be done with a spectrum analyzer. (Figure 6). The FFT function allows the use of wide bandwidths to make quick and accurate measurements and to display all the 60 Hz frequency-related components.

For all these tests, microprocessor-based spectrum analyzers provide easy recording of data, either by directly dumping it to a plotter or printer, or by storing it in a computer. This information is then accessible for further detailed analysis at the operator's leisure. In fact, measurement can be automated for headend or field testing by using a portable, hand-held computer with the spectrum analyzer. Because automatic tests are fast and repeatable, both test time and operator error are reduced.

Improving system quality

The modern, portable spectrum analyzer is a versatile tool for headend, field and bench testing. Today's spectrum analyzers allow you to make CATV tests quickly and more accurately than was possible before. Thus, operators are freed from much of the mundane tasks of performance assurance testing. They then can devote their time not merely to maintaining, but to improving system quality.

An overview of signal leakage

By Edwin L. Dickinson
Vice President, Dovetail Systems Corp.

A cable television system theoretically has a totally confined RF spectrum spanning as great a bandwidth as 5 to 550 MHz. In reality, however, physical faults in this cable system will allow leakage of signals into the surrounding electromagnetic environment. These leaks may produce harmful interference, which is defined as any emission endangering the functioning of radio navigation or other safety services, or seriously degrading, obstructing or repeatedly interrupting radio communications services.

The specific frequency ranges of interest to cable operators are from 108 to 137 MHz and from 225 to 400 MHz. Aircraft navigation and communication services are found in the lower band, while aircraft navigation, government fixed, mobile, marine, air, amateur, satellite and other services occupy the higher frequency band.

Part 76 of the FCC rules and regulations describes acceptable leakage levels and the equipment, techniques and intervals for their measurement. Table 1 summarizes the applicable portions of Part 76, Subpart K, Technical Standards. It is intended to help explain some of the details associated with signal leakage compliance.

It is, of course, the cable operator's responsibility to be familiar with all the applicable FCC rules regarding one's particular operation.

Two signal leakage measurement parameters are defined in 76.611. They are referred to as the cumulative signal leakage index (CLI) and are taken from the *1979 Final Report on Cable Signal Leakage*. Basically, they provide a simple performance index that statistically correlates ground level measurements to an acceptably low level of airspace signal. They are defined as:

$10\log I_{3,000} \leq -7;$ $\qquad$ $10\log I_{\infty} \leq 64;$

$$I_{3,000} = \frac{1}{p}\sum_{i=1}^{n}\frac{E_i^2}{R_i^2} \quad (1) \qquad I = \frac{1}{p}\sum_{i=1}^{n}E_i^2 \quad (2)$$

where:
- p = system fraction tested
- n = total number of leaks greater than 50 μV/m
- E = field strength of leak *i* (μV/m/meter)
- $R_i^2 = r_i^2 + H^2$
- R_i = slant height from leak *i* to reference point *H* meters above the center of the cable system (meters)
- r_i = distance of leak *i* from the center of the cable system (meters)
- H = reference point altitude (3,000 meters)
- i = leak identification index

Shorthand notation for these two indices are $CLI_{3,000}$ and CLI_{∞}. $CLI_{3,000}$ provides an expression for acceptable leakage referenced to a point 3,000 meters (10,000 feet) above the system center, a reference to a point very high above the system (i.e., slant height R_i approaches the reference point altitude *H*). In other words, $CLI_{3,000}$ provides proportionately lower weighting of those leakage sources that are physically far from the center of the cable system with respect to those near the center, while CLI_{∞} includes only the magnitude of the individual leaks. Note that leaks below the 50 μV/m level are not included in either leak index.

Airspace signal leakage measurements also are defined in 76.611. This

Table 1: Summary of rules concerning leakage compliance

Section and title	Summary
76.601 Performance tests	Cable operator responsible for design, installation and operation in compliance with Subpart K. Yearly signal leakage measurements per 76.609. Results, description of instrumentation and procedures, and statement of qualification of person testing. Five years on file.
76.609 Measurements	Field strength meter with horizontal dipole, oriented 10 feet above ground, at least 10 feet from system components and 10 feet from other conductors.
76.610 Operation	Signal monitoring of all portions of system at least once per year. Log detailing leakage sources: date found, location, date eliminated and probable cause. Two-year retention of leakage log.
76.611 Signal leakage performance criteria (effective July 1, 1990)	No service in 108-137 and 225-400 MHz unless compliance demonstrated by: 1) Ground measurements and computation of cumulative signal leakage index: a) $10\log I_{3,000} \leq -7$ or b) $10\log I_{\infty} \leq 64$; or 2) Airspace measurements of less than 10 μV/m RMS at 450 meters above average terrain. At least 75 percent of total strand must be tested using unmodulated or correlated modulated signal in 108-137 MHz range or airspace measurement must be used. Average power level is equivalent to the strongest cable TV carrier.
76.613 Interference from a cable television system	Prompt measures must be taken to eliminate harmful interference. If interference is not promptly eliminated, the engineer-in-charge may suspend operation and may require operator report on cause, corrective action and efficacy of correction.
76.614 Regular monitoring (108-137 MHz and 215-400 MHz)	Regular monitoring program that substantially covers the plant every three months. Equipment and procedures capable of detecting 20 μV/m at 3 meters. Leak log required, on file for two years.
76.615 Notification requirements	Annual notification of all signals in aeronautical bands, including type of information carried. Timely filing of FCC Form 325, Schedule 2 meets this requirement. Notification prior to transmitting any aeronautical band signal with average power level $\geq 10^{-4}$ watts, 160 microsecond peak duration, in 25 kHz detection bandwidth.
76.618 Grandfathering	Use of aeronautical frequencies permitted under 76.619 if requested or granted for use by November 30, 1984; *until* July 1, 1990.
76.619 Grandfathered operation in 108-136 and 225-400 MHz	Annual notification of all signals in aeronautical bands, including type of information carried. No extension of system radius without prior FCC approval. Regular monitoring, log on file for two years.

type of measurement may be used if desired, but *must* be used if ground level leakage mesurements cannot be achieved for at least 75 percent of the total system strand. Demonstration of no more than 10 μV/m per meter RMS (root mean square) at an altitude of 450 meters above the average terrain of the cable system constitutes compliance.

If we solve the expression for CLI_{∞} (Equation 2 for the trivial case of a single leak), we find that a single radiation source of 1,300 μV/m per meter, measured at 3 meters, would result in CLI_{∞} equal to 64.

Using the reciprocal relationship of field intensity to distance, this 1,300 μV/m at 3 meters translates to 8.7 μV/m at 450 meters. Thus, for the single leak case we can see the equivalence between the airspace measurements and the ground leakage index. In practice the situation is far more complex than this single leak simplification, with a myriad of leaks of various intensities present.

Airspace measurement

Special instrumentation is required to make the airspace signal leakage measurements. A horizontally polarized antenna is specified. The standard aircraft navigation antenna is commonly employed. However, the antenna used for these measurements should be mounted on the underside of the aircraft to preclude shielding by the airframe.

A receiver, meeting appropriate aircraft standards, is modified to provide an analog output signal proportional to the received signal strength. This receiver is fed by the antenna. The receiver output is fed to a suitable recording device to capture the instantaneous field strength reading. Position, altitude and other information also must be logged during the course of the measurement run. Multiple trace chart recorders, audio cassette units, hand-held dictation equipment, magnetic tape instrumentation recorders and written logs have been employed to this end. The modified receiver must be calibrated by means of a laboratory quality RF signal generator and step attenuator. A plot of signal level output voltage vs. RF input level is generated over the full receiver dynamic range.

The final step in measurement equipment setup is to calibrate the antenna/receiver/recorder system in flight. This calibration is accomplished by positioning a known field strength source in an unobstructed area and flying over the site at a controlled speed and altitude. The record of such calibration runs provides the field strength vs. signal level curve for that particular equipment configuration.

It is important to note that coordination of the exact frequency to be used in these tests should be accomplished with the local FCC and/or FAA (Federal Aviation Administration) authorities prior to this airspace calibration procedure.

Preparation for actual leakage measurement overflight begins with the procurement of the appropriate maps or charts of the area. U.S. Geological Survey 7.5- and 15-minute topographic quadrangle maps provide excellent ground reference sources. The cable system map information then must be overlaid onto these maps.

The next step consists of planning the exact flight path over the system. The normal path would consist of parallel, striaght-line ground tracks with equal spacing. A uniform spacing of one-half mile is recommended as a starting point, with appropriate adjustments made for areas with sparse cable plant. It is best to carefully plan reference points, which would determine each line segment. Prominent ground reference features may be used, as well as electronic "fixes" from aircraft radio navigational facilities. Special care must be taken to avoid flight near obstructions such as radio towers and the like. Adjacent airports and aircraft traffic patterns also must be taken into account. The flight should be planned and conducted in a "holding" rather than a "cruise" configuration. This slow mode of flight will allow the pilot to achieve maximum conformity to the planned ground track.

The altitude also must be planned to meet the 450 meter (1,500 feet) above average terrain requirement. Proper coordination must be made with air traffic control and adjacent flight patterns for normal air safety. The precision nature of this flying will require the full attention of the pilot, thus mandating the use of a second individual for operation of the equipment.

Measurement flights normally are conducted under fair weather or VFR (visual flight rules) conditions. Good visibility is important for maintaining the proper flight safety and avoiding other traffic. Calm or light winds also are desirable, as crosswind and turbulence will adversely affect the pilot's ability to fly the desired path.

The calibration run would be the first activity after takeoff. This is important: first, in achieving the "recent calibration" requirement of the regulations; and second, to confirm that the equipment is working properly. Once the calibration run(s) has been made, the measurement runs can begin. It is important to remember that operation of the aircraft communications transceiver (an amplitude modulated signal in the aeronautical band with a power output of about 25 watts) will affect the field strength measurements. It is important that these transmissions be logged as part of the measurement run record.

