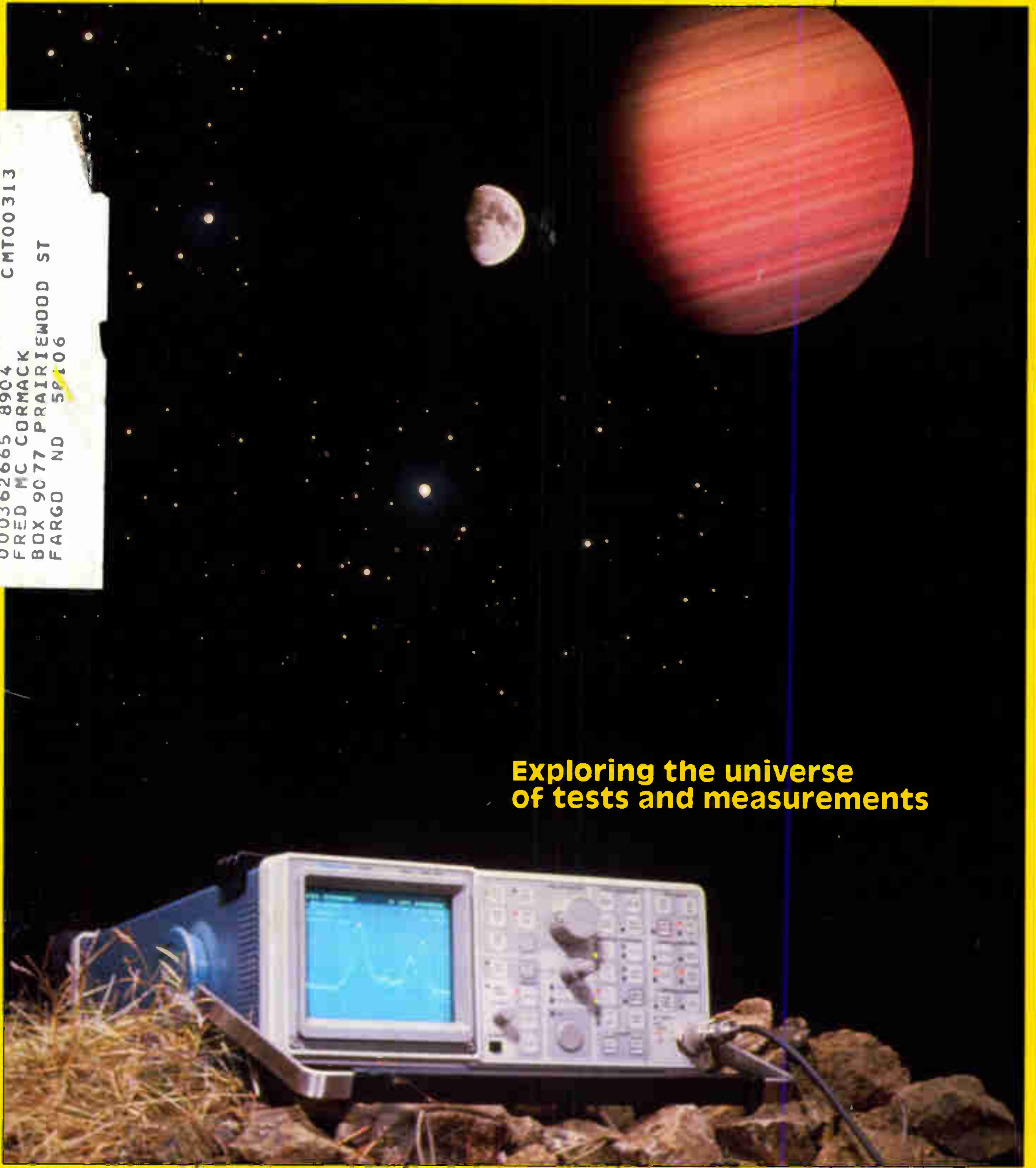
COMMUNICATIONS TECHNOLOGY

Official trade journal of the Society of Cable Television Engineers



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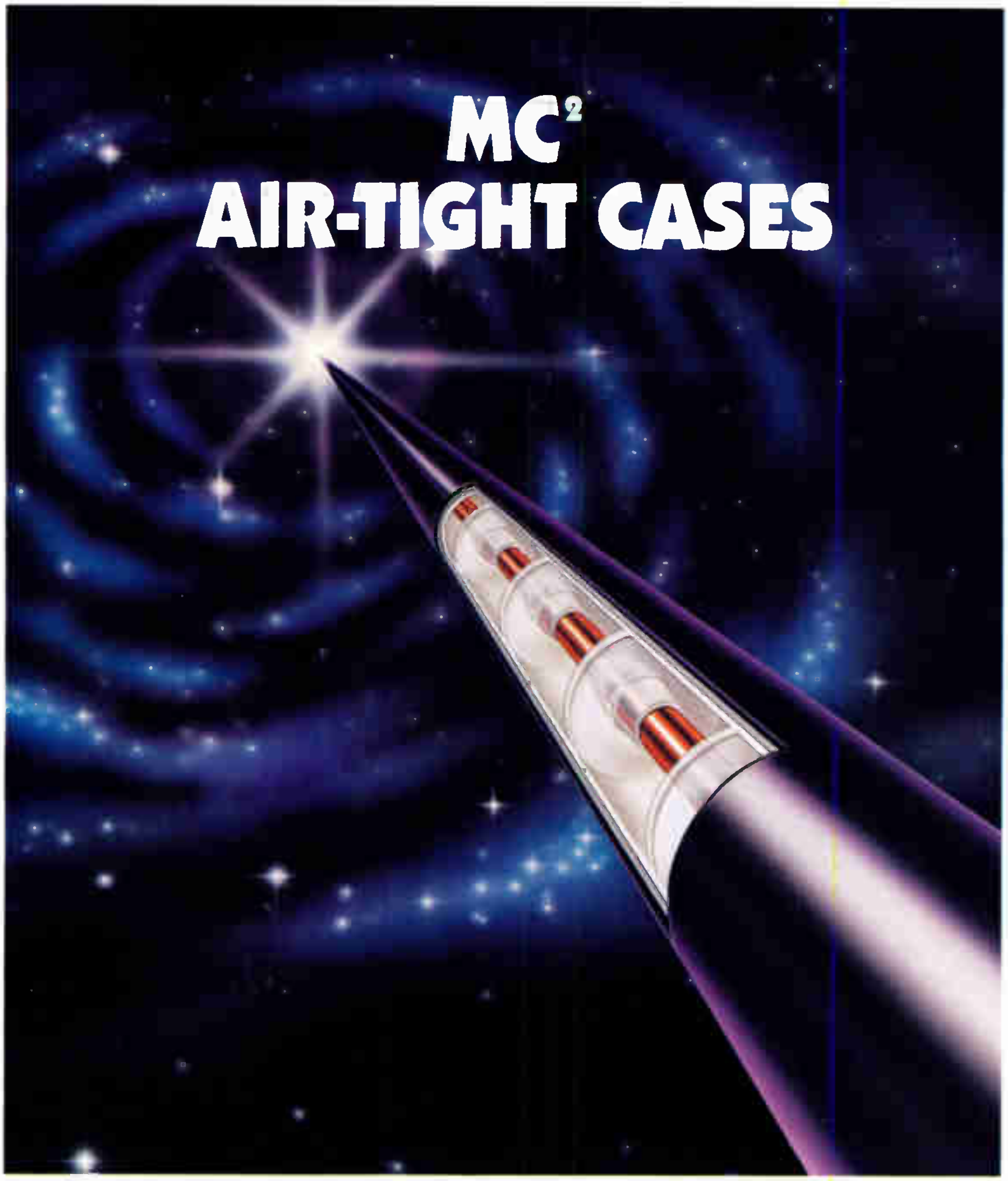

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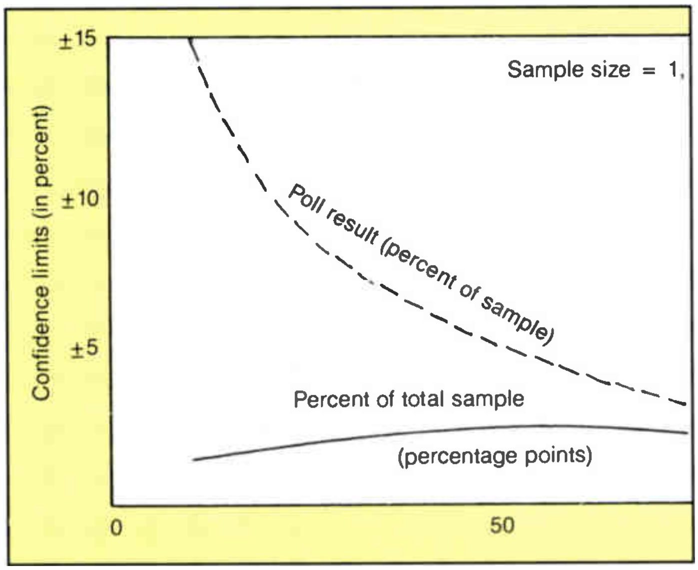

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Photo courtesy Tektronix Inc.; special effects by Image Corp.

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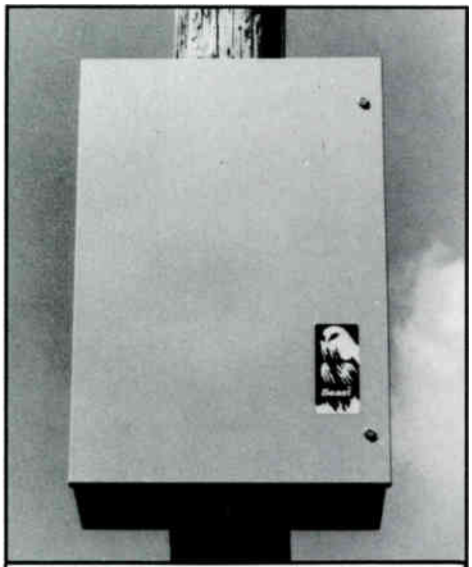


EDITOR'S LETTER

Keeping in practice

In last November's "Editor's Letter," we introduced most of our readers to the SCTE's Interface Practices Committee with a report of its activities. Another year has gone by, so let's hear what the committee has been doing lately. Secretary Joe Lemaire of Raychem reports:

"The SCTE Interface Practices Committee was organized in 1988 to address improved compatibility among CATV cable, connector and component interfaces. It has met on a quarterly basis since that time and plans to meet again in December in conjunction with the Western Show. Elections of committee and subcommittee chairpersons will be held at this meeting. Significant progress has been made during the past year, but much work remains.

"The first published output from the committee was a wall chart (in June *CT* and *Installer/Technician*), indicating the proper selection of connectors, cables and crimp tools for drop connector installations, based on manufacturer's recommendations. Since that time, draft documents representing interim practices have been prepared on the following subjects: basic recommendations on performance and compatibility, F-male and F-female mechanical interfaces, dimensional evaluation of flexible coaxial drop cables, tensile pull test procedure for drop cable connectors, hex crimp tool verification/calibration and aluminum cable core depth.

"The Interface Practices Committee consists of volunteers from cable system operators, vendors and contractors. Participation is open and wider representation is always sought."

For information regarding the committee, its next meeting and its documents, contact Lemaire at (415) 361-5792.

Adventures in fault locating

At a recent SCTE chapter seminar, I asked fellow attendee Dick Hall of United Artists—the big winner at the First Annual Cable Games in July—how he liked our write-up in the September issue. He liked it but said we goofed on the final tally, repeating the title of one of the events. So, the winners of the *fault locating* event were: first place, Greg Jolliffe (Columbine Cablevision); second place, Romeo Battazzi (Columbine); third place, Dick Hall (UA).

Also, we were somewhat "off color" in last month's issue, so let's make good. In Dan Pike's article "The effects of reflections," on page 48 the colors of the key to Figure 2 were not printed correctly. We provide the figure again, this time with the correct color key.

It's show time in Anaheim

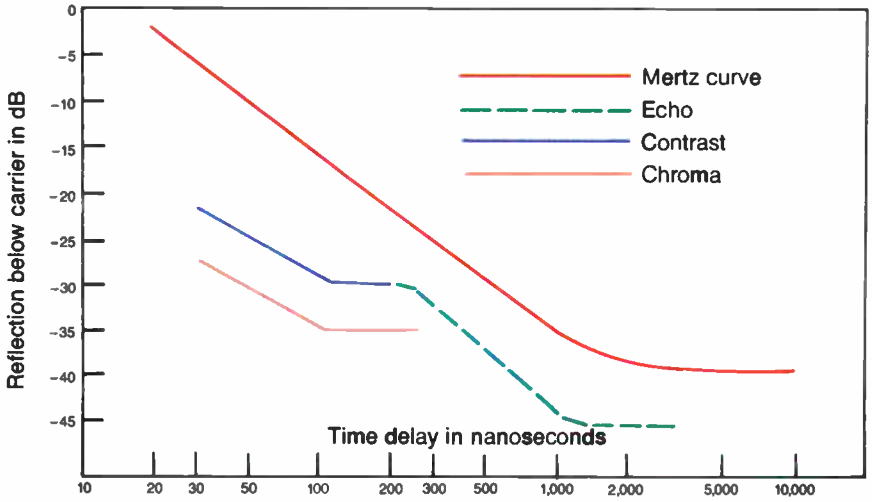
Everyone's gearing up for the California Cable Television Association's Western Show, Dec. 13-15 at the Convention Center in Anaheim, Calif. Neither Santa Ana wind nor San Andreas fault (techs, start your TDRs) will deter the thousands of attendees. This year's event looks at "Creating a new decade of television" and will feature panel discussions about the 1990s (and beyond). Seminars to ink in on your personal agenda include "Economics of fiber," "The consumer interface," "Telco TV" and a panel of representatives from the Federal Communications Commission.

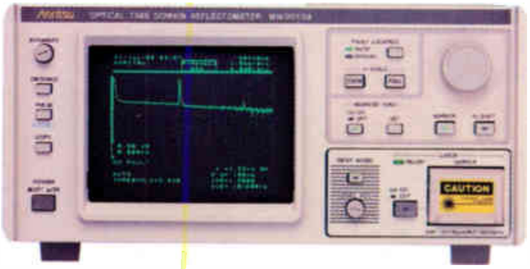
As usual, we'll cover action from the floor (packed with over 200 exhibitors) and the technical seminars (coordinated by the SCTE) with our *CT Daily*. By the way, if you're exhibiting and have a show-related announcement or a better mousetrap on display that you'd like the attendees to know about, send the information to: CT Daily, 50 S. Steele St., Suite 700, Denver, Colo. 80209; or fax it to (303) 355-2144. The deadline for the first daily is Nov. 27. It'll be great hearing from you.

And have a happy Thanksgiving!

Rikki T. Lee

Figure 2: Reflection impairment curves





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BPA

Society announces new fiber conference

EXTON, Pa.—The Society of Cable Television Engineers recently announced preliminary information on its second fiber-optics seminar. According to the SCTE, the three-day conference will be held March 21-23 in Monterey, Calif; no location has been set. Coordinated by the SCTE's Florida Chapter, the first seminar occurred January 1988 in Orlando, Fla., with 412 people attending. Those interested in presenting technical papers for the second seminar are requested to submit abstracts to Pete Petrovich, Conference Chairman, c/o SCTE, 669 Exton Commons, Exton, Pa. 19341.

The Society also issued its last call for papers for Cable-Tec Expo '90, slated for June 21-24 at the Convention Center in Nashville, Tenn. Proposals for technical papers to be delivered at the Annual Engineering Conference as well as for expo workshops are being requested. Abstracts should be sent to Bill Riker, Expo '90 Chairman, no later than Dec. 1.

For more information, contact SCTE national headquarters at (215) 363-6888.

TCI orders Jerrold on-premises modules

DENVER—Tele-Communications Inc. recently ordered 250,000 Starport on-premises addressable control modules from General Instrument's Jerrold Division; TCI's Boulder, Colo., system will be the first to implement the units. The Starport module is placed in a box attached to the outside of a subscriber's home. On this initial model, four addressable ports and a disconnect feature control the flow of TV signals into the home. This allows or disallows signals, depending on the preference of individual subscribers. Once the unit's signal passes into the home, a sub can hook up as many cable-compatible sets, VCRs or other devices with no extra charges and no additional converter equipment.

TCI's Executive Vice President and COO J.C. Sparkman suggested that the units would make pay-per-event a more economically viable endeavor for the cable operator.

TwixTel, Heritage unveil new service

KEYSTONE, Colo.—In what is being called "the world's first system for interactive cable TV/telephone services," the TwixTel System was launched here Sept. 13 jointly by TwixTel and Heritage Cablevision. The system, developed by the Framingham, Mass.-based telecommunications company TwixTel Technologies, allows pay-per-stay, pay-per-view, hotel-type amenities and

"CT," Transmedia announce move

DENVER—Effective Oct. 9, Transmedia Partners-I, L.P., publishers of *Communications Technology, Installer/Technician, Media Business, Media Business Review, MSO* and *Newspapers and Technology*, has moved to 50 S. Steele St., Suite 700, Denver, Colo. 80209, (303) 355-2101. The new facsimile number is (303) 355-2144.

direct-billed long distance service for condominium vacationers and time sharers via touch-tone phone. Prior to this, premium cable TV services, telephone service, operator service and room services were often unavailable in condos and time-share units.

The system utilizes the existing installed local cable operator's plant and addressable services that are integrated with specialized information gateway technology and controlled by a standard residential telephone. Service will be installed initially in the United States in condos, time-share units and resort hotels; later it will be extended to urban hotels, hospitals, college campuses and short-term rental units in and near military installations.

According to Heritage in Silverthorn, Colo., the TwixTel System is now available in six Colorado communities: Dillon, Frisco, Silverthorn, Breckenridge, Avon and Vail.

S-A displays yen for Japanese market

TOKYO—At the Festival CATV '89 Oct. 12-14, Scientific-Atlanta introduced its addressable subscriber products for the Japanese market. The units included a Model 8591 converter with Japanese character labeling on both the set-top and remote. According to Steven Necessary, S-A director of subscriber systems, "Features were configured specifically to meet Japanese marketplace requirements where high quality and advanced features are standard expectations."

The System Manager V addressable control system, also introduced at the show, uses Japanese character language interface.

Copyright Office announces decision

WASHINGTON, D.C.—The U.S. Copyright Office recently announced its long-awaited policy decision on the status of "significantly viewed" stations. In terms of the Copyright Act, significantly viewed stations are treated as local stations for which no additional copyright royalties must be paid. According to the ruling, the office will regard a station as significantly viewed only if the Federal Communications Commission has made a formal determination that the station is entitled to such a status. The FCC rules specify the procedures to be followed in determining whether a station is significantly viewed. An independent station is significantly viewed if it achieves a 2 percent share and a 5 percent net weekly circulation among non-cable homes. A network station is significantly viewed if it achieves a 3 percent share and a 25 percent net weekly circulation among non-cable homes.

Also in the decision, if the FCC issues a formal designation of a station as significantly viewed in the middle of a six-month copyright accounting period, a cable system may nonetheless treat the station as though it had been deemed significantly viewed as a local station for the entire accounting period.

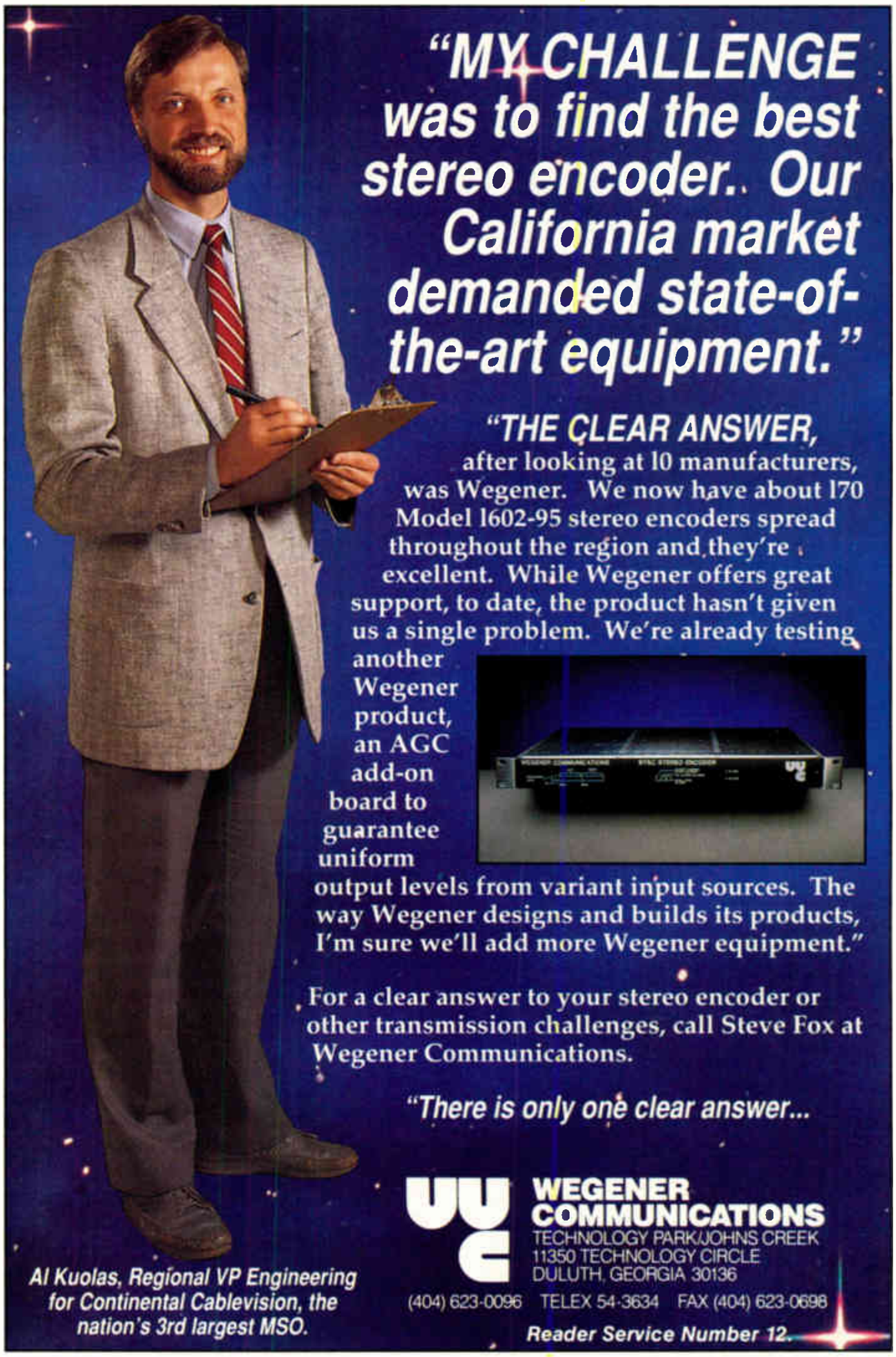
In addition, the Copyright Office issued a Notice of Inquiry concerning the treatment of merged systems. According to the rules, cable facilities in contiguous communities are treated as one cable system whenever the facilities are under common ownership, whether or not the facilities have separate headends or are technically, operationally or otherwise distinct. Initial comments are due Dec. 1, with reply comments due Dec. 29.

TCI's Sie blasts telco CATV delivery

WASHINGTON, D.C.—During a recent address at a telco/cable seminar sponsored by *Telecommunications Reports*, Tele-Communications Inc.'s Senior Vice President John Sie aired his views on telco/cable system architecture for the year 2000 and beyond. If a national fiber integrated broadband network combined both personalized telephony and data use and distributive mass media communications (as proposed by the telcos), this would be fundamentally flawed and "wrong for America," Sie contended.

He proposed the development of a system architecture based on the "four C's." This means the merging of computers and communications (the personalized telco ISDN or integrated services digital network) with cable and consumer (the distributive hybrid fiber coax network) on the customer's premises. Voice, data and still images would run via the cable system or ISDN, depending on which is more applicable; all full-motion video would use the cable network. Integration, formatting and processing of information from both networks for presentation on a display screen would be done by consumer premise equipment; this would supply consumers with the best qualities of both systems.

- Donley Cablevision Supply of Houston was named a master stocking distributor by Uniden of Fort Worth, Texas. Donley will stock Uniden's new line of commercial headend equipment.
- C-COR Electronics is offering a series of regional technical seminars on broadband local area network technology. The course covers network theory, component, industry standards and maintenance at a level appropriate for the novice. For information, contact Theresa Harshbarger at (814) 238-2461.
- Corning Glass Works will increase the capacity of its Wilmington, N.C., optical fiber manufacturing facility by 25 percent. The additional worldwide demand is due to increased international requirements and higher demand from North American cable manufacturers. The increased demand in North America reflects the growing acceptance of fiber by telcos and rapid adoption of fiber backbone systems by CATV.
- Scientific-Atlanta announced that bookings for its AM fiber system exceeded 100 orders in less than six months. S-A is increasing production to accommodate the increasing demand.
- Eidak Corp. retained Temple, Barker & Sloane (a Lexington, Mass.-based management consulting firm) and Alexander and Associates (a New York-based marketing and business planning firm) to spearhead a research effort to assess the impact of copy protected pay-per-view on cable and home video. Also, Eidak relocated its headquarters to 4 Cambridge Center, Cambridge, Mass. 02142, (617) 876-9000.
- Prestige Cable of Maryland announced that the Telecorp System 6000 audio response unit (ARU) was able to complete 49 percent of all inbound customer service and pay-per-view calls without CSR intervention during July. According to the company, the ARU has also increased pay-per-view (PPV) buy-rates.
- Tele-Communications Inc. and Westmarc Communications announced recently that they will install over 400 plant miles of AM optical fiber trunk in their cable systems next year at a cost of over $11 million.
- Arvis Corp. of Waltham, Mass., recently signed an agreement with Raleigh, N.C.-based AEI Music Network to package AEI's Spectra service with the Arvis ad view photo classified system.
- BradPTS and Keptel Armiger reached an agreement whereby BradPTS will exclusively supply the AA-103A-4CATV impulse PPV telephone interface device. BradPTS also signed an agreement with Alpha Technologies to provide warranty and out of warranty repair services on Alpha standby power supplies.
- RTK recently moved its corporate office and national warehouse to a 32,000-square-foot facility at 120 Floral Ave., New Providence, N.J. 07974, (201) 665-0133.
- Multicom Inc. of Longwood, Fla., has agreed to be a national distributor of the Jerrold Model S1450R VideoCipher II satellite receiver. The unit can switch to either C- or Ku-band and accepts signals from 950 to 1,450 MHz.
- The Wegener Network Communications and Control System is being fully utilized by Turner Broadcasting's CNN, TNT and Headline News. Rather than provide affiliates with audio cues for commercial insertion, the system transmits digital data cues from a satellite transmission facility.
- Channelmatic introduced a new line of syndex switching equipment at the Atlantic Cable Show. The product line, with over 45 systems, products and accessories, was developed in recognition of the many differences in existing headends and in the switching configurations of each cable system.
- Nexus Engineering Corp. and Nexus Group of Companies were recently awarded four Certificates of Merit in the 1989 Canada Awards for Business Excellence. Nexus Engineering's awards were in the categories of entrepreneurship, marketing and quality. Statpower Technologies Corp., a member of the Nexus Group, won in the innovation category.
- Midwest CATV recently agreed to purchase the inventory of Hudson Supply and will honor all open orders reissued to the company. Hudson will notify its current customers about the transfer of inventory and services. Also, Wavetek RF Products signed a national distribution agreement with Midwest CATV to be Wavetek's master distributor for its signal level meters and other selected products.



The FCC has the power

By Isaac S. Blonder
President, Blonder Broadcasting Corp.

The Federal Communications Commission has the power to revitalize the entrepreneurial spirit and financial investment in high definition TV (HDTV). This should encourage and indeed demand long-range planning for HDTV research, featuring a dynamic drive for superiority in TV science. The FCC has the power to return the bulk of TV manufacturing to our shores and to redress some of the foreign trade deficit. The FCC has the power to stimulate the training of electronics engineers in the art of TV design and efficient manufacturing technologies. This should provide an incentive for the secondary school complex to train technicians capable of assuming the demanding tasks in production. This will enable our factories to compete fairly in the world cauldron of subsidized and dedicated electronics manufacturers.

As a complementary spin-off of the research and manufacturing activity engendered by FCC fiats, the U.S. military posture will be undeniably improved by the presence of 1 million skilled electronics employees, 1,000 automated factories and 10,000 innovative engineers. (These are my rough estimates based on the glory days of the '60s.)

How does that courageous lone agency, the FCC, accomplish such a miraculous turnabout in our economy? The answer is to rely upon the strengths of a democratic society, stop regarding the world as a clone of our moral and legal sensitivities and make the financial health of our country the primary issue in the conduct of foreign affairs. In my 40 years of jousting at the potential foreign market for U.S. manufactured goods, I was wasting my sales pitches at the countless trade barriers and exclusionary national product standards. From my experience with the "friendly" Western World bureaucrats, World War III continued serially from World War II with the opposition now composed of our former allies!

My recommendations

Thus I recommend that the FCC proceed as follows:

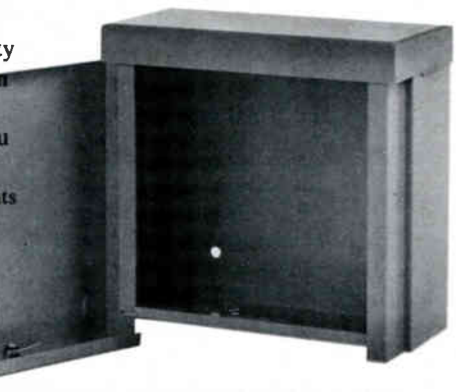
1) Declare that the inventor is entitled to a royalty on any invention that gives rise to a service standardized by an FCC rulemaking. I would recommend a license fee of 3 percent over a term of 10 years (a figure less than the common 5 percent and the life of the patent). I think this is fair if there is a lack of a litigation on the part of all parties. How else can inventors obtain the funds needed to materialize their brainstorms without the vision of a pot of gold (i.e., license fee) at the end of the rainbow to entice the moneybags to underwrite hair-brained schemes? All agencies of the government—not just the FCC—should awake to the realities of a capitalistic society and offer big rewards for the big jumps in technology.

2) Require that all beneficiaries of FCC awards of licenses and rulemaking allot 3 percent of their gross income to research and development of a high order. This rule also will apply to networks, programmers and all forms of non-manufacturers. The funds shall be either expended by the individual firms or by the associations to which they may belong. Fifty passive years have slid by since the birth of NTSC and the principal beneficiaries of television (the viewers and the programmers) have contributed virtually nothing to improving the art of television for the future. Meanwhile, other countries use license fees and government sponsored research to position themselves as pioneers in HDTV and are leaving us far back in the dust in the race for technical and financial achievement.

3) Request that Congress impose a 20 percent import tax on all radio and TV products with less than 51 percent American-made content. The rationale for not exceeding the 51 percent figure is to lessen the potential for global retaliation in trade barriers and to provide a reasonable level of competition to protect the U.S. consumer.

It is well-known that the entities covered by this initiative are currently so bottom-line handcuffed that the industrywide percentage devoted to R&D is well under 1 percent, or even totally absent. Similar foreign operations boast R&D expenditures exceeding 5 percent and the results are tragically shown in the superiority of their technology. Even typical U.S. industry R&D figures put the FCC-regulated poor boys to shame. Just to name a few: computers, 10.3 percent; medical, 8.6 percent; office equipment, 9.1 percent; semiconductors, 9.4 percent; software, 15 percent.

