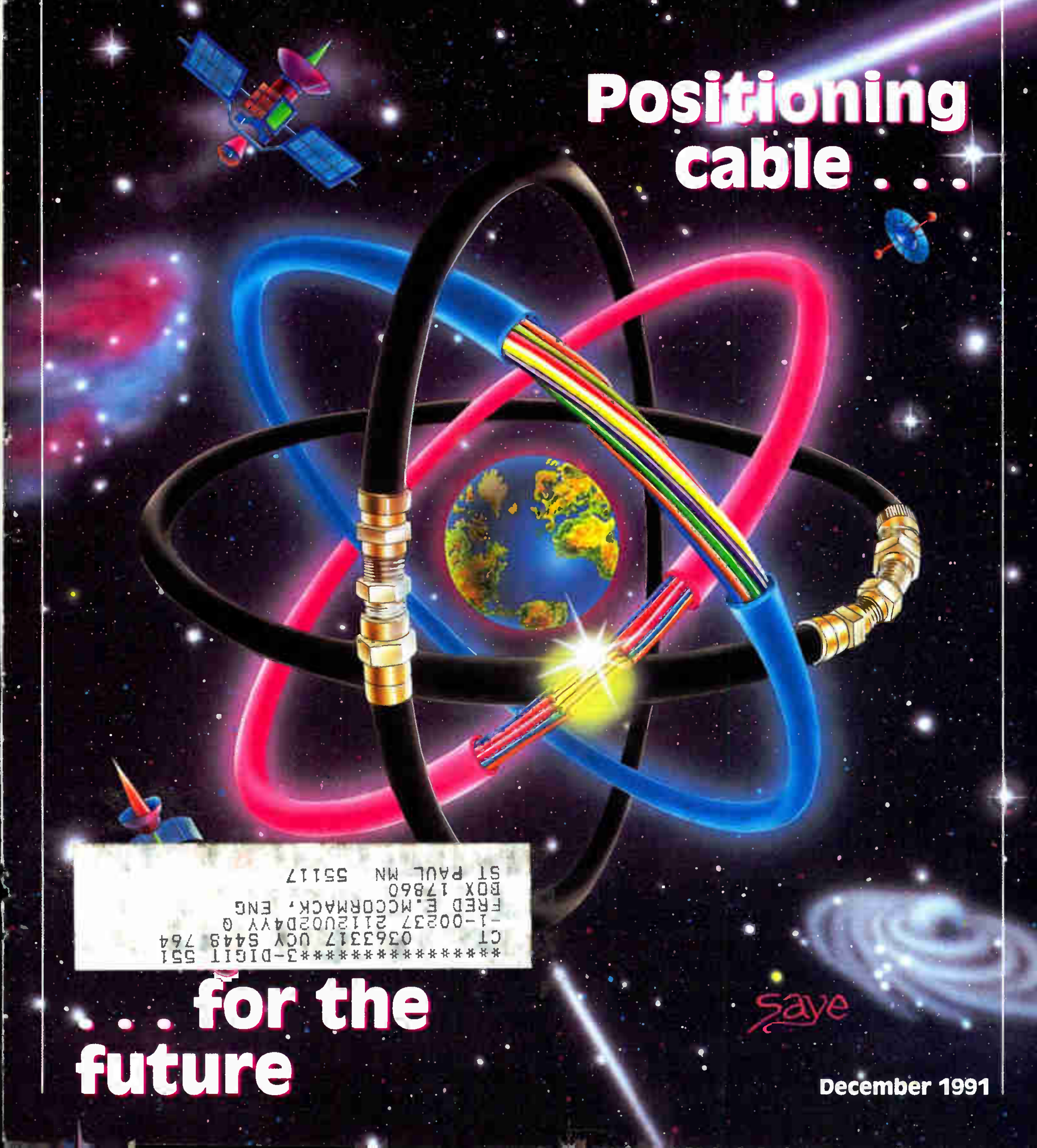
COMMUNICATIONS TECHNOLOGY

Official trade journal of the Society of Cable Television Engineers



December 1991

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Reader Service Number 2

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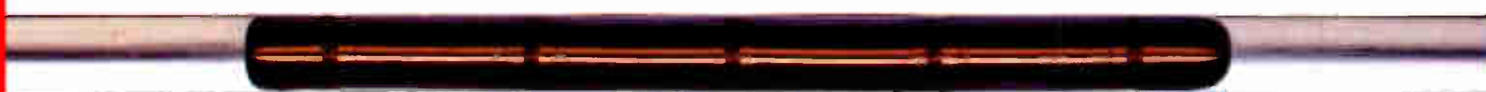

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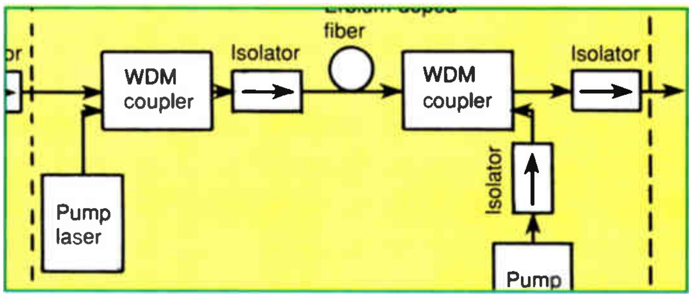
CONTENTS DECEMBER 1991

Departments


Geri Saye



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Backbone fiber architecture
- Number of fiber nodes: 3 (4 fibers per node)
- System optical loss: 11.63 dB
- Number of trunk amplifiers: 80

Features

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Reader Service Number 5

Who am I?

I have what I consider to be the best jobs in the technology side of our business. And I stress the plural in "jobs." Many of you know me as the senior technical editor for *Communications Technology* and *International Cable* magazines. Others know me as the vice president of engineering for Coaxial International. And a lot of you know me as the Society of Cable Television Engineers' Region 2 director.

In fact, I am all of these, but I'm first and foremost a CATV engineer.

I'm frequently asked just what it is I do. While I won't get into the nitty-gritty details, here's an overview: As senior technical editor for two of the industry's trade publications, I'm in one sense a journalist. This position is probably best considered an advisory capacity job, since the majority of my 8 a.m.-5 p.m. time is spent in the offices of Coaxial. As that company's vice president of engineering, my job is not unlike that of the senior technical officer at any MSO or manufacturer. My involvement with the SCTE, however, is voluntary in nature, since national board members are elected and serve *sans* compensation. To keep things interesting, I carry business cards for all three.

Journalist, customer or salesman?

Besides truly enjoying what I do, I find that this unique combination of jobs — keep in mind that all of them are actually separate from one another — make for some interesting conversations with people in the industry. They don't know if they're talking to a member of the press, a customer or a salesman. (And yes, I've been known to have fun with all of this.) Let's look at the last one first.

I've never really considered myself a true salesman. Even so, you'll find me selling the virtues of membership and active participation in the SCTE. At the same time, I'm in a sales capacity of sorts for Coaxial, since the company is in the consulting business. And being affiliated with publications of which advertising is lifeblood, I have to be in a sales mode for *CT* and *IC* (even though I don't actually sell any of the advertising).

I'm also a customer, since I recommend products to Coaxial's clients or purchase equipment for the company's own use.

And I'm a member of the press. I contribute an occasional newsworthy item to *CableFAX*, and write and edit extensively for *CT* and *IC*. I certainly don't consider myself to be an ace reporter looking for the latest scoop, but I am obligated to provide useful and balanced information that makes your job easier.

What happens if you ask me my opinion about something? Will you get an answer from a journalist, a customer or a salesman? Unless you request otherwise, I will almost always give you an *engineer's* point of view. Of course, we all know that engineers don't have particularly strong opinions about anything, right?

Odds and ends

• Ham radio operators in the cable TV industry now can participate in an HF net held two weeks of each month. Tune to 14.2425 MHz (±QRM) on the second and fourth Wednesday of each month at 0200 UTC. ATC's Al Dawkins, K0FRP, is net control.

• How's this for service: I called the operator (US West) recently to find out the phone number of the second line in my home. Yeah, I forgot what it was, but then I use that line only for outbound data communications with my computer's modem. There's not even a phone connected to it. The number's *not* an unlisted number, but it's also not printed on my phone bill or in the book. Would they tell me what it was? "If you take a guess, I can tell you if you're right or not." I finally found the piece of paper the installer wrote the number on. Sheesh!

• In November, I had the honor of participating in a live satellite teleconference panel discussion with *Multichannel News*' Gary Kim, *CED*'s Roger Brown, and *Cable World*'s Bob Diddlebock. I must say it was a pleasure working with these industry professionals! (I think the hosts expected something confrontational, but we actually agreed on almost every topic.)

• And finally, happy holiday wishes!

Ronald J. Hranac
Senior Technical Editor

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Reader Service Number 7

Olympics Triplecast products in demand

CHICAGO, NEW YORK, GLENVIEW, Ill. — Interest in marketing, manufacturing and buying products for cablecasting the 1992 Olympic Triplecast shows signs of heating up as the event draws nearer.

Anixter Cable TV announced an agreement with Eagle Comtronics to market Eagle's sideband interdiction system and standard positive trapping devices for the triplecast. For A Corp. of America is manufacturing a device to be distributed by Kalcom that will allow systems with limited channel capacity to have another option to clear three channels for the event through a split-screen video carriage device. Zenith reports that it has received orders for its Event System from several leading MSOs including ATC, Jones Intercable, Times Mirror and more for cablecasting the Barcelona, Spain, Olympics between July 26 and Aug. 9, 1992.

Jerrold announces agreements, contract

HATBORO, Pa. — Jerrold Communications has entered into a marketing partnership with First Pacific Networks and a joint development agreement with AM Communications. Jerrold and FPN will market FPN's new broadband integrated telephone and data network technology for use on British cable systems and the agreement includes provisions for European expansion. Jerrold and AM Communications agreed to develop an improved status monitoring system for Jerrold's Starline SX and Cableoptics line gear, which will reportedly be available to the industry during the first quarter of 1992.

In related news, TeleCable Corp.(a Virginia-based MSO) ordered 69 fiber-optic links from Jerrold's Cableoptics unit.

S-A delivers set-tops, makes decoder deal

ATLANTA — Scientific-Atlanta announced it delivered 20,000 of its new set-top terminals with on-screen display to Cablevision S.A de C.V. in Mexico City. This is part of a contract that included a complete headend installed earlier and other equipment that is valued at more than $5 million.

S-A also concluded an agreement with Request Television to provide the latest version of its B-MAC equipment for secure satellite delivery of programming to the pay-per-view programmer's affiliates beginning in early 1992. The agreement makes Request the first residential PPV provider to offer the B-MAC encryption technology to its affiliates.

In other S-A news, the main building of its broadband communications group in the Gwinnett Park complex had its first three numbers changed from 925 to 903. Callers should dial 903 followed by the same last four numbers. All (800) numbers remain the same. Numbers for all of the company's other facilities in the Atlanta metro area not beginning with 925 will remain the same until early 1992.

CATV businesses report fiscal results

Augat Inc., C-Tec Corp., Zenith Electronics and Pico Products Inc. were among the companies doing business in the CATV industry that reported losses for 1991's third quarter. Augat had $70.015 million in sales with a net loss of $1.13 per share. In the same quarter in 1990, the company had $76.311 million in sales with a net gain of 25 cents per share. C-TEC announced sales of $60.936 million and a net loss of 37 cents per share for the third quarter compared to sales of $51.011 million and a loss of 15 cents per share during the same period in 1990. Zenith Electronics reported sales of $343.9 million for 1991's third quarter with a loss of $1.82 per share compared to sales of $342.3 million and a loss of $1.42 per share for the same period in 1990. Pico had sales of $4,820,756 with a net loss of 36 cents per share. Last year during this period, the company's sales were reported at $5,037,527 with a net loss per share of 75 cents.

Reporting earnings for the 1991 fiscal year was Photon Kinetics. The company recorded its most successful year in its 12-year history with year-end results indicating bookings of the company's fiber test and measurement equipment had increased by more than 26 percent over the previous year. C-COR (which marks its fiscal year ending on the last Friday in June) announced financial results for the first quarter ended Sept. 27, 1991. It reported sales of $9.4 million with earnings per share for the period of 3 cents. This compares to a loss per share of 6 cents for the same quarter of the previous year. Scientific-Atlanta reported sales of $128.001 million with a net gain of 10 cents per share for its first quarter. This compares to sales of $128.445 million with a net gain of 25 cents per share for the same quarter in 1990.

Zenith, AT&T get HDTV nod from FCC

WASHINGTON, D.C — Zenith Electronics Corp. and AT&T announced their all-digital high definition TV (HDTV) system was certified by the Federal Communications Commission Advisory Committee on Advanced Television Services for industry testing. The companies report that their system is expected to transmit interference-free signals to a larger geographical area than possible through conventional broadcasts. Testing is set to begin in January 1992.

A bi-rate coding system was developed for the two companies' Digital Spectrum Compatible high density TV system. This coding is said to extend the coverage area so more people can get HDTV programming.

☛ Phoenix, Ariz.-based Pyramid Industries Inc. was acquired by Denmark-based Cabel-Con. Pyramid became a wholly owned subsidiary of Cable-Con and is now using the trade name of Pyramid Connectors Inc.

☛ Photon Kinetics signed a letter of intent to enter into an acquisition agreement with IFR Systems in which IFR proposed to acquire 100 percent of the common stock of the privately held company. As well, Photon Kinetics moved to Creekside Corporate Center, 9405 S.W. Gemini Dr., Beaverton Ore. 97005-7160. The telephone is (503) 644-1960 and the new fax is (503) 526-4700.

☛ Budco became the exclusive distributor of GatorGuard cable spacers. The product's spacers are said to prevent

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cable damage caused when three-bolt suspension clamps are allowed to touch and eventually rub a hole in the cable's protective outer coating.

☛ Sixteen cable system employees in the United Kingdom are the first graduates of the National Cable Television Institute's International Installer and Excellence in Customer Service courses. Also, nearly 50 more U.K. cable system employees are currently enrolled in NCTI's new international courses.

☛ Compression Labs Inc. introduced its Spectrumsaver, a broadcast TV system that digitizes and compresses broadcast TV signals. It is geared for business TV, distance learning and satellite news gathering markets, according to the company.

☛ Cable TV Montgomery released preliminary results of its ongoing campaign against cable theft. Reportedly, thousands of illegal converter boxes were discarded, destroyed or turned in to the company during an amnesty campaign.

☛ Washington Cable Supply moved its corporate headquarters to 4600-D Boston Way, Lanham, Md. 20706. The new phone number is (301) 577-1200 and the new fax is (301) 577-5551.

☛ The multimillion dollar expansion of Corning's production facilities has made it possible for the company to triple its manufacturing capability for planar fiber-optic couplers for cable TV and telecommunications applications. The manufacturing equipment is fully automated and on-line in the company's facility in Avon, France.

☛ The third shipment of AT&T's LXE fiber-optic cable to Cox Cable for its Spokane, Wash., system was announced by Optical Networks International. Also, ONI reported the activation of Inland Valley Cablevision's first optical link in southwest Riverside County, Calif.

☛ A request for proposals from developers of video compression technology was issued by Primestar Partners, a direct broadcast satellite (DBS) firm. According to the company, it will make a vendor choice next month and introduce compression technology to its customer base by the end of 1992.

☛ The Society of Broadcast Engineers approved the recognition of amateur radio activities for certification credits. People holding a valid amateur radio extra class license who meet the service requirement for employment in broadcast or broadcast-related industries will be awarded broadcast technologist certification on application. Contact the SBE national office at (317) 253-1640.

☛ Cable Communications Cooperative of Palo Alto is seeking proposals to test data services in its cable TV system. Testing is scheduled to begin in early 1992 and both equipment vendors and turnkey service providers are encouraged to participate.

☛ Cencom Cable Television acquired cable TV properties in the Birmingham, Ala., metro area from CableSouth Inc. These properties serve a total of 23,000 basic subscribers. Financial terms were not disclosed.

☛ Interactive Network Inc., which is designing, developing and marketing a subscription-based interactive TV entertainment system, made an initial public offering of shares. Priced at $8 a share, 2.25 million shares were made available by its underwriter, R.G. Dickinson & Co.

☛ The digital cable audio service Digital Planet had its first DP-91 tuners built by the Japanese cable equipment manufacturer Mitsumi. The tuners were developed by Digital Radio Laboratories.