After the conclusion of the measurement flight, it is time to summarize the results of the tests. Keep in mind that the regulations specify curve smoothing for analog and 90th percentile for digital recording. If the data indicates that you are in compliance, congratulations on a tight system. If not, your task is not yet completed. Further work will be required throughout the system to eliminate the offending sources of leakage. It may be of assistance to overlay a contour representation of the airspace leakage data onto the charts used for flight planning. This will indicate the general areas of greatest signal leakage and may help eliminate "tight" sections of the system.

Further refinements

The rules and regulations prescribe certain techniques for measuring leakage from the cable system, but allow for alternate approaches, providing correlation can be demonstrated with their specified tested techniques. Several factors to keep in mind in exploring alternate measurement approaches are receiver bandwidth correction, antenna system polarization and directivity, and recording device frequency response, to name a few.

The control of signal leakage from a cable TV system to the limits of 76.611 is a task requiring serious attention on the part of the cable operator. Airspace measurements may be advantageous for the large system or essential to the system with inaccessible back-alley or high-rise plant. A well-structured program of monitoring and repair, combined with careful record keeping, is required to keep a system in compliance.

July 1990 soon will be upon us; do you know if *your* system complies? If not, it is not too soon to find out just how "tight" your plant is. ■

The care and feeding of NiCad batteries

By Wade Anderson and Duff Campbell
Riser-Bond Instruments

Nickel-cadmium batteries have experienced rapid acceptance in many new products and applications due to their unique characteristics and capabilities. The batteries are suitable for virtually an unlimited variety of consumer, commercial, industrial and military applications. By far, the most unique characteristic of the batteries is their ability to be recharged. Because of this feature the batteries have a very long working life. This reduces the effective operating cost of the battery-powered equipment, since the user can avoid the inconvenience of having to replace non-rechargeable cells. NiCads provide a long trouble-free and maintenance-free reusable source of electrical power that in most applications has a life expectancy of many years. But in order to get the most out of your NiCad batteries, it is important that you develop good battery habits.

NiCad batteries are unpredictable little beasts and have a quality known as *memory factor.* Let's say you have an instrument that can be used for one-hour operating time before it needs recharging. But you want to keep it well charged, so for several months you use it for half an hour at a time then recharge the batteries.

One day you need the instrument for a whole hour but you find it only will run for half an hour. By continually discharging and charging to one-half capacity it only will work to one-half capacity. These batteries now have developed a memory. NiCads should be cycled down completely before recharging. A deep discharge can erase the false memory that the NiCad cells have acquired. In effect, you have to force them to forget the self-learned charging limits (by deep discharging) and give them a new memory by recharging them to the original capacity.

If you take the instrument into the field and use it for just 20 minutes and then store the battery, you might be better off to let it sit until the next call. At least that's better in most cases than bringing it back to the plant every day after 20 or 30 minutes of operation and bringing the battery immediately back to full charge. If the battery is partially discharged to various and random depths before recharging, the memory effect is not encountered. The battery will operate much longer if it is used for short periods as this allows time between uses for recombination. However, the best solution is always to run the instrument until it has shut itself down from lack of operating voltage; don't constantly recharge from a semi-discharged state.

Do not freeze or heat up the batteries

There also are environmental considerations that must be taken into account when using NiCads. Temperature is a prime concern. Both low and high temperatures can affect the batteries (see page 4 for figure on temperature effects).

When the NiCad battery is discharged at very low temperatures, the effective internal resistance is increased significantly due to the reduced level of electrochemical activity. If the drain rate is very low, the battery may be operated continually at temperatures down to −40°C without damage. Charging at low temperatures presents a more severe limitation, since at lower temperatures the recombination capability of the battery cannot balance the normal charge energy input and gas pressure may rise. For extended periods of charge, the battery temperature should be above 5°C.

High temperatures in batteries, as in most components, accelerate the degradation of the system and reduce the operating life. For example, a four-cell battery operating at 27°C will last twice as long as one operating at 37°C. The most susceptible element of the standard battery to high temperature degradation is the separator, which at sustained high temperatures tends to degrade and lose chemical and physical integrity. Eventually, a short will develop from plate to plate through the decomposed separator. All in all, the maximum allowable sustained cell temperature of the NiCad battery, in order to achieve reasonably long life, is 45°C.

In addition to temperature considerations there also are charging precautions that must be followed carefully. Care should be exercised to ensure that the charge current for standard cells does not exceed 10 percent of the rated battery capacity. An example: If the rated capacity of the battery is 1 amp per hour then it should be charged at 100 milliamperes. If the overcharge capability of the cell is exceeded, excess gas pressure will develop and the pressure relief safety vent will open to relieve the excess pressure, then reseal. If the excess charge current is not terminated, the vent may continue to remain open and dry out the cell.

Use the included charger

Instruments normally come with their own charger. It is highly recommended that this be the only one used. Although other chargers may work to some extent it is important to remember that there is not just one type of NiCad battery available. One of the worst things a person can do is put a lead-acid battery charger on NiCad batteries. Why? Because the batteries never will be fully charged, yet they will heat up. This can be hazardous because the batteries can start venting acid, which could result in a fire.

Generally, you should bring the batteries up to room temperature before going into a fast charge. But remember that not all batteries are fast-charge types. For a slow charge, it's possible to charge in low temperatures. However, all charging is recommended at room temperature. Since all batteries are not alike, it's best to read the manual or literature that comes with the batteries.

In conclusion, with NiCad batteries continuing to experience rapid acceptance in many new products, it is extremely important to know and understand their characteristics and capabilities. Because of the ability to be recharged, these batteries can provide the user with years of operation, provided the operator cares for them properly. Therefore, it is imperative that you develop good habits when you start using a NiCad-powered device. With proper care and feeding, your battery supply will last a long time.

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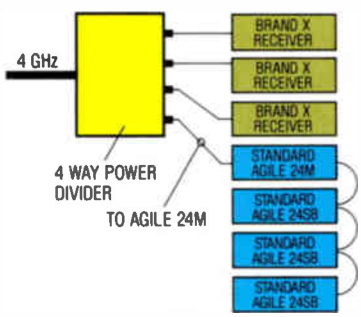

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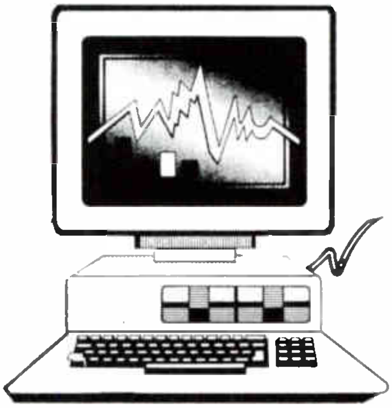

A forum for CATV professionals

By Steven C. Johnson
Senior CATV Project Engineer,
American Television and Communications

'Through shared use of the forum, cable and broadcast professionals hopefully can . . . appreciate each others' situations'

In this high-tech era in which we live, we have a constant need for rapid delivery of accurate and timely information. Articles printed in traditional types of publishing media sometimes are outdated by the time they get to the reader. Much of what is discussed in this article no longer will be current when you read it. This is not meant to be a slight against the publishing industry, but is just an example of deadlines in publishing.

The computer industry has brought us a more rapid delivery media through the use of telecommunications. With the increasingly widespread use of electronic mail (E-Mail), instant communication can be possible (provided everyone reads the mail). Numerous telecommunications companies have begun to offer E-Mail (CompuServe, The Source, MCI Mail, GEnie, Delphi, People Link, etc.) and are used widely by small- to medium-sized companies and by individual users. Larger companies, in many cases, have instituted their own in-house E-Mail systems.

E-Mail usually is directed communication. Often a message is sent to a number of users but traditional E-Mail does not allow messages to be read by all users. This privacy usually is advantageous but often it is desirable to post messages to all users—an electronic bulletin board, if you will. To meet this need, electronic forums and special interest groups (SIGs) have been created. The electronic forums and SIGs allow an open exchange of information by individuals with like interests.

A CATV electronic forum can be useful due to the changes in 1) technology, 2) rules and regulations, 3) marketing philosophy, etc., that the industry is facing today. Ideas could be exchanged more easily and news of interest to CATV personnel could be disseminated more easily. For these reasons, a CATV forum recently was started on CompuServe Information Service.

A variety of services

CompuServe Information Service (CIS) is a worldwide, broad-ranged two-way data service for home and business computer telecommunication applications. The system can be accessed by telephone (a local call in most cities) and offers a variety of services. Among these are home shopping, electronic newspapers and magazines, information on various subjects, SIG forums, travel information, etc. The service was started first in 1969 and currently has over 300,000 users worldwide. A thorough description of CompuServe is beyond the scope of this article. For more information on the service contact it directly at: CompuServe Information Service, Corporate Headquarters, 5000 Arlington Centre Blvd., Columbus, Ohio 43220; or call the customer service department at (800) 848-8199.

Membership costs are reasonable and you are billed only for the amount of time used—there is no monthly minimum. Presently 80 to 90 current CIS users have indicated interest in CATV and related fields. More can be expected as computer ownership and telecommunication use grow.

The CATV forum actually is a subsection of the Broadcast Professional Forum (BPF). Also included in the BPF are sections devoted to radio, television, land mobile radio service, FCC questions and answers, and others. The Society of Broadcast Engineers is an official sponsor of a section as well. Members of the BPF are able to access the CATV section and members of the CATV section are free to access other sections, too. Through shared use of the forum, cable and broadcast professionals hopefully can come to appreciate each others' situations, thereby fostering a better relationship between the two groups.

After accessing CompuServe, to get to the Broadcast Professional Forum, type "GO BPFORUM" at the "!" prompt. Once in the forum, respond appropriately to the prompts that appear.

The forum has the following message sections:

1) General forum information
2) Television
3) CATV
4) Technical
5) Freelance and film
6) Strictly audio
7) SBENET
8) AESNET
9) FCC questions and answers
10) Radio
11) Classified, jobs
12) Manufacturers
13) The lobby

CATV section uses

Message section (#3): Presently the forum is being used to communicate with others having similar interests. A sample exchange might be as follows: ". . . I'm having problems with an XYZ amplifier going into oscillation. Anyone had similar problems with these units?"

The reply: "Yes, we've noticed similar problems. We solved it by beefing up the grounding on the module."