Under 1 percent is the road to oblivion and there seems no remedy at hand except through action by the FCC. ■



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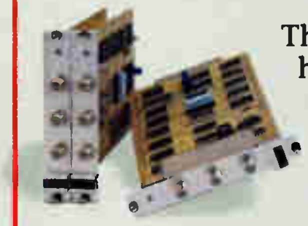

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Wendell Bailey: NCTA marches on

"CT" recently caught up with Wendell Bailey, vice president of science and technology for the National Cable Television Association. In this conversation Bailey discusses, among other things, working with the Federal Communications Commission and polishing CATV's image.

CT: What is the status of the NCTA's work with the FCC in establishing technical standards?

Bailey: The FCC is reviewing the issues that the Supreme Court passed down. The court stated that the FCC was correct in deleting the Class 1 signal standard and then pre-empting other bodies from establishing greater standards, but the FCC has never made it clear what standards applied to Class 2, 3 and 4 signals. In effect, the court said to the FCC, "Tell me what you meant here."

The FCC has several things it could do. One, it could decide to begin to develop standards for Classes 2, 3 and 4. Two, it could say that it always had standards for Classes 2, 3 and 4 even if they weren't clearly stated; it would be their understanding and intention that Class 1 standards applied to Classes 2, 3 and 4. And that's the most likely outcome. But it could just flat make a decision that it never said anything one way or the other about it and say, "Here's our decision, which is, 'It was our intention that the old standards apply, so we hereby apply them; and now we hereby remove them and pre-empt.'"

CT: What is your position?

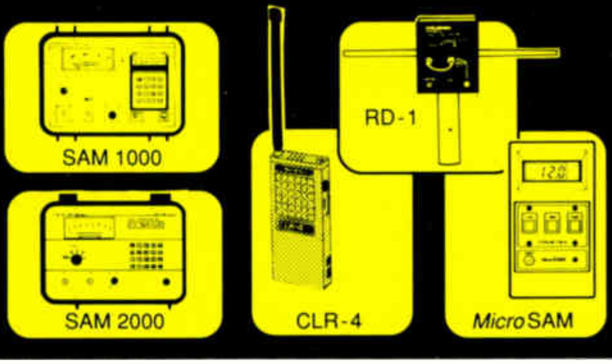
Bailey: We think the second way would be the proper approach, which is to say that it should be patently obvious to anyone that if you apply certain standards to Class 1 signals— that, since the cable is a pipe, is applying standards to certain sections of the pipe and in which case the whole pipe must reach those standards. The whole pipe also carries Classes 2, 3 and 4. In effect they did have standards for Classes 2, 3 and 4: They were the standards for Class 1. And that they intended to pre-empt in that area, and they did so.

Now subsequent to all that, the commission I would say is probably—if I had to put a word to it, I don't mean this in a negative way—holding off on what they do because it's their understanding and ours as well that the cities and the cable industry are contemplating beginning a series of meetings aimed at discussing the issue of cities and technical standards.

Bob Sullivan

CT: That's a bit political...

Bailey: It's got politics in it and it's also going to include a team of engineers from the cable side and a team of engineers from the cities' side. Politics certainly has to get worked out, there's no doubt about that. But after the politics are worked out or even concurrent with the politics getting worked out, the engineers would talk



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about what numbers in fact would constitute the standards. Now, I'm not saying that in fact this will go forward. I'm saying that the discussions are under way about whether it should go forward this way or not. I believe that (in fact, I'm reasonably sure) the FCC is aware of this and would like to see something happen because it would help them out. There wouldn't be people complaining afterward, so to speak.

CT: How much is the NCTA getting involved in making sure that the standards set by the city are more or less uniform?

Bailey: Part of our position going in was that the idea of each city setting separate standards was something we could never live with and we would never agree to. The only way we could do this was if the other side agreed that whatever standards were arrived at were uniform across the nation. In effect, replacing FCC standards by agreement.

Now I should also say that we have not agreed that the old standards need to be revised. I don't believe that wild and crazy claims by the cities about perfect pictures are something the cable industry is interested in hearing. Some of those claims are not supported by psychophysical testing; that is to say, it's one thing to say that you've got to have 90 dB signal-to-noise ratio (that's quite a number), and it's also quite silly when you consider that the human eye can't detect anything close to that. Why should everyone pay to have something delivered that no one can see? We want these to be pragmatic, real possibilities and frankly we want it to be something cable operators can do.

CT: But isn't this a way of saying to the cable operator by the governments, "We hear this HDTV is going to get started real soon, and we want you to make sure you can provide this in the near future"?

Bailey: I really don't think so, and I'll tell you why. Because no one in Washington, D.C., thinks HDTV is going to start soon. And without any prompting from anybody, each industry—broadcasting and cable—has realized there are certain improvements in certain parameters that must be achieved in order to deliver HDTV as we currently understand it. The systems are very poorly defined in that sense. If I had to guess I would have to say that we all agree that we have to improve in a couple of areas in order to make sure that we can deliver whatever it is. I think while the FCC and the other government agencies have recognized this is a motivational force, no one believes that this is the prime motivational force at this time.

CT: Is there any need in the future to take a look at the NCTA Recommended Practices for measurements on cable systems?

Bailey: We mean those numbers to be where an engineer doing good engineering practice and in a reasonable situation should strive to meet those numbers. They're clearly higher than the old FCC numbers in many instances. And it's also true that a lot of cable operators routinely meet the NCTA numbers. But I don't believe that I would wish to be in a position where an operator was penalized in some way for not meeting those numbers, because while they're goals for engineers using good practice—they're not sacrosanct.

And when you see the second edition, in some cases we have increased those numbers, but we have not increased them just to be increasing them. We've increased them after good and careful thought and understanding of what current industry practice is in certain areas. And we have not raised them beyond rational advances in day-to-day technology. Because you can do something doesn't mean that all 10,000 cable systems are going to do it right away.

CT: Right now cable TV seems to have a pretty tarnished image, especially politically with the call for re-regulation. What do you think engineers and technical people can do to help the managers and their lobbyists to improve our image?

Bailey: I'm going to say something that's not going to be popular, but I think the engineers have tried, tried, tried for a long time to do what has been helpful. The problem has not been an engineering problem. We generally deliver pretty good signals, better than people can get by other means. The problem has been one of, well a couple of things. One, our service image has not

been the best (service and response). And two, I think that our promotion of ourselves and what we are has not been what it should be.

I don't think those are directly technical issues. There's a large technical and engineering component in delivering good service. I would say that the engineers have met that burden and have consistently met it for some time. The rest of this is a management issue; the engineers are more than willing to put efforts and resources that we're allowed to put into the equation—we're more than willing to do that.

CT: Do you think engineers really have a handle on what CLI is and are they really getting their act together?

Bailey: As I said publicly, and I'll say again, signal leakage and CLI and the flyover issues are not primarily technical problems. It's true that signal leakage is a technical flaw. It's also true that most engineers and technicians know what it is and how to fix it. I'm not saying that everybody understands the rules or understands what a CLI is or how you calculate it, but a leak is a leak, and virtually every engineer or technician knows what it is and how to fix it.

The problem generally is that in order to comply with the CLI and meet the rules you need an ongoing, systematic commitment to that type of activity and that is a management issue. Managers need to understand that they need to fund for this activity, they need to provide the resources, they need to provide the training and the people, and they need to do it forever. It's not something that you do for this quarter and then you get caught up and then you can kill it. It's something that you have to do once you're committed to doing it every day from now on. It's a management commitment issue.

CT: How aware of CLI are the managers?

Bailey: In the CLI seminars, I would say that 75 percent of the people that attended were management. I think that they are interested. Let's say we reached 2,000 people, that's a lot of cable managers potentially since most of them were managers. But it's certainly not the majority by any means. As I've travelled around, I've met quite a few corporate managers who were not only interested but have made the effort to get on top of it.

Frankly, they all tell me that while they hated doing it, hated the cost and expense of doing it, that they look up two years later (those that have gotten started early) and they say that the cost has been amortized. It's been amortized by reduced service calls. They say, "You said that at the beginning, but we didn't believe it. Now that we believe it, we wish we'd started earlier." So the message is getting out through publications like yours, through the seminars of the NCTA, and through lectures and talks. But, like educating in any large group, it takes time. I think that it's getting done, and it will accelerate as we get closer and closer to the operative date.

CT: U.S. operators are getting more involved in Europe and elsewhere. Where does NCTA fit in? Do you address foreign conferences as a representative of the U.S. cable industry?

Bailey: Other NCTA staff members as well as myself have done that; we speak for the industry. To the extent that the cable industry is doing business across international borders, there is interest in hearing NCTA's position and benefitting from NCTA's insight into various industry practices and regulatory and technical issues. I think that our members' business interests are of interest to us. Not their business activities—that is, we don't tell them how to do business—but if we can participate in international forums and can recommend groups to visit in Europe or anywhere else, then it behooves us to do so.

CT: What is your greatest fear and what is your greatest hope for the next 10 years?

Bailey: My greatest fear would be that the policy makers in Washington, D.C., would fail to understand the potential danger of fiddling with a formula that has brought the American public a great deal of diversity at a very fair price. When government bodies lay their hands on successful operations they tend to be less successful shortly thereafter.

My greatest hope would be that the cable industry comes to the point where it has wired the majority of America and is delivering service that doesn't cause complaints from anybody.

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How to adjust audio carrier deviation

Attaining consistent audio deviation on all of a system's channels has been an ongoing problem in the CATV industry. Overdeviation causes a channel to exhibit excessive volume and use excessive bandwidth (both of which can lead to distorted audio on the subscriber's TV set), while underdeviation causes low volume on a channel. Inconsistent audio levels among channels may sell remotes (with volume control) but also can be a major subscriber irritant. As the universe of stereo TVs increases, the importance of proper deviation becomes even more important in order to maintain proper stereo separation and quality. This article will explore various methods of setting deviation and discuss the advantages and disadvantages of each.

By Ron Hranac
Senior Staff Engineer, Jones Intercable Inc.

And Steve Johnson
Senior CATV Project Engineer, American Television and Communications Corp.

Before we get into the techniques of setting deviation, let's review some of the background math and terminology. The audio signal of a TV channel uses FM (frequency modulation). With AM (amplitude modulated) signals, the amount of modulation is described in terms of depth or percentage of modulation. With FM, we refer to modulation index instead; the formula to calculate it is:

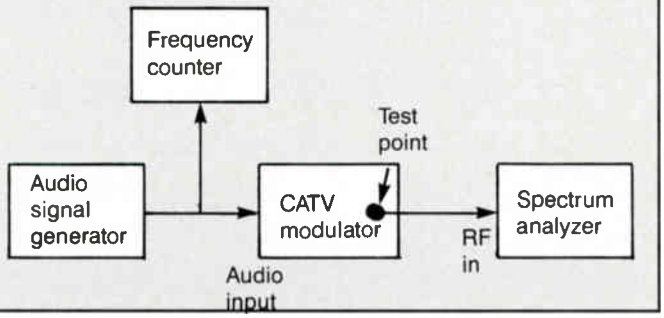
$$m = d/f$$

where:
m = modulation index
d = peak frequency deviation in Hz
f = maximum modulation frequency in Hz

Since we know that the peak deviation of a monaural TV audio carrier is 25 kHz and the maximum modulating audio frequency is 15 kHz, we can easily determine the carrier's modulation index:

$$m = 25{,}000/15{,}000$$
$$= 1.67$$

Figure 1: Bessel null equipment setup



In AM, the modulating signal varies the amplitude of the modulating RF signal. The volume level is expressed as a percentage of modulation that is equal to the peak-to-peak modulating voltage divided by the peak-to-peak unmodulated RF carrier voltage. With FM, the modulating signal causes the modulated signal's frequency to deviate—that is, to go higher and lower in frequency in proportion to the "loudness" of the modulating signal. Deviation of an FM broadcast signal in the 88 to 108 MHz band is ±75 kHz and TV audio is ±25 kHz.

Methods of setting deviation

1) *Ear*: Listen to the over-the-air channels and try to match your cable channel audio levels to that of the broadcast channels. Since you have no control of deviation on a headend signal processor, set the audio deviation of your satellite services as close to the deviation of your over-the-air channels as possible simply by listening and trying to match the apparent loudness. Drawback: very inexact. Apparent loudness can vary on broadcast stations between programs and from one station to the next. Levels also can vary between satellite services on the same transponder or between transponders.

2) *Blinking light*: Some manufacturers furnish a light that is illuminted when the deviation exceeds a preset threshold. This light may be more

Table 2: Pre-emphasis response chart

Frequency in Hz	Decibels
400	0.15
1,000	0.87
2,000	2.76
3,000	4.77
4,000	6.58
5,000	8.16
6,000	9.54
7,000	10.75
8,000	11.82
9,000	12.78
10,000	13.66
11,000	14.45
12,000	15.18
13,000	15.86
14,000	16.49
15,000	17.07

Table 1: Bessel null chart

Null	Modulation index (m)		Frequency in Hz (f) for 25 kHz deviation		Frequency in Hz (f) for 75 kHz deviation	
	Carrier	First sideband pair	Carrier	First sideband pair	Carrier	First sideband pair
First	2.4048	3.83	10,396	6,527	31,188	19,582
Second	5.5201	7.02	4,527	3,561	13,587	10,684
Third	8.6531	10.17	2,889	2,458	8,667	7,375
Fourth	11.7915	13.32	2,120	1,877	6,361	5,631
Fifth	14.9309	16.47	1,674	1,518	5,023	4,554
Sixth	18.0711	19.62	1,383	1,274	4,150	3,823
Seventh	21.2116	22.76	1,179	1,098	3,536	3,295
Eighth	24.3525	25.90	1,027	965	3,080	2,896
Ninth	27.4935	29.05	909	861	2,728	2,582
10th	30.6346		816		2,448	

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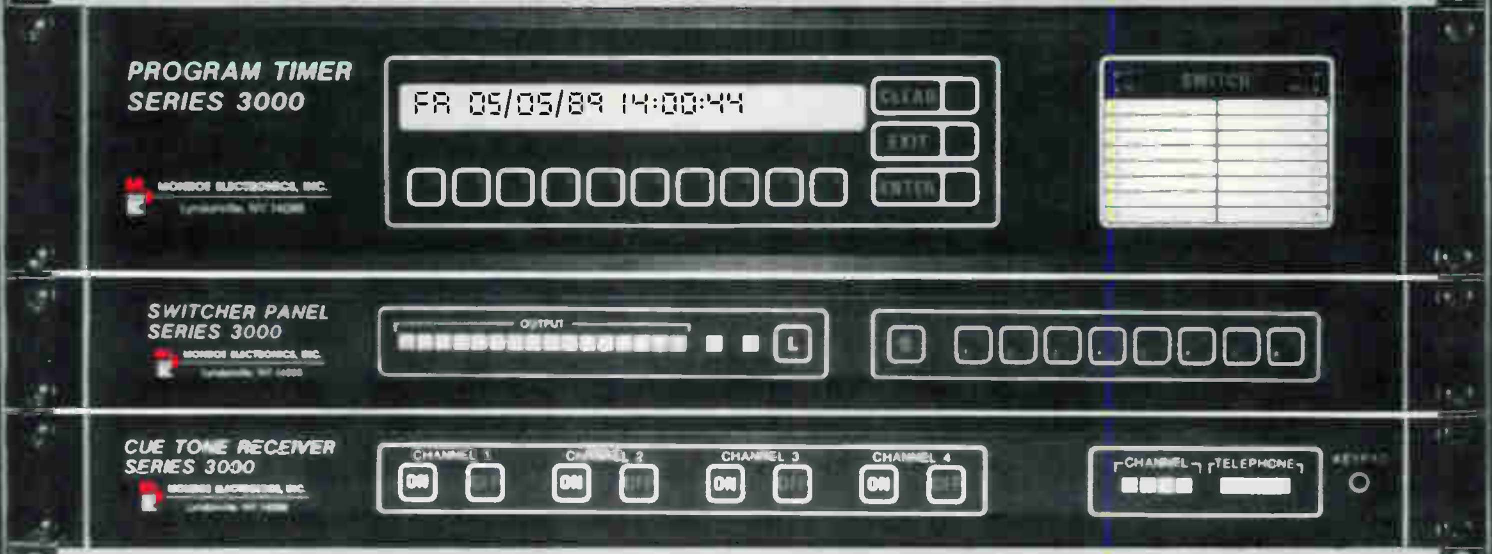

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or less accurate than the ear method, depending upon how consistent the thresholds are set from modulator to modulator. As a visual indication, the thresholds can be reset after you use a more precise method to adjust deviation. This will give you a better level of trust in the indicator for occasional visual checks of peak deviation.

3) *Front panel meter*: Another available accessory is a meter module. This can be standard or an option, depending upon the manufacturer. Usually this meter serves multiple functions: video modulation level, audio

Figure 2

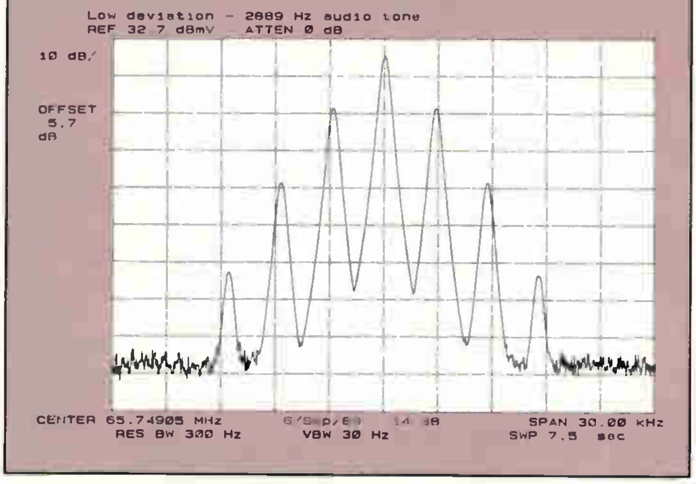


Figure 3

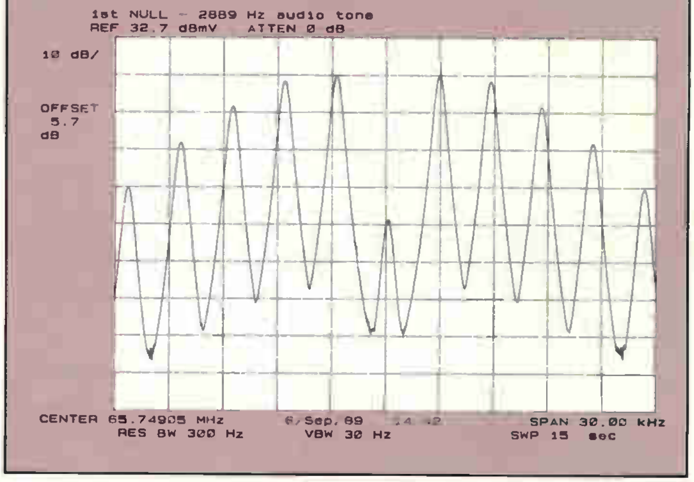


Figure 4

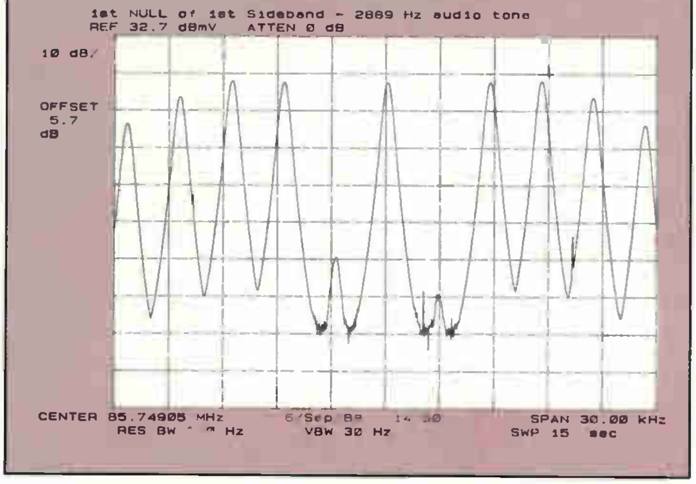


Figure 5

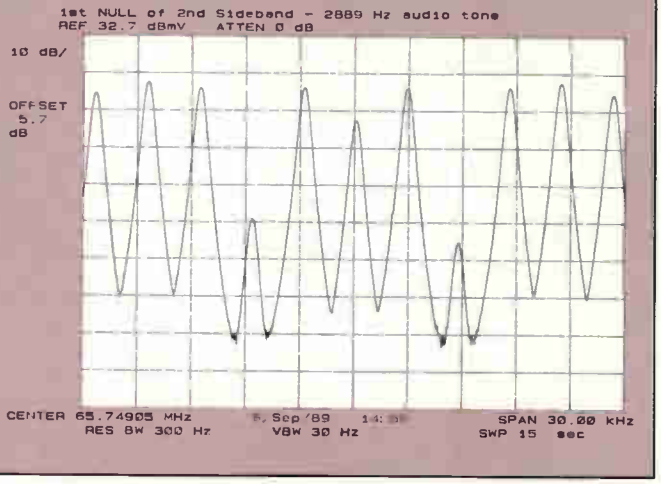


Figure 6

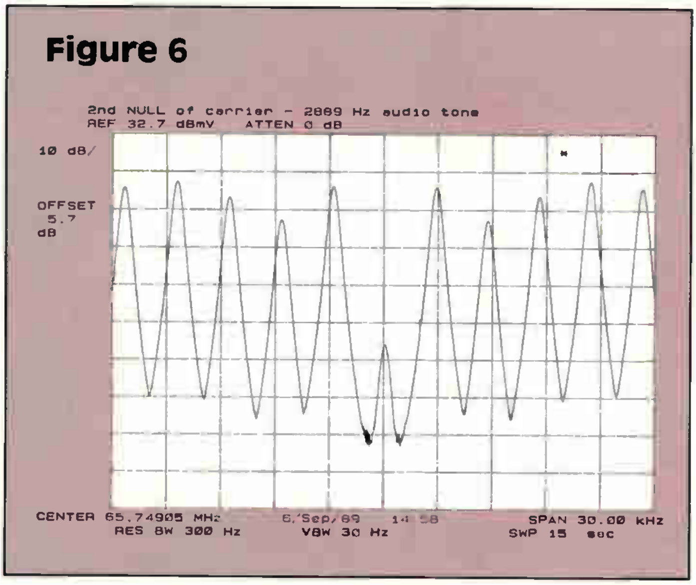
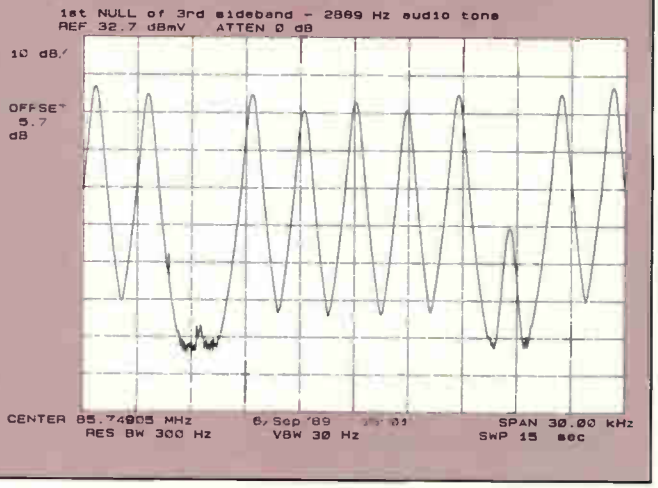


Figure 7



deviation, B+ voltage, etc. This meter can provide a relatively good indication of modulation and deviation but can suffer from calibration errors if not checked periodically. Meters also tend to be more accurate with fixed frequency tones and test signals than with program audio or video, because of the dynamics of analog meter movements.

4) *Deviation monitor*: An audio deviation monitor can provide very accurate measurement of an audio carrier's deviation. Both monaural and stereo versions are available. Broadcast deviation monitors generally are too expensive for CATV use, although at least one CATV manufacturer has a deviation monitor available for quite a bit less than broadcast units cost.

5) *Bessel null:* The Bessel null method requires a stable audio signal generator and an accurate spectrum analyzer (Figure 1). Deviation can be set extremely accurately with this technique, and your headend deviations will be very accurate providing your signal sources are set accurately. Unfortunately, this is often not the case. The Bessel null method also can be used to calibrate deviation monitors.

6) *Occupied bandwidth:* A properly deviated audio signal will occupy a finite bandwidth. This occupied bandwidth can be used as an indicator of the signal's deviation. Using techniques described in this article, deviation can be adjusted so that the modulated carrier occupies the proper bandwidth.

Now that we've look at our options, let's look more closely at the last two, which you may be less familiar with.

Using Bessel null

The Bessel null is a function that describes the relationship between the modulation index and the carrier and sideband amplitudes. When the modulation index = 2.4048, a null of the carrier occurs, which can be used for deviation measurement. As the deviation is increased, successive nulls of the carrier and the sidebands will occur. Any of these nulls can be used to indicate some amount of deviation, but generally only nulls of the carrier or first pair of sidebands are used (see Table 1).

As an example, using the third carrier null (modulation index = 8.6531), when we modulate the carrier with a 2,889 Hz audio tone, the carrier will null for the third time as the audio level is brought up to the point that a TV audio carrier's deviation is ±25 kHz. This is calculated with a variation of the modulation index formula:

$$\begin{aligned} 8.6531 &= 25{,}000/f \text{ or} \\ f &= 25{,}000/8.6531 \\ &= 2889 \end{aligned}$$

Audio noise is more predominant in the upper range of audio frequencies. In order to compensate for this and improve the signal-to-noise ratio, the higher frequencies are pre-emphasized. This is done in the transmitter or modulator by increasing the audio levels as the frequency increases (see Table 2). In the receiver, the audio signal is de-emphasized—reducing the audio levels as the frequency increases. We must either allow for the pre-emphasis in our testing or disable the pre-emphasis in the modulator when making Bessel null adjustments.

If we choose the first carrier null, the required audio tone will be in the high range of the transmitted audio spectrum. By using the third carrier null (or higher), we can select an audio frequency closer to the lower end of the audio spectrum where there is less pre-emphasis in the modulator, as shown in Table 2. If we choose the eighth carrier null, we can use a 1 kHz tone, which requires less than 1 dB of correction.

The following procedure is for the third null of the carrier, but is easily modified as necessary for other null multiples.

1) Adjust the audio signal generator to a frequency of 2,889 Hz. (The third null of the carrier occurs with a modulation index of 8.6531. ±25 kHz deviation ÷ 8.6531 modulation index = 2,889 Hz tone.)
2) Connect the audio output of the generator to the CATV modulator and turn the deviation control of the modulator fully counterclockwise. Set the output of the generator to 0 dBm, or to −4.77 dBm if you cannot disable the modulator's pre-emphasis.
3) Connect the spectrum analyzer to the modulator's IF output, RF output or test point. Tune in the audio carrier on the analyzer so that the carrier and at least four sideband pairs (which will be spaced 2,889 Hz apart) can be viewed. You may need to turn up the deviation control slightly for the sidebands to appear. At this point, you should have

Figure 8

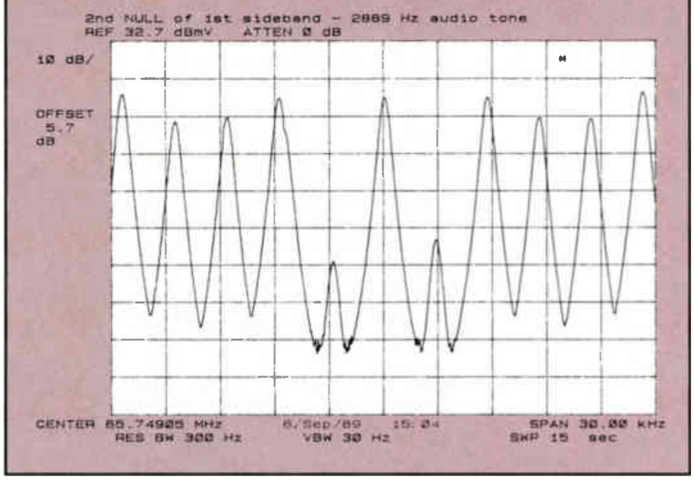
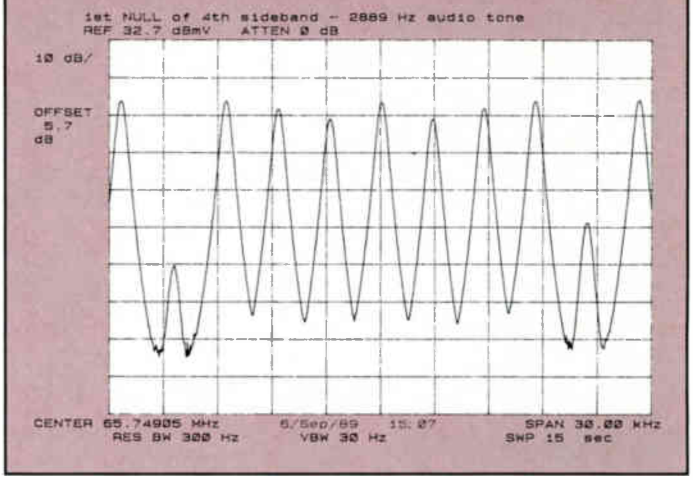


Figure 9



a display similar to Figure 2, which also shows the analyzer settings for span, resolution bandwidth and sweep time.

4) Slowly turn the modulator's deviation control clockwise until you find the first carrier null on the spectrum analyzer display (Figure 3).

5) Continue to turn the deviation control clockwise through the first null of the carrier, first null of the first sidebands (Figure 4), first null of the second sidebands (Figure 5), to the second null of the carrier (Figure 6).

6) As you continue to increase the deviation, you will pass through the first null of the third sidebands (Figure 7), the second null of the first sidebands (Figure 8), the first null of the fourth sidebands (Figure 9), the second null of the second sidebands (Figure 10), until you finally reach the third null of the carrier (Figure 11). At this point the modulator will be set up for ±25 kHz deviation with the proper input level.

Option: Follow the previous procedure, but use a 1 kHz tone at 0 dBm and adjust the modulator deviation control for the eighth carrier null. This method will result in a deviation of 24.35 kHz rather than 25 kHz; however, the difference is negligible, and a 1 kHz tone is available from many programmers during testing schedules.

In order to accurately set your audio deviation, your audio input to the modulator must be set to 0 dBm (1 mW or 0.775 volt across 600 ohms); when doing the initial deviation adjustment you must compensate for preemphasis as mentioned earlier. You also must set your audio program source level so that it does not exceed 0 dBm on maximum peaks. Most programmers provide test tones—usually at 1 kHz—at certain scheduled times that will allow you to calibrate your satellite receivers and measurement equipment. Check with each programmer for the scheduled test times.

Sometimes satellite transponders are shared between various services. Unfortunately, not all programmers are consistent with their audio levels, which may cause deviation differences between program sources. This illustrates the advantage of using leveling amplifiers or audio AGC (automatic gain control) units with your CATV modulators that share services, especially those with ad insertion.

The occupied bandwidth approach

If it is not desirable or possible to use the Bessel null technique, the deviation of an audio carrier can be adjusted fairly accurately by observing the occupied bandwidth of a modulated carrier on a spectrum analyzer. An audio tone at the same level that your peak program audio will reach (e.g., 0 dBm) can be used with either of the following two variations of this procedure. While this method is less exact than the Bessel null technique, it will allow you to set your modulator's deviation within a few percent of the desired deviation.

