JULY 1988

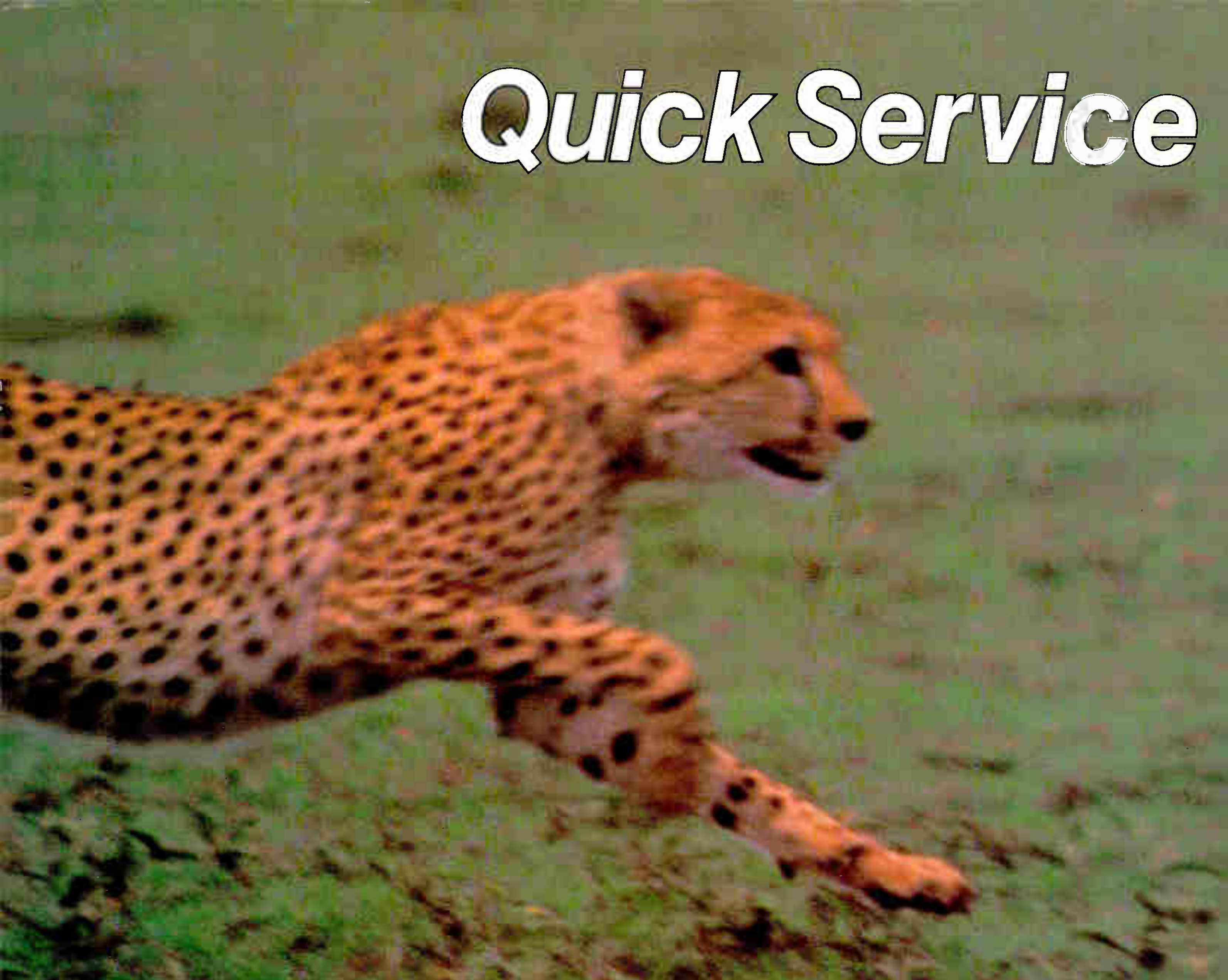
COMMUNICATIONS ENGINEERING AND DESIGN
THE MAGAZINE OF BROADBAND TECHNOLOGY

CED

Rebuilding with fiber

Testing modulator reliability

The construction boom: Feast or famine in '89?


Quick Service

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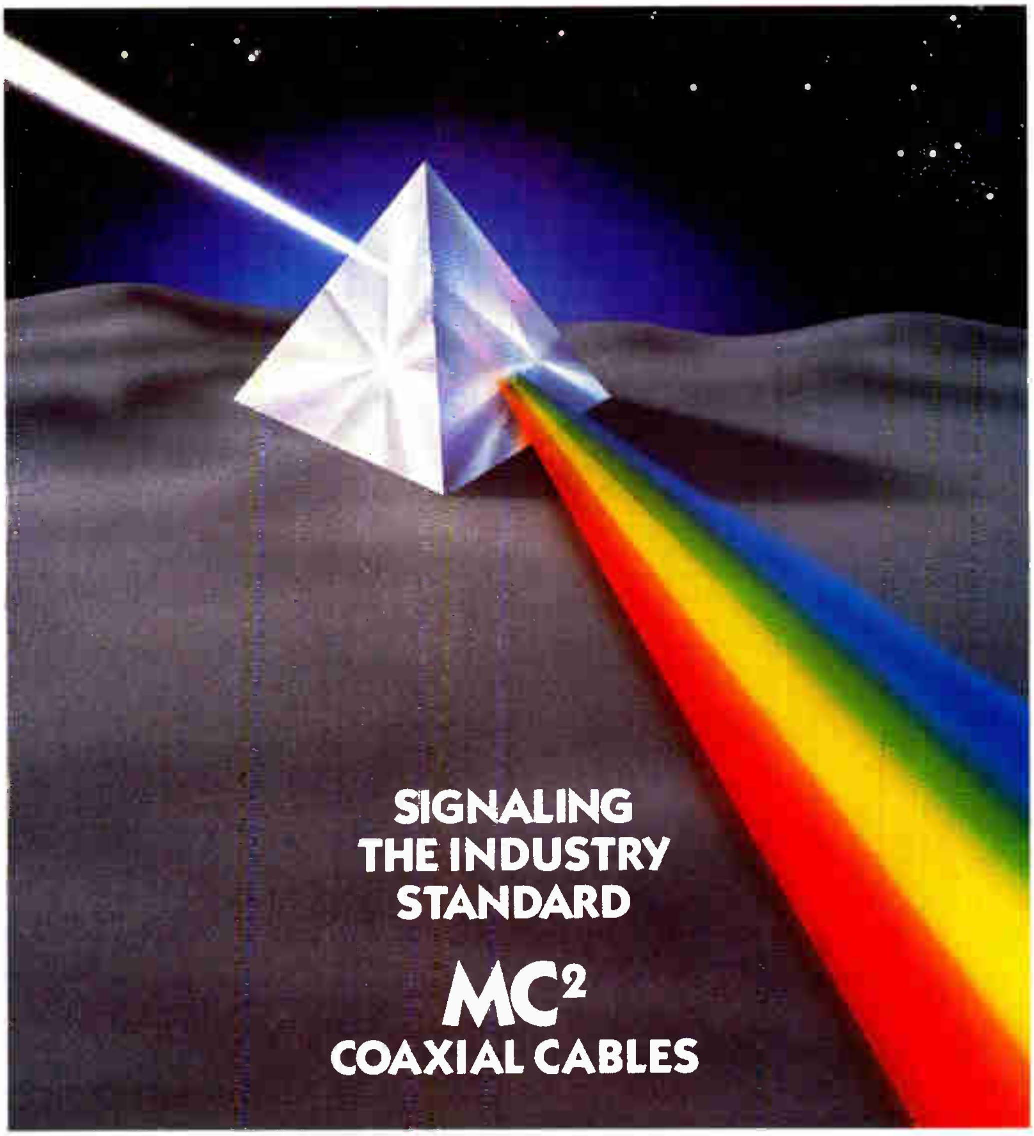

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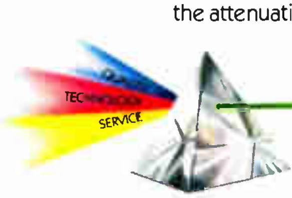

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CED

July 1988 Volume 14, Number 7

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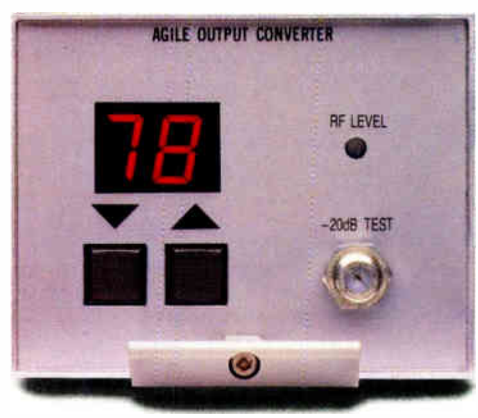

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Reader Service Number 4

spotlight

Matt Miller

The fine art of juggling

It's doubtful that when Matt Miller was hired by Viacom International he had to demonstrate his ability to juggle objects without dropping any of them—but there's no question he's learned the art since becoming vice president of science and technology at Viacom's corporate headquarters in New York.

Most of Miller's counterparts who work for other MSOs have just one perspective to keep clear in their minds: cable TV. But Viacom is extensively diversified. So when Miller looks at an issue, he has to balance the interests of cable operations, programming, radio and television broadcasting, production, syndication and international film syndication when coming up with a corporate position on the subject.

Miller, who holds an undergraduate degree in physics from Harvard and masters and Ph.D. sheepskins in solid state physics from Princeton, began his professional career in 1973 at RCA's David Sarnoff Research Center. As a member of the semiconductor device research group, he performed theoretical and experimental work on solid state lasers, ICs, solar cells and other devices. "I was working in optical communications before it was sexy," Miller recalls.

In 1976, he moved on to Perkin-Elmer Corp.'s research department where he managed high-tech R&D projects related to long-wavelength semiconductor lasers, infrared detectors, etc. The work was leading-edge, difficult and highly rewarding, Miller says. Through a series of job title changes, Miller began the gradual transition from a scientist who knew a little about business to a more business-oriented scientist.

The 1984 shift to Viacom was completely unexpected; he got the job by helping the company's vice president of human resources (who was a friend of Miller's wife) write a job description for the director of science and technology post. Miller's wife suggested that Matt throw his hat into the ring. "I gave her the 15 reasons why I wouldn't be interested and she turned each of those reasons into reasons why I should be interested," says Miller.

After interviewing with Frank Bias, Terry Elkes and Ralph Baruch, Viacom made an offer Miller couldn't refuse and he was hired.

As director of science and technology, Miller reported directly to Bias, then-vice president at Viacom. In fact, Miller was hired expressly to be groomed as Bias' successor. As a rookie in the cable/broadcast industry, Miller had the advantage of Bias' and Baruch's years of expertise and knowledge. "I can't speak highly enough of Frank Bias," Miller says, "he was my mentor."

Bias and Miller reversed roles in 1985 when Bias retired and became a special consultant to the company.

Now, as VP, Miller's time is split between advising the corporate leadership on the importance and ramifications of new technologies, and advising his field engineers on how to solve problems.

"When the company gets together and tries to understand how to chart its course into the 21st century, I'm the fella who's supposed to provide the technical input to those discussions," explains Miller. But it isn't necessarily as easy as that statement makes it out to be. Because Viacom owns so many properties in a wide variety of competing and complementary industries, "there are no easy answers," Miller says. "We find ourselves having differing views on almost every issue."

A timely case in point is the "company position" on high definition television and what form of transmission the new technology should take. Presently, the company approach to the issue is fluid because technology, economics and politics all enter into the discussion and the winds are constantly changing. However, it was Miller's task to integrate the varying interests into a common voice and write Viacom's FCC filing on HDTV.

But most of Miller's time is devoted to working with Viacom's other talented engineers to solve problems or examine multi-divisional issues of strategic importance. "We have good engineers in all our divisions and I don't pre-empt our people ever," Miller says.

Miller played the role of technical consultant in pulling together the national ANI pay-per-view service in Milwaukee. Here he had to work with Viewer's Choice, uplink technicians, system engineers, AT&T people and a host of others to achieve the common goal.

Miller's 1984 career change gave him an interesting perspective on technology, it's development and use. "The first 15 years of my career I never did anything that anyone else had ever done," he says.

"It was very satisfying intellectually to be involved in activities like that. It was also very hard work." Now that he's not developing technology but using it, "it's less exciting technically," he says. But he's keenly aware of the promise technology holds for the future.

As a strategic planner, DBS, fiber optics and HDTV occupy most of Miller's time and discussions. But he's convinced that by planning ahead and keeping its options open, the cable industry will continue to be a dominant voice in the delivery of entertainment services. "The technical horizons are essentially unlimited," he says. "Our ability to deliver what people want is not going to be limited by technology—which means the business has the potential to continue to grow in some very extraordinary ways."