This exchange probably would be over a period of hours, days or weeks, and would not be done in real time unless both participants happened to be on-line at the same time. This exchange would be open for all to read unless the messages were posted as private messages.

On-line conferences: Another use is real-time on-line conferences. Conferences on specific topics can be scheduled ahead of time and notices posted so that those interested could log in at the specified day and time for a real-time exchange. Other forums have had expert guest "speakers" scheduled for their conferences. Summaries of the conferences could be placed in the data library for all to read.

Data library: 1) Text files—Text files regarding new regulations, news stories, etc., can be uploaded by any user for all to read. Sources of stories and bulletins must give permission to be quoted. 2) Computer programs—The forum's data libraries also contain BASIC programs in an ASCII format, Lotus 1-2-3 spread sheets in a binary format and MS-DOS programs in a binary format.

The BPF is maintained by a system operator or SYSOP (John Hoffman with NBC in New York) with each section having an assistant SYSOP. The CATV Section SYSOP is Jeff Darter with O'Toole and Associates in West Palm Beach, Fla.

The CATV section is relatively new, having been on-line only since the end of November 1986. So far, activity has been limited. Hopefully, as the word gets out, the activity will increase—perhaps even to the point to justify a fully dedicated CATV forum with various sections devoted to subtopics of interest. The CATV forum will not replace trade publications but can be a useful complement. Magazines provide a much better media for detailed articles and graphics. The forum can fill a need for brief, timely information and dialog; however, *if* it gets sufficient use.

In order to be successful, we need your support. If you are a CompuServe user, join the BPF and use the CATV section. It costs nothing to join the forum and the only usage fee is the normal CompuServe connection charge. (Actually, very few of the forums have membership or usage fees.) If you are not a CompuServe user but have access to the necessary telecommunication equipment, please consider joining. Upload information that will be of interest to other users.

The CATV section does not have to be strictly engineering-oriented. Input and responses from all departments of cable—marketing, local production, sales, operation, etc., are welcome. Again the success is dependent upon the users.

We are in the technical communication business. Let's use some of our technology to communicate with each other.

Author's note: I would like to thank Jeff Darter for his efforts in getting the SIG off the ground. Also thanks to Jeff and to John Hoffman for their input and assistance during the preparation of this article. The author welcomes your comments. Contact him at ATC, 160 Inverness Dr. West, Englewood, Colo. 80112, (303) 799-1200; on CompuServe EasyPlex (E-Mail), user number 72376,464; or on the Broadcast Professional Forum.

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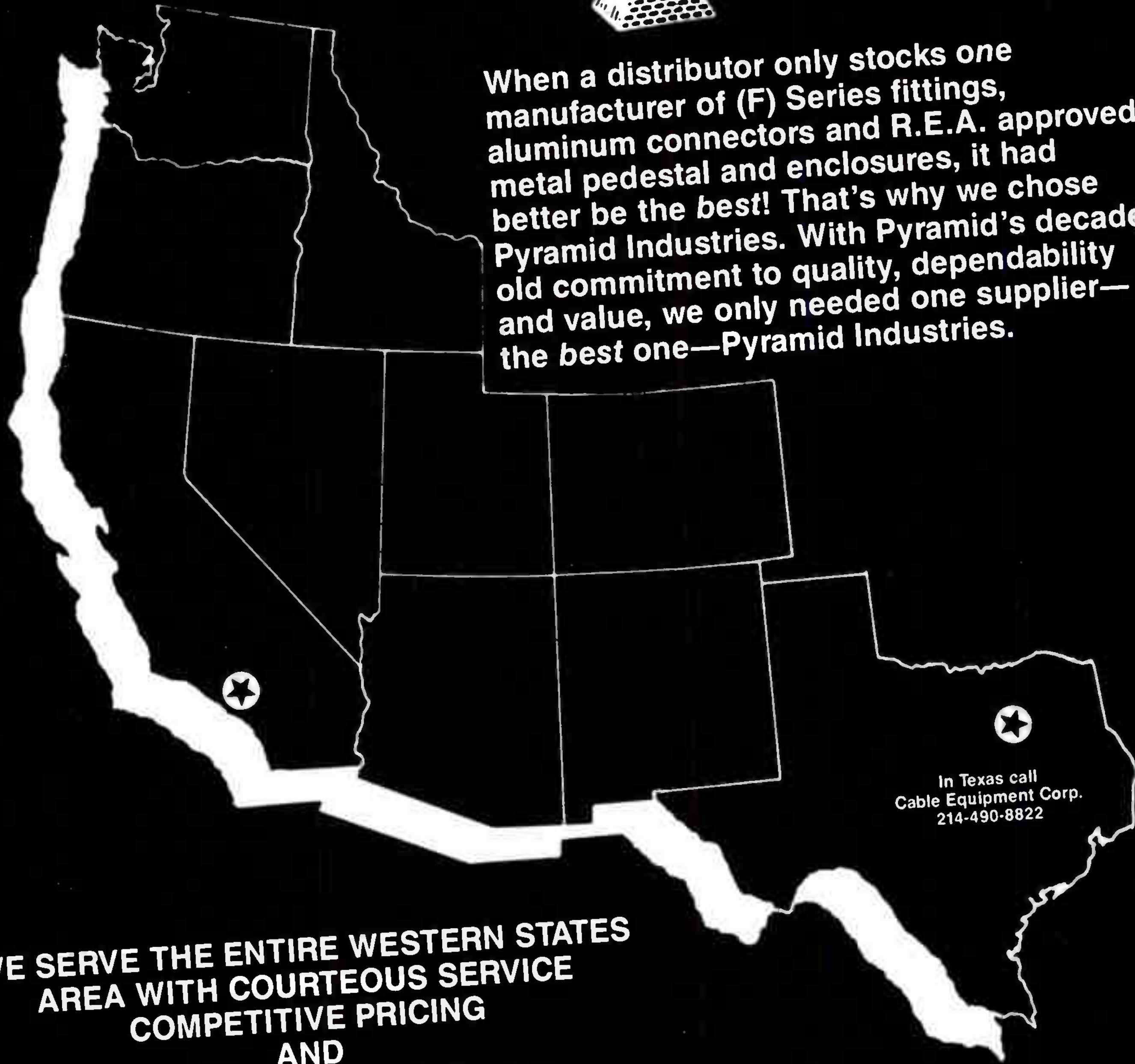

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Broadband LAN performance testing

The fifth installment of this series discusses signal leakage testing for local area networks (LANs).

By Steve Windle
Applications Engineer, Wavetek Indiana

A broadband network in top condition is one that does not allow the RF (radio frequency) energy to radiate into the outside environment. This leakage or *egress* causes no direct health hazard to anyone, but could be a hazard through interference with other over-the-air signal transmissions such as aircraft navigation or communications. This interference with over-the-air transmission is not the only hazard of RF leakage.

Another byproduct of a "not to tight" system is *ingress*. This is when signals from an over-the-air transmission find their way into the closed network. Ingress, when it occurs at or near a data carrier, can cause the obliteration of essential data.

'Excessive off-air levels are an indicator of ingress and egress and should be investigated to find the source'

Well-maintained LANs should have a preventive maintenance program that:
1) provides for consistent monitoring for leakage of data carriers or leakage "beacons" (test signals).
2) provides for consistent monitoring for the ingress of local broadcast frequencies such as VHF and FM signals.
3) measures absolute levels of system leakage.

A program like this will guard against untimely shutdowns due to carrier ingress or possible FCC-imposed leakage evaluations. Leakage or ingress problems often will indicate that another problem, sometimes more serious to network operation, is imminent.

The most common method of testing for leakage is to equip all service personnel with a narrow-band receiver tuned to the frequency of a leakage test signal injected into the headend. This technique is inexpensive to implement and assures the greatest system coverage. Loose fittings or broken cables can be found before they develop into major system failures.

To monitor egress, a narrow-band receiver with a beacon signal or alarm can be used. The beacon on this receiver will be activated when a signal of sufficient amplitude (1 microvolt) is detected. A signal generator can be used to provide the signal to be monitored. A dipole antenna and a signal level meter (SLM) with sufficient sensitivity will be required for measuring absolute levels.

To monitor for ingress, a spectrum analyzer may be used.

Egress monitoring

To implement a leakage monitoring test, insert the carrier (which may be tone modulated to provide another means of identification) at system levels at the headend. This signal should be present on the system at all times to provide a continuous source for leakage monitoring. The receiver, tuned to receive this test signal, should be hand carried (or clipped to a belt) throughout the system. When a leakage signal is detected, the receiver (depending on design) will emit a tone that varies in pitch proportional to the strength of the signal, enabling the operator to locate the source of the leak with a high degree of precision (as you move closer to the source of leakage the pitch of the tone increases).

The leakage levels to be measured typically are in the −30 to −50 dBmV range. Since most SLMs do not operate well at these levels, a dipole antenna with a built in amplifier will detect the leaking signal and amplify it to a level within the measurement range of the SLM. Select the frequency to be checked and set the dipole whips to the correct length. Field tests have shown that the exact length is not critical, but care should be taken to be reasonably accurate when setting the dipole length. The dipole should be positioned 10 feet away from, and parallel to, the cable. The dipole then is moved along the cable, maintaining its parallel attitude, while monitoring the measured signal for peak level.

The peak reading obtained using this method is given in dBmV. The FCC has specific requirements for cable systems that call for signal leaks to be less than 20 microvolts per meter at a distance of 10 feet in the most sensitive frequency bands. In order to convert the level in dBmV to microvolts per meter, use the following equations:

$$\text{microvolts per meter} = 21\log^{-1}\left(\frac{\text{dBmV}}{20}\right) f_{MHz}$$

where:
f_{MHz} = frequency of the leakage signal

For example; if a leak at 181.25 MHz is measured at −29.5 dBmV (using a dipole with 16 dB amplification), then,

$$21\log^{-1}\left(\frac{-45.5\ \text{dBmV}}{20}\right) 181.25\ \text{MHz} = 20.2\ \text{microvolts per meter}$$

Ingress measurement

With a spectrum analyzer connected to a return system test point, examine all known off-air frequencies for system ingress and record the levels for reference at a later date. Excessive off-air levels are an indicator of ingress and egress and should be investigated to find the source.