Occupied bandwidth method #1: The easiest way to set deviation using this technique is to apply a 0 dBm 1 kHz tone to the audio input of the headend modulator. Tune your spectrum analyzer to the carrier being adjusted, then set the analyzer's controls to the following:

Vertical display	10 dB/division
Resolution bandwidth	1 kHz
Span per division	10 kHz
Trigger	free run
Sweep time	auto or 300 msec
Video filter	auto or 30 kHz

→

Figure 10

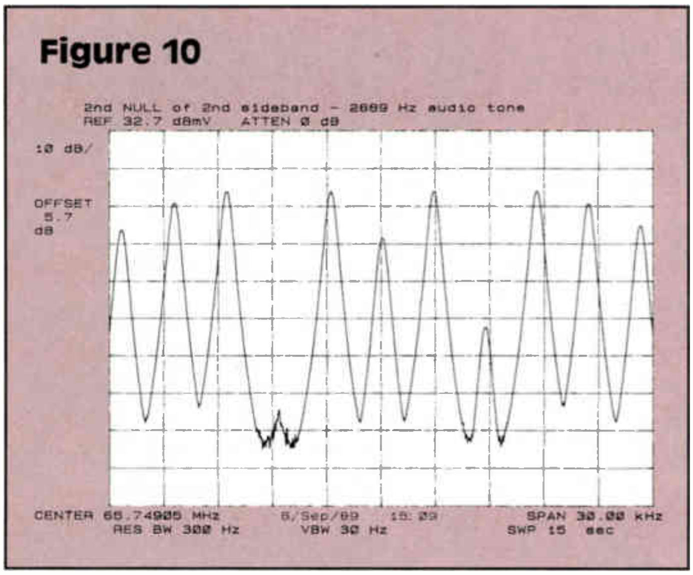


Figure 11

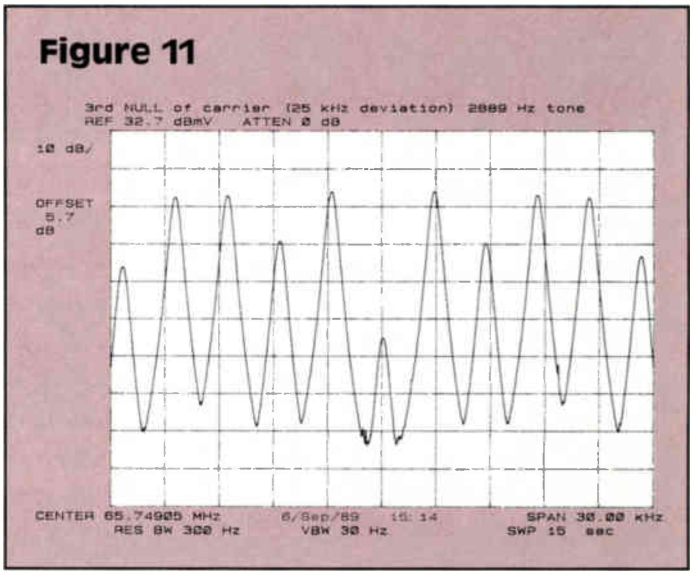


Figure 12

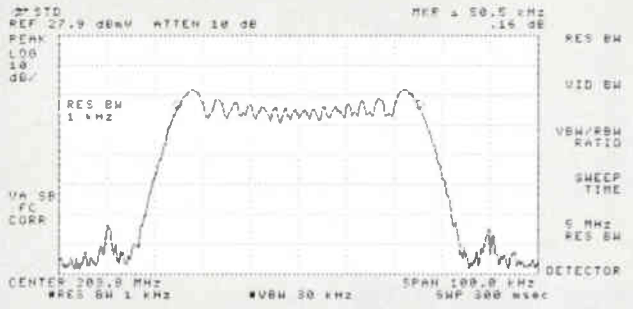
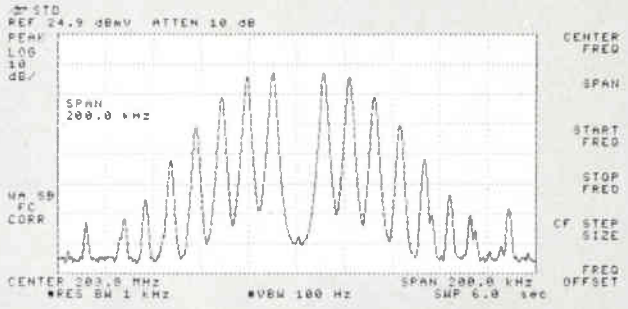


Figure 13



Slowly turn up the modulator's deviation control until the analyzer displays an occupied bandwidth of 50 kHz at the −6 dB points (Figure 12). This corresponds to approximately ±25 kHz deviation with peak program audio input.

Figure 13 shows the same modulator adjusted to the first Bessel carrier null using a 10.396 kHz tone to produce ±25 kHz deviation. By changing the resolution bandwidth and video filter (Figure 14), you can see that the −6 dB points are 50 kHz, confirming the validity of this procedure.

Occupied bandwidth method #2: Another way to measure deviation is to observe the "slope" of the modulated audio carrier as shown in Figure 15. Again, connect a 0 dBm 1 kHz tone to the modulator's audio input, and tune the spectrum analyzer to the audio carrier being measured. Set the analyzer's controls to the following:

Vertical display	10 dB/division
Resolution bandwidth	30 kHz
Span per division	10 kHz
Trigger	free run
Sweep time	auto or 20 msec
Video filter	auto or 30 kHz

When you have adjusted the deviation correctly, the occupied bandwidth of the "slope" of the carrier will be 50 kHz, which corresponds approximately to ±25 kHz deviation. You may have to adjust the center frequency and vertical position controls on the analyzer to locate the desired display. Note that with the analyzer set up as shown, the width of the signal when correctly adjusted is five horizontal divisions, or ±25 kHz.

Setting satellite receiver output

After you've adjusted the deviation of all of your headend modulators to ±25 kHz with a reference audio signal using one of the procedures described in this article, it's important that you set the output of your satellite receivers so that the peak program audio level does not exceed your reference peak test level (0 dBm). The best time to do this is when the satellite programmers transmit their test signals, as mentioned earlier.

Believe it or not, after you've done all of this, you'll find that the audio levels may still vary in loudness from channel to channel. This can happen even though your modulator deviation is exactly ±25 kHz, and your program audio is set so maximum peaks do not exceed the reference level you used. The reason this happens is that the audio dynamic range (difference between the loudest and quietest passages) varies from programmer to programmer. Unlike broadcasters, satellite programmers and CATV operators seldom process their audio. In broadcasting, it is fairly common to find that the dynamic range of the audio is squeezed down to just a few dB using compressors/limiters.

The broadcaster then "turns up" this compressed and limited audio so that the peak program level just reaches the maximum deviation. The result is a much louder sounding signal, even though the peak deviation is not being exceeded. If you listen closely, you'll notice that the difference between the loudest and quietest passages is much less than that of most of your satellite channels.

Because the satellite program audio is not processed to the extent that over-the-air broadcast audio is, satellite audio usually has a bigger difference between the loudest and quietest passages. As a result, even though the peak program audio (loudest passages) is set to produce maximum deviation, the overall audio will not sound as loud.

You really have only two solutions to this, other than leaving your channels with varying levels of loudness among them. One is to increase the program source audio level (*not* the modulator deviation control) until the channel sounds as loud as your over-the-air signals. But as discussed earlier, this method is inexact and certainly should not be done on BTSC stereo channels.

The other solution is to process your audio in a manner similar to the broadcasters. Many CATV manufacturers now have audio AGC or leveling amps that cost much less than their broadcast equivalents and perform nearly as well. This is probably the best route to choose: it will eliminate loudness variations among your channels, and keep your audio at the correct deviation.

There are stereo versions of these audio processors available, and some manufacturers are including similar circuits in their BTSC encoders. This will allow you to provide optimum stereo performance by maintaining constant deviation and avoid irritating your subs with unnecessary loudness variations. ■

Figure 14

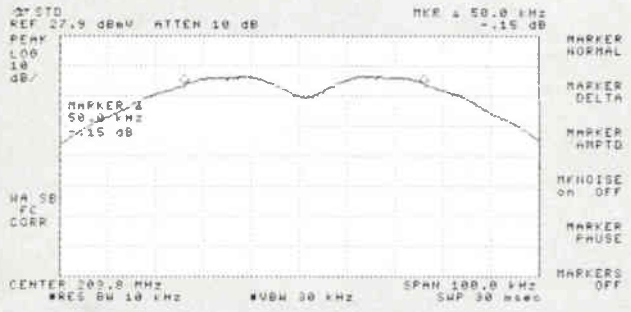
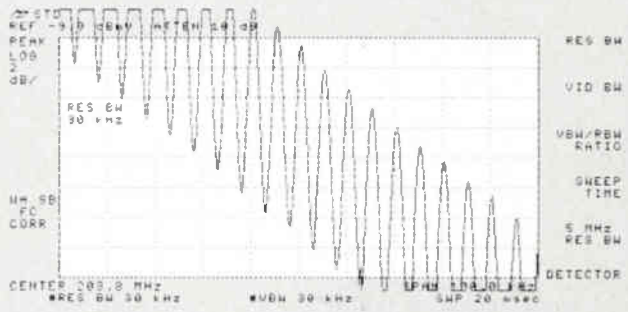


Figure 15



Part I: Measuring in-depth

This is the first in a series of articles designed to cover the currently available measurement techniques used in CATV plant maintenance and design. The authors expect to cover a number of specific topics, including: improvements in spectrum analyzer measurements, digital test and monitoring techniques, carrier-to-noise vs. signal-to-noise, satellite downlink realignment and testing, composite triple beat measurements, baseband tests and others. This should be an open forum and the authors would welcome comments and suggestions from readers regarding both topics of interest and as-yet-undisclosed new measurement techniques. The first installment covers non-interfering system sweep measurement technology.

By A. William Le Doux
Marketing Product Line Manager

And William R. Benedict
Applications Marketing, Tektronix Inc.

The CATV industry has employed a variety of methods in attempting to verify the frequency response of an operating system—using everything from an RCA signal generator coupled with a 704B, to a spectrum analyzer or a signal level meter with a broadband noise source. A variety of system sweep equipment has been produced over the years: the original *high-level* (20 dB above the carriers), the *low-level* (20-30 dB below the carriers), a *mid-level* (which started at 10 dB above the carriers), low-level/band limiting and more recently, sweep response without the use of a sweep generator. This last attempt uses a spectrum analyzer to plot the levels of the car-

Figure 1: Headend insertion of sweep transmitter

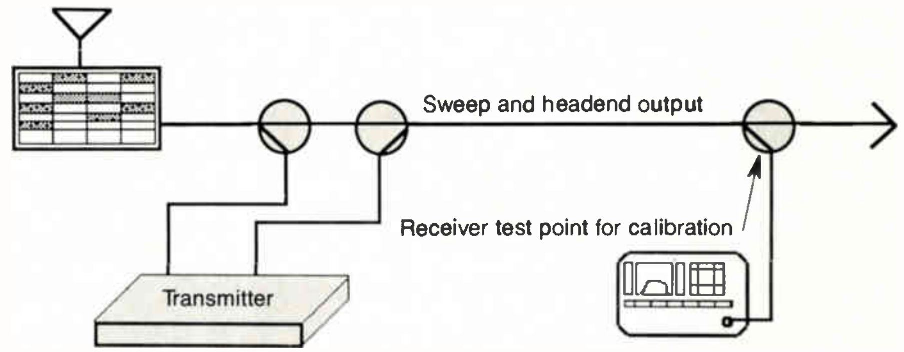


Figure 2: Sweep reference

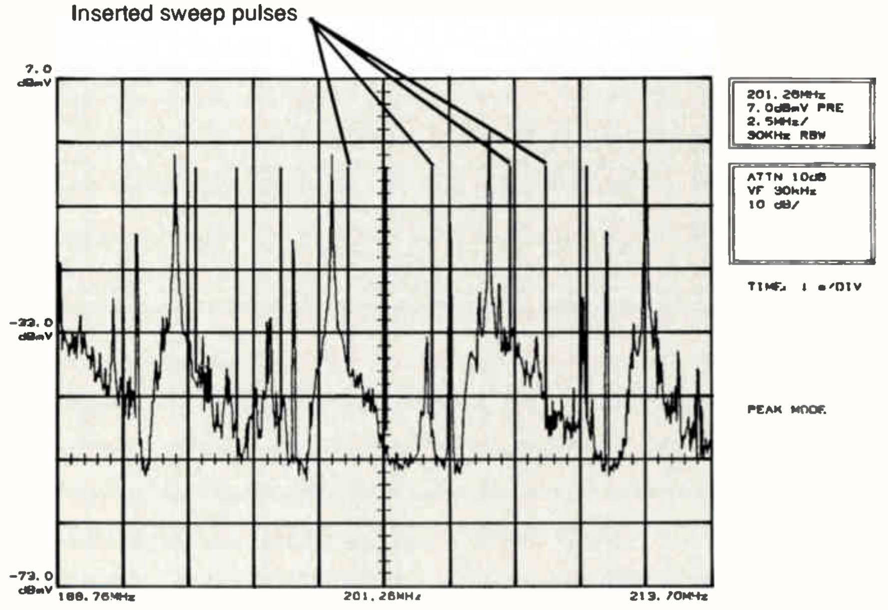


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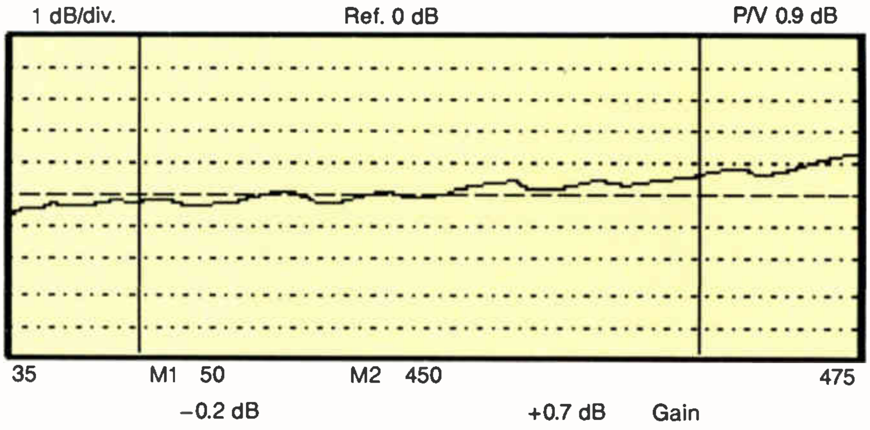
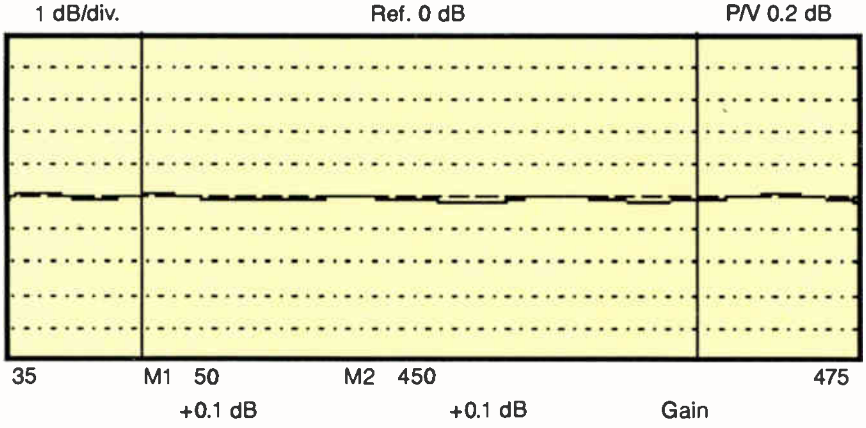
Figure 3: Un-normalized headend sweep reference



> *"Advances in digital technology have allowed a new method of sweep ...that is injected synchronously with the carriers on the system."*

Figure 4: Normalized headend sweep reference



riers on the system and then connect the dots to produce a sweep response.

Apart from the obvious benefits a system sweep has of in-band flatness, correct levels and overall unity gain, one of the key benefits has been the ability to use sweeping for preventive maintenance; in other words, seeing the problem before subscribers do. This includes seeing a low- or high-end rolloff before it caused damage to the lowest or highest channels. Over the years, it has become an almost de facto standard to set up a system sweep to view the response about 20 MHz above and below the operating band, just for this reason.

The basic peak-to-valley (P/V) requirement—where P/V (in dB) = (n/10)+1, with n as the number of amplifiers in cascade—can be very difficult to carry out in actual system operation. The low-level approach to sweep, which dominated the market during the 1970s, included a 5-300 MHz tracking generator/tracking spectrum analyzer pair to accomplish the sweep function, running about 35 dB below the carrier level and at line rate. The interference to the carriers was minimal running at such a low level, but deeper into the cascade the rising noise floor caused a significant amount of variation in the sweep trace, limiting the typical resolution to about ±1 dB. Transmitter/receiver flatness specifications of ±1 dB compounded the error to a total of ±2 dB built into the equipment. At just 15 amplifiers into the cascade, the flatness target is 2.5 dB [P/V = (15/10) + 1] or only 0.5 dB more than the resolution on the test equipment.

The introduction of a mid-level system sweep approach added back the resolution to the display that was first seen with the original high-level, and solved some of the interference problem by using a faster sweep rate with an improved detector. Use of a 1 ms rate to cover 400 MHz dramatically reduced the interference by minimizing the dwell time per channel. But as satellite services increased the average system channel loading, the total power level seen by a sweep detector dramatically increased. The mid-level system had to increase its power level accordingly, just to recover the sweep, effectively turning it into a high-level system. This type of high-level system was not a serious problem to use, until addressability introduced far more susceptible set-top converters. High-level approaches to sweep can momentarily reset the scrambling telemetry, sometimes causing a picture roll or intermittent scrambling. System sweep was now used very sparingly.

The low-level/band limiting sweep technology operates with a sweep carrier 10 dB below the video carriers. This is high enough to avoid the noise buildup problems associated with earlier low-level sweep equipment, but low enough to reduce interference to the pictures. This type of system sweeps the bandwidth *around* the carriers and measures the actual RF carriers during "no sweep" periods. These measured levels are combined with the recovered sweep data to produce the actual frequency response display.

Synchronous sweep response

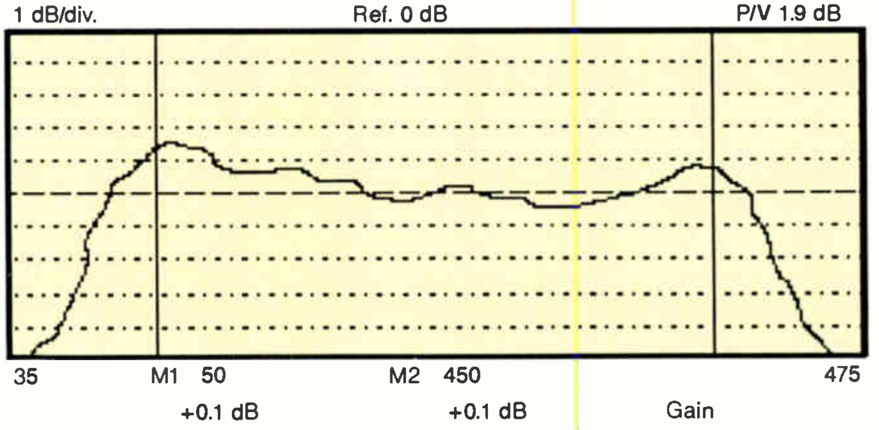
Advances in digital technology have allowed a newer method of sweep, which can completely eliminate the interference yet maintain the required resolution for day-to-day maintenance: Inject sweep pulses across the band but fire these pulses only during the vertical blanking. Since the sweep energy is only present during blanking, the video content remains entirely undisturbed; i.e., a sweep that is injected *synchronously* with the carriers on the system. For the first time, level of a system sweep, with relation to the carriers, now becomes insignificant. As a consequence, the sweep can be run at carrier level, offering the maximum trace resolution in the field (assuming a decent carrier-to-noise ratio), without the interference that we've lived with for so long.

To accomplish this, the carriers on the system must be sampled to obtain the timing required. Just prior to the injection point of the sweep, a sample of the headend output is taken for this purpose (Figure 1). As part of its installation, the sweep transmitter is then programmed, channel by channel, identifying the channels for synchronous operation. Since the system is based on channel locations, the sweep pulses fired within each channel's limits must be programmed for either instantaneous firing ("timed" firing during the blanking period) for timed firing after locating the blanking period on a sync-suppressed scrambled channel, or skipping a channel completely, with no pulses fired. The end result of this careful timing of reference pulses is a full-band sweep reference, as much as 600 MHz at a time, with up to a maximum of three sweep pulses per 6 MHz channel bandwidth (Figure 2).

In operation, the transmitter proceeds from low to high frequency, firing its sweep pulses as fast as possible. Beginning out-of-band, as all standard system sweeps do, the system will fire pulses with no timing constraints until it reaches a channel boundary. It then follows the preprogrammed instructions for timing of the inserted pulses, firing during the blanking period of the channel, then continues across the band. The sweep receiver tracks the transmitter, much as a tracking spectrum analyzer, using a frequency agile telemetry pilot for timing instructions. The telemetry pilot's frequency agility is designed to allow the sweep system to operate in a variety of broadband circumstances, including sub-, mid- and high-split frequency configurations.

The receiver uses normalization techniques, by storing a master reference trace at the headend output. Because of the use of this reference, flatness errors within the transmitter and receiver are included as a constant in the measurement and are thus eliminated from the measured results. (See Figures 3 and 4.) The transmitter also has the capability to store other channel configurations, to allow for more than one headend or for specialized two-way testing. The receiver can select from different amplitude reference traces, stored in non-volatile RAM, which can be used in the field to allow for different tilt and output level variations, such as trunk, bridger and line extender outputs. The receiver is a dual-detection scheme. This allows the first detector to make a reading on a sweep point, while the second detector is moving forward to set up for the next occurring pulse. The receiver can then track as fast as possible across the band, not being limited by the detector speed, to create an almost continuous display update (Figure 5).

Figure 5: Synchronous sweep field display



A word about resolution

Obviously, with the benefits of a synchronous system sweep, and 1 or 2 dB per division resolution on the screen, the next question that comes up is what about the limited sampling rate on this type of a system? When system sweep first started nearly 20 years ago, all of the methods were analog and, as a result, had an infinite number of points across any specified sweep width. Digital sampling and limited sweep point resolution simply did not exist. However, the high-level sweep mostly in use over the past nine years in the industry is in fact a limited sampling technique. The display used was a 256 × 256 point readout, drawn with the use of a raster scan CRT.

Translated to resolution, with a maximum span of 400 MHz, this means that for years, a limited resolution for system sweep has been used; a resolution of 400/256 = 1.5625 MHz. The industry standard for system sweep resolution has been no better than 1.5 MHz, proving that the broadband sweep job, with only a limited sampling, produces excellent results.

Taking guesswork out of fiber testing

By Todd Jennings
Product Specialist, Siecor Corp

With the newly found benefits of fiber-optic transmission for CATV comes a concern for practical implementation. Because CATV applications push the limits of fiber transmission equipment, a high-quality system is essential for the required performance. Hence, to ensure overall integrity and performance, three types of testing should be performed: end-to-end attenuation, optical time domain reflectometer (OTDR) testing and return loss testing.

End-to-end attenuation

Attenuation represents optical power loss and is the key limiting factor in assuring proper performance of a fiber system. The physical properties of the glass fiber as well as splices, connectors, couplers and other devices contribute to the total attenuation of the cable plant. In addition, physical conditions of the fiber and cable may induce attenuation: sharp bends, compressive forces, tension or moisture. Since installation can dramatically affect loss, attenuation should be measured on each fiber after completion of installation, splicing and termination.

The end equipment drives the amount of attenuation acceptable for a given system. The difference between the transmitter's specified output power and the required receiver sensitivity establishes a link loss budget in dB. A system designer should stay within this budget with allowances for upgrades, degradation due to laser aging and safety margin for the possibility of repair splices. A calculated system loss can be approximated by adding the specified losses of the individual components. These include fiber, splices, connectors, etc.

Typical optical return loss

Connectors	
● Conventional	15-25 dB
● Physical contact ("PC" or "Super PC")	30-50 dB
Mechanical splices	20 to >50 dB
Fusion splices	>50 dB
Single-mode fiber	>50 dB

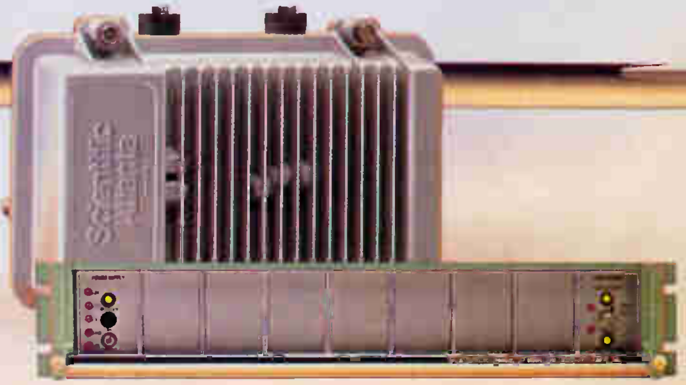
Insertion loss is the accepted standard for measuring end-to-end attenuation—the actual total loss of cable, splices, connectors and other components in line. This two-step procedure requires a stabilized light source and power meter. This combination of light source and power meter is often called an *attenuation* or *optical loss test set*. To perform an attenuation test (as shown in Figure 1): *Step 1: Measure the reference power.* Attach a short jumper (about 2 meters long) between the light source and power meter. Record this reading in dBm as the reference power. *Step 2: Measure the test power.* Remove the reference jumper from the power meter and connect the light source to the near end of the system. Take the power meter to the far end and attach it to the same fiber with a second jumper. Record the loss or test power. So:

$$\text{Attenuation (in dB)} = P_r - P_t \qquad \textbf{(1)}$$

where:
P_r = reference power in dBm
P_t = test power in dBm

The end-to-end attenuation is simply the difference between these two readings in dB. Many test sets are designed to store the reference power and display end-to-end attenuation directly in dB. This saves time, eliminates calculation errors and reduces recordkeeping in the field. To get meaningful and accurate attenuation measurements you should:

1) Test at the system operating wavelength, typically in the 1,300 nm range. If the system operates at 1,550 nm or if there is a possibility of



upgrading in the future, an attenuation test should also be performed at 1,550 nm. Attenuation at 1,300 nm has no fixed relationship to the one at 1,550 nm due to the fiber construction and the inherently higher bend sensitivity at 1,550 nm.

2) Match the light source and power meter to the system wavelength.

- *Light source*: Test with a laser that has a center wavelength of 1,300 (and/or 1,550) nm ±20 nm. A laser has a power output and spectral width on the same order as your end equipment. Confining its wavelength within this region assures accurate results.
- *Power meter*: Test with a power meter calibrated to the appropriate wavelength of 1,300 and/or 1,550 nm, preferably both to allow the maximum flexibility.

3) Match reference jumpers to the cable tested. The connectors and fiber type should be the same as the cable system.

4) As a minimum, the attenuation of the fiber should be tested in the actual direction of signal transmission corresponding to the transmit/receive orientation of the active components; i.e., laser light source at the hub and power meter at the node.

Bidirectional attenuation measurements are preferred because they can reveal directional differences in system loss caused by couplers, wavelength division multiplexing devices and fiber core mismatch; and can provide increased accuracy by averaging the two-directional results. They also supply documentation required for upgrades or rerouting and minimize test errors by flagging any unexpected discrepancies.

OTDR testing

While the attenuation test discussed previously measures the lump sum end-to-end loss of a link, an OTDR allows measurement of the distance to and loss of individual components such as fiber, splices and connectors. An OTDR (analogous to a TDR used on coaxial cable) requires access to only one end of the fiber and works like an optical radar, measuring reflected light and displaying the information as a trace on a screen. The following is a key to interpreting the OTDR as shown in Figure 2:

1) *Linear portions* of continuous sections of fiber. Length can be measured by its location on the horizontal scale. The slope of the line in-

Figure 1: End-to-end attenuation test

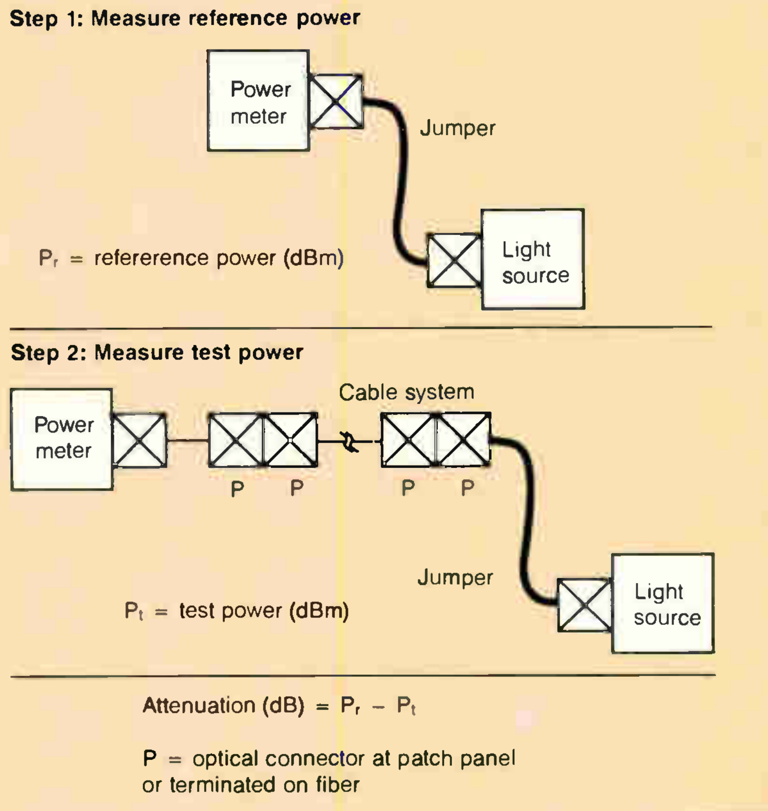
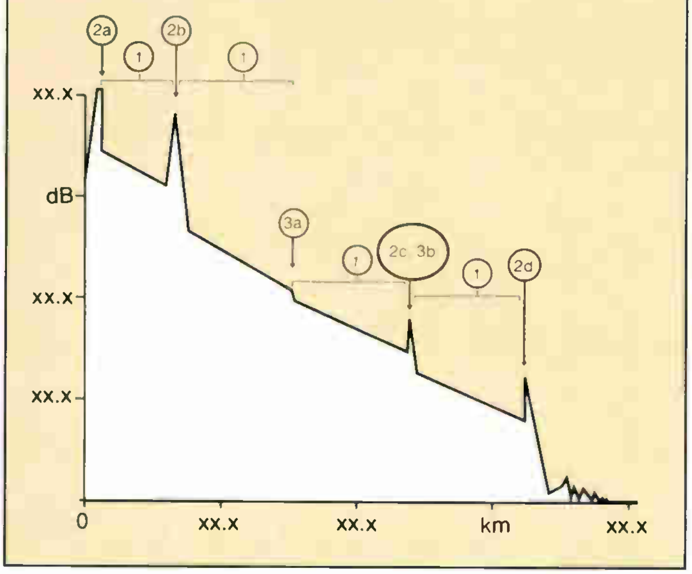


Figure 2: OTDR trace



dicates the fiber quality in dB/km—the steeper the slope, the higher the fiber loss.

