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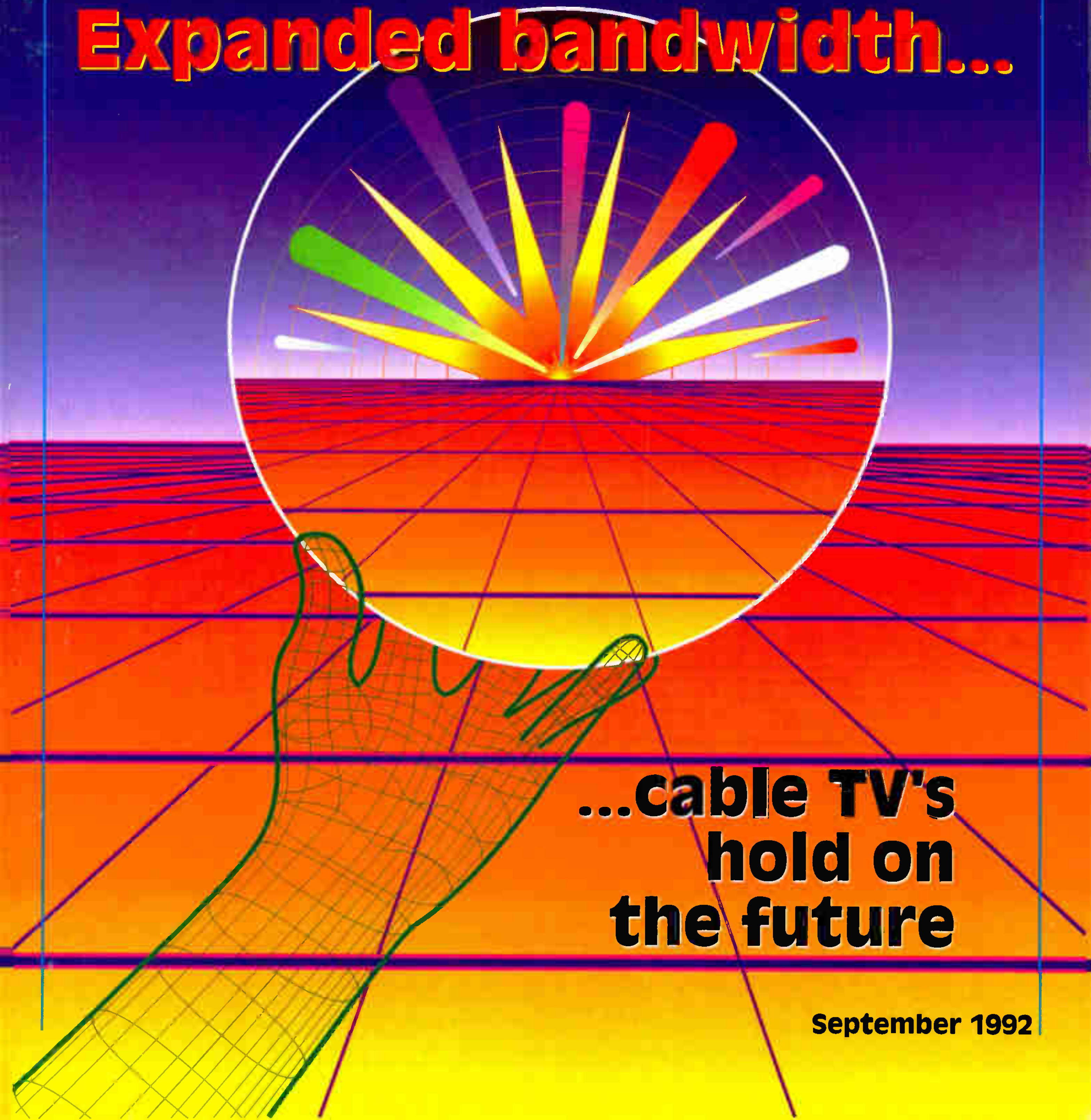

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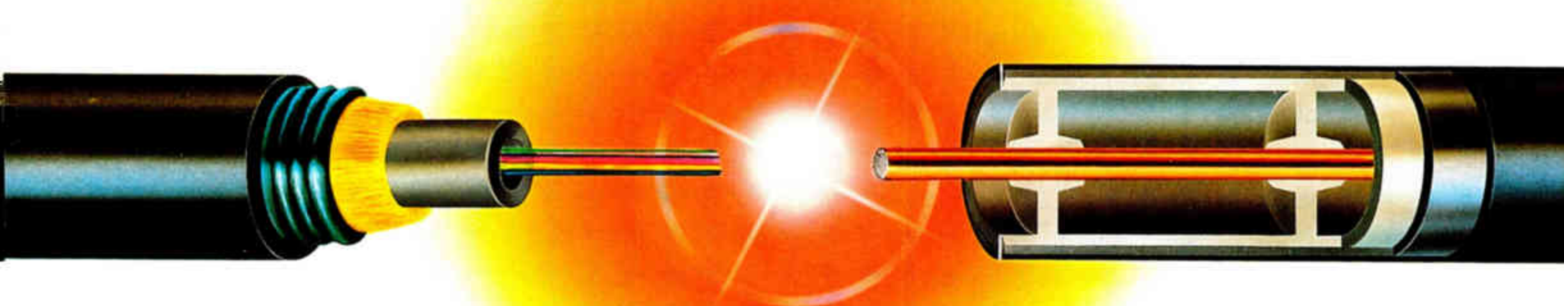

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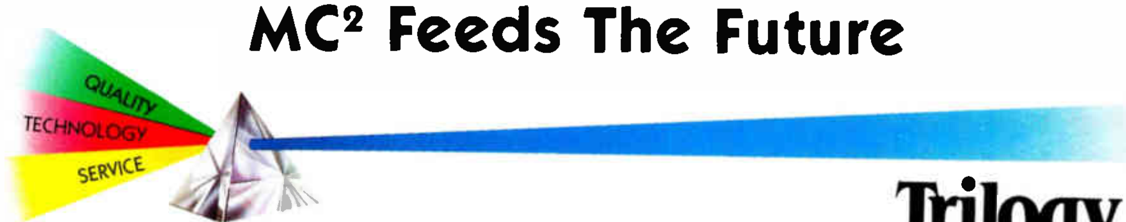

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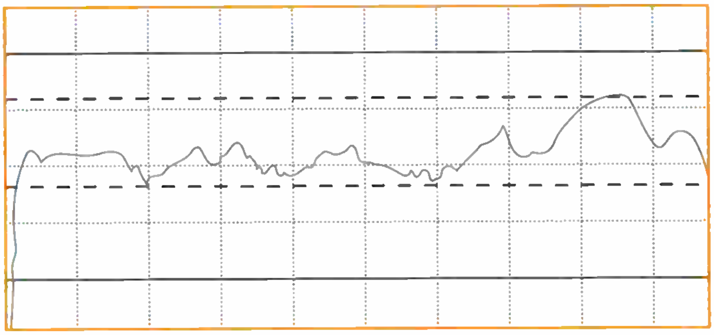

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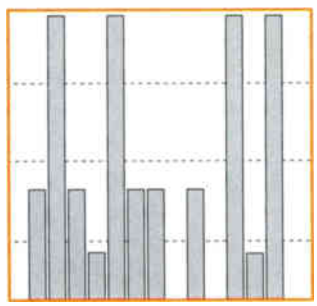

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Optical Network News

The following highlights are from Optical Networks International's quarterly newsletter.

Passive cable networks

ONI developed the Star-Star-Bus (SSB) architecture to facilitate economic deployment of fiber deeper into the plant. ONI has now taken the SSB one step further and drafted a totally passive SSB network. The design further positions operators for future opportunities by increasing plant reliability, increasing interactive capabilities, and lowering power and maintenance requirements.

(See related story in the Fall issue of ONN.)

Scratching the surface

Alternate access is still just the tip of the iceberg in terms of what cable operators could offer on their communications networks. Using a hybrid star-star-bus architecture, cable systems could also offer services such as "virtual office" and residential access. New revenue opportunities are just beginning to emerge for this revolutionary architecture.

(See related story in the Fall issue of ONN.)

Is your system reliable?

Without a doubt, reliability is the single most important concept facing cable operators during the next several years. As operators continue to devise methods of improving reliability, future issues of ONN will highlight those efforts so that others can benefit from the information. If you have a story to share on reliability, please write to Kathy Berlin, editor of the *ONN*, at ONI, 8101 East Prentice Avenue, Englewood, CO 80111, or call her at 1•800•FIBER•ME.

Simplifying aerial fiber storage

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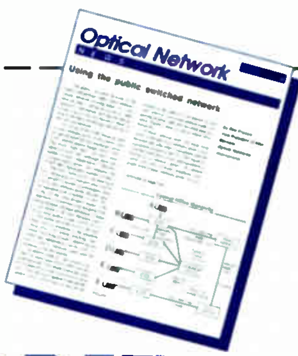

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EDITOR'S LETTER

CATV, telephony: The differences blur

During the past couple of years I have hinted in a number of presentations here and abroad that the cable TV and telephone industries have been on parallel tracks that will eventually converge. A bold statement? Perhaps. But consider the thought process behind this idea.

First of all, it's fairly easy to see the two as parallel industries. Wired networks using public rights-of-way are common to each. Both are communications industries, both provide a useful service to their respective customer base, and in the eyes of some, both are perceived as utilities. While telephone companies are without question regulated monopolies, cable companies are more broadly defined as entertainment delivery services, although our detractors tend to lump us in the monopoly category. As you can see, there are many similarities, but there also are many differences. Thus my "parallel industries" description.

An ultimate convergence?

But are they really parallel industries headed toward a convergence of some sort? I think so. And this is where the two are no longer parallel. For the past several years some of the regional bell operating companies (RBOCs) have been involved in various joint ventures with U.S. cable operators overseas. There is no question that both have been doing this in part to learn more about each other's business. Domestically, cable companies have been experimenting with personal communications network (PCN) technology, as well as upgrading networks with fiber and expanded bandwidth.

Fiber upgrades are evolving toward smaller and smaller CATV service areas per fiber node, resulting in architectures that more closely resemble the telephone companies' star networks. Digital transmission (compressed video) on cable systems isn't too far off, and the extra bandwidth in these refurbished hybrid plants will seriously be considered for non-entertainment services such as bypass, data transmission and alternate access. Our evolution in cable TV is making us look a lot like true telecommunications network providers, not just an entertainment delivery service.

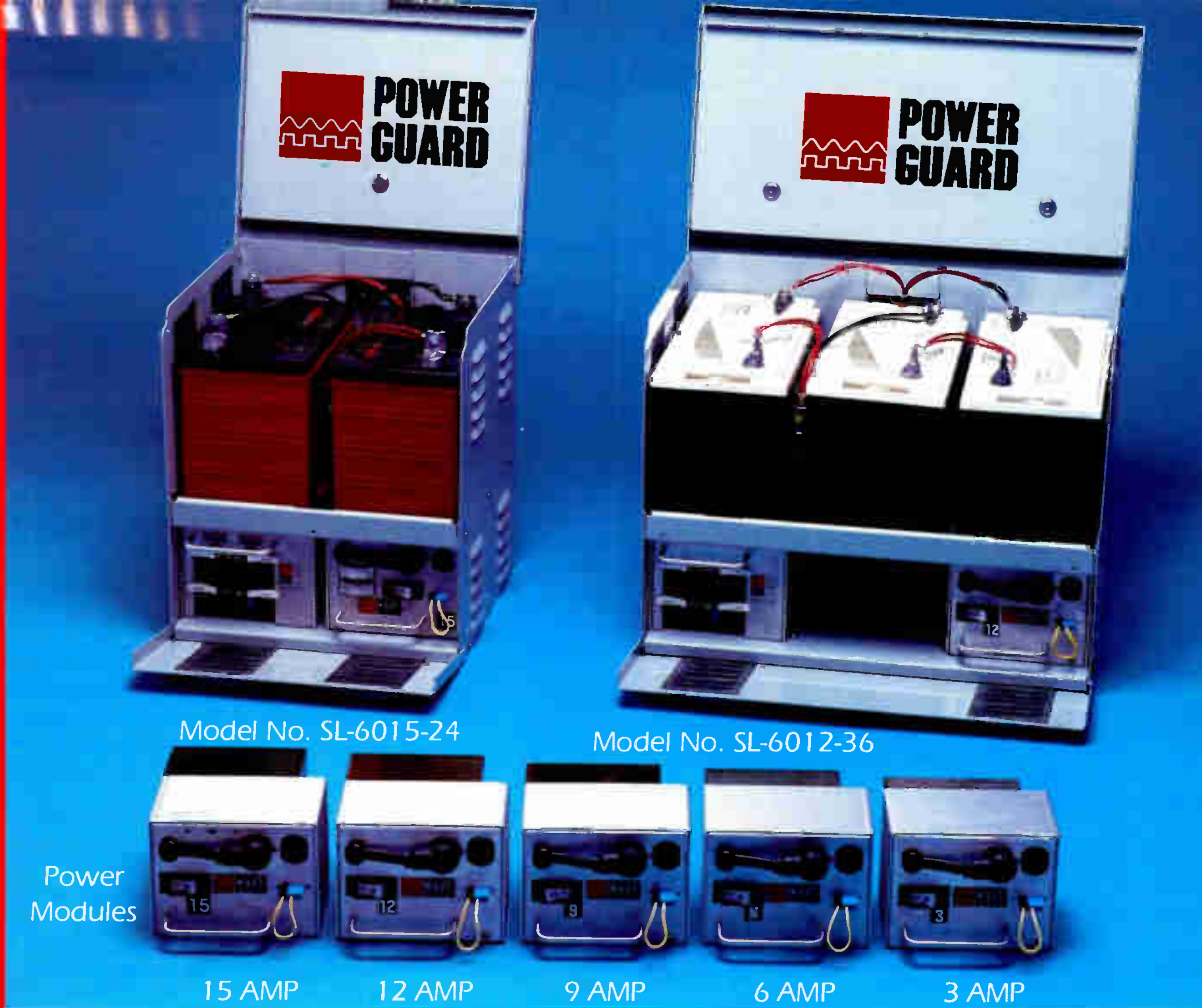
Look at the telco side. The government has given the OK for video dialtone (a decision I feel has accelerated the converging of cable and telephone), and most of the RBOCs are experimenting with ADSL and HDSL technology to allow single-channel VCR-quality video transmission over twisted pair. Couple that with experience being gained abroad (in addition to some of the domestic experiments such as Cerritos and the telco/CATV video-on-demand test in Colorado) and telephone companies begin to resemble cable companies!

I predict that the differences between the two industries will continue to diminish to the point where there is no longer *any* perceived difference by the customer. You want video services? No problem. Either will be able to provide them. How about telecommunication or telephony services? Same answer. One question remains, though. Will cable and telephony be competing or will they become one? It's quite likely that two separate industries will be part of our future.

But let me leave you with this scenario: Why not take the broadband fiber/coax infrastructure of cable and combine it with the switching capabilities and business transaction/billing systems of the telcos (and abandon those inefficient twisted pairs)? Do you think this hasn't been discussed in cable and telco boardrooms alike? Think about it.

Ronald J. Hranac
Senior Technical Editor

Power by Design



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LETTERS

Nyquist who?

In the May 1992 article "Performance of digital modulation methods" by Leo Montreuil and William Wall of Scientific-Atlanta the term "Nyquist filter" was used. While I'm familiar with the Nyquist stability criterion and Nyquist sampling, I've been unable to track down how his name got attached to a response curve.

Roy Trumbull
KRON-TV, San Francisco

Author's response: The filters used in the simulation are raised-cosine filters. These filters are not introducing any intersymbol interference (ISI) while limiting the bandwidth of the signal. These filters are part of a family called Nyquist filters and they meet the following three criteria given by Nyquist: 1) equally spaced axis crossing in the impulse response, 2) equal times between transitions values and 3) preservation of pulses areas.

See the following for more information: 1) H. Nyquist, "Certain Topics in Telegraph Transmission Theory," Transaction AIEE, April 1928, pages 617-644. 2) Bennet and Davy, "Data Trans-mission," McGraw Hill, 1965, pp 53-66.

Leo Montreuil
Staff Engineer, Scientific-Atlanta

The PAC problem

I enjoyed your column on political action committees (PACs), which ran in "Editor's Letter" in *CT's* May 1992 issue. You hit the problem on the nose.

I spent 25 years in the cable TV industry and now enjoy retirement. Any problem we had in Washington, D.C., we earned.

Maynard Poldingborn
Bellvue, Washington

Tech issue: Re-reg

The CATV technical community has not done a very good job of communicating what has occurred in Washington, D.C., this year regarding our industry (re-regulation under H.R 4850/S.R. 12).

The focus of most trade publications and the SCTE Cable-Tec Expo '92 was on the FCC's new technical standards. However, if a presidential veto does not occur or if it is not sustained, many of us will not have to worry about the FCC.

Too many techs and engineers have not written letters to their senators or representatives in opposition to this legislation. Many do not even understand the ramifications of the passage of this legislation. If this legislation becomes law, SCTE will drastically decline in membership. When profits are decreased, the first thing to get cut is training.

This is a call to arms. We must react now. We must flood our congressmen with letters in opposition to this attempt to destroy this industry.

Joe Agostini
Cablevision of Shreveport (La.)

NEWS

House passes re-regulation bill

WASHINGTON, D.C. — A bill similar to a measure passed by the Senate in January to re-regulate the cable TV industry was approved by the House of Representatives. As of press time, the bill was moving slowly toward a joint Senate/House conference committee to iron out differences in the proposals before sending it on to the president.

President Bush's advisers indicated they would recommend a veto, but supporters of the bill said measures to block such "consumer legislation" this year could hurt the president's re-election campaign. As well, both bills passed by enormous margins and could be veto-proof.

The House bill included the following measures: to regulate the amount charged for basic cable; to give regulators the ability to set service standards and reduce existing rates if they are deemed unreasonable; to regulate charges for remote controls, converters and additional outlets; to require equipment be usable with cable-compatible TV sets; to discourage charging viewers for major sports events like the World Series; to prohibit operators from requiring subscribers to buy certain program packages to receive premium channels; and to allow competitors access to programming at non-discriminatory prices.

FCC gives telcos nod for video delivery

WASHINGTON, D.C. — The Federal Communications Commission announced a decision to let telephone companies provide TV signals through telco lines. The telephone video services would only be allowed to provide transmission lines for programming. No creation of programming or denial of access to telco lines would be allowed.

FCC Chairman Alfred Sikes said video dialtone (wherein dozens of video options could be dialed up over the phone) would provide competition to cable TV and that it negates the need for the legislation pending in Congress to re-regulate cable.

In other news, the commission proposed ways to allocate spectrum space for personal communication services.

Cox to test PCS microcell antennas

SAN DIEGO — Cox Enterprises made agreements with Nexus Engineering and Omnipoint Corp. that will allow Cox to test a less expensive deployment of microcell antennas for personal communication systems (PCS) delivered by cable TV.

In this phase of its ongoing PCS experiments, Cox will use its cable system here to test the new remote antenna drivers (RADs) for the U.S. personal computer market, operating in the 1,850-1,990 MHz frequency band. According to Cox, benefits to consumers may include improved reception, lower costs and a faster introduction of service. →

Shelley Ollig

TCI-Boulder's team won the team competition at this year's Colorado Cable-Tec Games. From left to right: Dave Steplsnik, Gene Wheaton, Steve Grimsley and Tom Lockwood (who also won overall individual gold).

Rocky Mountain show hosts Cable-Tec Games

BRECKENRIDGE, Colo. — The Fourth Annual Cable-Tec Games held here at the Rocky Mountain Cable Television Expo resulted in a record-setting performance by one contestant and a new home for the all-around team trophy.

Sponsored by Anixter Cable TV, *Communications Technology*, the Society of Cable Television Engineers Rocky Mountain Chapter, and the cable TV associations of Colorado, New Mexico and Wyoming, the Games have contestants from area cable operators competing against each other in CATV technical events ("Splicing," "Signal Analysis," "Cable Jeopardy," and "Go Fetch.") Tom Lockwood of TCI Cablevision of Boulder, Colo., turned in an unprecedented performance by winning all four events and the overall title. He posted perfect scores in three of the four events and helped take the team trophy away from two-time defending champions, United Artists/TCI Cable of Englewood, Colo. Second place went to Mile High/ATC Cablevision.

Event hosts included Gilbert Engineering and Comm/Scope, Trilithic, National Cable Television Institute and ATC National Training Center. Next year the competition promises to be tougher as competitors will come from New Mexico and Wyoming as well.

☛ The FCC announced several decisions that, according to TV Answer, will pave the way for local interactive video and data services (IVDS) licensees to roll out their interactive TV services to consumers in a logical and consistent pattern. The decisions refined some technical points on system operation, including the attachment of outside antennas to home units, if necessary, and flexible power levels in cell site base stations.

☛ Mile High Cablevision in Denver and Teleport Denver Ltd. announced plans to move forward on a joint downtown telecommunications network. Teleport Denver is installing a high-capacity telecommunications network utilizing Mile Hi's Denver franchise.

☛ Greenwich, Conn.-based Greenwich Technologies was issued a U.S. patent for ownership of a basic system architecture for video-on-demand. According to the company, within 10 years consumers will be able to order a movie or a symphony from an automated library and within moments receive it as a burst of digital data in their homes, where it is stored for playback at their convenience.

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Expo '93: Call for papers

EXTON, Pa. — The Society of Cable Television Engineers is currently seeking proposals for technical papers and/or workshops for Cable-Tec Expo '93, to be held April 21-24, 1993, in Orlando, Fla.

Technical papers that are accepted will be presented at the expo's 17th Annual Engineering Conference. Proposed workshops should accommodate hands-on sessions that will provide attendees with in-depth instruction on technical procedures that are used in everyday practice.

Submissions, which should include a brief abstract of the paper or workshop, should be sent to: Bill Riker, SCTE, 669 Exton Commons, Exton, Pa. 19341, no later than Oct. 1.

For further information, please contact SCTE at (215) 363-6888 or FAX to (215) 363-5898.

Bob Fielder

William Cohn of the SCTE Greater Chicago Chapter shares a suggestion that has worked well with his chapter at the second annual House of Delegates meeting, held at Cable-Tec Expo '92.

Expo '92 hosts membership meetings

SAN ANTONIO, Texas — The Society of Cable Television Engineer's Second Annual House of Delegates meeting was held here at this year's expo. The first House of Delegates meeting was held in Reno, Nev., during Cable-Tec Expo '91.

The purpose of these meetings is to give chapters and meeting groups an opportunity to discuss, as a collective body, new ideas, concerns and successes with the national board of directors, national staff and fellow chapter officers. This

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was such a success in Reno that it has become a permanent part of the expo program. These sessions have produced many good ideas and have helped everyone participating to make SCTE's 73 chapters and meeting groups the best they can be.

The number of groups attending the meeting represents just over half of the Society's total chapters and meeting groups. A number of the representatives came with a list of questions and comments from their local board of directors and membership.

Local group finances was a recurring topic throughout the discussions. Most of the chapters and meeting groups are doing well in managing their budgets, but with some difficulty and much work. One of the best ways to raise revenue is continued membership growth and several groups shared successful promotional ideas.

The topic that came up in discussions more than anything else was the Broadband Communications Technician/Engineer (BCT/E) Program. Discussion among the representatives in attendance revolved around when, where and how the testing sessions are held.

Another area of the BCT/E Program that was discussed is the availability of bibliographic resource material. Most groups are looking for ways to make all of the reference material available to their members. Some have polled members asking what materials they own or have available at their offices, compiled a comprehensive list of this material and circulated it among the members, making the references available to each member. The other method mentioned is asking each cable company office to donate a reference to the group. These are then held in a chapter "library" or other central area where members can check out and use the material.

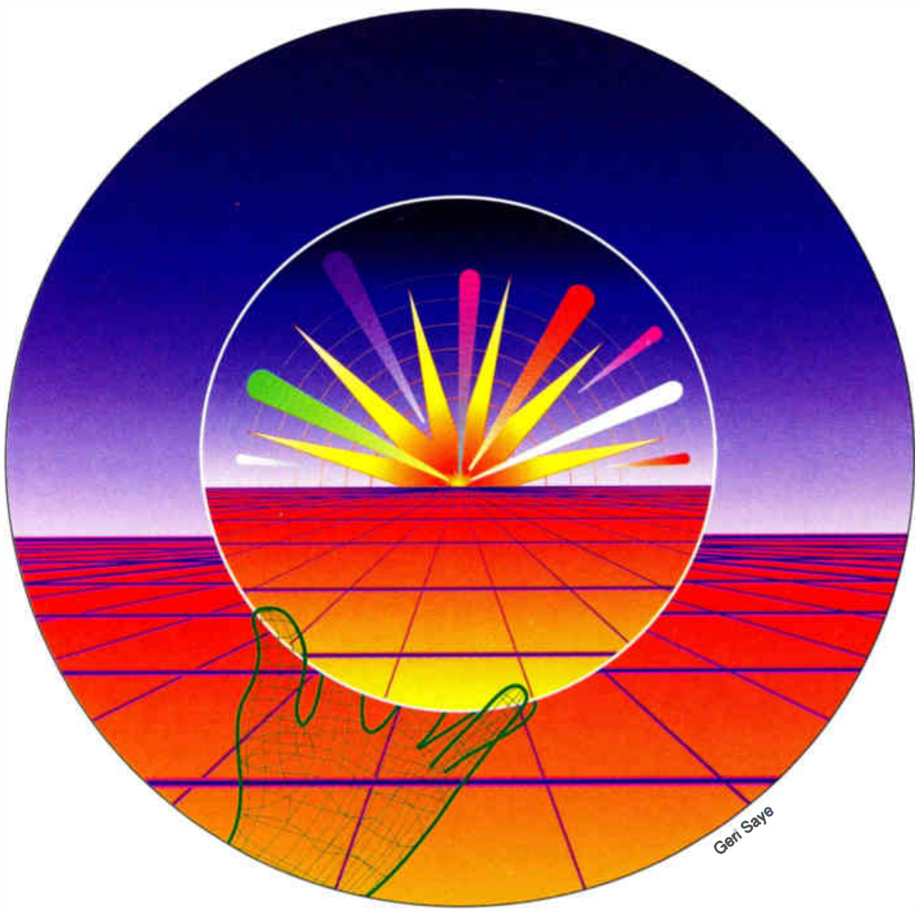
The representatives requested that SCTE compile BCT/E references and study material. This was not only the wish of the local groups but of the national board of directors as well. It was formalized into an objective for the Society at a recent board meeting. The first phase of this project is underway. Much of the material listed in the bibliographies of each of the categories is being compiled into one resource book that will soon be available through national headquarters. This is the first time the Society has done this, and it promises to be a very useful addition to the BCT/E Program. As well, SCTE is planning the development of study books specific to each category.

The Society also held its Annual Membership Meeting June 14 in San Antonio. During the meeting, a request was made to look into the possibility of adopting a membership pin that would include BCT/E certification. The SCTE staff is researching the design and manufacturing of such a pin.

Comments were made by members regarding the videotapes offered by the Society, both general training programs and BCT/E tutorials. The Society has reviewed the first 20 training tapes listed in its catalog. SCTE has just completed the production of an outstanding tutorial for Category VII, which was funded by Cable Television Laboratories and is available to SCTE members for only \$18. This is a high-quality tape that uses scenarios from the previous Category VII tests and will prove helpful to anyone preparing to take the new exams at either level. In addition, a meeting was held at the expo with the manufacturers of signal level meters to make a new, generic videotape about the various types of meters, their care and use. SCTE will continue to work for the early completion of this project. **CT**

Reader Service Number 21

Considerations for 1 GHz potential upgrades



By Jay Vaughan
Senior Project Engineer
American Television & Communications Corp.

System operators are faced with numerous franchise renewals in the next several years. Personal communication networks, high definition TV and many channel pay-per-view (or video-on-demand) are some of the potential uses for a 1 GHz or expanded bandwidth system. The potential revenue streams from any of these services are still unclear. Operators have been cautious in formulating system upgrade strategies to be implemented as part of the franchise renewal process.

This article discusses several of the upgrade concepts whose objective is to define a clear evolutionary path to 1 GHz system bandwidth in the future. For the purpose of discussion, the upgrade to 550 MHz (or 450 MHz) that meets immediate plant requirements (i.e., the upgrade that would commence in the next 12-24 months) is referred to as "today's" upgrade. A subsequent plan to increase the system bandwidth from 550 MHz to 1 GHz is referred to as the "future upgrade."