With a planned and methodical leakage monitoring program, and the proper test equipment and procedures, severe system outage or communication interruption problems can be avoided. Monitoring for leaks is easy, since operators need only wear the small receiver as they go about the normal daily routine in the plant. The receiver will notify them of the presence of leakage signals. The specific test equipment required for these tests is relatively inexpensive, and the SLM is an essential piece for other system maintenance tests.

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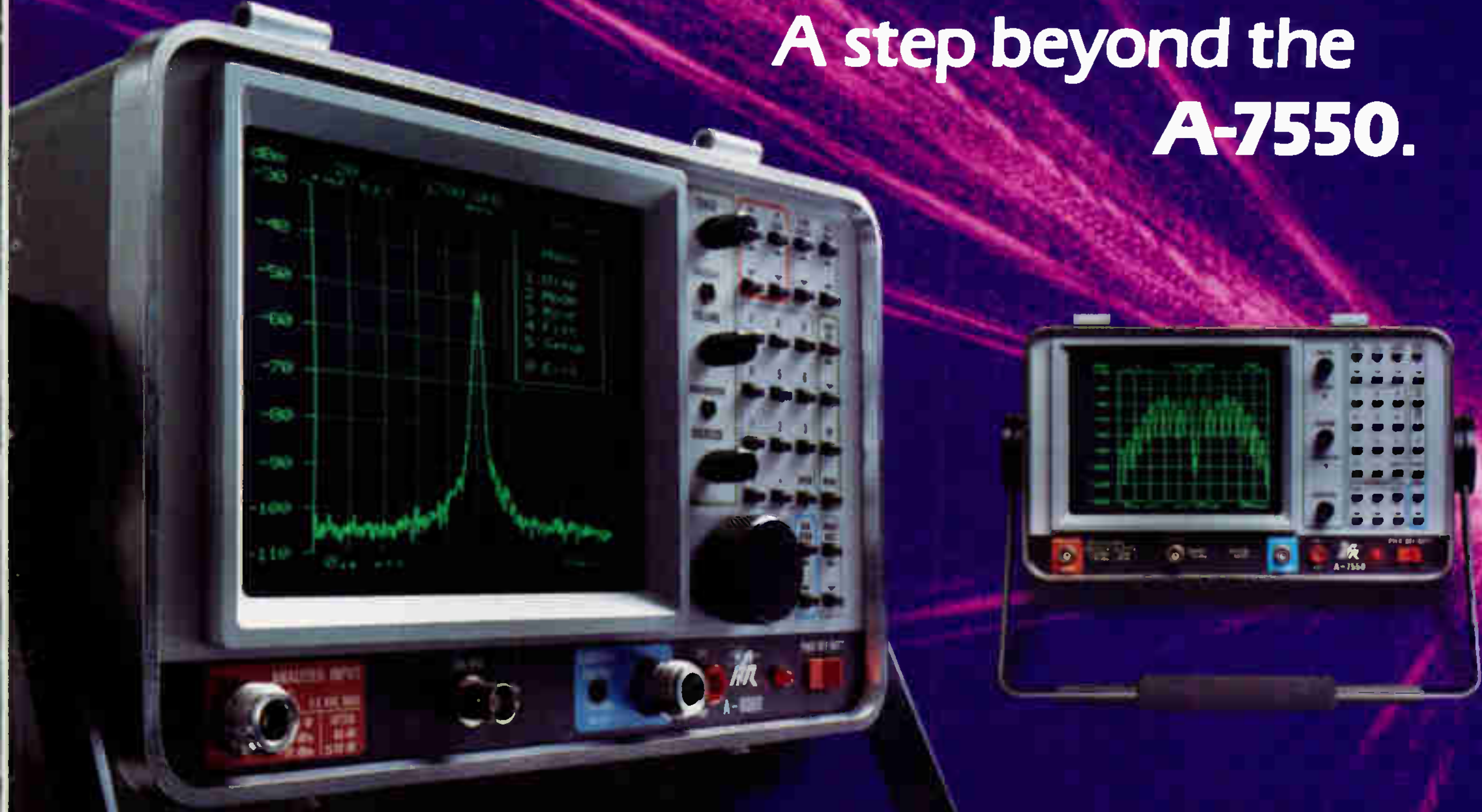

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Power supply

Qualidyne Systems has introduced its Case 21 high-current, switch-mode power supply, with features and capabilities typically found in larger slot supplies. The 5-inch by 6½-inch by 10-inch switcher is said to deliver up to 600 watts, offers up to seven fully regulated outputs and is available with either AC or DC input.

The product offers output inhibit/enable, input power fail, DC power good, overvoltage and overload protection, remote sensing and paralleling. Its "starpoint" paralleling circuit permits single-wire current sharing of multiple power supply outputs, said to be ideal for N+1 redundancy applications. It meets international EMI/RFI safety standards.

For further details, contact Qualidyne Systems Inc., 3055 Del Sol Blvd., San Diego, Calif. 92154, (619) 575-1100; or circle #132 on the reader service card.

Stereo decoder

Pico Macom has introduced its Model PMI-6210 stereo decoder. According to the company, the model is a stereo TV adapter that provides stereo sound from a Channel 3 output (from a stereo-compatible set-top converter) or from a standard MPX output (from a television).

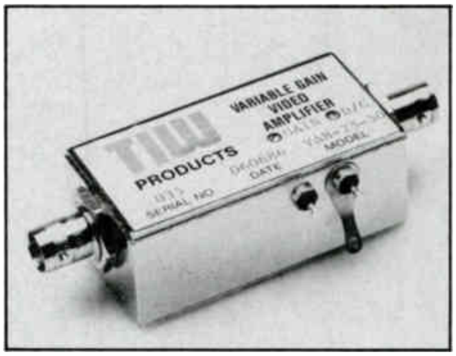
One switch provides selection of stereo, mono and SAP programming. Stereo and SAP indicators provide automatic indication of MTS in a stereo program.

For more information, contact Pico Macom Inc., 12500 Foothill Blvd., Lakeview Terrace, Calif. 91342, (818) 897-0028; or circle #137 on the reader service card.

Spectrum analyzer

The HP8590A portable RF spectrum analyzer from Hewlett-Packard has a frequency range of 10 kHz to 1.5 GHz, an amplitude range of −115 dBm to 30 dBm, and 50- or 75-ohm (optional) input. According to the company, easy-to-use controls let the operator select over 100 different functions at the press of a key; all functions are programmable over the optional computer interface.

For more details, contact Hewlett-Packard, P.O. Box 10301, Palo Alto, Calif., 94303-0890, (415) 857-1501; or circle #125 on the reader service card.



Video amplifiers

TIW Systems has announced its new VAB Series of variable gain video amplifiers. The products are designed to compensate for signal at-

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In every industry there are leaders who are innovative and dedicated to producing the highest quality product. The vision of these leaders fuels progress; they forge ahead and bring new solutions to the marketplace. Most of all, these leaders listen to their customers and translate their needs into products and services of the highest standard.

In CATV, Alpha has set the standard in Standby Power technology. This leadership is based on a long list of 'firsts' in powering concepts and product capabilities. Implementation of Alpha's single ferro-resonant power supply design revolutionized the industry and gave new meaning to cable system reliability and customer satisfaction.

Direct cost reductions through improved battery performance and

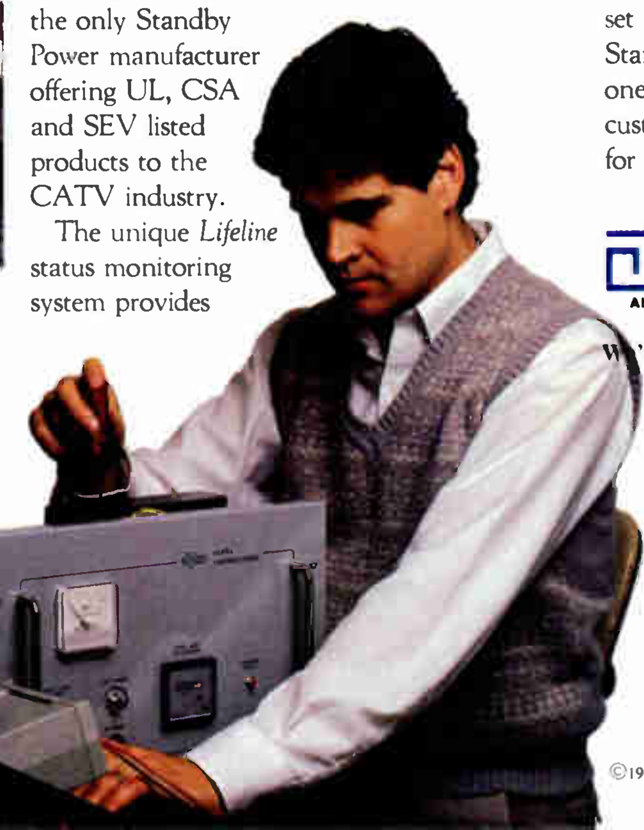
simplified system maintenance were brought about by Alpha's temperature compensating and performance monitoring circuit designs. In addition to these technological contributions, Alpha has

established the highest quality and safety standards. To date Alpha remains the only Standby Power manufacturer offering UL, CSA and SEV listed products to the CATV industry.

The unique *Lifeline* status monitoring system provides diagnostic information and remote control facilities on *one-way* and two-way cable systems. This pioneering development now enables operators to optimize service strategies and reduce overall system maintenance costs. *Lifeline* is Alpha's latest in a series of historic status monitoring milestones: the first and only stand-alone power-supply monitoring system, hardware interfaces

for the major amplifier monitoring systems, and complete monitoring software have all preceded the *Lifeline* introduction.

Alpha Technologies set the standards in Standby Power for one reason: Alpha's customers won't settle for second best.



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tenuation due to cable losses and general amplification and buffering of wide-band analog video and digital baseband signals.

According to TIW, the amplifiers provide a flat frequency response from true DC through 30 MHz and guarantee a minimum 3 dB bandwidth of at least 40 MHz. They operate over a temperature range of −25°C to 85°C. Power supply voltages may be either ±12 VDC or ±15 VDC, with a supply current of 50 milliamperes.