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Reader Service Number 14

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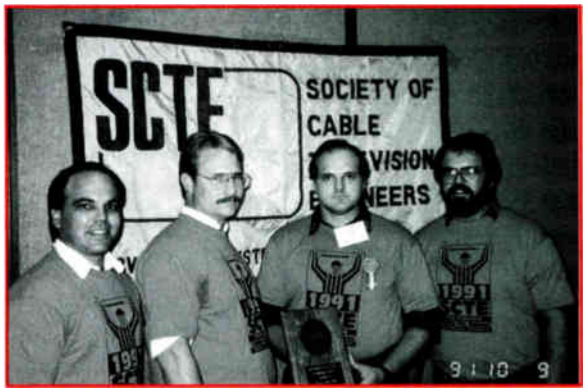
Games held at Mid-America Show

(Submitted by Ron Wolfe, ATC National Training Center, and Chairman, SCTE Cable-Tec Games Subcommittee)

The now familiar call of "Let the Games Begin!" signalled the start of the first Cable-Tec Games event to be held at the Mid-America Show on Oct. 9 in Kansas City, Mo. The games were organized by Ron Wolfe of the ATC National Training Center and Society of Cable Television Engineers President Wendell Woody of Anixter Cable TV, who also served as masters of ceremonies for the games.

The competition was heated and the contestants evenly matched as indicated by the results. Al Wilke of American Cablevision of Kansas City and the Heart of America Chapter took home the bulk of the hardware by being the first contestant ever to win medals in all four events, as well as the overall individual championship. In spite of his individual performance, his team came up just eight points short of taking the team championship plaque, which went to the team from Jones Intercable.

The events varied from station to station, and the Jones Intercable team (while taking only one event medal) demonstrated that teamwork and a broad range of skills is the key to winning the team championship. The Wheat State Chapter team, from Wichita, Kan., took home six medals, winning two of the events. The Great Plains Chapter, based in Omaha, Neb., was shut out of the medal round, but they've promised to return next year and change that!



The Jones Intercable team took home the championship plaque from the Cable-Tec Games held in Kansas City, Mo.

The events proved to be very challenging to the contestants, and the event hosts and judges kept a watchful eye on each player to evaluate techniques and tabulate scores. One of the contestants was overheard speaking about an event he had just completed: "He's a tough judge, but a fair one."

Contestants are timed in the signal level meter techniques event at the Mid-America Cable-Tec Games.

A running commentary on the games and on-the-spot interviews were conducted by Wolfe, and the awards were presented by Woody.

The lead in the events and the overall competition changed hands several times during the course of the games, and the audience was kept up-to-date by the scoring team of Patty Linster from *Communications Technology* and Frank Croan from American Cablevision. When Linster and Croan blanked the screen and pushed the magic button, the following results came up:

Efficiency and technique were the keys to winning the fusion splicing event, which was one of the four events held at the first Mid-America Show Cable-Tec Games.

- Signal leakage and TDRs event (hosted by ComSonics and Riser-Bond): First — Joe Cvetnich (Wheat State), Second — Al Wilke (American Cablevision), Third — Percy Kirk (Wheat State).
- Cable splicing event (hosted by Comm/Scope and Gilbert Engineering): First — Joe Cvetnich (Wheat State), Second — Al Wilke (American Cablevision), Third — Percy Kirk (Wheat State).
- Signal level meters (hosted by Wavetek/Mega Hertz and Trilithic): First: Al Wilke (American Cablevision), Second — Gordon Bennett (American Cablevision), Third — Percy Kirk (Wheat State).
- Fiber splicing and signal analysis (hosted by ONI/Sumitomo and CaLan): First — Ron Eggert (Jones Intercable), Second — Joe Williams (Wheat State), Third — Al Wilke, American Cablevision.

- Overall winners: First — Al Wilke (American Cablevision), Second — Jeff Bickel (Jones Intercable), Third — Tony Fox (Jones Intercable).
- Team winners: First — Jones Intercable (2,947 points), Second — American Cablevision (2,939 points), Third — Wheat State (2,920 points), Fourth — Great Plains (2,586 points).

The Cable-Tec Games subcommittee would like to thank the event hosts listed, as well as the Mid-America Cable Television Association, Anixter Cable TV and *Communications Technology* for making the games possible.

Based on post-game reactions and comments from the players and the hosts, the Mid-America show will become one of the annual sites for Cable-Tec Games. Congratulations to the winners and good luck next year to the challengers!

For information on conducting games in your area, contact Ron Wolfe at (303) 753-9711.

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2000: CATV in retrospect

By Dave Willis
Director of Engineering, Tele-Communications Inc.

It's the year 2000. Let's take a look back at cable TV's first 50 years. Looking back at our industry's development, we'll perhaps develop some slight insight into the future.

Cable TV began circa 1950 in small isolated communities that were hungry for video entertainment but had no readily receivable broadcast stations. Cable began growing immediately despite a rather poor technological system and a franchise process that worked to limit the expansion of programming and tended to stifle experimentation. The technology improved to a point where channel availability outstripped channel supply.

In the mid-1970s HBO made the leap almost to the stars by implementing satellite transmission of its programming. The maturation of satellite telecasting brought a blossoming of programs that opened the entire country to cable. At last we had product to sell in the major cities that was not available through existing terrestrial networks!

The '70s and '80s saw the cabling of the metro areas of the United States and brought boom times to cable manufacturers and contractors. In 1990 Congress sought to reimpose regulation on the industry to combat the allegations that cable was "price gouging" and was insensitive to subscriber complaints. The charge of price gouging was largely unfair since price control in the extreme had existed from 1950 to 1985. Since rates had been artificially suppressed for so long, the removal of rate regulation was certain to result in a "catch-up" period of rate increases. The implementation of these increases resulted in a public outcry that some politicians believed provided a populist issue that they might ride to higher offices. As we saw in the 1992 and subsequent elections, this was not the case.

Reregulation

Legislation proposed in 1990 had fairly strong support. As the cable industry went through the extremely rapid growth of the 1980s, it was able to implement only rudimentary customer service programs. Emphasis on improving customer satisfaction through better quality pictures and better customer service began in the late 1980s.

No legislation passed in 1990, and in 1991 numerous bills were proposed to reregulate cable. The very number of bills worked to defuse broad support for specific proposals. As a result of these and other factors, 1991 also saw no legislation.

Legislation passed the next year was called "The Cable TV Reregulation Act of 1992." The bill guaranteed local broadcast station carriage and retention of channel number where feasible. Telephone companies were permitted to buy or build cable TV systems outside their own service areas. (It was finally recognized that the CATV and telephony businesses have certain synergies but are fundamentally different communication services.) Rate increases were limited to cost-of-living index plus increased programming costs for the basic service. All other services remained rate-unregulated.

The National Association of Broadcasters had pressed hard for a retransmission regulation that would permit broadcast stations to either charge cable companies for rebroadcast rights or otherwise negotiate for permission to carry the station on the cable system. The threat here, of course, was that cable operators would simply provide an A-B switch and subscribers could install an antenna or not at their option. It would obviously result in curtailed viewership for the stations. It was about this time that the NAB realized that broad incursion into cable by telcos could be very unhealthy for them. With broadband delivery into every home, the telco could provide local news, etc., at no charge to the subscriber, finance the service through advertising and obviate the need for broadcast stations.

The 1992 Cable Act was the last major cable legislation. It was a non-intrusive piece that essentially let the video industry follow its own course as dictated by the marketplace.

Fiber and digital

Fiber optics continued to be deployed at a rapid rate by cable companies throughout the '90s. At the end of the recession of 1990-1993 renewed availability of funds spurred a very strong capital investment period for almost four years. A contributor to this activity was the increased use of compressed digital video. The use of compressed video on cable systems began in 1994 — two full years after its introduction in satellite transmission.

In the '90s many systems began offering a service package that included a basic tier (analog) of 20 to 40 channels and a "menu" of digital services that could provide up to 80 channels of premium or "niche" services. The premiums tended to be of the "historical" type while the niche services became unique. The very nature of the niche services made them fairly "high ticket." The average consumer bill in 1996 was $28.50 for basic service and $32 for premium or special interest channels for an average gross bill of $60.50.

The subscriber interface device most commonly used is a standard RF converter with an integrated digital-to-analog (D-to-A) converter. Tuning from analog to digital is entirely transparent to the subscriber. As the 16:9 aspect ratio TV sets penetrate the market, the integration of the D-to-A converter in the TV receiver is becoming more commonplace.

Telcos entry into cable

Telco activity in cable began in the mid-1990s with numerous acquisitions by the RBOCs. These were small MSOs or midsize independents.

Major impact wasn't felt until the year 1997 when 25 percent of the top 100 MSOs were owned and operated by a telco parent. Since that time there has been little change in this number. There has, however, been substantial investment in cable by the Japanese and the composition of the ownership of the cable TV industry has undergone significant changes.

HDTV and data

High definition TV (HDTV) made little impact during the early 1990s. This was due to the cost of the HDTV receiver, the paucity of HDTV program-

(Continued on page 30)


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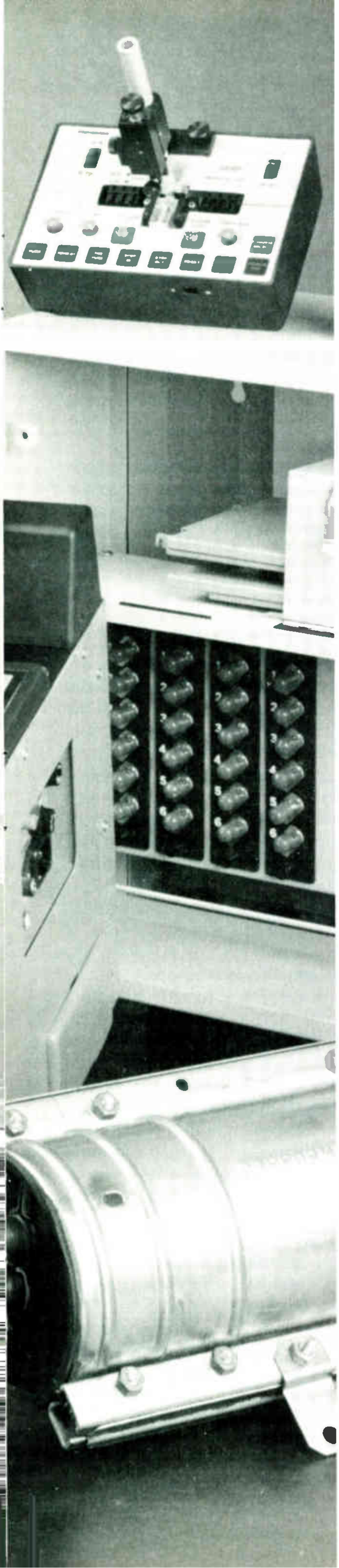

Promising CATV technologies: EDFAs and digital video compression

This article discusses two emerging technologies that show promise for application in CATV networks — the erbium-doped fiber amplifier (EDFA) and digital video compression.

EDFAs have potential for use in CATV systems, but there are major limitations on their usefulness in this application. This article describes the basic operation of these amplifiers and shows a typical circuit design. Their performance is discussed with emphasis on parameters important for CATV and it is shown that they are best suited for use as power amplifiers to enable splitting on links where carrier-to-noise ratio (C/N) requirements are modest.

The rapid evolution of CATV systems to higher bandwidths has encouraged a new round of forward-looking architecture proposals. As digital video processing techniques ride the crest of advancing processing power, an obvious direction is an evolution to hybrid digital/analog systems. We'll take a look at the state of digital video compression techniques with a focus on the implications such systems might place on a system evolving from analog to a digital/analog hybrid.

By Clive E. Holborow
Distinguished Member of Technical Staff
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Supervisor
Cable TV Lightwave Group, AT&T Bell Laboratories

EDFAs

AM fiber-optic technology is now fully established as a technically and economically viable option for improving CATV systems. The desire to extend the reach and reduce the per-link cost of AM systems has driven a continuing search for high power linear sources for modulated optical signals. One of the most promising devices to emerge recently is the EDFA. Over the last three years there has been a major international research effort to develop the EDFA for commercial use and there are now several products on the market.

Most of the research has been aimed at telecommunications network applications. In this part of the article, we'll look at EDFAs from a CATV perspective and stress characteristics that are important in CATV applications.

Basic operation

An EDFA works by exploiting the photoluminescent properties of the rare earth element erbium. The atomic energy levels of erbium allow it to absorb energy (photons) at any one of several wavelengths and to release this stored energy in the 1,550 nm wavelength range.

The absorbed energy comes from a pump laser. In terms of the classic atomic model, the absorbed energy raises the state of some of the erbium electrons to a higher level. The pump wavelengths most used are 980 nm and 1,480 nm. The pumped electrons reach a metastable state from which the rate of spontaneous decay is very slow. (The mean lifetime for electrons to remain in this state is several milliseconds.)

From here the electrons decay slowly to the ground state and emit light in the 1,550 nm band. The spontaneously emitted light covers roughly 1,530 nm to 1,560 nm. This spontaneous emission is optical noise.

Decay can be stimulated by the presence of photons in this wavelength band and the stimulated emission results in amplification of the incident optical signal. This is similar to what happens in a laser but in an EDFA the reflection of light into the fiber is prevented so that the fiber does not lase. This amplification process works equally well both for signal and for noise generated by spontaneous emission. At the amplifier output there are two optical signals: the desired amplified input signal and amplified spontaneous emission (ASE), which is a noise signal.

Typical implementation

A typical circuit of an EDFA is shown in Figure 1[1]. The amplification takes place in a length of erbium-doped fiber that is spliced to standard single-mode fiber. The erbium-doped fiber is designed to utilize pump energy as efficiently as possible and has a mode field diameter much smaller than standard single-mode fiber. As a result, splices to standard fiber have high loss (about 1 dB).

There are three possible arrangements for pumping the amplifier. The pump light can be fed in at the input of the amplifier so it travels in the same direction as the signal (copropagating pump), or it can be fed in at the output of the amplifier so that it travels in the opposite direction to the signal (counter-propagating pump), or the amplifier can be pumped at both input and output (dual or bidirectional pump-

Figure 1: Typical EDFA circuit

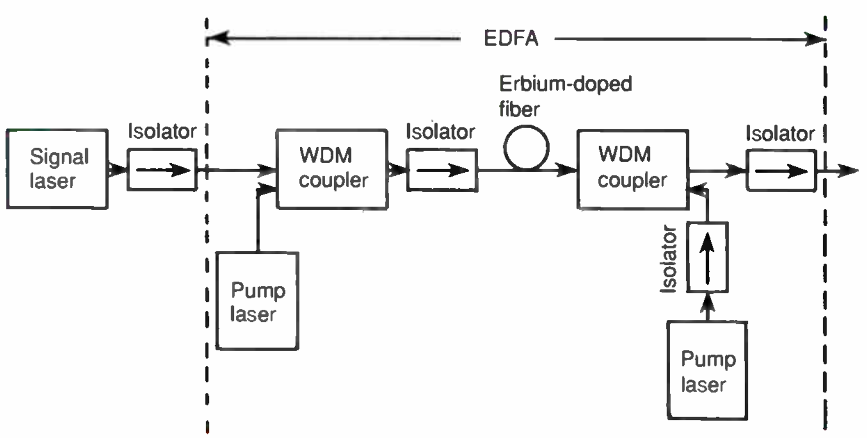

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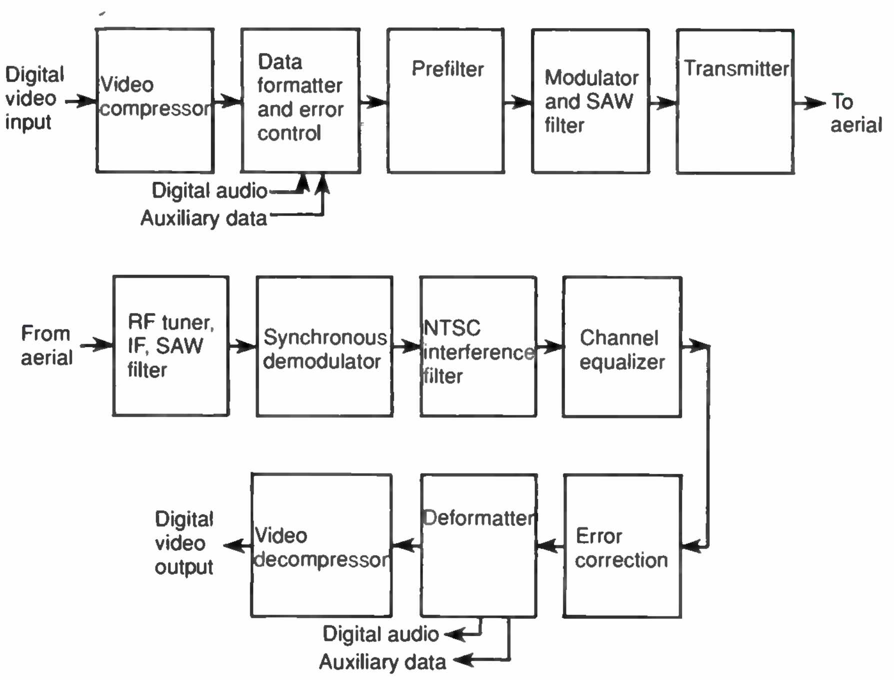
Figure 2: Zenith/AT&T proposed HDTV system



ing). Again, refer to Figure 1. The gain of the amplifier is not affected by pump configuration but the noise figure usually is.