—Roger Brown

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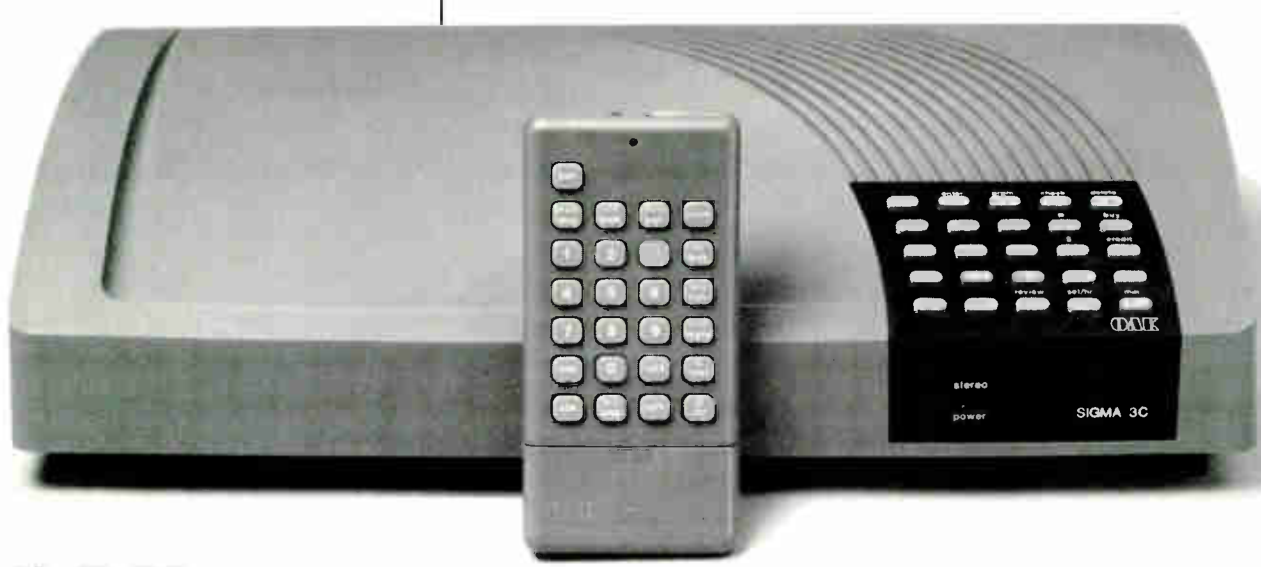

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Reader Service Number 5

'Blue sky:' Is it coming?

For the Spring 1988 issue of *Malarkey-Taylor Review*, I wrote a fanciful scenario to dramatize the confluence of HDTV, fiber optics and telephone integrated services technology. The following excerpts set the rather scary tone of the piece. (Copy of the MTA Review is available on request.)

> *A large oil painting, hanging above the fireplace, is flipped like the movie screen on a wide-body jet airplane. The screen is about 3 feet high by 5 feet wide, and only 2 inches thick. Actually, it is a liquid crystal dislay (LCD), like today's digital watch or calculator, but in full color. We are comfortably seated around the room with our host. He points a wireless remote control at the screen and presses some keys. There is Paul Hogan as "Crocodile Dundee" on HBO, as big and uncivilized as ever. There are no scan lines to be seen, even when viewed at close range. The images are as crisp and clear as in a movie theater. No crawling artifacts, or ghosts, or smeared color. And the sound is as good as compact discs.*
>
> *"How do you do that? How much does it cost?" you ask. "Well, back in 1999," he says (remember, this is fantasy), the "Bell Telco people installed a glass fiber cable to our house. They called it B-ISDN (broadband integrated services digital network)."*

By Archer S. Taylor, Senior Vice President, Engineering, Malarkey—Taylor Associates Inc.

Fred Dawson mildly challenged the piece as "a bit short of the mark when it comes to painting the full picture of what television might bring to American households over the next decade" (*Cablevision*, 5/9/88, p.111). He is right, of course. There is a great deal of activity going on, well beyond the scope of an article that deliberately focused on HDTV and the telephone BISDN. Yet, this activity does, in fact, bear directly on the future of the BISDN, which must necessarily depend in large part on non-video revenues for viability.

The "gee-whiz" era of gasping in awe at the wonderfully amazing possibilities foreshadowed by technological innovations tumbling forth in wild profusion goes back at least 25 or 30 years, to my own knowledge. Dean Burch, as chairman of the FCC when the 1972 rules were adopted, reflected the "blue sky" thinking of the 1960s when he said that cable TV would not be worthy of concern if its only purpose was entertainment. In 1971, Malarkey-Taylor Associates, in a 600-page report commissioned by the White House Office of Telecommunications Policy, described in considerable detail every identifiable service that could conceivably be provided by a broadband coaxial network. We did not miss much. Our list included merchandising, banking, electronic mail, education, medicine, meter reading, load management, home security, electronic newspaper, highway traffic control, vehicle location, and others, some of which were too proprietary to be released. We also included pay-TV, pay-per-view and demand access video.

What has transpired in 17 years since then? Only the entertainment services have shown any lasting signs of marketability.

The fact of the matter is that home entertainment is the only kind of information for which there is presently a demonstrated residential market. In part, this lack of popular demand for non-entertainment services may be a consequence of the technical limitations of the available communications networks. The telephone network, to which almost every household has access, is presently limited by the narrow bandwidth of the copper wire pairs. On the other hand, the coaxial cable TV networks provide plenty of bandwidth, but are connected to only half as many households. The switched video networks are more efficient for full-service, point-to-point transmission in both directions; but cable TV networks are better arranged to handle one-way point-to-multipoint transmissions.

The telephone industry is presently wrestling with the prospect of enormously expanding its residential bandwidth capabilities by replacing the existing copper subscriber loops with optical fiber. Published accounts indicate that future networks, whether ISDN, BISDN, or some modification thereof, will be based on digital video switching and transmission, which could result in significant improvement in reliability, maintainability and signal quality. These developments are apparently motivated by a belief that the emergence of the residential information market would be stimulated by the availability of high speed digital transmission networks.

There is a definite growing trend in the cable TV industry toward optical fibers, primarily for improved signal quality and reliability. There is, as yet, no perceptible trend toward what Dawson called "The switching imperative."

Let's face it. A switched video system is much more expensive than tree-and-branch. This was true when Rediffusion pushed Dial-A-Program 20 years ago; when Ameco demonstrated its coaxial Discade; when Times Fiber pushed its Mini-Hub; and, even now, John Holobinko of American Lightwave Systems frankly states that the

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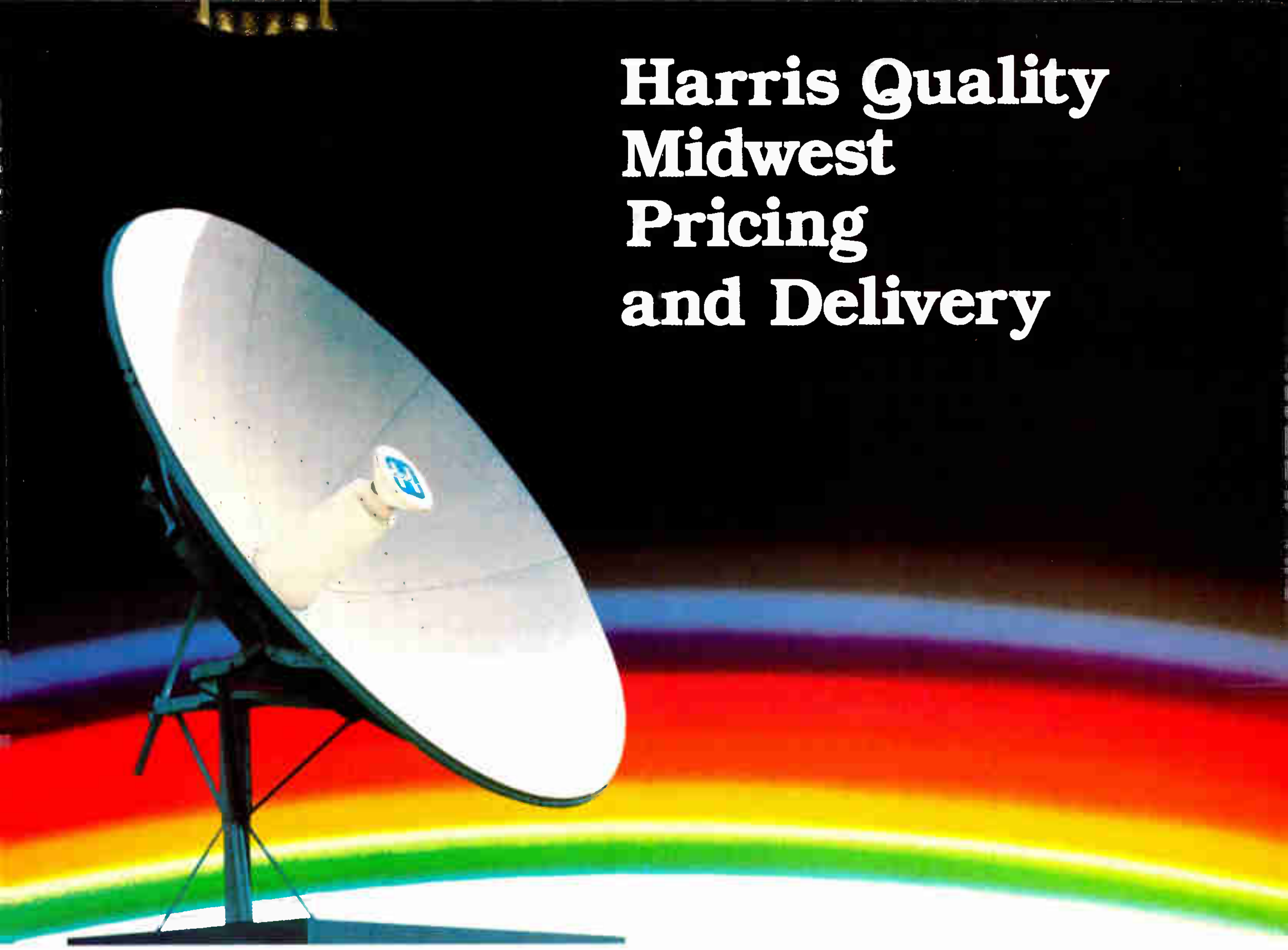

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Unless circumstances change drastically, cable TV operators may never be able to enjoy revenue from POTS.

switched fiber system is much too costly for cable TV without substantial revenue from voice and data services.

The telephone companies are coming into the new era with revenues and profits from POTS (plain old telephone service) virtually guaranteed. Obviously, they are counting on substantial additional revenue from the expected information services. Some believe that revenue from "demand access video" alone would support fiberization of subscriber loops. Others claim that POTS plus information services would be enough.

Should cable operators prepare to "take the capital-intensive steps necessary for developing switched video services," as Dawson suggests? In my opinion, that would be a fatal and costly mistake. Here is why I think so.

Unless circumstances change drastically in the next few years, cable TV operators may never be able to enjoy revenue from POTS. Moreover, cable TV operators are at a distinct disadvantage in competing for the residential information services, since cable TV reaches only about half of all residential telephone subscribers.

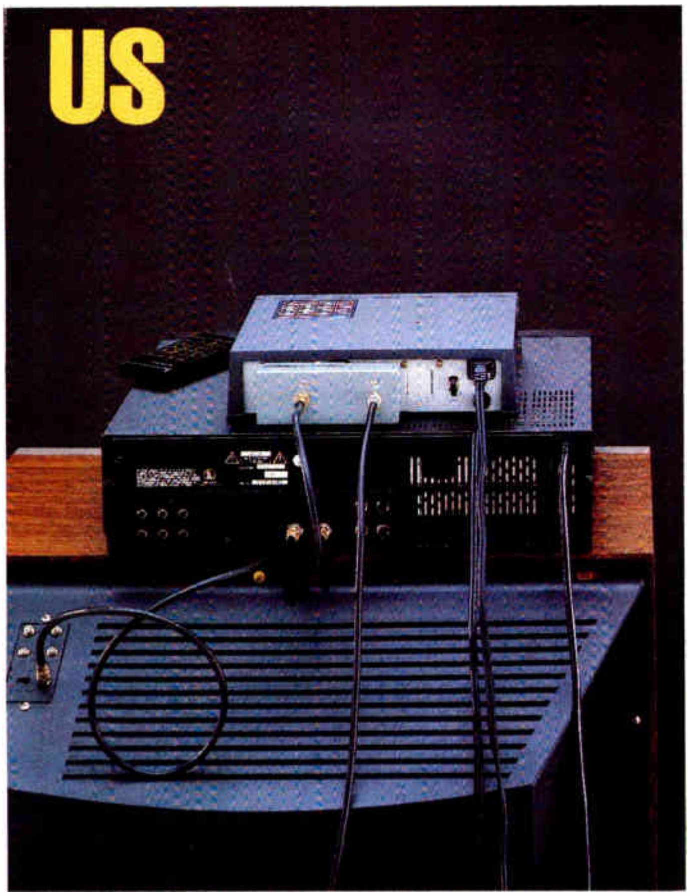
How could cable TV operators even hope to compete against such strength with only one-way video entertainment as an exisiting profit center to support the high cost of the switched video network? By not falling into the switched video trap, cable TV operators can provide subscribers already connected to cable TV facilities with a service that is more user-friendly than the telephone company can offer. The switched video network, such as the telco will use, is designed to deliver only one channel to each TV set. The various channel selection functions, as provided by the TV set manufacturer, are necessarily useless with switched video delivery. Multiple remote control units would probably be needed for remote sound volume control and mute; and, even for remote on/off control of the TV set. Video inserts from second programs now possible in digitally processed TV sets require simultaneous access to all programs. This is not feasible with switched video systems.

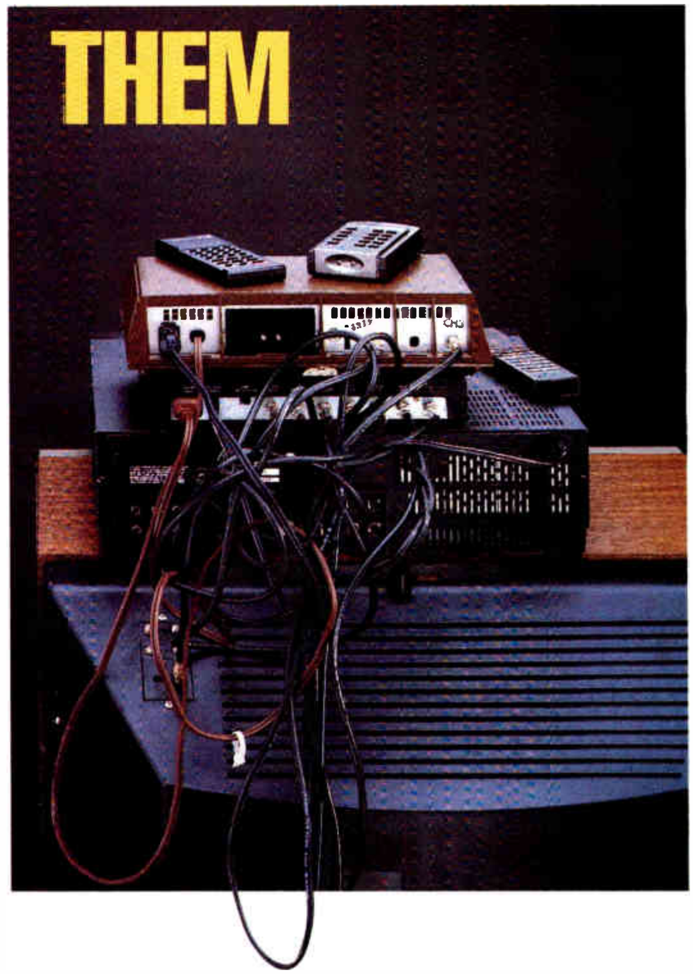
Here, then, is the opportunity for cable TV operators to gain a decided advantage over the projected telephone switched video system. The IS-15 MultiPort connector would do it. Trapping or jamming would do it. Or, why not just bypass the non-scrambled channels around the converter so that a subscriber with a cable-ready TV set could use the regular TV remote control with all its special features? The converter would be used only for scrambled channels, all of which would be received on channel 3 (or whatever). With some minor modifications in converter design, this concept could be significantly more user-friendly than the switched video which the telephone companies will offer their subscribers. It would seem a mistake for cable TV to adopt switched video and lose this advantage unless they see real prospects for substantial revenue from the residential information services.