For more information, contact TIW Systems Inc., 1284 Geneva Dr., Sunnyvale, Calif. 94089, (408) 734-3900; or circle #139 on the reader service card.

Signal generator

Marconi Instruments has introduced its Model 2022A portable signal generator. With a specified output flatness of ±0.5 dB over the entire range and low harmonically related signals typically better than −35 dBc, the model is said to provide high performance at a reasonable cost.

According to the company, the product offers a wide frequency range of 10 kHz to 1,000 MHz. The RF output is settable in 0.1 dB steps from −127 dBm to 6 dBm, with up to seven calibration units selectable by the user. FM distortion is improved to less than 0.5 percent THD at 1 kHz for deviations up to 25 kHz and less than 2 percent THD at 1 kHz at maximum deviation, for any carrier frequency greater than 250 kHz.

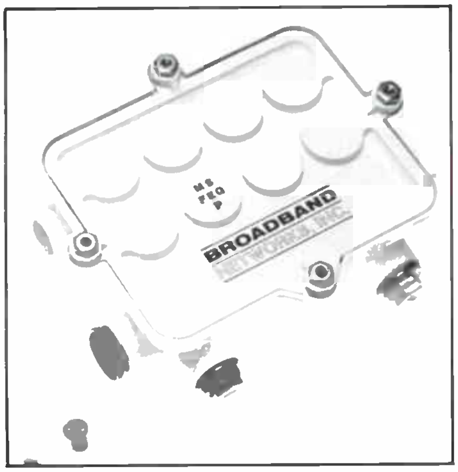
For more information, contact Marconi Instruments, 3 Pearl Ct., Allendale, N.J. 07401, (201) 934-9050; or circle #134 on the reader service card.

Low-pass filter

The Model 4762 low-pass filter from Microwave Filter passes from 2 to 4 GHz with 0.75 dB maximum loss and rejects from 7 to 11 GHz with 40 dB minimum loss. Impedance is 50 ohms. The unit has SMA male connectors on the input and

SMA female connectors on the output.

For more information, contact Microwave Filter Co. Inc., 6743 Kinne St., East Syracuse, N.Y. 13057, (315) 437-3953; or circle #128 on the reader service card.



Equalizers

Broadband Networks' line of split-band feeder equalizers are said to improve the performance of single-cable broadband LANs used to configure MAP, TOP, IEEE 802.4 and 802.7 systems. According to the company, they have the ability to pad the reverse path, as well as equalize coaxial cable attenuation characteristics in both forward and reverse signal paths. They also feature unified construction of filter and equalizer circuits, minimizing the insertion loss of the device.

The mid-split equalizer has a return path frequency bandpass of 5 to 115 MHz and a forward bandpass of 150 to 450 MHz. The high-split model has a return bandpass of 5 to 186 MHz and a forward bandpass of 220 to 450 MHz.

For more details, contact Broadband Networks Inc., P.O. Box 8071, State College, Pa. 16803, (814) 237-4073; or circle #136 on the reader service card.

Data cable tester

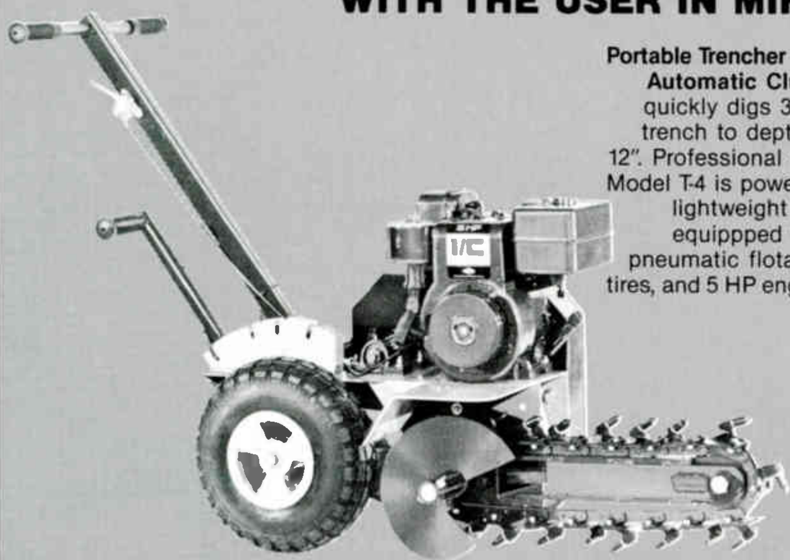
L-COM Data Products has introduced its Model DX-50 portable tester, which is said to instantly evaluate the integrity of any two-, three- or six-wire RJ-11 modular telco or data cables. Three two-color LEDs indentify which pair shows continuity or open. At the same time, the LED color determines whether the cable is properly wired for data use with straight-thru pinning.

For more information, contact L-COM Data Products, 1755 Osgood St., North Andover, Mass. 01845, (617) 682-6936; or circle #133 on the reader service card.

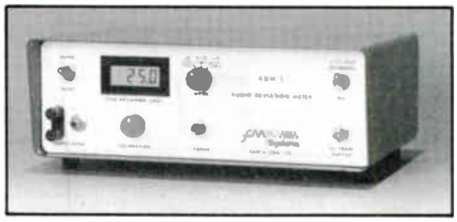
Line boosters

Black Box's 232 line booster is designed to receive and retransmit the 12 most commonly used signals of the RS-232C interface. This results in doubling the signal transmission distance beyond the accepted RS-232 specification of 50 feet. The product is said to be powered from either the interface or a detachable power supply, and is data rate and data format transparent.

For more information, contact Black Box



Corp., P.O. Box 12800, Pittsburgh, Pa. 15241, (412) 746-5500; or circle #135 on the reader service card.

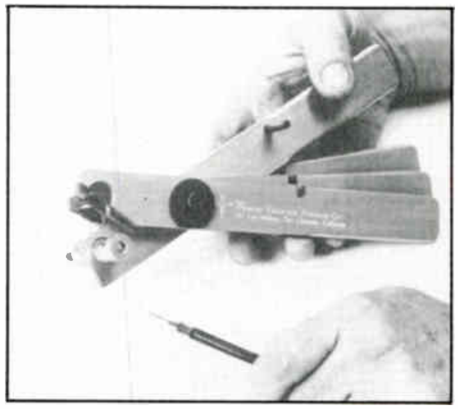


Deviation meter

FM Systems has announced its ADM-1 FM deviation meter designed to measure audio deviation in cable and SMATV systems. The product measures the peak deviation of actual program audio as well as test tones and holds the highest peak deviation reading until reset.

According to the company, the meter can read up to 199.9 kHz deviation in positive and negative peak and peak-to-peak deviation. Measurement accuracy is ±0.5 percent when measuring audio at ±25 kHz. The ADM-1 also can detect distortion in the TV channel modulator by measuring the difference between positive and negative deviation when modulating with a sine wave.

For more details, contact FM Systems Inc., 3877 S. Main St., Santa Ana, Calif. 92707, (714) 979-3355; or circle #122 on the reader service card.



Cable stripper

According to Western Electronic Products, its Model CX-1 coaxial cable stripper prepares most cables from .075 to .485 diameter in a single operation with any stripped configuration. Three independent cutting members and a replaceable cable holder allow the operator to turn the cable in contact with the cutters and sever the insulation and shielding.

For more information, contact Western Electronic Products Co., 107 Los Molinos, San Clemente, Calif. 92672, (714) 492-4677; or circle #141 on the reader service card.

CATV protector

GTE Control Devices has introduced its Smart Breaker, a solid-state protector designed to improve quality and reliability of CATV networks. According to the company, if there is a temporary surge in the system that can damage the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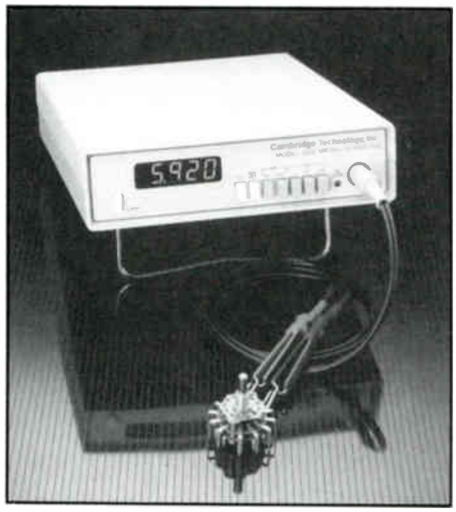
amplifier, the device opens and protects the circuit from damage. It then resets itself and restores service automatically.

For more information, contact GTE Control Devices, 100 Endicott St., Danvers, Mass. 01923, (617) 777-1900; or circle #121 on the reader service card.



Micro-ohmmeter

Cambridge Technology has introduced its Model 510A micro-ohmmeter, designed to measure the resistance of switch and relay contacts, transformer and motor windings, connectors, or any other low-resistance devices. It has five ranges from 19.999 milliohms to 199.99 ohms, full scale, 1 micro-ohm resolution and a basic accuracy of .02 percent.

Three measurement modes are provided. The continuous DC mode can be used to make measurements on inductive components. The switched DC mode removes the effect of thermal voltages. The pulsed mode is provided for thermally sensitive devices such as fuses.

For more information, contact Cambridge Technology Inc., 2464 Massachusetts Ave., Cambridge, Mass. 02140, (617) 876-0891; or circle #124 on the reader service card.

Signal level meter

Wavetek's Model SAM IIIE 600 signal analysis meter is a portable SLM featuring microprocessor-controlled tuning. The unit can be tuned by entering any frequency or channel number (standard or HRC format) up to 600 MHz. An LCD displays the channel to which the meter has been tuned. Also, the meter tunes to the audio carrier associated with any channel with the flip of a switch.

According to Wavetek, the SLM provides spectrum analyzer display capability using an ordinary X-Y oscilloscope. Also, carrier-to-noise measurements and hum modulation testing are achieved with function switches.