Performance characteristics

The optical noise produced by an EDFA makes systems using them behave differently from simple AM optical systems in subtle but important ways. In particular, there is a major limit on the C/N that can be achieved in a system using an EDFA[2].

The ASE propagates with the amplified optical signal through the fiber until they reach the photodetector. Because a photodiode is a non-linear device, the two optical signals mix and produce beats of the signal with the ASE and of ASE components with each other. For a single stage of amplification with an EDFA, some of the noise components are negligible. The signal-spontaneous (s-sp) beat noise is the only additional noise term that must be considered in an EDFA system that does not appear in a simple AM fiber system.

The s-sp beat noise limits the amplifier C/N. This limit can be expressed by the ratio of carrier to s-sp beat noise. It can be shown that[2]:

$$C/N_{s\text{-}sp} = m^2P_oh_{in}G/4Fhn(G-1)B_e$$

Where:
m = modulation index per channel
P_o = signal laser power
h_{in} = EDFA input efficiency (loss of input coupler, isolator and splice to erbium-doped fiber)
G = EDFA internal gain
F = EDFA noise figure
h = Planck's constant
n = optical frequency
B_e = electrical bandwidth of receiver

Note that this expression is independent of fiber loss and for reasonable gains ($G \geq 10$), it is independent of amplifier gain. For reasonable component values, this limit will be in the range of 50 to 60 dB.

The EDFA gain (G) is an internal gain; it is the gain provided by the erbium-doped fiber. The EDFA noise figure (F) depends on the signal power, the pump power and the length of the erbium-doped fiber. The minimum value of the noise figure of an EDFA is 2 or 3 dB[3]. Noise figures of 5 to 7 dB appear to be readily achievable.

Like any amplifier, an EDFA will saturate when the input signal level is high. However, the EDFA has the remarkable property that it will still amplify high frequency signals linearly when operating in saturation. The reason is the long lifetime of electrons in the excited state. As long as the signal modulation frequency is higher than the inverse of this lifetime (approximately 10 kHz), the amplifier will remain linear. Since subcarrier multiplexed CATV signals have frequencies in the 50 to 550 MHz range, EDFAs can be used far into saturation to provide linear amplification[1]. It is possible to operate an amplifier 20 dB into saturation (i.e., an EDFA with a small signal gain of 30 dB driven hard enough to reduce the gain to 10 dB) to maximize output power and still not produce significant distortion of CATV signals[1,4].

Application considerations

The major parameters of interest to a CATV system builder are the signal output power and wavelength plus the standard trunk performance parameters of C/N, composite second order beat (CSO) and composite triple beat (CTB).

The gain, noise figure, and output power of the EDFA vary with signal wavelength. The amplifier noise figure varies with how far into saturation it is operated and how much pump power is used.

For systems carrying 40 or more channels (i.e., $m \leq 5$ percent) and requiring a link $C/N > 50$ dB, the $C/N_{s\text{-}sp}$ limit severely restricts use as an optical repeater or a receiver preamplifier because low optical input power to the EDFA will yield an unacceptably low-link C/N. (See previous equation.)

The accompanying table shows calculated C/Ns for several optical losses using the following parameters: 6 dB noise figure, 2.5 dB input and output coupling losses, 5 percent modulation index, and 6 pa/sqrt (Hz) receiver noise current. The amplifier internal gain is 14 dB with 3 dBm input and is recalculated for 0 and 6 dBm inputs assuming no change in pump power. The amplifier is operating about 20 dB into saturation, so the output power changes are small compared to the changes in input power. With 0 dBm input, the EDFA is not useful for any CATV application. With 3 dBm input, the EDFA is useful as a post-amplifier but the C/N is insufficient to allow cascading with another link of similar performance. With 6 dBm input, the performance is better but still low for supertrunking or cascading.

The obvious application for EDFAs in CATV systems is as a power amplifier to produce high optical power from a medium power signal laser. This allows the use of optical splitting to reduce the per-link costs of AM fiber in architectures like fiber-to-the-bridger. There also are long-reach applications where a very high power source is needed to

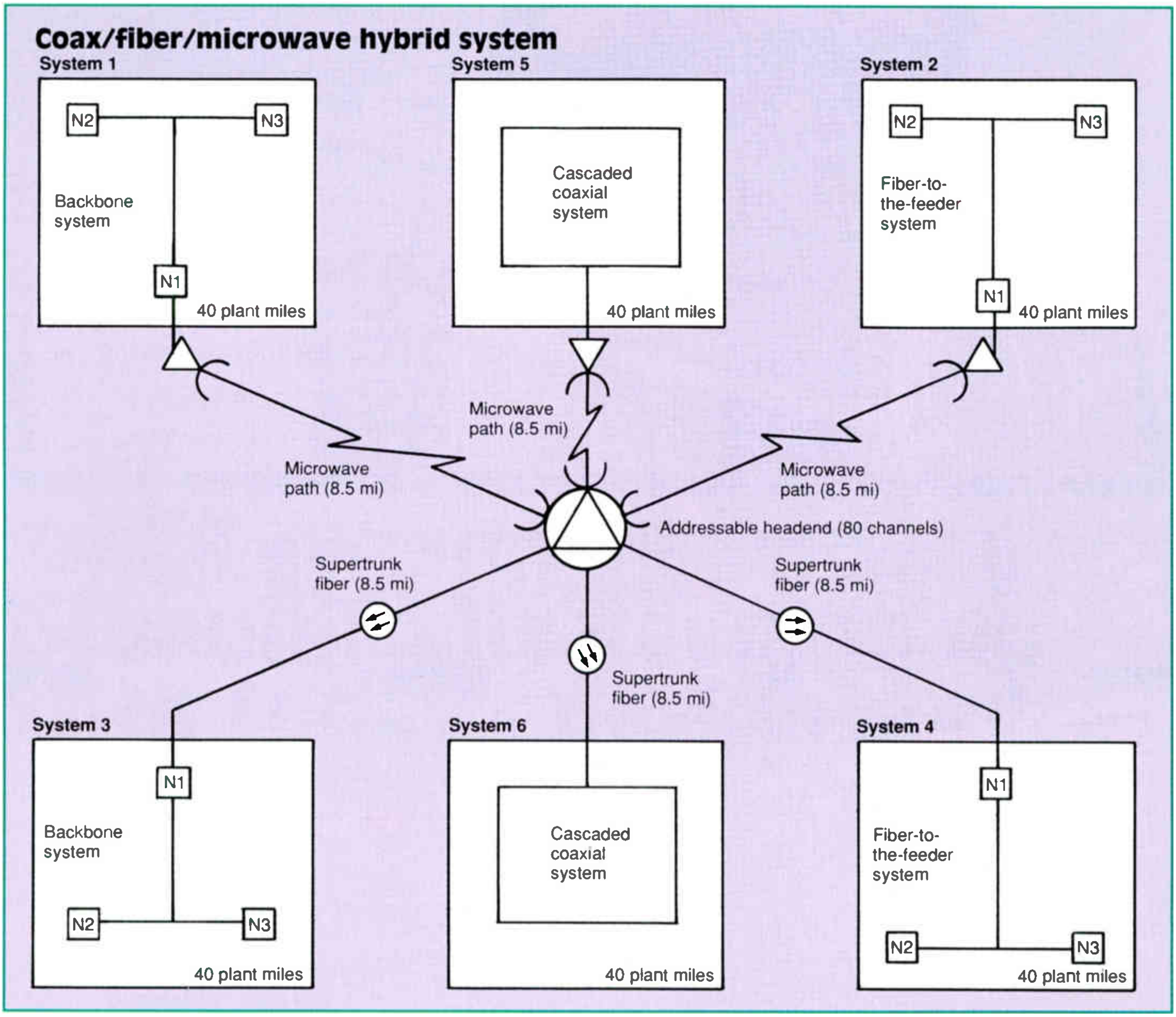
(Continued on page 32)

Small system operators: Economically keeping up with today's design choices

By Terry M. Cordova
Vice President of Engineering, Galaxy Cablevision

The growing feeling throughout the industry as we move into the '90s, is to design and implement state-of-the-art cable TV systems that provide increased reliability, improved noise and distortion characteristics, and increased bandwidth. Such systems will have to offer the subscriber a more diverse channel package, which might be made up of 60 channels of standard NTSC video, 10 high definition TV channels and 100 channels of compressed interactive pay-per-view.

The direction that we are headed seems to have been brought about largely from the increased threat of competition by such technologies as MMDS (multichannel multipoint distribution system), DBS (direct broadcast satellite) and the possibility of the telephone companies providing video services. Thus, as an industry we have risen to our own defense and have made a very big effort in recent years to subdue competition threats by substantially upgrading existing systems.



The evolution of cable systems and the tree-and-branch configuration that has been used to distribute a broadband signal throughout a particular area has seen its limitations. These limitations are directly related to bandwidth and the noise and distortion that are introduced through cascaded amplifiers. As bandwidths increased, so did channel loading and along with loading came CSO (composite second order), CTB (composite triple beat) and XMOD (cross-modulation) problems. The advent of feedforward and power doubling techniques for broadband amplifiers allowed us to greatly decrease these distortions.

Although at that point our distortion numbers had improved, we had done very little to decrease the number of active components in a system and thereby improving on system noise and reliability. The use of fiber optics allows us to provide a very high-quality broadband signal that, by nature of its transportation medium, has a very wide bandwidth and is extremely reliable. With the use of 1 GHz trunk amplifier housings and by keeping cascades to five amplifiers or less in the coaxial system, we are able to break up conventional cascaded systems into many small systems. Such design techniques incorporate system nodes, each with its own RF and powering source, which in turn help to alleviate the downstream problems of cascaded amplifiers and give the operator the desired reliability, improved performance characteristics as well as increased bandwidth.

Problems facing the small operator

With over 87 percent of the homes in the United States having already been passed by cable, there is a problem of providing current state-of-the-art cable TV to small town and county franchises where the number of homes dip down to 20 to 40 per mile. This problem is a very definite concern for the small system operator. Large system operators with high number of homes passed allow for an easier cost justification view of the problem. As cable systems age and franchise renewals come up, the small town and county operator must give consideration as to what current technological advances should be used to keep up with a demanding and competitive market.

Thus, the operator of small systems (500-5,000 homes passed) must come up with a designed system that will be economically feasible yet capable of providing a very diverse high-quality

(Continued on page 38)

Table 1

Headend characteristics
- Bandwidth: 550 MHz (80 channels)
- Fully addressable
- LNB (950-1,450 MHz)
- C/N = -60 dB
- CTB = -75 dB
- XMOD = -75 dB
- CSO = -75 dB

Microwave characteristics
- Transmitter power: 5 watts
- Transmitter bandwidth: 550 MHz
- Transmitter noise figure: 13 dB
- Receiver bandwidth: 550 MHz
- Receiver noise figure: 4 dB

Microwave system calculations

	Power/carrier	Transmit C/N (dB)	Transmit CTB (dB)	Receive C/N (dB)	Receive CTB (dB)	Microwave system C/N (dB)	Microwave system CTB (dB)	Microwave system XMOD (dB)	Microwave system CSO (dB)
Path 1 (8.5 miles)	-3.031 dBm	-58.5	-60.0	-54.0	-76.5	-52.5	-59.8	-65.0	-60.0
Path 2 (8.5 miles)	-3.031 dBm	-58.5	-60.0	-54.0	-76.5	-52.5	-59.8	-65.0	-60.0

Headend and microwave combined calculations

	Combined C/N	Combined CTB	Combined XMOD	Combined CSO	Annual rain outage
Path 1 (8.5 miles)	-52.0	-58.5	-62.5	-58.5	1.65 hours
Path 2 (8.5 miles)	-52.0	-58.5	-62.5	-58.5	1.65 hours

Table 2

System 1
Combined headend and microwave calculations
- C/N = -52.0 dB
- XMOD = -62.5 dB
- CTB = -58.5 dB
- CSO = -58.5 dB

Miles of coaxial plant: 40
Homes passed: 1,200 (30 homes per mile)

Backbone fiber architecture
- Miles of fiber cable: 2.25
- Number of laser transmitters: 2
- Number of fibers: 12 (2 forward, 1 reverse, 1 spare)
- Number of fiber nodes: 3 (4 fibers per node)
- System optical loss: 6.46 dB
- Number of amplifiers: 80
- Average amplifier cascade: 4-5
- Miles of plant per node: ≈13

System 2
Combined headend and microwave calculations
- C/N = -52.0 dB
- XMOD = -62.5 dB
- CTB = -58.5 dB
- CSO = -58.5 dB

- Miles of coaxial plant: 40
- Homes passed: 1,200 (30 homes per mile)

Fiber-to-the-feeder architecture
- Miles of fiber cable: 2.25
- Number of laser transmitters: 2
- Number of fibers: 12 (2 forward, 1 reverse, 1 spare)
- Number of optical receivers: 3 (4 fibers per receiver)
- System optical loss: 6.46 dB
- Number of distribution amps: 100
- Average amplifier cascade: 7-8
- Miles of plant per node: ≈13

Table 3

	C/N (dB)	CTB (dB)	XMOD (dB)	CSO (dB)
System 1	-46.5	-50.5	-50.0	-53.0
System 2	-48.0	-50.0	-49.5	-55.5
Desired	-45.0	-52.0	-51.0	-55.0

Improving picture quality with hybrid upgrades

By Fred Rogers
President
And John Tinberg
Director of Research and Development
Quality RF Services

Test points are in your system's future. It has been proposed by the National Cable Television Association that cable systems with 1,000 subscribers or more test key RF parameters twice a year, at a minimum of six widely scattered locations (most likely extremities) reflecting geographical areas served.

If the suggestions are adopted by the Federal Communications Commission, a 40 dB carrier-to-noise ratio (C/N) level must be met in one year and a 43 dB C/N in three years. Also, each authorized customer outlet will require a minimum of 0 dBmV.

Let's say you test your system and fail or, at best, obtain marginal results. (It works now, but will it pass after extreme temperature changes?) What can be done? To cable TV's good fortune, in the past six months advances in hybrid technology have been unveiled that surpass any hybrid improvements achieved in the past 10 years. The new advances are:

1) A hybrid with 4.5 dB noise figure at 450 MHz and 5 dB at 550 MHz. This

(Continued on page 60)

"When the time arrives to comply with tougher distortion requirements, new hybrid technology advancements may be the least expensive upgrade solution."