2) *Spikes*: Indicate reflections or breaks in the continuity of the fiber as the light goes from the glass into air. These typically may result from connection to the OTDR (a), a connector in the system (b), a mechanical splice (c) or the end of the fiber (d).

3) *Vertical drops*: Indicate a localized loss in power. Loss at these points can be determined by measuring the magnitude of the vertical drop. Distance to each point can be measured by locating the horizontal position along the trace. Figure 2 shows two common cases: a) A continuous fiber with localized loss. We would normally expect this to be a fusion splice. However, this loss could result from the cable experiencing a tight bend, kink or other stress. b) This point shows a vertical drop as well as a spike indicating localized loss and reflection. This typically is a mechanical splice or other component with mechanical junction of fibers.

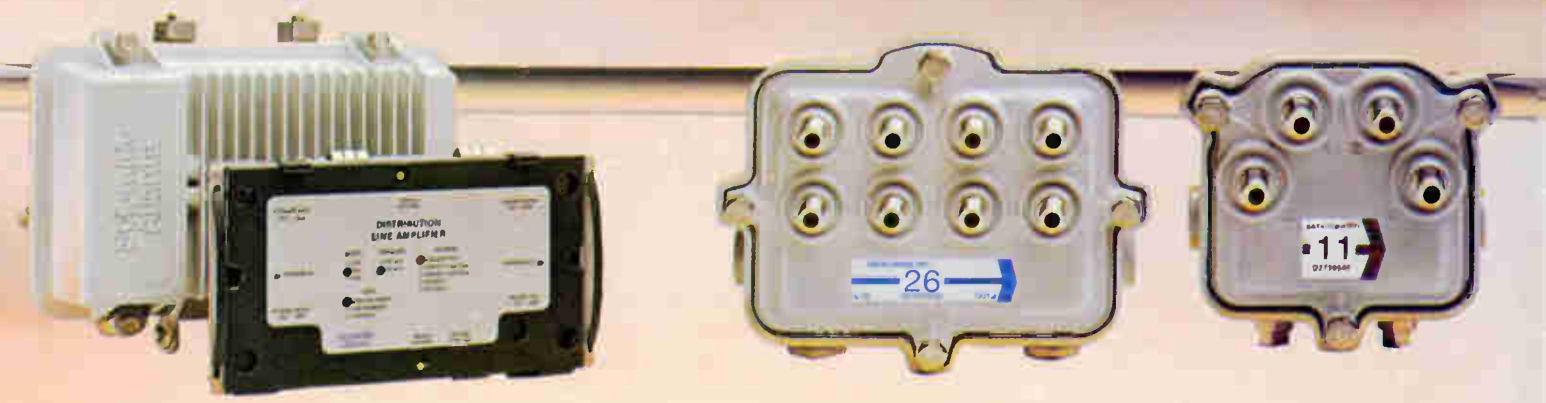
Another key to interpreting the OTDR trace is to cross-reference it with the cable route diagram, revealing the location of system components. Because of the valuable information the OTDR can provide, it is particularly useful for:

- *Cable acceptance*—It can evaluate the quality of fiber in incoming cable reels and installed cable that has insufficient records. An OTDR can measure fiber loss in dB/km and can detect point faults and discontinuities.
- *Splice and connector loss*—It can measure and document losses of individual splices, connectors and other components.
- *Documentation*—It can produce hard copies of OTDR traces, which provide the single most useful documentation of the installed cable system for maintenance and system upgrades.
- *Troubleshooting and fault location*—The OTDR can identify faults or breaks and locate them. Fiber discontinuities and localized losses caused by cable damage are readily visible by examination of the OTDR trace and comparing to original as-built records.

OTDR testing of each completed link should be performed at the system wavelength. Testing at 1,550 nm will normally show a lower fiber loss than specified for 1,300 nm and virtually the same splice loss as that measured at 1,300 nm. Discrepancies showing high loss at 1,550 nm indicate bending problems, which the OTDR can locate and quantify.

Return loss testing

Return loss testing measures the amount of light reflected back from the fiber and components in the fiber system. The primary concern in CATV systems is the sensitivity of most AM fiber transmitters to reflections. Reflected light enters the laser cavity, where it causes interference that



can lead to instabilities in signal output power and spectral behavior. The resultant noise introduces power penalties and reduces the system signal-to-noise ratio.

Return loss simply defines the amount of reflection. By comparing the reflected light to the transmitted light using the following formula, return loss is quantified in dB.

$$\text{Return loss (in dB)} = -10\log\left[\frac{(P_t - P_r)}{P_o}\right] + c \qquad (2)$$

where:

P_o = optical power incident on fiber
P_r = reflected optical power (reference)
P_t = reflected optical power (test)
c = constant (determined by test setup)

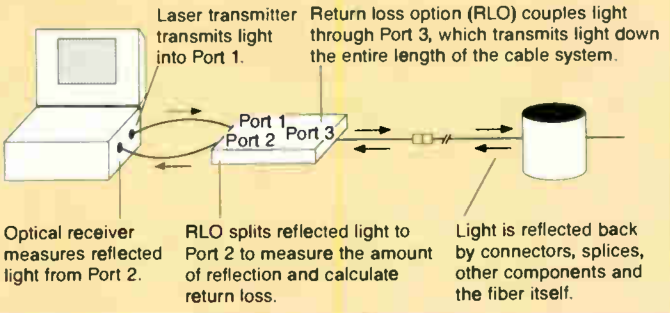
Figure 3 shows the accepted method used to measure return loss outlined by the Electronic Industries Association in its recently published FOTP-107 *Return Loss of Fiber-Optic Components*. The goal is to minimize overall system reflection and prevent its impact on the actual transmission.

Each of the system components can be evaluated individually for its return loss. The accompanying table shows typical values for single-mode components. Note that larger dB values indicate less reflection. Currently the most successful means of maximizing return loss are to minimize the number and magnitude of reflective points.

Although components can be evaluated individually for return loss performance, the key to system performance is the combined effect of all the reflections. This combined reflection is interdependent upon the number, magnitude and location of all the reflections as well as the attenuation of the fiber. As a result, return loss cannot be simply added together or calculated but must be measured as described here. In summary, actual system return loss:

1) is based on the combined effect of the components
2) cannot be added or calculated, but is dependent on the number, magnitude and locations of the reflections
3) must be measured to accurately determine the combined effect of the individual components and reliably predict system performance.

Figure 3: Return loss test setup



Field tests sets are available to measure return loss of a system. In fact, some test sets can measure both attenuation and return loss with the same laser source and power meter, saving time and money.

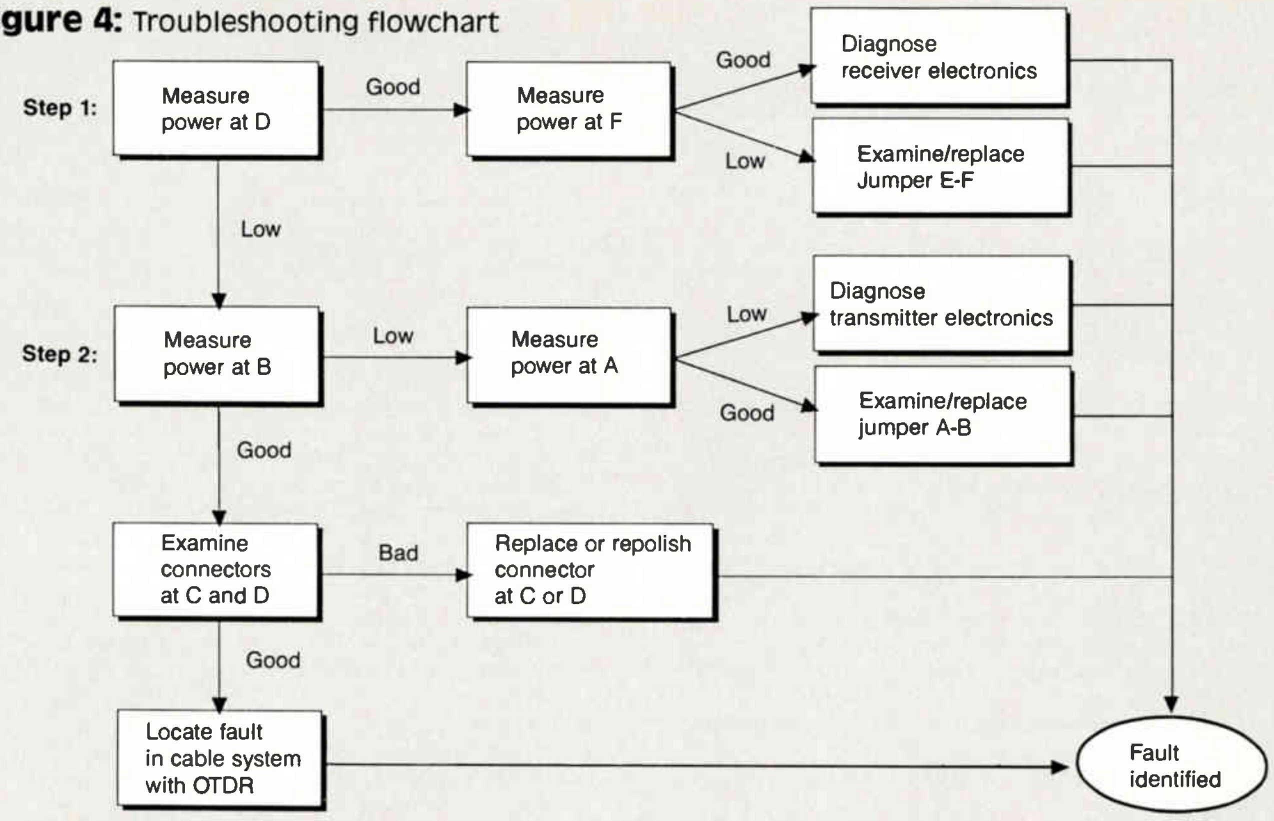
For systems with potential limitations from reflection now or in future upgrades, the following guidelines for system design and testing are recommended:

1) Evaluation and specification of return loss for system and individual components prior to installation.
2) Considering the impact of future enhancements on overall system reflection in the original design and specification.
3) Testing overall system return loss after installation as an acceptance test for designed system specification. This should be performed at the system wavelength in the direction of transmission.

Documentation and maintenance

Documentation plays a key role in the continuing success of any cabling

Figure 4: Troubleshooting flowchart



1) After Steps 1 and 2 are performed with a power meter, the loss of the cable system is calculated $P_d - P_b$.
2) In case of simultaneous failure of all fibers in a cable, assume catastrophic damage at one point and locate the fault.

system, especially in the areas of maintenance, rerouting and system upgrades. By providing documentation of initial performance and clarifying when and how a problem occurs, records also establish responsibility and protection in liability issues. It is important to maintain thorough, up-to-date records of system configuration, labeling and testing results to minimize downtime and maintenance costs. Having as-built test results in a permanent file will enable you to troubleshoot problems with fiber systems if they occur. Careful planning and up-to-date records will help avoid costly retesting and even cable plant replacement in the future.

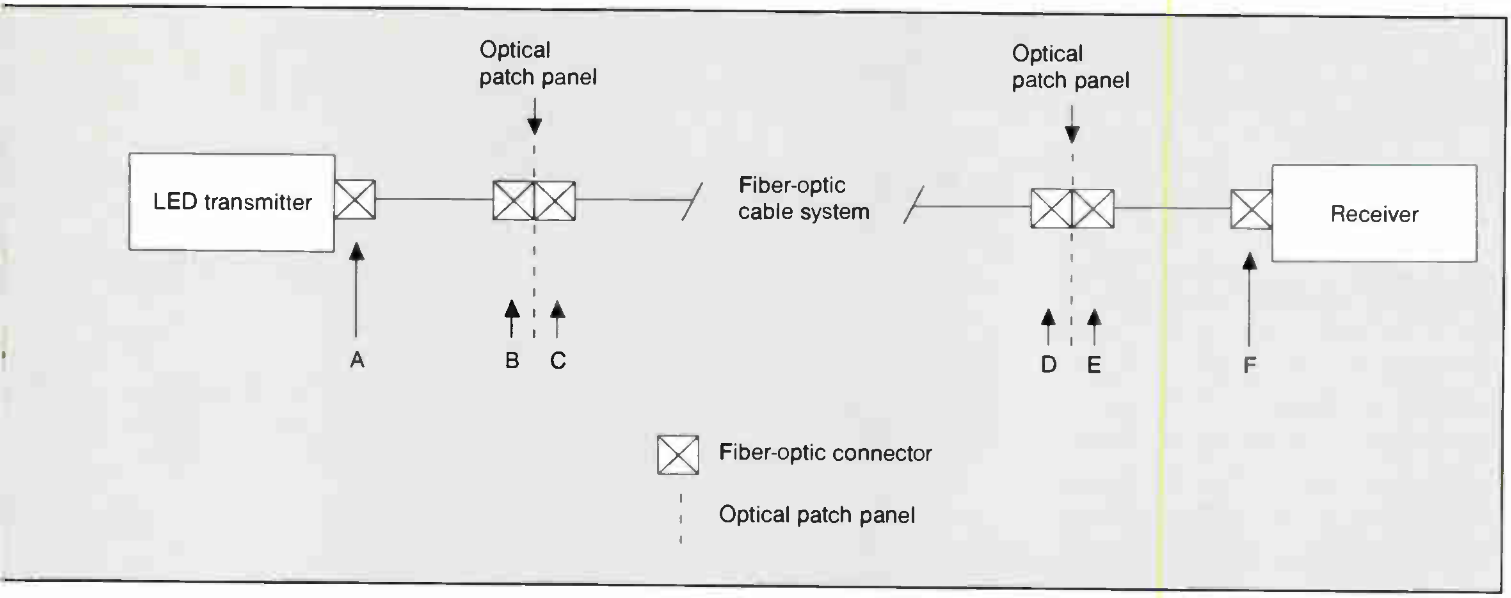
The permanent records for a cable plant should include the following documentation for each link:

1) Placement
   - Cable route diagram, including slack locations and lengths
   - Start and end points
   - Color code and label identifier
   - Link length/sequential markings from cable sheath
2) Data
   - Fiber type
   - Cable manufacturer data
   - Cable reel and serial number (if available)
3) System test data
   - End-to-end attenuation test
   - OTDR signature traces
   - Return loss

The following information should be recorded for each of these tests: test equipment used (including model and serial numbers, and date of last calibration), direction of measurements, test wavelength and date and operator.

4) End equipment data
   - End equipment vendor/model
   - Serial numbers of transmitters
   - Power readings at transmitter and receiver
   - Date and operator

A properly installed and tested system requires little routine maintenance. Preventive steps and periodic checks to ensure there are no kinks or bends

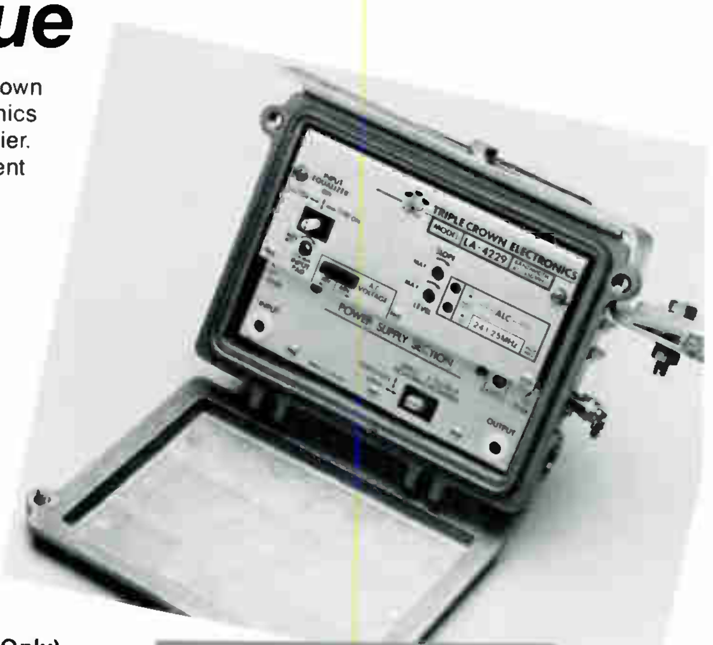


in the cable and that the connector tips are clean will prevent many of the more common problems.

Service proves especially important because of the large capacity and critical nature of the information transmitted over the fiber. Should your system go down, troubleshooting and restoration can be performed quickly and easily, provided there is adequate documentation and reliable test equipment available.

Complete as-built documentation is extremely important when troubleshooting. When these records are compared to the current test results, the breakdown in the system can be quickly and clearly identified. Figure 4 diagrams a troubleshooting flow chart that can be used to trace a problem to the transmitter, receiver, jumpers or cable plant. The first crucial step is performed with a power meter. Simply take a reading at the receiver end and compare it to the installation value. If the received power is normal, the receiver is suspect. If the received power is low, take a reading at the transmitter end. If the transmitter output is low, then the transmitter is the problem. However, if the transmitter output is normal, but the power meter reading at the receive end is low, the problem lies in the cable plant. These two steps isolate the fault to either end, electronics or cable system. If the fault is in the cable system, the OTDR would then be used from either end to identify and locate the fault.

Proper testing and maintenance will lead to implementation of a system with optimum signal quality, quick and straightforward response should a problem arise and flexibility for system growth and enhancements.



Sweep technology comparisons

By Mark Daugherty
Lead Technician, Jones Intercable Inc.

Figure 1a

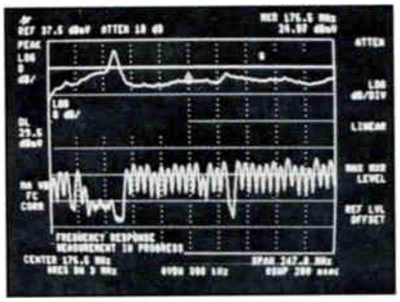


Figure 1b

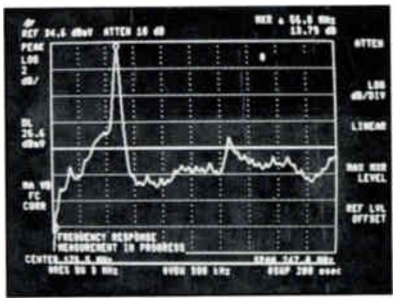


Figure 2

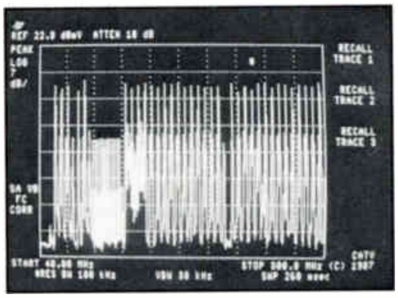


Figure 3a

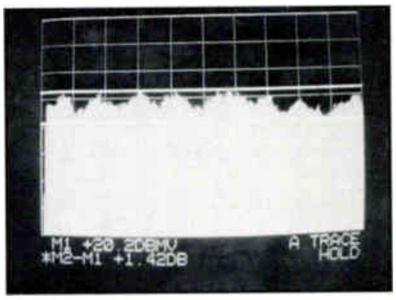


Figure 3b

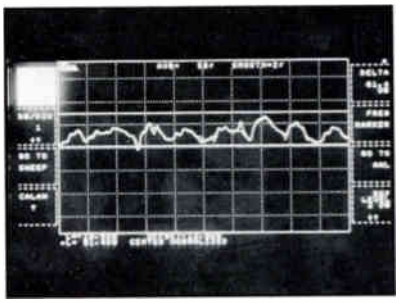
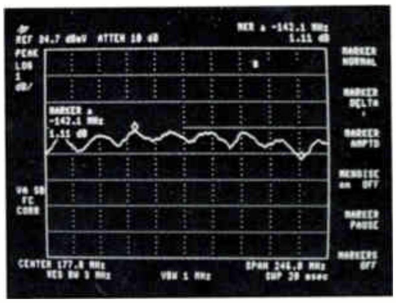


Figure 3c



For the past five years, I have been primarily involved with engineering, design and system performance—the latter of which involves the ongoing measurement and correction of system frequency response. A fair amount of time has been spent using the conventional high-level sweep system; I have been reluctant to consider using another method. This led me to ask: How do some of the new technologies compare with this field-proven standard?

The comparisons are aimed at determining what signature differences (if any) exist between three different technologies currently available for system sweeping. These technologies include high level, low level/band limiting and normalization. Each of the three is fundamentally different in its approach to system response measurements. High-level systems use a sweeping carrier injected into the system at a level 10 to 20 dB above the video carriers and use this for determining system signature. The only low level/band limiting system currently available inserts a frequency selective carrier 10 dB below the video carriers. It sweeps the bandwidth just before and after the carriers, thereby reducing the interference level. During the "no sweep" periods (on carrier), the actual RF carrier is measured; its level is integrated with the sweep information to display the resulting signature. The normalization systems use the carriers for their initial reference and show all other references relative to this.

Since I used only one manufacturer's model to represent each method, do not necessarily consider the comparisons typical. Other units may produce different results. I also wanted to compare the amount of picture interference introduced into the system by each method. However, due to the subjective nature of this comparison, my conclusions will be subject to some interpretation.

The tests were conducted at our Carmel, Ind., system prior to a recent quality assurance inspection. The system is loaded to 300 MHz (video channels only) with the exception of Chs. A-1, A-2 and 13. The FM band is only partially loaded, with 10 operating carriers. The system has no addressability or other special features that might require unique sweep techniques.

The actual comparisons were performed during the late evening/early morning hours and done sequentially with one method being tested, then the next method and so on. We selected four test locations for their unique signatures (i.e., standing waves, rolloffs, etc.) to determine the resolution and accuracy of each unit. One exception was our first location, which we selected to compare each unit under near ideal conditions.

The test equipment used was as follows: Wavetek's Model 1855/65 sweep analyzer (high level); CaLan's Model 1776/77 sweep/spectrum analyzer (low level/band limiting); and Hewlett-Packard's 8590A/H50 spectrum analyzer (normalization). These particular models were chosen because of my familiarity with each and their ready availability. It also should be noted that the normalization method requires either a fully loaded spectrum or the addition of extra RF carriers in the unused portion of the band to perform an accurate measurement. Without the use of these additional carriers, a phenomenon commonly referred to as "power addition" results; this adds the noise floor variations from the unused spectrum to the response trace on a power basis, thereby distorting the measurement waveform. Figure 1a illustrates this effect by showing the sweep trace directly above the RF spectrum. The distortions (spikes) present coincide with empty or sparsely populated areas of the bandwidth. Figure 1b is the same location with the attenuation set at 2 dB/div. to show the severity of this effect.

Significant contributors of distortion

Faced with the problem of power addition measurement distortions on normalization-type units, and the need to compare each method under its optimum operating conditions, I conducted a number of experiments to determine what were (and were not) significant contributors to this effect. I found that one unused channel by itself does not *drastically* affect the overall peak-to-valley of the measurements.

The prominent distortion at Ch. 13's frequency (Figures 1a and 1b) was not present at other locations during preliminary tests; therefore I can only assume this to be attributed to ingress from local broadcast Ch. 13. Two or more unused, adjacent channels will contribute significantly to the measurement's inaccuracy. This is illustrated in both Figures 1a and 1b by the severe spike at Chs. A-1 and A-2's frequencies. Carriers that are adjacent but separated by an unused channel or bandwidth (i.e., FM carriers) will have a cumulative effect on the measurement. Figure 1b illustrates this by the significant hump to the left of the spike.

Based on this information I searched for a

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Figure 4a

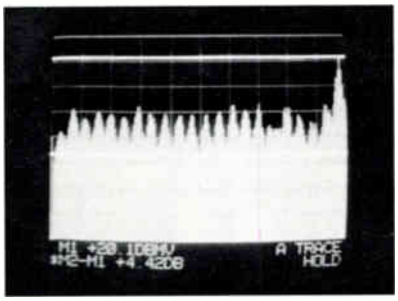


Figure 4b

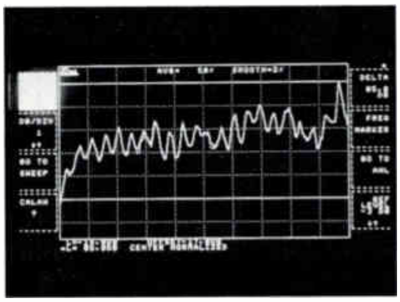


Figure 4c

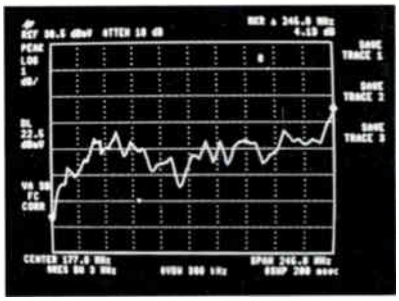


Figure 5a

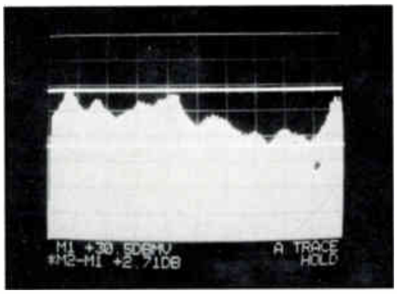


Figure 5b

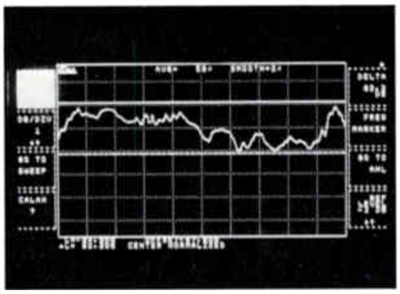
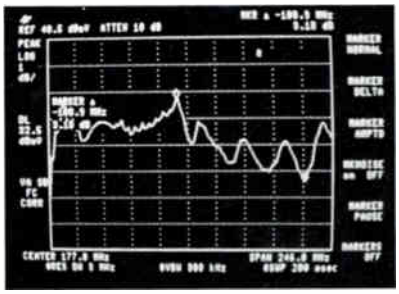


Figure 5c



method that would saturate the bandwidth between 88 and 118 MHz with as many carriers as possible, as this was the most noticeable area of trouble in our application. We accomplished this by substituting the FM carriers with a sweep transmitter programmed to sweep this bandwidth in the continuous sweep mode, simulating channels at every location between these points. The output level was set to match that of the system audio carriers (Figure 2). I also chose to add a CW carrier in Ch. 13's slot to prevent any ingress-related accumulations from popping up unexpectedly.

Figures 3a, 3b and 3c detail responses taken with each of the three units at our first amplifier. The actual responses are taken from the amplifier's output test point in all cases. All three units compared favorably at this location with their respective 1.42, 1.40 and 1.11 dB peak-to-valleys and their nearly identical signatures. The maximum peak-to-valley deviation between the three units was roughly 0.3 dB.

Figures 4a, 4b and 4c show three responses taken at a location seven amplifiers deep in cascade. The standing wave shown is caused by a splitter inadvertently installed 40 feet past the amplifier station. This location was included to compare the resolution of the units in the event that an origination point for a standing wave would need to be determined using the following formula. This calculation requires the different frequency between the wave(s) to be input as variables.

L (in feet) = 492 × n × v/f

where:
L = distance to fault
n = number of cycles between markers
v = velocity of propagation factor
f = marker frequency (MHz) or marker delta

The first two responses again are nearly identical. The normalization method's overall peak-to-valley is very close to those of the first two, although determining the standing wave frequency proves rather difficult due to the inconsistency of the waves throughout the spectrum. The maximum deviation between the three units would be 0.87 dB for this location.

Figures 5a, 5b and 5c illustrate each of the three sweep instruments after 14 amplifiers in cascade. The three units compare at 2.71, 2.20 and 3.18 dB, respectively, for a maximum deviation of approximately 1 dB.

Figures 6a, 6b and 6c compare the three units at our final location after 21 amplifiers in cascade. The actual peak-to-valley readings are 8.14 (high level), 10.9 (low level/band limiting), and 11.0 dB (normalization). The photographs do not support this because Figures 6b and 6c do not fit onscreen in the 1 dB/div. setting. This setting was necessary to detail each signature's frequency characteristics vs. another and to maintain previous test location conditions. Maximum deviation between the three units is 2.8 dB.

Picture interference

A brief word concerning picture interference: Normalization technology is ideal because of its lack of a transmitter (and therefore no interfering sweep signal). No carrier exists to cause any level of interference. High-level technologies produce a small degree of interference, but our experience has shown only a very small number of complaints related to this (excluding special applications such as addressable scrambling, etc.).

A word of caution concerning high-level systems with variable sweep times: Slowing down the sweep time (speed) will improve low end resolution (perceived low frequency rolloffs due to scan loss) at the expense of picture interference. A setting of 2 ms provided the needed resolution (over the default 1) without sacrificing picture quality. Sweep time settings above 3 ms produced negligible improvements in low end response and made noticeable differences in subscriber interference. The low-level sweep, when set correctly, produces no perceivable interference by selectively sweeping the spectrum adjacent to the carriers.

For those wishing to reconstruct our comparisons or create their own, the setup parameters for each of the three units were kept as close to the default values as possible. We set the Wavetek transmitter's sweep time for 2 ms. All other values are default, except for bandwidth that was set at 54-300 MHz for all three units.

We programmed the CaLan transmitter using the STD scan function along with the manual entry of FM stereo channels. Guard bands were set at 2.2 MHz for video and audio and 0.3 MHz for FM carriers. Dwell times were set at values per the CaLan operating manual depending on their type (i.e., video, video/scrambled, audio/stereo, etc.).

The HP was set using the fast sweep selection with the number of sweeps set at 20. We set the attenuation (during the initial reference setup to bring the analyzer's noise floor above that of the systems to prevent the "power addition" distortions from occurring (per the manual). However, this seemed to have little effect.

Figure 6a

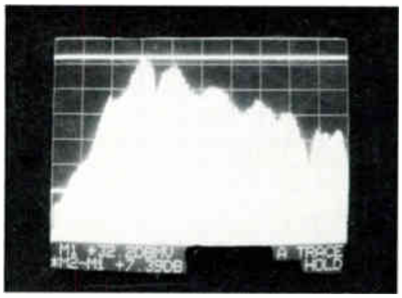


Figure 6b

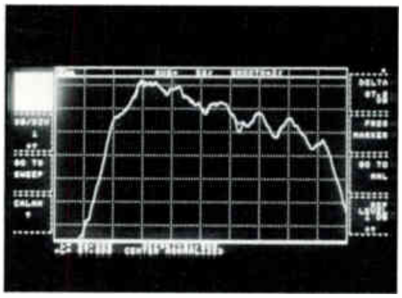


Figure 6c

In conclusion, all three technologies performed admirably and with the resolution required for conducting measurements over a wide range of conditions. Although subtle differences occurred in each of the units' signatures when compared to one another, their overall responses were for the most part identical. Special considerations, such as addressability or local area network application, may necessitate the use of one of the non-interfering technologies. With the exception of this, any of the three technologies tested is a viable method for maintaining CATV system performance.

References

1) Hewlett-Packard Cable Television Operating Guide 890A Option H50.
2) CaLan 1776/77 Integrated Sweep System/Spectrum Analyzer Operation Manual, Version 2.0.
3) Texscan Technical Reference Data.