For more details, contact Wavetek Indiana Inc., P.O. Box 190, Beech Grove, Ind. 46107, (317) 788-9351; or circle #129 on the reader service card.

Drafting aid

The Linex 201 Scriber automated lettering machine from A.D.S./Linex now has a centering function. The product is designed to increase productivity and efficiency in land surveying, construction, cable mapping, design engineering, graphic design and so on. In addition to the centering function, the Scriber includes a two-inch by 10-inch drafting area, 4K internal memory with editing ability and various function keys (size, slope, rotation, vector and tab).

For more details, contact A.D.S./Linex Inc., 3130 Gateway Dr., Suite 400, Norcross, Ga. 30071, (404) 448-0977; or circle #131 on the reader service card.

Waveform analyzer

The Series 656 disturbance waveform analyzer from Dranetz Technologies is designed to monitor and analyze power line disturbances for up to a month. It stores the data in a nonvolatile memory and displays it on a built-in CRT. Touch-screen operation is said to eliminate the need for key commands.

According to the company, the product's zoom capability allows details of waveforms to be examined closely. The operator uses a finger to move the zoom to the area of interest and enlarge it to full screen. Hard-copy printouts can be made via a built-in printer.

For further details, contact Dranetz Technologies Inc., P.O. Box 4019, Edison, N.J. 08818-4019, (201) 287-3680; or circle #127 on the reader service card.

Figure 4: Cross modulation spectrum, square wave modulation

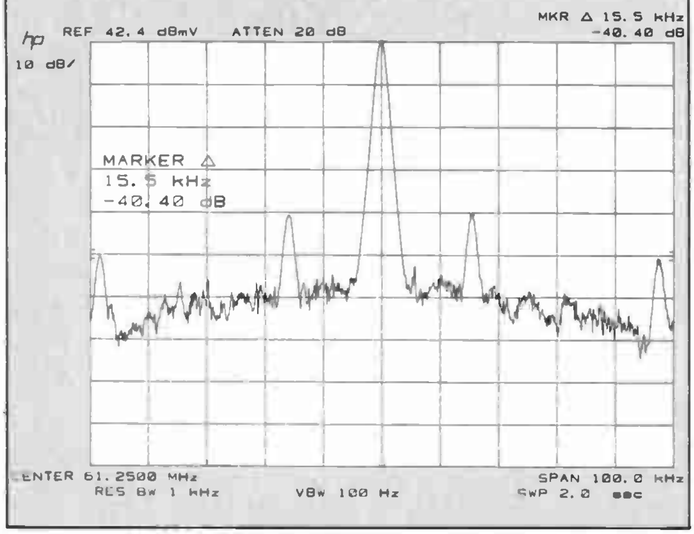
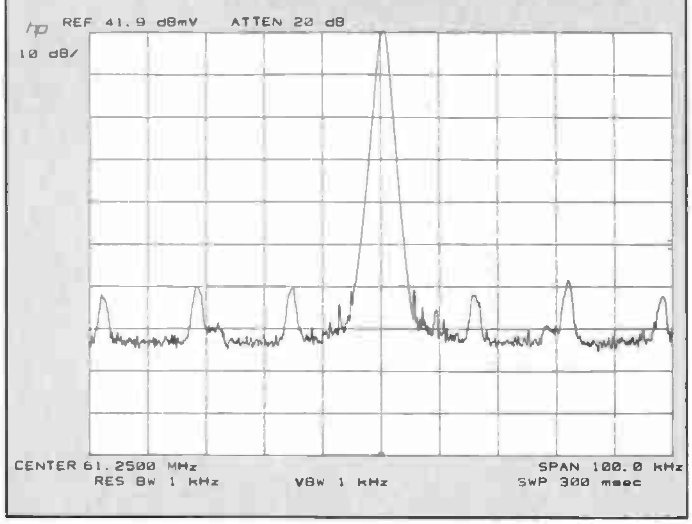


Figure 5: Cross modulation spectrum, video modulation



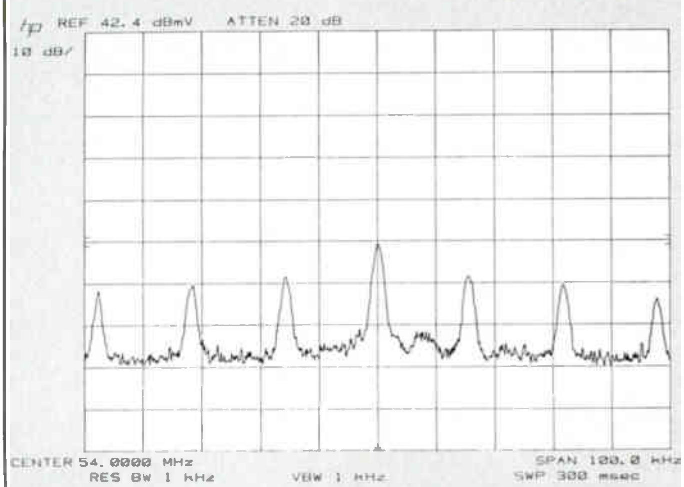
(Continued from page 75)

ing level using a square wave. Thus, this factor (10 dB) plus the 16 dB reduction for $\sqrt{N}$ form an explanation, although certainly not a rigorous one, for the large difference in sideband level that was experienced with video modulation.

Figure 6 shows the spectral interference at Channel 2 with the carrier off. All other channels are TV modulated (HRC phase-locked) and operating levels are the same as before. Non-linear distortion creates carrier beats (CTB, composite second-order beats, harmonics, etc.) and these are phasor summed at carrier frequencies with each beat modulated by carriers that produced it. The composite beat has a carrier coherent with the desired video carrier and modulation of the beats produce 15.75 kHz line-frequency sidebands. The result appears the same as cross modulation except that in this case the sidebands are present without the carrier for the channel under test, and by definition these cannot be due to cross modulation. These sidebands are evident in Figure 6.

In Figure 6, as in Figure 5, the recording was made with the spectrum analyzer operating in the peak hold mode for one minute. The sidebands are very nearly the same in both cases, suggesting the expected interference would be the same. Actually, there was noticeably a slight difference; interference (beat modulation) to Channel 2 was a little more pro-

Figure 6: Beat modulation spectrum, HRC phase-locked



nounced than the interference (cross modultation) observed in Channel 3. (Because of the random phase of the video carriers, the resulting beat modulation should be equally distributed between AM and PM, and the subjective interference will be less by nearly 3 dB than that for AM cross mod only. We concluded phase cross modulation was less damaging to a TV picture by approximately 9 dB.[7]) Thus, even at the lowest channel where CTB is lowest, beat modulation produces more interference than cross modulation; CTB will dominate even more at higher channels.

The sideband level reported here we believe to be essentially in agreement with that reported by Paul Wong[8] and Canadian Broadcast Procedure 23, Issue 2 (BP 23).[6] Wong states that cross modulation will be just visible to most people when the ratio of the first-order sidebands of the interference to the unmodulated carrier is greater than −58 dB, and that other established results using defined viewing conditions and a large variety of observers indicated that the threshold can be 3 dB worse, i.e., −61 dB. BP 23 specifies that qualification of cross mod specifications be conducted by measuring sideband levels at the subscriber terminal. Visibility threshold is given as 58 dB below peak video.

Conclusion: Overspecified

Based on the tests described in this paper it was found that the visibility threshold for cross modulation is at or near −31 dB as measured in accordance with the original NCTA definition. With other system operating environments, viewing conditions and subjects, results will vary. For CATV system design it may be prudent to allow some margin in specifying cross modulation distortion, but findings herein indicate that in current usage cross modulation is considerably overspecified.

References

[1] National Cable Television Association, Standard Number NCTA-002-0267, "CATV Amplifier Distortion Characteristics," (undated).

[2] G.G. Luettgenau, "Cross-Modulation in HRC Systems," *30th Annual NCTA Convention Technical Papers*, pps. 67-72, 1981.

[3] Dan Brayton, "Internal memorandum, CTB vs. Crossmod, visual," TRW Semiconductors, May 4, 1982.

[4] Michael F. Jeffers, "Technical Considerations for Operating Systems Expanded to Fifty or More Television Channels," *29th Annual NCTA Convention Technical Papers*, pps. 1-4, 1980.

[5] Hewlett-Packard Co., *Cable Television Systems Measurements Handbook*, January 1977.

[6] Broadcast Procedure 23, Issue 2, "Technical Standards and Procedures for Broadcasting Receiving Undertakings (Cable Television)," Department of Communications, Canada.

[7] Rezin Pidgeon, "Characteristics and Perceptibility of Crossmodulation," *32nd Annual NCTA Convention Technical Papers*, June 1983, pps. 129-134.

[8] Paul K. Wong, "Cross-modulation in the Time and Frequency Domains," *22nd Annual CCTA Convention Technical Papers*, April 1979, pps. 84-89.

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April

April 2-5: SCTE Annual Engineering Conference and **Cable-Tec Expo**, Hyatt Orlando Hotel, Orlando, Fla. Contact (215) 363-6888.

April 6-8: Tennessee Cable Association annual convention, Vanderbilt Plaza Hotel, Nashville. Contact Teresa Butler, (615) 256-7037.

April 14-17: Center for Personal Development seminar on antenna analysis, design and measurements, Arizona State University, Tempe, Ariz. Contact (602) 965-1740.

April 21-23: C-COR Electronics technical seminar, Atlanta. Contact Tammy Kauffman, (800) 233-2267 or (814) 238-2461.

April 21-23: West Virginia Cable TV Association spring meeting, Pipestem State Park, Pipestem, W.V. Contact (304) 345-2917.

April 22: SCTE Rocky Mountain Chapter review of Category II–video and audio signals and systems, and BCT/E testing. Contact Joe Thomas, (303) 978-9770.

April 22: SCTE Greater Chicago Meeting Group headend seminar. Contact William Gutknecht, (312) 577-1818.

April 22-24: Institute for Advanced Technology seminar on local area networks, Energy Tech Center, Minneapolis. Contact (800) 638-6590.

April 28: SCTE Satellite Tele-Seminar Program, "Digital TDRs, an Instrument You Can Find Fault With," 12-1 p.m. ET on Transponder 7 of Satcom IIIR. Contact (215) 363-6888.