Figure 1: Hybrid noise figure comparison

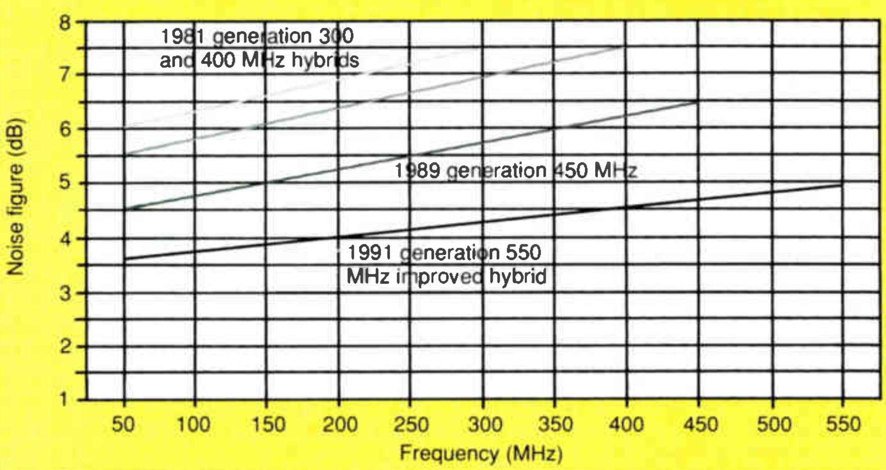
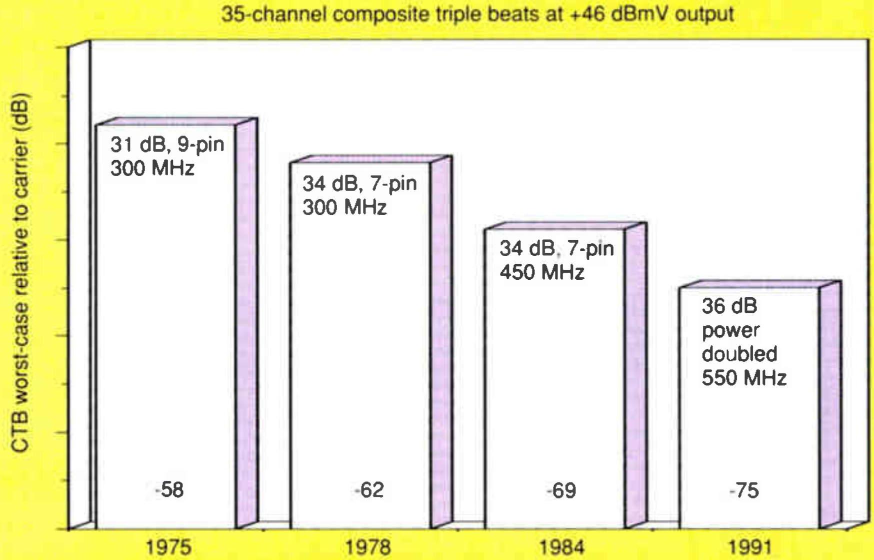
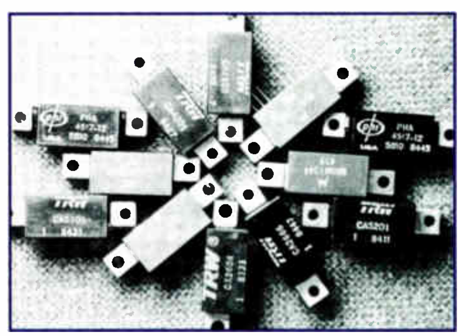


Figure 2: Distortion improvements in distribution hybrids

35-channel composite triple beats at +46 dBmV output





In the past six months advances in hybrid technology have been unveiled that surpass any hybrid improvements achieved in the past 10 years.

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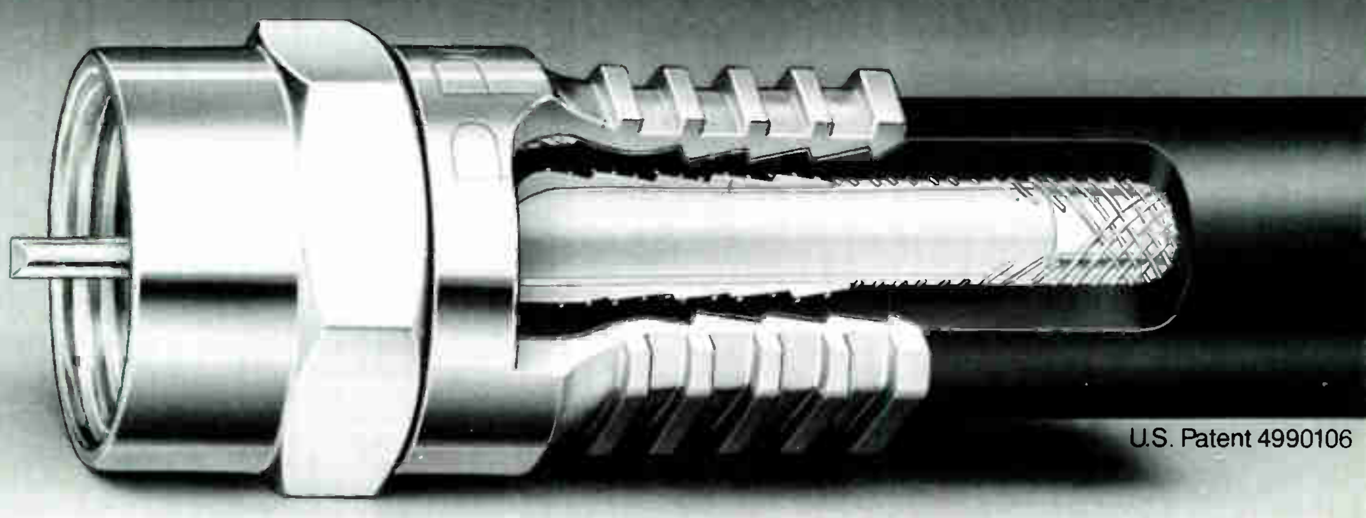

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CATV in retrospect

(Continued from page 19)

ming and the improvement in quality achieved through the enhancement of NTSC pictures. The incompatibility of 16:9 and 4:3 aspect ratios was a heavy burden on transition to HDTV. The mid-1990s saw deployment of HDTV receivers that were compatible with both HDTV format and NTSC format. (The HDTV receiver utilized double scanning even in the NTSC mode and thus produced substantially improved picture quality even using a standard NTSC broadcast signal.) HDTV and digital compression were a natural marriage and the advent of digital compression helped to spur deployment of HDTV receivers.

Data transmission to the home developed rapidly during the '90s. From data delivery to the personal computer (pioneered by X*Press in the late '80s), data transmission to the home took the form of data streams feeding small receive terminals with high memory capability. These terminals are capable of producing hard copies of any selected data as displayed by small screens incorporated into the receiver. Thus programming, weather and numerous other informational services can not only be monitored but can be printed out in hard copy. Discount coupons, blank application forms, event tickets and numerous other document services are being provided by this technology.

More tech advances

System design changes were for many years due to the improvement in IC components used in RF amplifiers. The advent of fiber-optic transmission provided a technological leap that changed system architectures dramatically in a very short period of time. Fiber design progressed from transportation, to backbone, to service areas, to fiber to the immediate service area, in little over half a decade.

The definition of "immediate service area" is not precise. The average potential home count for today's "service area" is 500 homes. The variation in service area size between various operators is tied primarily to the services offered. The number of channels and the services offered have been heavily influenced by "traffic" studies similar to those used by telcos for many years. With the advent of very high numbers of available channels it became prudent to use traffic analysis rather than to continue the historic procedure of making 100 percent of the available channels accessible by 100 percent of the subscribers 100 percent of the time.

RF amplifiers developed a bit more slowly with the advent of fiber. Minimizing cascades resulted in higher performance parameters from existing RF amps and development pressure was eased. The output capability and bandwidth capability have progressed to +60 dBmV and 1 GHz respectively with little real pressure from the cable industry. These amplifiers are referred to as 1 and 1, that is 1 volt at 1 GHz.

Cable penetration reached 75 percent in the year 1997. That is, 75 percent of the homes passed by cable were subscribers. There was much speculation that this was probably the highest penetration that could be achieved. However, with the advent of welfare support for cable service (basic and educational services only), it appears that number will continue to increase. As of May 2000, the penetration stood at 87 percent. **CT**

Promising CATV technologies

(Continued from page 24)

allow a single AM link to replace more expensive options such as FM or cascaded multifiber AM systems.

All these applications require 1,550 nm analog lasers capable of producing several dBm, as is evident from the table. Such lasers are in short supply at present, but improved availability can be expected on a time scale similar to that of 1,300 nm laser development over the last three years. The table shows that high output powers (>5 dBm) are needed for supertrunk applications.

The other major application issue for the technology is that since EDFAs amplify in the 1,550 nm band, dispersion-shifted fiber (DSF) must be used or some type of equalization must be used with standard fiber. The dispersion of standard fiber at the longer wavelengths results in unacceptable second order distortion products for links longer than a few kilometers that carry more than one octave modulation bandwidth[4].

The EDFA itself is a fairly simple arrangement of components. The only component that is a cause for concern is the pump laser. Reliability of lasers operating at the high power levels required for a high saturation power EDFA is not yet proven, but with careful control of laser temperature the available life test data[5] leads to the expectation that satisfactory pump lasers will become available.

Calculated C/N for optical losses

P_o (dBm)	Power at EDFA output	$C/N_{s\text{-}sp}$	C/N with losses of: 6 dB fiber	C/N with losses of: 10 dB (8-way split) + 6 dB fiber
0	11.8	52.5	50.4	49.2
3	12	55.5	52.9	51.1
6	12.3	58.7	55	52.5

Digital video compression applications and standards

Now let's move on to the other emerging technology we discussed in the introduction — digital video compression.

A digital representation of an NTSC picture requires about 100 Mb/s. This bit stream is highly redundant because there is usually little change in the picture from frame to frame. For some time, it has been normal practice to carry a compressed NTSC signal in a standard telephony DS3 channel (approximately 45 Mb/s). This compression by about 2:1 can be achieved without extensive processing at either transmitter or receiver. More elaborate processing can yield bit rates of around 10 Mb/s. This processing can be accomplished by processing each frame separately using a transform algorithm such as the discrete cosine transform (DCT). Compression to rates on the order of 1 Mb/s requires motion prediction and compensation with a major increment in required processing at both transmitter and receiver.

Several major applications have provided much of the impetus for research in and standardization of video compression algorithms. These include videoconferencing, high definition TV (HDTV), and digital picture storage.

Over the past decade there has been a large effort to achieve high compression ratios for videoconferencing at DS1 (1.544 Mb/s) and lower rates. Such high compression ratios require that motion prediction and compensation algorithms be used in addition to transforms and variable length codes.

These algorithms are very computationally intensive, and have become feasible for a reasonable cost for commercial equipment only in the last few years. These efforts have yielded commercial videoconferencing equipment operating in the range 56 kb/s to 384 kb/s and costing about $50,000 per terminal.

Quite good videoconference quality can be achieved at about 100 kb/s. Motion artifacts are obvious but not too distracting and processing does not result in awkward time delays in the transmission.

A major milestone is the development of the CCITT Px64 standard for video telephone compression[6]. This standard will allow videoconferencing terminals built by different manufacturers to communicate, and is expected to result in standard signal processing circuits at greatly reduced prices.

"The obvious application for EDFAs in CATV systems is as a power amplifier to produce high optical power from a medium power signal laser."

The current effort by the Federal Communications Commission to test and select a new TV signal format for terrestrial transmission of HDTV also has resulted in a large effort in video compression. The goals here are even more ambitious than other applications. A raw digitized HDTV image requires about 600 Mb/s and this must be transmitted in a 6 MHz broadcast channel. Initially, most proposals were for hybrid waveforms using analog encoding for some parameters and digital encoding for others. However, there has recently been a move to digital and most of the proposed systems scheduled for testing are now all digital[7].

The digital systems use similar techniques to compression for videoconferencing. However, the performance required (and computation required) is much higher. The received picture must produce rapid movement (as in sports) and still be perceived as essentially defect-free at a resolution approximately that of a 35mm color slide.

Typically, the digital compression produces a bit rate of approximately 15 Mb/s, and this is encoded on a 6 MHz channel using some form of quadrature amplitude modulation (QAM). QAM has for many years been used in voiceband data modems and digital radio transmission equipment, and is recognized as being one of the best available modulation schemes for a bandwidth-limited channel.

For example, the General Instrument HDTV proposal submitted to the FCC uses a video bit rate of 13.83 Mb/s. Audio and control bring the total information bit rate to 15.84 Mb/s, and a forward error correction coding increases this to 19.43 Mb/s. This is carried using 16-ary QAM (4 bits/symbol) at a symbol rate of 4.86 MHz in the 6 MHz channel. This scheme is claimed to be essentially error-free at a C/N of 19 dB[8]. Another example is shown in Figure 2, which is a block diagram of the Zenith/AT&T proposed HDTV system. →

Reader Service Number 20

The Joint Photographic Expert's Group (JPEG) is nearing completion of a standard aimed at digital recording of still color pictures. Compression factors of 10 to 50 are possible. The Motion Picture Expert's Group (MPEG) of the International Standards Organization is working on a draft standard for motion pictures plus sound. One application is compact disk storage at a rate of about 1.5 Mb/s.

CATV and compressed digital video

Current CATV systems carry around 30 to 80 channels and most new construction is for 60- or 80-channel systems (450 MHz or 550 MHz). While analog technology will steadily evolve to higher frequencies, it is not capable of providing major increases in channel carrying capability. It does not seem realistic to expect network bandwidths to go much beyond 1 GHz, so an upper limit of about 160 analog channels may be all that is achievable. This is about double that provided by today's technology.

For more channels at NTSC-quality levels, compressed digital signals are one option. Using compression techniques similar to those proposed for HDTV, it should be possible to carry several NTSC signals in each 6 MHz analog channel. Since viewers of these channels will need a decoder, premium channels are the obvious candidates for this treatment. Improved security will be a side benefit, because scrambling of digital signals is much simpler than for analog signals.

"Over the last three years there has been a major international research effort to develop the EDFA for commercial use and there are now several products on the market."

A major problem for terrestrial broadcast of digital HDTV is that digital systems have a very fast transition from very good to unacceptable as the C/N of the received signal decreases. The public is used to analog systems, which degrade more gracefully as the received signal strength declines. Powerful error correction codes are used in proposed HDTV systems to reduce this "cliff edge" effect.

Whether the problem is manageable is one of the objectives of the FCC testing. The proposed schemes will have to perform well at rather poor C/Ns (as claimed for the General Instrument system). This makes these signals very easy to carry on a CATV network, for they will perform well at C/Ns that would yield unacceptable NTSC pictures.

On a CATV system, there is no multipath to generate ghosts or aeroplane flutter, which are both difficult problems to deal with in terrestrial transmission. Furthermore, since they all meet NTSC compatibility required by the FCC by simulcasting in the current "forbidden" channels, the waveforms must generate negligible interference to adjacent channel NTSC signals and be robust against interference from the adjacent channel NTSC signals. On a CATV network, such HDTV signals should generate very low intermodulation distortion (IMD) compared with NTSC signals, and should be less susceptible to IMD from NTSC signals also being carried. It may be possible to carry digital

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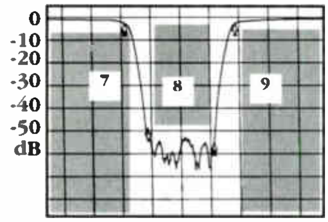

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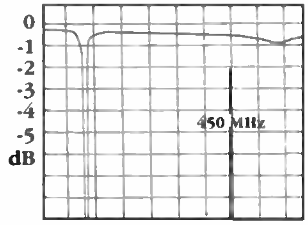

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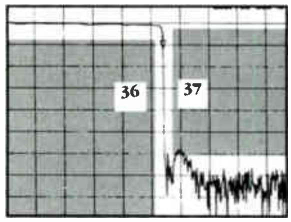

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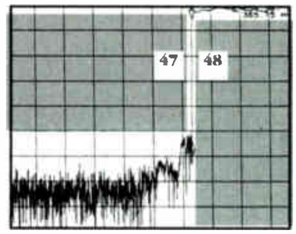

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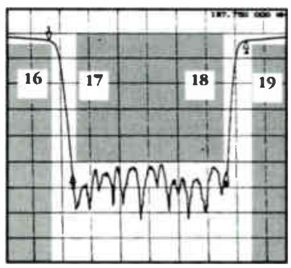

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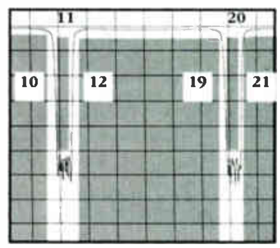
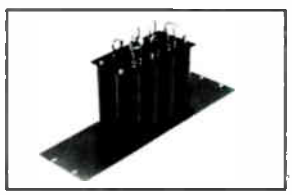


Scattered, Multichannel Type 6971-(2)(11,20)(450)



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signals at the upper frequencies of CATV networks where the performance is inadequate for NTSC signals.