Acknowledgements: Special thanks to Saconna Blair, Midwest quality assurance (Jones Intercable), for donating the CaLan equipment used in the tests, and Mike Dilullo (also of Jones) who helped with the midnight field comparisons. One final note of thanks to Dan Templin (Jones), who acted as contributing editor during the writing of the article.

The mystery surrounding converter preamplification

By Dan Moloney
Director of Product Management
Jerrold Subscriber Systems Division, General Instrument Corp.

It is virtually impossible to read any recent industry publications without observing advertisements promoting the advantages of preamplified converters. One must ask why this subject has become so popular during the past year. Clearly, preamplifiers do not contain anything new to the industry. Nor has the cost of the technology decreased significantly during the past several years. So why is all this attention suddenly being focused on the subject?

Two main factors have led to the recent push to demand preamplification in baseband converters: The quality of the subscriber's signal has improved as has the sub's ability to discern picture quality.

Cable operators no longer provide signals in the 37 to 40 dB signal-to-noise range. As the quality of distribution equipment improves, and especially as fiber-optic backbones are more widely implemented, typical subscribers receive carrier-to-noise (C/N) levels in the mid-40s. At this level, the noise figure of the converter becomes quite critical to picture quality.

In addition to the improved performance of distribution systems, subs also are exposed to other high quality video and audio systems. Super-VHS, digital audio and other new technologies have made the average sub more discriminating.

In general, the typical sub can differentiate picture quality up to 43 or 44 dB. Therefore, when you add a converter with a 13 dB noise figure to a system with a signal in the 44+ dB range, you degrade picture quality to a point where the average sub notices, regardless of the input level.

When to use preamplification

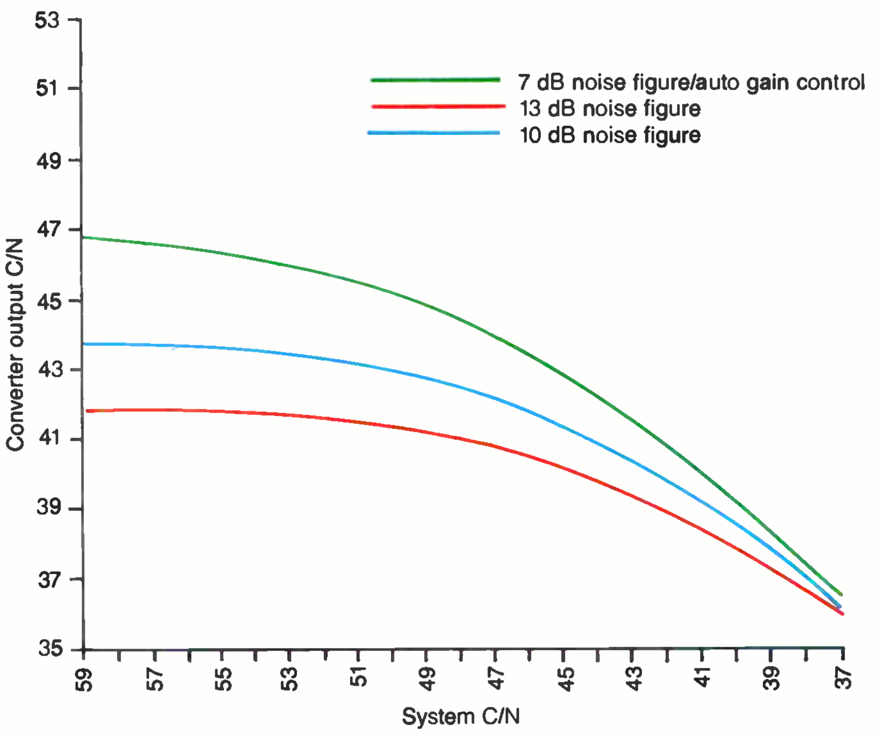
Despite the advantages of converter preamplification, there will be situations in a typical cable plant where it does not provide a noticeable benefit. As a general rule, the advantage will be seen at points in the system where the incoming C/N is high but the drop level is low.

Carrier-to-noise comparison at TV set

Tap level (dBmV)	+8			+15		
Drop loss	6			6		
Splitting loss	0	4	8	0	4	8
Level at converter (dBmV)	+2	−2	−6	+9	+5	+1
Converter C/N (noise figure = 12 dB)	49	45	41	56	52	48
Converter with preamp C/N (noise figure = 8 dB)	53	49	45	60	56	52
System C/N		46			46	
Net C/N—Converter	44.2	42.5	39.8	45.6	45.0	43.9
Converter with preamp	45.2	44.2	42.5*	45.8	45.6	45.0

*43.2 dB if system C/N is 48 dB

Figure 1: Combined C/N system and converter (at +10 dBmV in)



"The quality of the subscriber's signal has improved as has the sub's ability to discern picture quality."

The accompanying table compares two drop levels, each with three different combinations of splitters (zero, two-way or four-way). It compares two converters in both scenarios. One is a standard baseband converter (12 dB noise figure) and the other is preamplified (8 dB noise figure). In all cases, we assume C/N at the drop to be 46 dB, a reasonably good quality system.

As the table confirms, the advantage of preamplification will be noticeable to a sub where the tap level is lower and at least one splitter is present. The higher tap level minimizes the advantages of preamplification, even with a four-way split in the drop.

Through this analysis we've assumed a system with a 46 dB C/N as constant. If we deviate from this fixed level and assume a more realistic situation where the C/N level decreases when moving further from the headend, the application for converter preamplification becomes evident. Figures 1, 2 and 3 plot the output C/N of a converter for various system C/Ns assuming three converter noise figures (7, 10 and 13 dB).

As Figure 1 clearly demonstrates, with a +10 dBmV input level at the converter there will not be a visibly noticeable difference in picture quality among the three converters. With the input level reduced to 0 dBmV (Figure 2), there will be a visible difference in picture quality between the three converters in favor of that with preamplification. This, of course, assumes the system C/N is in the 43-46 dB range. For system C/N in the 50 dB range, while the difference between the three converters is more pronounced, the average sub will not see any visible improvement in picture quality. Figure 3 shows this phenomenon even more pronounced with a −5 dBmV input. Regardless of the converter noise figure, though, if the system provides only a poor signal (C/N below 40 dB), the picture will still be poor.

There are several means for improving picture quality in a cable system. Depending upon whether a system is upgrading the existing plant without respacing the amplifiers or rebuilding the system with state-of-the-art distribution equipment will play a key role in determining the need for converter preamplification.

With FM (frequency modulation) over fiber gaining popularity in supertrunking applications and AM (amplitude modulation) over fiber being pushed out further in the system, the importance of low noise figure converters becomes critical. The economics of this depend upon homes per mile and level of penetration, since the distribution system cost must be spread over all homes passed, whereas the cost of preamplification will be borne only by subs who need it.

In those situations where converter preamplification does make sense, a high quality automatic gain controlled low-noise preamplifier will make a visible difference. ■

Figure 2: Combined C/N systems and converter (at 0 dBmV in)

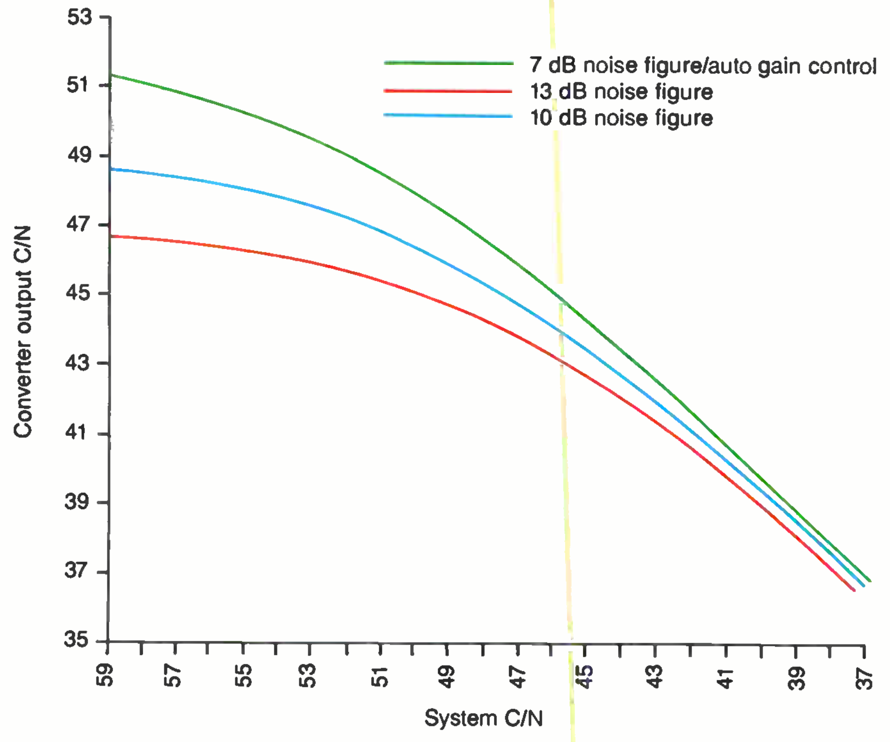


Figure 3: Combined C/N systems and converter (at −5 dBmV in)

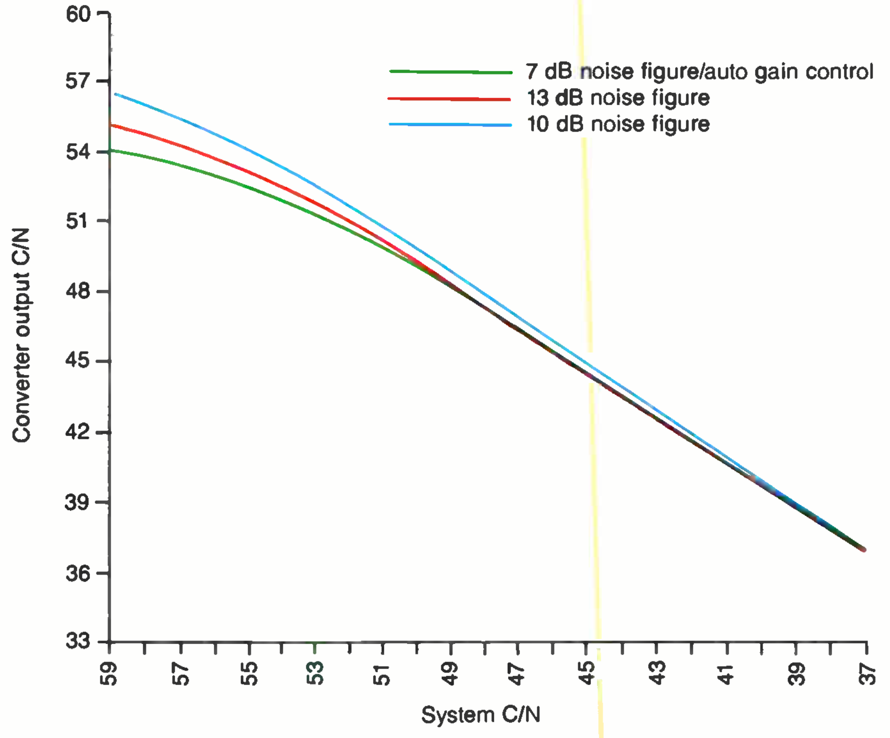


Table 1

Item	Low estimate	High estimate
Headend facilities	$ 3,000	$ 7,000
4 off-air signals	2,400	3,200
1 satellite dish	2,000	3,000
8 satellite signals	10,900	13,300
Cable plant (2 miles)	7,000	11,000
Service drops (50)	1,500	2,000
Subscriber terminals (50)	1,000	1,800
Other costs (estimate)	10,000	10,000
Total	$37,800	$51,300

Table 2

Item	Low estimate	High estimate
Headend facilities	$ 3,000	$ 7,000
5 off-air signals	3,000	4,000
2 satellite dishes	4,000	6,000
13 satellite signals	17,450	21,350
Cable plant (6 miles)	24,000	39,000
Service drops (120)	3,600	4,800
Subscriber terminals (120)	2,400	4,320
Other costs (estimate)	10,000	10,000
Total	$67,450	$96,470

Small systems— The last frontier

This is the eighth in a series of articles designed to help the small system operator or entrepreneur avoid some basic (and perhaps fatal) mistakes. This installment begins a discussion of economics. Editor's note: Any opinions expressed are those of the authors, based on their experiences in building small systems.

By Bill Grant
President, GWG Associates

And Lee Haefele
President, Haefele TV

If we apply our calculations from previous sections to a number of different situations we should get a good handle on small system operations. We'll calculate costs based on both the lowest and highest estimates we developed in the last section and, for comparison purposes, develop two basic approaches to the headend and system channel carriage. You may legitimately take exception to any of our figures but perhaps we can establish a sound methodology for evaluation.

Headend: First we will assume 18 channels of service using two satellite dishes are required; we will arbitrarily establish that five off-air channels are available. We must take into account the costs of the headend facilities themselves. This includes a structure for off-air antennas, a building and the basic air-conditioning and electrical equipment.

Item	Low cost range	High cost range
Headend facilities	$ 3,000	$ 7,000
5 off-air signals	3,000	4,000
2 satellite dishes	4,000	6,000
13 satellite signals	17,450	21,350
(11 descramblers)		
Total	$27,450	$38,350

Now we will assume 12 channels of service using one satellite dish are required. We will arbitrarily establish that four off-air channels are available.

Item	Low cost range	High cost range
Headend facilities	$ 3,000	$ 7,000
4 off-air signals	2,400	3,200
1 satellite dish	2,000	3,000
8 satellite signals	10,900	13,300
(7 descramblers)		
Total	$18,300	$26,500

Subscriber drops: We can simply use our individual low and high cost estimates for service drops (given in last month's installment) and multiply this figure by the number of paying subscribers we project. Our estimates were $30 low range and $40 high; these include materials and installation labor.

Subscriber terminals: Just as for drops, we can simply use our earlier individual low and high cost estimates for terminal equipment and multiply this figure by the number of subs we project. Our estimates were $20 low range and $36 high.

Feeder plant: We will not estimate the costs of the plant on a 20- or 35-channel basis but will use 300 MHz as the highest frequency for all cases. We will use low and high estimates for both self-support and conventional stranded construction. Our previously developed plant costs were as follows:

	Low cost estimate	High cost estimate
New strand plant	$4,000/mile	$6,500/mile
Self-support plant	$3,500/mile	$5,500/mile

Other costs

With some obvious limitations we have developed basic costs in increments that should permit evaluation of different size operations. But there are other costs that must be taken into account. Consider the costs of a service vehicle, test equipment and tools, spare parts, fittings, etc. Also, somebody will have to handle subscriber billing and other bookkeeping functions on a regular basis. There will be telephone, power and pole rental costs as well. And do not forget legal fees associated with franchising or incorporation, etc.

For our purposes we will simply include one basic figure as the start-up cost of going into business and operating for one year; we will use $10,000 and apply this figure to all analysis examples. You can adjust this in any way to your personal experience. We do not propose this figure as a precise estimate; we simply include it to show that some such allowance must be considered.

Last, but certainly not least, somebody might need to be paid a salary to maintain the system and run the business, even if that person is a part-time employee. However, in our examples we will not include any such amount on the basis that the system owner/operator will do this work on a part-time unpaid basis. If this is not the case, then some allowance for salary must be added to each of our developments (such an addition is simple). Note also that our figure for "other costs" only covers the first year of operations.

Given this input of cost data we can develop the capital requirements for different scale applications. We will not try to cover all the possibilities because our objective is to develop a method rather than try to analyze specific systems.

Example 1: We will assume a 12-channel operation requiring two miles of self-support (messengered) cable plant to serve 50 subs (see Table 1). If you examine this table, you will see just how easy it is to alter any of the input data or any individual cost and still be able to quickly come up with a total capital required estimate. For example, suppose we wanted to do the same development but utilize stranded cable construction instead. The item identified as "cable plant (2 miles)" would change from $7,000 and $11,000 to $8,000 and $13,000.

Suppose we wanted to examine the cost for 40 subs instead of 50? The item for "service drops" would change from $1,500 and $2,000 to $1,200 and $1,600. "Subscriber terminals" would change from $1,000 and $1,800 to $800 and $1,440. (If you decide that any individual figure used in our analyses is not correct for your application, it is a simple matter to make an ad-

(Continued on page 59)

"I'm from the FCC and this is an inspection"

By Clark E. Poole
EMU Engineer, Field Operations Bureau
Federal Communications Commission

"That's fine, what would you like to check first?" is the response you should be able to give with ease as the Federal Communications Commission inspector displays his identification in your front office. If you are prepared and know what to expect, an FCC inspection at worst should be an infrequent inconvenience.

Reasons for inspection

Many cable TV systems are scheduled for inspection because of cable interference complaints received by the commission's field offices. If there's ingress allowing citizens band or other interfering signals into your system, there's probably egress too. Minimize your chances of inspection by promptly correcting leakage-related complaints. Every leak your subscribers point out to you through an interference complaint is one less the FCC might find later.

In addition to investigating complaints filed by the commission, some inspections are scheduled to gather statistical information. The inspection program is likely to intensify when the new cumulative leakage index rules take effect. Don't get excited if we show up at your door; there may not be any complaints on your system.

What do we check? The major emphasis is on leakage, leakage records, and frequency notification. For the details on these and other topics, read Part 76 of the commission's rules, which you are required to have. Not all the rules will apply to your system. Read them carefully to determine rule exceptions due to market size, grandfather clauses, number of subscribers or other considerations. Subscribe to trade magazines to keep abreast of changes but remember that the authority for cable operation is the commission's rules.

Usually engineers from the nearest commission field office will inspect. Less frequently the regional electronics measurement unit (EMU) engineer conducts the inspection. EMU engineers generally conduct special projects but sometimes make cable inspections when they are in the area.

The inspecting engineer will look for leakage in the system and check your records. You will be advised of record-keeping discrepancies and system leak locations before the inspector leaves. Make sure that you understand any violations cited and what action is necessary to satisfy the commission. Don't be upset if a few minor leaks are found. It's unusual to find a totally leak-free cable system.

After the inspection, you will receive a formal discrepancy letter indicating what problems were found and which rules were violated. If no violations are found, nothing will come in the mail; i.e., "no news is good news." You have 10 days to respond and describe what was done to correct the leakage or other discrepancies. That should be plenty of time to repair leaks or organize your files. You may request additional time for good reasons but don't fail to respond within the allotted 10 days.

What about fines?

The commission's word for a fine is "forfeiture." It's impossible to name every situation that could result in forfeitures or the respective amounts since each case has different circumstances. A few situations that may result in forfeitures include:

1) ignoring the inspection discrepancy letter,
2) having cable leakage and no leakage monitoring program and
3) operating on aeronautical frequencies without prior commission notification.

If you are found liable for a forfeiture you will be sent a Notice of Apparent Liability (NAL). This states which rules were violated and the proposed forfeiture amount. (A typical forfeiture is $1,000.) You have 30 days to respond and give reasons why the forfeiture should be reduced or cancelled. Word your response carefully but don't be creative. If the commission still decides to impose the forfeiture after considering your response to the NAL, you will receive a Notice of Forfeiture. The final amount may be the same or reduced, depending on your response to the original NAL. You have 30 days to pay.

"The inspection program is likely to intensify when the new cumulative leakage index rules take effect."

FCC EMU engineers like Clark Poole often make inspections of cable systems when in the area.

The commission doesn't have enough staff to conduct routine inspections of all cable systems. However, should you get inspected, if you promptly take care of all leakage-related complaints, maintain a well-documented leakage repair program and have FCC Form 325 handy to show that the commission has been notified of all aeronautical band operation, you probably don't have to worry.

Small systems

(Continued from page 46)

justment.) Let's try another example.

Example 2: We will assume an 18-channel operation requiring six miles of stranded cable plant to serve 120 subs (Table 2). Just as in the first example, any figure of either unit cost or quantity estimate can be changed easily and the total capital requirement quickly determined. We could even extend the system by some amount of cable plant (or add some additional subscribers) and establish the impact of such changes on capital requirements. We also could use two different cost figures for subscriber terminals if wished, perhaps to look at the impact of used or new converters. Adding a figure for salary would be a simple process in any development.

Before we attack the question of service levels and charges, it would be useful to determine just how much revenue the system must produce each month. This revenue must cover all operating costs, recover the invested capital in a reasonable period of time and hopefully produce an attractive return.

We must establish a time frame for recovering all invested capital; perhaps a five-year period is reasonable. The next step would be to determine what return on the capital investment is desired. We suggest 15 percent but this is purely arbitrary.

If we know the investment capital required, the period across which it must be recovered and the return on investment, then it is a fairly simple accounting procedure to develop revenue requirements for each year and each month of system operations. Why is this figure necessary or important?

We need some idea for what we must target as annual revenue before going further. Given a reasonable estimate of annual revenue required we can address the questions of what services to offer and what service rates to charge. We can do this with some confidence that the rates developed actually will produce sufficient revenue to cover all costs, recover all capital and produce a profit. If we attempt to establish service charges without some reference to revenue requirements, we may find that actual operations fall short of providing the required amount.

Since we have no particular accounting expertise to offer and are not generating an accounting handbook or procedure, we will not pursue this further. Whatever method you use to arrive at the figures, what we need to have available is an annual and monthly revenue requirement.

Do not forget that operating costs need to be developed and applied for each year after the first year of operations. We covered the start-up first year with the item we called "other costs" but that included franchising, legal fees, etc., that may not directly apply to subsequent years of operation. We would expect the costs to be somewhat lower after the first year.

Twenty questions: CLI quiz

This is the second of two parts. Test your knowledge by filling in the blanks. Answers are provided on page 80.

By Mark Harrigan
Bay Area District Engineer, United Cable

1) Cumulative leakage index is a ________________ problem, and people and equipment must be provided if it is to be dealt with successfully.

2) If you fail a flyover CLI, do you need to repeat it if your system fails? ________

3) Flyover testing makes sense when ________________ is important, ________ percent of a system is inaccessible (backyards), the ________________ are right (system size) and if you are relatively sure that you will ________.

4) The Federal Communications Commission regulation that covers flyover testing is Section ________________.

5) Is it important to have a system specific defineable leakage detection signal? ________

6) Other things that must be considered before picking a leakage detection frequency are: not a ________________ or spurious output of a local transmitter, preferably in the aeronautical portion of the ________ band and one that's ________ from FAA frequencies.

7) How much plant must be "substantially" driven out on a quarterly basis for monitoring and repair of leakage? ________

8) Is leakage an important factor at the headend? ________

9) Does the FCC consider equipping all vehicles with leakage detection equipment sufficient for quarterly monitoring? ________

10) A report of all signals carried in the FAA bands must be filed ________________. This must include ________, ________, ________, ________ and their ________________.

11) The portion of a cable system most likely to create the highest level of leakage is ________________, with ________, ________ and ________ leading the list.

12) Which will most likely result in leakage—an open unterminated tap port or a tap port with a cheap and/or loose terminator? ________

13) The most successful leakage programs have sufficient ________________ monitoring leakage on a regular basis and a specific grid of system areas to be monitored on a "by this date" regular basis.

14) If an MDU that you serve injects its own frequency and it leaks, who is responsible? ________________

15) What must you not do when looking for a leak? ________ against the strand or pole, as this may temporarily eliminate the leak.

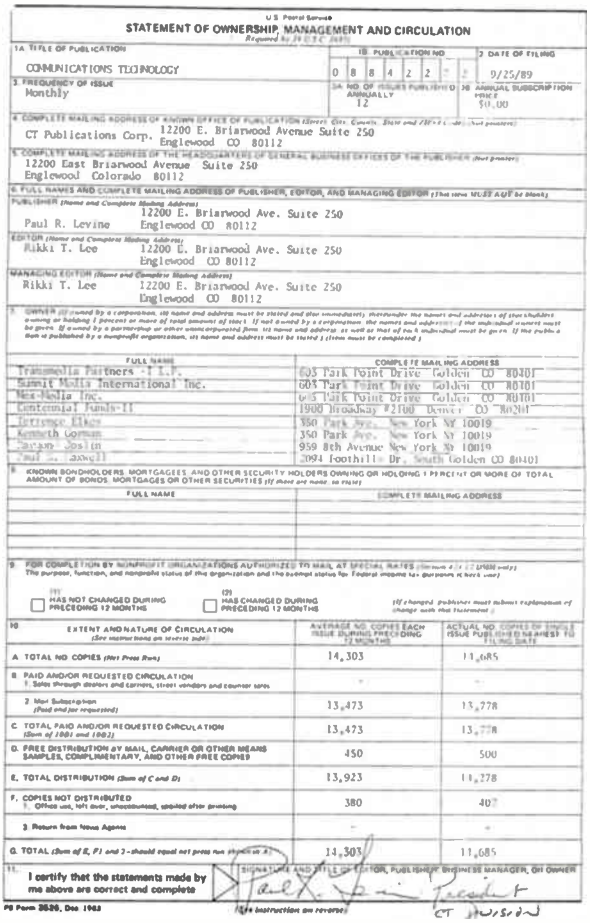
16) Fix the ________________ and ________________ complaints first.

17) Describe side benefits to a good leakage program.

18) How often should leakage detection equipment be calibrated? ________________. There should be a calibrated leak set up in an area that trucks pass by ________________.

19) To calculate CLI using the I_{3000} method you first calculate the ________________ of your system. From that point as a reference you need to calculate the distance from there to your leaks. The next step is to convert this distance in miles to ________________. Example: 1 mile = 5,280 feet ÷ 3.28 feet/meter = 1,610 meters. The formula from that point is ________ for all leaks. ________________ these together, multiply by ________________ (plant mileage/plant driven) gives your answer. In this case the number must be less than a ________________.

20) Are leaks likely to be of varying intensity due to frequency? ________



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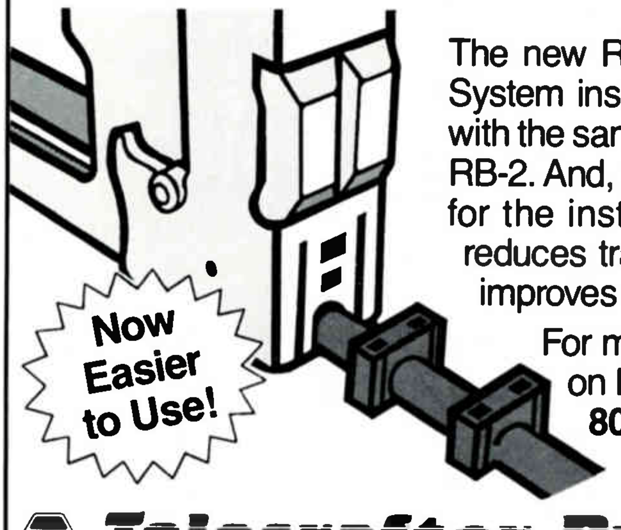

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The CIE chromaticity diagram

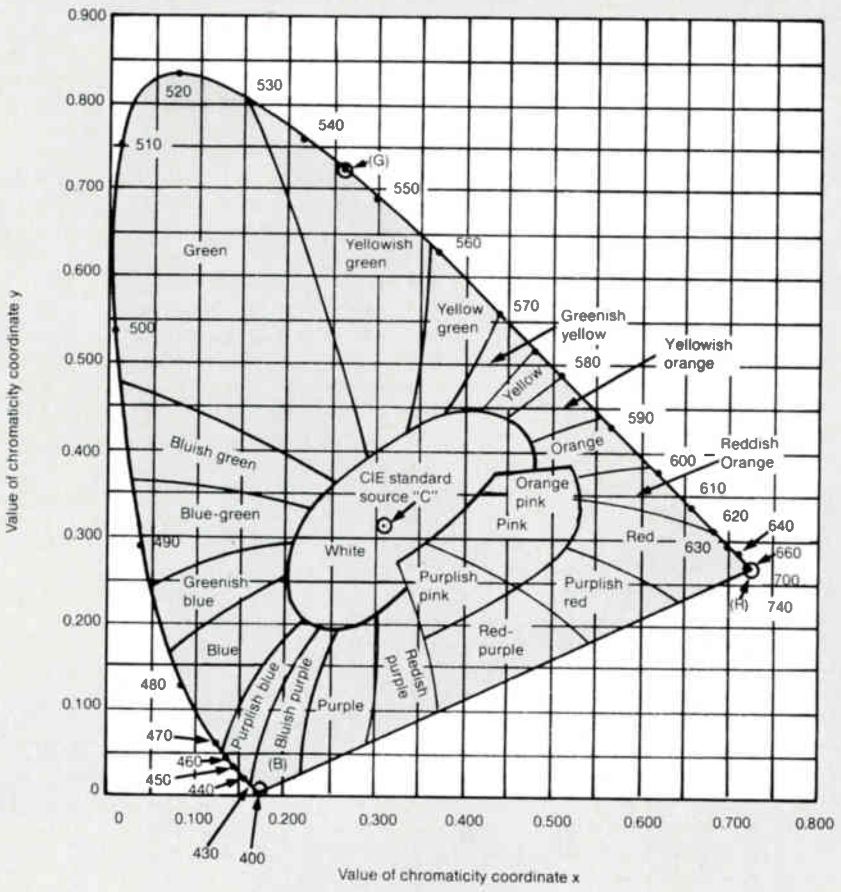
As noted in a previous column ("CT," May 1989), noise in an HDTV (high definition TV) system—and probably IDTV (improved definition TV) also—will be defined by measurements related to the noise that appears to the human observer from the display. Measurement techniques, also based on human observers' perception, will be used for determination of HDTV/IDTV color presentation capabilities. Such analyses are particularly important because, since most of the HDTV and IDTV transmission schemes do not suffer from the limitations of NTSC color transmission, they produce colors that are often referred to as "richer, truer," etc.

Light, including the spectrum that is visible, can be treated quite reasonably and thoroughly by the physical laws of electromagnetic radiation. But add the concept of color and confusion enters the picture. This is because the human has entered the loop. If color perception is thought of in an information theory context, the disturbing element becomes apparent. The transmitter is the source of light, with possibly some frequencies more dominant than others, the transmission channel is usually air only (although obviously other factors can disturb the channel; i.e., glass) and the receiver is the human being. And that is the problem. The receiver—the final transducer—does not obey any neat set of concise mathematical laws of physics that we presently know. Therefore, the main source of data about color vision is largely empirical. Multitudinous test data is the foundation for visual colorimetry.

It is at this point that the CIE chromaticity diagram (Figure 1) enters the picture as an international standard for colorimetry specified by the "Commission Internationale de l'Eclairage" (CIE). This diagram, properly used, is an indispensable tool in the field of colorimetry. This article outlines its history, its derivation and its applications.

This is the third of four parts.

Figure 1: CIE chromaticity diagram



By Lawrence W. Lockwood

Principal Scientist-Video Technologies, Contel Corp.
East Coast Correspondent

The transformation from the RGB to the XYZ form of the chromaticity diagram is illustrated in Figure 2. The triangle RGB is enclosed by a larger oblique triangle XYZ, which fits the spectral locus as closely as possible. The size and position of XYZ are not chosen arbitrarily. The triangle is arranged to enclose all physically realizable colors and its shape is such as to simplify computations.

The diagram shown in Figure 2 is transformed by three linear equations designed to produce on the x-y coordinates an oblique projection of RGB, such that the triangle XYZ becomes a right isosceles triangle, with Point X at $x = 1, y = 0$; Point Y at $y = 1, x = 0$; and Point Z at $y = x = 0$. The transformed diagram is shown in Figure 3. The transformation is so arranged that the Point W, representing equal-energy white light, appears at the center of gravity of the figure XYZ. We note that there are no negative values in the XYZ diagram, that no value of x or y exceeds unity. The transformation is arranged, moreover, so that $x + y + z = 1$.