The key to the 1 GHz "potential" approach

The key to a cost-effective upgrade to 1 GHz in the future is to design small coaxial service areas around the node today as part of the 550 MHz upgrade. In the approaches discussed here, the fiber nodes installed as part of today's upgrade represent all the nodes required for the future upgrade to 1 GHz. That is, the node locations and corresponding coaxial service areas are defined today to allow a 1 GHz upgrade in the future. This typically results in three to six miles of coaxial plant (250-800 homes passed) served by each of the fiber nodes. The small service area radius, crucial to a 1 GHz upgrade, facilitates future data and telecommunications service offerings.

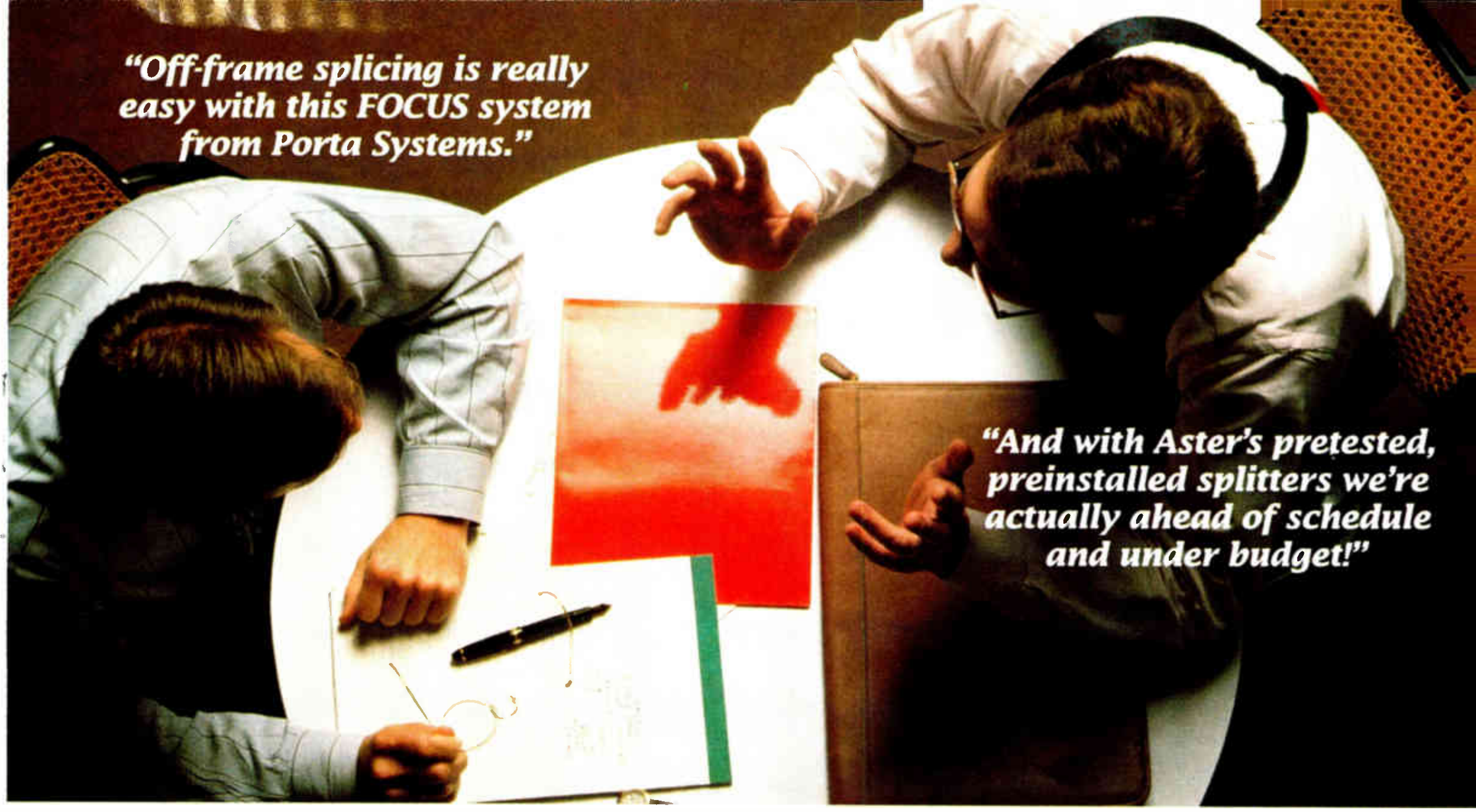
The neutral network concept is a different approach to allow future system flexibility. This approach creates a "structured" coaxial plant, making it easy to relocate the fiber nodes in the coaxial plant in the future should more nodes and/or shorter cascades be required. In contrast, the "1 GHz potential" approaches fix the location of the nodes permanently, while the coaxial portion of the plant is allowed to evolve over time as required.

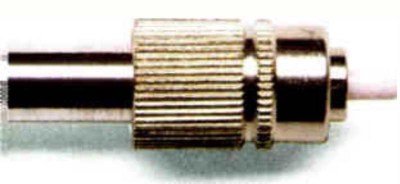
Several possible scenarios

Four of the possible "1 GHz" scenarios will be compared. How the coaxial portion of the plant is treated today differs in each approach. In the *1 GHz active* case, the coaxial portion of the plant is upgraded to 1 GHz operational. In the *low-cost 550 MHz* scenario, while the fiber and associated node are installed for the 1 GHz system, significant additional work would be required in the future to upgrade the coaxial portion of the plant. For the purpose of this discussion, the strategies can be defined as follows:

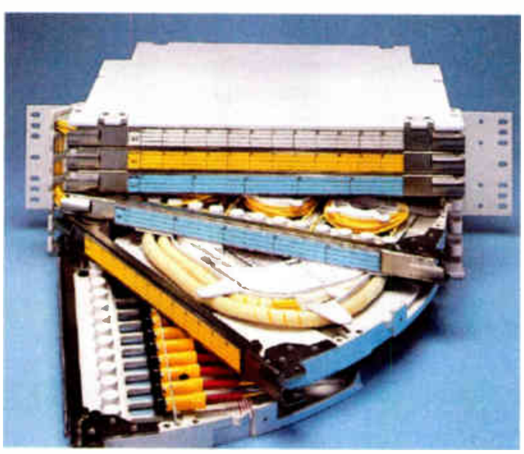
- *1 GHz active plant* — In this approach, all the necessary fiber equipment, amplifiers, passives and express cable are installed to allow 1 GHz operation from the onset. Amplifier performance is assumed to be that available today. Tap output levels used in the plant design are those necessary to support conventional set-top converters in the home.
- *1 GHz ready 550 MHz plant* — In this scenario, the plant has been designed for 1 GHz operation using amplifier performance data that is anticipated to be possible in the next 12-18 months. Tap output levels at 1 GHz are high enough to support existing set-top converters. The upgrade construction is identical to that described in the *1 GHz active plant* approach, except that the 550-1,000 MHz band optical transmitter and detector modules have been deferred. While amplifiers are installed in

(Continued on page 38)





At Porta Systems, our focus is on developing products that solve real problems in the field — like the splice tray insert of the FOCUS™ system that unspools up to five feet from the frame to provide the craftsperson easy access. And FOCUS trays that are supplied fully equipped with tested couplers, WDMs, and angle polish connectors, resulting in installation savings and improved system integrity. For your convenience, Porta Systems is your "one-stop shop" for fiber optic products and support required for even the most ambitious CATV applications.



Here's what they're saying about Porta Systems' fiber optic products:

Universal Housings. Since no two installations have exactly the same requirements, Porta Systems' FOCUS housings offer modularity, so you can put the functions you need right where you need them. One housing can accommodate spliced fibers, couplers, and pigtails, doing the job of two or three dedicated housings.

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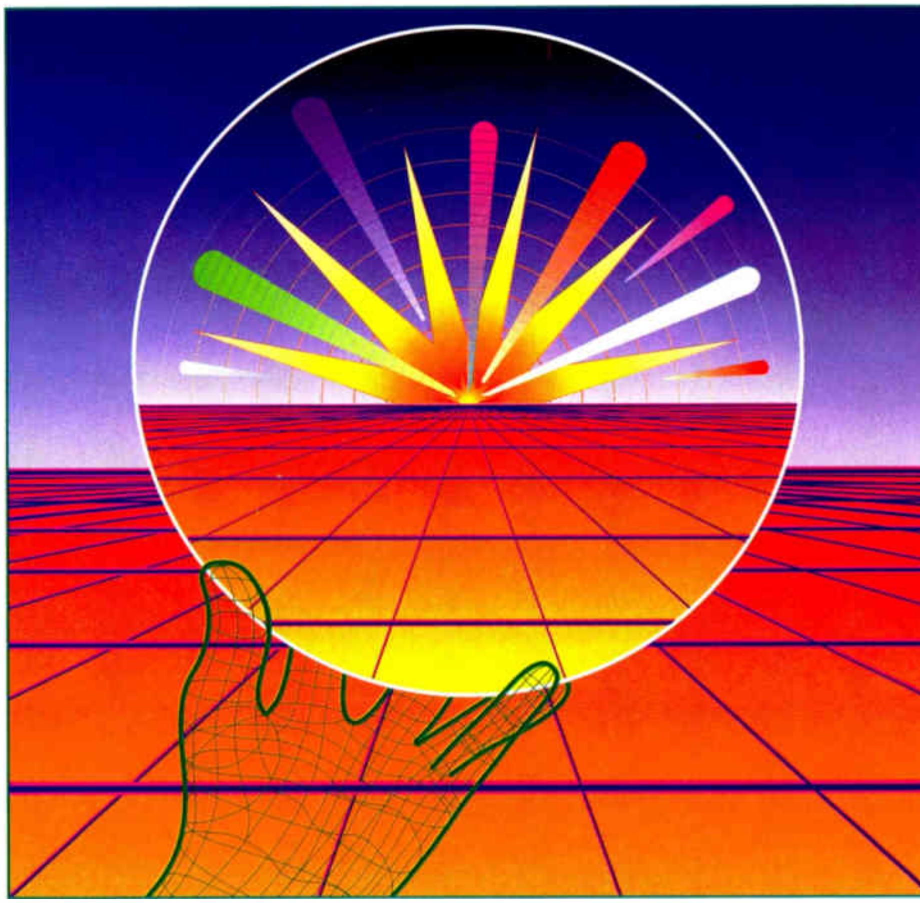
Reader Service Number 73

The steps to 150+ channels with 1 GHz

By Colin J. Horton
Product Manager, C-COR Electronics Inc.



Geri Saye

The cable TV industry is faced with a number of opportunities over the next few years. The horizon reflects a multitude of video services available to the home. In addition, cable TV operators are looking for new revenue sources to continue growth stimulation. Employing 1 GHz or 150 channels of information capacity offers an opportunity to add new revenue sources and positions cable systems for future competition.

While the concept of using 150 channels may not seem real now, it is quite conceivable that with video-on-demand services, for example, a 1 GHz bandwidth with compression would yield a system with hundreds of channels. Figure 1 shows how a 1 GHz system channel lineup might look. Channel capacity can be achieved with extended bandwidth or compression, or with a combination of the two. These technologies are not mutually exclusive, rather they are complementary. The combination of the two can create a very large channel capacity capable of supporting the future service opportunities that will be available during this decade.

When considering compression or extended bandwidth, the goal is to maximize the future growth of a CATV system while minimizing the required capital investment. To build extended bandwidth systems, there are a number of considerations that must be addressed.

Design technique and architecture

This is the most critical component of an extended bandwidth system, because without it the practicality of an extended bandwidth system is significantly reduced. Over the last five years considerable work has been done in designing CATV systems for transition to extended bandwidth from 550 MHz. The design of fiber-based CATV systems can be divided into two sections:

1) Trunk design architecture. A recently developed technique, neutral networking (developed by Adelphia Cable), allows the express feeder or trunk portion of a fiber-based system to be designed for easy addition of more fiber. This approach allows a graceful upgrade to extended bandwidth to occur when the demand justifies it.[1] This design approach not only allows the system to gracefully evolve to utilize more fiber, but is also an extremely efficient and cost-effective design planning tool.

2) Feeder design architecture. Rogers Cablesystems in Canada has been designing all of its aerial feeder plant to be upgradable from 550 MHz to 1 GHz using amplifier technology capable of carrying 150 channels. This architecture is called superdistribution. The main feature is that high output level line extender amplifiers are not cascaded (as in conventional feeder); a relatively low output level amplifier is cascaded and a pair of high output level amplifiers are used to feed taps in a manner similar to current trunk and feeder designs. Figure 2 shows conventional and superdistribution feeder designs at 550 MHz and 1 GHz.

The superdistribution design requires amplifiers with less output capacity at 1 GHz than the conventional feeder design,[2] making upgrades to 1 GHz in the near future a real possibility.

Coaxial cable

Most coaxial cable, both hardline and drop, is capable of carrying bandwidths greater than 1 GHz. Existing cables (especially the drops) can be left in place if they have foam or other later type dielectric materials. New cables can be purchased that are tested to 1 GHz.

Passives and directional taps

Main line and in-home passives do have to pass up to 1 GHz. Tap units also must pass 1 GHz. Main line passives and tap units that will pass signals up to 1 GHz are being used by many MSOs in 550 MHz designs as "insurance."[3] Because no amplifiers are fed from taps in the superdistribution architecture, non-power passing taps can be used.

Figure 1: Channel lineup for 1 GHz system

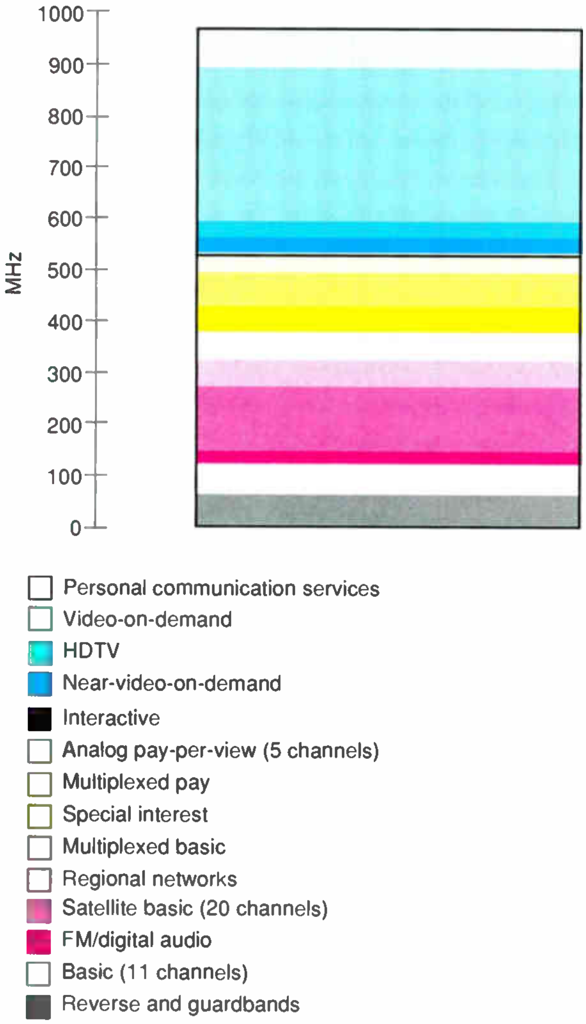
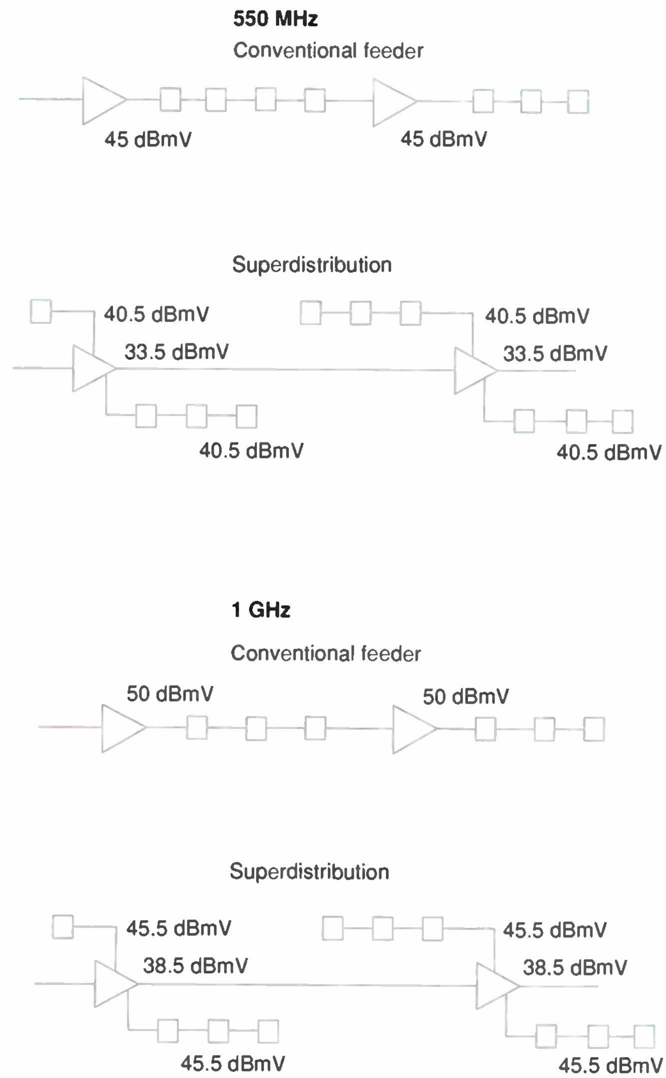


Figure 2: Feeder designs



RF amplifiers

Amplifiers for a 1 GHz system must fulfill two main requirements: they must pass signals to 1 GHz, and they must have the output capability (the ability of a RF amplifier to operate with low distortion such as composite triple beat) to carry 150 channels. Compression could reduce the output capability requirements of a RF amplifier in a 1 GHz system. However, it is prudent to assume that the amplifiers must operate with a 150-channel loading. The amplifier also must have the active output configuration necessary to support the superdistribution feeder architecture. (See Figure 3 on page 46.)

Connectors

Both hardline and drop cable connectors must be designed for 1 GHz operation. Most installed hardline connectors should be replaced for 1 GHz operation and would be in a rebuild or upgrade situation.

Fiber

Fiber provides the strategic connections to the RF plant that allows reasonable 1 GHz performance to be achieved and segments the system to allow the implementation of video-on-demand. Fiber-optic systems for 1 GHz can require three fibers for complete carriage of 150 channels. When designing a fiber network, it is important that enough fibers be used so that there is room for two-way operation and for spares. A typical fiber count per receiver would be six.

Converters

Set-top converters capable of tuning 150 channels are required. On-screen menus would make selection of programming easy. When compression to the home becomes viable, decompression devices will have to be installed in the home to provide access to the additional channels.

Going for it today

If an operator wanted to build a 1 GHz system today (and some do), all of the equipment previously mentioned is available now. Compression over RF and in-home decompression devices are not yet available, although they are expected to be over the next couple of years. In reality, not all operators are prepared to build 1 GHz systems today, but no operator can afford not to take insurance and build for the future.

If systems are being upgraded or rebuilt to 550 MHz, ap-

(Continued on page 46)

Upgrades: Putting the pieces together

By John Tinberg
Director of Research and Development
Quality RF Services

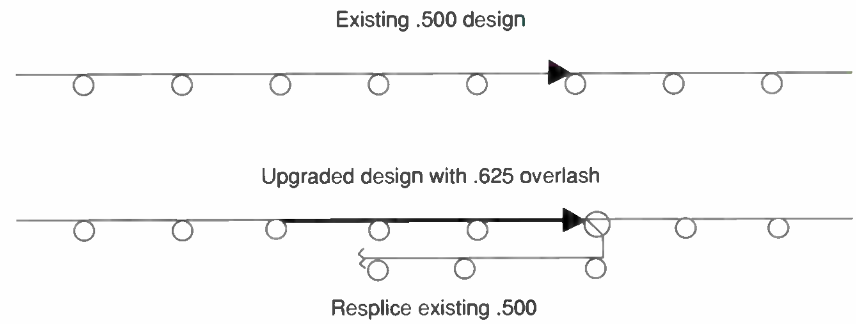


Figure 1

Today, the cable TV industry is facing continual demands for change. Articles appear on upgrading bandwidth, expanding system channel loading and, most important to us all, enhancing overall reliability. All of this is possible without total system rebuild, as you by now already know. With today's financial and regulatory issues upon us, the funds are not always abundantly available in order to allow us access to every available resource.

Certainly fiber is one of the most important resources of the 1990s. This technology now opens the door to many more service possibilities, some of which are still on paper. With strategically placed "nodes," our dreams of cascade reductions can be finally met. Even though the glass technology is here, all things must return to copper, wherein lies our continuing quest to improve the performance of this portion of plant. It is time to devote our energies to the most efficient means of coaxial improvement. It can be done by means of reprogramming the system by drop-in replacement modules or through existing module hybrid replacement. That is, if we can fit all of the pieces together.

Coaxial condition

The majority of the coaxial plant is quite capable of performing at much higher frequencies than we realize, and most often quite well. What must be looked for is the present condition of the trunk and feeder cables. Throughout the years much controversy has been expressed on the subject of properly formed expansion loops. If the cable was originally treated well at the time of installation and was carefully lashed or buried, then you may have a good shot at some surprisingly good numbers.

Aside from radial cracks, damaged passives and poorly made connectors, the final conclusion drawn from a technical staff is that some spans are just high loss ones (even at the existing bandwidth). Be assured there is indeed an explanation for this: impedances have changed. Historically, what has been found is corrosion on the center conductor's skin or, without you realizing it, the center conductor has "wandered" from the exact center of the dielectric material. The latter has been the most predominant, due to earlier manufacturing without center conductor/dielectric bonding or, additionally, to tightly bent loops or "pull-ups." Not to place the entire blame on the initial crews; it has been found in a trenched cable lying for years without any bends whatsoever.

Keeping this in mind, adjust your test methods to sense changes in the characteristic impedance of the coax. In other words, base your initial examinations around return loss testing of the system to be upgraded. Very few TDRs exist that will accurately illustrate these subtle reactions to changes in impedances.

Plan a program whereby you will record return loss by photograph or printout, with a 10 percent sampling of both the trunk and feeder system return loss. The selection of the spans should be as random as possible. If you allow the technical staff to select which spans to test, you will most likely find a weighted result. Have a front office employee (or an outside person unfamiliar with the system condition) sift through the prints and run a highlighter pen through the spans to be tested.

Now arm yourself with a sweep system and variable return loss bridge that will allow you to perform this. In the case of a feeder, you may want to disconnect individual tap-to-tap spans randomly until you can evaluate the tap passives. Because this involves disruption of service, early morning scheduling is advised.

Here comes the hardest part of this exercise: what to fail and pass. By now you must know the game plan for which you will base the upcoming decision. If you are infusing a fiber plan into the cable system, you may relax the return loss criteria or findings slightly because of the cascade reductions. If you will be continuing to operate a lengthy cascade for a long period of time, be more critical. The original rule of thumb for return loss acceptance in cable was the loss one way plus 16 dB. However, if the re-

(Continued on page 50)

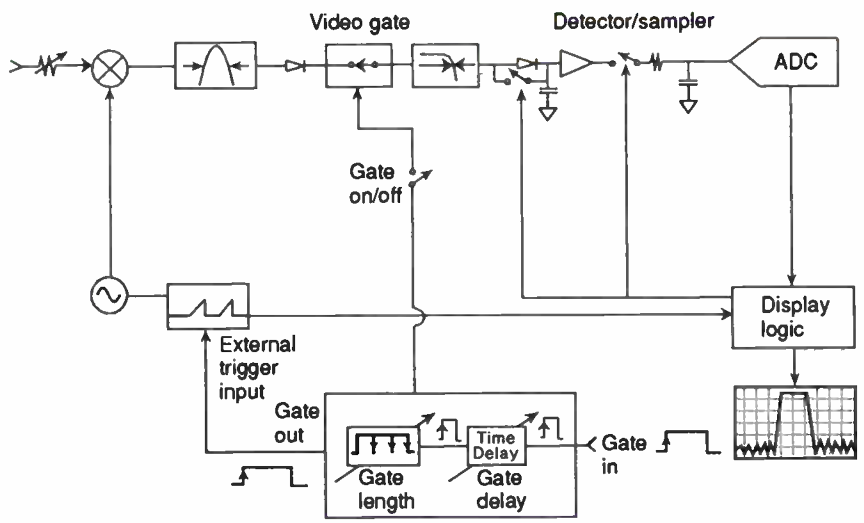
Time-selective spectrum analysis: Non-intrusive analysis of a cable system

This article was updated from a paper presented at the National Cable Television Association's 1992 convention.

By Francis M. Edgington
Development Engineer, Hewlett-Packard Co.

Numerous carriers with varied modulation types, a crowded frequency spectrum and the demand for better signal quality requires high dynamic range measurements be made on operating systems *without* interruption of service. Large systems comprised of many different function blocks also complicate the question of "where did the signal go bad?" The ability to view a signal's spectrum, at a specific instant in time, in the presence of modulation is key to the non-intrusive diagnosis of cable system problems.

Figure 1: A video time gate



What TSSA is

The time-selective signal analysis (TSSA) technique involves choosing when to trigger within a specific modulation type, selectively capturing data, and revealing its frequency-domain characteristics. TSSA's operation is analogous to the stroboscopic effect seen in movies of a wagon wheel appearing to be stopped when its rotational speed, relative to the film's frame rate, is synchronized.

This synchronization and data-taking sequence will be applied to the following examples, each without the need to remove modulation:

1) The vertical interval reference signal to determine the intermodulation product between the visual, audio and color subcarrier.

2) A quiet line of video to find composite second order (CSO) intermodulation products, amplitude modulated link (AML)-generated intermodulation products and in-band noise.

3) The multiburst test signal to test for in-channel flatness.

4) A synchronizing pulse to measure sync level bandwidth.

TSSA is not new. Radar uses timed return signal analysis for range determination. TDRs use a timed return pulse for computing distance to a fault. Some network analyzers use time and frequency-domain reflectometry.

Application of time-selective signal analysis to cable TV was shown in 1983 by John Huff. He developed external circuitry for timing control and used z-axis modulation on a spectrum analyzer. Huff has used TSSA techniques since 1970 to do cable TV system proofs. Manufacturers have not used the technique until recently. Now, it is proving to be an excellent way to isolate and view certain types of impairments.

"Time gating allows you to examine in-band noise, intermods and bandwidth non-intrusively at any location within the RF chain."

Today's use of TSSA includes: testing advanced digital communications formats (such as time-division multiple access); isolation and measurement of individual transmitter, processor or modulator characteristics; and testing disk drive sector quality and assessment of individual VCR video head quality. Signals that have more than one contributor to the spectrum or have a timed sequence of modulation, make TSSA mandatory for determination of system parameters.

The block diagram of a swept-tuned, triple-converted spectrum analyzer (Figure 1) is simplified to one downconverter for ease of explanation. The blocks we will be concerned with are: the adjustable bandpass filter or resolution bandwidth filter (RBW) that is part of the intermediate frequency (21.4 MHz) signal path section; the adjustable post detector bandwidth, or video bandwidth filter (VBW); and the video gate, which is located between the detector and video bandwidth filter.

Digital signal processing methods

Digital signal processing can be performed in a number of different ways. One approach would be to take a continuous stream of data and later laboriously search the data for the specific impairment of interest. This also requires a relatively large data memory, especially for low repetition rate signals. It also requires specialized firmware processing for the characteristics desired.

A second approach would be to start and stop an analyzer's sweeping to acquire data only during a desired time period. This is limited, however, by how quickly and accurately the sweep can be started and stopped.

A third approach would be to take data continuously and zero out the undesired data, thus leaving only the desired data displayed. While this places the burden of configuring the analyzer for a particular measurement on the user, it is the most flexible for developing new measurements. This is the approach taken for video time-gated spectrum analyzers.

Gated measurements are limited by the spectrum analyzer's processing blocks and the modulation burst lengths. Selecting the appropriate modulation sequence for analysis, as in a vertical interval test signal, allows the operator to concentrate on the receiver's characteristics: resolution bandwidth (RBW) settling time, video bandwidth (VBW) settling time, sweep time for the displayed frequency span, span/RBW ratio, and gate timing resolution.

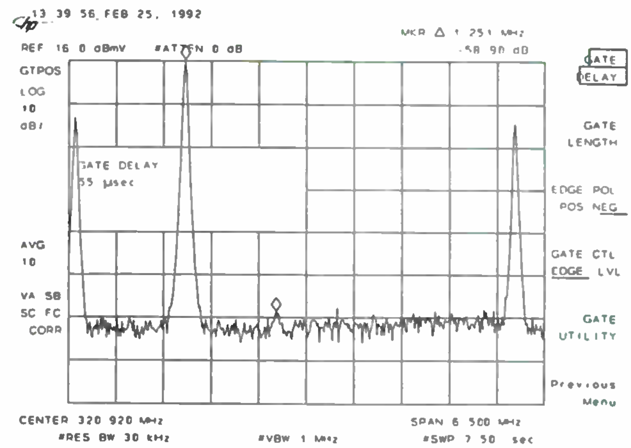
RBW setting guidelines are: gate delay > 2/RBW to exclude its transient response when on the filter skirt; and RBW > 2/pulse modulation on time to get the amplitude maximum or minimum accurately.