The advent of reasonably priced digital compression hardware for TV signals will open many service and architecture options for CATV system operators.

It seems likely that the systems will carry a mixture of NTSC and digitally encoded signals. Basic channels are likely to remain analog for many years, since the installed base of TV sets and VCRs is analog.

HDTV signals will probably be carried in a digital form identical to the terrestrial format. The continuing demand for more channels and higher performance may result in a migration of premium channels to a digital format, which is less costly to encode and decode than HDTV. The market will determine the balance between improved performance and increased channel count. New services such as near video on demand (repeating a popular program on several channels with staggered start times) and switched video offerings (facilitated by the ease of switching digital signals) are other possibilities[9]. **CT**

"It may be possible to carry signals at the upper frequencies of CATV networks where the performance is inadequate for NTSC signals."

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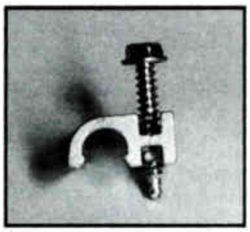

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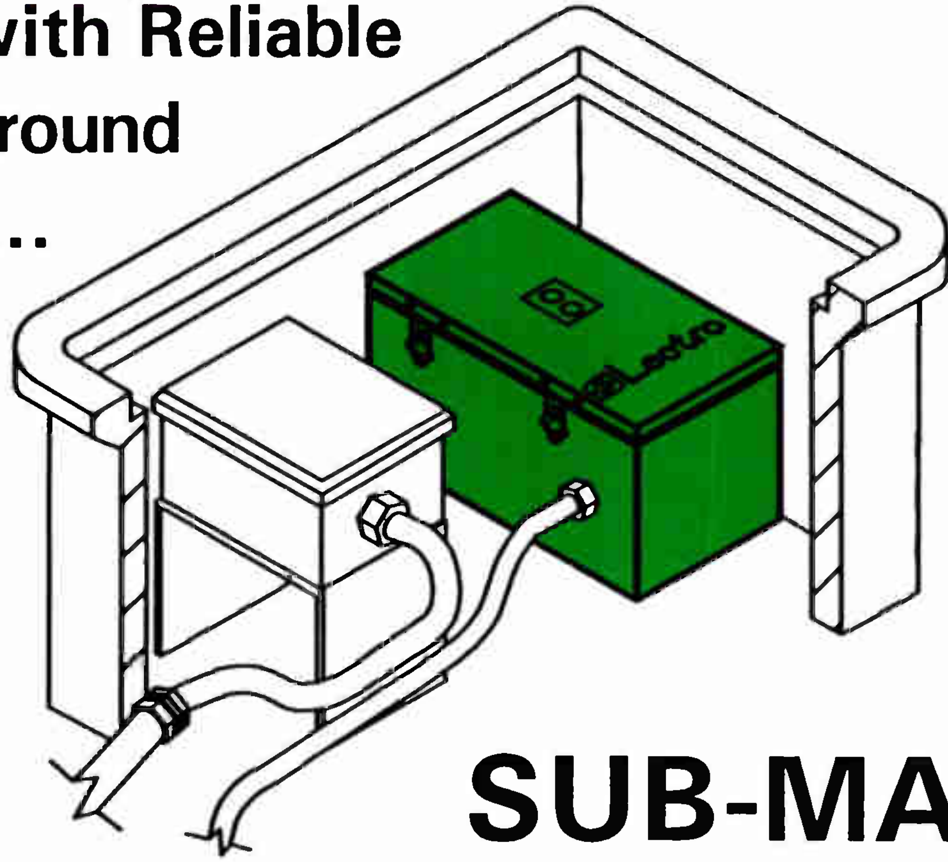

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Table 4

System 3
Miles of coaxial plant: 40
Homes passed: 1,200 (30 homes per mile)

Supertrunk fiber distance: 8.5 miles
- Number of laser transmitters: 2
- Number of fibers: 12 (2 forward, 1 reverse, 1 spare)

Backbone fiber architecture
- Number of fiber nodes: 3 (4 fibers per node)
- System optical loss: 11.63 dB
- Number of trunk amplifiers: 80
- Average amplifier cascade: 4-5
- Miles of plant per node: ≈13

System 4
Miles of coaxial plant: 40
Homes passed: 1,200 (30 homes per mile)

Supertrunk fiber distance: 8.5 miles
- Number of laser transmitters: 2
- Number of fibers: 12 (2 forward, 1 reverse, 1 spare)

Fiber-to-the-feeder architecture
- Number of fiber nodes: 3 (4 fibers per node)
- System optical loss: 11.63 dB
- Number of distribution amps: 100
- Average amplifier cascade: 7-8
- Miles of plant per node: ≈13

Table 5

	C/N (dB)	CTB (dB)	XMOD (dB)	CSO (dB)
System 3	-47.0	-54.5	-52.5	-54.0
System 4	-48.5	-53.5	-51.5	-58.0
Desired	-45.0	-52.0	-51.0	-55.0

Small system operator

(Continued from page 27)

broadband signal. The considerations for such a system might include supertrunk fiber or a microwave system serving two to five small towns all from a single master headend. The towns themselves may have fiber-to-the-feeder (FTF) or a backbone fiber system. With dial-up or dedicated phone circuits, we could establish addressable control of an 80-channel (550 MHz) headend and in doing so could have control of all the systems in the network. This type of communication system could allow for individual subscriber channel control, possibly through a high definition or compressed video signal. And so, knowing what technology has to offer, the small operator must determine what can be done feasibly to implement some of the new advances in the industry yet still be adaptable to additional changes. There is a point in the analysis where the operator may feel that slightly lower carrier-to-noise ratios or limited amounts of rain outage as it relates to microwave systems, is acceptable. The engineering analysis of the problem could take on many forms, based on the individual system and the technical and economic criteria that is desired.

Microwave system

The technology of conventional AM microwave has improved substantially in the past years taking us from non-linear, tube-type klystron amplifiers with narrow bandwidths, to very linear broadband gallium arsenide amplifiers. The latter device is currently offering 550 MHz (80 channels) of bandwidth and multiplexed systems offering 20 watts or more of output power. This option provides us with a quality choice between microwave and fiber in supertrunk applications. Although the choice between microwave and fiber is available, there may be specific cases where an individual headend may have supertrunk fiber feeding a neighboring community and at the same time have microwave links feeding more feasible line-of-site communities. Each of the system choices have performance characteristics that are associated with them and so we are able to combine operational noise and distortion levels with that of the coaxial system. The calculations quickly tell us what acceptable options are available. The accompanying figure (page 26) shows what a typical system might look like.

The diagram shows a headend that has both microwave and fiber feeding six separate communities. The communities themselves in some cases incorporate FTF, backbone fiber technology or conventional tree-and-branch technology. Examining just the transportation segments of the network, and more specifically the microwave segments for Systems 1 and 2, we can perform some calculations that will help us in our analysis. Then headend performance and the microwave system performance can be added to give us the resultant characteristics at the receive points for both

(Continued on page 55)

Table 6

System 5
Miles of coaxial plant: 40
Homes passed: 1,200 (30 homes per mile)

Microwave path distance: 8.5 miles
- Transmitter power: 5 watts
- Power per carrier: -3.031 dBm

Coaxial system
- Maximum trunk amplifier cascade: 20
- Maximum line extender cascade: 2
- Size/generation of trunk cable: .750″/P3
- Size/generation of feeder cable: .500″/P3

System 6
Miles of coaxial plant: 40
Homes passed: 1,200 (30 homes per mile)

Supertrunk fiber distance: 8.5 miles
- Number of laser transmitters: 2
- Number of fibers: 12 (2 forward, 1 reverse, 1 spare)

Coaxial system
- Maximum trunk amplifier cascade: 20
- Maximum line extender cascade: 2
- Size/generation of trunk cable: .750″/P3
- Size/generation of feeder cable: .500″/P3

Table 7

	C/N (dB)	CTB (dB)	XMOD (dB)	CSO (dB)
System 5	-44.0	-51.0	-52.0	-53.5
System 6	-44.0	-52.0	-50.0	-54.0
Desired	-45.0	-52.0	-51.0	-55.0

Small system operator

(Continued from page 38)

systems. The added characteristics are shown in Table 1 (page 27).

The combined calculations give us an idea as to what our performance numbers could look like at the base of the receive towers prior to the coaxial plant. The next step of this analysis is to decide whether or not microwave and some of its limiting factors are acceptable. The decision could purely be an economic one and if that was the case, some of the thinking might be whether or not building a supertrunk fiber system would be cost-effective. Or, the decision could be a technical one, based on receive performance numbers. In any case, here are a few questions that might come up:

1) Is the system large enough to justify the building of a supertrunk fiber system?

2) Is the amount of annual rain outage too much of a limiting factor?

3) At this point in the game, and based on the size of system that we are dealing with, are 80 channels sufficient?

4) Are the receive performance numbers enough to meet our desired standards at the last subscriber's home in the system?

5) Is the chosen system configuration going to help to eliminate headends and actives and ultimately improve on system reliability?

These are just a few questions that come up when making such a decision and answers will vary from operator to operator.

Microwave serving fiber systems

Now let's say that in this analysis, microwave Path 1 feeds 40 miles of plant with a backbone fiber system in place. Let's also say that microwave Path 2 serves 40 miles of plant with an FTF design. Backbone fiber architecture is a way to integrate fiber throughout the existing cable system. This is accomplished by running fiber directly from the laser transmitter site to numerous nodal areas throughout the system. The number of nodes is typically dictated by the number of actives in a given system and how many actives in cascade the system designer will allow. FTF is simply a takeoff of a backbone design, in that the fiber is run from the laser transmitter site to select bridger locations. This essentially

Table 8

Headend costs	
• 60 channels @ $3,000 per channel (IRD receivers, modulators and processors)	180K
• Four 4.5-meter earth stations (@ 6K each)	24K
• One 200´ transmit tower (self-support)	20K
• One 14´x20´ headend building (@ $30/sq. ft.)	8.5K
• Associated hardware (equipment racks, cable and connectors off-air antennas, air conditioning)	4K
Total headend costs	$236.5K
Microwave costs (for 8.5-mile paths)	
• One 550 MHz/5-watt transmitter	52K
• One 550 MHz receiver	13K
• Two 10´ microwave antennas	8K
• Associated hardware (waveguide, multipath kit, phase-lock generator, coaxial cable & connectors)	2.5K
• One 120´ receive tower (self-support)	10K
Total cost for first path	$85.5K
Cost for additional paths	$33.5K
Supertrunk fiber costs (for 8.5-mile runs with no optical splits)	
• 8.5 miles of 12-fiber cable @ .96/ft. (44,880 ft.)	43.1K
• One dual-laser transmitter	25K
• One optical receiver (already included for the FTF and backbone cost breakdown)	3.5K
• Associated hardware (headend driver amp, mechanical splices, splice trays, splice enclosures, tools, optical splitters)	3K
• 8.5 miles of aerial fiber construction (44,880 ft @ .65/ft.; hardware @ $600/mile)	34.4K
Total cost for first run	$109K
Cost for additional runs	$109K
Backbone fiber costs (for a 3-node, 2.25-mile fiber system off either the microwave or fiber transportation system)	
• 2.25 miles of 12-fiber cable @ .96/ft. (11,880 ft.)	11.5K
• Three optical receivers (@ 3.5K per)	10.5K
• Associated hardware (mechanical splices, splice enclosures, tools, optical splitters)	2.5K
• 2.25 miles of aerial fiber construction (.65/ft., 11,880 ft.; hardware @ $600/mile)	9K
• One dual-laser transmitter (cost added to microwave total only)	25K
Total cost off microwave system	58.5K
Total cost off supertrunk fiber system	31.5K
Fiber-to-the-feeder costs (for a 3-node, 2.25-mile fiber system off either the microwave or fiber transportation system)	
Total cost off microwave system	58.5K
Total cost off supertrunk fiber system	31.5K
Conventional coaxial system costs (40 miles of trunk and feeder)	
• 40 miles of coaxial plant @ 15K/mile (includes labor and material)	600K
Just coaxial feeder system (40 miles of feeder)	
• 40 miles of coaxial plant @ 10K/mile (includes labor and material)	400K

leaves a system that strictly consists of only feeder cable and distribution amplifiers. Both of the architectures would break up the existing coaxial system into many small systems. If a particular system needed to be rebuilt, the ideal design would be to go in with an FTF system, which would leave you with a system of all feeder and one that would have all of the same type amplifiers. Knowing all of that, we can at this point analyze the performance numbers off of the microwave system, through the fiber interconnect and on through the coaxial system. The results should tell us whether or not this type of network layout is a viable option. The fiber and coaxial system specifics are shown in Table 2 (page 27).

As can be seen from Table 2's descriptions, both systems require very little fiber cable to implement fiber optics into the existing system. The use of 12 fibers is an area that is based on the designer's feeling of future adaptability; the decision could be to use fewer fibers. But, it should be apparent that in the design of fiber systems, adding additional fibers adds very little to the overall cost. The scenario for both System 1 and 2 uses 12 fibers. This will allow four fibers per node, with two being used as forward transportation from a dual-laser transmitter, one for the use with a reverse system and one as a spare for future use.

With all the information in place, the combined system totals can be shown for Systems 1 and 2. It should be noted that the results for each system represent a combined calculation of the noise and distortion imposed by the microwave, the fiber system and the coaxial distribution system. The coaxial system in the backbone design includes a maximum cascade of five feedforward trunk amplifiers with a maximum of two parallel hybrid line extenders off of each amplifier. The coaxial system in the FTF design includes a maximum cascade of eight feedforward distribution amplifiers with AGC. Thus, the results should reflect what level of picture quality will be experienced at the last amplifier off of the fiber nodes that are farthest from the laser transmitter. Table 3 (page 27) shows the results as well as what could be considered minimum performance criteria. The results indicate some reasonable options and based on the size of the system and microwave path distances, the results could all improve anywhere from 2-5 dB. →

Table 9

System 1: 8.5 miles of microwave transportation serving a 2.25-mile backbone fiber system that feeds a 40-mile coaxial trunk and feeder system

Headend costs	39.4K
Microwave system costs	50.8K
Fiber system costs	58.5K
Coaxial system costs	600K
Total cost	$748.7K
($624/home passed @ 1,200 homes passed)	
($1,134/subscriber @ 55% penetration/660 subs)	

System 2: 8.5 miles of microwave transportation serving a 2.25-mile fiber-to-the-feeder system that feeds a 40-mile coaxial feeder system

Headend costs	39.4K
Microwave system costs	50.8K
Fiber system costs	58.5K
Coaxial system costs	400K
Total cost	$548.7K
($457/home passed @ 1,200 homes passed)	
($831/subscriber @ 55% penetration/660 subs)	

System 3: 8.5 miles of supertrunk fiber transportation serving a 2.25-mile backbone fiber system that feeds a 40-mile coaxial trunk and feeder system

Headend costs	39.4K
Supertrunk fiber costs	109K
(less 4.5K for receiver accounted for below)	
Fiber system costs	31.5K
Coaxial system costs	600K
Total cost	$775.4K
($646/home passed @ 1,200 homes passed)	
($1,175/subscriber @ 55% penetration/660 subs)	

System 4: 8.5 miles of supertrunk fiber transportation serving a 2.25-mile fiber-to-the-feeder system that feeds a 40-mile coaxial feeder system

Headend costs	39.4K
Supertrunk fiber costs	109K
(less 4.5K for receiver accounted for below)	
Fiber system costs	31.5K
Coaxial system costs	400K
Total cost	$575.4K
($480/home passed @ 1,200 homes passed)	
($872/subscriber @ 55% penetration/660 subs)	

System 5: 8.5 miles of microwave transportation serving a 40-mile trunk and feeder system

Headend costs	39.4K
Microwave system costs	50.8K
Coaxial system costs	600K
Total cost	$690.2K
($575/home passed @1,200 homes passed)	
($1,046/subscriber @ 55% penetration/660 subs)	

System 6: 8.5 miles of supertrunk fiber transportation serving a 40-mile trunk and feeder system

Headend costs	39.4K
Supertrunk fiber costs	109K
Coaxial system costs	600K
Total cost	$754.4K
($629/home passed @1,200 homes passed)	
($1,143/subscriber @ 55% penetration/660 subs)	

Supertrunk fiber

Now let's take a look at what the results would look like if we simply replaced the microwave interconnect with a supertrunk fiber run. The systems themselves would be identical to the system scenarios outlined previously. The 8.5-mile fiber run would extend from the headend to the first node of each system. The nice thing about supertrunking with fiber is that you are able to minimize the amount of optic loss by not having any optic split loss come into play, although it is entirely possible to have optic splits anywhere along the fiber run to feed a desired area. Your considerations at that point would be what the split does to the overall system performance as well as what are the new numbers of lasers and fibers required to incorporate the split. Once again the results should tell us if this configuration is a suitable option. The fiber and coaxial specifics are shown in Table 4 (page 38) for both Systems 3 and 4.