To effectively compete with the switched video service, cable operators need to prepare to invest in major upgrades or rebuilds designed to provide both the flexibility and transmission quality needed to keep pace with Advanced and High Definition TV developments, in both broadcasting and videocassette technology. Present indications point toward the hybrid fiber backbone with multiplexed VSB/AM channels. Some FM or other channel transmission methods may later be combined with the VSB/AM to accommodate ATV and HDTV. The fiber backbone and a premium converter/descrambler arranged to bypass the non-scrambled channels appears to be a practical and flexible plan for dealing effectively with whatever comes along. Telephone companies will have a hard time persuading existing cable subscribers to disconnect from a well-run cable TV system that allows the use of sophisticated consumer electronics in favor of a switched network.

Be alert. For the next 10 to 20 years, technological change must be expected. So what else is new? ■

Consumer Interface





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Reader Service Number 8

IDTV is just a short-term fix

In all the meetings about HDTV, one of the questions that is always asked is, "Why this rush? Why are we so interested in getting high definition (HDTV) or enhanced (EDTV) television right now? Can't we, for instance, improve the NTSC signal that we all know and love? It has, after all, lasted for a good 40 years and seems to be getting better all the time."

While no one seems to have a good answer to these questions, there are several things that give us pause in our deliberations on this aspect of improved television. Many of the consumer electronics companies (mostly headquartered in Japan, with a few exceptions) are working very hard on what's called IDTV, or improved definition television.

This means improvements in the TV set itself. Those among you who are experts in the design and building of TV sets and the production and pricing considerations used therein may or may not think that it's possible to improve TV pictures significantly just by fiddling with the set.

I am not sufficiently versed in the magic or art of electronic design to argue, but ask anyone who was at the recent Consumer Electronics Show in Chicago about what they saw there in terms of prototype IDTV enhancements. They'll be quick to tell you that there are things you can do to a TV set that do away with all (or at least most) of the artifacts that plague NTSC while at the same time retaining "hooks" for future enhancements.

The real importance in this activity is that nothing else has to be done to get the improvement. You buy the TV set, it has built-in IDTV features, and lo and behold, every NTSC picture delivered to your television looks better, whether it's delivered by the over-the-air broadcasters, videotapes or cable television. But none of this magic is free. These TVs are at the high end (27-inch and bigger) of the companies' product lines. The price tags are high-end as well, with early information indicating a $500 to $800 premium over comparably sized units.

> Unfortunately, this tinkering with the NTSC signal will eventually come up against barriers to further improvement.

Some will say that this, at least, takes care of the issue of improved definition and high definition TV. If the TV sets can be fixed, why do we have to worry about bandwidth (proposals on record vary from 6 MHz to 12 MHz), compatibility (from none at all to completely compatible with today's TV sets), aspect ratio (from current 4x3, 5x3 and 16x9) and all of the other things that are under serious study and scrutiny in various arenas. One thing that concerns me about rushing to embrace a simple solution while dismissing the effort required to settle these questions as unnecessary is that when TV sets improve TV signals our customers will begin to see how good a television signal can be made to look. IDTV can make a significant difference in the current NTSC pictures.

We all tend to agree that they can't make it as good as some of the truly spectacular pictures that can be delivered by the top-notch HDTV transmission schemes and none of them come close to the spectacular picture of a high quality HDTV studio production. And I don't just mean the Japanese proposed standards either. There are examples of European and American pictures that rival the studio production example that we have previously discussed.

Unfortunately, this tinkering with the NTSC signal will eventually come up against barriers to further improvement. When that time comes we must either fish or cut bait. If the customers demand better pictures we're going to have to find a way to send them better pictures.

Then the issues of bandwidth and compatibility will become extremely serious and the resolution of those issues will require some hardheaded reasoning and decisions on trade-offs between signal quality, compatibility and bandwidth.

The biggest trade-off of all, of course, will be what we ask a customer to pay to get this improvement. What the customer pays or is willing to pay is at the heart of the issue for cable systems because we deliver television for pay. All television that we deliver is pay television, not just the premium channels.

The investment in bandwidth that we have to make and in boxes that we may have to provide our subs, the investments in programming, changes in our headends, changes to our plant, increased technical performance areas such as maintenance and reliability, all go into the formula that determines how much we charge. Like so many things in the cable business and, in fact, in most business, the trade-off between the value perceived by the customer for the price of the product is the ultimate determinant of whether or not this venture, like so many others, is successful. ■

By Wendell Bailey, Vice President Science and Technology, NCTA

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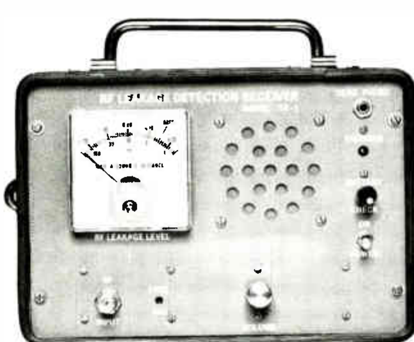

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Reader Service Number 9

A review of frequency modulation

Frequency modulation is a scheme in which the *frequency* of the transmitted carrier varies in accordance with the amplitude of the input modulating or message signal. If the modulating signal is sinusoidal in nature and if the system is AC coupled, then the RF carrier will be made to vary or "deviate" symmetrically above and below its unmodulated or center-frequency position by an amount which is determined by the *amplitude* of the modulating signal. The peaks of this deviation of the RF carrier, both above and below the center frequency, will therefore coincide with the peaks of the sinusoidal modulating signal.

Similarly, as the input signal passes through zero volts, the RF carrier passes through its center-frequency position. The magnitude of the shift in frequency of the RF carrier, above and below its center frequency, is called its *deviation*. Therefore, an RF carrier which shifts ± 25 kHz with peaks of modulation is said to have 25 kHz peak deviation.

For a standard terrestrial broadcast television signal, the audio subcarrier's peak deviation is limited to 25 kHz for monaural broadcasts and to 73 kHz peak deviation for the combined stereo signal (including SAP and utility channel transmission); for commercial FM radio broadcast transmissions, the peak deviation is limited to 75 kHz; and for C-band video satellite transmission, the peak *video* deviation is typically limited to 10.75 *MHz*.

The deviation chosen for each application is a tradeoff between transmission bandwidth and noise immunity. The wider the deviation for a given application, the better the system noise immunity, but the bandwidth requirements are greater. For example, with all else being equal, a carrier deviated 75 kHz by an audio signal would produce 9.5 dB S/N improvement over an equivalent RF carrier deviated only 25 kHz (20 log 75 kHz/25 kHz) by that same audio signal. The catch is that it would require over twice the transmission bandwidth. The bandwidth required for transmission of an FM signal is easily *estimated* by Carson's rule:

$$B = 2(f_d + f_m)$$

where B is the bandwidth of the FM signal, f_d is the peak deviation, and f_m is the maximum modulating frequency.

Another parameter of interest for an FM signal is its *modulation index*. The modulation index for an FM signal is defined as the ratio of its deviation (f_d) to the modulating frequency (f_m). If, for example, the input signal *amplitude* of a 10.4 kHz modulating signal is such that it produces 25 kHz of FM deviation on its RF carrier, the modulation index is said to be equal to 2.4 (25 kHz/10.4 kHz). A *particular* value of modulation index, known as the deviation ratio, is defined as the maximum permissable deviation divided by the maximum permissible modulating frequency. Thus the deviation ratio for television audio (monaural) is defined as 1.67 (25 kHz/15 kHz); for commercial FM broadcasting it is equal to 5 (75 kHz/15 kHz); and for C-band video transmission over satellite, the deviation ratio is equal to 2.56 (10.75 MHz/4.2 MHz).

It's interesting to note that unlike amplitude modulation, where the RF carrier is wasted power and doesn't provide any useful message information (all of the message power is in the sidebands), in FM, the carrier does contain information. If you view a frequency modulated signal on a spectrum analyzer, for example, you would find that the *total* transmitted power of the RF signal remains constant as the modulation index varies, but that this power is continually being transferred back and forth between the RF carrier and its sidebands. In AM, on the other hand, the total transmitted output power varies instantaneously with modulation. The relationship between carrier and sideband power in an FM system is governed by a series of mathematical relationships called Bessel Functions.

Since, in the FM process, power is continually being transferred between the carrier and its sidebands, you could imagine that there must be some values of modulation index where all of the power is transferred to the sidebands, leaving none in the RF carrier. This is indeed the case. The first value of modulation index where all of the power is transferred to the sidebands, leaving none in the RF carrier is called the First Bessel Null and it occurs at a modulation index of 2.4 (there are other Bessel Nulls beyond the first one at modulation indices of 5.52, 8.65, 11.79, etc.). This disappearance of the RF carrier is a very useful measurement tool because it is very easy to observe on a spectrum analyzer when using single tone modulation. Since we know:

$$\text{modulation index} = f_d/f_m$$

we can easily figure out how to set the correct deviation for most any piece of FM equipment. Substituting a modulation index of 2.4 and a deviation of 25 kHz into the above equation, for example, yields the "famous" value of 10.4 kHz as the input modulating tone (f_m) required for First Bessel Null calibration of a TV audio subcarrier.

In an article of this size, it's impossible to provide a rigorous or detailed explanation of a subject as broad as frequency modulation. But we were able to briefly cover several important topics, including: deviation, modulation index, deviation ratio and the Bessel Null. ■

By Chris Bowick, Engineering Dept. Manager, Scientific-Atlanta


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Reader Service Number 11

A technical analysis of a hybrid fiber/coax system

Improvements in the quality of the delivered NTSC signal in CATV systems may be obtained by the application of fiber backbone technology.

These signal improvements will be the result of decreased cascades of traditional cable television amplifiers following the fiber node. These improvements are measurable in terms of carrier-to-noise ratio and intermodulation products.

The resulting improvement in system overhead may be exchanged for additional bandwidth, for increased system reach, or for improved quality of the delivered signal.

This paper presents the evaluation we performed for one of our existing systems. We show the improvements in performance which are obtained with fiber backbone. We also show how the same system can be upgraded from 270 MHz to 550 MHz, without changing trunk cable, trunk locations or using microwave hubs. The 270 to 550 MHz upgrade example focuses on the exchange of performance for additional bandwidth.

Scope

American Television and Communications (ATC) management directed the engineering staff to undertake the analyses described herein because of its belief that our future depends on six primary operational considerations:

1. Delivery of signal quality directly comparable to present and perceived future sources, while providing economics comparable to, or better than, alternatives now available to our systems.
2. The ability to transport to the home any enhancement which may be forthcoming in the art of television systems.
3. The ability of our systems to offer ancillary services which may become desirable to our subscribers.
4. The ability of our systems to meet competitive situations in a cost effective manner.
5. The ability of our systems to operate in a more reliable fashion.
6. The ability of our systems to take advantage of a more flexible evolutionary architecture.

This paper will deal only with the technical performance aspects of the application of the fiber backbone concept.

Fiber backbone

The fiber backbone concept requires that conventional amplifier cascades be reduced to a small number, such as two, three, four or five. In order to create such short cascades, a number of "fiber nodes" must be created. Each node is connected to the headend by single mode optical fiber which transmits the optical signal from the headend to the node.

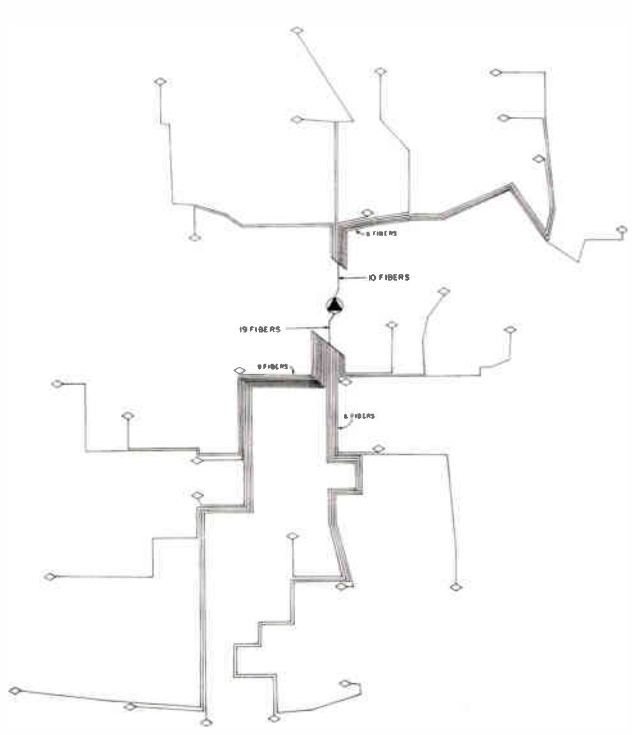
In the headend, the radio frequency (RF) signals are converted to optical frequencies and coupled onto the fiber. The multi-fiber cable follows traditional trunk routings and is likely to be overlashed to existing cable. As the fiber proceeds toward the furthest node point, it is split, and spliced many times. An example of a fiber route is shown below.