The XYZ diagram is the internationally accepted representation of chromaticity values. The hue and saturation exhibited by any light source or colored object, illuminated by a particular light source, can be specified by the quantities x and y, which are known as the "trichromatic coefficients" of the specified color. These two coefficients, plus a statement of the brightness, give the complete specification of the color in physical terms.

The transformation from the RGB to the XYZ diagram is a mathematical operation without physical significance, designed to avoid negative values and to simplify certain calculations. Nevertheless, the XYZ diagram can be given a physical interpretation that serves to fix in mind certain of its properties. In this interpretation, the apex points X, Y and Z are thought of as representing the color coordinates of three *fictitious* primary colors, just as the points R, G and B in Figure 4 of Part II (*CT*, October 1989) represent three actual primaries, the spectral colors of wavelengths 700, 546.1 and 435.8 nm.

Following out this analogy, the X, Y and Z fictitious primaries are such that if they were physically realizable and were used in a colorimeter to match the equal-energy white light and the unknown color (as in last month's section about the RGB chromaticity diagram), the amounts of these primaries needed to achieve the match in each case could be inserted in Equations 1 to 3 (of Part II) and the quantities x, y and z computed directly from these equations.

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On this basis, following the discussion last month on numerical specification, we note that the equal-energy white point should fall, as it does, at the point $x = 0.333$, $y = 0.333$. The line YX represents the locus of all colors that can be matched by combining the X and Y fictitious primaries. None of these colors are real, since the spectral locus falls inside Line YX.

We note that all the color mixture properties of the RGB diagram are possessed by the XYZ diagram. The real colors are those enclosed by the spectral locus. Since this locus is not a closed figure, it is necessary to specify the limit of real colors in the open region. It might be expected that a straight line, joining the red and blue ends of the locus, would represent the limit of all the physically producible colors in the purple region, and experiment verifies this.

The CIE spectral primaries, located as shown on the spectral locus, form the triangle RGB. This triangle covers only about two-thirds of the area enclosed by the spectral locus. Colors represented by points outside this triangle (in the shaded area, Figure 3) cannot be matched by additive combinations of the standard CIE spectral primaries. These include the saturated greens and blues previously mentioned.

> *"Complementary colors are not a very satisfactory specification since the indication of subjective sensation is lost."*

If another set of primaries had been chosen, say, spectral hues of wavelengths 700, 500 and 460 nm (Figure 4), many of the saturated blues could be very closely matched, but the triangle formed by these primaries would not enclose the important region of saturated oranges, yellows and reds. For purposes of color reproduction, it is more essential to reproduce saturated reds, oranges and yellows than saturated blues and greens, since the former colors occur more often in nature. Accordingly, the CIE spectral primaries are a better choice. The filters and phosphors used in color TV receivers are chosen to be as close approximations to these spectral primaries as is feasible.

Following further the analogy of X, Y and Z as fictitious primaries, we can specify these primaries by a set of color mixture curves having the same significance as the mixture curves for the real primaries (shown in last month's Figure 3b). The corresponding curves for X, Y and Z are shown in Figure 5. These curves completely describe the primaries and correspond to the choice of the particular points X, Y and Z in Figure 2. Since the shape of the triangle XYZ is subject only to the condition that it enclose the spectral locus rather closely, the corresponding color mixture curves (known as "distribution coefficients" and designated as $\bar{x}$, $\bar{y}$ and $\bar{z}$) can be chosen in a correspondingly arbitrary manner to meet the purposes of the transformation. The values of $\bar{x}$, $\bar{y}$ and $\bar{z}$ are shown in the accompanying table.

Tristimulus values of the spectrum

Wavelength (mμ)	$\bar{x}$	$\bar{y}$	$\bar{z}$	Wavelength (mμ)	$\bar{x}$	$\bar{y}$	$\bar{z}$
380	0.0014	0.0000	0.0065	585	0.9786	0.8163	0.0014
385	0.0022	0.0001	0.0105	590	1.0263	0.7570	0.0011
390	0.0042	0.0001	0.0201	595	1.0567	0.6949	0.0010
395	0.0076	0.0002	0.0362	600	1.0622	0.6310	0.0008
400	0.0143	0.0004	0.0679	605	1.0456	0.5668	0.0006
405	0.0232	0.0006	0.1102	610	1.0026	0.5030	0.0003
410	0.0435	0.0012	0.2074	615	0.9384	0.4412	0.0002
415	0.0776	0.0022	0.3713	620	0.8544	0.3810	0.0002
420	0.1344	0.0040	0.6456	625	0.7514	0.3210	0.0001
425	0.2148	0.0073	1.0391	630	0.6424	0.2650	0.0000
430	0.2839	0.0116	1.3856	635	0.5419	0.2170	0.0000
435	0.3285	0.0168	1.6230	640	0.4479	0.1750	0.0000
440	0.3483	0.0230	1.7471	645	0.3608	0.1382	0.0000
445	0.3481	0.0298	1.7826	650	0.2835	0.1070	0.0000
450	0.3362	0.0380	1.7721	655	0.2187	0.0816	0.0000
455	0.3187	0.0480	1.7441	660	0.1649	0.0610	0.0000
460	0.2908	0.0600	1.6692	665	0.1212	0.0446	0.0000
465	0.2511	0.0739	1.5281	670	0.0874	0.0320	0.0000
470	0.1954	0.0910	1.2876	675	0.0636	0.0232	0.0000
475	0.1421	0.1126	1.0419	680	0.0468	0.0170	0.0000
480	0.0956	0.1390	0.8130	685	0.0329	0.0119	0.0000
485	0.0580	0.1693	0.6162	690	0.0227	0.0082	0.0000
490	0.0320	0.2080	0.4652	695	0.0158	0.0057	0.0000
495	0.0147	0.2586	0.3533	700	0.0114	0.0041	0.0000
500	0.0049	0.3230	0.2720	705	0.0081	0.0029	0.0000
505	0.0024	0.4073	0.2123	710	0.0058	0.0021	0.0000
510	0.0093	0.5030	0.1582	715	0.0041	0.0015	0.0000
515	0.0291	0.6082	0.1117	720	0.0029	0.0010	0.0000
520	0.0633	0.7100	0.0782	725	0.0020	0.0007	0.0000
525	0.1096	0.7932	0.0573	730	0.0014	0.0005	0.0000
530	0.1655	0.8620	0.0422	735	0.0010	0.0004	0.0000
535	0.2257	0.9149	0.0298	740	0.0007	0.0003	0.0000
540	0.2904	0.9540	0.0203	745	0.0005	0.0002	0.0000
545	0.3597	0.9803	0.0134	750	0.0003	0.0001	0.0000
550	0.4334	0.9950	0.0087	755	0.0002	0.0001	0.0000
555	0.5121	1.0002	0.0057	760	0.0002	0.0001	0.0000
560	0.5945	0.9950	0.0039	765	0.0001	0.0000	0.0000
565	0.6784	0.9786	0.0027	770	0.0001	0.0000	0.0000
570	0.7621	0.9520	0.0021	775	0.0000	0.0000	0.0000
575	0.8425	0.9154	0.0018	780	0.0000	0.0000	0.0000
580	0.9163	0.8700	0.0017	Totals	21.3713	21.3714	21.3715

We note that the curves in Figure 5 are generally similar to those in last month's Figure 3b, with the following exceptions: 1) There are no negative values of $\bar{x}$, $\bar{y}$ and $\bar{z}$; on this account no negative values of x, y and z occur. 2) The area under each curve is chosen to be the same; thus, equal amounts of the primaries X, Y and Z are required to match the equal-energy white, for which $x = y = z = 0.333$. 3) The shape and ordinate scale of the $\bar{y}$ curve are chosen to be identical to the relative luminosity curve (last month's Figure 8). Actually these two curves have quite different significance: $\bar{y}$ represents the amount of a green (fictitious) primary color required to match each spectral hue in combination with two other fictitious primaries, whereas the luminosity curve represents the relative effect on the eye of each spectral hue. If these two curves are made identical, however, a single computation serves to produce two results: the value of the *color coordinate* y of a particular colored light and the *luminosity* of that light.

Thus, the three curves in Figure 5, with the spectral output curve of a particular colored light source, serve to make available the complete description of the color in numerical terms; namely, values of x and y that specify the hue and saturation, and the value L that specifies the luminosity (brightness) of the color.

Locating x and y coordinates on the CIE chromaticity diagram for a color

To illustrate the manner in which these computations are carried out consider the color described by Figure 6a. This is a spectroradiometric curve of a particular color, obtained by measuring (with a scanning spectroradiometer) the number of watts (W) radiated by the given source at each wavelength (λ) in the visible spectrum. This curve is plotted with its maximum ordinate as W watts. To obtain the trichromatic coefficients of this color, we proceed as follows: First, we divide the w (λ) curve by W, thus producing a maximum ordinate of unity. Next, we multiply this w(λ)/W curve by the $\bar{x}$ curve (see table). The area

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Figure 2: XYZ triangle plotted with reference to the RGB chromaticity diagram so as to enclose the spectral locus

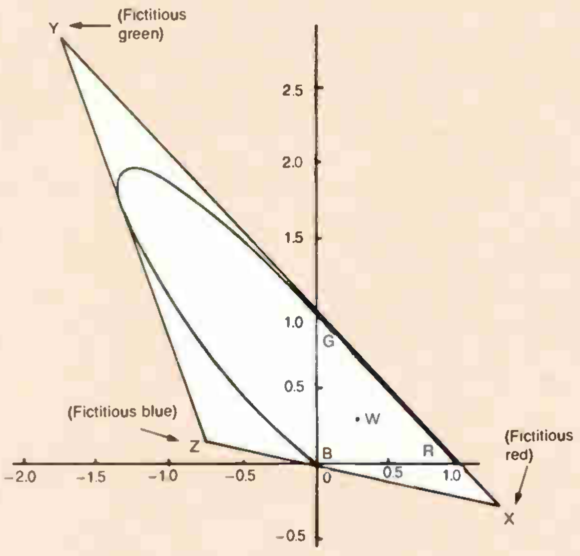
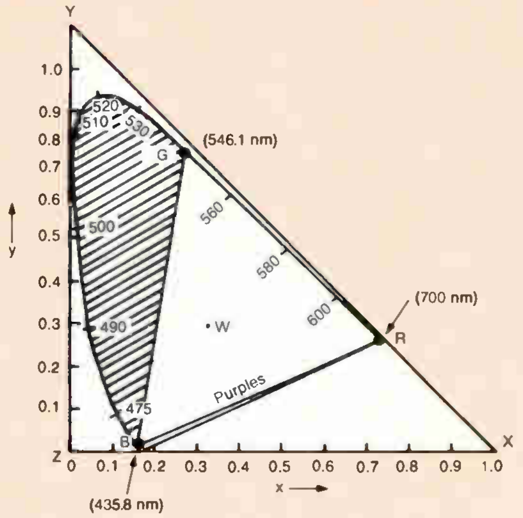


Figure 3: Transformation of XYZ triangle of Figure 2 into a right isoceles triangle, with resulting compression of spectral locus and relocation of Points R, G and B. This is the standard CIE chromaticity diagram.



under the product curve, designated as the "tristimulus coefficient" X, represents the ratio L_{rc}/L_{rw} in last month's Equations 1 to 3, except that the color matches with the color $w(\lambda)$ and the equal-energy white are now understood to be performed with the fictitious primaries X, Y and Z. Similarly, by taking the area under the product of the $w(\lambda)$ curve (maximum ordinate unity) with the $\bar{y}$ curve (see table), we find the tristimulus coefficient Y (having the significance L_{gc}/L_{gw}) and a similar process involving the $\bar{z}$ curve (see table) gives the tristimulus coefficient Z (having the significance L_{bc}/L_{bw}).

Stated symbolically, the tristimulus coefficients are:

$$X = \frac{1}{W}\int_0^\infty w(\lambda)\bar{x}(\lambda)\,d\lambda \qquad (1)$$

$$Y = \frac{1}{W}\int_0^\infty w(\lambda)\bar{y}(\lambda)\,d\lambda \qquad (2)$$

$$Z = \frac{1}{W}\int_0^\infty w(\lambda)\bar{z}(\lambda)\,d\lambda \qquad (3)$$

By analogy with last month's Equations 1 to 3, the trichromatic coefficients x, y and z are then given by

$$x = \frac{X}{X + Y + Z} \qquad (4)$$

$$y = \frac{Y}{X + Y + Z} \qquad (5)$$

$$z = \frac{Z}{X + Y + Z} \qquad (6)$$

From these equations we note that $x + y + z = 1$ and that the maximum value of x, y and z

Figure 4: Alternative choice of real spectral primaries to cover the lower region of the area enclosed by the spectral locus

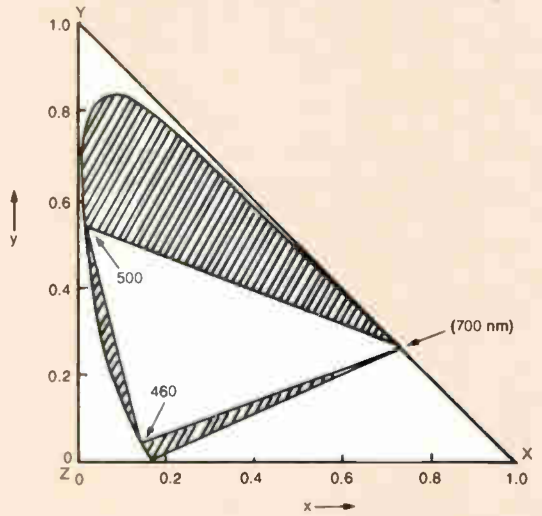


Figure 5: CIE distribution coefficients, the color mixture data of the fictitious primaries X, Y and Z

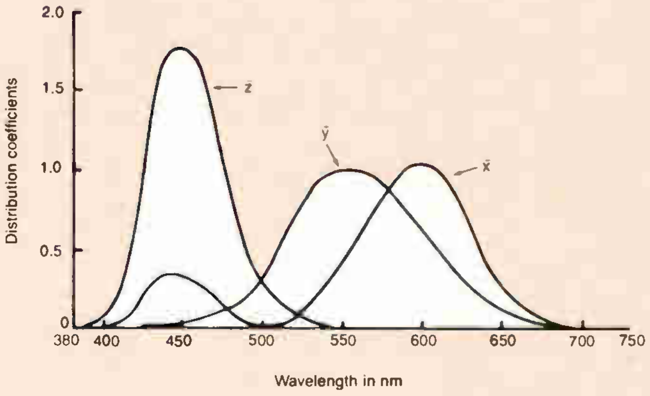
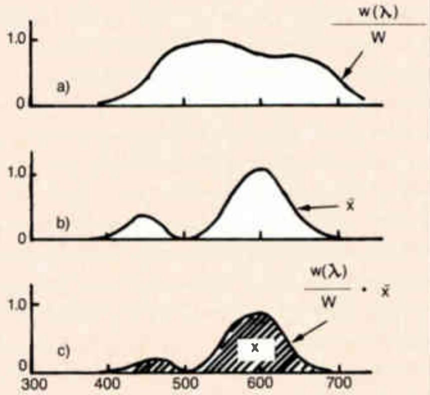


Figure 6: Example of the use of the distribution coefficient $\bar{x}$ in conjunction with the spectral output of source (a) to determine the tristimulus coefficient x of the source (c).



is unity, as previously stated. Determination of x and y provides the CIE chromaticity diagram coordinate values and thus its location.

The luminosity of the color w(λ) is given by Equation 2, since the $\bar{y}$ curve is identical to the relative luminance curve of the eye. Since the factor converting lumens to watts at the peak of the latter curve is 680 lumens per watt, the luminosity is expressed directly in lumens as

$$L = 680WY \text{ lumens} \qquad (7)$$

The integrals in Equations 1 to 3 are indicated as covering the whole wavelength range from zero to infinity. Actually, since the $\bar{x}$, $\bar{y}$ and $\bar{z}$ curves are zero outside the visible range from 380 to 780 nm, the integration need not be carried outside these limits.

Specification of colors by dominant wavelength

The values of x and y specifying the hue and saturation of a particular color, while of great value in technical specification, have the disadvantage that they offer no direct clue to the spectral hue that most nearly describes the color represented. Thus a color described by the wavelength 550 nm is more clearly recognizable than the same color described as x = 0.3, y = 0.7. To avoid this difficulty, an alternative specification of a color can be taken directly from the chromaticity diagram, which gives a more evident indication of its subjective appearance.

This specification is in terms of the *dominant wavelength* (or dominant hue), the *purity* and the *luminosity* of the color. To find the dominant hue and purity of a color, we pass a line through Point C (representing the color) and Point W (representing the equal-energy white light) and extend this line until it intersects the spectral locus, as shown in Figure 7. The wavelength corresponding to the point of intersection is defined as the dominant wavelength *d* of the color and the corresponding spectral hue is the dominant hue.

The purity *p* is a measure of the saturation of the color—that is, of the proximity of its point to the white point—and is given by

$$p = 1 - 0.333 \left(\frac{1 - y_s/y_c}{0.333 - y_s}\right) \qquad (8)$$

where:

y_c = the y coordinate of the color and
y_s = the y coordinate of the intersection of the spectral locus.

The purity ranges from 0 to 1. For example, the color Point C in Figure 7 has a dominant wavelength of 560 nm (red-orange) and a purity of 0.69.

From Equation 8 we note that colors near the spectral locus (y_c nearly equals y_s) have a purity near one, whereas colors near the white point (y_c near 0.333) have a purity near zero. The purity is, in other words, a direct measure of saturation. This system of specification falls down when the color is one of the purples; i.e., when its point falls below the white point in such a position that the extended line does not pass through the spectral locus, as Point C in Figure 7. In such cases the line is extended in the opposite direction, as shown, intersecting the spectral locus at a wavelength representative of the dominant hue *complementary* to that of the given color. Complementary colors are not a very satisfactory specification since the indication of subjective sensation is lost. The puritv of such purple colors is computed by Equation 8, taking y_s as the y coordinate of the complementary dominant hue. Io distinguish the color so indicated from color having the same actual dominant hue and purity, the purity of purples is stated as a negative number.

The foregoing illustrates the ease with which complementary colors (colors that when mixed produce white light) can be identified on the chromaticity diagram. To find a complementary color to a given color C (Figure 8), we pass a line through C and W, extending it so as to intersect both sides of the spectral locus, or through the locus above and the saturated purple line below. The dominant hues so indicated are said to be "complementary" to one another. ■

Views expressed here are the author's and do not necessarily reflect those of Contel.

Figure 7: Specification of colors by the dominant wavelength and purity

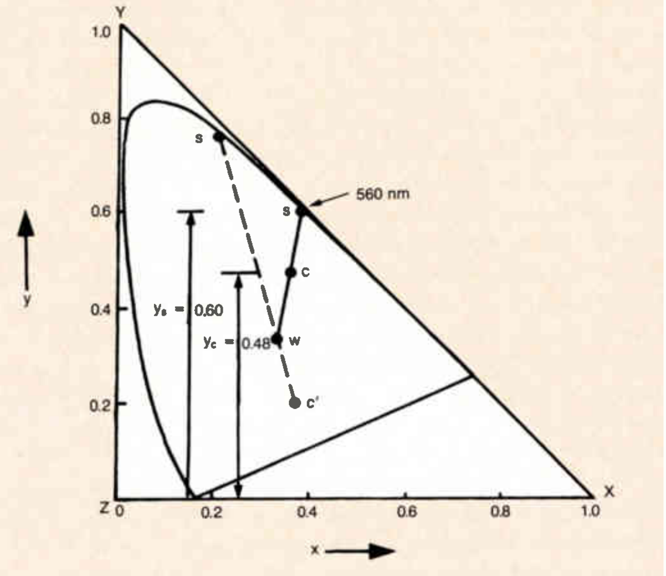
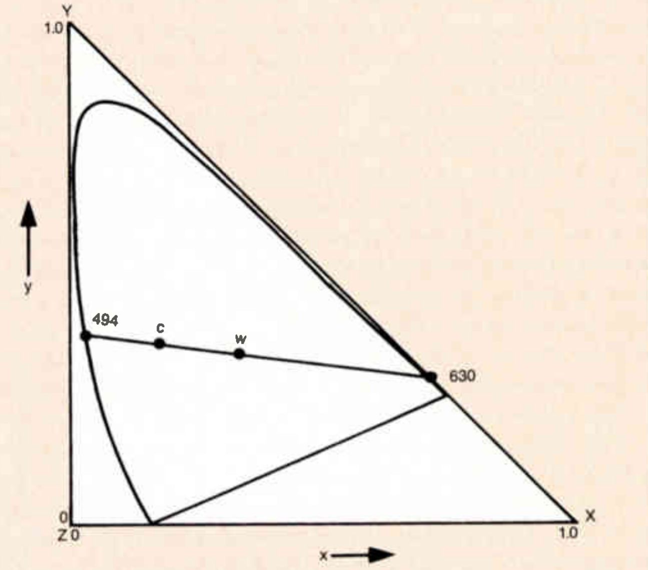


Figure 8: Complementary colors



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Accuracy in visual carrier level measurements

By Ron Hranac
Senior Staff Engineer, Jones Intercable Inc.

The visual carrier of a TV channel is amplitude modulated by a fairly complex video waveform. In its baseband form, this video signal contains significant energy out to about 4.2 MHz.

As the video signal's picture content varies, so does the amplitude of information from just above blanking to peak white. Portions of video that remain constant as the picture varies include, among other things, blanking and sync. When the video modulates the TV signal, the video is "inverted" so that the unchanging sync pulses represent the peak power of the visual carrier.

This is why visual carrier level measurements refer to peak sync. In fact, FCC Regulation 76.609(h)(2) says, "Field strength shall be expressed in terms of the RMS value of synchronization peak for each cable television channel ...measured." In order for a test instrument to accurately indicate this value when video modulation is present, a *peak* detector is necessary so that the instrument can display the RMS value of the synchronizing peak.

For example, if we say that a given visual carrier amplitude is +40 dBmV (100 mV RMS), that means the amplitude of the signal's AC voltage during the sync pulse is the same as the amplitude of an unmodulated 100 mV RMS signal. A peak detector circuit determines the instantaneous peak value of the modulated visual carrier, so that the test instrument can display the RMS value of that instantaneous sync peak. Nearly every modern signal level meter (SLM) operates by this principle. There is a common misconception that a peak detector equipped meter displays the peak sync voltage; but it actually displays the RMS value of the sync's instantaneous peak voltage.

Errors in measurement

Many factors are responsible for errors in signal level measurement equipment. Some of them include an instrument's accuracy vs. frequency (flatness), accuracy vs. signal level (detector non-linearity), accuracy vs. attenuator setting (attenuator tracking) and accuracy over temperature. But when a video modulated carrier is being measured, the *kind* of detector used in the instrument is very important. How close the detector actually responds to true peak voltage is a function of the design of the detector circuit. If a good quality peak detector is not used in an instrument designed for measuring TV visual carriers, then that instrument probably will give different readings when modulation is present than it does when the carrier is not modulated.

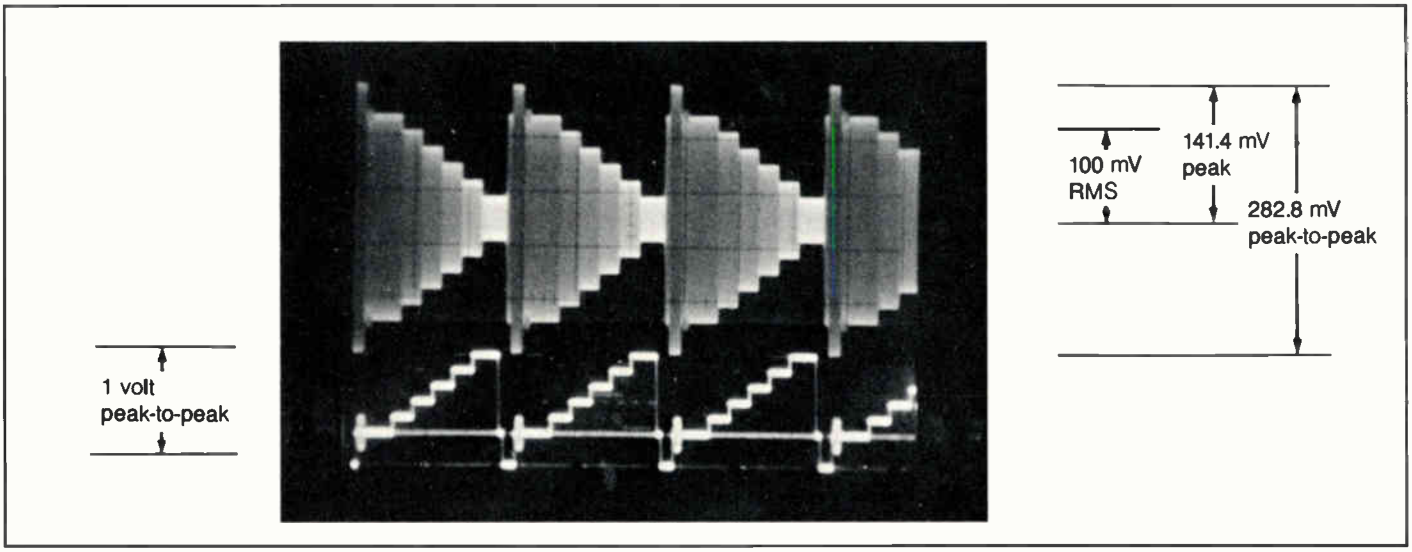
While most good SLMs do not have this problem, some instruments (including some signal leakage detection equipment) do not use true peak detection. A good way to see if yours does is to measure a visual carrier with and without modulation present. There should be less than 1 dB difference between the two readings; ideally, there should be no difference.

Most non-peak detector equipped test instruments will be fairly accurate with unmodulated carriers. But when video modulation is applied, the reading likely will be on the low side—sometimes by as much as 4 or 5 dB. If you are using such a device to measure signal leakage on a modulated carrier, your actual leakage—and even your CLI—could be higher by several dB!

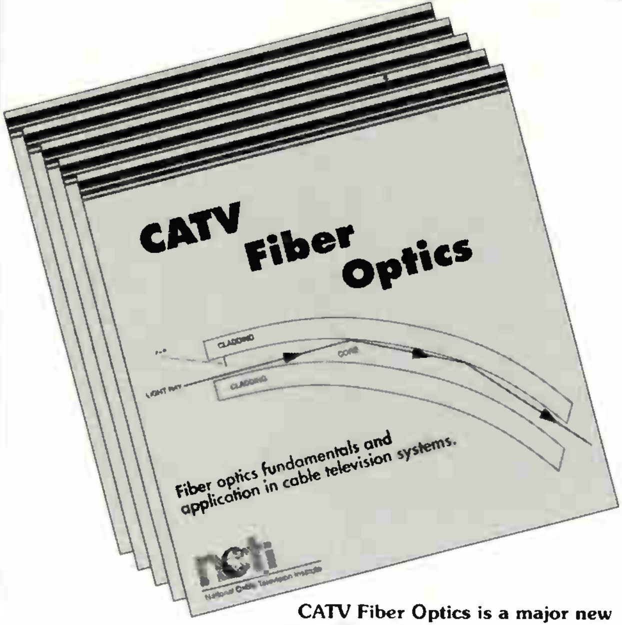
If you suspect this to be the case, the following calibration procedure should be used: After using a conventional SLM of known accuracy to verify the amplitude of the channel under test, pad that signal to your measurement reference level of 20 μV/m (e.g., −42.9 dBmV for Ch. C). Then connect the padded signal source to your leakage measurement instrument and note the signal's amplitude with video modulation temporarily removed from the carrier. Make sure the instrument is peaked, then turn the channel's video modulation back on. Note the new level; if it is lower than the unmodulated reading, then you must use that difference (in dB) as a correction factor to add to the instrument's reading when you are measuring signal leakage on a modulated carrier.

As video modulation changes between black and white, a non-peak detector equipped instrument also may vary with these changes. Fortunately, most of the measurement equipment used in CATV has sufficiently narrow bandwidths to keep these variations to less than 1 dB.

The bandwidth of the instrument also can affect the accuracy of measurements, particularly those made in an over-the-air environment. For example, if you are measuring a leak whose actual amplitude is −40 dBmV, and an over-the-air signal also is present very close to the leakage measurement frequency, the two signals may combine in a test instrument whose selectivity is poor (bandwidth too wide) and produce a reading higher than the actual leakage level. You can check to see if this is happening by repeating the measurement with a spectrum analyzer operated in a very narrow resolution bandwidth. Other than trying to find a measurement instrument with a better selectivity, about the only option here is to select a different measurement frequency that will not be affected by adjacent over-the-air carriers.



The upper trace in this oscilloscope photograph is a +40 dBmV (100 mV RMS) modulated Ch. 3 carrier, and the lower trace is the 1 volt peak-to-peak video baseband waveform that is modulating the Ch. 3 signal.



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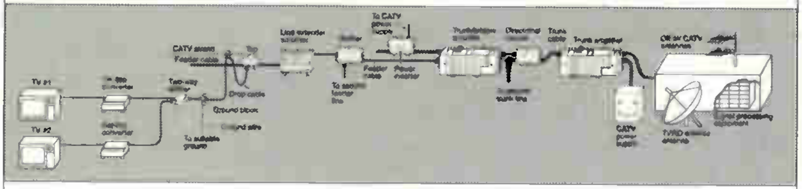

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Reader Service Number 43.

Spectrum analyzer

Hameg Instruments introduced Model 8028 spectrum analyzer and tracking generator for testing headend equipment, amplifiers, passives and measuring signal leakage. The unit connects with an oscilloscope to read signals as low as −40 dBmV with a 70 dB dynamic range at 12.5 kHz resolution.

For further information, contact Holland Electronics, 5308 Derry Ave., Suite W, Agoura Hills, Calif. 91301, (818) 597-0015; or circle #124 on the reader service card.

Connectors

Pyramid announced the development of its hard line PI Series connectors. According to the company, the design meets or exceeds all current electrical, mechanical and CLI specifications. The connectors are equipped with EP O-rings, stainless steel radiation sleeve, metal to metal positive stop and visual alignment of center conductor. Electrical specifications include passband to 700 MHz with 30 dB return loss and RF shielding of less than 115 dB.

For more details, contact Pyramid Industries, P.O. Box 23169, Phoenix, Ariz., (602) 269-6431; or circle #132 on the reader service card.

Converter/modulator

B&K-Precision announced its Model 1201SR TV frequency converter/modulator that converts the output of a video pattern generator to operate on a VHF broadcast channel, cable TV channel and several UHF broadcast TV channels. Channels are displayed with a two-digit LED readout. Bands are selected with push buttons and channels are selected by one push button that advances or scrolls 10 channels at a time, or another that advances or scrolls one channel at a time. The unit accepts a video input or Ch. 3 RF input.

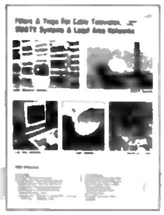
For more details, contact B&K-Precision, 6470 W. Cortland St., Chicago, Ill. 60635, (312) 889-9087; or circle #125 on the reader service card.