May

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

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

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

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

June

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

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

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

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

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

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

Planning ahead

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

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

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

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

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

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

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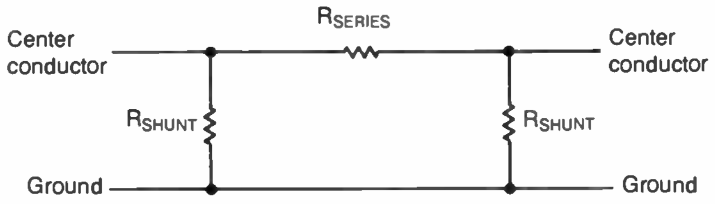
By Ron Hranac and Bruce Catter
Jones Intercable Inc.

Sometimes it's necessary to build your own 75-ohm attenuators; for example, to satisfy a temporary requirement for standard values that may be out of stock, or perhaps a need for a non-standard attenuator for use on the test bench. The accompanying table includes resistor values for 75-ohm symmetrical pi attenuators from 0.5 to 20 dB in ½-dB steps. It also includes predicted attenuation error for various resistor value tolerances. Since many of the resistances shown are non-standard values, it may be necessary to use series/parallel combinations of standard values to achieve the required resistances.

The formulas used to calculate attenuator resistor values are on the next page, along with an example of their use.

75-ohm attenuator schematic



Resistor values and tolerance errors

Loss (dB)	R_{SERIES} (ohms)	R_{SHUNT} (ohms)	Maximum error (dB) for resistor tolerance 0.1%	1%	10%
0.5	4.32	2606.48	0.001	0.005	0.053
1.0	8.65	1304.32	0.001	0.010	0.105
1.5	13.02	870.75	0.002	0.015	0.158
2.0	17.42	654.32	0.002	0.020	0.210
2.5	21.89	524.75	0.002	0.025	0.262
3.0	26.42	438.60	0.003	0.030	0.313
3.5	31.05	377.28	0.003	0.035	0.364
4.0	35.77	331.46	0.004	0.039	0.414
4.5	40.62	295.98	0.004	0.044	0.463
5.0	45.60	267.73	0.005	0.049	0.512
5.5	50.73	244.75	0.005	0.053	0.559
6.0	56.03	225.71	0.006	0.058	0.606
6.5	61.51	209.71	0.006	0.062	0.652
7.0	67.20	196.09	0.007	0.067	0.697
7.5	73.11	184.38	0.007	0.071	0.740
8.0	79.27	174.21	0.007	0.075	0.783
8.5	85.68	165.32	0.008	0.079	0.824
9.0	92.38	157.49	0.008	0.083	0.864
9.5	99.39	150.55	0.009	0.087	0.903
10.0	106.73	144.37	0.009	0.091	0.941
10.5	114.42	138.84	0.009	0.094	0.978
11.0	122.49	133.87	0.010	0.098	1.013
11.5	130.96	129.38	0.010	0.101	1.047
12.0	139.87	125.32	0.010	0.104	1.080
12.5	149.24	121.63	0.011	0.107	1.112
13.0	159.11	118.27	0.011	0.111	1.143
13.5	169.51	115.20	0.011	0.113	1.172
14.0	180.46	112.39	0.012	0.116	1.201
14.5	192.02	109.81	0.012	0.119	1.228
15.0	204.21	107.44	0.012	0.122	1.254
15.5	217.08	105.26	0.012	0.124	1.279
16.0	230.67	103.25	0.013	0.127	1.303
16.5	245.02	101.39	0.013	0.129	1.326
17.0	260.18	99.67	0.013	0.131	1.348
17.5	276.21	98.08	0.013	0.133	1.369
18.0	293.15	96.60	0.013	0.135	1.389
18.5	311.07	95.23	0.014	0.137	1.408
19.0	330.01	93.96	0.014	0.139	1.427
19.5	350.05	92.77	0.014	0.141	1.444
20.0	371.25	91.67	0.014	0.142	1.461

Data courtesy of Texscan Instruments

To calculate the required resistor values for a symmetrical pi attenuator, use the formulas

$$R_{SHUNT} = Z_O\left(\frac{K+1}{K-1}\right)$$

$$R_{SERIES} = Z_O\left(\frac{K^2-1}{2K}\right)$$

where Z_O = attenuator impedance (e.g., 75 ohms for CATV)

and $K = 10^{\left(\frac{\text{attenuation in dB}}{20}\right)}$

Problem: What resistor values are needed to construct a 75-ohm impedance, 30 dB attenuator?

Solution: First solve for K, using the formula

$$K = 10^{\left(\frac{\text{attenuation in dB}}{20}\right)}$$

$$= 10^{\left(\frac{30\text{ dB}}{20}\right)}$$

$$= 10^{1.5}$$

$$= 31.6227766$$

The shunt resistor values then are determined by using the formula

$$R_{SHUNT} = Z_O\left(\frac{K+1}{K-1}\right)$$

$$= 75\left(\frac{31.6227766 + 1}{31.6227766 - 1}\right)$$

$$= 75\left(\frac{32.6227766}{30.6227766}\right)$$

$$= 75(1.065310864)$$

$$= 79.90 \text{ ohms}$$

The series resistor value is found with the formula

$$R_{SERIES} = Z_O\left(\frac{K^2 - 1}{2K}\right)$$

$$= 75\left(\frac{(31.6227766)^2 - 1}{2(31.6227766)}\right)$$

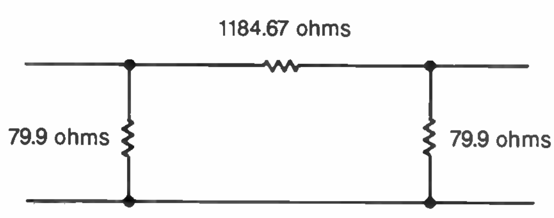
$$= 75\left(\frac{999.9999999 - 1}{63.2455532}\right)$$

$$= 75\left(\frac{998.9999999}{63.2455532}\right)$$

$$= 75(15.79557691)$$

$$= 1184.67 \text{ ohms}$$

30 dB attenuator (75-ohm impedance)



AD INDEX

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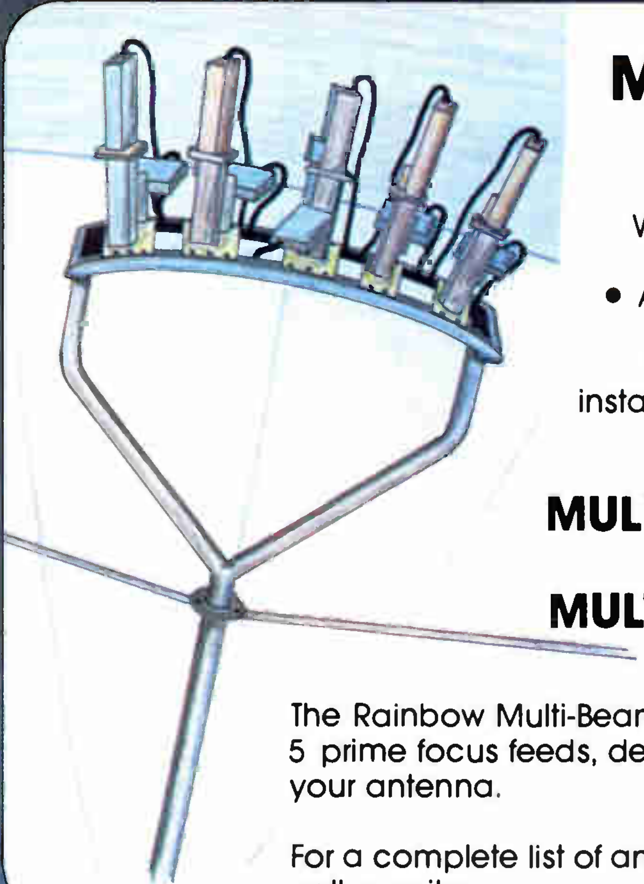

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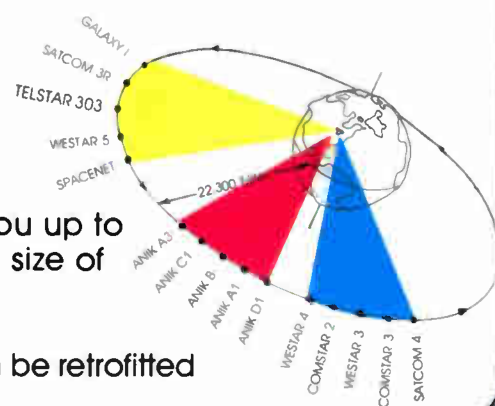

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Reader Service Number 101.

Pole change-outs

By Michael J. Berrier
Head Technician, TCI of Pennsylvania

Given the large number of poles that the average cable company's plant is attached to, the fact that many of these poles were set decades ago, and that the life expectancy of a modern wooden pole is only 25 years, it is not infrequent that a utility company's pole will be replaced, requiring rework from the CATV company. The bigger cable operators often will have a construction department that handles all correspondence and work required by the utilities. However, in a moderately sized system, this work often is the responsibility of one person.

As a supervisor, you should rely on a technician who possesses a strong insight on aerial construction equipment, as well as the associated tools and hardware. This individual's abilities to load, haul and set up a cable trailer, as well as operate a lasher, are only the minimum criteria. In addition, it will be necessary to read strand and electronic maps, splice strand and cable, and set up the active devices. In addition to this, understanding guying principles and strand tensions indeed is critical to enable the technician to do the job correctly, efficiently and cost consciously.

System upgrades, vehicle accidents, aging and the forces of nature are just some of the numerous reasons a utility company will replace existing poles. The annual costs involved by cable operators are intimidating. Predominately it is only a single pole in an isolated location that is replaced. However, occasionally a whole poleline will be replaced or relocated, thus causing the additional concerns of wreckout, dropline relocation, cable loss and allocating the manpower to do the work.