At the fiber node location, we believe the equipment required will be housed in an enclosure similar to existing trunk amplifiers. The purpose of the node is to terminate the optical fiber cable and convert the optical signal on that fiber to RF for transmission to the home via traditional cable television trunk and line extender amplifiers.

How good must the node RF performance be?

We believe the signals recovered from the fiber must have at least 55 dB carrier-to-noise, −65 dB composite triple beat and −65 dB composite second order performance.

By Perry Rogan, senior project engineer; Raleigh Stelle, standards engineer; and Louis Williamson, technical staff, American Television and Communications.



NODE LOCATION AND FIBER ROUTING FOR FOUR IN CASCADE

Optical link performance

ATC staff engineers began active experimentation in fiber optic transmission systems in the spring of 1987. While our focus is directed primarily at broadband amplitude modulated, vestigial sideband (AM-VSB) transmission, we also closely monitor the progress being made in the area of FM transmission on fiber. Either modulation technique (AM or FM) may be applied to the fiber backbone approach.

Several vendors of lasers, fiber and detectors were contacted with requests for product information and sample items. The initial results were disappointing, yielding carrier-to-noise ratios of 47 dB, and composite triple beat ratios of 50 dB. With these devices, the second order performance was unacceptable. The composite second order beat products were eliminated from the

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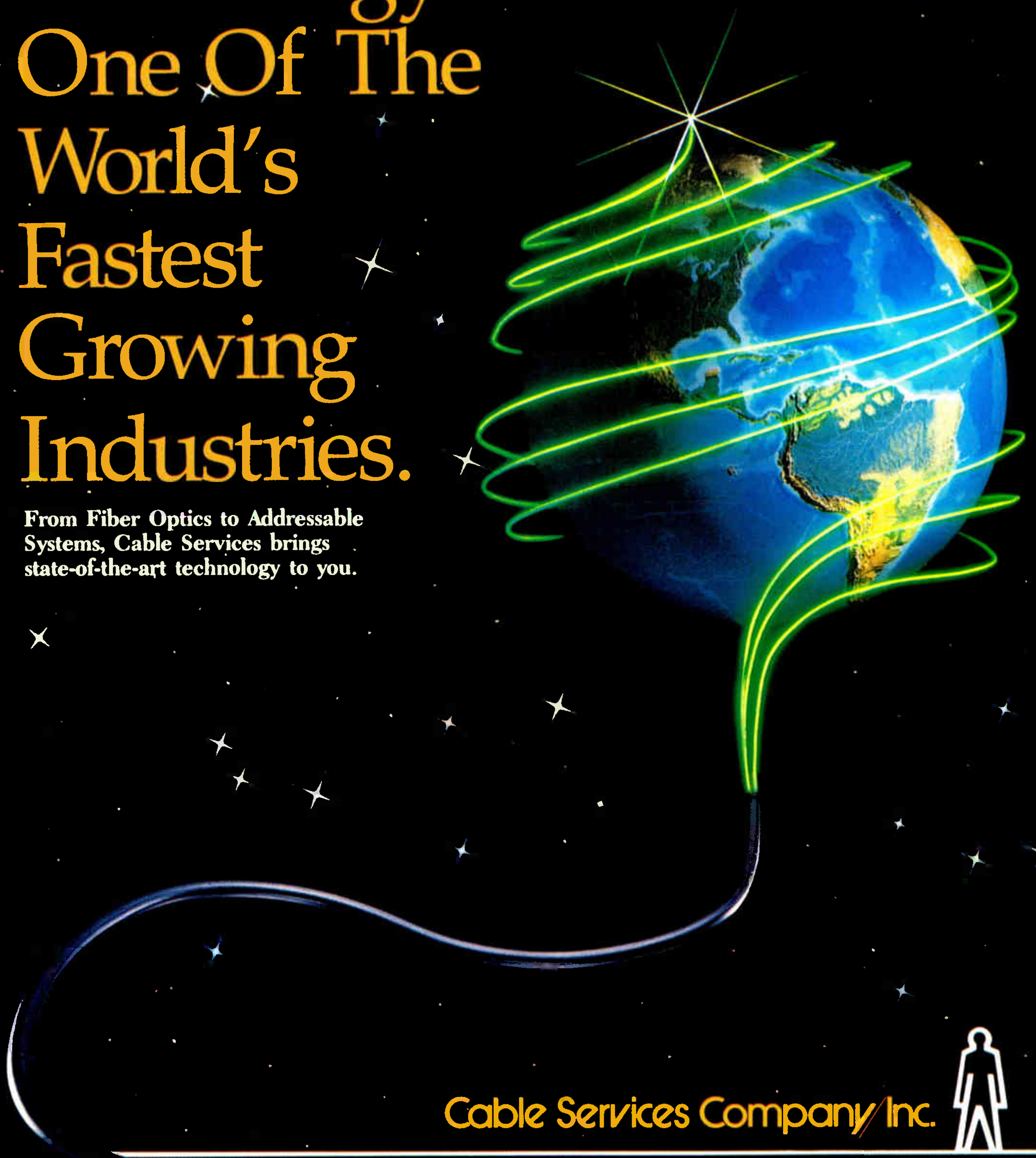

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The progress made in laser technology over the past year makes us very optimistic.

band of interest by choosing an octave of bandwidth from 200 to 400 MHz for the initial experiments. In practical application, it may be necessary to convert the 55 to 550 MHz spectrum to 605 to 1155 MHz prior to modulating the laser. Two advantages are expected from this process. One advantage is that all second order products will fall outside the band of interest and may be removed by filtering. The second advantage is that this frequency range allows the laser to function in a more favorable region of its operating characteristics.

This performance was initially perceived as disappointing because it was so far from the performance required to make the fiber backbone concept a reality. The disappointments did not last very long, however.

The following graph, Figure 1, indicates the performance improvements we have been able to observe from the various components of fiber systems to

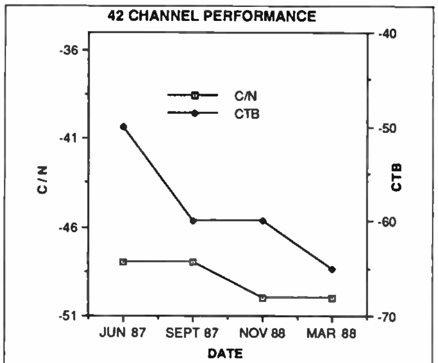

Figure 1. Link Performance over 15 KM

date.

The best performance observed so far produces 48 dB carrier-to-noise ratios and −65 dB composite triple beat with 42 channel loading through 15 kilometers of fiber.

A future element of the fiber experiment is to block convert the 42 channel spectrum (55 to 330 MHz) to 605 to 935 MHz. At these frequencies the signals occupy less than an octave of bandwidth and we will be better able to determine the second order performance. Experiments are presently in progress on this phase of the project.

The progress made in laser technology over the past year makes us very optimistic that the required node performance goals will be achieved in the near future, at acceptable prices. An especially significant item of note is that in our discussions with various manufacturers of lasers and detectors, we have learned that there are no known physical limits preventing the laser and detector manufacturers from creating devices with the parameters required to deliver the performance we expect.

Assuming that the required node performance is obtainable, we analyzed the performance improvements which can be expected in the sample 270 MHz system. We then performed an analysis on this same system to determine the

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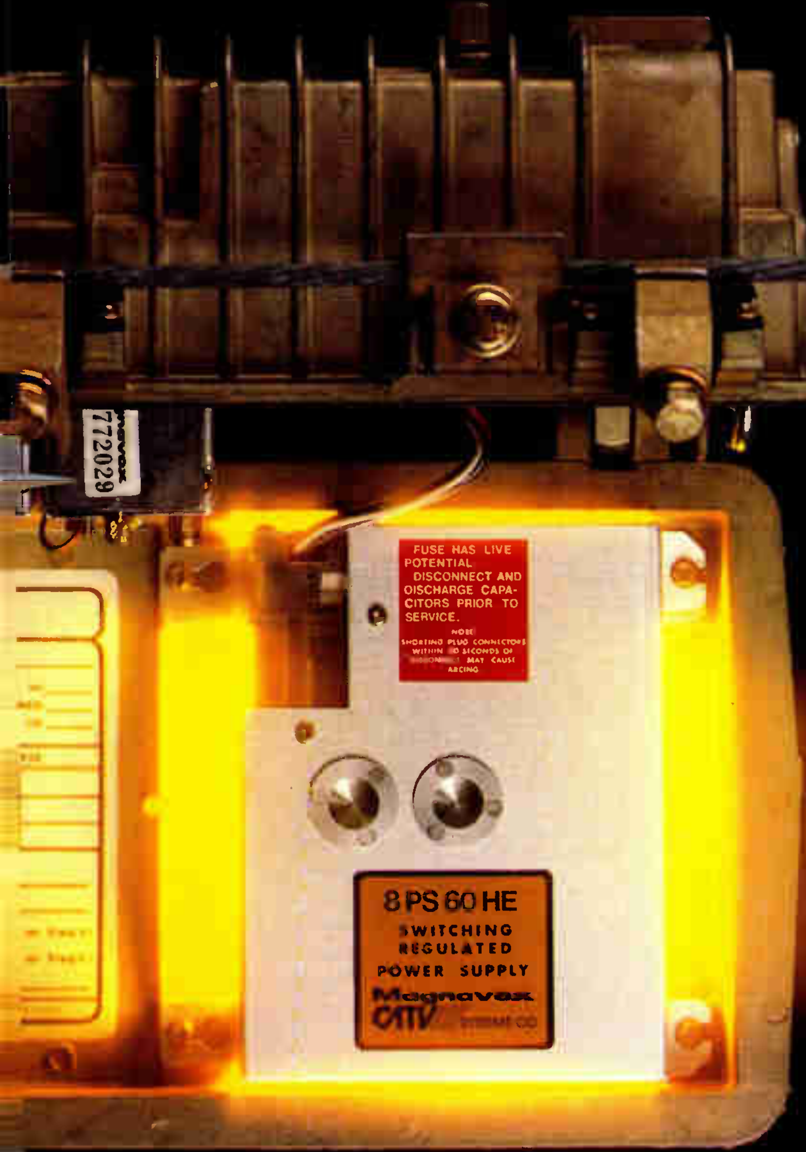

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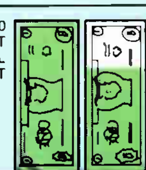
Example of Power Cost Savings

(Savings per trunk amplifier, assuming current costs of $100 per year, per amplifier, using 55% efficient linear power supply.)



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In the 550 MHz upgrade, we decided to attempt to use the same trunk cable and amplifier locations.

CATV SYSTEM DISTORTIONS

SYSTEM NAME.		FWD. BW	4.0	FWD. NOISE	-59.2
DATE	1-Mar 1988	REV. BW	4.000	REV. NOISE	-59.2

MANUFACTURER SPECIFICATIONS	TRUNK	BRIDGER	L.E.
NOISE FIGURE	9.5	10.5	11.0
CTB OUTPUT CAP	33.0	50.0	50.0
CTB RATING(-dBmv)	-93.0	-59.0	-59.0
XMOD OUTPUT CAP	33.0	50.0	50.0
XMOD RATING(-dBmv)	-92.0	-59.0	-59.0
2nd OUTPUT CAP	33.0	50.0	50.0
2nd RATING(-dBmv)	-85.0	-70.0	-70.0
CHANNEL CAPACITY	42.0	35.0	35.0
MANUFACTURER TILT	3.0	6.0	6.0
HUM SPECIFICATION	-70.0	-70.0	-70.0

SYSTEM SPECIFICATIONS	TRUNK	BRIDGER	L.E.
AMPLIFIER INPUT	12.0	13.0	17.0
GAIN OR BR DC LOSS	21.0	-20.0	26.0
DESIRED TILT	6.0	6.0	6.0
AMPLIFIER OUTPUT	33.0	48.0	43.0
CHANNEL LOADING	35.0	35.0	35.0
CASCADE LENGTH	30.0	1.0	2.0

CALCULATED EQUIPMENT SPECIFICATIONS		TRUNK	BRIDGER	L.E.
	C/N......	-46.9	-61.7	-62.2
	CTB......	-67.6	-63.0	-67.0
	XMO.....	-66.2	-63.0	-67.0
LOG..15.0	2ND.....	-62.8	-72.0	-72.5
	HUM.....	-40.5	-70.0	-64.0

CALCULATED SYSTEM SPECIFICATIONS	FWD. TRUNK	FWD. TRUNK PLUS BRIDGER	FWD. SYSTEM TR+BR +LE(S)	
C/N......	-46.9	-46.8	-46.7	...C/N
CTB......	-67.6	-59.0	-56.1	...CTB
XMO...	-66.2	-58.4	-55.7	...XMO
2ND....	-62.8	-61.4	-60.3	...2ND
HUM.....	-40.5	-40.2	-39.6	...HUM

NOTES: CURRENT OPERATING PERFORMANCE.

TABLE 1

SYSTEM END PERFORMANCE DATA

	C/N	CTB	CSO	NODES
BEFORE FIBER BACKBONE	46.7	-56.1	-60.3	0
AFTER FIBER BACKBONE 2 TRUNK IN CASCADE	52.4	-55.2	-61.3	61
AFTER FIBER BACKBONE 3 TRUNK IN CASCADE	51.9	-55.1	-61.2	41
AFTER FIBER BACKBONE 4 TRUNK IN CASCADE	51.5	-55	-61	29

Figure 2. end of the line performance calculations based on trunk cascade and "quad power" line extenders.