The described system information in Table 4 indicates a complete fiber transportation system feeding the same system architectures as was used in the calculations for Systems 1 and 2. The coaxial system incorporates the same feedforward and parallel hybrid technology as was used before. Table 5 (page 38) shows the noise and distortion results for Systems 3 and 4 as well as what could be considered the minimum performance criteria.

The results in Table 5 are not too surprising in that the desired numbers are met in almost all distortion categories for both fiber designs. If we reflect back briefly on all four systems, the FTF architecture tends to provide the better numbers, regardless of our choice of transportation. If we were in the position to have to make a decision concerning which architecture to use, it may well be a matter of economics. If we already have the coaxial system in place and all we have to do is redirect the RF path in some parts of the system, backbone probably would be the selected architecture. If the system required a complete rebuild, FTF would most likely be the designer's choice. In any case, as was mentioned earlier, design of such systems will require many individual considerations.

Microwave, supertrunk fiber feeding conventional systems

In order to provide a complete analysis of the engineering options, we must consider the performance of a conventional tree-and-branch system. This final analysis will be of two separate systems, one of which is fed by 8.5 miles of CARS band microwave and one of which is fed by an 8.5-mile supertrunk fiber run. Both systems are identical in that they are strictly conventional coaxial systems. The system specifics are shown in Table 6 (page 38).

The system descriptions in Table 6 describe two systems, each being served by a different transportation source, yet both are basic coaxial systems. Each system is made up of a maximum trunk cascade of 20 and a maximum line extender cascade of two. Once again, the amplifiers used in the calculated results are either feedforward or parallel hybrid as was used in the previous scenarios. The results are shown in Table 7 (page 38).

The results for both Systems 5 and 6 could give a designer a couple of possible choices. Although our C/N falls slightly short of our desired number, both noise results still exceed what the Federal Communications Commission terms an acceptable visual signal level to system noise ratio.

It should be apparent to the engineer that increasing or decreasing the specific attributes of any of the discussed scenarios, would directly relate to the performance outcome. As an example, the system transportation, be it fiber or microwave, could be just four miles, or we could possibly see ourselves using a maximum of 60 channels in the small community we are dealing with and consequently our overall numbers would improve.

Brief cost analysis

The cost of a particular design is an obvious consideration for any design engineer. The engineer must closely weigh the performance numbers achieved in the chosen design vs. the cost of delivering such numbers. The thoughts in making such a decision will require consideration to be given to current system size, current and projected penetration, expected system life as well as the adaptability of the new design for additional channels or new technologies.

Table 8 (page 55) provides a look at the cost of building the system scenarios that were discussed. With all of the costs outlined, we can determine individual system costs. In an effort to minimize the possible variations to the analysis, let's assume that one headend is serving the six individual systems discussed in this article. Therefore, microwave transmit costs will be split up among the three microwave paths and the headend costs will be split up among all six systems. Table 9 (page 57) shows these costs.

The results of the cost analysis provide a number of options. The components for any of the six systems may change to accommodate the designer's own personal system analysis. Any system changes would obviously change the total technical and economic outcome.

Conclusion

The entire analysis should give the designer of small networks an idea as to what type systems might be implemented for current and future adaptability. The final system design could take on many forms of which discussion space in this article is the limiting factor. The network transportation system, whether it be microwave or fiber, could feed a fiber interlaced system with a switched-star or interdictive tap system in place. The system fiber nodes could be used to facilitate the integration of a wireless service such as personal communications services (PCS). This type of use could allow the operator to provide a high-speed data path, a voice path and a broadband video path. Although the architecture for the FTF or the backbone fiber network is not ideal for the implementation of metropolitan area networks or local area networks, the system could adapt to a ring-type architecture with the addition of more fiber to complete the network. The different systems that were discussed could accommodate such additions if the application was available and the economics worked.

The future of cable TV is a very promising one with emphasis being placed on customer satisfaction by giving the customer a more diverse choice of product and by increasing picture quality and reliability. Consequently, the operator of small systems will have some very big decisions to make in the years to come. It is hoped the choices made will put the system in a position to adapt to many different types of changes without having to substantially redesign or rebuild the existing system. **CT**

Hybrid upgrades

(Continued from page 28)

represents a full 1.5 dB improvement over recently available components while maintaining the same output distortions. (See Figure 1.)

2) A 22 dB and a 36 dB gain power doubler hybrid that allows push-pull hybrid amplifiers to be upgraded to power doubling and high gain operation by just replacing one hybrid in each module. The 36 dB gain parallel hybrid is brand new and available in limited production.

Hybrid output distortions have steadily improved over the years as CATV component manufacturers strive to obtain 550 MHz, then 750 MHz and, it is hoped, 1,000 MHz (1 GHz). These distortion improvements carry a much smaller current increase than power doubling or feedforward technologies. For example, by installing the latest generation push-pull hybrids, a 400 MHz amplifier made 10 years ago would achieve a 3 dB improvement in noise figure, 2 dB extra gain and a 7 dB improvement in composite triple beat (CTB) with 54-channel loading. The electrical current increase would be less that 0.1 ampere per module. With a new input hybrid and a high gain power doubling hybrid on the output, a 13 dB improvement in CTB has been measured over the original CA4108 and CA4208 type hybrids. (See Figure 2.)

The extra current consumption with power doubling can often be offset by purchasing high efficiency power packs from the original manufacturer. There are 90 percent efficient highly reliable power packs available from most amplifier manufacturers or from secondary suppliers.

Even amplifiers with "quads" can be upgraded by installing custom-made printed circuit boards that accept the new hybrids to be plugged in. The original ALC/ASC and flatness boards are retained, only the RF circuitry is replaced. One final advantage can be additional usable bandwidth. With the tremendous advances in distortion improvements, modules can be "reworked" to gain as much as 150 MHz of additional usable bandwidth.

So, when the time arrives to comply with tougher distortion requirements, new hybrid technology advancements may be the least expensive upgrade solution. **CT**

December 1991

BACK TO BASICS

The training and educational supplement to Communications Technology magazine.

Drop troubleshooting

Geri Saye

Table of Contents

Getting the most from your antenna system — Part 3

In Part 1 of this article (October) we discussed types of antennas and how they work. Part 2 (November) discussed the theory of propagation of electromagnetic waves in the atmosphere. In this final installment we will talk about interference and describe methods of minimizing it without causing deterioration of the desired signal.

By Rick Murphy
President, Wade Antenna Ltd.

Interference to radio and TV signals can be generated within the receiver circuits or picked up from the atmosphere by the antenna system. Interference generated within the receiver is usually in the form of noisy pictures or cross modulation. Noisy pictures are caused by low signal levels at the receiver input. Cross modulation is caused by high signal levels at the preamplifier or receiver input. This often occurs when a preamplifier is used to increase the level on distant stations with a strong local channel.

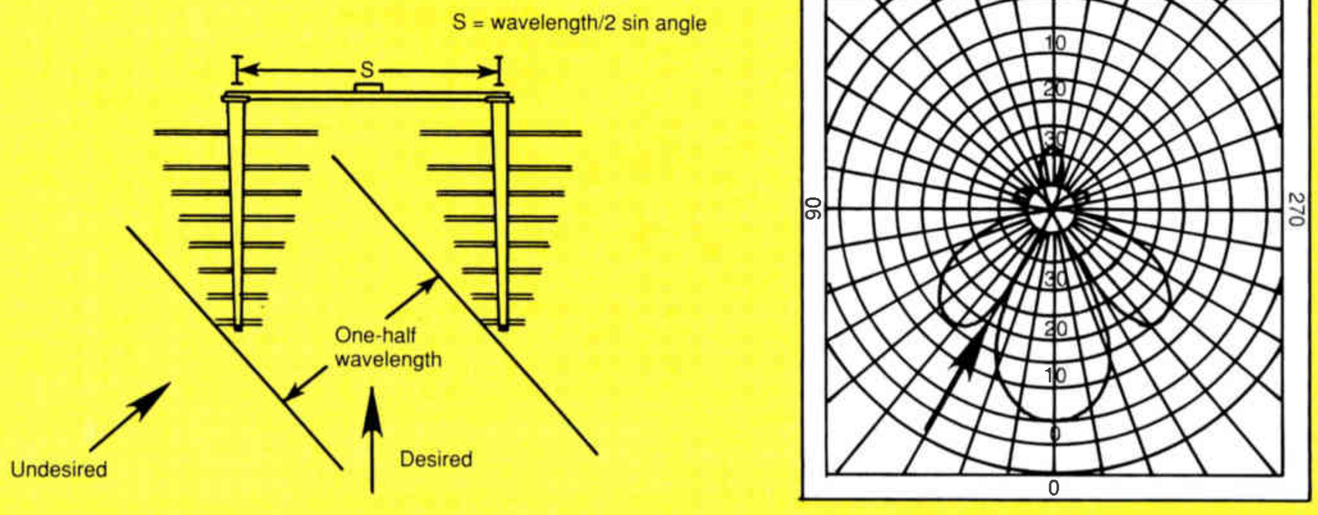
External interference is picked up by the antenna system along with the desired signal. Any signals that are at or near the resonant frequency of the antenna will produce a voltage at the terminals. The resulting voltage will be the sum of the induced voltages based on their phase relationship. The receiver is unable to tell the difference between wanted and unwanted carriers. Once the interfering signals are passed on to the receiver they are processed with the desired signal.

Interference from strong local transmitters in the form of spurious carriers in the upper and lower sidebands often causes beat problems on distant adjacent channels. The most common problem is third order intermodulation of the 3.58 MHz color subcarrier or the 4.5 MHz audio carrier, which fall about 1.16 MHz and 3 MHz respectively above the picture carrier of the upper adjacent channel. These spurious transmitter carriers are normally at least 46 dB below the picture carrier. However, the received level of a distant signal can easily be 30 to 40 dB lower than a local signal, placing the interfering beat level at or near the level of the desired signal. These spurious carriers are picked up by the antenna system along with the distant signal. However, bandpass filters and traps placed at the preamp input to attenuate the local carrier will have no effect on the level of this type of interference. Attempts to remove the interfering carrier with the use of in-band traps will cause severe distortion to the desired signal as well.

Other forms of external interference are ghosting, multipath, electrical and co-channel interference. Ghosting occurs when the antenna receives the desired channel's direct signal as well as a reflected signal of the same channel. If the path length of the reflected signal is several wavelengths greater than the direct signal path, the reflected signal will appear on the screen as a second image or ghost. Multipath is a form of ghosting that is caused by storm fronts and other atmospheric conditions as they move across the path of the signal. Electrical interference is caused by random bursts of RF energy from power lines and electrical equipment. This type of interference tends to be scattered over a wider area and treatment is more difficult. Co-channel occurs when the antenna system receives signals from two different stations operating on the same frequency. Rules have been established to prevent two transmitters from operating on the same frequency within a certain distance of one another. Transmitter frequency, power and location are controlled by the federal government. Even with these controls, interference can and does occur.

Regardless of the source, once the interference is combined with the desired signal it cannot be removed easily without distorting the original signal. However, we can use the antenna system itself to reject the interfering signal before it is combined with the desired signal. This method of reducing the level of interference is a proven technology and provides a much higher quality picture than one that relies on filters and traps.

Figure 9: Phased array with 'pure' log periodic antennas



Minimizing interference

Much of the interference that is experienced by cable systems can be reduced significantly. The methods of minimizing internally generated interference are already familiar to the cable technician. Receiver noise is normally quite low and can be readily overcome by increasing the input signal level. This can be achieved by using a higher gain antenna or by adding a low noise preamplifier to the system. Care must be taken to ensure that increasing the level of the desired carrier does not cause overloading of the preamp or receiver input circuits as discussed earlier.

Techniques for reducing the level of interference from external sources are less well-known. As a result, picture quality in most cable systems is not as good as it can be. Co-channel and other forms of externally generated interference can be greatly reduced in level by using an array of two or more antennas. Each time the number of antennas is doubled the gain is increased by 3 dB. This is equivalent to doubling the power of the transmitter. We could use a single antenna with more gain, but increasing the gain of a single antenna by 3 dB also will increase the level of the interfering carrier by nearly the same amount.

If two identical antennas are spaced horizontally and connected electrically, we can manipulate the resulting side lobe pattern to create a null in the direction of the interfering signal. Maximum rejection will occur when the array is designed such that the horizontal spacing is one-half wavelength in the direction of the interference. The desired signal from each antenna will be in-phase at the combiner and add. The interfering signal will arrive at the first antenna one-half wavelength before it arrives at the second antenna. Thus, the interfering signal from each antenna will be 180° out-of-phase at the combiner and will cancel, giving as much as 35 dB of rejection (see Figure 9). Cancellation will occur at any frequency within the bandpass of the antenna provided the spacing ("S") is one-half wavelength at the interfering frequency.

While this method of rejection works extremely well with almost any type of interference, multipath is more difficult to reject because the interference normally comes from the same general direction as the desired signal. Electrical interference also is difficult because this type of interference is often scattered over a wide area. The most effective method of reducing multipath and electrical interference is an array with a narrow front lobe and low level side lobes.

"The predictable performance of the 'pure' log periodic antenna ... make it ideally suited for use in standard custom-designed arrays."

The engineering technology used in array design is not new. Most broadcast transmitters use arrays to increase the effective radiated power and to direct the signal toward more heavily populated areas. Reception is the reciprocal of transmission. Therefore, this same technology can be used just as effectively and as reliably for reception. The key to realizing the full benefits of a properly designed array is the use of good quality antennas with predictable performance. The predictable performance of the "pure" log periodic antenna with its cantilever mount and rugged design, make it ideally suited for use in standard and custom-designed arrays as shown in Figure 9.

The use of a high quality antenna in itself is not enough to ensure optimum array performance. Each antenna has a specific radiation pattern, which is based on the design of that particular model. As we saw in Part 1, this pattern is dependant on a number of factors including proximity of other antennas and metal objects such as the mount or the tower itself. Optimum performance will be achieved if each antenna is identical and the individual antennas remain precisely aligned for maximum rejection in the required direction. Precise alignment is maintained by using a welded mounting structure. This ensures that individual antennas on the array cannot be moved independently and the level of rejection remains constant. Unlike electronic filters and traps, performance is unaffected by changes in temperature or moisture. Maximum rejection is maintained with absolutely no distortion to the desired signal.

Few technicians are aware of the difference in the performance of the Yagi and the log periodic antenna. There are significant benefits to be realized by using log periodic antennas either as a single antenna or a phased array to increase the desired signal level, reject undesired signals and improve the overall signal reliability.

The development of the log periodic antenna was undertaken specifically to overcome many of the limitations of the Yagi antenna. With the exception of gain, the performance of the log periodic antenna, as a single antenna or in a phased array, is superior to that of the Yagi. Increased gain will only improve the signal quality if the problem is caused by low signal level at the input to the receiver. If the interference is from an external source, increasing the gain of the antenna will increase the level of desired and undesired signals by nearly the same amount. The use of phased arrays of log periodic antennas will increase the level of the desired signal while reducing the level of the undesired. Thus we have the benefit of increased gain with reduced interference, good back-to-front ratio on adjacent channels and stable, predictable performance even during icing conditions. These benefits are achieved with no active or passive devices other than a broadband combiner network and with absolutely no distortion of the desired signal caused by the antenna system.

The stability and the predictability of the performance of the broadband pure log periodic antenna either as a single antenna or in a phased array, make it ideally suited for use as a VHF and UHF receiving antenna for CATV systems. **BTB**

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Author's note: A special thank you to Geoff Wade for his comments during the preparation of this article.