Note that the RBW setting also establishes the noise floor for the measurement. The resolution bandwidth filters appear before the gate in the block diagram, so they are subject to all modulation coming into the analyzer. The pulse rise and decay times are limited by RBW setting. The modulation pulse width (time) may dictate the RBW setting to capture the amplitude accurately. These times are meant to cover worst-case situations of pulse modulation and production tolerances of the analyzer to obtain the best accuracy. Reduction of these times may be in order depending on the specific situation. The dynamic range of the measurement is controlled by the signal level, the RBW and augmented by correction algorithms used.

The video bandwidth setting guideline is VBW > 1/gate length minimum. The video filters appear after the gate in the block diagram and therefore cannot be used for post-detector filtering in the example measurements. To prevent measured amplitude degradation, the filter must rise from zero to its final value during the gate length time. A low-pass filter bandwidth is half that of a bandpass filter bandwidth. Therefore, to not degrade the system bandwidth, the video filter bandwidth should be even wider than the minimum for situations where RBW selection is less than optimum.

A sweep time greater than 401/signal repetition frequency is needed for complete data acquisition. Video averaging increases measurement acquisition time also. There are 401 segments, or "buckets," on the x-axis of the display of the

Figure 2



spectrum analyzer used for this article. We must make sure that we get at least one burst per bucket. If this is not the case there will be dropouts, or zero values, in some of the trace elements. Video averaging improves the accuracy of the noise floor measurement at the expense of measurement acquisition time.

Span/RBW ratio is important in order not to miss the desired signal. A ratio of 40 is needed for 0.1 dB accuracy (40 x 300 kHz RBW = 12 MHz span), and a ratio of 120 is needed for 1 dB accuracy.

Unfortunately, we don't know where the gate pulse will occur in relationship to the RBW. However, we can ensure that one-half the RBW's width for a desired amplitude error is on the order of the bucket size. Since there are 401 buckets on the x-axis, each bucket must be less than half the RBW's width for the worst-case error allowed.

Gate delay has 1 µs resolution and a range from 1 µs to 65.5 ms with ±1 µs accuracy. Gate length has 1 µs resolution, and a range from 1 µs to 65.5 ms. These are determined by the clock frequency used and length of counters following the clock, as well as the synchronism of the gate input in relation to the clock.

Measurement, computational review

A review of measurement and computational techniques also will be helpful. These include bandpass filter/preamp usage, composite distortion generation, attenuator test, noise-near-noise calculation, distortion-near-noise calculation, and adjacent signals vs. RBW.

A bandpass filter and preamp are sometimes used to ensure the spectrum analyzer doesn't add distortion and noise to the measurement. A low-noise preamp can be used to bring system noise at least 10 dB above the analyzer's noise, so an accurate system noise level can be measured. A bandpass filter limits signals and, therefore, total power into the preamp and analyzer. This ensures minimum test instrument-generated distortion. Unfortunately, this adds extra hardware and manual control complications. A spectrum analyzer's noise figure, second and third order distortion levels may not be good enough to make carrier-to-noise, composite triple beat (CTB) and CSO measurements without error unless careful control of first mixer input power is practiced. External hardware is less desir-

(Continued on page 58)

To sweep or not to sweep

By Syd Fluck
President, CaLan Inc.

With much of the modern cable TV system performance centered on fiber optics, power doubling and feedforward amplifiers, and reducing the cascade lengths, a fourth parameter all too often is overlooked in attempting to obtain better system performance — sweeping.

The distortions produced in a system by a single amplifier must be modified by the following four basic factors in order to determine the overall system performance: 1) system operating levels, 2) system channel loading, 3) system cascade number and 4) system frequency response.

Normally, the foregoing considerations regarding the degradation of system performance are taken into account at the initial design stage. As a practical matter, the system response deteriorates as a function of time and must be routinely maintained in order to protect the integrity of the system performance.

Some history

In 1972, while working for what was then called Jerrold Electronics Corp., I was issued a U.S. patent for a simultaneous sweep testing system for CATV. The system was referred to as the "sleep saver" by the first engineers and technicians who used it because prior to the invention, sweep balancing was done with conventional bench equipment late at night with system carriers off. The simultaneous sweep allowed scheduled daytime maintenance procedures to be employed and operators gained improved insight on the performance of their systems.

Today's peace of mind

Modern technology has allowed instrument functionality and sophistication to eclipse that first invention. However, if you are responsible for maintaining a broadband system you will still sleep better knowing that the system is healthy and performing within specified technical requirements.

Over the years, one of the most reliable methods to establish the health of a broadband system has been through frequency response measurement.

Utilizing current microprocessor and surface-mount technologies, modern test and measurement equipment can provide operators with sweep frequency response by tracking a programmable sweep generator with a portable spectrum analyzer. The resulting response can be displayed normalized to a selected reference location (typically the headend or first amplifier).

Instrument manufacturers accomplish this in different ways. Some require time synchronization of the sweep output frequency with each particular TV channel (to minimize interfering with that channel) while others use the programmability to place and track the sweep output frequency in specific locations within the band.

Head room

At any given location in a broadband system, the frequency response (peak-to-valley) will allow the maintenance person to determine the head room at that location. See Figure 1. The sweep response test is most important in evaluating the actual operating performance compared to the tolerance allocated in the initial design.

Head room is the relationship between the peak-to-valley of the frequency response and the system tolerance at that location. (Credit goes to Ken Simons for teaching us early on about system tolerance relative to distortion and noise.) The relationship among head room, system tolerance and sweep response is that one can calculate the system tolerance at a desired performance for any system location, then do a sweep response test, with the difference being head room.

System tolerance is: $T_S = T_1 - 2C$

Where:
T_1 = tolerance of a single amplifier ($S_{max\,1} - S_{min\,1}$)
C = cascade factor (3 dB per double)

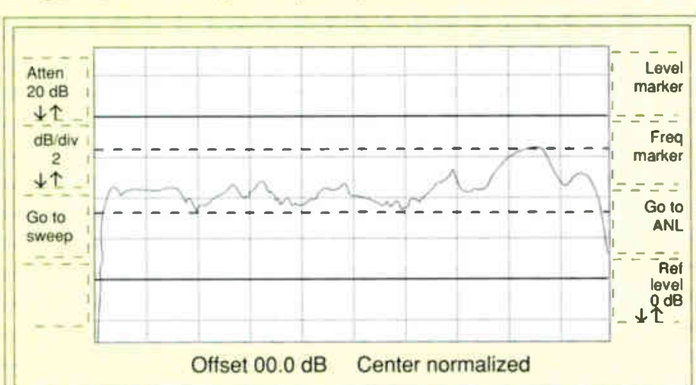
That is, for a two-amplifier cascade, C = 3 dB. For a four-amplifier cascade, C = 6 dB. For a 10-amplifier cascade, C = 10 dB. For a 20-amplifier cascade, C = 13 dB.

In terms of system levels:

System maximum output = $S_{max} = S_{max\,1} - C$
System minimum output = $S_{min} = -59 + G_a + F_a + C + R_{min}$

Where:
$S_{max\,1}$ = maximum output of a single amplifier for a specified cross-modulation (X-mod) or third order distortion
G_a = gain of a single amplifier
F_a = noise figure of a single amplifier
R_{min} = minimum acceptable carrier-to-noise ratio (C/N) expressed in dB

Figure 1: Frequency response measurement



As an example, refer to Figure 2 on page 66. Operating design parameters were selected as follows:

C/N required = 43 dB
Gain per amplifier = 22 dB, NF = 8 dB
$S_{max\,1}$ = 48 dBmV for - 66 dB X-mod
$S_{min\,1}$ = -59 dBmV + (22 + 8 + 0 + 43) dBmV
First amplifier C = 0
$S_{min\,1}$ = 73 - 59 = 14 dBmV
T_1 = 48 - 14 = 34 dB

(Continued on page 66)

Figure 8: DOM of all channels measured on one cable system

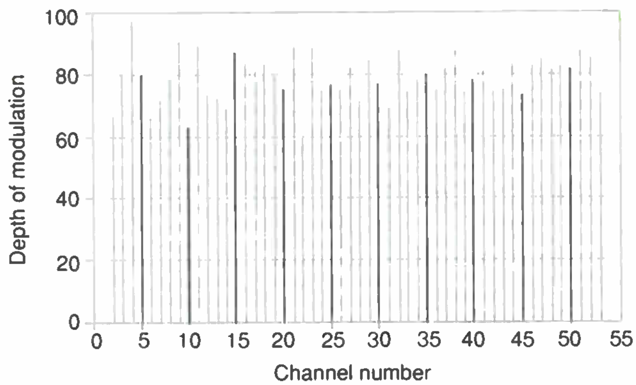
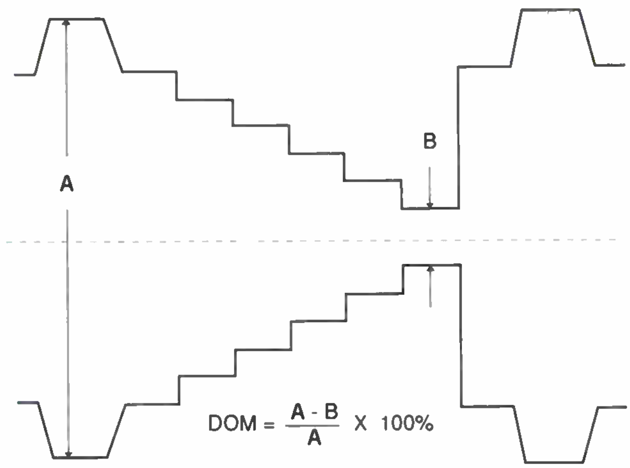


Figure 9: DOM of a video carrier



Measuring and evaluating video signals in the headend — Part 2

The following is adapted from a paper that ran in the "1992 NCTA Technical Papers." Part 1, which was in the August issue of "Communications Technology," covered measurement test techniques and obtaining test waveforms. This part covers impairments.

By Blair Schodowski
Senior Staff Engineer
And James O. Farmer
Division Technical Manager
Scientific-Atlanta Inc.

As you'll recall from Part 1 of this article, the National Cable Television Association and the cities agreed to a set of basic measurements to be made on video signals. While not specified in the agreement, video depth of modulation (DOM) is a most important parameter and we have found that some systems are not good about maintaining it. Low DOM will cause pictures to look dark, and can sometimes cause sync circuits to work poorly. With some scrambling systems, incorrect DOM will cause even more severe problems.

Figure 10: Relationship between video level and carrier

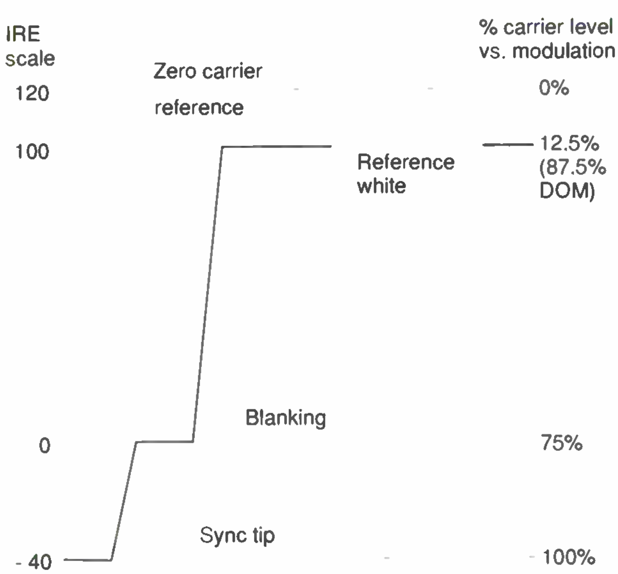
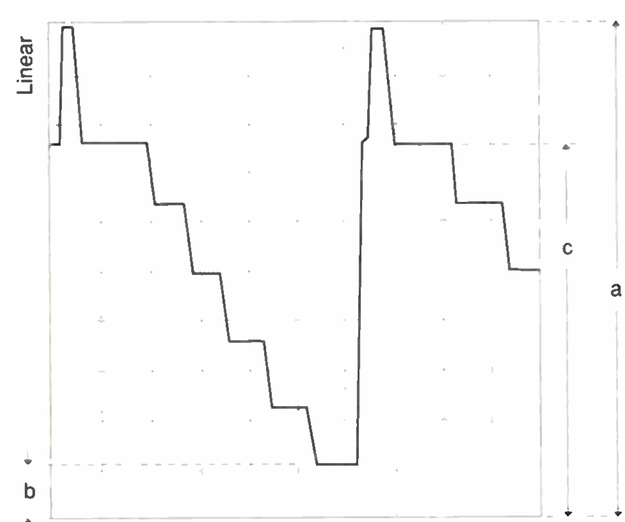


Figure 11: Measurement of DOM using spectrum analyzer

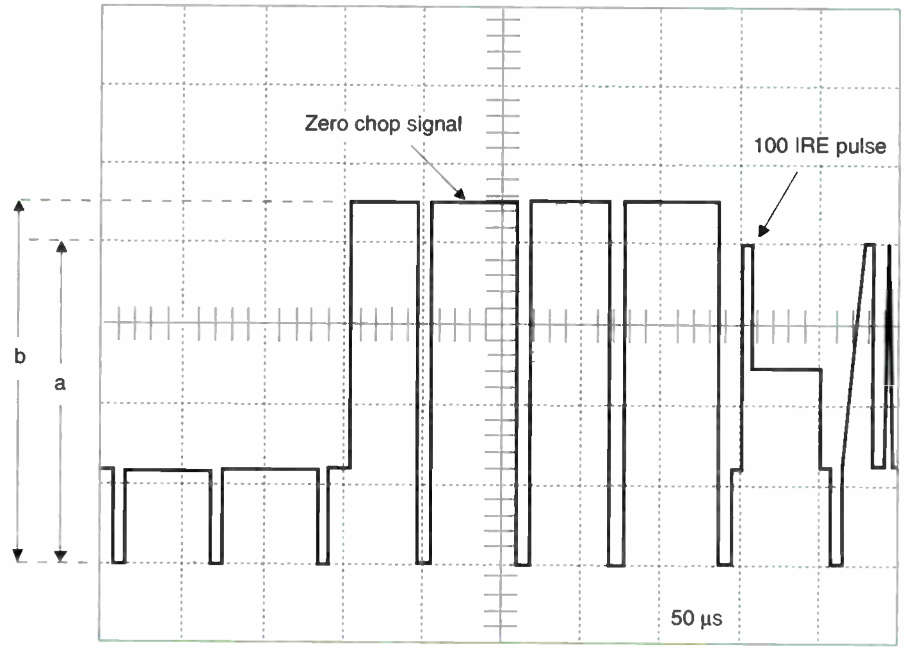


High DOM will cause light areas of the picture to wash out, and will cause an audio buzz in some TV sets.

The Federal Communications Commission specifies that DOM should be set to 87.5 percent for optimum picture quality. One would expect that the DOM on the majority of channels would be close. However, this turned out not to be true at two cable systems measured. Figure 8 shows the result of DOM measured on one of the cable systems. The system offered 53 channels. The average DOM of all 53 channels measured was 81 percent. The lowest DOM measured was 65 percent and the highest DOM measured was 94 percent. The standard deviation was 6.5 percent. It was interesting to note that even on several of the premium channels, DOM was below 80 percent.

DOM is a measurement of percent modulation. It is the ratio of an RF carrier's amplitude change during peak white modulation, to the maximum amplitude. Figure 9 illustrates DOM of a video modulated carrier.

Figure 12: Zero chop pulse produced by a demodulator



In an NTSC video system, peak carrier is reached during the sync tips, -40 IRE. During this time 100 percent of the video carrier is transmitted. Horizontal and vertical blanking, 0 IRE, result in 75 percent of the RF carrier being transmitted. White level, 100 IRE, produces 12.5 percent of the available video carrier. Figure 10 illustrates the NTSC DOM.

DOM measurement methods

The three most common methods for measuring DOM are: 1) spectrum analyzer, 2) demodulator with zero chop and 3) calibrated video demodulator. The method one uses is primarily a function of available equipment, knowledge of measurement technique or personal preference.

Spectrum analyzer

Depending on the type of analyzer used, analog or digital, there are several variations and limitations regarding the spectrum analyzer's settings. With an analog spectrum analyzer, DOM can be monitored either at a video field rate or horizontal line rate. With a digital spectrum analyzer, DOM becomes very difficult to monitor at video line rates. Regardless of the type of analyzer used, the spectrum analyzer must have an RF bandwidth of at least 300 kHz, zero frequency span capability and a linear display scale mode or calibrated decibel vertical axis. Video triggering also is required if sweeping at a horizontal line rate.

To measure DOM:

1) Connect the modulated RF or IF output from the modulator under test to the spectrum analyzer's input.
2a) Configure the analog spectrum analyzer as follows for displaying a full video field: →

Figure 13: Zero chop display

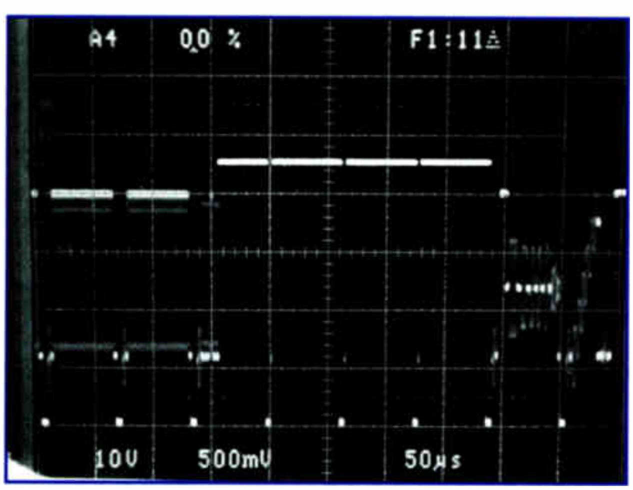


Figure 14: Calibrated demodulator setup

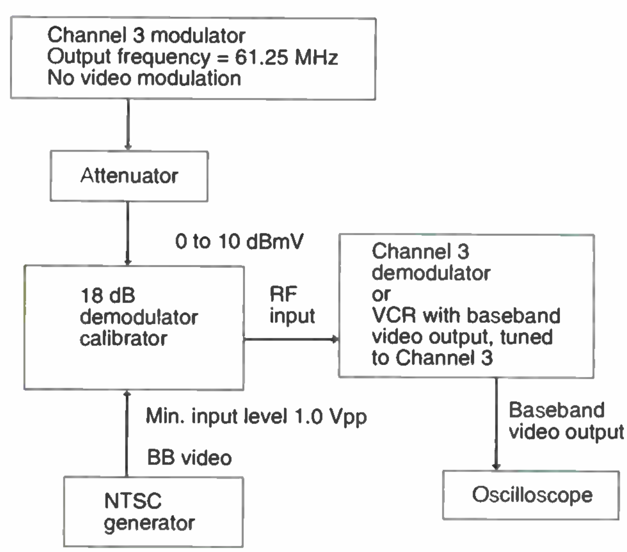


Figure 15: Descending vertical blanking

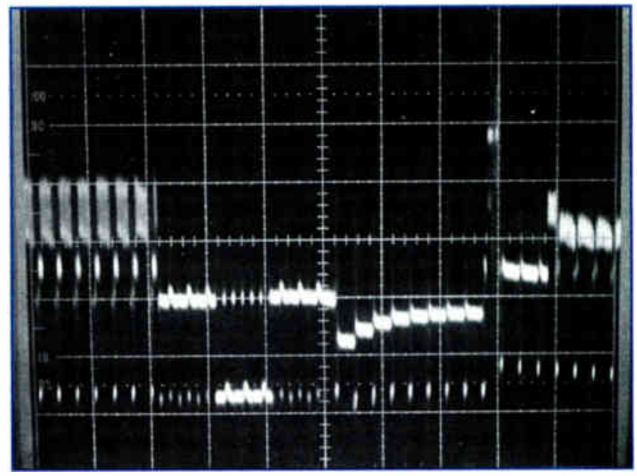
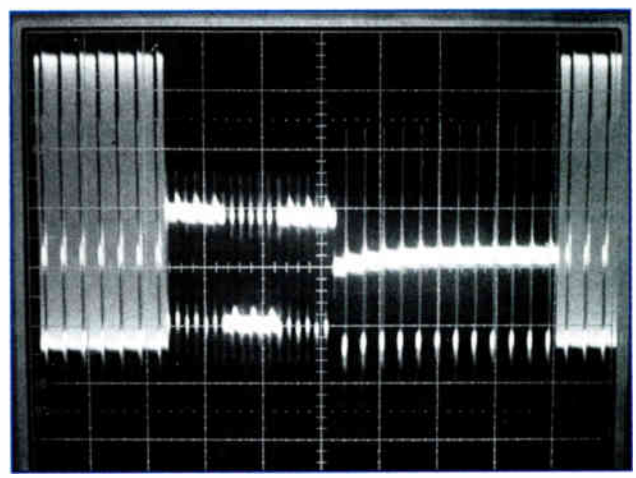


Figure 16: Shift of sync tips in vertical blanking



Bandwidth: 300 kHz minimum, 3 MHz preferred
Frequency span: Zero span
Trigger: AC line
Scan time: 200 ms
Video filtering: None, 1 MHz preferred

2b) Configure the analog or digital spectrum analyzer as follows for displaying several video lines:

Bandwidth: 300 kHz minimum, 3 MHz preferred
Frequency span: Zero span
Trigger: Video
Scan time: 200 µs
Video filtering: None, 1 MHz preferred

3) Tune the analyzer to the output frequency of the modulator under test. The displayed waveform represents the peak detected video signal. Fine tune the analyzer's center frequency control to maximize the amplitude of the detected video signal.
4) Use the linear amplitude display, positioning the sync tips on the top most graticule, as shown in Figure 10 on page 28, by adjusting the amplitude sensitivity (often called reference level). This calibration sets the top most graticule to 100 per-

cent modulation and the bottom-most graticule to 0 percent modulation. Percent modulation of the displayed waveform can now be expressed as follows:

% DOM = [(a-b)/a] x 100 %

Where:
a = total number of major displayable vertical graticules
b = number of major graticules the 100 IRE signal is displaced from the bottom-most graticule

For example, if the RF carrier is modulated by a five-step linearity signal such as that shown in Figure 11 (page 28) and an analyzer display of 10 major graticules, 87.5 percent DOM would place the 100 IRE step at 1.25 major divisions from the bottom-most graticule.

Unfortunately, when observing DOM with active video signals, a 100 IRE reference pulse is not always present. In this situation DOM can be monitored by observing the blanking level with respect to sync tips. The percent of modulation referenced to blanking, assuming no sync compression from the headend, can be expressed as follows:

% DOM = 3.5 x [(a-c)/a] x 100%

Where:
a = total number of major displayable vertical graticules
c = number of major graticules the 0 IRE, blanking, signal is displaced from the bottom-most graticule.
3.5 = ratio of peak-to-peak video with respect sync tip amplitude

An even easier way to set up the spectrum analyzer display is to position the sync tips eight divisions up from the bottom. The peak white should then just reach one division from the bottom. Sync tips should be six divisions from the bottom.

Zero chop

In order to measure DOM using the zero chop method, two references must be established. One reference corresponds to the transmitted peak carrier level (100 percent of available carrier) and the other corresponds to zero (0 percent of available carrier). By establishing these two references and knowing that a standard NTSC video signal has an amplitude of 140 IRE units (40 IRE units from sync tip to blanking level, 100 IRE units from blanking-to-peak white and 160 IRE units from peak carrier-to-zero carrier) DOM can be easily determined by taking the ratio of the 100 IRE signal amplitude (measured from sync tip) with respect to the amplitude of the zero chop signal (measured from sync tip).

A zero carrier reference cannot be transmitted from the modulator without causing severe system problems. Most professional video demodulators have the ability to switch off the IF signal for a few microseconds during the vertical interval. This simulates a situation in which the transmitted signal is 100 percent modulated. Figure 12 (page 29) shows the zero chop signal generated by an Scientific-Atlanta 6250 demodulator.

To measure DOM:

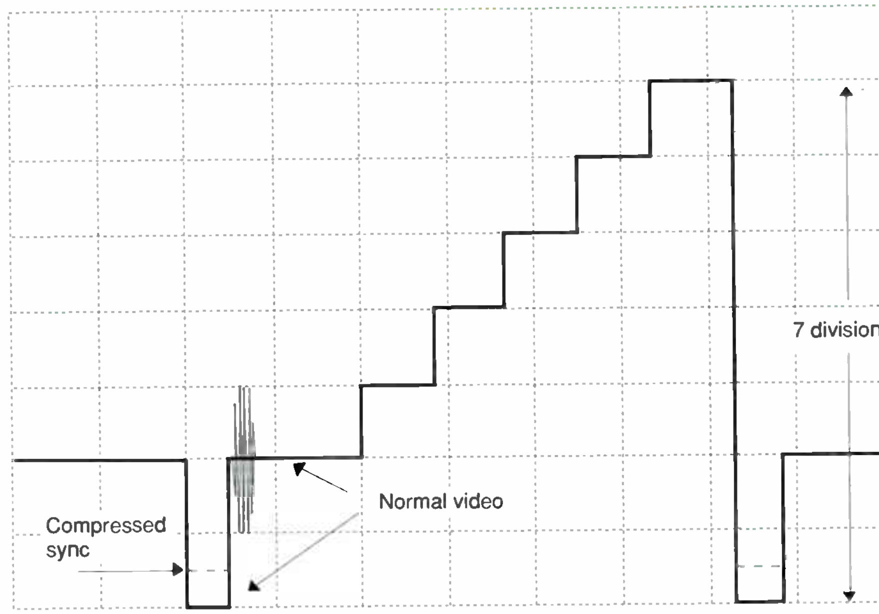
1) Tune or set the input converter of the video demodulator to the output frequency of modulator under test.
2) Switch the demodulator's zero chop function on.
3) If incidental carrier phase modulation is present, set the demodulator to envelopment detection. If not, synchronous detec-

tion often gives more accurate results.
4) Display the output of the video demodulator on a video waveform monitor or oscilloscope. If using an oscilloscope without 1 V triggering, use the TV set triggering circuit.
5) By using a combination of the demodulator's signal output level adjustment and the oscilloscope's vertical gain adjustments, set the amplitude of the video signal to 160 arbitrary units from sync tip-to-peak of zero chop pulse. Figure 13 (page 29) illustrates this setup by showing a portion of the vertical blanking interval with an inserted zero chop signal. The 100 IRE signal identified in the illustration is a portion of the VITS reference for the multiburst signal. DOM can be determined using the 100 IRE bar reference and zero chop signal as follows:

% DOM = a/b x 100%

Where:
a = amplitude of the 100 IRE signal
b = amplitude of the zero chop signal

Figure 17: Sync compression



If VITS or a 100 IRE signal in not available, DOM can be measured using the amplitude of the sync pulse as follows:

% DOM = 3.5 x c/b x 100%

Where:
c = amplitude of the sync pulse
b = amplitude of the zero chop signal
3.5 = ratio of peak-to-peak video (inclusive of sync) with respect to sync amplitude

Calibrated video demodulator

Video DOM also can be determined by using the calibrated video demodulator technique. This method is primarily used when a zero chop demodulator is not available. It also is an excellent method for measuring DOM when using a VCR with a baseband video output. An advantage of using a VCR with a baseband video output is that it can double as an agile demodulator.