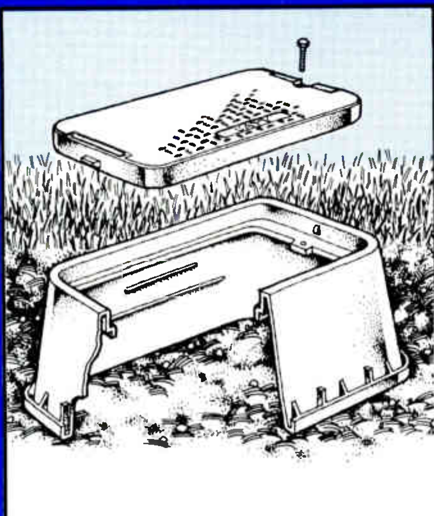
performance achievable if the system were to be upgraded to 550 MHz.

In the 550 MHz upgrade, we decided to attempt to use the same trunk cable and amplifier locations, and to "drop-in" appropriate 550 MHz amplifiers, if possible.

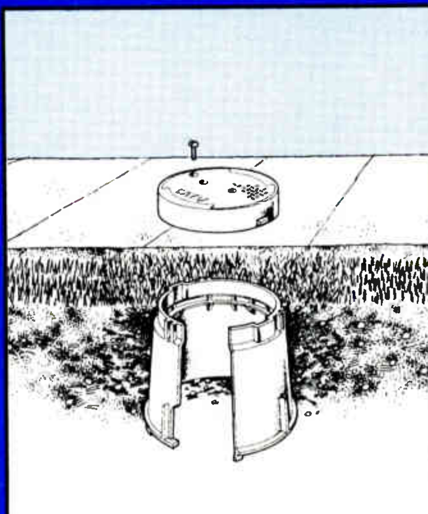
All of the analyses presented are performed with various computer pro-

Reader Service Number 51

Carson Grade Level Boxes...



GLB-1320-12B



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- GLB-1320 — For underground drop and passive electronics applications. Also used for coax feeder and trunk cable splices.
- GLB-1324 — Available in 12″ and 15″ depths for housing underground single or dual passive applications, and for coax feeder and trunk cable splices.
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Reader Service Number 17

The system chosen for analysis is one of ATC's older 270 MHz systems.

grams which permit the entry of all necessary variables and calculate performance accordingly. The programs require the entry of the equipment operating parameters in the area designated "Manufacturer's Specifications." The operating parameters, as the equipment is applied in the system, are entered in the "System's Specifications" area. Included in this area is the data for the number of each type of amplifier in cascade. In the area labeled "Calculated Equipment Specifications," the program calculates the performance which is expected from the contribution of each of the elements cascaded (i.e., trunk, bridger, line extender and converter), derating appropriately for the operational parameters chosen. The "Calculated System Specifications" area indicates the expected performance of the elements in cascade, indicating "end of the line" performance. Using a program simplifies the repetitive process necessary to arrive at optimum solutions to diverse system applications.

The following material represents our progress to date in the process of arriving at an optimum solution to the problem of implementing the fiber backbone concepts.

Signal quality improvements

The system chosen for analysis is one of ATC's older 270 MHz systems which has been in operation for more than 15 years and requires improved operational performance to meet competitive pressures and market demands. The system segment analyzed consists of 375 miles of plant, serving approximately 10,000 subscribers. The longest cascade consists of 28 trunk amplifiers, one bridger and two line extenders. The trunk spacing is 21 dB, and the cable

CATV SYSTEM DISTORTIONS

SYSTEM NAME		FWD. BW	4.0	FWD. NOISE	-59.2
DATE	1-Mar 1988	REV. BW	4.000	REV. NOISE	-59.2

MANUFACTURER SPECIFICATIONS	FIBER	TRUNK	BRIDGER	L.E.
NOISE FIGURE		9.5	10.5	11.0
CTB OUTPUT CAP		33.0	50.0	50.0
CTB RATING(-dBmv)		-93.0	-59.0	-59.0
XMOD OUTPUT CAP		33.0	50.0	50.0
XMOD RATING(-dBmv)		-92.0	-59.0	-59.0
2nd OUTPUT CAP		33.0	50.0	50.0
2nd RATING(-dBmv)		-85.0	-70.0	-70.0
CHANNEL CAPACITY		42.0	35.0	35.0
MANUFACTURER TILT		3.0	6.0	6.0
HUM SPECIFICATION		-70.0	-70.0	-70.0
SYSTEM SPECIFICATIONS	**FIBER**	**TRUNK**	**BRIDGER**	**L.E.**
AMPLIFIER INPUT		12.0	13.0	17.0
GAIN OR BR DC LOSS		21.0	-20.0	26.0
DESIRED TILT		6.0	6.0	6.0
AMPLIFIER OUTPUT		33.0	48.0	43.0
CHANNEL LOADING		35.0	35.0	35.0
CASCADE LENGTH		4.0	1.0	2.0
CALCULATED EQUIPMENT SPECIFICATIONS	**FIBER**	**TRUNK**	**BRIDGER**	**L.E.**
C/N.....	-55.0	-55.7	-61.7	-62.2
CTB.....	-65.0	-85.1	-63.0	-67.0
XMO....	-65.0	-83.7	-63.0	-67.0
LOG..15.0 2ND.....	-65.0	-76.0	-72.0	-72.5
HUM....	-70.0	-58.0	-70.0	-64.0

CALCULATED SYSTEM SPECIFICATIONS	FWD. TRUNK PLUS FIBER	FWD. TRUNK PLUS BRIDGER	FWD. SYSTEM TR+BR +LE(S)	
C/N.....	-52.3	-51.8	-51.5	...C/N
CTB.....	-64.2	-57.6	-55.0	..CTB
XMO.....	-64.0	-57.5	-55.0	...XMO
2ND.....	-63.9	-62.2	-61.0	...2ND
HUM....	-56.0	-54.4	-51.9	...HUM

NOTES: PERFORMANCE IMPROVEMENT ONLY.
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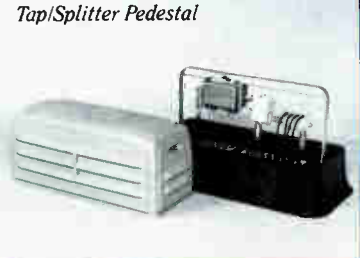

CPH-1730B5 Trunk Amplifier Pedestal. 500 series heat dissipation cover shown.

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CPH-816B Tap/Splitter Pedestal with bracket and stake pre-installed	6	12 Pedestals @ $24.80 each $297.60	6 Free CPH-816B Pedestals
CPH-1230B Line Extender, Tap/Splitter Pedestal with bracketry and ground skirt pre-installed	4	8 Pedestals @ $90.80 each $726.40	4 Free CPH-1230B Pedestals
CPH-1730B Trunk Amplifier Pedestal with bracketry and ground skirt pre-installed	1	2 Pedestals @ $159.80 each $319.60	1 Free CPH-1730B Pedestal
TOTAL		**$1,975 — Your cost for 2 Miles**	**Third Mile Free... Valued at $987.50 when you buy 2 miles!**

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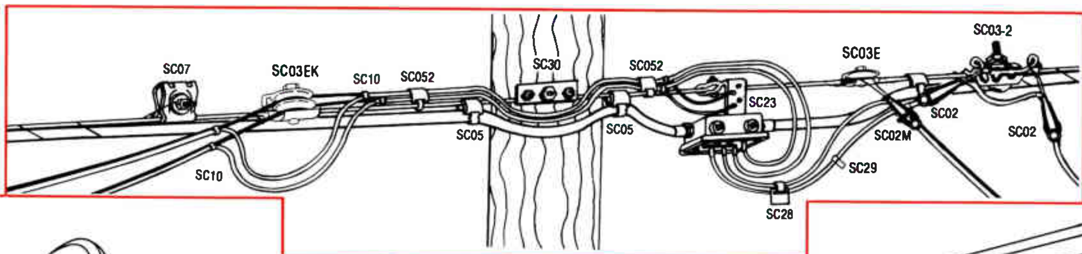

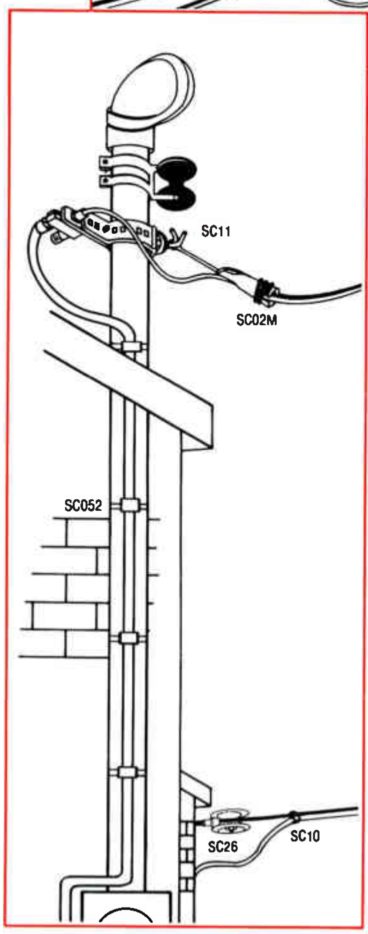

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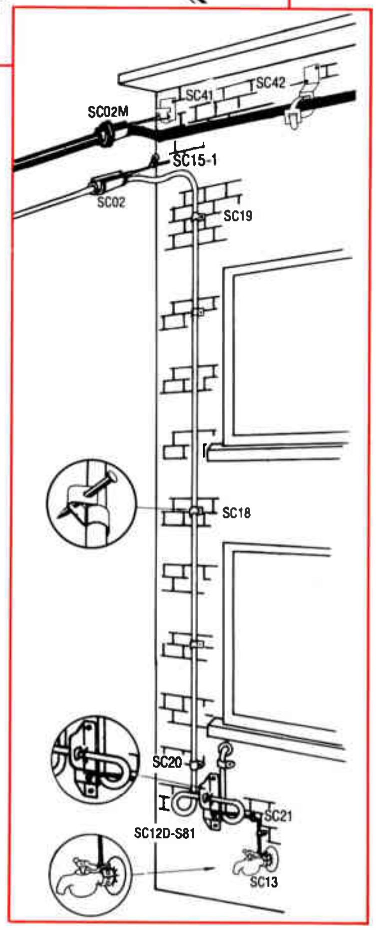

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Implementation of a fiber backbone in this system will yield an improvement in carrier-to-noise of 4.8 to 5.7 dB.

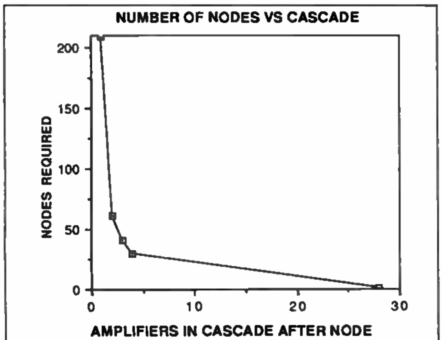


Figure 3. The relationship between cascade selected, and fiber nodes required.

is .750-inch P-3. The distribution levels are 48/41 dBmV for the bridger and 43/37 for the line extenders. The end of the line performance of this system is: 46.7 dB carrier-to-noise, −56.2 dB composite triple beat and −60.3 dB composite second order.

The system performance is shown in the cascade analysis in Table 1.

Implementation of a fiber backbone in this system will yield an improvement in carrier-to-noise of 4.8 to 5.7 dB, depending on the number of amplifiers cascaded after the fiber node. In this example, the intermodulation products were slightly worse after implementing the fiber backbone. These intermodulation products are the result of the high tap levels required in the distribution portion of the system, to meet end of the line tap levels. See Figure 2 and Tables 1 and 2.

This range of improvements is made possible by the flexibility of system architecture produced by implementing the fiber backbone concept. In this example, our goals were:

- Reuse as much of the existing plant as possible to minimize the complexity of any future upgrade which might be undertaken. Existing equipment was reused, and only direction reversals on approximately half the trunk locations were required.
- Provide performance improvements which will allow this system to meet present market pressures and permit future bandwidth expansion.

As the system design for the quality improvement example evolved, it was necessary to consider the number of fiber node locations to be used. Several alternatives were evaluated with emphasis on the system performance with various cascades after the fiber node. An analysis of the number of nodes required is contained in Figure 3. It can be seen that in each of the 209 existing trunk amplifiers is a node location; the number of nodes required is 209. Similarly, if the number of amplifiers cascaded rises to 28 (the original cascade), the number of nodes is one. Between these values, we selected the numbers two, three and four for cascade and fiber route evaluation.

Due to this system's architecture, and the curve from Figure 3, it appears there is no apparent advantage to continuing beyond the four in cascade point. To do so would defeat our purpose because of the buildup of noise and distortion in longer cascades.

As a preamble to the next section, two terms to be used require definition. They are: route miles and fiber miles. A "route mile" is total linear distance which will require lashing of the fiber bearing cable to the existing plant. The "total fiber mileage" is the sum of the distances from each node to the headend, with one fiber run per node.

For each of the analyses presented we have calculated the route mileage to provide an indication of the magnitude of the overlashing required, and the fiber mileage to indicate the possible fiber costs.

The node location data and fiber mileages for the system analyzed are shown below.

For four in cascade after the node: (miles)

1. Route mileage – 43.7
2. Fiber mileage – 128.6
3. Nearest node – 1.13
4. Furthest node – 8.99

For three in cascade after the node:

FIBER ANALYSIS VS CASCADE

	ROUTE MILES	FIBER MILES	NODES (FIBERS)	NEAREST NODE, MI.	FARTHEST NODE, MI.
2 CASCADE	50.9	248	61	.9	8.99
3 CASCADE	45.3	174.6	41	.9	8.61
4 CASCADE	43.7	128.6	29	1.13	8.99

Figure 4. Fiber requirements versus cascade chosen.

Design samples were performed to determine the architecture of the system after application of the fiber backbone.