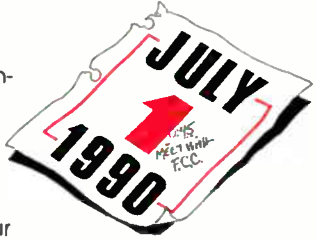
Battery

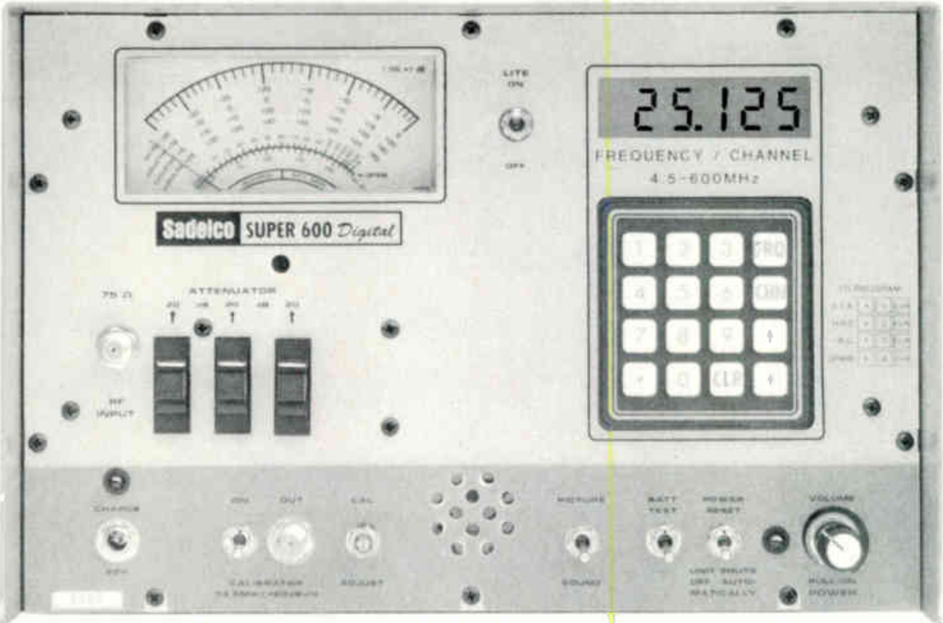
Bat/Pak introduced its Model 12/30 BP-sealed lead acid battery mounted in a custom flight case. According to the company, the battery can power

Before

After







equipment for days, weeks or months. Features include flush-mount meter and XLR connection. Dimensions are 6.75 inches wide, 9.5 inches deep and 9.5 inches high. It weighs 25 pounds.

For additional details, contact Bat/Pak, 7102 Grand Blvd., Houston, Texas 77054, (713) 747-6433; or circle #127 on the reader service card.

Power delay

According to Lindsay its new LPD 100 power delay module manages power restoration to trunk amplifiers to prevent maximum current ratings from being exceeded. The module is activated when power is restored after an outage and eliminates high current surges by delaying AC connection to the trunk amplifiers for two to four seconds.

The module is compatible with the company's 100 Series family of active and passive hard line products and is housed in the lid normally used for power supply.

For more details, contact Lindsay Specialty Products, 1248 Clairmont Rd., Suite 3-D231, Atlanta, Ga. 30030, (404) 633-2867; or circle #119 on the reader service card.

Fall prevention

North has introduced its Saf-T-Climb fall prevention system for use above or below ground or on straight or curved sites. Components include carrier rail, ladder rung clamps, sleeve and safety belt. According to the company, the rail can be retrofitted to existing ladders or designed into new construction.

If a fall should occur, the locking pawl is said to instantly lock into a notch, thus stopping the fall. The system comes complete with all necessary hardware and instructions for installation and complies with the Occupational Safety and Health Administration's standards for ladder climbing safety.

For complete details, contact North Consumer Products, 2664-B Saturn St., Brea, Calif. 92621, (910) 583-5944; or circle #120 on the reader service card.

LEX option

The low-end frequency extension (LEX) option has been introduced by Wavetek for its Model 2510A (1,100 MHz) and Model 2520A (2,200 MHz) synthesized signal generators. The option extends the low-end frequency range from 200 kHz to 100 Hz for Models 2510A and 2520A for use in communications Tempest testing.

For more details, contact Wavetek, 5808 Churchman Bypass, Indianapolis, Ind. 46203-6109, (317) 788-9351; or circle #129 on the reader service card.

F connectors

According to Times Fiber, its one-piece weatherproof F connectors for CATV applications can be installed with just one crimp. Features include two weathertight seals inside, and a third seal that is formed when installed with Times Fiber's round crimp tool. A built-in stripping guide is also included. The connectors (when coupled with the company's drop cable with lifeTime corrosion protectant) are said to help minimize CLI.

For more information, contact Times Fiber Communications, 358 Hall Ave., Wallingford, Conn. 06492-0384, (203) 265-8500; or circle #128 on the reader service card.

Fiber-optic link

Laser Diode introduced the Model LDAL 2200 Link, an RF analog fiber-optic link that delivers a 1,200 MHz bandwidth signal over 6 dB (10 km) of optical loss. The unit provides a carrier-to-noise ratio of 120 dB/Hz and third-order intermodulation distortion greater than 60 dB and has a 1,300 nm laser coupled to single-mode fiber. Contained in a DC-powered 3- × 5-inch module, the unit is also available in a reduced size of 2 × 3 inches or in an AC-powered rack mount.

Recommended applications for the unit include high fidelity pulse transmission, two-way radio communications, antenna remoting and multichannel video link.

For additional details contact Laser Diode, 1130 Somerset St., New Brunswick, N.J. 08901, (201) 249-7000; or circle #134 on the reader service card.

Design software

Cablesoft announced its Cable Designer 2.0, which allows the layout and design of all systems that use a tree-and-branch architecture. According to the company, the product can be used in CATV, SMATV, LAN and limited fiber-optic design applications and conforms to all known IEEE, NCTA and SCTE system design specifications.

Features include unlimited number of entries and branches allowed, works with portables and calculates all design requirements including pad and equalizer values at amplifiers.

For additional information, contact Cablesoft, 838 Sandusky Dr., Iowa City, Iowa 52240, (319) 337-8412; or circle #130 on the reader service card.

Video generator

Team Systems introduced the Astro VG-819 programmable video generator that provides for engineering, testing, and calibration of monitors, projectors and flat panel displays. It stores and recalls up to 40 programs or patterns including SMPTE, color temperature, brightness, high/low frequency crosstalk, power supply regulation, etc.

The product offers independently programmable horizontal scan rate from 10 to 130 kHz and dot clock (pixel frequency) from 5 to 240 MHz. The unit supplies analog, ECL, and TTL outputs, GPIB and RS232 interfaces. Programmable patterns include 5 × 7 or 7 × 9 ASCII characters in various programmable cell sizes. According to the company, the product is recommended for service applications due to its small size and weight (20 pounds).

For complete details, contact Team Systems, 2934 Corvin Dr., Santa Clara, Calif. 95051, (408) 720-8877; or circle #137 on the reader service card.

Wattmeter

Bird Electronic Corp. introduced its portable, battery-powered Model 4410A Thruline RF directional wattmeter, said to accurately measure signal power within ±5 percent of reading. Standard elements provide frequency ranges from 0.2-2,300 MHz and power ranges from 0.002-10,000 watts. Special elements can provide measurements at frequencies as low as 50 KHz.

Recommended for field service work and laboratories where high accuracies and low power levels are required, it measures milliwatts, watts or kilowatts and includes a standard 9V battery. According to the company, the unit is unaffected by temperature extremes and contains an amplifier employing an inherently self-balancing measurement technique.

For more details, contact Bird Electronic Corp., Marketing Department, 30303 Aurora Rd., Cleveland, Ohio 44139-2794, (216) 248-1200; or circle #140 on the reader service card.

Socket tool

Multilink's new Z coring stripping socket tool was designed to work with CommScope QR cable, Trilogy MC2 cable and Times Fiber TX cable. According to the company, the tool does not clog and tamper the aluminum sheath so the O ring does not get cut.

For more details, contact Multilink, 196 Morgan Ave., P.O. Box 955, Elyria, Ohio 44035, (216) 324-4941; or circle #118 on the reader service card.

Pliers

The Model D203-6CR long-nosed pliers from Klein Tools can wrap, loop and cut wire and apply solderless connectors. The product is 6 inches long and has knurled jaws for gripping and contoured plastic-dipped handles.

For more information contact Klein Tools Inc., 7200 McCormick Blvd., Chicago, Ill. 60645; or circle #139 on the reader service card.

Message system

According to Quanta its All Channel Message System is designed to place a video message on any or all channels simultaneously, either as a stand-alone message or over the normal video program. Applications include syndex switching with advisory message for viewers, emergency alert and preparedness system and satellite-delivered system specific promotions, ads and bulletins by channel.

The system is said to be able to control four channels of switching and messaging and many multichannel headends (remotely by modem). Syndex data base interfaces are planned. Audio is full balanced stereo, and a remote voice override with beeper is available from the company for emergency alert without disrupting program video.

For more information, contact Quanta, 2440 S. Progress Dr., Salt Lake City, Utah 84119, (801) 974-0992; or circle #122 on the reader service card.

Demodulator

Cadco's Model 370 demodulator now has the added option of sub-low channels. The factory option adds Channels T-7 through T-13, allowing full frequency agility for sub-low channels, standard NTSC off-air Chs. 2-69 and all EIA/NCTA cable channels through 552 MHz. Previous models may be retrofitted for this option. The Model 370 features fully front-panel frequency agility, synchronous detection, vertical and composite sync output and standard demodulator outputs.

For more details, contact Cadco, 2405 S. Shiloh Rd., Garland, Texas 75041, (214) 271-3651; or circle #141 on the reader service card.

Answers to CLI quiz

(from page 60)

1) Cumulative leakage index is a *management* problem, and people and equipment must be provided if it is to be dealt with successfully.

2) If you fail a flyover CLI, do you need to repeat it if your system fails? *Yes*. Or submit a ground-based CLI.

3) Flyover testing makes sense when *speed* is important, *25* percent of a system is inaccessible (backyards), the *economics* are right (system size) and if you are relatively sure that you will *pass*.

4) The Federal Communications Commission regulation that covers flyover testing is Section *76.611*.

5) Is it important to have a system specific defineable leakage detection signal? *Yes*. Try to choose a leakage measurement frequency not used by neighboring systems.

6) Other things that must be considered before picking a leakage detection frequency are: not a *harmonic* or spurious output of a local transmitter, preferably in the aeronautical portion of the *mid*-band and one that's *offset* from FAA frequencies.

7) How much plant must be "substantially" driven out on a quarterly basis for monitoring and repair of leakage? *100 percent*.

8) Is leakage an important factor at the headend? *Yes*.

9) Does the FCC consider equipping all vehicles with leakage detection equipment sufficient for quarterly monitoring? *Yes*. But a structured drive-out is strongly recommended.

10) A report of all signals carried in the FAA bands must be filed *annually*. This must include *types of modulation*, *names and numbers of system contacts*, *system name and address*, *carrier and subcarrier frequencies* and their *tolerances*.

11) The portion of a cable system most likely to create the highest level of leakage is *the feeder plant*, with *loose tap plates*, *loose connectors* and *cracked shields* leading the list.

12) Which will most likely result in leakage—an open unterminated tap port or a tap port with a cheap and/or loose terminator? *The terminator*.

13) The most successful leakage programs have sufficient *staff* monitoring leakage on a regular basis and a specific grid of system areas to be monitored on a "by this date" regular basis.

14) If an MDU that you serve injects its own frequency and it leaks, who is responsible? *You are*.

15) What must you not do when looking for a leak? *Bang up* against the strand or pole, as this may temporarily eliminate the leak.

16) Fix the *ham* and *feeder plant* complaints first.

17) Describe side benefits to a good leakage program.
a) *Service calls are reduced*
b) *Customer complaints are reduced*
c) *Pass CLI and keep your job*
d) *Picture quality will improve as ingress is reduced*
e) *System sweep response will improve*

18) How often should leakage detection equipment be calibrated? *Daily*. There should be a calibrated leak set up in an area that trucks pass by *daily*. This leak must emit less than 20 μV/m at 10 feet and should be set up through a bandpass filter. It should be activated for a minimum amount of time to allow calibration.

19) To calculate CLI using the I_{3000} method you first calculate the *geographic center* of your system. From that point as a reference you need to calculate the distance from there to your leaks. The next step is to convert this distance in miles to *meters*. Example: 1 mile = 5,280 feet ÷ 3.28 feet/meter = 1,610 meters. The formula from that point is $\mu V/m^2 \div (meters^2 + 3{,}000^2)$ for all leaks. *Add* these together, multiply by *10log* (plant mileage/plant driven) gives your answer. In this case the number must be less than a -7.

20) Are leaks likely to be of varying intensity due to frequency? *Yes*.

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This career opportunity will require good communication and presentation skills. Primary responsibilities will be technical interface with customers, sales and marketing staff, and engineering personnel. These responsibilities will require approximately 70% travel and relocation to the Hickory, North Carolina area.

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CableLabs is looking in the Denver area for a Senior Electronics Technician to work in their Boulder facility. Responsibilities will include: light fabrication, modification, installation and testing of electronic hardware and operation of standard RF and digital test equipment. Responsible for maintenance, alignment and testing of cable television headend, computer system management and network administration for all internal communications networks.

Minimum of five years experience required, two of which must be in the cable industry. Formal education should include graduation from a technical school, college or equivalent service training or industry training courses, plus experience.

Qualified candidates should send resume to:

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Microvolt per meter conversions

By Ron Hranac
Jones Intercable Inc.

Some of today's signal leakage detection equipment is calibrated in decibels relative to either 20 or 50 microvolts per meter (μV/m). The usefulness of this is that your detection equipment can, for example, display the amplitude of a leak as "x number of dB above (or below) 20 μV/m." The following tables provide conversions between μV/m and dB relative to both 20 and 50 μV/m. The formulas from which these tables were created, along with examples of their use, are on the next page.

dB relative to 20 μV/m	μV/m	dB relative to 20 μV/m	μV/m	dB relative to 50 μV/m	μV/m	dB relative to 50 μV/m	μV/m
-20	2.00	10	63.25	-20	5.00	10	158.11
-19	2.24	11	70.96	-19	5.61	11	177.41
-18	2.52	12	79.62	-18	6.29	12	199.05
-17	2.83	13	89.34	-17	7.06	13	223.34
-16	3.17	14	100.24	-16	7.92	14	250.59
-15	3.56	15	112.47	-15	8.89	15	281.17
-14	3.99	16	126.19	-14	9.98	16	315.48
-13	4.48	17	141.59	-13	11.19	17	353.97
-12	5.02	18	158.87	-12	12.56	18	397.16
-11	5.64	19	178.25	-11	14.09	19	445.63
-10	6.32	20	200.00	-10	15.81	20	500.00
-9	7.10	21	224.40	-9	17.74	21	561.01
-8	7.96	22	251.79	-8	19.91	22	629.46
-7	8.93	23	282.51	-7.96	20.00	23	706.27
-6	10.02	24	316.98	-7	22.33	24	792.45
-5	11.25	25	355.66	-6	25.06	25	889.14
-4	12.62	26	399.05	-5	28.12	26	997.63
-3	14.16	27	447.74	-4	31.55	27	1119.36
-2	15.89	28	502.38	-3	35.40	28	1255.94
-1	17.83	29	563.68	-2	39.72	29	1409.19
0	20.00	30	632.46	-1	44.56	30	1581.14
1	22.44	31	709.63	0	50.00	31	1774.07
2	25.18	32	796.21	1	56.10	32	1990.54
3	28.25	33	893.37	2	62.95	33	2233.42
4	31.70	34	1002.37	3	70.63	34	2505.94
5	35.57	35	1124.68	4	79.24	35	2811.71
6	39.91	36	1261.91	5	88.91	36	3154.79
7	44.77	37	1415.89	6	99.76	37	3539.73
7.96	50.00	38	1588.66	7	111.94	38	3971.64
8	50.24	39	1782.50	8	125.59	39	4456.25
9	56.37	40	2000.00	9	140.92	40	5000.00

To convert "dB relative to 20 μV/m" into μV/m, use the formula

$$\mu V/m = 20 \left(10^{\frac{dB}{20}}\right)$$

To convert "dB relative to 50 μV/m" into μV/m, use the formula

$$\mu V/m = 50 \left(10^{\frac{dB}{20}}\right)$$

Examples

Problem: You are measuring leakage with a detector that is calibrated in dB relative to 20 μV/m and find a 133.2625 MHz leak whose amplitude is displayed on the detector as "+15 dB." What is this level in μV/m?

Solution: Use the formula:

$$\begin{aligned} \mu V/m &= 20 \left(10^{\frac{dB}{20}}\right) \\ &= 20 \left(10^{\frac{15}{20}}\right) \\ &= 20 \left(10^{0.75}\right) \\ &= 20\ (5.62) \\ &= 112.47\ \mu V/m \end{aligned}$$

Problem: What would the leak in the previous problem be in dBmV?

Solution: First, convert from μV/m to μV with the formula:

microvolts = microvolts per meter/0.021/frequency in MHz
= 112.47/0.021/133.2625
= 40.19 μV

Then, convert from μV to dBmV using the formula:

$$\begin{aligned} dBmV &= 20\log\left(\frac{\text{microvolts}}{1{,}000}\right) \\ &= 20\log\left(\frac{40.19}{1{,}000}\right) \\ &= 20\log(0.04019) \\ &= 20(-1.39590) \\ &= -27.92\ dBmV \end{aligned}$$

Problem: You are measuring leakage with a detector that is calibrated in dB relative to 50 μV/m and have found a "−8 dB" leak. What is its amplitude in μV/m and does it exceed the Federal Communications Commission's 20 μV/m limit?

Solution: Use the formula:

$$\begin{aligned} \mu V/m &= 50 \left(10^{\frac{dB}{20}}\right) \\ &= 50 \left(10^{\frac{-8}{20}}\right) \\ &= 50 \left(10^{-0.40}\right) \\ &= 50\ (0.40) \\ &= 19.91\ \mu V/m \end{aligned}$$

This leak is just below the FCC 20 μV/m limit.

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8	22	36	50	64	78	92	106	120	134
9	23	37	51	65	79	93	107	121	135
10	24	38	52	66	80	94	108	122	136
11	25	39	53	67	81	95	109	123	137
12	26	40	54	68	82	96	110	124	138
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CT 11/89

Daniel

Catel Telecommunications appointed **Paul Daniel** as chief financial officer. He was most recently vice president of finance for Digital RF Solutions.

Also, **Jim Caldwell** was named director of the CATV and Telecommunications Division. He was formerly division manager of telecommunications.

Ron Todd was promoted to general manager of the Broadband Transmission Division. Prior to this he was division manager of CATV.

The company also appointed **Diane Hinte** as sales manager for the CATV Division. Before this she was cable sales manager for the Satcom Division of Standard Communications Corp. Contact: 4050 Technology Pl., Fremont, Calif. 94537-5122, (415) 659-8988.

Bell

Bob Baxter was promoted to director of sales and development for **Channell Commercial Corp.** He was previously direct sales representative in the Northeast Division.

Bob Cook was named as customer service and development manager. Previously he was direct sales rep in the Southwest Division.

Channell also appointed **George Bell Jr.** as direct sales rep in the Southwest Division. Prior to this he was in sales for Times Fiber Communications

Finally, **Anthony Keator** was appointed direct sales representative in the Northeast Division. Most recently he was with Channelmatic and Video Data Systems. Contact: 27040 Ynez Rd., Rancho California, Calif. 92390, (714) 768-4877.

Clough

Jerrold promoted **Paul Clough** to director of marketing for new business development. Previously he was a manager for the Digital Cable Radio product development program.

Doug Light was promoted Southeast regional manager. Prior to this he was vice president of sales and marketing for RMS Electronics. Contact: 2200 Byberry Rd., Hatboro, Pa. 19040, (215) 674-4800.

Times Fiber Communications named **Denis Biglin** national sales manager. Most recently he was the senior account manager at Jerrold. Contact: 358 Hall Ave., P.O. Box 384, Wallingford, Conn. 06492-0384, (203) 265-8500.

Pyramid Industries announced three new staff members. **Rex Ickes** was named director of engineering, **James Mathis** was appointed regional representative for the Southeast and **Bill Tielert** was named regional representative for the Northeast. Contact: P.O. Box 23169, Phoenix, Ariz. 85063, (602) 269-6431.

Gregory Marx was named director of sales and marketing for instrument products by **Trilithic Inc.** Previously he was regional sales manager for Wavetek RF Products. Contact: 9202 E. 33rd St., Indianapolis, Ind. 46236, (317) 895-3600.

Riley

Rhodes

Advantest America Inc. appointed **Michael Riley** regional sales manager for the Instruments Division. Previously he was the Central regional manager for Anritsu.

Larry Rhodes was named Western regional sales manager for the Instruments Division. Formerly he was a technical specialist for Advantest. Contact: 300 Knightsbridge Pkwy., Lincolnshire, Ill. 60069, (312) 634-2552.

Raymond Lucas was appointed senior vice president of strategic operations and chief strategic officer for **Scientific-Atlanta**. He was previously vice president for planning and business development of GTE products and systems in Stamford, Conn. Contact: 1 Technology Pkwy., P.O. Box 105600, Atlanta, Ga. 30348, (404) 441-4000.

C-COR Electronics appointed **Edward Kopakowski** as national sales manager for the U.S. Data Group. Prior to this he was national sales manager of the Professional Systems Division of NEC Home Electronics. Contact: 60 Decibel Rd., State College, Pa. 16801, (814) 238-2461.

Tom Walsh was named vice president of business development at **Channelmatic**. Prior to this he was executive vice president for the company. Contact: 821 Tavern Rd., Alpine, Colo. 92001, (619) 445-2691.

Nymeyer

JVC Professional Products Co. appointed **Dennis Nymeyer** as regional manager for the West Coast Division. He was formerly senior district sales manager for JVC. Contact: 41 Slater Dr., Elmwood Park, N.J. 07407, (201) 794-3900.

Jim Deveraux retired as general manager of **United Cable TV of Wyoming** after 35 years with the company. In addition to being general manager, he held various divisional and regional positions with United Cable TV Corp.

Bob Carnahan was appointed general manager of the Wyoming system to succeed Deveraux. Most recently Carnahan was assistant general manager. Contact: 1 Bill Daniels Center, 2930 E. 3rd Ave., P.O. Box 65008, Denver, Colo. 80206-9008, (303) 321-4242.

Pioneer Communications named **Mark Stropki** as field service engineer. Before this, he held sales positions with Sensotec Inc. and Gestetner Corp. Contact: 600 E. Crescent Ave., Upper Saddle River, N.J. 07458-1827, (201) 327-6400.

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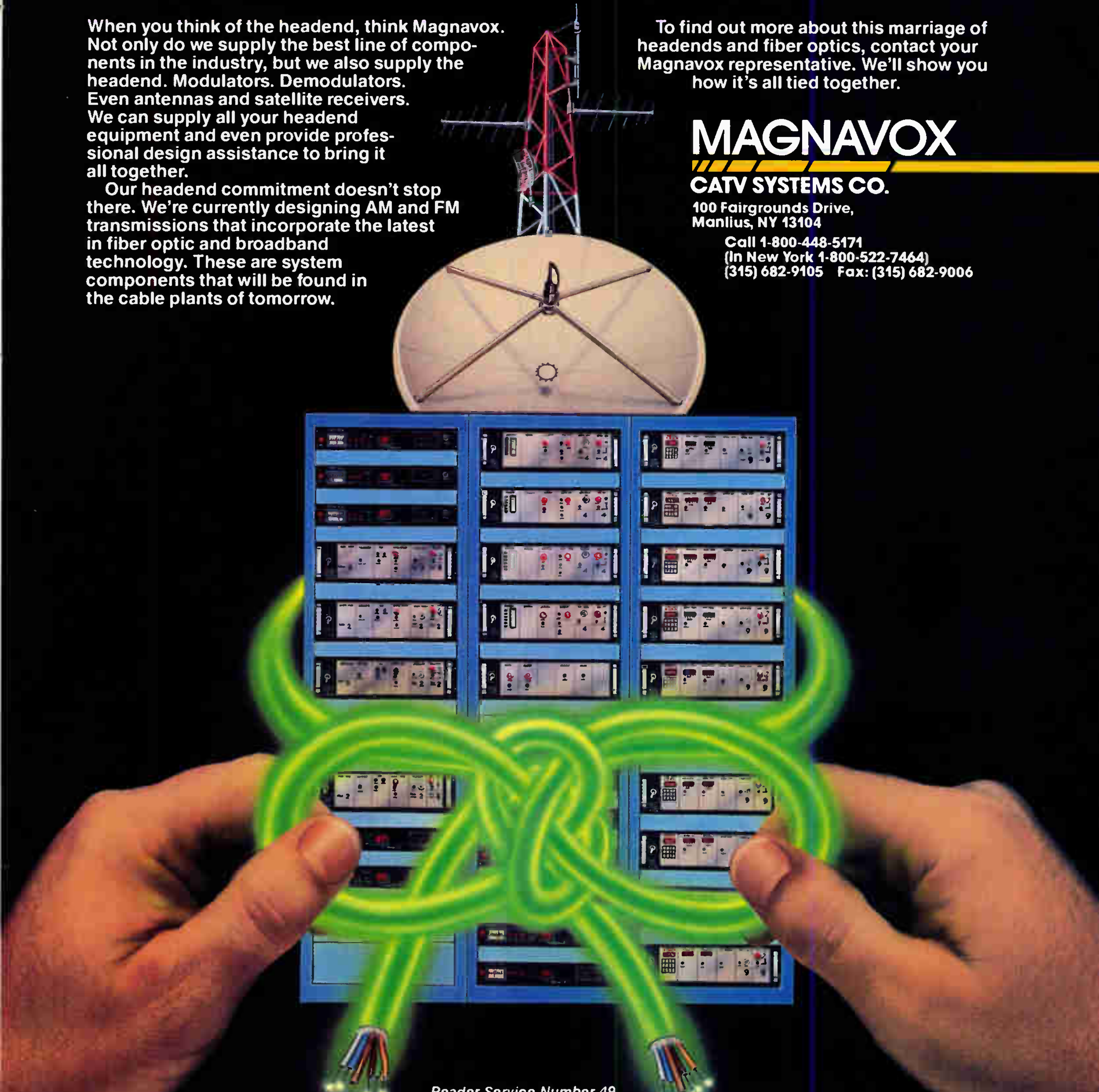

Reader Service Number 49.

PRESIDENT'S MESSAGE

Toward the professional installer

By Jack Trower
President, Society of Cable Television Engineers

Let's talk about installer certification. After many months of long, hard work on the part of many individuals and companies, the SCTE Installer Certification Program is now a reality. In September the first edition of the *SCTE Installer Certification Manual* came off the presses; a copy has been sent to every SCTE chapter and meeting group. In this manual the chairman of the Installer's Committee recognized and thanked the many individuals and companies that provided their time, money, expertise and good, old-fashioned labor to produce a manual as professional and error free as possible. I also would like to say "thank you" on behalf of the entire Society. It is through the support of our members and their companies that we are able to achieve the Society goals that we set.

One person was not listed in the "thank you," "we appreciate" or "thanks again" list in the manual; this individual is the chairman of the Installer's Committee. I personally know that without his relentless pursuit of materials to include in the manual and his tireless efforts in editing and prodding others to complete their tasks, we would not have the excellent program we now have. He has always demonstrated his belief in the Society's goals and programs and his dedication to the same. He has always, to my knowledge, been ready to perform any job that was needed for the benefit of the Society and its members, without any desire for praise or recognition.

In spite of his reluctance in accepting credit where it is due, I want to take this opportunity to extend a hearty thank you to Richard Covell, chairman of the Installer's Committee, for a professional job well-done. This program will be a monument to your efforts, Richard.

The timing for this program seems to be about right, although some of us wish we had started it earlier. It seems that management—I refer to the non-technical type—is starting to place more emphasis on quality of service and happy customers. What could make a customer more happy than a professional installation of a good cable service that gives years of enjoyment without the need for service calls? If an installer places the required materials and equipment in and around a customer's home in such a manner that doesn't distract from the home's appearance or beauty and it works properly, then we have a professional installation and a happy, satisfied customer. What more could we want, now that we don't have the expense of additional truck rolls, more materials and work-hours expended, that usually comes from a poor non-professional installation?

The installer as a professional

You will notice that I like to use the word "professional" when I talk about installer technicians. We are finally realizing in this business that an installer is a professional instead of a laborer. We still, of course, place our newest people in these installer positions. But we are now training them in a more professional manner so that they develop good work habits, good customer relations and have better job knowledge. These efforts are paying dividends to those companies that are training their people and to the industry as a whole. More and more companies are recognizing that we can have professional career installers. Instead of always moving these professionals away from their level of competence, under the guise of a promotion, we can give them pay increases and professional recognition for jobs that are well-done and keep them doing what they do best.

> *"More and more companies are recognizing that we can have professional career installers."*

Hopefully, through this certification program and individual company efforts this industry will be able to recognize that the title "installer technician" describes a true professional who takes pride in one's work and the service that their company provides to its customers. With this professional approach our business will be more successful, which is what we all want.

The administration of this program will be at the local level. This is because the certification process requires some "hands-on" demonstration of skills. Each chapter or meeting group will be responsible for developing tutors and proctors for the practical portions of the certification process using the guidelines furnished by the Society. I would challenge each SCTE group to ensure that the tutorial and proctoring functions are handled in such a manner as to, in no way, cast doubt on the credibility of the certification program. A professional program will give professional results. I also would ask that if anyone should detect any error in the material or see a need to update any information in the program to please notify SCTE national headquarters at (215) 363-6888.