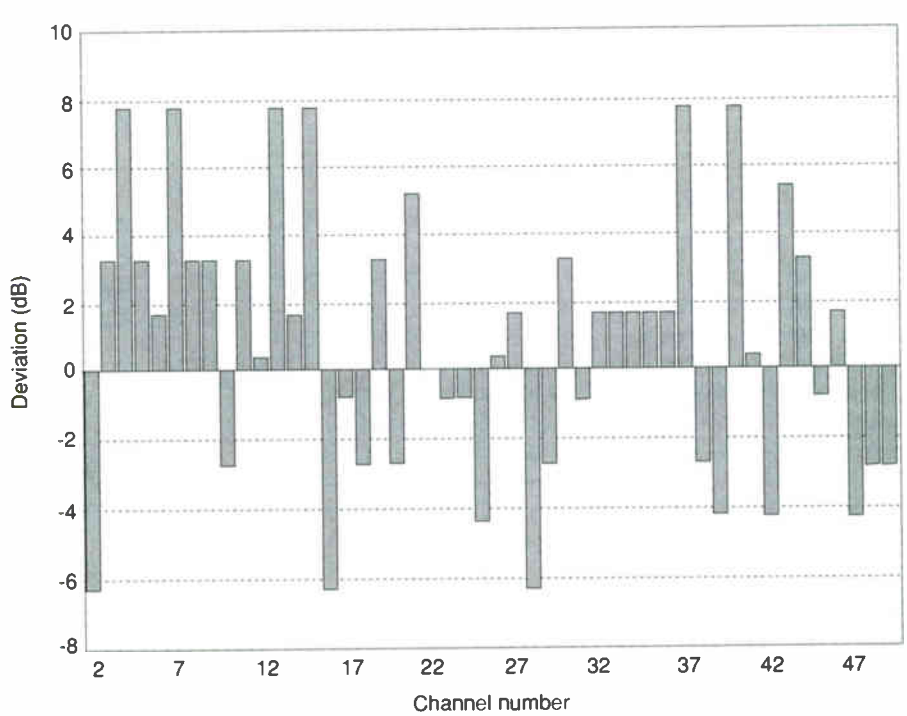
As the method's name implies, the demodulator needs to be calibrated. Calibration is accomplished by the output of the demodulator when supplying a known input signal. Once the output of the demodulator is calibrated, DOM can easily be determined by taking the ratio of the amplitudes of the unknown signal with respect to the calibrated signal. The calibrated input signal can either be from a video source and modulator pair or from a demodulator calibrator circuit. If using the video source and modulator pair, the modulator should be set to 87.5 percent DOM using the spectrum analyzer method or zero chop method.

If using the demodulator calibrator circuit, the output signal simulates a signal with 87.5 percent DOM. This is accomplished by attenuating the input carrier by 18.06 dB at the horizontal line rate. The attenuation level of 18.06 dB was derived from the following equation:

Attenuation level (dB) = 20log[1-(% DOM/100)]

Where:
% DOM = 87.5%

Figure 18: Audio deviation as a function of channel



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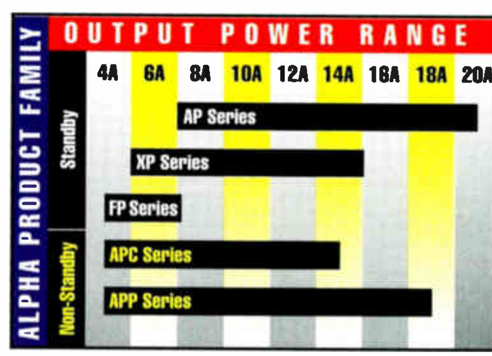

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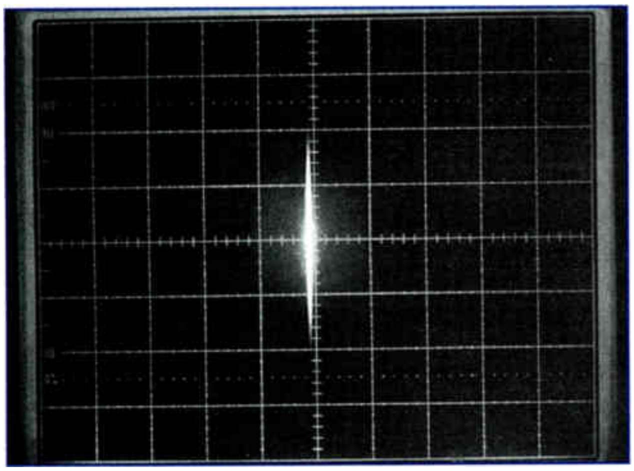
Figure 19: Peak audio deviation displayed on an oscilloscope having no X-deflection



To measure DOM:

1) Configure the test setup as shown in Figure 14 on page 29.
2) If using the demodulator calibrator circuit, verify that there is no video modulation on the output from the Ch. 3 modulator.
3) If using the video generator and modulator pair, verify that the modulator is calibrated to 87.5 percent DOM.
4) To minimize the effects of incidental carrier phase modulation distortion, set the demodulator to envelopment detection if necessary (though you may not get a choice).
5) Display the output of the video demodulator on a video waveform monitor or oscilloscope. If using an oscilloscope without TV triggering, use the TV triggering circuit.
6) For maximum accuracy, adjust the oscilloscope's gain control for maximum displayable peak-to-peak signal.
7) Measure and record the peak-to-peak amplitude of the displayed signal. The amplitude of this signal represents this modulator's output amplitude for a signal with 87.5 percent DOM.
8) Remove the demodulator calibrator.
9) Tune the modulator to the output frequency of modulator test.
10) Adjust the oscilloscope's delayed trigger control to view the 100 IRE pulse located in the vertical interval test signal.
11) After measuring the amplitude of the 100 IRE pulse ($V_{100\ IRE\ peak\text{-}to\text{-}peak}$), DOM can be determined as follows:

$$\%\ DOM = [87.5 \times V_{(p\text{-}p)}] / V_{(cal\ p\text{-}p)}$$

12) Similar to the spectrum analyzer method and zero chop method, if a 100 IRE pulse is not available, DOM can be determined by measuring the amplitude of the sync pulses. The following equation is used:

$$\%\ DOM = 3.5 \times 87.5 \times [V_{(0\ IRE\ p\text{-}p)} / V_{(cal\ p\text{-}p)}]$$

Vertical blanking interval problems

The only video signals that are permitted to descend below blanking, 0 IRE, are the color burst and synchronizing pulses. Some dark colors also may cause the color subcarrier to go below 0 IRE during active video. All other signals descending below blanking are improper and may cause trouble.

As previously mentioned, if any portion of the video signal were to cause grief, it would likely be the vertical interval. Unfortunately, one cable system demonstrated several good examples of illegal video. Figure 15 on page 30 shows a good example of a problem seen in the vertical interval in which the vertical interval blanking signals are descending below normal blanking level. Notice the nearly 20 IRE of blanking droop starting immediately after the post equalizing interval. This descent exponentially decreases to 0 IRE after about 10 lines.

Notice also that the sync pulses after this period, beginning at about Line 17, are raised. Problems of this type may not be noticed during casual TV viewing. However, descending vertical blanking could manifest itself in professional and consumer equipment that relies on the integrity of the vertical interval. The most likely cause of the problem is a defect in baseband equipment. In one case it was traced to a defective VITS generator at the uplink and in another case it was due to a defective character generator at the headend.

Another problem seen in the vertical interval was the shifting of many line of sync. Here the pre-equalizing, vertical sync pulse and post-equalizing intervals were shifted above the horizontal sync pulses by 10 IRE. Figure 16 (page 30) shows an example of sync shifting. A problem of this nature also has the potential of causing problems with vertical sync separators in VCRs, TV sets, and closed-caption equipment. It was again traced to a defective character generator at the headend. Also notice the extremely high chroma. This channel had lots of problems!

Sync compression

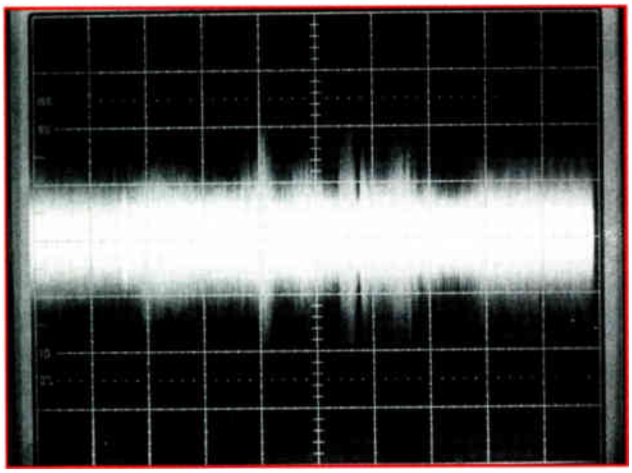
Sync compression is a common problem with lower cost and consumer equipment and can manifest itself as unstable sync on some TV sets, poor character generator performance and poor videotape results. The FCC specifies that the amplitude of synchronizing pulses should be 40 IRE. Anything less than 40 IRE is considered to be compressed. Sync compression is measured by taking the ratio of blanking-to-peak white, divided by blanking-to-sync tip. This ratio should equal 2.5.

Figure 17 on page 32 illustrates sync compression. The easiest way to check this is to adjust the vertical position and gain on your oscilloscope until the blanking interval is two divisions from the bottom and the peak white is seven divisions from the bottom. If the sync is not compressed, the sync tips will be on the bottom graticule as shown. Compression will result in higher sync tips.

One source of sync compression is the headend modulator. Compression in the modulator could be a result of poor clamping or output amplifier non-linearity. Another less controllable source of sync compression is from local UHF and VHF transmitters. The high output power from these transmitters has been known to compress sync pulses.

We encountered one such example a few months ago, at a UHF PBS affiliate. A call to the station's engineer indicated that he was operating on one klystron rather than the three normally used. The station was installing a new transmitter and he couldn't get replacement klystrons for the month until the new transmitter was ready. He was amazed that we weren't measuring even more severe problems! If your headend is processing a signal with sync compression, there is nothing to be done short of correcting this problem at the transmitter. If con-

Figure 20: Time elapsed oscillograph tracing of deviation



verting to baseband then remodulating, a video processor should do the trick.

Descending characters

Most headends today have the capability of inserting on-screen characters on some channels. For example, The Weather Channel allows local cable operators the option of inserting local weather forecasts and current conditions using on-screen characters. The problem with overlaying locally inserted on-screen characters is that the incoming video signal level may not match the inserted on-screen character levels. One manifestation is that the black level boarding the characters will drop below the input video's black level. When this occurs, video equipment that relies on sync pulses becomes confused when it sees additional pulses dropping below the black level. Fortunately, this problem is usually easily corrected by monitoring the video signal at the baseband input to the modulator while making the appropriate adjustments to the on-screen inserting equipment.

Audio deviation

Similar to video DOM, headend audio deviation is not one of the proposed operational standards. However, inconsistent deviation is the source of many subscriber frustrations and complaints. Deviation is a measure of the loudness of a signal.

Figure 18 (page 32) shows the relative detected audio levels measured on one cable system. The relative audio deviation was computed by first measuring the detected audio level on all channels using a VCR's VU meter. (By the way, VU stands for volume units, not "view" or some of the other strange terminology sometimes applied.) Since typical audio programs vary in level the average meter reading of the channel being measured was recorded. After recording all channels, the average reading of all channels was determined. This average was then used as a reference to compute the relative audio deviation on each channel. The horizontal line on Figure 18 indicates the average level of the three network stations.

Notice the wide variation in relative audio deviation across the 50 channels measured. This type of variation can become annoying when scanning the dial. Subscribers are frequently adjusting the TV set or converter volume control for the desired audio level. Today's TV viewers have become more discriminating to audio quality. CD players, hi-fi VCRs, BTSC stereo and digital music on cable have sensitized many subscribers to high-quality audio. Therefore, it is imperative that cable operators maintain high-quality audio throughout the headend.

Audio levels can be evaluated several ways: average, peak, peak factor and loudness. Average refers to averaging the amplitude of the audio signal over a period of time (RMS). This is usually accomplished with the use of a VU meter.

Peak is an instantaneous measurement of the audio signal's peak amplitude. A peak program meter is usually used to make this measurement. However, an oscilloscope also can be used with adequate accuracy. Figure 19 on page 34 shows a sample of audio metering using an oscilloscope with the sweep speed set to XY and no deflection horizontally.

The meter is first calibrated by connecting it to the output of a demodulator tuned directly to an off-air signal. Broadcasters are usually pretty good about maintaining the correct peak deviation, so you can use a broadcast signal to calibrate your modulation indicator if you have nothing better available.

Peak factor refers to the ratio between the peak voltage and the RMS voltage in an audio signal. Measuring peak factor requires a specialized piece of equipment called an audio deviation meter. (For more details see "How To Measure It, Set It Right, And Keep It That Way" by Frank F. McClatchie in the *NCTA 1988 Technical Proceedings*.)

The final method of monitoring deviation is loudness measurement. The human ear's ability to sense loudness is very similar to measuring the RMS value of an audio signal. This is true because the human ear perceives loudness as a power-derived factor. Unfortunately, the human ear's poor loudness memory makes it very difficult to set deviation accurately.

As previously mentioned, an oscilloscope can be used to balance the audio deviation in a headend. Basically, this is done by monitoring the demodulated audio signal using an oscilloscope with its horizontal sweep set to 500 ms or higher. The vertical trace, similar to the one shown in Figure 19, sweeping across the oscilloscope is the audio signal. The peak-to-peak excursions represents peak-to-peak deviation. Figure 20 shows deviation vs. time for about 3 seconds of audio. The audio deviation on all channels can now be set to some predetermined reference peak level. Since off-air network channels usually have their volume levels carefully monitored, they should be used to establish this reference.

Using an oscilloscope calibrated against a local broadcaster may not be the perfect method to set deviation, but is a lot better than what some systems are doing now. The peak flasher on many modulators also may be used, but is really intended more as an alarm to indicate that the legal deviation is being exceeded.

The NCTA Engineering Committee is painfully aware of many subscriber complaints of poor audio consistency and is working with program suppliers to do something about it. (This information was obtained from Ned Mountain of Wegener.) It is hoped that by this fall a reference tone will be transmitted once a week from one or more program suppliers, which will allow you to set deviation on all modulators supplied from VideoCipher decoders. We urge you to take advantage of this test tone. **CT**

The authors wish to acknowledge the help of the few cable systems who unwittingly provided a plethora of examples of what not to do, for us to write about. Brenda Roberts constructed and tested the circuits shown and took many of the photographs.

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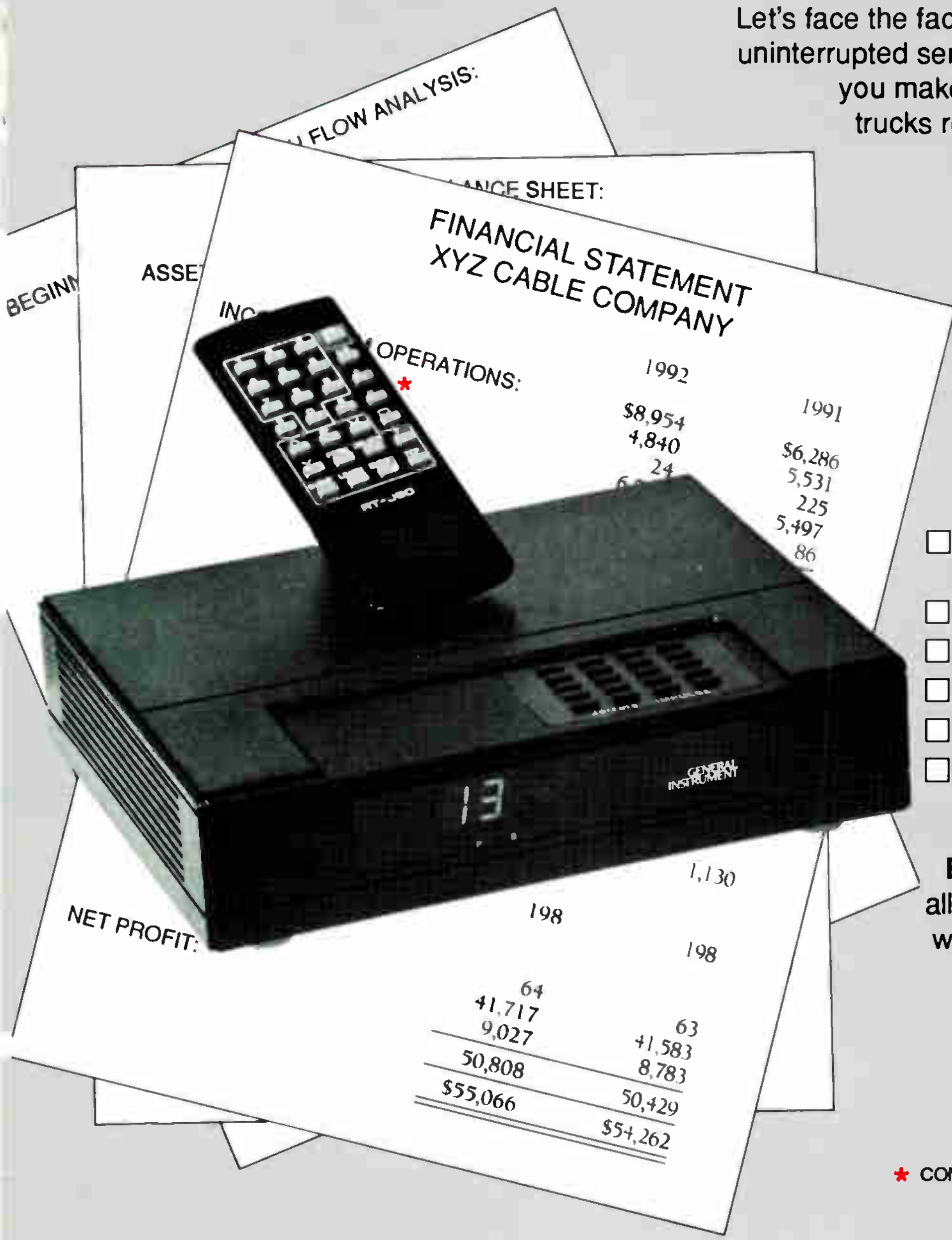

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1 GHz potential upgrades

(Continued from page 18)

their "1 GHz" locations, the amplifier modules installed are lower cost, 550 MHz power doubled technology using fewer hybrids.

In order to upgrade this plant to 1 GHz active, it will be necessary to install the additional laser transmitters and receivers for the 550-1,000 MHz band. The low-cost 550 MHz amplifier modules will be replaced with 1 GHz, multiple active output modules. No other changes would be needed.

- *Almost 1 GHz ready 550 MHz plant* — In this approach, the plant is initially designed at 1 GHz. This could be a fairly rough design, the purpose being to establish the 1 GHz node locations and service areas. The express cable requirements also would be determined. The coaxial plant would be redesigned at 550 MHz, using multiple output, high-performance 550 MHz amplifiers. This approach yields short amplifier cascades (typically only two amps in cascade) and a low per-mile amplifier count (2.5-3 amps per mile) by taking advantage of the express cable required for the 1 GHz coaxial design.

In the actual upgrade process, the fiber, fiber equipment and express cable would be installed as called for in the 1 GHz design, similar to the previous case. The difference is that amplifier usage and location, as well as tap output levels, are optimized solely for 550 MHz operation. This yields the low amplifier usage at 550 MHz as compared to the final 1 GHz amplifier requirements.

In order to subsequently upgrade the plant to 1 GHz active in the future, amplifiers will have to be added (and the existing 550 MHz modules replaced). Some feeder rework will be required. In order to accomplish this in the most cost-effective manner, reversible tap face plates would be needed to eliminate tap resplicing. The 550-1,000 MHz optical equipment also would have to be added.

- *Low-cost 550 MHz in a 1 GHz service area* — In this scenario the fiber is installed, and the node locations are chosen to yield the 1 GHz service area. In addition to deferring the purchase of the 550-1,000 MHz laser transmitter and detector modules, the optical nodes installed might be low-cost, single detector models (equipped, however, with return laser transmitters) that would need to be replaced by a full-size, full-featured node at the time of an eventual 1 GHz upgrade.

For the coaxial portion of the plant, the primary objective is to upgrade the coax in the most cost-effective manner possible to satisfy the immediate bandwidth requirement (e.g., 550 or 450 MHz). The majority of the express cable that would be required in the 1 GHz upgrade would be deferred unless it was cost-justified today as part of the 550 MHz upgrade. The feeder system would likely require additional line extenders and tap face plates would be swapped to the degree possible. If new taps were required, 1 GHz reversible taps would be a desirable option, unless that feature imposed a cost premium. Tap levels in this design focus on only today's needs.

Potential issues affect the options

Three major factors exist that may

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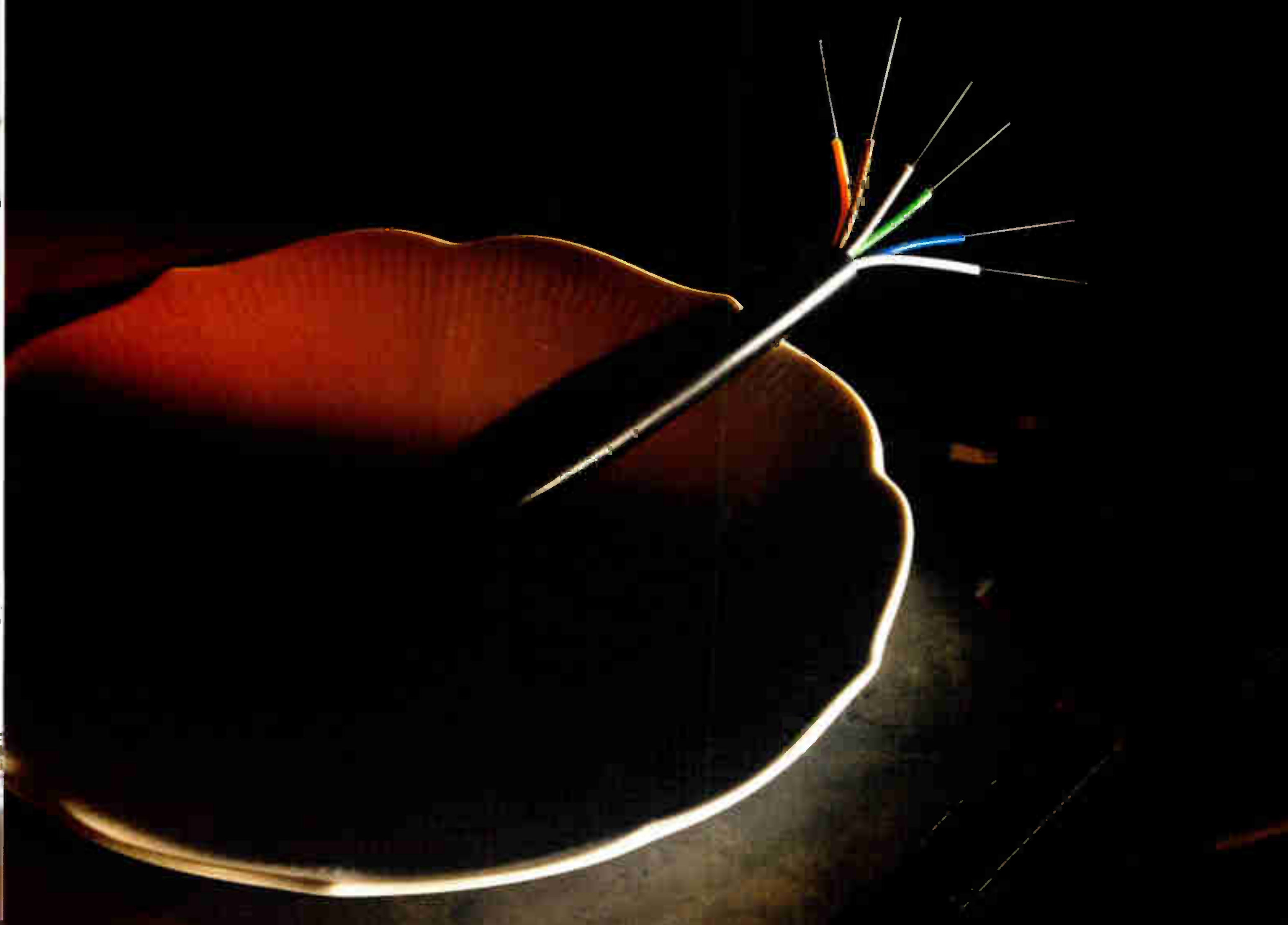

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Reader Service Number 32 For Literature   Reader Service Number 72 For Demo have positive or negative effects on the different upgrade strategies:

1) Digital video compression. With the anticipated reduced carrier-to-noise ratio (C/N) needs for digital signals comes the opportunity to transport these signals in the plant at a lower level than their analog companions. If the bandwidth above 550 MHz was dedicated for this purpose, there may be an "effective" gain in amplifier distortion performance. The use of digital video compression also may lead to lower amplifier usage rates through lower tap output levels, again due to the digital carrier noise immunity.

2) Consumer interface issues. How the TV signals will be treated from tap to TV set also may have a significant bearing on tap output levels and amplifier usage rates. If a strategy to deploy devices such as the point of entry (POE) or drop amps for multiple outlets were adopted prior to future upgrade, tap output level requirements might be reduced by as much as 6-8 dB as compared to those required in conventional approaches. This would have significant impact on the 1 GHz amplifier usage and, therefore, on plant upgrade cost.

"The key to a cost-effective upgrade to 1 GHz in the future is to design small coaxial service areas around the node today as part of the 550 MHz upgrade."

3) Performance specification evolution. Performance improvements in 1 GHz amplifiers are likely to follow trends similar to that the industry has previously experienced in amplifier development. Some of the upgrade strategies outlined require an estimation of what amplifier performance will be available at the time when the 1 GHz upgrade might occur.

The time value of money affects the merits of each upgrade approach. Since the timing of the 550-1,000 MHz upgrade is unknown at this point in the analysis process, this issue will be addressed later.

A discussion on the strengths of each upgrade strategy and the effect of the previously mentioned issues follows.

The *1 GHz active* approach should produce the lowest total project cost since the upgrade labor occurs only once and there are no materials to be salvaged. However, this approach requires the largest capital expenditure today. Since the system would be designed based on today's 1 GHz amplifier specifications with conventional tap output levels, the electronics cost will be slightly higher than if the project were to start three to five years from now.

In the *1 GHz ready 550 MHz active* scenario, cost savings are possible as compared to the previous case since the amplifiers contain 550 MHz modules, which cost less than the 1 GHz units. Deferred expenditures include the cost of the 550-1,000 MHz laser transmitter and detector modules. The cost to upgrade the 550 MHz plant to 1 GHz is driven by the amplifier module and optical equipment costs. The additional labor cost for the future upgrade is minimal since it involves only amplifier module replacement.

Today's downside with this approach concerns the total number of amplifiers in the system. Since there is

a 550 MHz amplifier installed at each of the 1 GHz locations, the amplifier count is higher today than absolutely necessary for an operational 550 MHz system. Some cost savings have been obtained since the 550 MHz amplifier performance requirements are low, given the 1 GHz spacing and operational levels.

By planning for a "drop-in" upgrade to reach 1 GHz, the ability to reduce 1 GHz amplifier usage through improved performance or lower tap output levels will be limited, unless the cost and disruption of amplifier relocation is undertaken.

The downside to the *almost 1 GHz ready 550 MHz plant* is that this upgrade strategy costs only marginally less than the previous case. The savings stem from very low amplifier usage rates at 550 MHz. The future upgrade cost will be higher than in the previous case since some amplifiers will need to be relocated and most of the tap face plates will need to be juggled. Some minor feeder resplicing also would be required. However, this approach provides an attractive option if the subsequent upgrade will not occur for "many" years, since there would be fewer amplifiers to maintain as compared to nearly any other approach. Given only two amplifiers in cascade and the express cable concept, system reliability should be excellent. Also, this approach may allow lower 1 GHz amplifier counts since the location of the 1 GHz amplifiers are not fixed today, hence a future design could take advantage of improved amplifier performance. If lower tap output levels are possible in the future (due to digital compression or POE type interface at the home), this also will tend to reduce the 1 GHz amplifier count per mile.

In the case of the *low-cost 550 MHz in a 1 GHz service area,* cost savings result from performing the minimum amount of changes in the feeder network today. However, the future upgrade cost will be the highest of the options discussed in this article since little is being done to the feeder today. (In the future, taps may need to be respliced, amplifiers added and express cable installed.) This approach may be quite competitive with any other 550 MHz upgrade approach, since the small 1 GHz service area allows better amplifier usage rates as a result of short amplifier cascades.

Evaluating the upgrade options

Once the costs for each approach have been developed, it is interesting

to take three of the four scenarios one step further. In order to get a complete picture of the total cost to upgrade the plant from the 300 MHz (or 330 MHz) today through 550 MHz and finally to 1 GHz, it is necessary to estimate the cost of upgrading the plant from 550 MHz to the 1 GHz bandwidth. While this is an easy exercise for the *1 GHz ready* case, since only amplifier modules need be swapped and additional (550-1,000 MHz) optical equipment added, the process is slightly more difficult for the *almost 1 GHz ready 550 MHz* approach and any *low-cost 550 MHz* approach.

In order that senior management can appreciate the complete picture, and apply the time value of money to the cost estimates provided, a spreadsheet is created that shows the following data for each upgrade approach:

- Today's upgrade cost
  (The upgrade to 550 MHz.)

- The future upgrade cost
  (The upgrade from 550 MHz to 1 GHz.)