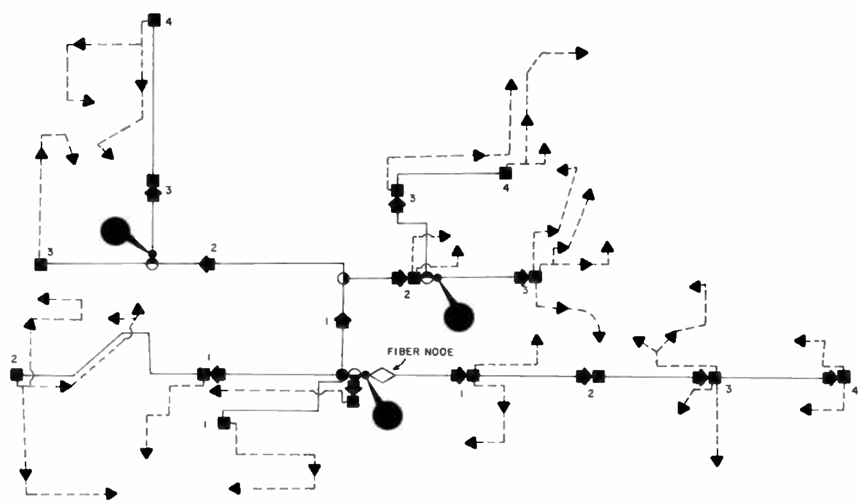


EXHIBIT II, TYPICAL TRUNK DIAGRAM FOR FIBER NODE PLUS FOUR IN CASCADE

FIGURE 5. TYPICAL TRUNK DIAGRAM FOR FIBER NODE PLUS FOUR IN CASCADE

1. Route mileage – 45.3
2. Fiber mileage – 174.6
3. Nearest node – .9
4. Furthest node – 8.61

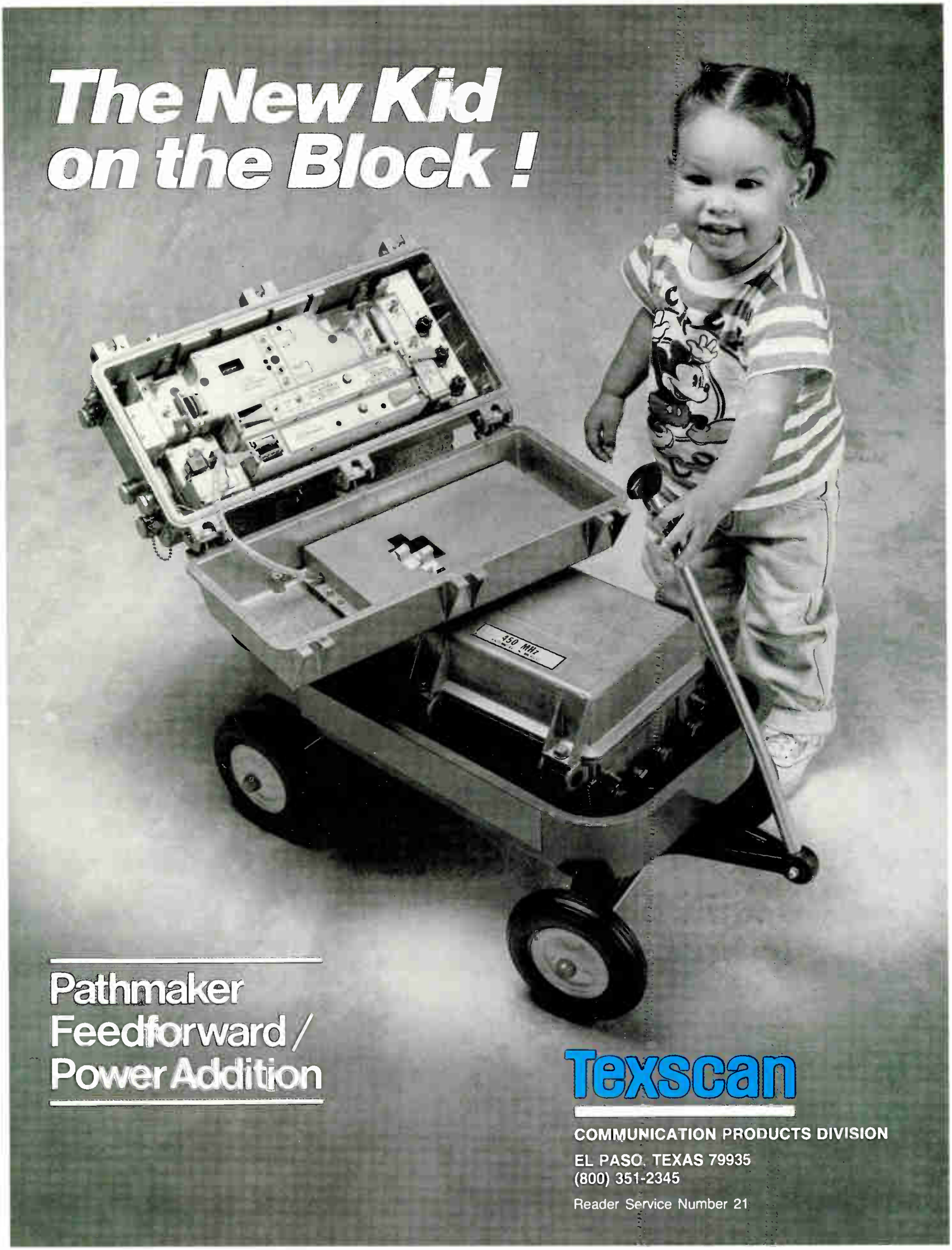
For two in cascade after the node:

1. Route mileage – 50.9
2. Fiber mileage – 248
3. Nearest node – .9
4. Furthest node – 8.99

Figure 4 is a tabulation of the number of nodes, fiber miles and route miles for each cascade evaluated.

Design samples were performed to determine the architecture of the system after application of the fiber backbone. The typical trunk routings for a fiber node plus four amps in cascade is shown in Figure 5. While it was not necessary to physically relocate any of the trunk stations, 50 percent of them will require reversal. The distribution portions of the original system remain unchanged.

Another point of interest is that the same node locations will be used re-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Even more significant is with this performance in place, the stage is set to upgrade this system to 550 MHz.

END OF LINE PERFORMANCE	QUAD LE (2)	P.D. LE (3)	CONV LE (3)
C/N	48.4	-47.9	-48.3
CTB	-52.5	-52.3	-49.0
CSO	--59.8	-59.8	-49.0

FIGURE 6. END OF LINE PERFORMANCE VS. LINE EXTENDER TECHNOLOGY

gardless of whether the plan is to simply upgrade the system performance or to increase the bandwidth. This condition occurs because the same trunk locations and cascades will be used in either situation.

The preceding information shows the performance improvements which can be achieved with existing plants. As can be seen, the performance improvements in themselves are significant. Even more significant is with this performance in place, the stage is set at any time in the future to upgrade this system to 550 MHz. Not only can this system be upgraded, it can be upgraded for a relatively low cost compared to the alternative of a total rebuild.

270 to 550 MHz upgrade. The performance improvements generated

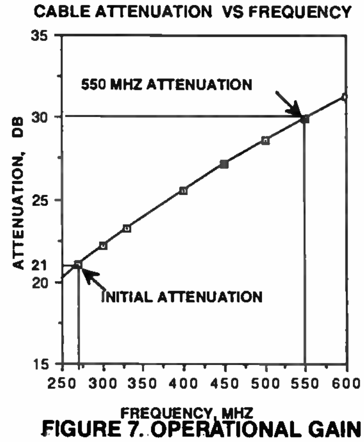


FIGURE 7. OPERATIONAL GAIN REQUIRED WHEN UPGRADING FROM 270-550 MHz

The test design for the upgrade of the system was a sample of 15.8 miles of plant.

CATV SYSTEM DISTORTIONS

SYSTEM NAME	FIBER TEST	FWD BW	4 0	FWD NOISE	59 2	
DATE	7 Mar 1987	REV BW	4 000	REV NOISE	59 2	
MANUFACTURER SPECIFICATIONS		FIBER	TRUNK FF	BRIDGER CP	L E XCLE	
NOISE FIGURE			11 5	9 5	12 0	
CTB OUTPUT CAP			38 0	48 0	47 0	
CTB RATING(dBmv)			85 0	65 0	69 0	
XMOD OUTPUT CAP			38 0	48 0	47 0	
XMOD RATING(dBmv)			85 0	65 0	69 0	
2nd OUTPUT CAP			38 0	48 0	47 0	
2nd RATING(dBmv)			87 0	71 0	73 0	
CHANNEL CAPACITY			77 0	77 0	77 0	
MANUFACTURER TILT			6 0	10 0	10 0	
HUM SPECIFICATION			70 0	70 0	70 0	
SYSTEM SPECIFICATIONS		FIBER	TRUNK	BRIDGER	L E	
AMPLIFIER INPUT			8 0	18 0	19 0	
GAIN OR BR DC LOSS			30 0	20 0	29 0	
DESIRED TILT			6 0	9 0	9 0	
AMPLIFIER OUTPUT			38 0	48 0	48 0	
CHANNEL LOADING			77 0	77 0	77 0	
CASCADE LENGTH			4 0	1 0	2 0	
CALCULATED EQUIPMENT SPECIFICATIONS		FIBER	TRUNK	BRIDGER	L E	
	C N	55 0	49 7	67 7	63 2	
	CTB	65 0	73 0	64 3	60 3	
	XMO	65 0	73 0	64 3	60 3	
LOG 15 0	2ND	65 0	78 0	71 0	67 5	
	HUM	70 0	58 0	70 0	64 0	
CALCULATED SYSTEM SPECIFICATIONS		FWD TRUNK PLUS FIBER	FWD TRUNK PLUS BRIDGER	FWD SYSTEM TR+BR +LE(S)		
	C N	48 6	48 5	48 4		C N
	CTB	62 1	57 1	52 5		CTB
	XMO	62 1	57 1	52 5		XMO
	2ND	64 2	62 2	59 8		2ND
	HUM	56 0	54 4	51 9		HUM

NOTES 550 MHz UPGRADE FIBER BACKBONE
FOUR TRUNK AMPLIFIERS IN CASCADE FROM FIBER NODE

TABLE 3

CATV SYSTEM DISTORTIONS

SYSTEM NAME	FIBER TEST	FWD BW	4 0	FWD NOISE	59 2	
DATE	7 Mar 1987	REV BW	4 000	REV NOISE	59 2	
MANUFACTURER SPECIFICATIONS		FIBER	TRUNK FF	BRIDGER CP	L E XCLE	
NOISE FIGURE			11 5	9 5	12 0	
CTB OUTPUT CAP			38 0	48 0	47 0	
CTB RATING(dBmv)			85 0	65 0	69 0	
XMOD OUTPUT CAP			38 0	48 0	47 0	
XMOD RATING(dBmv)			85 0	65 0	69 0	
2nd OUTPUT CAP			38 0	48 0	47 0	
2nd RATING(dBmv)			87 0	71 0	73 0	
CHANNEL CAPACITY			77 0	77 0	77 0	
MANUFACTURER TILT			6 0	10 0	10 0	
HUM SPECIFICATION			70 0	70 0	70 0	
SYSTEM SPECIFICATIONS		FIBER	TRUNK	BRIDGER	L E	
AMPLIFIER INPUT			9 3	19 3	19 0	
GAIN OR BR DC LOSS			30 0	20 0	29 0	
DESIRED TILT			6 0	9 0	9 0	
AMPLIFIER OUTPUT			39 3	48 0	48 0	
CHANNEL LOADING			77 0	77 0	77 0	
CASCADE LENGTH			3 0	1 0	2 0	
CALCULATED EQUIPMENT SPECIFICATIONS		FIBER	TRUNK	BRIDGER	L E	
	C N	55 0	52 2	69 0	63 2	
	CTB	65 0	73 0	64 3	60 3	
	XMO	65 0	-73 0	64 3	60 3	
LOG 15 0	2ND	65 0	78 6	71 0	67 5	
	HUM	70 0	60 5	70 0	64 0	
CALCULATED SYSTEM SPECIFICATIONS		FWD TRUNK PLUS FIBER	FWD TRUNK PLUS BRIDGER	FWD SYSTEM TR+BR +LE(S)		
	C N	50 3	50 3	50 1		C N
	CTB	62 1	57 1	52 5		CTB
	XMO	62 1	57 1	52 5		XMO
	2ND	64 2	62 3	59 8		2ND
	HUM	58 0	56 0	53 1		HUM

NOTES 550 MHz UPGRADE/FIBER BACKBONE
THREE TRUNK AMPLIFIERS IN CASCADE FROM FIBER NODE

TABLE 4

by the fiber backbone approach and very short amplifier cascades permits an exchange of end of the line performance for expanded bandwidth. Adding improved technologies permits the upgrading of this 270 MHz system to 550 MHz, while maintaining adequate end of the line performance, with no change in trunk cable, distribution cable or trunk locations.

The test design for the upgrade of the system was a sample of 15.8 miles of plant, with areas selected to represent an average sample of the densities in existence. Three areas of five miles each were designed, with densities ranging from less than 75 homes per mile to densities exceeding 130 homes per mile.