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(Continued from page 64)

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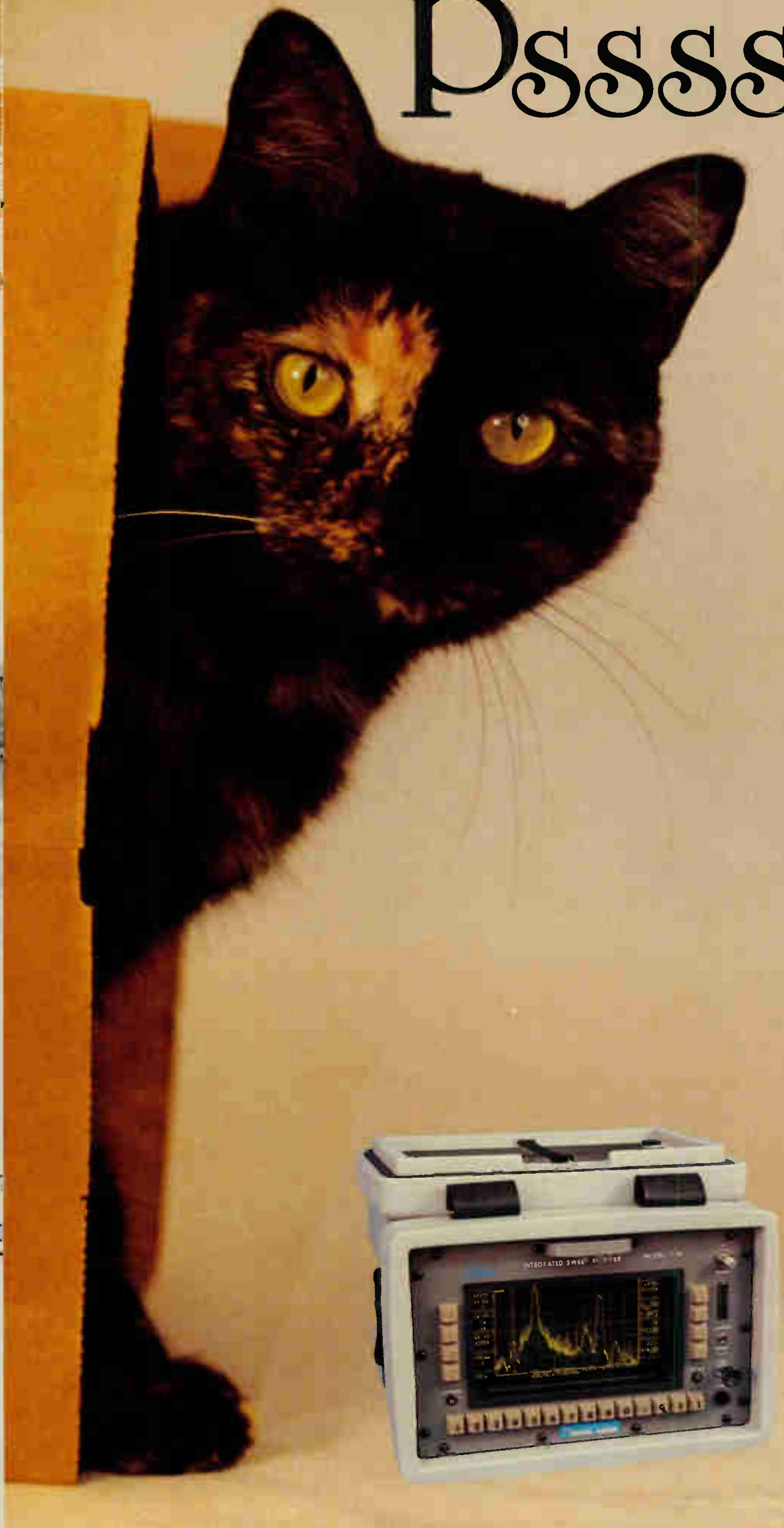

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Reader Service Number 51.

Statistical booby traps

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

Perhaps you have heard the ancient saying, attributed to that wise old prophet Anonymous: "Figures never lie; liars figure."

Be that as it may, statistics is still an honorable branch of mathematics. At its best, it is an essential tool in all departments of science for estimating the accuracy of measurements, collecting and analyzing data, and avoiding errors of observation and personal bias. Statistics is particularly useful in identifying and presenting the facts concerning complex phenomena that are often beyond comprehension. In fact, it has been truly said that statistics is a means for organizing ignorance.

Unfortunately, statistical methods are subject to abuse, sometimes inadvertently by neophytes and often deliberately by demagogues and scoundrels. Most of us occasionally misuse such statistical terminology as *percentage*, *coverage* and *accuracy*.

Everyone knows that *percentage* is a way of expressing a ratio or proportion between a quantity of something and 100 of the same thing. But sometimes we fail to ask: "percent of what?" A president's approval rating may be 62 percent. Is that a percent of the total 250 million population including infants and the mentally incompetent? Or percent of eligible voters? Or percent of all males over 18? Or just what does it mean? You should ask.

Average is a mathematical term, meaning the arithmetic sum of comparable quantities, divided by the number of such items. Sometimes the average does not exist in the real world. Where can you find an average family of 3.21 persons? Weather reports on TV sometimes compare today's temperature with the "normal" condition. Actually, it is the average temperature that is being mislabelled as normal. There is no such thing as normal temperature. As Mark Twain once said; "If you don't like the weather, just wait a minute."

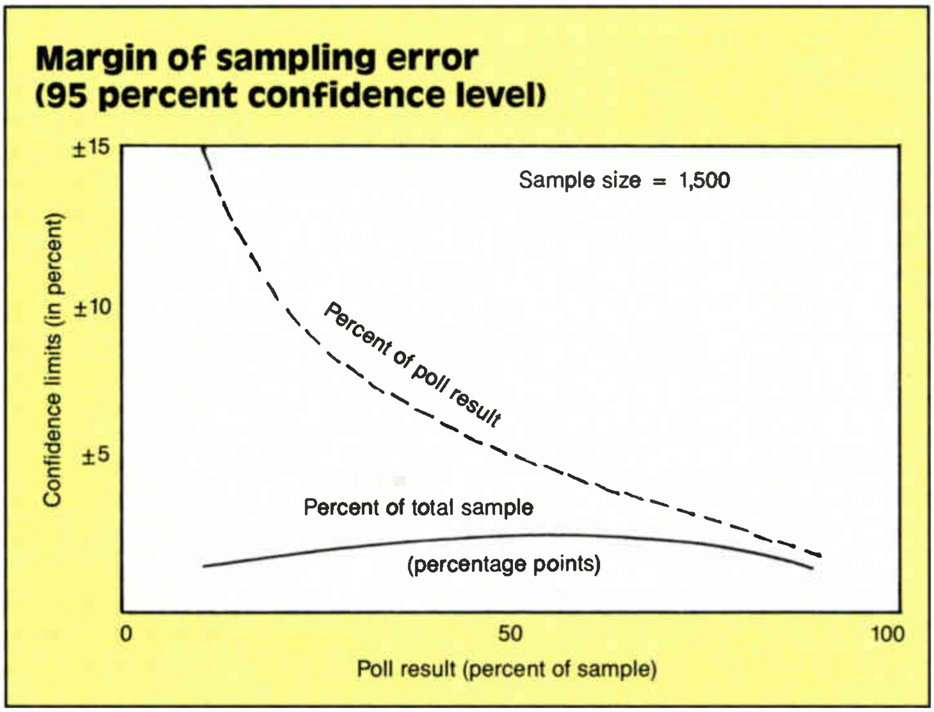
Then there was the report many years ago by John Hopkins University that 33⅓ percent of all the women enrolled in a new class had married into the faculty. It turned out that there were only three women in the class, one of whom was married to the teacher. The figure was accurate, but the impression created by the statistic was not.

At one time, the death rate among soldiers in the Philippines was reported by the military authorities to be about the same as the death rate among the general population. Therefore, it was concluded (incorrectly) that the soldier's death rate should not be considered abnormal. Soldiers are mostly in an age group whose death rates are lower than for the general population, which includes high-risk infants and the elderly. Had the comparison been made with death rates among males in a comparable age group, the story would have been quite different, probably embarrassing to the military (who put out the story in the first place).

A critical attitude toward conclusions based on numerical data is the only safeguard against misrepresentation.

Sampling and polling

Probably the greatest opportunity for abusing the statistical method lies in sampling and polling. The accuracy of a sample survey depends most heavily on a) selection of a truly random sample, without biases, b) on the interview questions and c) on the absolute size of the sample. Strange as it may seem, the relative size of the sample compared with the size of the total population has almost nothing to do with sampling accuracy. A 1,500-member sample is equally reliable for a city of 10,000, a state of 5 million, a nation of 250 million or a world of 5 billion, providing only that the sample is truly random.



Margin of sampling error (95 percent confidence level)

What is a "random sample"? Very simply, it is a sample in which each and every person in the total population has an equal chance to be included. People who do not have a telephone obviously have no chance to be included in a telephone-based sample, the usual kind. If you want to sample your cable system for leaks, every foot of cable has to have an equal chance of being selected for the sample. You cannot ignore backyard easements (overhead) or cables in remote or inaccessible locations and still call it "random."

The accuracy of opinion polling is usually stated as the range of deviations in percentage points from the poll results. The accompanying figure shows quite clearly the difference between percentage points relative to the total sample and percentages of the poll result. There is not much difference where the poll result is greater than 80 or 90 percent of the sample. But the confidence limits as a percent of the poll result widen quite rapidly for poll results that are a small percentage of the total sample.

The stated accuracy for a 1,500-unit sample, for example, is 2 to 3 percentage points at the 95 percent confidence level. If the poll shows 80 percent favoring an issue and 20 percent opposing, the potential error is within about ±2.5 percent of those favoring the issue, but within ±10 percent of those opposing.

For all practical purposes, the margin of sampling error at 95 percent confidence level, expressed as a percentage of the total sample, is approximately 100 divided by the square root of the sample size (or $100/\sqrt{N}$). Remember, this is percentage points to be added or subtracted from the particular poll results.

"Percentage of what"? This is the important question that needs to be answered critically. To treat percentages without knowing the base is

(Continued on page 102)

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Reader Service Number 52.

Off-air Ch. 11

By Steven I. Biro
President, Biro Engineering

This is the 10th in a series of maps with technical and program parameter listings for off-air Channels 2-69, designed to be used when the cable system experiences co-channel interference. With this information, the headend technician can pinpoint the closest (i.e., the most probable) offenders, determine their directions and start the verification process with the rotor-mounted search antenna. Based on the tabulated technical information, the search can be concentrated on the most powerful stations or those that have the highest transmitting antenna towers.

The computer program for the maps was developed and data for the listings was collected by the staff of Biro Engineering, Princeton, N.J. The information is accurate as of Sept. 1, 1988.

Key to listing
Call letters: Ch. 11 station identification

City: Station location or the area served by the station

Network affiliation:

A/C	CBS and ABC programming
C/N	CBS and NBC programming
A/N	ABC and NBC programming
ACN	ABC, CBS and NBC programming
ED	Educational station (PBS)
IND	Independent station
CBC	Canadian Broadcasting Corp.
CTV	Canadian Television Network
RRQ	Reseau Radio Quebec
TVA	Canadian Independent Programming
SRC	Societe Radio-Canada
SP	Spanish language programming

Power: The effective visual radiated output power (in kilowatts)

Offset: The offset frequency of the station

0	No offset
–	–10 kHz offset
+	+10 kHz offset

HAAT: Transmitting antenna height above average terrain (in feet)

Call letters	City	Network affiliation	Power	Offset	HAAT
KTVA	Anchorage, Alaska	CBS	51	0	300
KTVF	Fairbanks, Alaska	A/C	28	+	5
KMSB	Nogales, Ariz.	IND	150	0	1570
KTHV	Little Rock, Ark.	CBS	316	0	1760
KTTV	Los Angeles	IND	166	0	2940
KNTV	San Jose, Calif.	ABC	81	+	2769
KKTV	Colorado Springs, Colo.	CBS	233	0	2380
WINK	Fort Myers, Fla.	CBS	316	+	960
WFSU	Tallahassee, Fla.	ED	316	–	777
WXIA	Atlanta	NBC	316	+	1048
WTOC	Savannah, Ga.	CBS	316	0	1470
KHAW	Hilo, Hawaii	NBC	2	0	1

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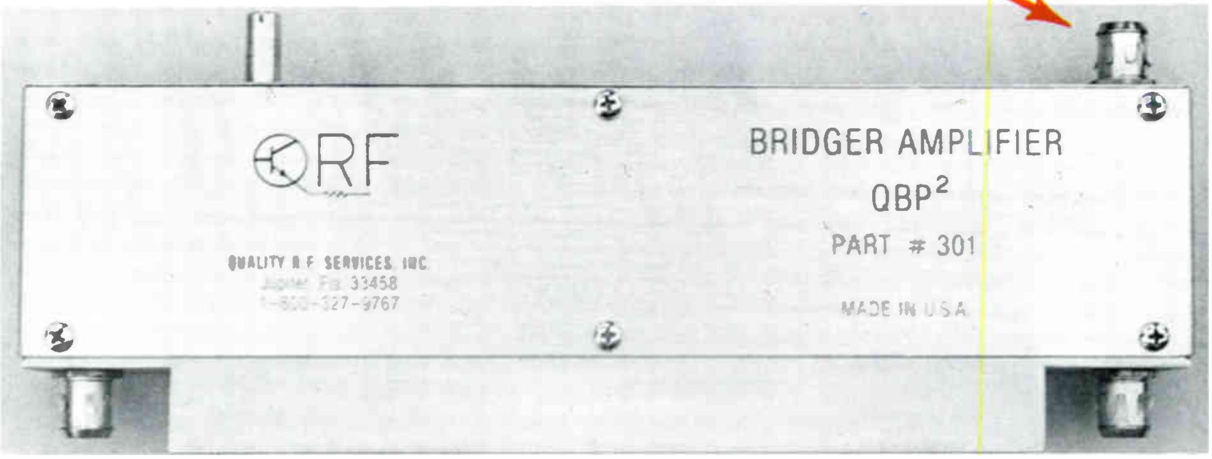

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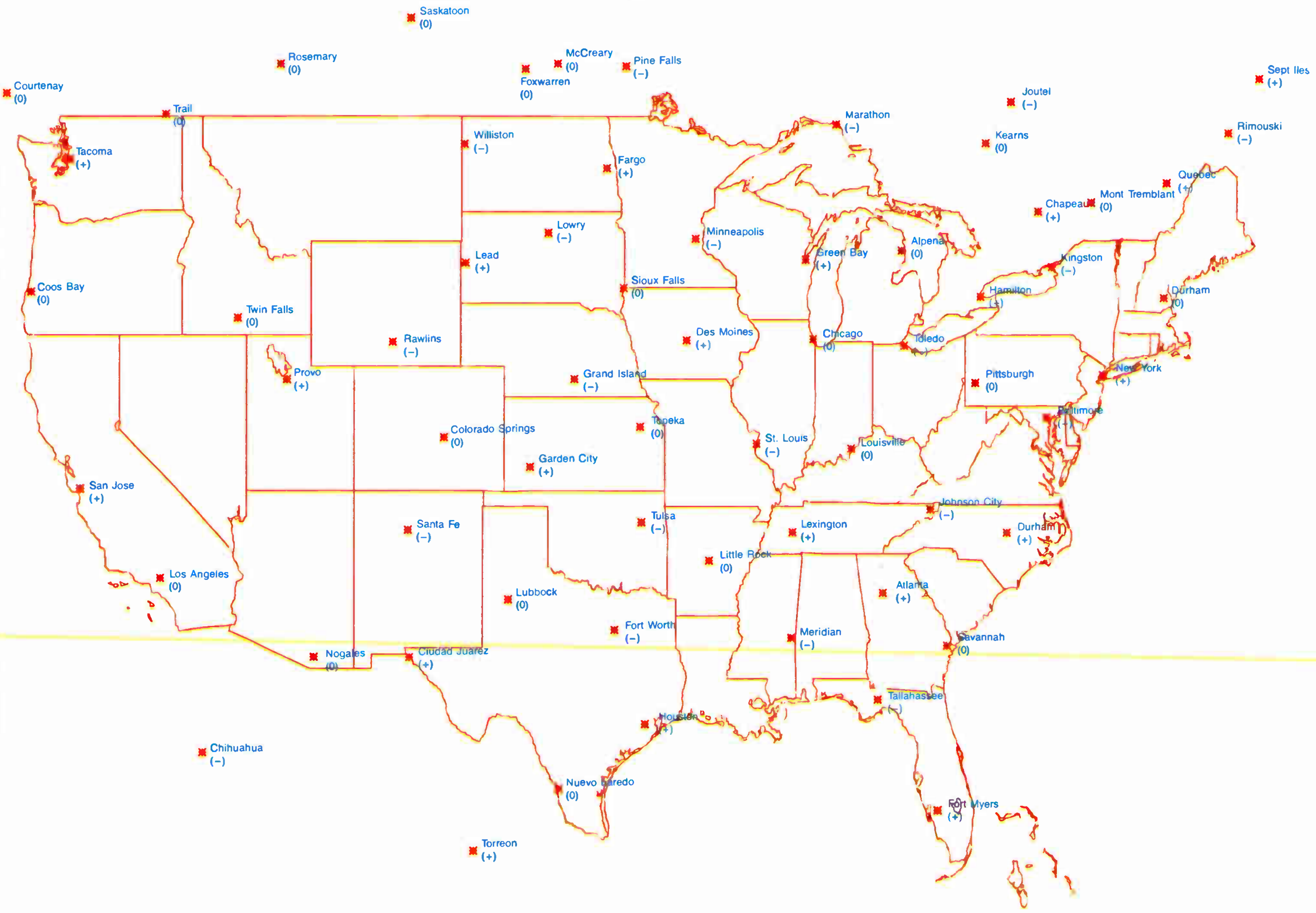
City/State ____________________ ZIP ________
Telephone (   ) ____________________
Your Name ____________________ Position ____________________
Equipment Used in System ____________________

Please:
- ☐ Send Replacement Components Catalog
- ☐ Send information on repair service.
- ☐ Send information on Circuit Boards to increase your channel capacity.

DMV

Reader Service Number 53.

Call letters	City	Network affiliation	Power	Offset	HAAT
KHET	Honolulu	ED	148	+	1
KMVT	Twin Falls, Ill.	A/C	316	0	1060
WTTW	Chicago	ED	60	0	1634
KDIN	Des Moines, Iowa	ED	316	+	1973
KSNG	Garden City, Kan.	NBC	200	+	800
KTWU	Topeka, Kan.	ED	316	0	1064
WHAS	Louisville, Ky.	CBS	135	0	1290
WBAL	Baltimore	CBS	316	–	1000
WBKB	Alpena, Mich.	CBS	316	0	670
KARE	Minneapolis	NBC	316	–	1440
WTOK	Meridian, Miss.	ABC	316	–	536
KPLR	St. Louis	IND	316	–	1007
KGIN	Grand Island, Neb.	CBS	316	–	1010
WENH	Durham, N.H.	ED	316	0	995
KCHF	Santa Fe, N.M.	IND	263	–	2028
WPIX	New York	IND	58	+	1663
WTVD	Durham, N.C.	ABC	316	+	1990
KTHI	Fargo, N.D.	NBC	316	+	2000
KXMD	Williston, N.D.	CBS	174	–	979
WTOL	Toledo, Ohio	CBS	316	–	1000
KOED	Tulsa, Okla.	ED	316	–	1713
KCBY	Coos Bay, Ore.	CBS	11	0	631
WPXI	Pittsburgh	NBC	316	0	990
KHSD	Lead, S.D.	ABC	316	+	1890
KQSD	Lowry, S.D.	ED	234	–	1040
KELO	Sioux Falls, S.D.	CBS	316	0	2000
WJHL	Johnson City, Tenn.	CBS	254	–	2320
WLJT	Lexington, Tenn.	ED	316	+	640
KTVT	Fort Worth, Texas	IND	316	–	1669
KHOU	Houston	CBS	316	+	1441
KCBD	Lubbock, Texas	NBC	316	0	760
KBYU	Provo, Utah	ED	162	+	29430
KSTW	Tacoma, Wash.	IND	316	+	900
WLUK	Green Bay, Wis.	NBC	316	+	1260
KFNR	Rawlins, Wyo.	ABC	2	–	230
CBXF	Edmonton, Alberta	SRC	90	–	474
CBRT	Rosemary, Alberta	CBC	227	0	619
CHAN	Courtenay, British Columbia	CBC	3	0	1325
CBUF	Terrace, British Columbia	CBC	1	0	1500
CBUA	Trail, British Columbia	CBC	3	0	762
CKX	Foxwarren, Manitoba	CBC	99	0	670
CKXT	McCreary, Manitoba	CBC	78	0	575
CBWF	Pine Falls, Manitoba	CBC	7	–	362
CBAF	Moncton, Maritime Provinces	SRC	325	0	469
CBHT	Sheet Harbor, Maritime Provinces	CBC	18	+	410
CBHT	Yarmouth, Maritime Provinces	CBC	38	–	620
CBNA	Roddickton, Newfoundland	CBC	1		56
CHCH	Hamilton, Ontario	IND	325	+	1500
CKSO	Kearns, Ontario	CTV	325	0	734
CKWS	Kingston, Ontario	CBC	325	–	851
CBLA	Marathon, Ontario	CBC	19	–	932
CBOF	Chapeau, Quebec	CBC	5	+	360
CJDG	Joutel, Quebec	CBC	1	–	500
CBFT	Mont Tremblant, Quebec	CBC	6	0	1647
CBVT	Quebec	SRC	317	+	641
CFER	Rimouski, Quebec	IND	325	–	1420
CFER	Sept Iles, Quebec	CBC	6	+	606
CBKS	Saskatoon, Saskatchewan	CBC	325	0	866
XETT	Chihuahua, Mexico	SP	1	–	125
XEDI	Ciudad Juarez, Mexico	SP	5	+	165
XEDR	Nuevo Laredo, Mexico	SP	4	0	200
XHOO	Torreon, Mexico	SP	11	+	305
WLII	Caguas, Puerto Rico	SP	200	–	1245
WLII	San Juan, Puerto Rico	SP	200	–	1635


Saskatoon (0)
Rosemary (0)
McCreary (0)
Pine Falls (–)
Foxwarren (0)
Courtenay (0)
Sept Iles (+)
Joutel (–)
Trail (0)
Marathon (–)
Kearns (0)
Rimouski (–)
Tacoma (+)
Williston (–)
Fargo (+)
Quebec (+)
Mont Tremblant (0)
Chapeau (+)
Lowry (–)
Minneapolis (–)
Alpena (0)
Green Bay (+)
Lead (+)
Kingston (–)
Coos Bay (0)
Sioux Falls (0)
Hamilton (+)
Durham (0)
Twin Falls (0)
Rawlins (–)
Des Moines (+)
Chicago (0)
Toledo (+)
Provo (+)
Grand Island (–)
New York (+)
Pittsburgh (0)
Baltimore (+)
Topeka (0)
Colorado Springs (0)
St. Louis (–)
Louisville (0)
Garden City (+)
San Jose (+)
Johnson City (–)
Santa Fe (–)
Tulsa (–)
Lexington (+)
Durham (+)
Little Rock (0)
Los Angeles (0)
Lubbock (0)
Atlanta (+)
Fort Worth (–)
Meridian (–)
Savannah (0)
Nogales (0)
Ciudad Juarez (+)
Tallahassee (–)
Houston (+)
Chihuahua (–)
Nuevo Laredo (0)
Fort Myers (+)
Torreon (+)

In-home wiring: Where to from here?

By Walter S. Ciciora, Ph.D.
Vice President of Technology
American Television and Communications Corp., Stamford, Conn.

Last month we introduced the subject of in-home wiring and compared the cable industry's approach with those of the power and phone industries. This month, we'll consider what needs to be done to bring the option of subscriber responsibility for in-home wiring into reality.

The signal leakage issue

There appears to be substantial disagreement over the likely contribution of leakage from subscriber installed in-home wiring to the cumulative leakage index (CLI). On the one hand, a vocal group of engineers feels that CLI is almost entirely dominated by leaks in the large signal portion of the plant. This group says that contributions from drops and in-home wiring won't add up to much and can be ignored.

On the other hand, an equally vocal group feels we haven't yet begun to see the full scope of trouble that can come from subscriber in-home wiring. While it is true that many subs now do their own wiring, they usually do it knowing their cable company doesn't approve. Therefore they limit their extra outlets to just a few. If subs were told that in-home wiring was their responsibility, more would do it and they probably would wire more rooms. If they used low quality hardware and/or inadequate workmanship, leakage could certainly result. Anecdotal evidence from flyovers indicates that apartment buildings and especially college dorms yield leakages that are not insignificant. While it is not known how many of these incidents are necessary to cause a cable system to fail the CLI, they do create a "background level" of leakage that reduces the tolerance for leaks in the rest of the system.

Picture quality is becoming more and more important as consumer electronics hardware evolves. The interest in high definition TV (HDTV) will only emphasize quality. When we allow subs to do their own wiring, video quality is likely to suffer. Wiring installations that may leak also will suffer ingress. Excessive splitting of the signal will cause noisy pictures and subscriber installed amplifiers will degrade noise figure. This will contribute to composite triple beat, cross-modulation and second-order effects. Also, cheap amplifiers may oscillate.

CeBus and Smart House

The Electronic Industries Association has been working diligently on a standard for home appliances to communicate with one another. This standard is called the "Consumer Electronics interface Bus" (CeBus). Communication occurs over four possible media: via radio, over twisted pairs, over coaxial cable or by infrared links. Fiber may be in the future.

This EIA project raises two important issues: 1) Consumers are led to expect that their televisions should be interconnected. Service companies will call to sell installation of wires and connectors for CeBus. This must not lead to a CLI hazard or to degraded video quality. 2) The CeBus standard intends to distribute in-home video to the TV sets connected to the bus. In-home video comes from VCRs, satellite receivers, front-door and baby-sitting cameras and graphics generators associated with security and home automation systems. Some of the early work involved trapping out a piece of the spectrum for use by the in-home video equipment. Cable involvement in these efforts is mandatory if we are to protect our interests. Specifically, we need to prevent the trapping of our channels to make room for in-home generated video.

A similar but incompatible effort is under way by the National Association of Home Builders. It calls its project "Smart House." Its goal is to have new homes pre-wired with an interconnection scheme that would include in-home coaxial cable. Again, cable involvement is necessary to ensure that its interests are protected. The NCTA Science and Technology Department has representation on the Smart House board; this may not be enough. More cable industry participation would be helpful.

One possible approach to minimizing problems from subscriber in-home wiring is to establish a set of hardware standards and an approval labeling system. Training booklets, video tapes and seminars would support these resources and subs who use them would likely do a job that minimizes the CLI hazards and protects their picture quality. The cable company could reserve the right to disconnect installations that do not measure up.

Nearly all cable operators charge for multiple outlets. Depending on the amount and the degree of enforcement, this can be a significant bottom-line contributor. The financial positives of subscriber responsibility for the in-home wiring will have to outweigh the loss of multiple outlet income.

There is also a strategic issue. The single most important trend in consumer electronics is the proliferation of televisions and VCRs in the home. These products have become impulse purchases. Multiple receivers in the home are very common and will become more so. If subs only have cable on the TV set in the principal viewing room, they remain tied to over-the-air broadcast in the rest of the home. Strategically, it would be best if cable were available on nearly all of the TV receivers and VCRs in their homes. This becomes more important as we face competition from telco and possibly direct broadcast satellite (DBS).

Initiatives

The NCTA Engineering Committee has a new subcommittee on in-home wiring chaired by Larry Nelson, executive vice president of Comm/Scope Inc. Its purpose is to explore these and other issues and to reach an industry position on them. In addition, Cable Labs is considering what might be appropriate for its involvement. Broadly speaking, the differences between these two groups are that the NCTA is generally responsible for regulations and congressional matters, while Cable Labs has the funding and full-time staff to undertake technological projects that require the expenditure of resources for their accomplishment.

A third group that has the potential to contribute is the EIA. Cable has had joint efforts with the EIA for at least seven years, and the relationships developed can be used to reach common goals.

Taylor's Vantage

(Continued from page 96)

to invite misunderstanding. Averaging percentages is a case in point. Consider the following 1990 projections:

State	Black population (in millions)	Total population (in millions)	Percent black
California	2.392	29.126	8.7
Maryland	1.233	4.729	27.9
New York	2.858	17.773	16.1
Total	6.483	51.628	52.7

Average 100 × 6.483/51.628 = 12.56 percent
or 52.7/3 = 17.6 percent

The black population in these three states combined is actually only 12.6 percent of the total, not 17.6 percent as calculated by averaging percentages rather than actual numbers.

Where you really get in trouble is saying that the error due to averaging the percentages in this example is 40 percent. One could also say that the true average is 28.5 percent below the average percentage. On the other hand, the error is 17.57 − 12.56 = 5 percentage points!

You really have to be careful with percentages!

Here is another one. If the consumer price index is defined as 100 in 1967, government statistics show that it was 382 in 1986. The index increased in 19 years by only 282 percent, not 382 percent. However, it is also correct to say that the index in 1986 was 382 percent of the 1967 index.

Percentages are slippery, and the words used to talk about them can be treacherous. The key, however, is always to ask: percent of what? If you can answer that one question with respect both to what you read and what you say, you will be well on the road to avoiding many of the accidental or malicious statistical booby traps.

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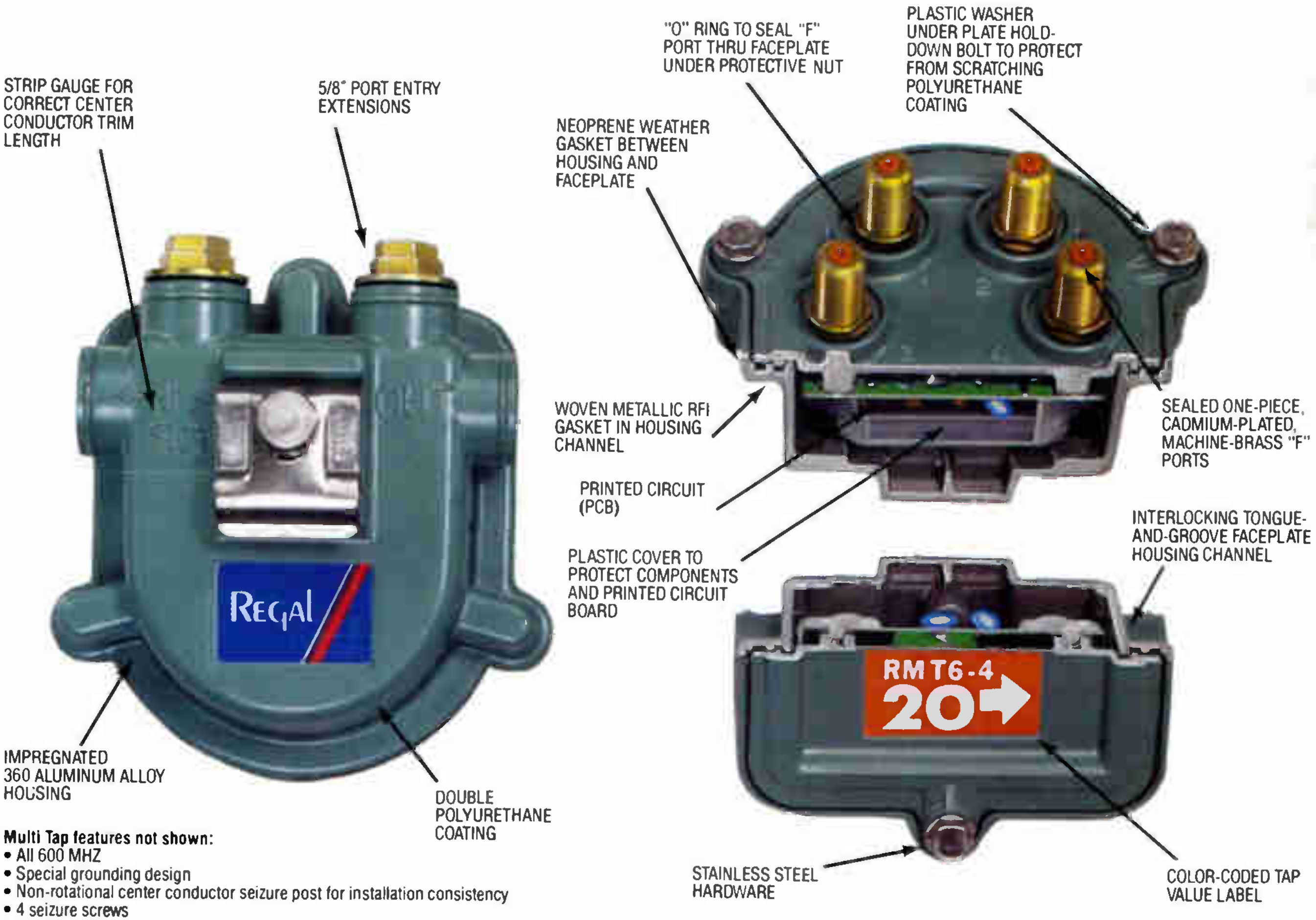

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