- The sum of the above
  (This represents the total cost to get from 300 MHz to 1 GHz.)

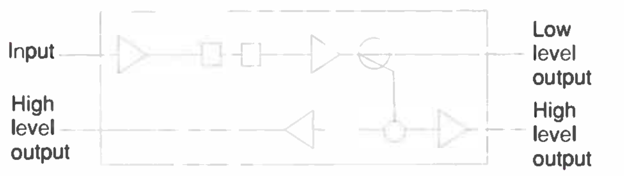
- Salvage value or write-off of material
  (This assumes that the 550 MHz to 1 GHz upgrade occurs before the equipment, mainly amplifiers, is fully depreciated. Hence, unless this 550 MHz equipment can be reused elsewhere in the company or sold at, or above, its depreciated book value, there will be an associated write-off to add to the total project cost.)

Summary

If the possibility of 1 GHz is in your future plans, one of these strategies may be worth considering. Ranking each strategy based on its cost and merits can be difficult until the timing of a subsequent 550 to 1,000 MHz upgrade is known. Any one of the approaches discussed will preserve the possibility of 1 GHz without the need to severely modify the fiber architecture deployed as part of the 550 MHz upgrade. This should minimize future plant disruption and upgrade cost at the time of the 1 GHz upgrade. The *low-cost 550 MHz in a 1 GHz service area* may be very cost-competitive with the lowest cost 550 MHz available today. **CT**

Reader Service Number 39

Figure 3: Active output 1 GHz amplifier



The steps to 150+ channels

(Continued from page 21)

plication of the neutral networking design principles and the superdistribution architecture will ensure that an easy upgrade to 1 GHz can be achieved without the need to rebuild or upgrade again. The beauty of a neutral networking design (besides its low total system cost) is that no additional cable has to be added to increase the amount of subscriber segmentation by adding more fiber receivers. Only amplifiers are turned around in the neutral network when fiber is added. When the superdistribution feeder is upgraded to 1 GHz, only the amplifier modules are upgraded.

Today there is one operating 1 GHz system. Time Warner Cable has upgraded a portion of its Queens, N.Y., cable system to 1 GHz and is carrying 150 channels.[4] A 40-channel near-video-on-demand package is being marketed, as well as significant amounts of special interest programming and multiplexed pay channels. Viacom in Castro Valley, Calif., is rebuilding a portion of its system to 1 GHz for marketing testing. The rest of the system is being designed for future upgrade to 1 GHz using superdistribution. Time Warner's Rochester, N.Y., system is being designed for upgrade to 1 GHz using superdistribution. Adelphia is using both neutral networking and superdistribution in the design of its upgrades and rebuilds (all of Adelphia's designs are capable of upgrade to 1 GHz). Rogers in Canada has designed its feeder plant with the superdistribution architecture for upgrade to 1 GHz.

The future holds a lot for 1 GHz systems. Improved RF amplifier hybrids for more effective amplifier and system designs are being pursued. To-the-home compression technology is being developed; when available, it will provide the ability to deliver hundreds of channels to the home in a 1 GHz system. More systems will build 1 GHz and 1 GHz ready plant. The marketing studies in Queens (which have already exceeded expectations) will confirm the income potential of systems with 150+ channels. **CT**

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[2] "Fiber-Based CATV Systems — Bandwidth Upgrade," Colin J. Horton, C-COR Electronics Inc., SCTE Fiber Optics Plus, San Diego, 1992.

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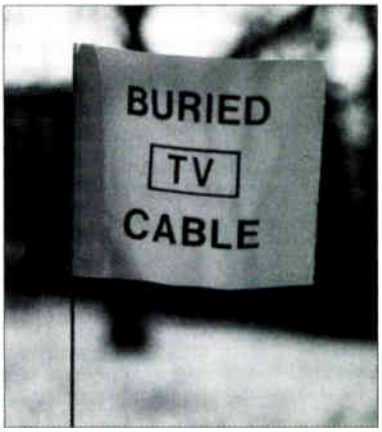

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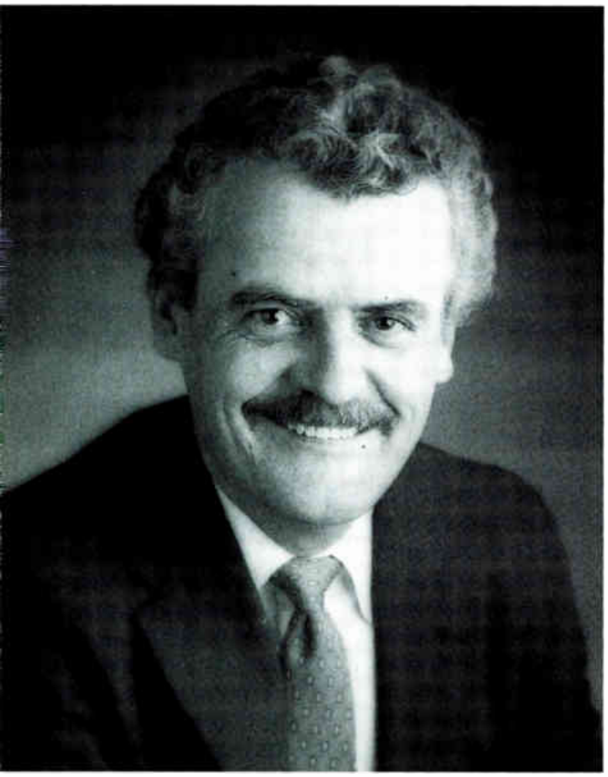

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Reader Service Number 43

Upgrades

(Continued from page 22)

turn loss illustrates only subtle changes that worsen at the desired bandwidth, you may find this acceptable. What you will be looking for is more dramatic changes. Imperfections will indeed stand out with this more sensitive method of testing. In other words, become intimate with your testing, analysis and interpretations based on your skills. Be assured that a "high loss" span tested in this fashion will stand out immediately. Armed with this data, you should be able to pen an estimate of total coaxial replacement for the system based on the test failure percentage.

Trunk redesign

Most systems have data sheets for every trunk station. This information can give you the comparison to your as-built prints with reference to existing span losses. The age-old formula to calculate higher bandwidth can be a valid guideline to estimate losses, but it cannot always be depended on. There are circumstances such as dielectric effect at higher frequencies and other phenomena that may increase the loss slightly more than the linear formula accounts for. If the cable system is relatively new, perhaps the coax manufacturer can give you more accurate data, depending on the frequency reach. If no other information is available, add another test to the coaxial determination testing (such as injection of a known amplitude carrier at the high frequency) and measure the level at the other end of the span. It is sometimes advisable to consider a factor of 3 percent additional loss.

Whatever the end result, the trunk span losses should be as equal as possible, including flat losses. There are those spans that will compute as significantly longer than average at the desired bandwidth. These should be included in the plan for replacement rather than moving stations. Overlash using a lower loss or larger trunk coax is often the most efficient remedy for an overstretched span.

Distribution redesign

Upgrading a trunk system is sometimes the easiest part of a system upgrade. With the lowest ratio of passive losses (power couplers and directional couplers) and relatively good condition cable, all we have to consider is higher operating outputs, gain and slope factors. This falls in with our considerations in the trunk amplifier itself. In the case of the distribution system, much more is to be considered, such as higher (insertion) flat losses and more limited amplifier output levels.

Along with the rest of the passives in the system, a sampling of the directional taps should be bench swept for return loss, as well as frequency response to the desire bandwidth. Assuming the passives are acceptable, the insertion losses found when sweeping should be recorded and used for the redesign.

There are so many different situations out there, that to attempt to define a set method of feeder redesign would be quite impossible in one or even two articles. One tip on the most common 300 MHz built systems: raising bridger and line extender levels much more than 1 dB is nearly disastrous to distortions. Applying an old design principal of "lash back" to our design might help reach the first and

second line extender with slightly more signal. That coupled with higher gain possibilities in reprogramming the modules can certainly make this happen. The trick to this is overlashing a larger (0.625) coax at the last three spans before the first, and second if necessary, line extenders. Make this a tapless run to the extender module. With a directional coupler on the line extender output, resplice the existing spans the opposite direction with either the same values or higher value taps as the design calls for. Usually, the first line extender is found to be closer spaced to the bridger. The "lash back" may allow you to move the first line extender one span closer to the second. (See Figure 1 on page 22.) Again, since there are so many design configurations in existence, and for the purpose of illustration, no calculations are offered.

Upgrading the amplifiers

Of all the bits and pieces of the coaxial system, the amplifier is truly the star performer. If the upgrade effort is now emerging toward reality, then this phase is the most cautious and detailed. Because of lengthy cascades, even if fiber nodes are installed to break them up, careful thought must be applied to noise and distortions. In the case of the CAN architecture, cascades are broken down into RF-switched cascades of a handful of trunk/bridger stations. Along with the reliability of the AM fiber come more difficult carrier-to-noise and composite distortions to work with.

Regardless of whether you are going to use drop-in modules or "rechip" the existing ones, the resultant coaxial redesign must apply directly to the new design configuration of the amplifier in order for it to work properly. If the average trunk span is to become, for example, 26 dB from the original 21 dB due to the higher bandwidth, then the amplifier will have to have a resultant operational gain for the cable span, including equalizer and other station losses. There must still be some gain left over for an AGC amplifier (for example, 2 dB) so that all temperature variations can be accommodated by this circuitry. Feedforward technology seems to be quickly called for. However, newer generation hybrids may enable you to achieve close to similar results with a much lower percentage of added power supplies.

For this article, let's examine this as a reprogram effort since the replacement module manufacturers most likely have addressed many of the historical problems.

Due to the emergence of fifth-generation hybrids, we now have available specification improvements never before thought possible. Regardless of the bandwidth goal, you should consider using 550 MHz hybrids to rechip your amplifiers. The benefits are:

1) Much improved distortions over previous generations, even in similar channel loading situations. (Fifth-generation 550 MHz hybrids loaded with 60 channels at 450 MHz exhibit a 2 dB improvement in composite triple beat over the 450 MHz hybrids.)

2) Improved noise figure for input hybrids, as much as 3 dB. (See Figure 2 on page 54.)

3) More ruggedized hybrid construction for reliability and longer lifetime.

If the original spacing was conser-

vative so that the newer losses would result in a modest increase in trunk levels, the lower noise hybrid installed will allow lower level input. This allowance can be calculated as an addition to the power doubled effect. That is, if an amplifier is modified to power doubling and nets a 5 dB im-

Figure 2: Hybrid noise figure generation comparison

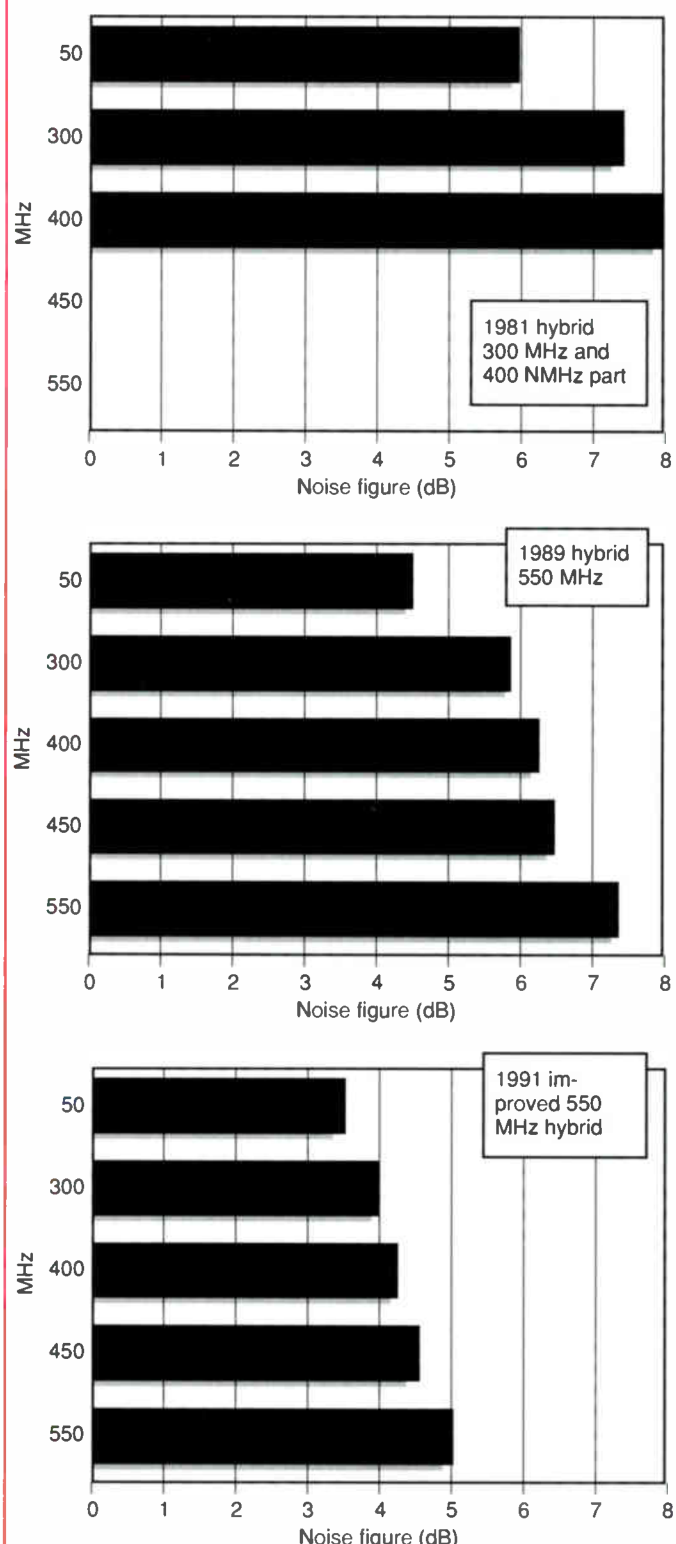


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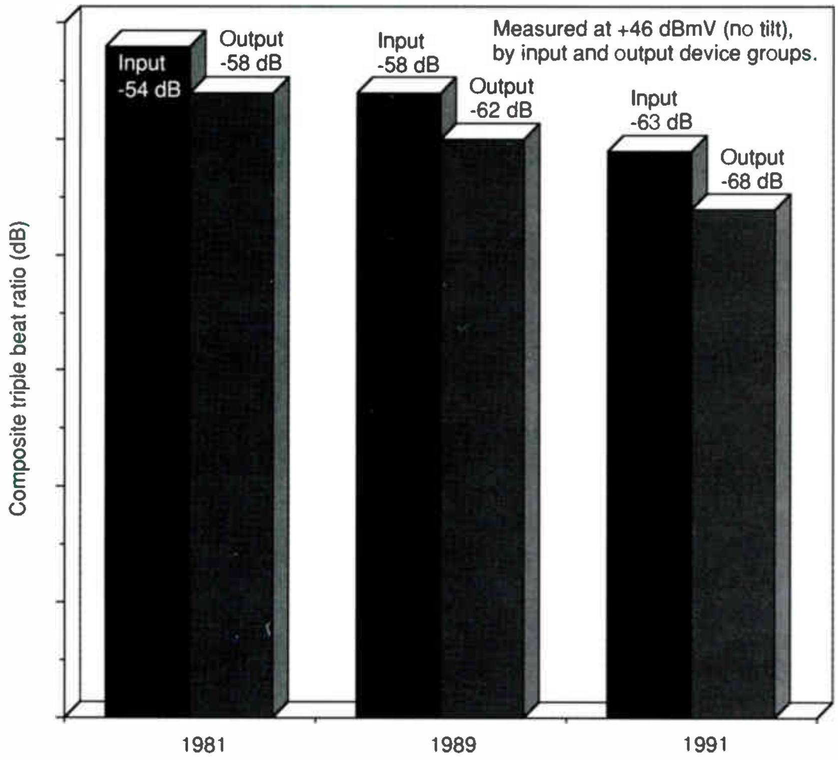
Figure 3: Distortion improvements at 400 MHz



provement in composite triple beat while operated at the same level, then depending on the additional channel loading, the slightly lowered input level allowed could be considered the increase in output we didn't need. In other words, we derated the trunk by lowering the noise figure. Although this may be rarely possible, it is a card to kept in your pocket.

While extending the bandwidth of the amplifier, certain other components also will be closely scrutinized. Most 300 MHz amplifiers or their associated connector chassis have AC chokes that may create immediate limitations in bandwidth. This is due to impedance changes or exhibiting self-resonances at the higher frequencies. Higher frequency versions of these ferrite chokes are available that do not necessarily require more physical space than the ones originally installed. In addition, the AC diplex capacitor used in combination with the choke is there to prevent any RF not blocked by the choke from entering the power pack. Because many older designs did not allow a high enough working voltage, these capacitors should be replaced with a 500 volt

"What may have appeared to be eroded was actually a coaxial plant in need of a little polishing of the electronics and a little loving care."

type. This will add greatly to the life of the module.

With higher operating levels in mind, perhaps the power doubled configuration is selected. This output hybrid also is much improved from earlier generations. (See Figure 3.) Among the other "super" hybrids is the new 36 dB power doubled hybrids that now enables us to upgrade most line extenders and single hybrid bridgers. Cautions to observe:

1) All hybrids used when reprogramming an amplifier should always be tested for all distortions and noise performance.

2) Bandwidth-limiting circuitry (such as the slope network in any amplifier) also plays a large part in the interstage as well as in the overall impedance of the amplifier. Bench technicians should attempt to reconstruct such circuitry only after adequate training is received.

3) If an outside facility is used to perform modifications to your equipment, make sure that this facility has a modern and full complement of necessary test equipment on hand. This should include distortion analyzers, multicarrier generators, spectrum analyzers, etc. Not only do the hybrids have to be tested, but the final product as well.

4) Certain amplifiers, due to existing design and component geography, will not perform well at higher frequencies. Although there are not many out there today, it is good practice to check and verify that your version of amplifiers have been reprogrammed successfully.

Conclusion

If the pieces look like they are beginning to fall together, then perhaps you have begun to realize that, in fact, you can restore and greatly enhance the overall performance of your system today with a realistic and proven method. What may have appeared to be eroded was actually a coaxial plant in need of a little polishing of the electronics and a little loving care. Armed with an approach such as this, you may become the accelerant toward financial reality in acquiring a new fiber system.

This article was meant to make you think about situations you face in your plant. There are so many different combinations of designs and equipment in existence today that to dig into the mathematics of a few examples would most likely fail to serve the circumstances of so many more. This was authored in hopes of simulating the thought process in a roundabout way. The hybrid technology advancements of this decade were, all along, the missing pieces.

It is true that many of the previous topics could be revisited more thoroughly, and perhaps they will in another follow-up. A reply to the editor could give us the key to addressing the issues as you face them today. **CT**

Time-selective spectrum analysis

(Continued from page 25)

able because of the possible errors that may be introduced.

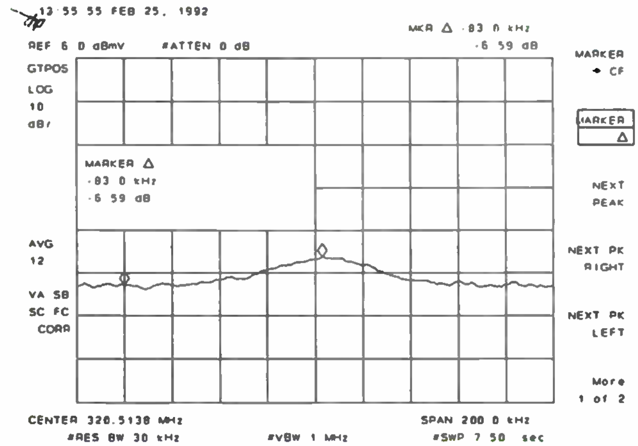
Composite distortion generation and measurement is a much written about subject. The number of beats increases drastically with number of carriers. Beat accumulation also is based on frequency spacing. Beat level builds up relatively as 10log(number of beats). The measured level is based on synchronism and average picture level of the contributors. Distortion creation mechanisms typically are not flat vs. frequency. The measurement of composite distortion may not be repeatable in a real system due to these factors. Only the visual carriers were considered for beats measurement locations of CTB and CSO since they have the largest peak power, but have average power similar to that of the audio carriers. The color subcarriers, FM and digital audio and data services also must be considered for completeness. For measurement of beat products, the National Cable Television Association recommends 30 kHz RBW to include all beat products with small frequency differences in the same measurement. The NCTA also recommends 30 Hz VBW to average the peak excursions to a single value.

A general channel equation for visual carriers is N x 6 + 1.25 (MHz) for typical channel and M x 6 + 1.25 + 4 (MHz) for Chs. 5 and 6. General beat locations for composite third order distortion are calculated from the equations A±B±C and 2A±B. The equation for CSO locations is A±B. One equation for CTB is A + B - C, which yields on-visual carrier distortion products except for Chs. 5 and 6 (which are offset from the others). If A + B + C were used it doesn't produce as many in-band beats but they do accumulate at the high end and are 2.5 MHz above the visual carrier. If A - B - C were used it again doesn't produce as many in-band beats but they appear 2.5 MHz below the visual carrier, which is very close to the color subcarrier of the lower adjacent channel. When all carriers are considered it could take days for a computer to calculate all the combinations and sum up the occurrences and would still not be complete. If a device's distortion-generation mechanism is not flat vs. frequency, and changes with temperature, then these theoretical curves would be incomplete. Higher order distortion-generation mechanisms also may be present in some equipment and their effect not being seen since we're not looking for it. Time-selective signal analysis allows one to go looking for intermods and backtrack until the cause is found without interrupting service.

The "attenuator test" is used to determine if measured distortion is being caused by the spectrum analyzer. Carrier levels don't move with attenuator change because of complementary changes in IF gain. For spectrum analyzer-generated distortion, second order distortion moves at twice the attenuation step size and third order distortion moves at three times the attenuator step size. If there is no spectrum analyzer contribution, carrier-to-distortion ratios remain constant with attenuator or input level change. For composite distortion, if the analyzer distortion is more than 10 dB below the system distortion, then the analyzer's contribution can be considered negligible.

The noise-near-noise calculation enhances an analyzer's measurement range. Average noise power adds linearly for the same RBW. Total noise = system noise + analyzer noise.

Figure 3



An analyzer measures in the units of dBmV for a large dynamic range. After doing some algebra one can calculate:

System noise = 10log[10^(total/10) - 10^(analyzer/10)]

If system noise is equal to analyzer noise, then total measured noise will be 3 dB higher. This equation allows accurate measurement of system noise closer than 10 dB to the analyzer's noise, by backing out the analyzer's contribution.

The distortion-near-noise calculation is an extension of the noise-near-noise calculation. Uncorrelated distortion products look like noise to the analyzers selected low bandwidth:

Beat level = 10log[10^(meas beat level/10) - 10^(meas noise level/10)]

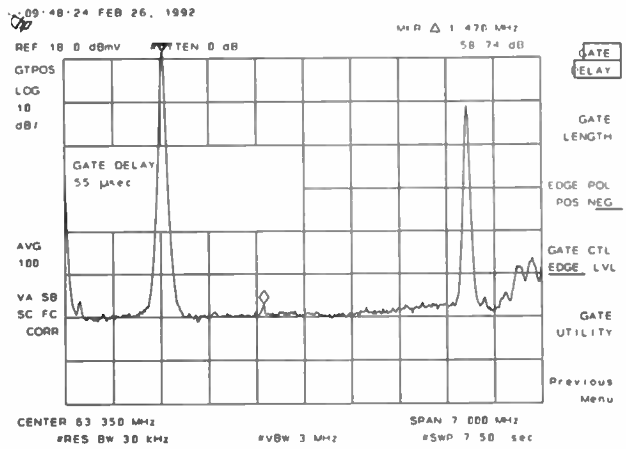
This equation allows measurement of composite distortion products closer than 10 dB to the noise level. It also allows the attenuator to be set high enough to keep analyzer distortion well below system distortion.

Adjacent signals measured with a relatively wide resolution bandwidth allows one signal's power to affect the other's level measurement. Use a smaller RBW, if possible, or calculate effect. The spectrum analyzer operation manual, or application notes, show the use of RBW to resolve close and unequal signals. Signal modulation will determine what RBW needs to be used and also whether a correction would have to be applied.

Performing measurements

With the previous information in mind, we can now make some measurements. The gated quiet line measurement is most revealing. Distortion products, in-band noise level and slope, mismatch, multipath, and local insertion contribution can be configured and interpreted with the proper setup and maybe a little experimentation to seek out the particular measurement desired. During the vertical retrace interval of a typical video signal are horizontal lines with no modulation (quiet lines) as well as specific vertical interval test signals (VITS) and closed-caption or data signals. For this example a spectrum analyzer can be set up to build a frequency-domain sweep of samples acquired during a quiet line to view the signal as if no other modulation were present. This allows one to see CSO distortion products at ±750 kHz and

Figure 4



"The ability to view a signal's spectrum at a specific instant in time in the presence of modulation is key to the non-intrusive diagnosis of cable TV system problems."

±1.25 MHz relative to the video carrier on any channel. Also, in-band noise can be measured along with noise floor slope to determine incoming signal-to-noise as well as at any other RF location in the system.

The implementation approach taken required two spectrum analyzers. One analyzer was used as the demod trigger receiver with TV line-trigger and fast time-domain sweep capabilities. The second analyzer served as the frequency-domain receiver with time-gating capability.

A second approach used a CATV demodulator with composite baseband video output that is routed to a special input to the TV trigger function. "TV trigger out" was then connected to "gate in." Other configurations can be used to give the same results.

Another aid to viewing gate setup in relation to the horizontal line is an oscilloscope. Ch. 1, connect "aux video out" from trigger source analyzer; Ch. 2, connect "gate out" from gated analyzer; and "ext trig" or Ch. 3, connect "TV trigger out" of trigger receiver.

For the two-analyzer approach the trigger receiver setup is as follows: Center frequency set to desired visual carrier frequency of channel to be tested (55.25 MHz for Ch. 2). Then push TRIG hard key in control section and then push TV TRIG softkey, which automatically sets the analyzer to span 0 Hz, RBW 1 MHz, sweep time 100 µs, linear detector, sample mode and appropriate reference level. If signal level is low then manual selection of 0 dB attenuator may be appropriate to get stable triggering. Set analyzer to trigger on a quiet line, which will be between lines 10 and 20 depending on test signals present and closed-captioning, or other data being transmitted during the vertical retrace interval. In order to reduce sweep time of the second (gated) analyzer, look in both odd and even fields for quiet time (0 IRE level) and then select TV TRIG, vertical interval (VERT INT).

The gated analyzer is set up as follows: Connect "TV trigger out" from the trigger receiver to "gate in" on the gated analyzer. Span 6 MHz, RBW 30 kHz, VBW 3 MHz. Center frequency set to visual carrier frequency + span/2, set sweep time to 7.5 seconds. Gate setup: Set gate delay to 54 µs and gate width to 1 µs and set for negative edge operation so reference edge for gate delay is trailing edge of sync. Turn gate on, video average 10.

The gated quiet line of Ch. 39 (Figure 2 on page 25) shows a frequency-domain representation of 0 IRE carrier level to average noise and average intermods. Accuracy of the carrier level is questionable since span to RBW ratio is greater than 200. But this does give a quick look at the whole channel. To properly average noise, the carrier amplitude may have to set above top of screen. If the averaged noise is not above the 60 dB graticule line then push Amplitude and set the reference level so this is so. This allows proper averaging of negative as well as positive peaks. Attenuator 0 dB may have to be selected if signal level is low or large dynamic range is needed. Attenuator test may need to be performed to check that the analyzer is not the cause of distortion. Noise-near-noise calculation will be needed if system noise is less than 10 dB above analyzer noise. The attenuator should be in manual so that reference level changes don't change the attenuator value and the mixer's distortion performance. See Reference 5 on page 64 for graphs of C/N, CTB or CSO for default attenuator starting point vs. carrier level.

Zoom in on the +1.25 MHz CSO product (Figure 3 on page 58). The accuracy of this noise measurement is based in part on the number of sweeps being video averaged so there is a trade off between time to acquire the data and the accuracy of the data. The gated positive peak detector is being used but the gating process uses a 1 µs gate length so it effectively samples the 30 kHz RBW. Logged noise reads high by 2.5 dB so subtracting 2.5 dB from the absolute noise level is in order. RBW shape correction factor is low by 0.5 dB so add 0.5 dB correction. To refer the noise level to another RBW use 10log(RBW new/RBW old). For noise measured in a 30 kHz RBW and referred to a 4 MHz RBW, the correction factor would be +21.25 dB. Noise-near-noise correction also will be needed.

Since we can't use the VBW to average the noise, use (Smooth TRA 10;). This can be executed from the external keyboard. Since the peak is broad, smoothing over 10 buckets (one quarter of a division) is reasonable.