CATV SYSTEM DISTORTIONS

SYSTEM NAME:	FIBER TEST	FWD. BW	4.0	FWD. NOISE	-59.2	
DATE	7-Mar 1988	REV. BW	4.000	REV. NOISE	-59.2	
MANUFACTURER SPECIFICATIONS		FIBER	TRUNK FF	BRIDGER CP	L.E. XCLE	
NOISE FIGURE			11.5	9.5	12.0	
CTB OUTPUT CAP			38.0	48.0	47.0	
CTB RATING(-dBmv)			-85.0	-65.0	-69.0	
XMOD OUTPUT CAP			38.0	48.0	47.0	
XMOD RATING(-dBmv)			-85.0	-65 0	-69.0	
2nd OUTPUT CAP			38.0	48.0	47.0	
2nd RATING(-dBmv)			-87.0	-71.0	-73.0	
CHANNEL CAPACITY			77.0	77.0	77.0	
MANUFACTURER TILT			6.0	10.0	10.0	
HUM SPECIFICATION			-70.0	-70.0	-70.0	
SYSTEM SPECIFICATIONS		FIBER	TRUNK	BRIDGER	L.E.	
AMPLIFIER INPUT			11.0	21.0	19.0	
GAIN OR BR DC LOSS			30 0	-20.0	29.0	
DESIRED TILT			6.0	9.0	9.0	
AMPLIFIER OUTPUT			41.0	48.0	48.0	
CHANNEL LOADING			77.0	77.0	77.0	
CASCADE LENGTH			2.0	1.0	2.0	
CALCULATED EQUIPMENT SPECIFICATIONS		FIBER	TRUNK	BRIDGER	L.E.	
	C/N.....	-55.0	-55.7	-70.7	-63.2	
	CTB......	-65.0	-73.0	-64.3	-60.3	
	XMO......	-65.0	-73.0	-64.3	-60.3	
LOG..15.0	2ND......	-65.0	-79.5	-71.0	-67.5	
	HUM......	-70.0	-64.0	-70.0	-64.0	
CALCULATED SYSTEM SPECIFICATIONS		FWD. TRUNK PLUS FIBER	FWD. TRUNK PLUS BRIDGER	FWD. SYSTEM TR+BR +LE(S)		
	C/N......	-52.3	-52.2	-51.9		...C/N
	CTB......	-62.1	-57.1	-52.5		...CTB
	XMO......	-62.1	-57.1	-52.5		...XMO
	2ND.	-64.3	-62.3	-59.9		..2ND
	HUM......	-60.5	-58.0	-54.4		...HUM

NOTES: 550 MHz UPGRADE/FIBER BACKBONE.
TWO TRUNK AMPLIFIERS IN CASCADE FROM FIBER NODE.

TABLE 5

Distribution analysis

The analysis process of this upgrade began with the end of the line performance criteria established for our systems. It was determined that these parameters would be met or exceeded in the 550 MHz upgrade.

The major performance specifications to be met are:

1. 46 dB carrier-to-noise
2. −53 dB composite triple beat
3. −53 composite second order
4. +15/10 dBmV at the tap (drops are 150 ft. RG-6).

These specifications forced the levels required, and the distribution distortion values.

Various line extender and bridger technologies were evaluated to determine which would offer the most economical upgrade while meeting the performance required. It was possible to meet end of the line performance with either two "quad power" line extenders in cascade or three power doubling line extenders. Three conventional line extenders in cascade failed

The next phase of the analysis was to examine the trunk from the fiber node to the bridger input.

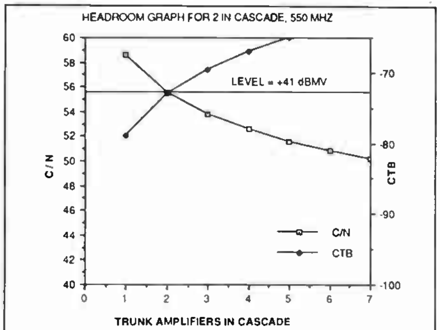


Figure 7

to meet the required performance criteria. The use of three line extenders in cascade requires the addition of up to 147 percent more line extenders than the "quad power" choice, and in that case, 46 percent of the distribution system required the use of three line extenders in cascade.

Figure 6 shows the distribution end of the line performance of the line extenders evaluated. Complete 550 MHz cascade analysis was done for each of the line extender technologies. These analyses appear as Tables 3, 4 and 5.

Trunk analysis

The next phase of the analysis was to examine the trunk from the fiber node to the bridger input. The P-3 cable in use on the example system has a 270 MHz loss of 0.85 dB/100 feet. At 550 MHz, this same cable has 1.21 dB loss/100 ft., or 29.97 dB per span at 550 MHz. Figure 7 shows the attenuation versus frequency for this cable.

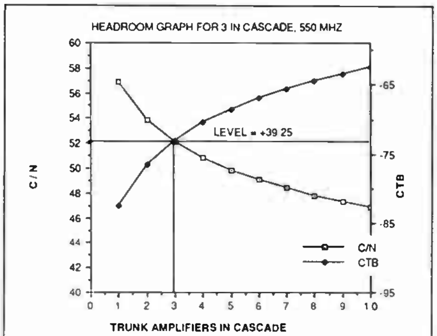


Figure 8

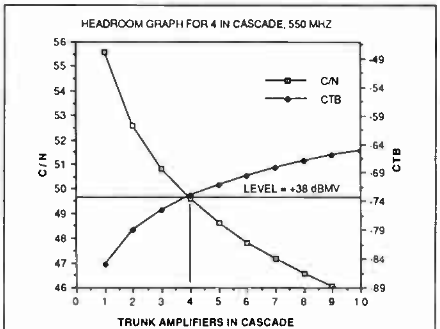
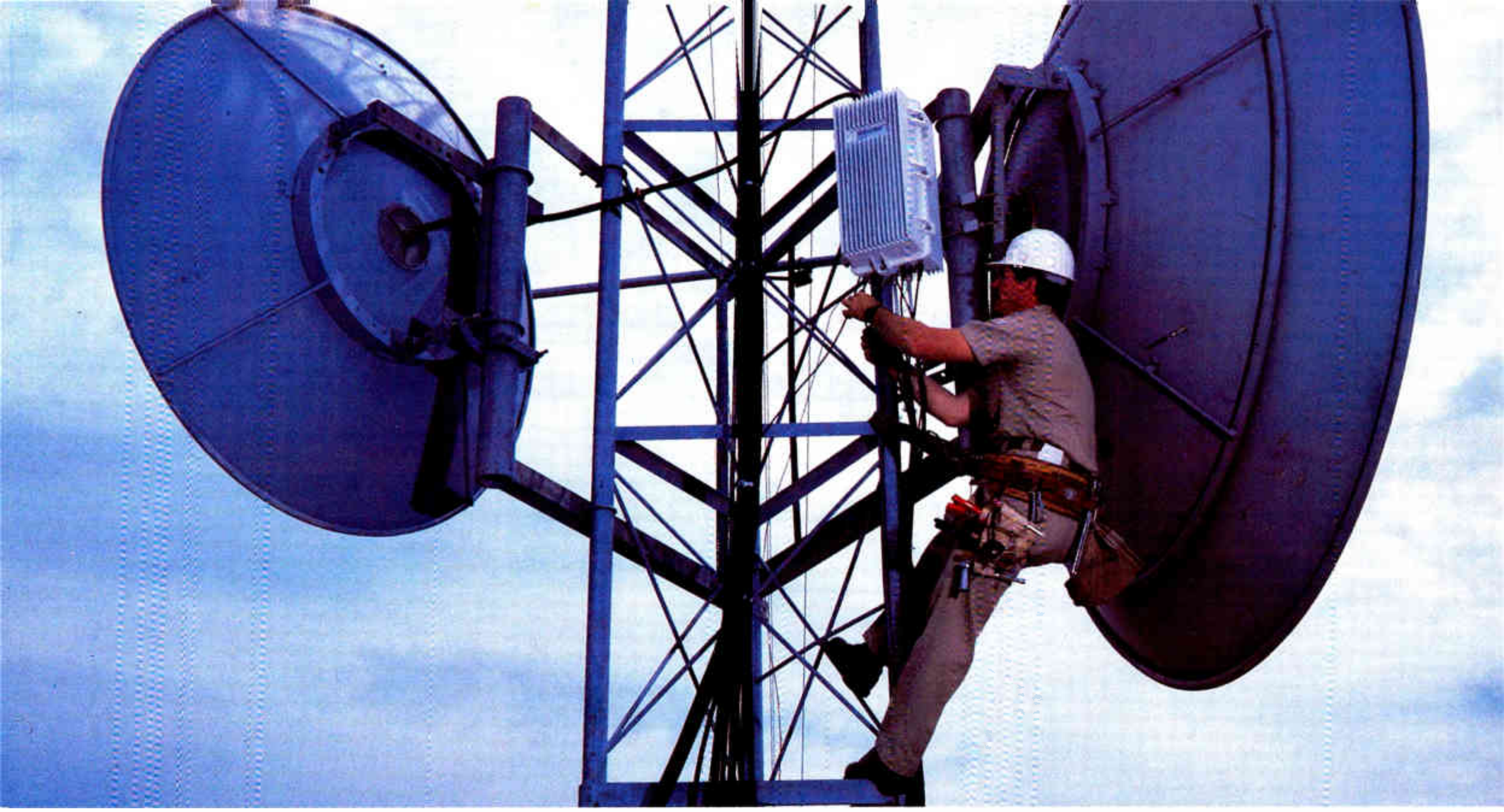


Figure 9

Since 30 dB gain trunk stations are available in several technologies, it appeared possible to "drop-in" the new amplifiers in the existing locations.

Utilizing feedforward technology, trunk cascades of two, three and four were analyzed for headroom. The headroom graphs display the carrier-to-noise and composite triple beat limits



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Further headroom analysis graphs were prepared to determine what performance could be expected.

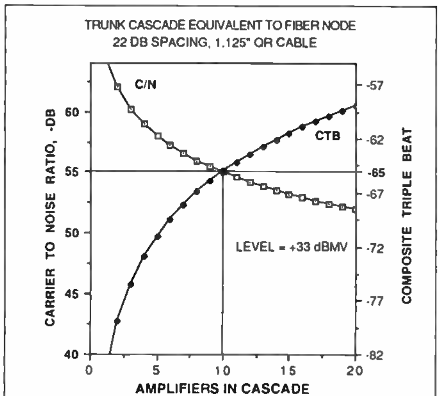


FIGURE 11

which are achieved with the output levels chosen. The graphs of these performances are shown in Figures 8, 9 and 10. Tables 3, 4 and 5 provide full cascade analysis.

From the preceding graphs and exhibits, one can see that the improvement to be expected from shortening the cascade after the node is in the area of carrier-to-noise. This performance may well be what is required to make enhanced television systems a reality.

Alternate solutions

Analysis was performed to establish whether the proposed upgrade could be accomplished without the use of AML or other hub techniques.

Further headroom analysis graphs were prepared to determine what performance could be expected with "normal" 22 dB spacing after replacement of the trunk cable. The results appear in Figures 11 and 12.

Figure 11 shows that performance equal to that of the fiber node was reached after a cascade of 10 feedforward trunk amplifiers. Figure 12 shows that performance equal to the fiber node plus four trunk amplifiers in cascade was reached after a cascade of 20.

Since replacing the trunk cable permitted the direct replacement of the amplifier locations, one can see that the "reach" is inadequate to replace the original 28 in cascade, and some sort of hub network will be required to complete the upgrade from 270 to 550 MHz. ■

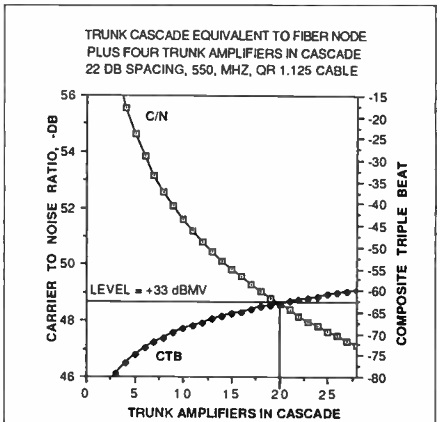
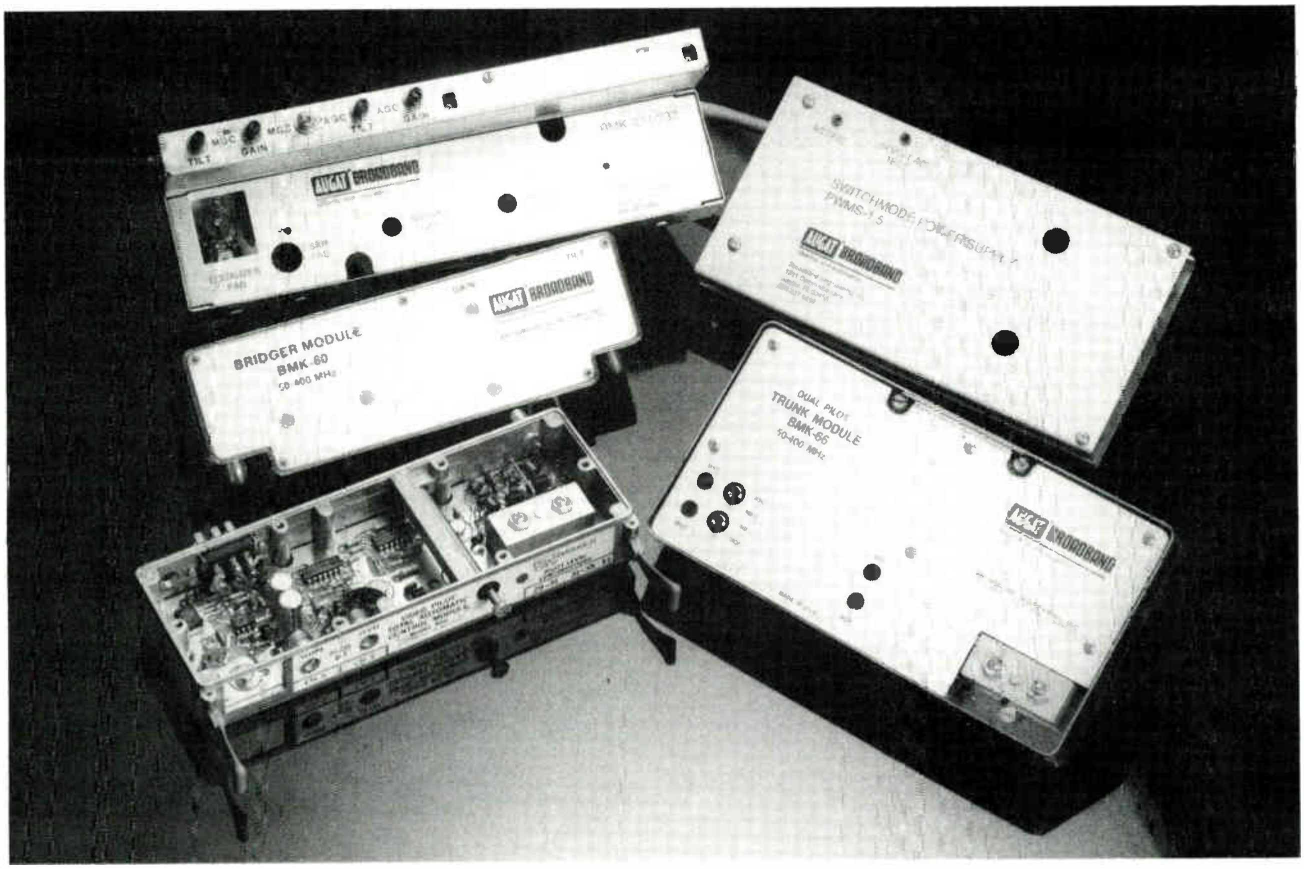


FIGURE 12



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CATV vendors poised for healthy 1989

Keep the gloves on and the lashers and trenchers out because, despite pessimistic views from other industry analysts, it appears cable operators will keep their construction checkbooks out in 1989 and fuel continued high business volume for manufacturers.