The in-line pole change-out is perhaps the easiest type of pole replacement, and usually can be completed within a half-hour. However, it is difficult to predetermine a time frame for any construction work. Guying of the system at each dead end or false dead end location is one variable that will add time to the work. Also, additional cable attachments such as drops or plant digressions will demand added concern. Perhaps the new pole is set out of line or on the opposite side of the strand, mandating splicing. Or the pole may have been set in an inaccessible spot where power equipment is useless, and time consuming manual labor is the only choice.

A good rapport

In order to minimize time and costs incurred doing utility company rework, field supervisors should develop a good rapport with all utilities. These utilities could be helpful in such areas as manpower assistance, where they may, upon completion of their linework, trim the poles to a stub, or tie the cables up and remove the retired pole completely. Sometimes they even may drill the holes and secure cable's attachments. Advanced, accurate information received from the utilities always will be a great assistance and aid in reducing the time involved. To schedule and complete the work efficiently, a supervisor must possess a good insight to the field staff's abilities, therefore picking the right personnel for the job, and using their assets to cross-train others.

The massive utility companies have built their systems and refined their techniques over the course of many decades. The homogeneous relationship CATV shares with these utilities made them a prime ally in the few short decades since community antenna television came to be. Cable companies only rent space on the utility company poles and these rental agreements subject them to strict guidelines established by the utilities.

As a supervisor, a little insight into the fieldman's responsibilities and forethought and planning about the work could prove invaluable in conserving time and resources. It also may help you gain respect and admiration from your subordinates while increasing operating efficiency and retaining a peaceful coexistence with the utilities.

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Reader Service Number 103.

Strategic technology issues

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

It's a pleasure to be writing this column expressing my views on strategic issues concerning communication technologies. I'm particularly pleased that the first column coincides with SCTE's 1987 Cable-Tec Expo.

In this column, I will outline topics to be covered in more detail in coming months. In my view, the principal strategic issues facing the cable technologists include: 1) signal leakage, 2) the consumer electronics interface, 3) the A/B switch, 4) responding to the competitive threat from technologies that can provide better signal quality, 5) the future of signal security and addressability, 6) coping with satellite jamming, 7) maximizing advantages cable has over competitors, 8) providing a reciprocal threat to cable's competitors, 9) accommodating broadcast signal enhancements, 10) facilitating new subscriber services on cable, 11) avoiding onerous technical standards, 12) building a commercial communication services capability, 13) forecasting technology's impact on the business, 14) enhancing operational productivity, 15) building credibility and open channels of communications with the non-technical management of the cable business, and 16) providing a contingency capability to comply with syndicated exclusivity and the loss of compulsory license so that we're ready to comply if these become operational rules. While this is lengthy list, I'm sure it is not all-inclusive.

A number of additional issues fundamentally influence those mentioned in the preceding list. Included here are the lack of developmental resources in the cable industry, the need for better availability of quality training for the industry's technologists, means of improving professionalism, and better tools and test equipment. These underlaying issues come into sharp focus when compared to the situations in industries that would compete with cable. In particular, the telephone industry has resources, training and tools that yield a substantial competitive advantage when compared to cable.

The flavor of the column will be strategic rather than tactical. There will be a heavy concern for the long run rather than just the near term. For decades cable did not have to worry much about the future; it *was* the future. Now that the business is somewhat mature, this is no longer the case. A new way of thinking is in order.

You will see a lot of attention to the subject of competition. Where is it coming from, where to expect more and what might be done about it? In many ways, competition is a relatively new experience for cable. But competition will be a way of life as we go into the future. In fact, a naive approach to competition could be life threatening to both the business and the career.

Technical symbiosis

Another topic that will be addressed from time to time is the relationships between other relevant industries and cable. It is amazing how industries that logically seem to be symbiotic have few open lines of communications. A classic example is the relationship between cable and the consumer electronics industry. On the one hand, cable's services are enjoyed only through the vehicle of subscriber-owned consumer electronics. On the other hand, from the perspective of the consumer electronics industry, enjoyable cable services stimulate the purchase of new home equipment. With such mutual interests there should be a strong motivation to work together.

Another example of a related industry is broadcast. Over-the-air signals provide an important component of the subscriber's sense of cable value. From a technical perspective, broadcast signal quality is almost the standard. The subscriber compares other cable signals to broadcast signals on cable, and occasionally to those received off-air. From time to time a subscriber will compare an off-air signal to the same one seen on cable. Sometimes we invite that comparison by having an outage. Often the comparison is not flattering.

There is a natural fraternal relationship between technologists in differing industries that can be applied to advantage. As an example, engineers and technicians who design television sets and those who design, build and operate cable systems have a natural curiosity and interest in each others' business. By joining each others' technical societies, attending local chapter meetings and subscribing to technical trade magazines, we increase understanding of each others' problems and challenges. This can result in cooperation in solving common problems. Our subscriber, who is simultaneously their customer, will benefit.

We have technologist "cousins" in other countries. They work in government labs, for national telecommunications organizations or in private industry. Often they work under different constraints and priorities than we do in the United States. Because of this, their work sometimes can take different directions and thereby become a predictor of how technology may evolve in this country. Partial application of their results may prove beneficial. When they work as part of a telephone organization, they provide understanding on how U.S. telephone companies also may be thinking.

'There is a natural fraternal relationship between technologists in differing industries that can be applied to advantage'

From time to time I'll report on a major trade show or event from another industry—one not likely to involve many attendees from our business—but one that could have impact.

I look forward to communicating with you through this column on matters that impact our future.

Dr. Walt Ciciora is ATC's vice president of strategy and planning, emphasizing the role of technology. He joined ATC in December 1982 as vice president of research and development. Prior to that, he was with Zenith Electronics Corp. since 1965. He was director of sales and marketing, cable products, from 1981 to 1982. Earlier at Zenith, he was manager of electronic system research and development, specializing in teletext, videotext and video signal processing, with emphasis on ghost canceling for television systems.

He has nine patents issued and several more pending. He has presented over 50 papers and published about 30, two of which have received awards from the Institute of Electrical and Electronic Engineers (IEEE).

He currently is chairman of the National Cable Television Association Engineering Committee, has been active in the IEEE Consumer Electronics Group and has served on several industry standards-setting committees. Current interests center on the consumer electronics interface with cable.

Ciciora has a Ph.D. in electrical engineering from Illinois Institute of Technology. He received his MBA from the University of Chicago. His BSEE and MSEE are also from IIT. He taught electrical engineering at IIT for seven years.

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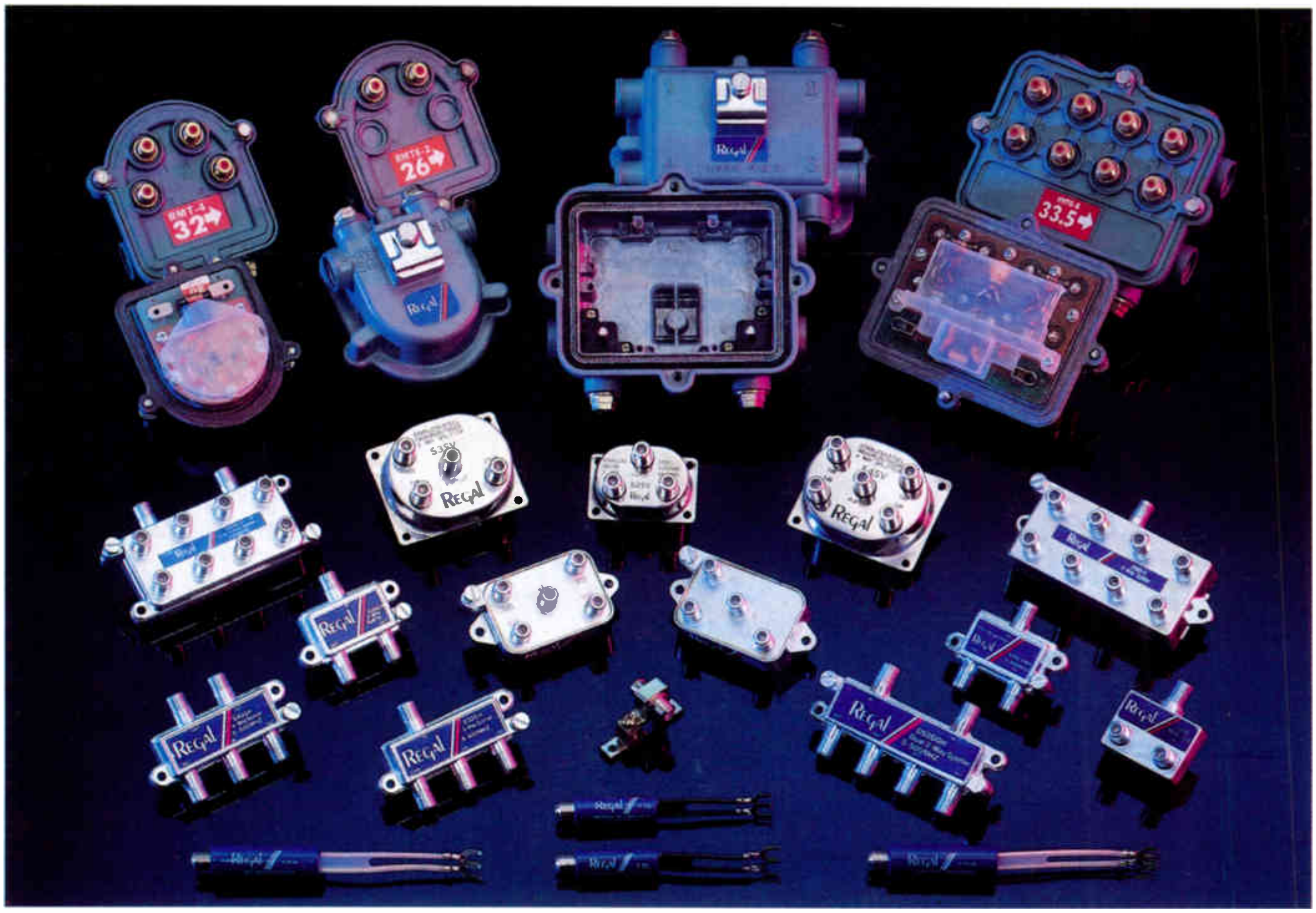

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