Also, since the distortion product is closer than 10 dB to the noise floor its level should be corrected. One way to do that is by looking at the delta level and correct the peak level accordingly. One also could use the absolute levels to do the correction:

$$\begin{aligned} \text{Error} &= 10\log[10\hat{}(0/10) - 10\hat{}(-6.6/10)] \\ &= 10\log(1 - 0.219) \\ &= -1.1 \text{ dB} \end{aligned}$$

The beat level is measuring 1.1 dB higher due to noise power adding in. So, subtracting 1.1 dB from the absolute beat level measured would give a more correct beat level. Most intermods vary in amplitude vs. time and therefore video averaging may conceal this fact. Setting the marker to an intermod and pressing marker to center freq, span 0 Hz and video average off may show its time-varying nature.

The gated quiet line of Ch. 3 (Figure 4) shows a +1.5 MHz intermod. This is probably due to the AML third order

Figure 5

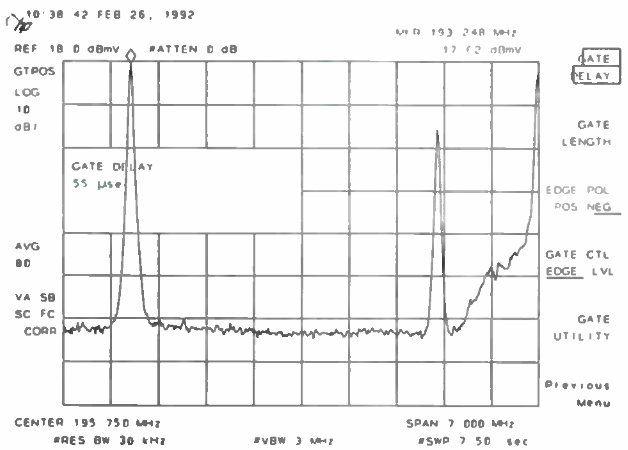
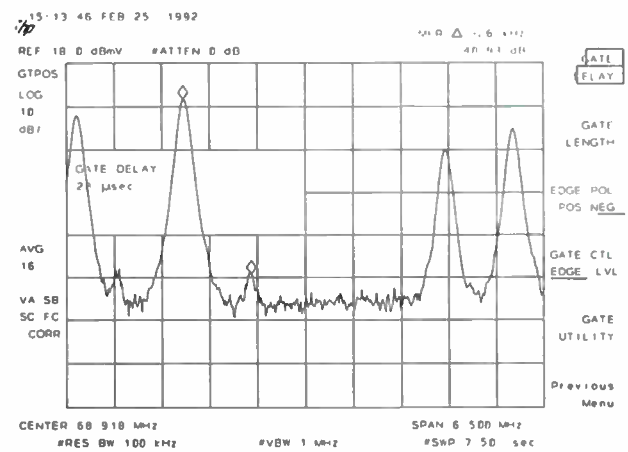


Figure 6



distortion product from Ch. 4 falling into Ch. 3. Two times the visual carrier of Ch. 4 minus the audio carrier of Ch. 4 creates a distortion product 4.5 MHz below the visual carrier of Ch. 4, which is 1.5 MHz above the visual carrier of Ch. 3. This is within the AML specification, but monitoring this intermod in zero span will allow the AML bias to be adjusted to minimize this intermod further. Also, observe the noise floor slope. This could be improved with an AML slope adjustment.

The gated quiet line of Ch. 10 (Figure 5) shows a negative noise floor slope. The small +750 kHz intermod is a CSO product caused by the odd spacing of Chs. 5 and 6 relative to the rest of the channels. Sometimes one can find other residual responses on a quiet line of horizontal sync comb teeth, or color burst, and this could be due to multipath. One also could gate on the ghost training signal sometimes present on some channels to see nulls in the frequency response due to multipath.

Gated VIR of Ch. 4 (Figure 6) shows a problem. On the trigger source analyzer, set TV line number to Vertical Interval Reference signal. Check if it's in both fields and if so select vert int (vertical interval).

On the gated receiver, set sweep time to 7.5 seconds if in both fields, and 15 seconds if not. Set RBW to 100 kHz so it will respond to less than full line duration of burst. Set gate delay to 28 μs and gate length to 1 μs. Turn video average on. This is a third order distortion measurement of (visual - color + aural) carriers at +920 kHz relative to visual carrier. Also, one can see a -920 kHz product relative to the visual carrier due to (visual + color - aural).

Zoom in on the +920 kHz distortion product (Figure 7). This measurement is most useful on broadcast channels or individual channel processors. The intermod level may be very low and difficult to determine but using a large number of video averages and distortion-near-noise calculation will yield a useful result. Smooth TRA 10 also helps resolve the distortion:

Error = 10log[10^(0/10) - 10^(- 8.2/10)]
= -0.7 dB

Where we saw the distortion product in Ch. 3 that may have been caused by the Ch. 4 AML bias adjustment, a gated measurement could be helpful in confirming that.

Gated multiburst on Ch. 4 (Figure 8): Gate delay is 18 μs and gate length is 38 μs. Set RBW to 100 kHz to resolve all bursts, but due to small pulse width of bursts a RBW of 300 kHz gives better amplitude accuracy. For 100 kHz RBW, the pulse time would have to be 2/100,000, which is 20 μs. This is not the case so a reduction of the pulse amplitudes is noted. For 300 kHz RBW, the pulse time would have to be 2/300,000, which is 6.66 μs, and this is not the case. That

Figure 7

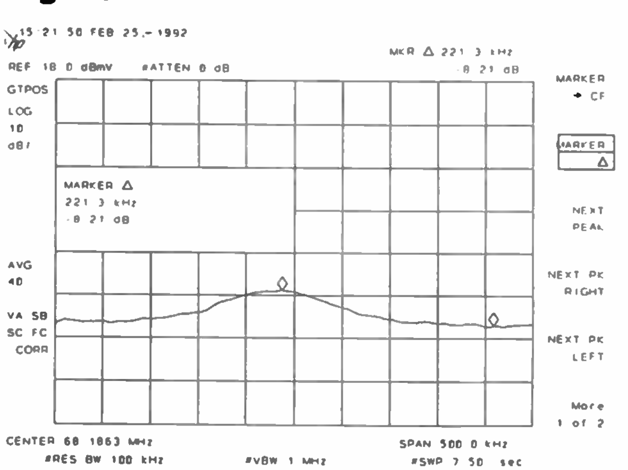


Figure 8

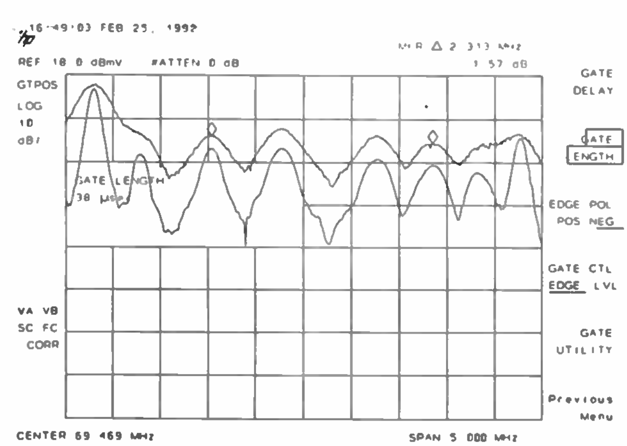


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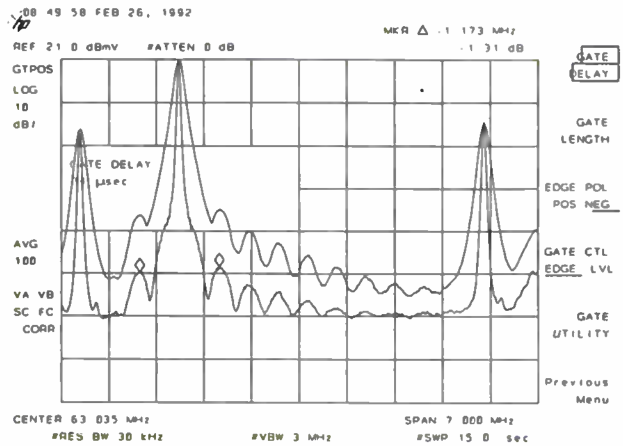
Figure 9



was for a worst-case situation, which we don't have here. The difference of the pulse amplitudes between the two RBWs is 3 dB for 1.25 MHz burst, 4.75 dB for 2 MHz, 5.5 dB for 3 MHz and 6 dB for 3.58 MHz. If the time requirement were cut in half, that would amount to about a 1 dB loss of pulse amplitude for a typical analyzer. Therefore, 300 kHz for RBW is a reasonable value to get an idea of the frequency response. Gating on one spike of the sin x/x test signal would give a more continuous shape of the channel flatness.

This is the gated equalizing pulse of Line 9/even field on Ch. 3 (Figure 9). This allows one to see sync level bandwidth and pulse width. Since the color burst is not present on this line, it does not clutter the display. This displayed measurement is different than the others in that the RBW filters are not allowed to charge to the full value due to the shortness of the pulse for the RBW used. Gate delay is 24 µs and gate length is 15 µs. Trigger source is set to Line 8/even field so that the gate pulse will window the Line 9 equalizing pulse. The line numbers are not correct at this point because we are getting two equalizing pulses per line. The depth of the nulls between the lobes is an indication of modulator balance, phase modulation and group delay. The steepness of the sync pulse rise and fall times, bandwidth, is indicated by the number of lobes seen between the visual and aural carriers and the rate at which they roll off. The spacing between the nulls is a measure of the sync pulse width, 1/435 kHz is 2.3 µs. Overall, this pulse response is a measure of picture quality. Mismatch in first lobe heights could indicate filter misalignment, modulator balance, phase modulation or group delay problems.

Summary

Time gating allows you to examine in-band noise, intermods and bandwidth non-intrusively at any location within the RF chain. Problem causes can be isolated before taking corrective action. Also, in most cases, intermods can be identified and reduced without taking the channel out of service. Other portions of test signals may be viewed. And, other test signals could be designed and inserted for specific use with time-gated measurements. **CT**

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2) Hewlett-Packard Application Note 63A, page 16, August 1977.
3) Hewlett-Packard Application Note 150-2, "Spectrum Analysis ... Pulsed RF," November 1971.
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5) HP 85716 CATV System Monitor Personality User's Guide, Part Number 85716-90001.
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8) "Troubleshooting Microwave Transmission Lines," Karl Kachigan, Hewlett-Packard Co., 1987 RF & Microwave Measurement Symposium and Exposition.
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14) "Theoretical Fundamentals of Pulse Transmission, Part 1," E. D. Sunde, *The Bell System Technical Journal*, May 1954.
15) "Pulse Transmission by AM, FM and PM in the Presence of Phase Distortion," E. D. Sunde, *The Bell System Technical Journal*, March 1961.

Author's note: Special thanks to John Huff, independent consultant; Bruce McPherran, applications engineer, Hewlett-Packard Co.; and Charles Fleshman, Post-Newsweek Cable TV.

To sweep or not

(Continued from page 26)

$S_{min\,20} = -59 + \underset{G_a}{22} + \underset{F_a}{8} + \underset{C}{13} + \underset{R_{min}}{43}$ dBmV

$S_{min\,20} = 86 - 59 = 27$ dBmV

$S_{max\,20} = 48$ dBmV $- C = 48 - 13 = 35$ dBmV

$T_{20} = 34 - (2 * 13) = 34 - 26 = 8$ dB, or

$T_{20} = S_{max\,20} - S_{min\,20} = 8$ dB

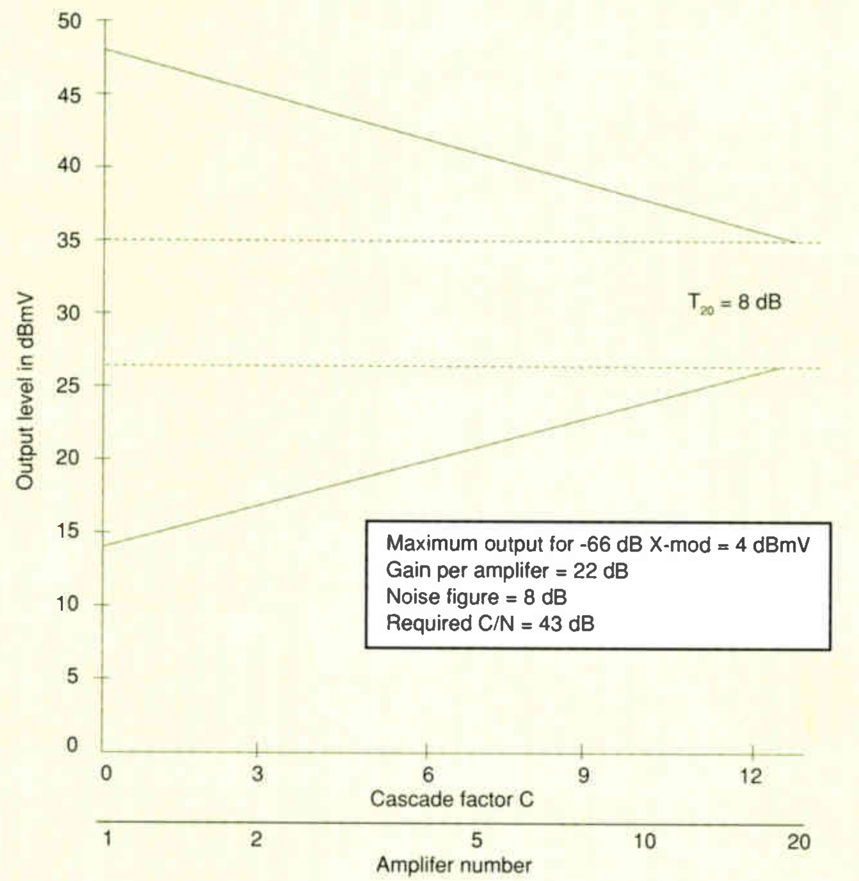
In a cascade of 20 amplifiers, you have T_s = 8 dB. Using a rule for system, flatness = (N/10 +1) dB, where N = 20. Therefore, flatness = 2 + 1 = 3 dB.

The head room in this example, assuming the flatness was 3 dB, would be 5 dB and the nominal level would be a function of the current temperature at the location. As previously stated, sweep response testing gives an operator the opportunity to measure and adjust for head room.

The power of a normalization function can be appreciated when you consider that several sweep technicians with their individual sweep receivers, drop cable and test probes can store a reference at a common test point, and get the same results (response) at some distant test point.

If the sweep receiver has analyzer functionally, measurements can be made on C/N, hum, composite distortion or crossmodulation. These measurement can be analyzed relative to the flatness and level measurements for conformation of overall system performance.

Figure 2: System tolerance



One of the assets of sweep response testing in a preventive maintenance program is that by logging history data (response at location XYZ) over a period of time, trends may become noticeable (such as increased or intermittent ripple in one area of the response, high end roll-off, and excessive level or slope change with temperature). Any of these trends in and of themselves could provide insight as to possible problems and service to be performed, but couple this with other system information such as leakage data, data from end-of-line monitors, data from signal level meters or status monitor reports and you will increase your chances of doing the right maintenance at the right place before a problem becomes extreme.

In the case of intermittent problems or outages, this history data combined with the information on areas where the intermittent problems or outages have occurred will help to pinpoint the trouble and get the system back to operational status.

The computer has become part of our industry and instrumentation capable of interaction with a computer data base has multiplied its value as a maintenance or troubleshooting tool.

The future

Fiber-optics deployment in broadband networks is increasing. Since cascade lengths are becoming shorter, there are those who believe there is less need to use sweeping as a primary maintenance tool. While it may reduce the numbers of amplifiers, the reduction of cascade length also will probably be coupled with an increase in bandwidth for those cascades. As the bandwidth increases, the physical association of the various connections become more critical. Phase relationships and return loss/reflection will have more importance to fully utilize the increased frequency spectrum, especially if the utility means high definition, compression or other digital formats.

RF-to-light and light-to-RF interfaces need to be well-matched and the RF sweep is still the best tool for this task, especially if the receiver is the tracking type that can serve additional needs such as level measurement spectrum analysis and data storage.

A single sweep transmitter can be set up at a headend or master node even with multiple lasers, and a response can be measured at subnodes and/or amplifiers cascaded from the subnodes.

The new digital compression systems may present cost-effective options to extend the life of existing plant by increasing channels without increasing bandwidth. The best way to run a clean system now and in the future is to keep sweeping it out.

Selecting an instrument

In closing, the following factors should be considered when selecting an instrument for a preventive maintenance program: 1) Is the instrument designed to be used in the environment? 2) Are the functions and features compatible with your current and future needs? 3) If future needs arise, is it likely that the instrument could be upgraded? 4) Is the instrument supported by application people who can help you with a particular problem? 5) Does the instrument interface with a computer through application software and will it be compatible with any other instruments interface formats?

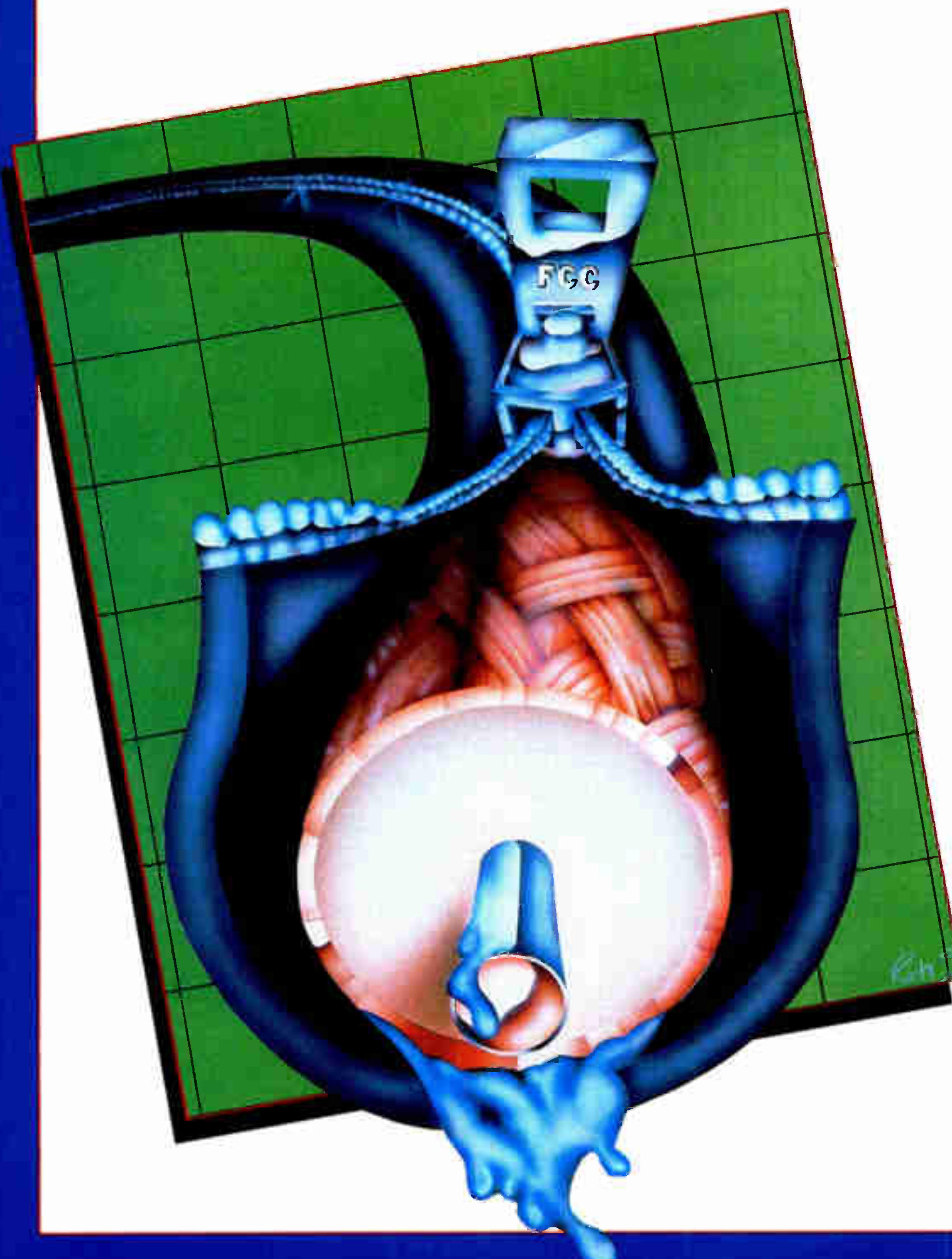
Successfully meeting these considerations will result in a well-maintained CATV system with the effective use of state-of-the-art technology. **CT**

September 1992

BACK TO BASICS

The training and educational supplement to Communications Technology magazine.

Leakage prevention



Rich Skiermont

Table of Contents

Leakage prevention — not detection

By Brian Wilson
Technical Trainer
National Communications Services

During the past two years, cable operators and manufacturers have worked in conjunction to improve the quality of the materials used in the drop system today. High-quality coaxial cable and premium and universal weather-resistant F-connectors will do their part to improve the reliability of the drop system. Focusing on signal leakage prevention will lead us to a reduced service call rate and improve customer satisfaction.

We have received manufacturers' engineering objectives, but to accomplish our goal we will need to train and improve the quality of workmanship being performed in the field. Extensive training and quality assurance programs should be implemented and preventive measures employed during routine daily activities.

Studies indicate that drop-related signal leakage is due primarily to the F-connector. About 60 to 70 percent of the F-connectors causing signal leakage were loose. Regardless of the engineering involved in the development of the F-connector and the preparation methods employed, if F-connectors are left loose, they will fail.

"About 60 to 70 percent of the F-connectors causing signal leakage were loose."

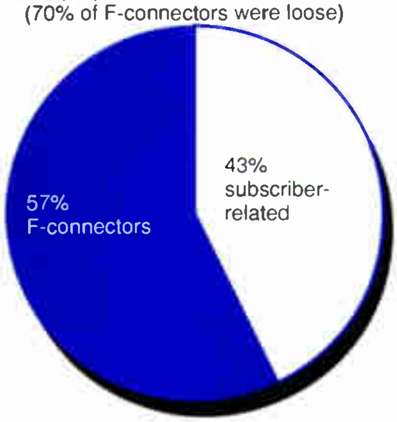
Leakage suggestions

During a survey taken at a large MSO, the technicians were asked what they could do to prevent signal leakage during routine service work. The following are the responses received:

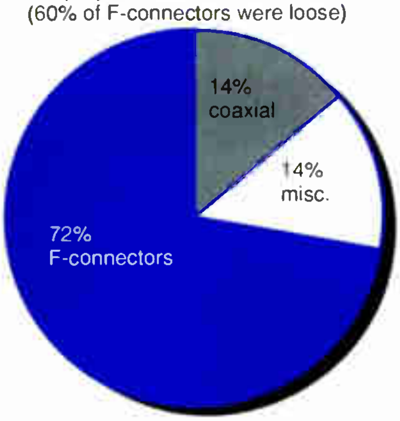
- Supply personnel with leakage detectors.
- Wrench-tighten all F-connectors.
- Remove F-connectors that are improperly installed, water damaged or defective.
- Replace poorly shielded drop cable.
- Replace drops that suffered shielding degradation due to age or corrosion.
- Remove manufactured VCR jumpers and slip-on F-connectors.
- Install A/B switch for video games.
- Weatherproof all exterior F-connectors.
- Tighten or remove locking terminators at tap.

Drop-related leakage sources

Drop system — interior
(70% of F-connectors were loose)



Drop system — exterior
(60% of F-connectors were loose)



- Install converters on limited-bandwidth tuners.
- Terminate drop at pole and check for picture and sound on locals.
- Use attenuators on subscriber equipment causing leakage.
- Adjust work load to compensate for addition time required to perform preventive maintenance requirements.
- Offer training.

The trend here is that the technician is aware of the steps involved in signal leakage prevention. The time allotted to do the job right or to perform preventive maintenance may be the contributing factor, resulting in future leakage or repeat trouble calls. Doing the job right the first time will involve the development of a comprehensive installation procedures and training manual, a well-developed training program and a good quality assurance program.

The prevention of signal leakage is everyone's responsibility and it will take a team effort to accomplish our goals. **BTB**

F-connectors revisited

By Pam Nobles
Senior Staff Engineer/Technical Training
Jones Intercable

You've no doubt heard that the tap to the TV is the weakest link in the cable system, and that the F-interface is the weakest in this link. Many advances have been made in F-interface technology, but field checks indicate we're not where we could or should be.

Moisture an enemy

For many years now people have been exploring ways to seal the F-interface. One of the most common ways to seal the connection is the use of a "spark plug" boot and some silicon gel or grease. Other ways of sealing the connection are heat shrink and different forms of sealing tapes. All of these methods were devised for one reason: to keep moisture out of the F-connection.

Moisture is the main enemy of any connection. Moisture will cause corrosion and degrade the electrical characteristics of the connection. Unlike many connections, the F-interface is an impedance-matched connection. When any deformity occurs in the connection the impedance match is affected, which can cause attenuation in the low band of the CATV drop, signal leakage, flashing pictures, ghosts and beat interference.

It is very important to properly weatherproof the F-interface. Recommended are weather boots filled with grease, PolyChem air-shrink or environmentally sealed F-connectors that can be used without exterior protection.

Never pack the inside of an F-connector with grease. A majority of the electrical contact that gives the F-interface the impedance match it needs is accomplished through the contact of the post on the F-connector and the port face. If a large amount of grease is used inside the connection the electrical contact between the connector and port will be depleted. This will cause signal leakage and drop signal attenuation.

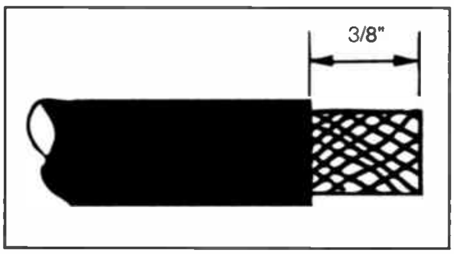
Use only a slight amount of grease on the threads! There is only a small amount of electrical contact between the F-connector and port at the threads and grease will not affect the contact in this area. Instead the grease will guarantee that moisture will not migrate down the threads of the port and get into the F-interface. A small amount of silicon on the threads also will help to alleviate the "stuck ports" that are in existence in many of the older drops.

Verification is important

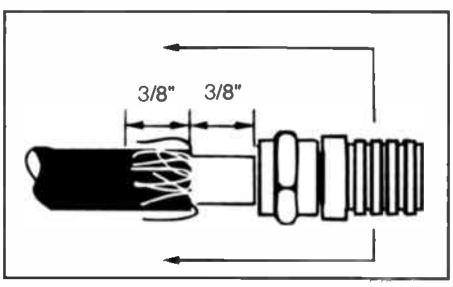
The *Installer Training* interactive video program, produced by Mind Extension Institute, leads an installer through prepping the cable. The training is provided through computer graphics; a summary is supplied in the participant's workbook. Although an installer can work alone on the training, the facilitator conducting the training still needs to ensure the F-connections are properly made in the classroom and properly tightened and weatherproofed in the field.

Following is an excerpt from the *Installer Training* participants' workbook.

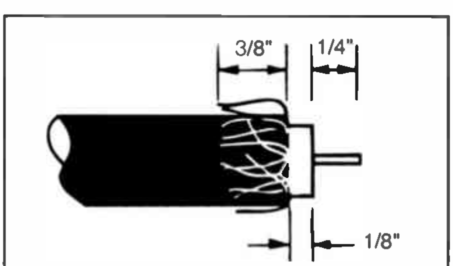
Installing standard F-connectors



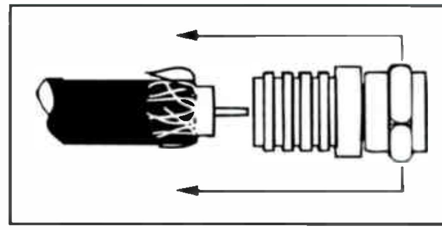
1) Cut end of cable off square with cutters.
2) Use knife to cut off 3/8-inch of jacket.



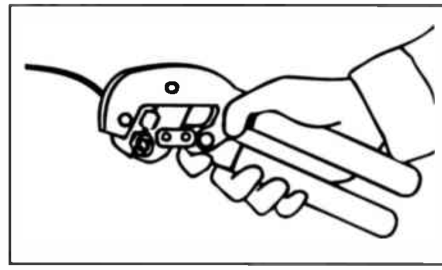
3) Fold all braid back over jacket. Make sure the foil is not torn or pushed off the dielectric.
4) Shape dielectric so it is round by pushing the connector on backwards.