Retrofit standby power supplies

By Jud Williams,
Owner, Performance Cable TV Products

The next few years will be decisive ones for the cable industry, particularly when it comes to implementing new plant. Now that fiber is rapidly becoming the distribution system of choice, questions arise as to the most cost-effective way to increase channel capacity, on an interim basis, particularly when it involves smaller systems.

Among the options open to many cable systems is retrofitting existing equipment with wider bandwidth, drop-in amplifiers. This may prove to be the the least expensive way to go since existing hardware is utilized. Along with such upgrades, it is often necessary to replace system power supplies.

Increasing demands for better reliability, due to the popularity of events such as the World Series and the Super Bowl, are rather obvious reasons for upgrading system power supplies. The requirement for more power due to the higher current demands of switching power supplies used with the newer distribution equipment often dictates an upgrade. Replacement of old, tired and worn-out power supplies is becoming increasingly necessary. Then, there is the situation where the power supply company that equipped your system has long since gone out of business.

A simple solution

One possible solution to cable's increasing power demands is retrofit power supply equipment such as Performance Cable TV Products' Model SB1000 universal retrofit standby power supply. Criteria for the design was for it to be completely utilitarian. With this in mind, the unit that evolved is a straightforward, functional power supply devoid of frills. It is designed to fit into virtually any configuration and is compatible with all ferroresonant power supplies with 60 volt RMS output. The terminal strip has pictorials for easy connection as shown in Figure 1. DC input voltage is standard 24 volts, using two batteries. Output is 60 volts RMS, 16 amperes. The unit contains all necessary functions such as the

"The requirement for more power due to the higher current demands of switching power supplies used with the newer distribution equipment often dictates an upgrade."

Figure 1: The Model SB1000 standby power supply upgrades any system to 16 amperes

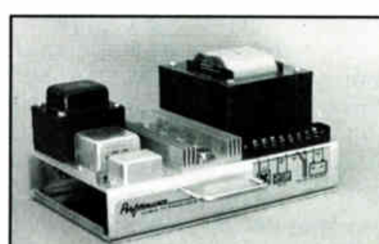

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Figure 2: Retrofitting the CCT inverter chassis with the SB1000

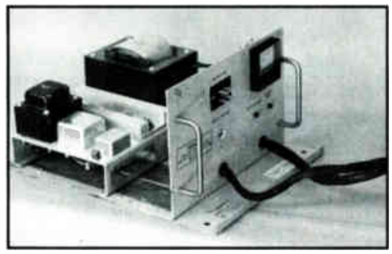
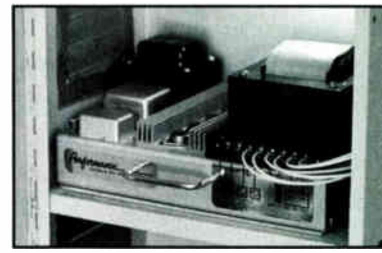


Figure 3: The SB1000 retrofits the Lectro Versatile increasing the output to 16 amps



transfer relay, low voltage cutoff and battery charger.

An example of a retrofit involving a defunct manufacturer is shown in Figure 2. The SB1000 is mounted into the chassis of a CCT inverter after the original circuit boards are stripped out and four holes drilled for mounting purposes. The original ferroresonant transformer continues to be used with one simple wiring change. In this case the existing pole-mounted cabinet is utilized. The power supply was upgraded to a standard 24 volt, two-battery system from an outmoded three-battery, 36 volt system.

The next example, Figure 3, illustrates the utilization of an existing manufacturer's cabinet. Here, the Lectro Versatile 12 ampere unit is replaced with the retrofit inverter, resulting in a higher rating of 16 amperes. The cabinet is designed to accommodate two batteries so the upgrade continues to be a 24 volt system.

A lasting solution

Long battery life is assured by virtue of the battery charger design used in the SB1000 inverter. It has been determined that the pulsating DC output of the charger has the effect of minimizing the sulfation within the batteries. Also,

"The alternative of retrofitting an existing power supply is certainly a viable option, particularly when you consider that the cost of the inverter is not much more than the cost of repairing two feedforward amplifiers."

with the peak output voltage set so that it is equal to the open circuit voltages of the batteries, the problem of excessive grid corrosion is greatly reduced regardless of temperature. This is due to the current-limiting nature of the charger. These features result in the documented doubling of battery life over previous charging methods.

The alternative of retrofitting an existing power supply is certainly a viable option, particularly when you consider that the cost of the inverter is not much more than the cost of repairing two feedforward amplifiers. **BTB**

SLM

The Model 951 portable CATV signal level meter was unveiled by Leader Instruments. An auto-scanning feature selects 32 channels encountered and displays measurement results autoranged and auto-scanned for storage to, or recall from, four groups of eight channel-bar graph data registers. Users also can select and store four memory-scans of picture and/or sound carriers and measured results.

Single- or multichannel displays are selectable with digital readouts and analog bar graph indications on a large, backlit, supertwisted LCD display. Both picture and sound levels are displayed in dBm, dBmW, dBμV and dBμE with ballistic choices including peak or maximum hold or average display modes with 0.1 dB resolution. Frequency and temperature effects are auto compensated for yielding a conservative ≤3 dB accuracy specification across all frequencies, levels and operating temperatures, according to the company. The unit provides continuous frequency coverage from 48 to 870 MHz and features EEPROM look-up tables for picture and sound carriers in broadcast VHF, UHF and CATV standards of 16 countries.

Reader service #197

Message-on-hold system

Two new models of Audiocom's digital message-on-hold system are available, the SAM 390 and SAM 490. The products are built around the company's original SAM 290 with the additional feature of a built-in cassette mechanism to transfer the pre-recorded cassette programming into the computer chips. The "hands-off" integrated tape transport mechanism automatically loads the cassette programming into digital memory during start-up or after power outages. Both models are available with digital storage capacity of up to 32 minutes while still maintaining excellent audio quality, according to the company.

The SAM 490 has a night mode that works like an announce-only answering machine. With an RJ-11 jack, the SAM 490 will answer an incoming call and deliver a pre-recorded message and then disconnect the line for the next incoming call.

Reader service #207

Prep/install kit

Jensen Tools' JTK-4100 cable prep and installer kit has a wide selection of cabling tools with a number of options like crimp tool frame, drill, cordless screwdriver, meter and staple gun. The kit is enclosed in a rugged-duty black polyethylene case, which also has two removable pallets, a document pouch, and combination lock and padlock hasp for added security. The kit is said to be equally useful for running fiber, copper or coaxial cable.

Reader service #206

Fault locator

The Model S665 mini-sized fiber-optic visual fault locator was introduced by Fotec. The unit injects a bright red light into the cable and regions of high loss become visible to the user, which calls attention to bad splices, connectors or kinked cables.

This technique has been used for years with HeNe lasers, but their size, price and requirements for high voltage power limit their application, according to the company. The new locator uses laser diode technology to reduce the same function into a package that is pocket-sized. The unit is powered by a 9 volt battery.

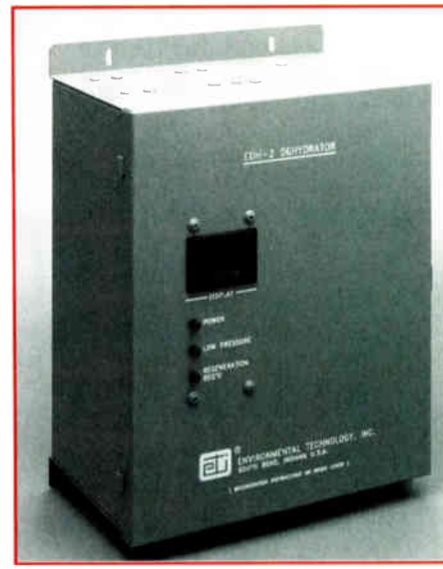
Reader service #205

Cable prep kits

Ripley Co. introduced kits containing Cablematic tools for the preparation of Comm/Scope's Quantum Reach trunk and feeder cables. The kits, which are designated with the prefix QRT, will contain a CST-QR2 combination core and strip tool (with ratchet handle and drill adapter or with tee handle and drill adapter) and a JST-QR jacket stripping tool.

The products are available in sizes .500, .540, .860 and 1.125. The kits containing CST tools with ratchet handles will have a suffix R. (For example — QRT 860R.) Those with tee handles will have no suffix. (For example — QRT 860.)

Reader service #195



Dehydrator

Environmental Technology made available its EDH-2 air dehydrator that provides 0.5 psig dry air required for Ku- and Ka-band satellite and microwave applications requiring flow rates up to 120 cubic feet per day. The product uses microcomputer technology, which is said to be a first for dehydrators employing renewable drying agent.

Standard features include built-in low pressure and high dew point alarms, summary alarm relay, digital pressure display, 100 percent solid-state control and an air pump time-out. The time-out is said to ensure long air pump life by limiting continuous operation to four hours in case of a serious leak. Safety features include 24 volt AC operation and no high pressure.

Reader service #204

Loudness control

The Matrex XL90 audio loudness controller from Matrex Industries is said to completely control audio loudness without requiring new rack space. It automatically sets channel-to-channel or ad insertion audio loudness to within 1/2 dB over a 30 dB range of input. The transparent RMS-based controller has 0.03 percent THD and 85 dB signal-to-noise. According to the company, the RMS method of determining loudness allows the unit to automatically compensate for loudness buildup caused by heavily preprocessed inputs ensuring parity with less processed audio inputs.

The stand-alone module instantly attaches to the back panel of any channel modulator. No extensive rewiring of the headend is said to be needed since the module may be placed adjacent to the audio inputs of the modulator. Other features include: a built-in calibrator that allows the user to set the modulation without the need of an outboard audio oscillator; input level display; an input attenuator; and an auto-bypass circuit. It measures 5.7 (width) x 1 (height) x 3.2 (depth) inches.

Reader service #203

Amplifier

The Model 310 amplifier from Sonoma Instrument covers 10 kHz to 1 GHz with a typical noise figure of 1.8 dB. The equivalent input noise voltage is 0.55 $nV/Hz^{1/2}$, including the thermal noise of a 50 ohm signal source. Gain is 32.5 dB at 100 MHz with a flatness specification of ±0.5 dB maximum from 25 kHz to 800 MHz. Output power at 1 dB gain compression is 11 dBm and the third order intercept point is at 23 dBm.

Transition time is 350 psec and group delay variation is ±75 psec, which is said to make it suitable for use with pulse and high-speed digital as well as RF and IF signals. The unit operates from 115 or 230 volts AC. It measures 3.6 x 4.3 x 7.2 inches. Available connectors include BNC or Type N. The operating temperature range is from 0 to 55° C. Applications for the unit include spectrum analyzers, receivers and high-spec fiber-optic links.

Reader service #201

OTDR module

Siecor announced a single-mode module is available for its Model 2001HR optical time domain reflectometer for testing and documenting of fiber-optic links. The plug-in module is for 1,300 nm testing and can be used to upgrade existing 2001HR OTDR mainframes. A separate equipment purchase is not required. The company reports that multimode modules also are available.

The OTDR has a built-in printer that prints the trace and all related information in less than 30 seconds. A standard disk drive allows trace storage. Full-page, permanent trace records can be printed via a personal computer using 2001 Batch, a companion software, which also is said to print an entire disk of traces, including length and loss measurements with a few keystrokes. It operates on dot matrix and laser jet printers. A help function is provided with the unit to provide instant display of operating instructions and on-line application notes.

Reader service #202

Transmitter

Hughes AML Products announced its Model AML-STX-141S transmitter that uses all solid-state technology instead of klystrons. With up to eight channels per 8-foot rack, the product's array requires only half the floor space required by the company's Model AML-STX-141 array. Power consumption also is less — on the order of 160 watts per channel, according to the company.

Each channel uses a fan to maintain the unit close to room ambient temperature. The unit's transmitters are optimum for use where large numbers of hubs are served or where long microwave paths may be encountered under adverse climatic conditions. The transmitters are said to be easily integrated with the company's existing STX-141 and SSTX-145 systems and are compatible with all of Hughes' AML CARS-band microwave receivers.
Reader service #200

Frequency counter

Cadco's new tunable counter Model 50-550 displays within 32 Hz accuracy video carrier and aural inter-carrier frequencies. The unit has automatic modulation stripping without program disruption and front-panel adjustable calibrator referenced to a network rubidium atomic clock 3.5795454 color subcarrier.

It uses pre-scaled LO output of the company's Model 362HL agile processor or Model 370 agile demodulator. Also, the product covers off-air, HRC and standard cable frequency plans.
Reader service #199

Ratchet wrench

A new ratchet wrench developed by Lowell Corp is both torque-limiting and open-ended. According to the company, the ratcheting action increases the speed and ease of use by installers while the torque-limiting feature addresses the care and sensitivity that must be used to prevent the crushing of coaxial connectors during installation.

Said to have been created with suggestions from linemen and installers in mind, the tool reduces signal leakage by ensuring proper F-connector and coaxial cable contact. Preset during factory production, audible and tactile signals tell when the desired torque has been reached. The wrench also features an ergonomically-sized handle that provides optimum comfort and control. It is available in standard sizes.
Reader service #195

Coax adapter

Featuring low loss over the frequency range of DC to 4 GHz, the Model PE9342 type BNC female to type MINI-UHF coaxial adapter was introduced by Pasternack Enterprises. It has a brass nickel-plated body and uses Teflon insulation, a gold-plated contact and has an operating temperature range of -65 to 165° C. The adapter will mate with any BNC male and MINI-UHF male connector.
Reader service #198

Passives

New from Just Drop is a line of

installation passives. The 5-600 MHz, two-, three- and four-way splitters have 125 dB RFI shielding. According to the company, this is achieved by using a diecast back plate with interlocking channels that form fit into the housing.
Reader service #196

Remote video control

The Leightronix C-Voice telephone remote control allows control capacity for any combination of up to 64 total tape machines and any combination of 64 switcher destinations. The user can dial the telephone number or extension that the product is connected to from any standard touch-tone telephone to control video equipment.

The unit uses a real digitized human voice to guide the user through the remote control operation. Control is available for most popular manufacturers and most videotape formats. Other features include multilevel, user-programmable password protection; automatic non-response timeout and disconnect; non-volatile memory for configuration information; user-programmable ring count for auto-answer; and easy-to-understand voice prompts and menus.
Reader service #194

Ratchet crimp tools

Selecta Switch added a complete line of ratchet-style crimp tools to its Selecta Terminal line. According to the company, the carbon steel construction provides a level of accuracy usually reserved for Mil-Spec tools and tool life is said to be conservatively rated at 50,000 cycles and meet all UL tensile requirements.

The frame design eliminates flex during high crimping loads and jaw opening orientation, molded palm grips and easy reach frame minimize fatigue. The positive ratcheting assembly features an emergency release and the multipurpose frame is manufactured to exacting specifications and will accept interchangeable dies. All bearing holes are reamed, pivots are centerless ground and all work components are heat-treated.
Reader service #193

Connector guide

Pearson Technologies released its *Trade Secrets for the Installation of Fiber-Optic Connectors* report. The 93-page report is designed to enable the reader to avoid problems, to increase yield and to reduce installation time and costs. According to the company, the guide differs from the instructions supplied by connector manufacturers in that it includes information that lets novice installers be successful even when mistakes are made.

The report has nine sections: an introduction to terminology; choosing and using epoxies; developing time/temperature cure cycles for heat cure epoxies; a complete 31-step procedure; creating and evaluating test leads; testing of insertion loss and interpretation of results; troubleshooting; and procedures for comparing and evaluating connectors.
Reader service #196

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13	32	51	70	89	108	127	146	165	184	203
14	33	52	71	90	109	128	147	166	185	204
15	34	53	72	91	110	129	148	167	186	205
16	35	54	73	92	111	130	149	168	187	206
17	36	55	74	93	112	131	150	169	188	207
18	37	56	75	94	113	132	151	170	189	208

AD INDEX

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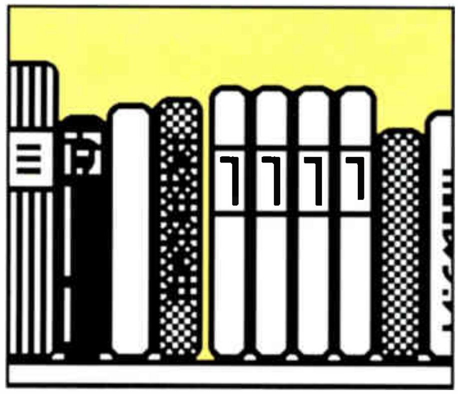
BOOKSHELF

The following is a listing of 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.