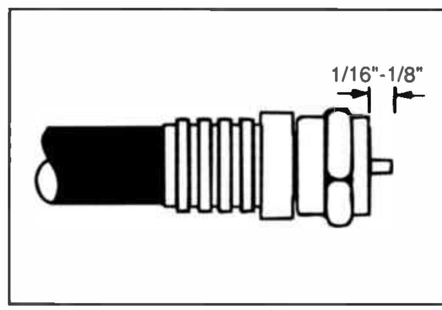
5) Cut off 1/4-inch of dielectric.



6) Push connector on to cable leaving braid folded back under crimp ring. Make sure dielectric is flush with inside bottom of connector.



7) Put connector into correct crimp hole and squeeze until crimpers stop. Never double crimp.



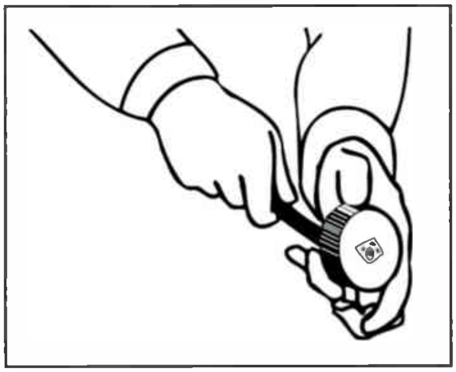
8) Check that center conductor extends out 1/16-inch beyond connector.

F-connector quality checklist

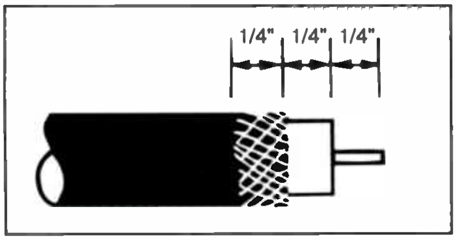
Each F-connector should be checked to make sure it meets the following quality guidelines:

- All braid folded back over jacket.
- Center conductor is clean; all dielectric has been removed.
- Foil is not peeled away from dielectric.
- Center conductor extends 1/16 to 1/8 of an inch from the edge of the connector.
- End of dielectric is pushed firmly against the post face of the connector.
- No braid sticks out from the crimped portion of the connector.
- Crimped part of connector is not cracked.
- Pull on the connector to make sure it is firmly attached to the cable.

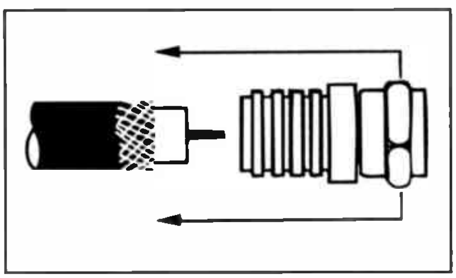
Installing universal F-connectors



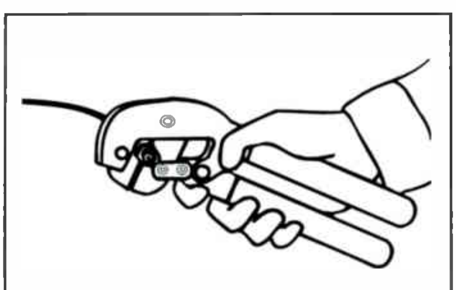
1) Cut end of cable off square with cutters.
2) Insert cable end into tool until it reaches the stop. Spin cutter until blade cuts through jacket, braid and dielectric.



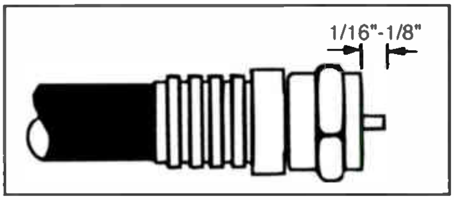
3) This cutter provides 1/4-inch prep distances.
4) Fold all braid back over jacket.
5) Push connector on. Make sure foil is not torn or pushed off the dielectric.



6) Push connector on to cable leaving braid folded back under crimp ring. Make sure dielectric is flush with inside bottom of connector.

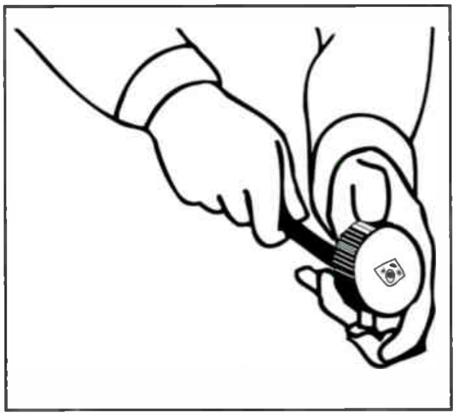


7) Put connector into correct crimp hole.
8) Squeeze until crimpers stop. Don't double crimp.

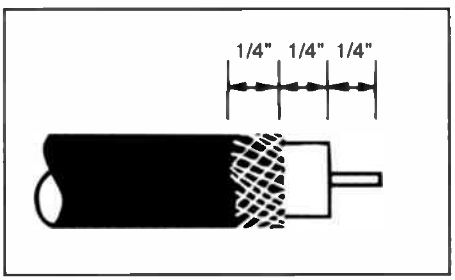


9) Check that center conductor extends out 1/16-inch beyond connector.

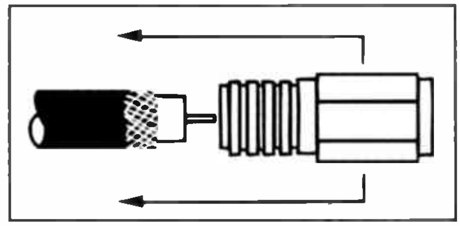
Installing universal weatherproof F-connectors



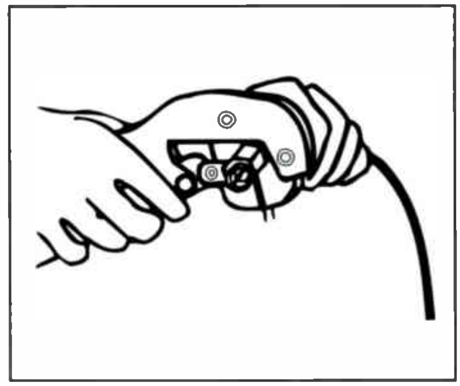
1) Cut end of cable off square with cutters.
2) Insert cable end into tool until it reaches the stop. Spin cutter until blade cuts through jacket, braid and dielectric.



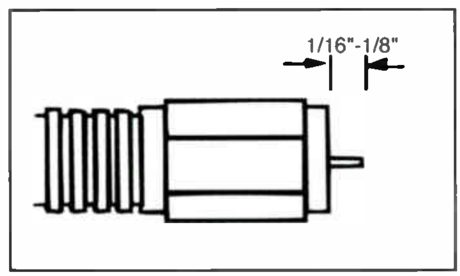
3) This cutter provides 1/4-inch prep distances.
4) Fold all braid back over jacket.
5) Push connector on. Make sure foil is not torn or pushed off the dielectric.



6) Push connector on to cable leaving braid folded back under crimp ring.
7) Make sure dielectric is flush with inside bottom of connector.



8) Put connector into correct crimp hole.
9) Squeeze until crimpers stop. Don't double crimp.



10) Check that center conductor extends out 1/16-inch beyond connector. **BTB**

The author would like to thank Mind Extension Institute for the use of the workbook pages and Frank Eichenlaub, now of TCI, for his thoughts on the subject.

Closing the lid

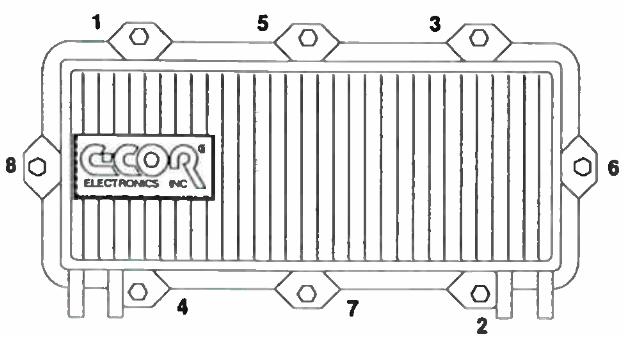
The following is adapted from spec sheets and installation manuals supplied by C-COR, Jerrold, Philips and Scientific-Atlanta. The information is provided to show the proper way to close amplifier housings.

C-COR

To close and tighten C-COR's four- and eight-port covers:

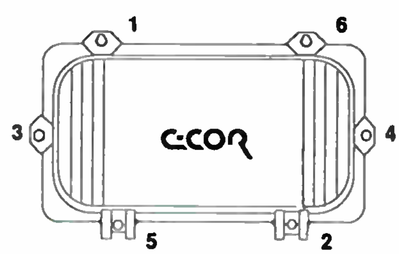
1) Examine the rubber gasket and aluminum mesh seal. Remove all foreign materials that could interfere with proper sealing. Dry any moist areas.

Figure 1: C-COR eight-port tightening sequence



2) Close the cover until it is flush with the rubber gasket. Refer to Figures 1 and 2 for the tightening sequence for four- and eight-port housings. Thread all cover bolts finger tight to hold the cover in place. Ensure that it seats evenly on the rubber gasket.

Figure 2: C-COR four-port tightening sequence



3) Hand tighten the cover bolts with a 7/16-inch nut driver. Tighten every other bolt following the pattern shown in Figures 1 or 2, depending on model. Observe that the cover seats on the rubber gasket. Caution: Do not torque the cover bolts more than 40 inch-pounds (4.5 newton meters). Over tightening may warp the housing, allowing moisture to enter and damage the components.

4) Repeat the tightening sequence (again, torquing no more than 40 inch-pounds) with a torque wrench. The cover should now seat evenly and compress the rubber gasket to create a weatherproof seal.

Jerrold

• To close the housing on Jerrold's MB-* Series amplifiers:

1) Check all module cover screws as well as module retaining screws for proper tightness.

2) Close the housing with care to avoid pinching the cord between the power pack and the amplifier module.

3) It is important to progressively tighten the closure bolts in the diagonal pattern shown in Figure 3 to a final torque of 10-12 foot-pounds to avoid water ingress.

Figure 3: Jerrold MB-* tightening sequence

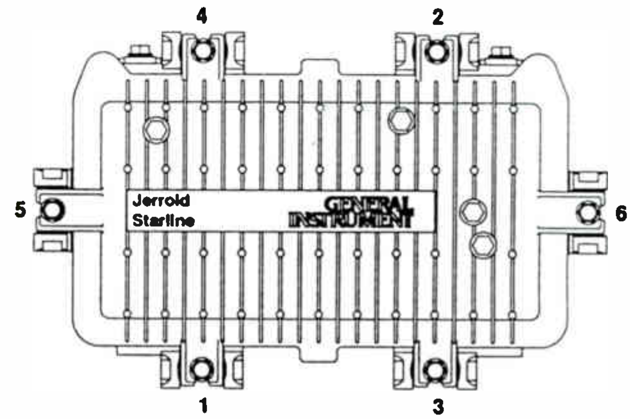


Figure 4: Jerrold JLX-*-* tightening sequence

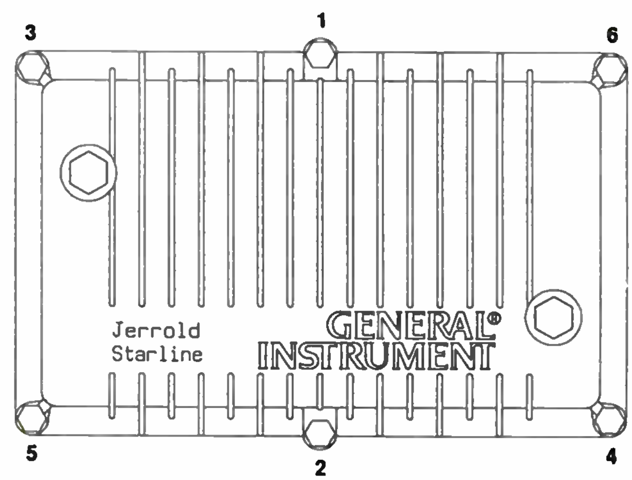
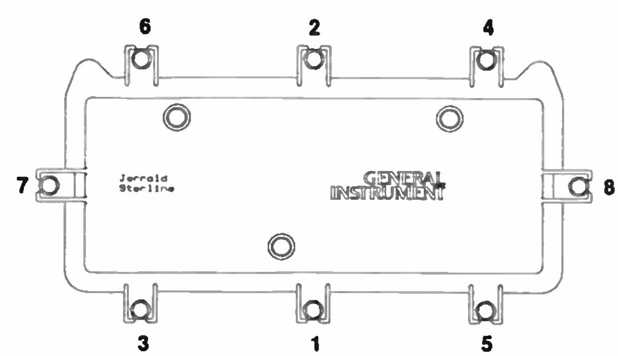


Figure 5: Jerrold SXHG-* tightening sequence



• When closing the housing on Jerrold's JLX-*-* Series line extenders:

1) Make sure the gaskets on the housing assembly are properly seated, then firmly close the housing.

2) The housing closure bolts should be torqued to 48-72 inch-pounds in the sequence shown in Figure 4.

• To close the housing on Jerrold's SXHG-* Series trunk stations:

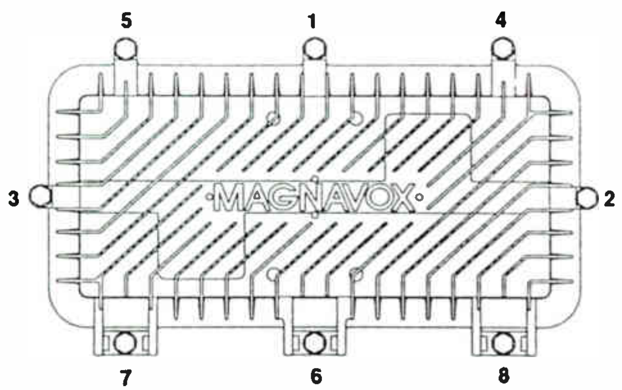
1) Loosen the three latch and bolt assemblies at the bottom of the housing assembly a few turns, in addition to the five assemblies on the top and sides of the housing.

2) Make certain that the sealing gasket in the flange of the housing assembly and the RFI gasket in the flange of the cover assembly are properly seated.

3) Then close the cover, avoid pinching the cables, and hand-tighten all eight latch and bolt assemblies.

4) Using a torque wrench, secure the cover. The tightening sequence shown in Figure 5 is for the housing assembly in its normal installed position. Final torque value is 7-9 foot-pounds.

Figure 6: Magnavox 7-TH tightening sequence



Philips/Magnavox

With Philips' Magnavox line, follow the specific patterns for loosening or tightening the bolts that secure the housing lid in place. All hinges and bolts should be retightened every time the housing is opened or closed.

• Close Magnavox's 7-TH Series mainstation housings by following these steps:

1) Make sure the housing is free of moisture and dirt.

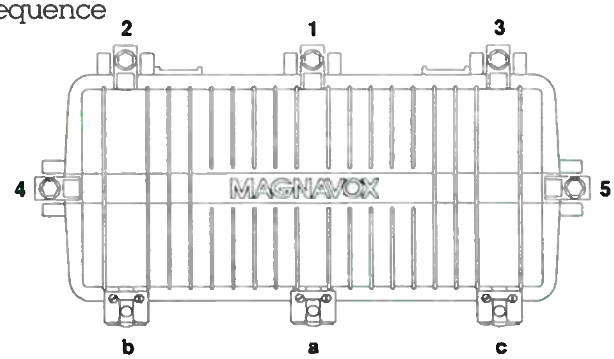
2) Inspect the rubber weather gasket. It should be firmly seated in its groove on the housing base. The gasket should appear uniform, with no wrinkles or bulges. The edge of the rubber weather gasket that will meet with the lid should point straight out. If the weather gasket has been disturbed, reposition it.

3) Check the hinge bolts. They should be loosened enough to allow the lid to close without binding. Swing the housing lid closed, and check to make sure that the power supply cord will not be pinched when you tighten the lid down.

4) Tighten hinge and perimeter bolts as shown in Figure 6 to a torque of 50 inch-pounds (5.6 newton meters). Repeat the sequence again with the same torque force on the perimeter bolts only. This torque can be easily achieved with a standard half-inch nut driver.

Note that you should never tighten the hinge bolts with the housing lid open.

Figure 7: Magnavox 5-TH and 6-TH tightening sequence



• On Magnavox's 5-TH and 6-TH Series mainstation housings do the following:

1) Make sure the housing is free of moisture and dirt.

2) Inspect the combination wire mesh/rubber gasket. It should be firmly seated in its groove on the housing base. The gasket should appear uniform, with no wrinkles or bulges. If the gasket has been disturbed, replace it.

3) Swing the housing lid closed and check to make sure that the power supply cord will not be pinched when you tighten the lid down.

4) If you have replaced the cover altogether, be sure to secure the hinge screws before tightening the perimeter bolts. Tighten the hinge screws as illustrated in Figure 7 in two rounds. On the first round, follow the sequence (a, b, c) tightening the screws to a torque of 20-30 inch-pounds (2.3-3.4 newton meters). On the second round, follow the same sequence tightening to a final torque of 45-55 inch-pounds (5-6.2 newton meters).

5) Tighten perimeter bolts as illustrated in Figure 7 in two rounds. On the first round, follow the sequence (1 through 5) tightening the bolts to a torque of 45 inch-pounds (5 newton meters). On the second round, following the same sequence tightening to a final torque of 80-110 inch-pounds (9-12.4 newton meters).

• To close Magnavox's *-LH Series line extender housings use the following procedure:

1) Make sure the housing is free of moisture and dirt.

2) On 7-LH models, inspect the rubber weather gasket. It should be firmly seated in its groove on the housing lid. The gasket should appear uniform, with no wrinkles or bulges. The edge of the rubber weather gasket that will meet with

Hazard Communication Standard training

By Michael H. Morris
President, Taylor, Morris and Associates

Between 1,000 and 3,000 new chemicals are created each year. Many of these chemicals are then introduced into the workplace. Many are toxic, some are lethal, and some are unknown. The Office of Technology Assessment (OTA) estimates that as many as 100,000 people die each year from occupational illnesses.

Forty years ago, employees summarily worked around asbestos. Few considered asbestos a hazard. Thirty years later, thousands of people died from lung cancer and many continue to die. Twenty years ago, children in Detroit exhibited a higher than average degree of mental retardation with the cause stemming from water pipes and paints from which the children ingested lead.

The perils of assuming

So what is the point? What does that have to do with me? The point is that we are exposed to various toxic materials on a daily basis, and we generally are ignorant of their impact on our health and the protective equipment we should use in handling them. We assume that because we can purchase the item from supermarkets, hardware stores, K-Mart, etc., it's not dangerous. We assume that because our employers provide us with the materials, they are safe. Forty years ago, workers assumed that asbestos was safe. Today we know that it is extremely hazardous to our health.

In 1970, Congress created the OSHAct to ensure a healthy and safe work environment because thousands of workers were being injured or killed on the job. In 1987, the Hazard Communication Standard (29 CFR 1910.1200) was enacted to protect the American worker from hazardous chemicals and materials that were causing occupational illnesses and deaths.

Hazard Communication Standard

Many employers do not adequately understand the Hazard Communication Standard. The most common excuse (for non-compliance) is: "We don't use any hazardous chemicals and/or materials here," or they may cite the supposed "K-Mart Act" — if you can buy it at K-Mart, it's not a hazardous chemical or material.

To begin with, there is no K-Mart Act. This was recently demonstrated when a major retailing chain was cited for not having a hazard communication policy and program. The citation was contested by claiming that Windex and Formula 409, the chemicals in question, were not hazardous chemicals. The retailer lost the appeal. The basis of the ruling was the application and environment of the two chemicals presented a substantial hazard to the health of the worker. Windex and 409 can be considered hazardous chemicals. *Webster's Dictionary* defines "chemical" as "a substance obtained by a chemical process or used for producing a chemical effect." If this definition were to be taken literally, anything (except food) that comes out of a bottle, can or package could be considered a chemical.

One highly placed industry engineer swears that he refuses to train his employees "not to drink Liquid Paper" (the white stuff some people use to occasionally cover up mistakes on the computer screen). He continues to say, "That's common sense."

Unfortunately, the problem with common sense is that it's not so common. The majority of individuals will not intentionally inhale or swallow Liquid Paper, but what about painting your child's face with it for Halloween? Do you know that Liquid Paper can be fatal if inhaled?

Defensive safety

The point here is that we must learn to practice defensive safety when it comes to chemicals. We must be aware of potentially dangerous chemicals with which we may come in contact while performing our work assignments. Chemicals that we use in cable TV can injure you, kill you, make you sterile and/or have long-term toxic organ impact.

Toxic chemical poisoning is a serious matter. The most common citation issued by OSHA is for Hazard Communication Standard violations.

The question that needs to be asked is, "How do I protect myself and others from the hazardous chemicals we use?"

Simply, the Hazard Communication Standard's scope and application "... requires chemical manufacturers or importers to assess the hazards of chemicals that they produce or import, and all employers to provide information to their employees about the hazardous chemicals to which they are exposed, by means of a hazard communication program, labels and other forms of warning, material safety data sheets, and information and training ... "

What the foregoing means to employers and employees is:

1) Your company must have a written hazard communication policy and program. That program defines your policies in reference to the Hazard Communication Standard, 29 CFR 1910.1200.

2) Your company must provide a listing of all hazardous chemicals and/or materials with which an employee may come in contact while performing normal job assignments. Your local OSHA office can provide a listing of hazardous and very hazardous chemicals. However, chemicals other than those listed may be hazardous and still require an material safety data sheet (MSDS).

3) Your company must acquire MSDSs and check them for accuracy. An MSDS must be on file for each hazardous chemical/material used on site or in extended work areas. MSDSs must be available for inspection by employees. An MSDS contains nine sections that include:

- Chemical identification
- Hazardous ingredients
- Physical data
- Fire and explosion data
- Health hazard data (emergency procedures to be used if exposed)
- Reactivity data (what happens if you mix it with other chemicals)
- Spill or leak procedures
- Protective equipment to be used in handling and working with the hazardous chemical and/or material
- Special precautions to be used in storing or handling the material →

4) Your company must provide a labeling and warning system for hazardous chemicals and materials. Several systems exist for hazardous material identification. Two of these are: the DOT standard (the triangular signs with numbers seen on trucks) and the Hazardous Material Identification System (HMIS) as used by the National Paint and Coating Association. This system very simply identifies hazardous chemicals and/or materials with a 0 through 4 rating, with 0 being minimal and 4 being extreme. These ratings cover four categories that include:

- Health effects
- Flammability
- Reactivity
- Protective equipment that should be used while handling the material

As an example, propane would usually require a "4" rating for flammability. Other ratings depend upon the application in which the product is used. Thus, the rating may vary depending upon the application and environment in which the chemical is used.

All hazardous chemicals must have a label affixed to the container. Some minor exceptions may apply.

5) Your company must train employees in respect to and not necessarily limited to the foregoing. Training must be provided to *all* employees.

Training is key

At first glance, this may appear overwhelming. In reality, it is not. The obvious intent of 29 CFR 1910.1200 is to train employees with respect to hazardous chemicals with which they may come in contact. As an example, the average cable TV service vehicle may contain marking paint, RTV, silicone grease, wasp and hornet spray, Fix-a-Flat, windshield solvent, PVC cement, Farboil removing agent (gas), carburetor cleaner, and perhaps many more chemicals. The simple questions that should be answered for each employee are: "If I get this stuff in my eyes, what should I do?"; "Is it going to have any long-term effects?"; and "How could I have avoided this accident?" Training all employees with respect to 29 CFR 1910.1200 will answer these questions.

A company that willfully avoids compliance with the Hazard Communication Standard not only puts itself at risk financially, but also puts its employees at risk in terms of illness, injury, death and long-term toxic organ impact. **CT**

PRODUCT NEWS

Power meter

The FPM-8200 from ILX Lightwave Corp., the newest member in its line of fiber-optic instrumentation, is a precision systems-capable fiber-optic power meter that provides optical power measurement from 800 to 1,600 nm. The FPM-8200 features 85 dB of dynamic range and NIST-traceable calibration. Maximum instrument flexibility is achieved with digital averaging, save and recall functions, and an LED bar graph that displays relative power as a percent of full scale for each gain range. The FPM-8200 offers standard analog output ports and a sophisticated GPIB/IEEE 488.2 interface option designed for complete system integration with other lab equipment.

Reader service #209

SLM, leakage monitor

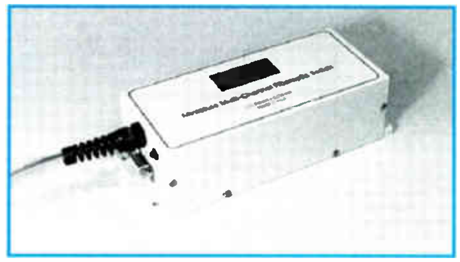
The Tricorder by Trilithic Inc. is a multifunction instrument that combines the features of a signal level meter (SLM), a leakage monitor and a data logger. The unit weighs only three pounds and is small enough to carry in one hand.

In SLM mode, the Tricorder provides fully synthesized, spin-knob tuning from 5 to 1,000 MHz (or 5 to 600 MHz), and can be set from the front panel to tune in NCTA, HRC, off-air channel plans, or in one of two plans defined by the user.

In leakage mode, the unit can be set in 12.5 kHz steps to monitor any frequency from 108 to 158 MHz. An optional mobile mount allows the operator to monitor leaks as small as 5 µV/m while driving.

The data logging option measures and stores up to 100 channel levels at up to 24 sites. The option also performs the FCC 24-hour level variation test automatically and on internal batteries. The rechargeable battery packs are field-replaceable. The Tricorder also will operate on alkaline batteries, 115 VAC or vehicle power.

Reader service #198



Multichannel switch

DiCon Fiberoptics introduced a miniature multichannel fiber-optic switch. According to the company, this is the first and only miniature multichannel switch available on the market.

It is a compact optical switch module designed for integrating within products that require 1 x N optical signal routing. The switch measures only 2 x 3 x 7 inches and provides highly accurate fiber-to-fiber positioning of either single-mode or multimode fibers with a 0.5 dB typical loss.

Reader service #208

Identification tags

Tech Products has developed Everlast, a tag/marker system using a patented two-step injection molding process. The company claims that because the tags are 0.04-inch thick, they are practically inert to adverse environmental conditions and are virtually abrasion proof. The tags are said to offer superiority over printed or hot-stamped markers in resisting UV rays, ground water chemicals, alkali and acid solutions. Also, in vandalism-prone areas, the increased visibility of the 3-inch character height of Everlast tags permits them to be installed higher up and out of reach.

The tags are available in 0 through 9, A through Z, and in standard or cus-

tom symbols, wordings or logos. They can be mounted individually or as a horizontal or vertical arrangement of tags in extruded aluminum or weatherable black poly holders. The holders come with holes and slots for mounting with nails, tie straps or banding.
Reader service #207

Remote-control panel

A new remote-control panel (RCP) designed to make uninterruptible power systems (UPS) even easier to use has been introduced by Best Power Technology Inc. The RCP, which comes standard on all Best FD and RD series FERRUPS UPS models and is available as an option on the ME and RE models, allows monitoring and controlling of the UPS from a remote location.

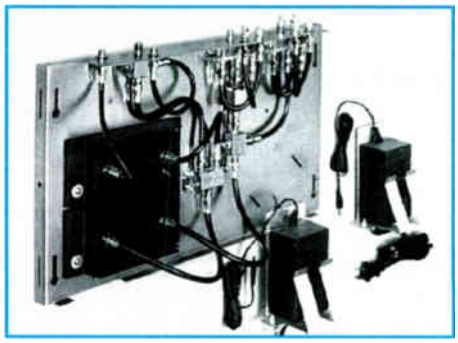
The new RCP automatically establishes communication with the FERRUPS with a single touch of the enter key. The improved configuration menu lets users control display brightness, turn beeper and key click on and off, and set communication rate. Users can lock out the display from the panel itself, rather than use the key switch on the front of the FERRUPS, for added security when operating the UPS from a remote location.
Reader service #206

Drop cable trimmer

Cablematic Division of Ripley Co. has introduced a cable trimmer for end preparation of CATV RG-59 and RG-6 drop cable in all braid and shielding variations. The new Drop Trimmer, which Cablematic claims is the most economical tool of its type on the market, has two cavities to prep the jacket and center conductor, using a high-carbon steel cutting blade.

The blade is preset at the correct cutting depths for both cable sizes and molded in place for accurate repetitive cuts. A "V" notch in the blade is designed to trim around the center conductor without nicking the conductor. The jacket trim is set to prevent penetration of the outer conductor braid.