☛ *Signal Leakage, CLI and the FCC* — A complete three-camera video production of SCTE's technical seminar on signal leakage held September 1985 in Denver. This 12-hour program includes presentations by Bob Luff, Sruki Switzer, Robert V.C. Dickinson and Cliff Paul concerning leakage monitoring practices, plus a satellite teleconference with engineers from the FCC discussing compliance with the commission's new rules regarding cable system leakage. (12 hrs.) Order #T-1021, $250.

☛ *Signal Leakage, CLI and the FCC Teleconference* — This excerpt of T-1021 features the live satellite teleconference between the seminar in Denver and members of the FCC in Washington. Panelists include John Wong, Ralph Haller, Wendell Bailey and Archer Taylor. Tom Polis moderates. (2 hrs., teleconference only) Order #T-1021A, $45.



Note: All videotapes listed were produced 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 post office 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 (see page 17) 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.

KEEPING TRACK

Greiner

Vaas

Two new appointments were announced by the CATV division of **Pico Products**.

Robert Greiner is the new vice president of sales and marketing. Prior to this, he was with RJG Enterprise (a company he formed in 1974).

Timothy Vaas accepted the national sales manager position for the division. He has 11 years of CATV sales experience including eight years with Magnavox CATV.

Jones Intercable named **Christopher Bowick** group vice president/technology and chief technological officer. Previously, he was vice president of engineering, headend and earth station systems, for Scientific-Atlanta's transmission systems business division.

As well, Jones appointed **Kenneth Wright** director of technology. Prior to this he was director of engineering for United Artists Cable's western division.

Lem Tarshis was added to **Nexus Engineering Corp.**'s board of directors. Formerly, he was vice president and general manager for the distribution systems division of Jerrold.

General Instrument Corp. appointed **James Bunker** president of the VideoCipher division. He joins GI after 30 years with M/A-COM Inc., where most recently he was senior vice president for business development.

Augat Inc. named **Larry Buffington** vice president and general manager of the company's communications division. Formerly, he was chairman and CEO of Adaptive Technologies Inc.

Additionally, **Sally Kinsman** joined Augat Communications Group as product manager for its OptiFlex line of 1 GHz capable fiber-optics distribution networks. Most recently she operated Kinsman Design Associates.

Contec International announced two new district sales managers. **Richard Kielb** will serve the northeast region and **Robert Sexton**, the southeast region.

The new position of information systems specialist at the **National Cable Television Institute** went to **Ed Milner**. Formerly he was vice president of technology at Flight Trac.

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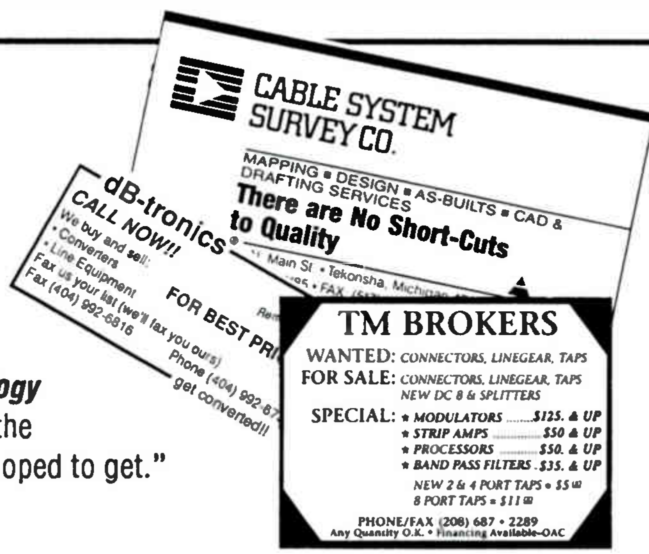

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December

3-5: C-COR fiber seminar, Pittsburgh. Contact (814) 231-4422.

4: SCTE Caribbean Area Meeting Group seminar. Contact John Green, (809) 848-7746.

4: SCTE Florida Chapter, BCT/E exams to be administered in Categories IV, V, VI and VII at both levels, Continental Cablevision, Pompano Beach, Fla. Contact Keith Kreager, (407) 844-7227.

5: SCTE Iowa Heartland Chapter, BCT/E exams to be administered in Categories I, II and III at the technician level, Cox Cable, Cedar Rapids, Iowa. Contact Mitch Carlson, (309) 797-9473.

5: SCTE New England Chapter, BCT/E exams to be administered in all categories at both levels. Contact Jeffery Piotter, (508) 685-0258.

5: SCTE Upper Valley Meeting Group seminar, digital alternatives, Holiday Inn, Whiteriver Junction, Vt. Contact Matthew Alldredge, (802) 885-9317.

5: Fotec fiber seminar, New York/New Jersey. Contact (800) 537-8254.

9: SCTE Satellite Tele-Seminar Program, video and audio measurements (part 2) and painless technical writing (part 1). To air from 1 to 2 p.m. ET on Transponder 6 of Galaxy 1.

9-10: Scientific-Atlanta fiber systems training, Minneapolis Marriott, Bloomington, Minn. Contact Dan Pruitt, (404) 903-5183.

9-11: SCTE Technology for Technicians II national seminar, Holiday Inn, Phoenix, Ariz. Contact SCTE, (215) 363-6888.

10: SCTE Badger State Chapter seminar, system design, MDU design and construction, Holiday Inn, Fond du Lac, Wis. Contact Gary Wesa, (414) 496-2040.

10: SCTE Chattahoochee Chapter seminar, signal leakage, CLI and FCC Form 320, Perimeter North Inn, Atlanta. Contact Hugh McCarley, (404) 843-5517.

10: SCTE Greater Chicago Chapter seminar on BCT/E Category II, BCT/E exams to be administered, Embassy Suites Hotel, Schaumburg, Ill. Contact Bill Whicher, (708) 438-4423.

10-12: Taipai Satellite & Cable TV '91, Taipai International Convention Center, Taipai, Taiwan. Contact 011-886-2-506-3335.

11: SCTE Great Plains Chapter, installer and BCT/E exams to be administered in Categories I, III, VI and VII at both levels. Contact Jennifer Hays, (402) 333-6484.

11: Scientific-Atlanta distribution systems training, Minneapolis Marriott, Bloomington, Minn. Contact Dan Pruitt, (404) 903-5183.

11-12: NCTI OSHA compliance seminar, Detroit. Contact Michael Wais, (303) 761-8554.

12: SCTE Music City Meeting Group seminar, Bonanza Trinity, Nashville, Tenn. Contact Jim Romese, (615) 244-7462.

11-13: Private Cable Show, Westin Resort, Hilton Head Island, S.C. Contact (713) 342-9655.

12: SCTE Northern New England Meeting Group seminar, test equipment. Contact: Bill DesRochers, (207) 646-4576.

12: Scientific-Atlanta headend and earth station training, Minneapolis Marriott, Bloomington, Minn. Contact Dan Pruitt, (404) 903-5183.

12-13: SCTE Dakota Territory Chapter, BCT/E exams to be administered, Bismark, N.D. (12th) and Pierre, S.D. (13th). Contact A.J. Vandekamp, (605) 339-3339.

13: SCTE Miss-Lou Chapter, installer and BCT/E exams to be administered in all categories at both levels. Contact Dave Matthews, (504) 923-0256.

13: SCTE Wheat State Chapter, BCT/E exams to be administered in Categories I, III, V and VII at both levels. Contact Mark Wilson, (316) 262-4270.

14: SCTE Cactus Chapter, installer and BCT/E exams to be administered in all categories at both levels. Contact Harold Mackey Jr., (602) 352-5860, ext. 135.

14: SCTE Chesapeake Chapter, installer and BCT/E exams to be administered in all categories at both levels. Contact Mike Manz, (301) 662-7734.

14: SCTE Delaware Valley Chapter seminar, headend maintenance and lightning and surge protection, Williamson's Restaurant, Willow Grove, Pa. Contact Rich Blandford, (215) 328-0977.

14: SCTE Piedmont Chapter, installer and BCT/E exams to be administered in all categories at both levels. Contact Rick Hollowell, (919) 757-0279.

17: SCTE Central Indiana Chapter, BCT/E exams to be administered in all categories at the technician level. Contact Joe Shanks, (317) 646-9102.

18: SCTE New Jersey Chapter seminar, amplifier theory, status monitoring, headend equipment and two-way cable. Contact Jim Miller, (201) 446-3612.

18: SCTE Snake River Chapter, installer and BCT/E exams to be administered in Categories V and VII at the technician level. Contact Ron Kline, (208) 376-0230.

18: SCTE San Diego Meeting Group seminar, test equipment measurements, Elks Lodge, Oceanside, Calif. Contact Frank Gates, (714) 492-4606.

28: SCTE Sierra Chapter, BCT/E exams to be administered in all categories at both levels. Contact Eric Brownell, (916) 372-2221.

Planning ahead

Feb. 26-28: Texas Show, San Atonio, Texas. Contact (512) 474-2082.

May 3-6: National Show, Dallas. Contact (202) 775-3550.

June 14-17: SCTE Cable-Tec Expo, San Antonio, Texas. Contact (215) 363-6888.

January

6: SCTE Satellite Tele-Seminar Program, painless technical writing (part 2). To air from 1 to 2 p.m. ET on Transponder 6 of Galaxy 1.

7: SCTE Desert Chapter seminar, fiber-optic electronics. Contact Chris Middleton, (619) 340-1312, ext. 258.

8: SCTE Oklahoma Chapter seminar. Contact Arturo Amaton, (405) 353-2250.

8-9: SCTE Fiber Optics Plus '92 national conference, Loews Coronado Bay Resort Hotel, San Diego. Contact (215) 363-6888.

9-11: Caribbean Cable TV Association annual meeting, Frenchman's Reef, St. Thomas, U.S. Virgin Islands. Contact Margaret Dean, (809) 775-4099.

15: SCTE Ohio Valley Chapter, BCT/E exams to be administered in all categories at both levels. Contact Jon Ludi, (513) 435-2092.

15: SCTE Razorback Chapter. Contact John Minginas, (501) 624-5781.

15: SCTE Southeast Texas Chapter, installer and BCT/E exams to be administered in all categories at both levels. Contact Tom Rowan, (713) 580-7360.

22: SCTE Bluegrass Chapter seminar, BCT/E Category III. Contact Liz Robinson, (606) 299-6288.

SCTE technology conference

By Wendell Woody
President, Society of Cable Television Engineers

The annual Society of Cable Television Engineers fiber-optics seminar is certainly developing toward being this industry's major technology conference. The conference is titled, "Fiber Optics Plus '92." The Society added the word "plus" to this year's title to give the seminar planning subcommittee the direction and power to include all the new developing technologies in this year's program. Fiber-optic systems will provide the transportation for most of the new technologies.

Agenda topics

As for the fiber-optic topics, they will be very focused and in-detail and will comprise three-fourths of the program. The general categories are: "The operational impact of fiber optics"; "New developments in fiber technology"; and "New applications for fiber optics."

There will be 19 fiber-optic speakers addressing a significant range of subjects such as: economics and reliability; outage reduction; measuring the benefits; operation flexibility and upgrade capability; AM supertrunking; external modulation; 1,310/1,550 WDM; optical amplifiers; laser technology; fiber-to-the-feeder designs; using 1,550 nm technology; 1 GHz systems; digital services; and hybrid fiber/coax systems.

Emerging technologies

The CATV industry is currently in a technological explosion. This will be addressed at the conference with the exploration of emerging technologies. A group of seven professional engineers will address subject materials such as: digital compression; digital TV and cable TV; digital transmission and modulation techniques for CATV; photonic technology; digital NTSC/CCTR-601 TV codec; and large-screen display technologies.

Register now

This technology conference will be held Jan. 8 and 9, 1992, in San Diego, at the Loews Coronado Bay Resort Hotel. The two-day seminar fee is only $195 for SCTE national members. This fee also includes a copy of the *Proceedings Manual* of collected technical papers delivered at this conference.

Your attendance can be significant for both you and your company. Telephone the SCTE Exton headquarters office if you have not already registered at (215) 363-6888.

1992 election

In January, all SCTE members will be asked to participate in an election to fill eight empty seats on the SCTE board of directors. Your involvement is important and so key that the nominations subcommittee gave every active member an opportunity to submit potential candidates to represent them.

Did you return a nomination form? Strong leadership on the national board is paramount for future SCTE growth, benefits and support for you and your industry.

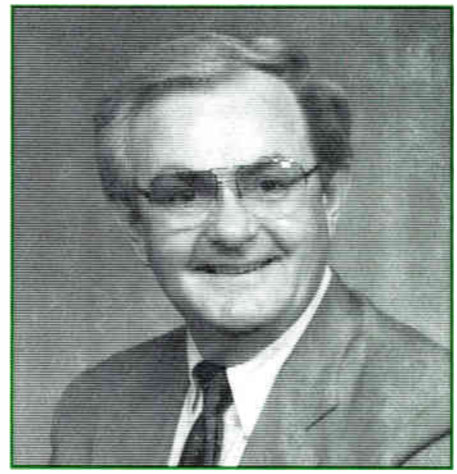
New chapters

Our Society continues to grow in quantity and quality achievements. However, the fact remains: The activities at the local level are the core strength of the Society and the initiative for continued growth and fulfillment as the professional engineering society for our industry.

We now have 70 chapters/meeting groups and are still growing. The recent elevation of five more meeting groups to the chapter level brings the total number of chapters to 55. It is with pride and great pleasure we acknowledge the following meeting groups for their recent elevation to full chapter status: Bluegrass (Elizabethtown, Ky., Billy Grubbs, president); Penn-Ohio (Butler, Pa., Bernie Czarnecki, president); San Diego (Laguna Hills, Calif., Jack Connolly, president); South Jersey (Vineland, N.J., Kevin Hewitt, president); Upper Valley (Springfield, Vt., Matt Alldredge, president).

International SCTE

The International SCTE Council conducted a meeting at the recent U.K. Cable Television Association (CTA) 1991 Cable Convention & Exhibition in London. The business session included reviewing the proposed



international charter, procedures for recognizing other countries, selecting a logo design and updating council appointments. Great interest was expressed by cable engineers from other European countries to either develop an SCTE group in their country or have their present society be associated with our international council. Some of our new contacts were: Thomas Jaskiewicz of Poland; Stefler Sandor of Hungary; Kristien Verhaeghe of Belgium; Larry Bournique of Spain; and Branko Djakovic of Yugoslavia. Sandor addressed our SCTE council meeting.

The CTA provided a joint U.K./U.S. SCTE stand (booth) at the Olympia Exhibition Centre. The U.S. SCTE distributed information on the sale of training tapes and publications; the Fiber Optics Plus '92 seminar; and the Cable-Tec Expo '92, which is to be held in San Antonio, Texas. The interest level was excellent for all these items. International attendance at our U.S. SCTE events is expanding.

Meeting the members

The Cable-Tec Games at the Mid-America Cable TV Show in Kansas City, Mo., brought together officers and members from three chapters: Great Plains (Omaha, Neb.), Heart-of-America (Kansas City) and the Wheat State Chapter (Wichita, Kan.).

The competition was furious and fun. Congratulations to the winning team: Jeff Bickel, Ron Eggert, Roy Wagener and Tony Fox (all from Jones Intercable). **CT**

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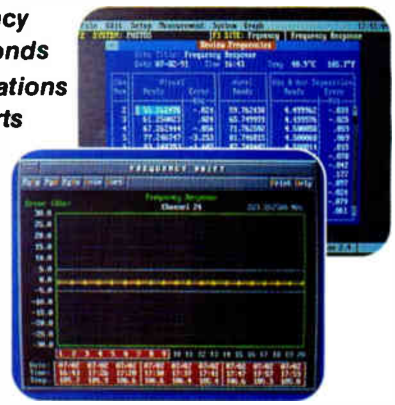

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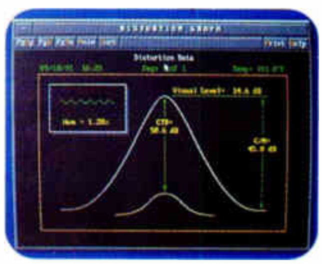

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