The U.S.-made stripper is molded from high-impact Delrin with a large finger loop for easy tool rotation during use. A strip gage is provided to check the finished cuts. When not in use, the stripper can be attached to a belt or tool bag with an integral storage clip.
Reader service #204



Cable panel

The new Channel Plus coaxial cable panel from Multiplex Technology provides a central point of distribution for multiroom video installations, delivering a premium quality picture to every TV set. Complete with all necessary com-

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This edition is the first to have an extended mailing beyond that of ***Communications Technology's*** total circulation of nearly 25,000. The ***Product Showcase*** will have a separate distribution of approximately 7,000 to shows and to key decision makers in corporate management, management, technical engineering and marketing.

As with any new publication, we are growing and will continue to entertain viable possibilities and ideas toward strengthening its service to the cable communications industry. For example, this edition is the first to include a "Lab Report" from ***Communications Technology.*** If the product tested had an update to it, the latest information would be presented, thereby reflecting the mission of the publication: to bring the readers up-to-date product news and information on equipment and services.

Your comments and suggestions are encouraged, and welcomed! We are here to serve you better!

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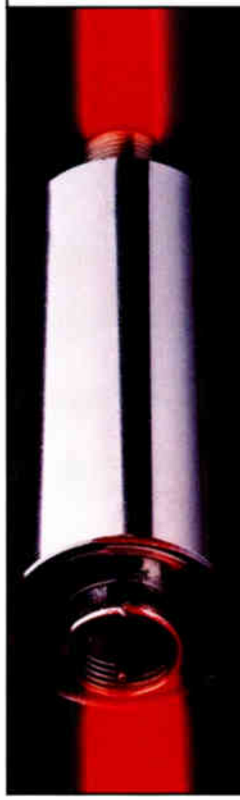

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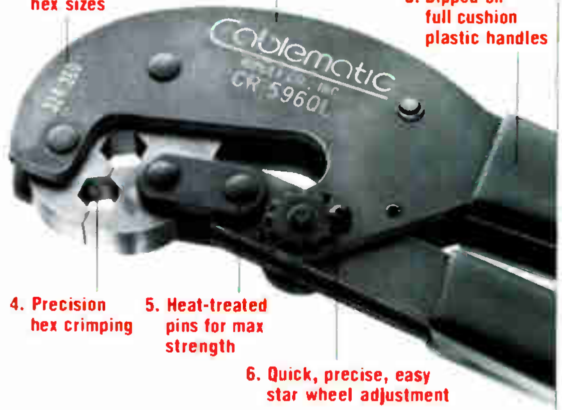

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Reader Service Number 231

Reader Service Number 232

Reader Service Number 233

Reader Service Number 234

Tektronix TSG-100 NTSC TV generator

The following originally appeared as "CT's Lab Report" in the April 1990 issue of "Communications Technology."

By Ron Hranac

When I think of Tektronix video test equipment, two attributes come to mind: high quality and high price. But a couple years ago, Tektronix introduced its TSG-100 NTSC video generator. What really made it unique was — in addition to the reputation normally associated with the company's TV products — a very reasonable price. For less than the cost of many CATV signal level meters, here was a digital video signal generator. About a year later, the company added a no-cost option to delete the standard test signals and replace them with transmission test signals (a combination perfect for CATV headend testing).

CT obtained a TSG-100 video generator configured with option 01 (transmission test signals) for this evaluation and had it put through the paces in Jones Intercable's corporate lab.

The product

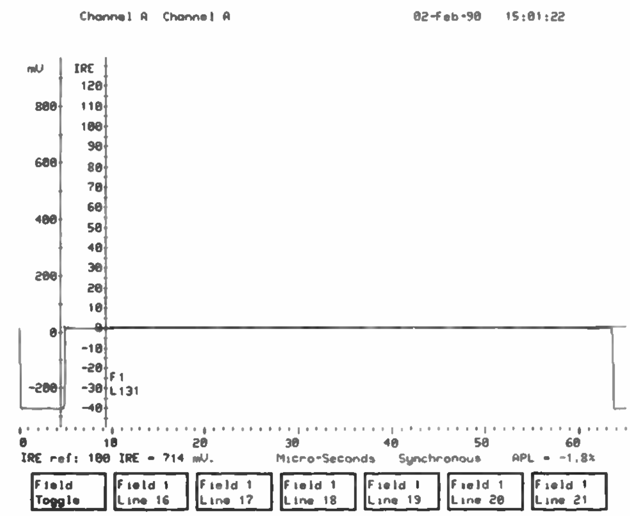
The TSG-100 video generator is not much larger than a typical hardbound book. It measures 1.7 inches high, 8.1 inches wide and 12 inches deep; it weighs a little over three pounds. This compact package provides the user with several video signals that are generated digitally as eight-bit words then converted to analog baseband waveforms. The option 01 test signal complement includes NTC-7 composite, NTC-7 combination, color bars, sin x/x matrix, field square wave, 50 IRE flat field and 0 IRE flat field signals.

For conventional oscilloscope measurements of the generated waveforms, the TSG-100 includes a scope trigger output that is switchable between horizontal and vertical rates. The generator also provides a user-adjustable 1 kHz audio tone (factory set at +8 dBm) that is perfect for setting headend modulator audio deviation. If portability is a concern, the generator operates via 120 VAC or an external +11 to +16 VDC source.

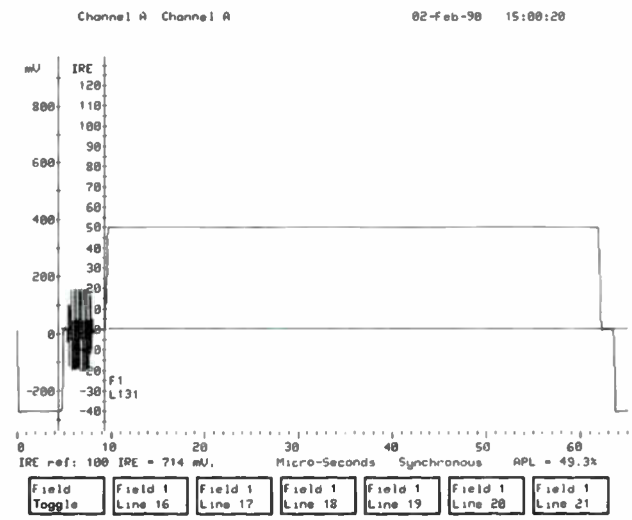
Front panel controls, indicators and connectors — Eight front panel momentary-contact push buttons are used to select the desired test signal and an additional push button selects between horizontal and vertical trigger pulses for external scope triggering. LEDs in the center of each button indicate which signal has been chosen. Two BNCs are located on the front panel; one is a 75 ohm full-field video output and the other is the trigger pulse output.

Rear panel controls and connectors — The only control on the rear panel is the on-off switch; Tektronix calls it an "on-standby" switch. Both AC and DC power are turned on and off with this switch. If you remove the AC power cord the switch controls the DC input and with the AC cord in place the switch

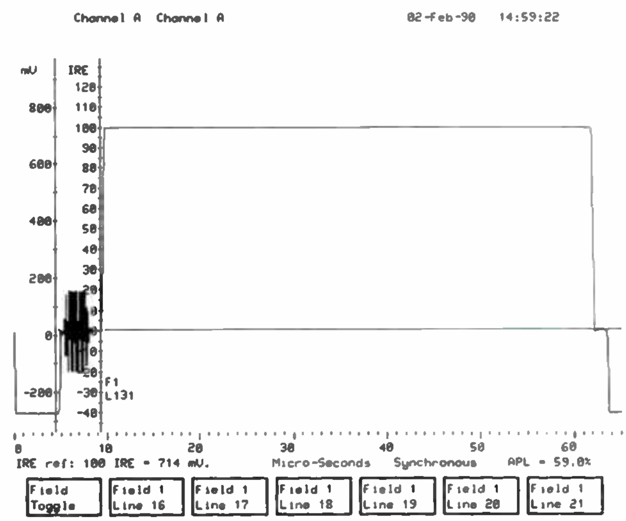
Zero IRE flat field



Fifty IRE flat field



Field square wave

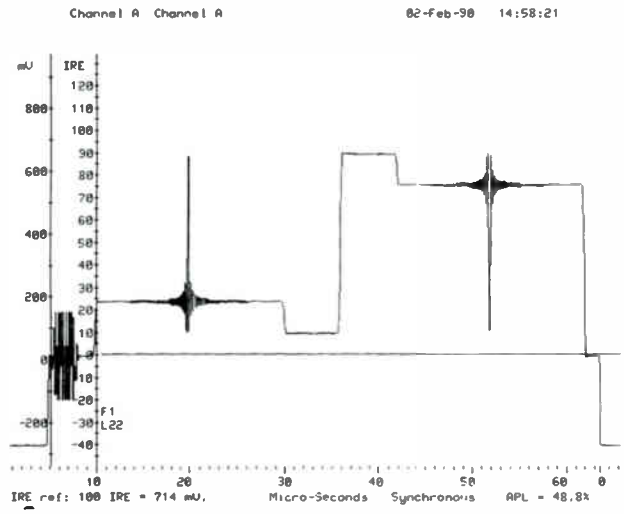


controls the AC input. When both power sources are connected, the TSG-100 operates off the AC input. The unit's AC fuse holder is located next to the AC power socket. Power consumption is under 10 watts.

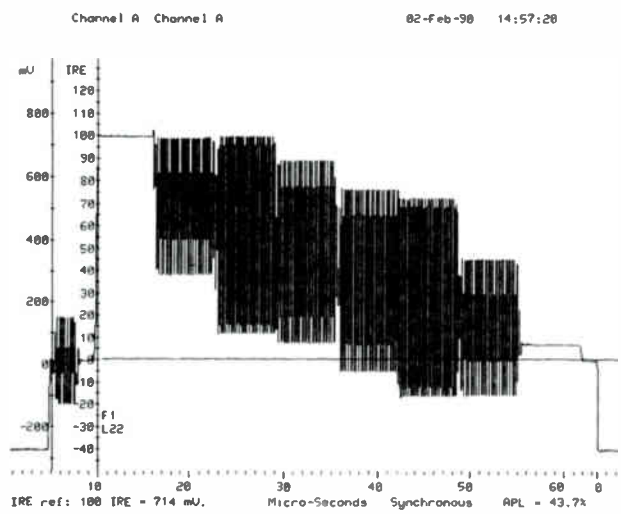
Comparing the specs

Performance parameters	Manufacturer's specifications	Lab measurements
Luminance amplitude accuracy (bar)	±1% of 100 IRE	100.1 IRE
Chrominance-to-luminance gain	±2% of 100 IRE	100.3 %
Chrominance-to-luminance delay	< 15 ns	0.3 ns
Burst amplitude	40 IRE, ±2%	40.1% bar
Sync amplitude ±1% of 100 IRE	285.7 mV (40 IRE)	40.1% bar
Sync risetime	140 ns, ±20 ns	139 ns
Differential gain	1% maximum	0.09%
Differential phase	0.6° maximum	0.26°
Signal-to-noise	> 60 dB	82.2 dB weighted
Line time distortion	< 0.5%	Not measurable
2T pulse ringing	< 1.5% peak	0.5%
Luminance non-linearity	< 1%	0.33%
NTC-7 combination multiburst:	(Note: no tolerances given by mfg. for the following parameters)	
White reference flag amplitude	100 IRE	100.1% bar
500 kHz burst	50 IRE	49.5% flag
1 MHz burst	50 IRE	50.0% flag
2 MHz burst	50 IRE	50.1% flag
3 MHz burst	50 IRE	50.4% flag
3.58 MHz burst	50 IRE	49.7% flag
4.2 MHz burst	50 IRE	49.1% flag
1 kHz audio signal:		
Amplitude	0 to 8 dBu into 150 ohm, 600 ohm or high impedance	< 0 to +10 dBm into 600 ohms
Frequency	1 kHz (tolerance not specified)	997 Hz
Distortion	< 0.5% THD@ 600 or 150 ohms	< 0.2% @ 600 ohms

Sin x/x



Color bars



The rear panel connections include AC and DC power inputs, a BNC video output (same as front panel) and a three-prong Cannon-style connector for the audio output. The level control for the audio output is accessible through a small hole in the side of the TSG-100 about two inches forward of the audio output jack.

A word of caution about the DC power input connector: It is wired for compatibility with a Sony BP90 battery pack, which means the center pin is grounded. If you reverse the polarity during DC operation, you will blow an internal 2-amp fuse.

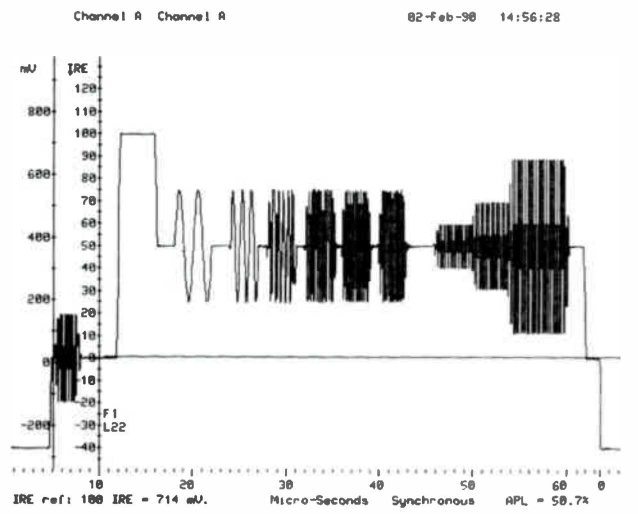
Lab measurements

All video measurements were performed on a Tektronix VM-700 automatic measurement system. The accompanying diagrams are VM-700 plots of seven of the eight video signals available from the TSG-100 with option 01. (The matrix signal is a "mixture" of the NTC-7 composite, NTC-7 combination, color bars, sin x/x and 50 IRE flat field waveforms, so it was not included in this evaluation.)

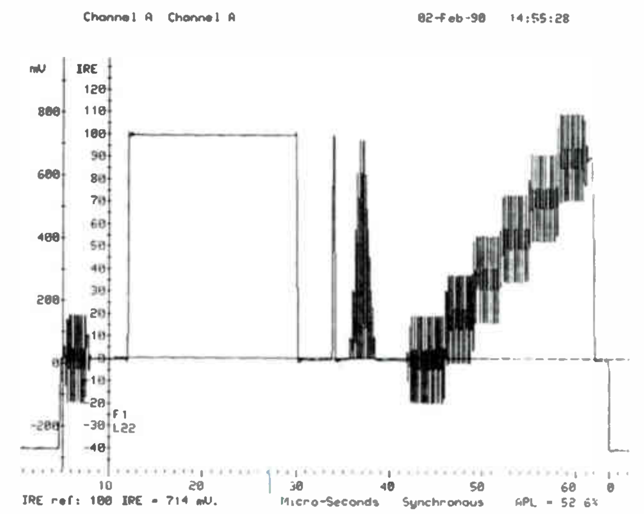
The accompanying table summarizes the manufacturer's specifications and what was measured in the lab.

The Tektronix TSG-100 with option 01 would be a useful

NTC-7 combination



NTC-7 composite



addition to any cable system's headend. Its low cost ($1,250 at the time of evaluation) places it within reach of most operators, and its small size and DC power capability make it handy for portable work.

The 100 IRE white reference available in both NTC-7 composite and combination test signals can be used to set video depth of modulation in headend modulators, and the generator's internal 1 kHz audio signal would be useful for setting audio deviation, although you probably will want to reset the audio amplitude to 0 dBm for this. When it comes time to do headend proof-of-performance measurements, the sin x/x test signal is ideal for measuring in-channel video frequency response of a modulator. The color bars can be used to adjust headend monitors and TV sets.

If you need a source of test signals for basic video distortion measurements, the waveforms from the TSG-100 will handle most requirements while saving you a bundle of money in the process.

For additional information, contact Tektronix Inc., P.O. Box 500, Beaverton, Ore. 97077.

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Reader Service Number 242

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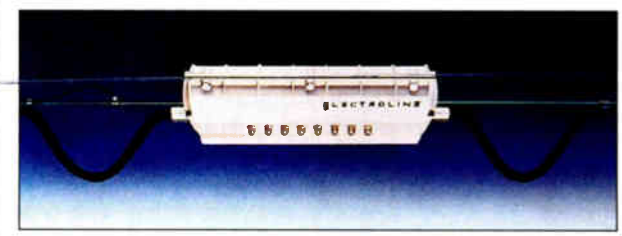

Electroline Equipment Inc., has introduced its new EAS Electronic Multi-tap in the international market. The EAS Electronic Multi-tap is the world's first 1 GHz broadband addressable system designed for off-premises television security and is a direct replacement for the standard multi-tap used in cable TV. It is designed for strand and pedestal installations and is compatible with PAL, SECAM and NTSC today, as well it is transparent to future HDTV formats. EAS Multi-tap offers operators a new choice for cost effective addressable control of signals delivered to individual family homes.

The EAS Multi-tap is based on the field-proven Electroline Addressable System, first put into operation in 1982 and which is currently in widespread use and serving more than 600,000 subscribers.

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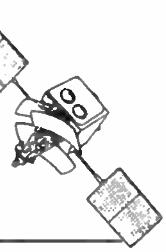

Call for literature: (201) 263-3355 FAX: (201) 263-9255

The following are videotapes currently available by mail order through the Society of Cable Television Engineers. The prices listed are for SCTE members only. Non-members must add 20 percent when ordering.

- *Fiber Optics: Here and Now* — Jim Chiddix of ATC, David Grubb of Jerrold Communications, James Hood of Catel, Vince Borelli of Synchronous Communications and Lawrence Stark of Ortel discuss this vitally important topic. (1 hr.) Order #T-1058, $45.
- *The Future of the CATV Business* — Industry leaders Edward Allen of InterMedia Partners, John Goddard of Viacom Cablevision, Bill Johnson of Scientific-Atlanta and Hal Krisbergh of Jerrold Communications discuss the industry's future horizons. (1 hr.) Order #T-1059, $45.
- *Signal Leakage and CLI Testing* — A basic presentation of signal leakage and cumulative leakage index (CLI) testing including what they are and how to deal with them. This program, which features Tom Polis of Communications Construction Group and Robert V.C. Dickinson of Dovetail Systems, provides necessary information concerning Federal Communications Commission rules and limits, grandfathering, filing and equipment. Ground measurement techniques and flyover procedures also are discussed. This is a useful tool for developing your own plan to deal with FCC requirements. (1 hr., 10 min.) Order #T-1060, $45.

Note: All tapes listed this month were videotaped at Cable-Tec Expo '88 in San Francisco. They are in color and available in the 1/2-inch VHS format only. Videotapes are available in stock and will be delivered approximately three weeks after receipt of order with full payment.

Shipping: Videotapes are shipped UPS. No P.O. boxes, please. SCTE pays surface shipping charges within the continental U.S. only. Orders to Canada or Mexico: Please add $5 (U.S.) for each videotape. Orders to Europe, Africa, Asia or South America: SCTE will invoice the recipient for additional air or surface shipping charges (please specify). "Rush" orders: a $15 surcharge will be collected on all such orders. The surcharge and air shipping cost can be charged to a Visa or MasterCard.

To order: All orders must be prepaid. Shipping and handling costs are included in the continental U.S. All prices are in U.S. dollars. SCTE accepts MasterCard and Visa. To qualify for SCTE member prices, a valid SCTE identification number is required, or a complete membership application with dues payment must accompany your order. Orders without full and proper payment will be returned. Send orders to: SCTE, 669 Exton Commons, Exton, Pa. 19341 or fax with credit card information to (215) 363-5898.

A complete listing of SCTE publications and videotapes is included in the March 1992 issue of the Society newsletter, "Interval."

CALENDAR

Planning ahead
Nov. 11-13: Private Cable Show, Marriott Sawgrass Resort, Ponte Vedra Beach, Fla. Contact (713) 342-9826.
Dec. 2-4: Western Cable Show, Anaheim, Calif. Contact (415) 428-2225.
Jan. 6-7: SCTE Fiber-Optic and Emerging Technologies seminar. Contact (215) 363-6888.

September

9: SCTE Great Lakes Chapter seminar, FCC technical standards, BCT/E exams to be administered, Holiday Inn, Livonia, Mich. Contact Jim Kuhns, (313) 541-4513.
9: SCTE Magnolia Chapter seminar, Ramada Inn Coliseum, Jackson, Miss. Contact Steven Christopher, (601) 824-0200.
9: SCTE Oklahoma Chapter seminar, microwave system design, installation and maintenance, BCT/E Category III, Fifth Season Hotel, Oklahoma City. Contact Arturo Amaton, (405) 353-2250.
9: SCTE Hawaii Meeting Group seminar, CATV power supplies, batteries and grounding. Contact Michael Goodish, (808) 834-4155.
9-11: Eastern Cable Show, Atlanta. Contact (404) 252-2454.
10: SCTE Hawaii Meeting Group seminar, FCC tech standards, Ritz Carlton, Kailua-Kona, Hawaii. Contact Michael Goodish, (808) 834-4155.
10: SCTE Mid-South Chapter seminar, Howard Johnson's, Senatobia, Miss. Contact Scott Young, (901) 365-1770, ext. 4150.
10: SCTE Penn-Ohio Chapter seminar, BCT/E and Installer exams to be administered at all levels, Sheraton Hotel, Warrendale, Pa. Contact Marianne McClain, (412) 531-5710.
10: SCTE Satellite Tele-Seminar Program, *Video and Audio Measurements Part Four*, to air from 2:30 to 3:30 p.m. ET on Transponder 6 of Galaxy I.
12: SCTE Chaparral Chapter seminar, CATV math fundamentals and calculations, BCT/E and Installer exams to be administered at all levels, Albuquerque, N.M. Contact Rita Erickson, (505) 761-6206.
14: SCTE Wheat State Chapter, BCT/E exams to be administered at all levels. Contact Lisa Hewitt, (316) 262-4270, ext. 191.
15: SCTE Central Illinois Chapter seminar, OSHA safety, Holiday Inn, Brandywine, Ill. Contact Chuck Prosser, (309) 347-7071.
15: SCTE New York City Chapter seminar, signal level and automated testing, FCC specifications. Contact Rich Fevola, (516) 678-7200.
15: SCTE Piedmont Chapter seminar, disaster recovery planning for the headend, office building, billing system, phone system, cable plant and other vital areas, Greensboro, N.C. Contact Tod Dean, (919) 662-1489.
15: SCTE Delmarva Meeting Group seminar, leakage theory and analysis, terminal devices, BCT/E exams to be administered. Contact Linc Reed-Nickerson, (215) 825-6400.
15-16: Telco-Cable Conference, Washington, D.C. Contact (202) 842-0520.
15-17: Great Lakes Cable Expo, Cleveland Convention Center, Cleveland. Contact Holly Mills, (517) 482-9350.
16: SCTE Appalachian Mid-Atlantic Chapter seminar, RF transportation systems, Holiday Inn, Chambersburg, Pa. Contact Richard Ginter, (814) 672-5393.
16: SCTE Dixie Chapter, BCT/E exams to be administered at all levels, Birmingham, Ala. Contact Scott Peden, (904) 968-6959.
16: SCTE Florida Chapter seminar, FCC tech standards, Holiday Inn, Ft. Lauderdale, Fla. Contact John Tinberg, (800) 327-9767.
16: SCTE Golden Gate Chapter seminar, video and audio, BCT/E exams to be administered in Categories I and II. Contact Mark Harrigan, (415) 358-6950.
16: SCTE Michiana Chapter meeting. Contact Russ Stickney, (219) 259-8015.
16: SCTE North Country Chapter seminar, Sheraton Midway Hotel, St. Paul, Minn. Contact Bill Davis, (612) 646-8755.
16: SCTE Piedmont Chapter, BCT/E exams to be administered in Categories II, III, IV and V at both levels. Contact Tod Dean, (919) 662-1489.
16: SCTE Snake River Chapter seminar, BCT/E Category III, "Transportation Systems," annual election of officers and board members. Contact Paul Elgethun, (208) 377-2491.
17: SCTE Cascade Range Chapter, BCT/E exams to be administered at all levels, Paragon Cable east county office, Portland, Ore. Contact Cynthia Stokes, (503) 230-2099.
17: SCTE Mid-South Chapter seminar, VideoCipher II technology, Ramada Inn, West Memphis, Ark. Contact Scott Young, (901) 365-1770, ext. 4150.
17: SCTE New England Chapter meeting. Contact James Kelley, (401) 943-7930, ext. 230.
18: SCTE Palmetto Chapter, BCT/E and Installer exams to be administered, University of South Carolina, Columbia. Contact John Frierson, (803) 777-5846.
18-19: Wireless Communications Conference, Hyatt Regency, Washington, D.C. Contact 1-800-4-USIMTA.
19: SCTE Cactus Chapter meeting. Contact Harold Mackey, (602) 352-5860, ext. 135.
20-22: SCTE Dakota Territories Chapter seminar, FCC tech regulations, Golden Hills Resort, Lead, S.D. Contact Kent Binkerd, (605) 339-3339.
20-21: SCTE Old Dominion Chapter seminar, Installer and BCT/E exams to be administered at both levels in all categories, Holiday Inn, Richmond, Va. Contact Margaret Davison, (703) 248-3400.
23: SCTE Golden Gate Chapter seminar, BCT/E Categories I, "Signal Processing Centers," and II, "Video and Audio Signals and Systems." Contact Mark Harrigan, (415) 358-6950.
23: SCTE Greater Chicago Chapter seminar, emerging technologies. Contact Bill Whicher, (708) 362-6110.
23: SCTE Rocky Mountain Chapter seminar, spectrum analysis, TCI offices, Englewood, Colo. Contact Patrick Kelley, (303) 267-4739.
24: SCTE Mount Rainier Chapter meeting, Silverdale Resort, Silverdale, Wash. Contact Gene Fry, (206) 747-4600, ext. 107.
24: SCTE Wheat State Chapter seminar, basics of fiber optics, Red Coach Inn, Wichita, Kan. Contact Lisa Hewitt, (316) 262-4270, ext. 191.
25: Society of Broadcast Engineers regional convention, Sheraton Convention Center, Liverpool, N.Y. Contact John Soergel, (315) 437-5805.
26: SCTE Rocky Mountain Chapter seminar, installer certification training. Contact Patrick Kelley, (303) 267-4739.
30: SCTE San Diego Chapter, BCT/E exams to be administered. Contact Kathleen Horst, (310) 831-4157.
30: NCTA seminar, FCC tech standards, O'Hare Marriot, Chicago. Contact Christie Love, (202) 775-3637.

SCTE now 10,000 members strong!

By Bill Riker
President, Society of Cable Television Engineers

It is my sincere pleasure to begin my first column as SCTE president with the announcement that the national membership of the Society has passed the 10,000 mark. This represents an increase from 1991's year-end membership count of 9,000, and that figure represented an increase of 1,500 members over the 1990 year-end figure of 7,500. We've come a long way in a short time.

The historic figure of 10,000 members takes into account the Society's 8,300 Active members, as well as the more than 1,700 members that have joined at the Installer level since the introduction of the Installer Certification Program in 1989.

The Society's staff has regularly set goals of membership figures we wished to reach by the year's end, and we had hoped (and expected) to reach the 10,000 mark by the end of 1993 — a mark we've looked forward to achieving for many years.

But the tremendously successful Cable-Tec Expo '92, held June 14-17 in San Antonio, Texas, greatly contributed to our Society reaching this goal six months ahead of schedule. When registering for the expo, many first-time attendees join the Society as Active members, taking advantage of reduced registration fees for members, as well as showing their commitment to technical training through support of and participation in the Society and its activities.

With the onslaught of new members that joined this year in conjunction with the expo, in addition to the ongoing popularity and success of the Society's numerous programs and services, we exceeded the 10,000 mark in time to make the official announcement during the expo's annual awards luncheon on June 14.

"The historic figure of 10,000 members takes into account the Society's 8,300 Active members as well as the more than 1,700 members that have joined at the Installer level."

What our Society offers

Among the programs and services that have proven to be attractive to prospective members are the Chapter Development Program, in which local chapters and meeting groups, operating under the auspices of the Society, offer technical seminars and professional fellowship at low cost to SCTE members and industry personnel throughout the country; the Broadband Communications Technician/Engineer (BCT/E) and Installer Certification Programs, which test and certify the industry's technical community based on their knowledge, skill and professionalism at one of three levels of employment; Cable-Tec Expo, the cable industry's premier training event; annual national conferences on emerging technologies affecting the industry; and the Technology for Technicians national training seminar program, which offers intensive training and hands-on practical experience at numerous locations across the country throughout the year.

Reaching the figure of 10,000 members is an important event in the Society's history. This number indicates the broadband industry's technical community's ongoing appreciation and support of the training and services provided by the Society. We look forward to continuing our efforts to serve the industry for many years to come. **CT**

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