Factors driving the boomlet include a combination of classic ingredients and some new to the industry: line extensions to franchise areas previously unfeasible economically until deregulation took hold; continued high level of franchise expirations creating pressure for channel expansion; a generally heightened requirement for delivery of better pictures to subscribers homes; a desire to head off overbuild threats; and to build system asset values. Looming competition from telephone companies and the higher standards of video quality brought on by advanced TV systems, which will begin to appear as early as 1990, also are catalysts.

From a low point in 1986, construction activity sustained by rebuilds and upgrades exploded in 1987 and are continuing at a heavy pace this year. Earlier this year, pundits expected 1989 construction activity to trail off as newbuild opportunities dried up and rebuilds started in 1987-88 neared completion.

But a survey of several important industry equipment manufacturers and distributors, completed in June, shows no indication that activity will slow; in fact, there is universal agreement that 1989's pace will rival that seen this year, with some possibility for even more growth. Construction activity certainly won't return to the 1982 level, when an astronomical number of plant miles were built, but won't slip to the bare-bone 1985-86 levels either.

"We expect 1989 to be an excellent year," said Chris Sophinos, president of Midwest CATV, a cable equipment distributor. Sophinos reports that equipment lead times are getting longer as 1987 levels show no signs of slowing down. In fact, several items have the highest backlogs on record, said Sophinos. "Customers are locking in the material they need for the future" and are consequently contributing to the manufacturers' lead times, he said.

The strand market is an example of what Sophinos is talking about. Already a long-lead item (most strand is shipped to the U.S. from overseas), Midwest is picking up 12- and 14-month contracts from several MSOs. "Volume through 1988 has skyrocketed," said Sophinos. Coaxial cable has a similar story. Midwest recently stocked what it thought was a 90-day supply of Trilogy's MC^2 cable and sold out in less than 30 days. "We thought we had plenty, but we had to demand more of it right away," Sophinos added.

With contracts like that, which promise to take them well into next year, Sophinos—and others—have reason to be optimistic.

Long lead times have led to shortages in other product areas as well. Amplifiers, hardware and other essentials are becoming difficult to stock, said Sophinos. "The manufacturers have been surprised" at the size and length of demand placed on hardware by MSOs. "If they weren't they'd have product," said Sophinos. (In fairness, suppliers are reticent to increase manufacturing capacity because they're unsure how long the demand will last. Having been burned once or twice in

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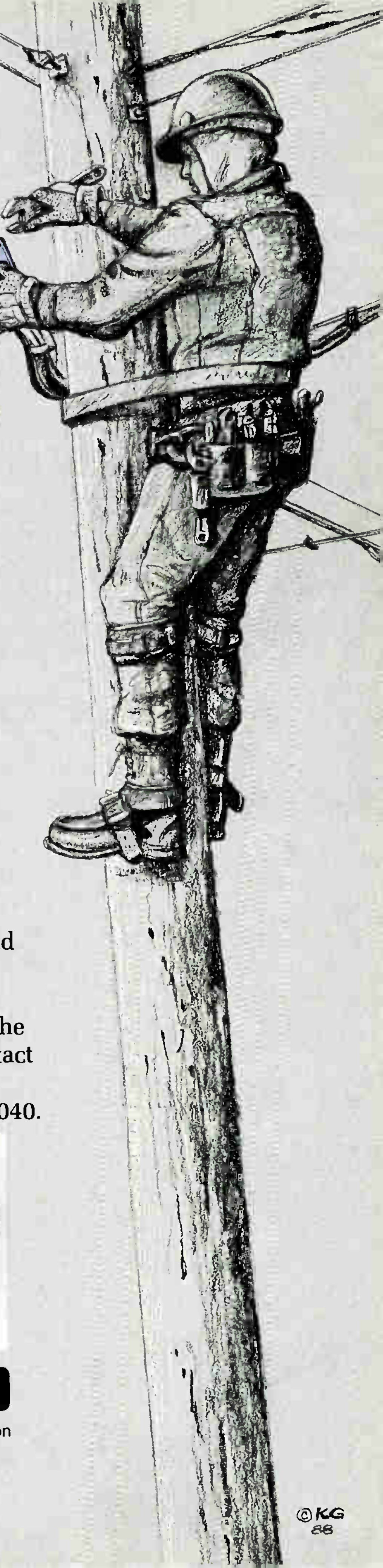

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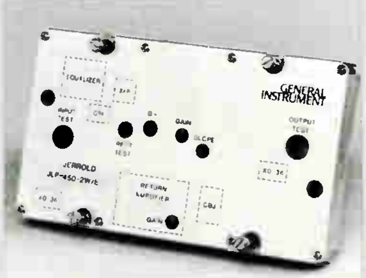
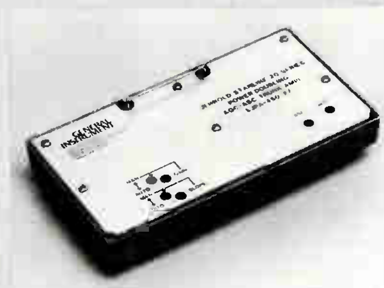
A high gain automatic trunk module, the Jerrold SJPA-450/27 uses the latest generation of hybrid IC technology for optimum performance. Its new die casting affords dramatic improvement in heat dissipation and is compatible with all earlier versions of the SJ series chassis and housing. The SJPA provides 27 dB of operating station gain with a bode slope control for flat output levels (sloped output levels are optional).

Jerrold JLP Series line extenders offer power doubling at 450 MHz and 550 MHz, making them ideal for rebuilds, upgrades and new builds.

It makes good sense to upgrade with power doubling modules from the original manufacturer of your equipment. For more information, contact your Jerrold account representative or call or write Jerrold Division, General Instrument Corporation, 2200 Byberry Road, Hatboro, PA 19040. (215) 674-4800.





GENERAL INSTRUMENT

JERROLD

. . . where innovation is a tradition

Reader Service Number 32

Krisbergh said he expects sales in his distribution division to grow between 5 percent and 10 percent.

the recent past, vendors are in no hurry to create huge stockpiles of product only to have to write off unsold units later.)

"Rebuilds are the name of the game," said Hal Krisbergh, president of Jerrold. Despite what some industry observers have said, Krisbergh says the rebuild market is "heating up" because of a strong need for more channel capacity (as new services like Ted Turner's TNT come into demand) and to provide operators with more opportunity for additional revenue streams.

"Nineteen eighty-nine will be at least as strong (as 1988) or maybe stronger," said Krisbergh. Fueling the activity is rebuilds of systems that are 12 to 15 years old and a lot of extension work, he said. Because of deregulation and the freedom to charge whatever price the market will bear, operators can now afford to build in less densely populated areas.

Krisbergh said he expects sales in his distribution division to grow between 5 percent and 10 percent over the next year. "The issue will be how quickly a number of upgrades are undertaken," he said.

Are MSOs taking a "wait-and-see" attitude toward rebuilds because of HDTV and fiber optic developments? Other than American Television and Communications, which has publicly stated that it plans to postpone rebuilds except where they are absolutely necessary, that doesn't seem to be the case, according to industry vendors. "I don't see any negative impact in any way from HDTV or fiber," said Jack Forde, president of Times Fiber Communications. "In fact, we've increased (our manufacturing) capacity; we're that optimistic," he concluded.

Steve Coffey, marketing manager at Comm/Scope, agrees. After initially forecasting a "slight downturn" in 1989, Coffey revised his prognosis and is now calling for '89 to reach levels like those in '88. "Eighty-eight has been a good year for everybody and in '89 we don't expect much change," he said. "In fact, it might be slightly better."

It's perhaps surprising to find coax manufacturers so optimistic when you consider that they don't feel the full impact during rebuilds. Operators typically throw away only about half of the existing cable when performing a rebuild. And with newbuilds winding down, a casual observer might think the cable makers would feel the brunt of that fact. But the difference is more than made up in the number of extensions that will occur, said Times' Forde.

The forecasters who anticipate a downturn in 1989 are "failing to consider that operators aren't waiting 15 years for franchises to expire or for equipment to fail" before rebuilding, said Midwest's Sophinos. Many rebuilds are now occurring on systems

At this point, amplifier manufacturers generally do not see any negative impact on their sales.

that are only 5 to 7 years old, he said. "Three hundred and thirty MHz is now nearly an obsolete product—manufacturers aren't pushing it; 450 MHz is now where the focus is," said Sophinos. "If you're doing a rebuild anyway, why not give your subs more channels now instead of later, when it will cost you more?"

Optimism prevails at Scientific-Atlanta also. Perry Tanner, marketing manager for distribution systems, is forecasting a modest increase or flat sales through 1989. "Most big-system rebuilds are 24- or 36-month projects," he said, "and operators are reporting that manpower is short, so it takes even longer to get some of those projects completed. We're optimistic that 1989 holds a lot for us—as it has in '87 and '88."

Looking out to 1992 or so, there may be another multi-year upswing as plant installed in the 1979-84 period comes up for another round of rewiring and cable plants begin to accommodate advanced television transmissions. We estimate that about 40 percent of all existing plant was built between 1979 and 1984 and that a substantial portion of that will be ready for rebuild in 10 to 15 years. That puts the rebuild window someplace between 1989-94 and 1994-99, with the largest portion most likely up for rebuild in the latter window.

Construction undertakings are a fairly reliable barometer of cable industry hardware spending in general since it drives the markets for distribution gear, installation and construction services and heavily influences the pace of converter purchases.

Fiber apparently won't have much of an impact on the total plant mile count for a few years, but will start making a much stronger appearance in the supertrunking market during that time frame. Fiber as a backbone trunk alternative representing significant mileage is still a few years away, although they may appear to industry decision-makers to be very short years. At this point, amplifier manufacturers generally do not see any negative impact on their sales of traditional broadband distribution gear as a result of the expected introduction of fiber into the plant. But the explosive advances in fiber technology we've seen in the past year are a warning that the situation could change almost without notice.

The industry's apparent fence-sitting posture on the fiber question becomes immediately apparent when talking to industry players. "When it comes to fiber, there's still a lot of talk but not a lot of orders," says Coffey at Comm/Scope. But at Cable Services Co., a nationwide construction/engineering/design firm, employees are already being trained on how to handle, splice and install fiber cable, said Harry Wahl, vice president/turnkey

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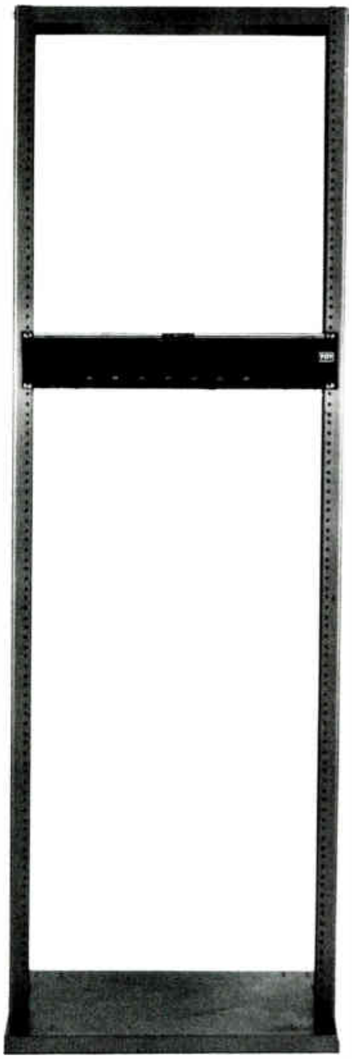

GEOMAX-10:
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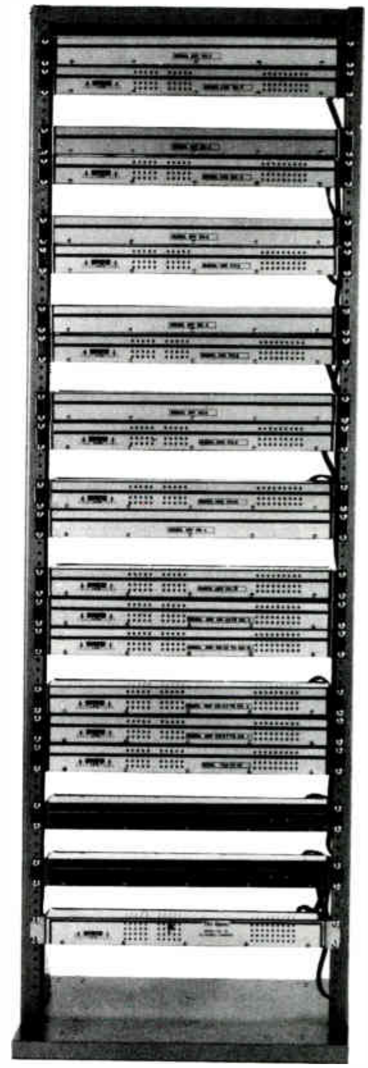

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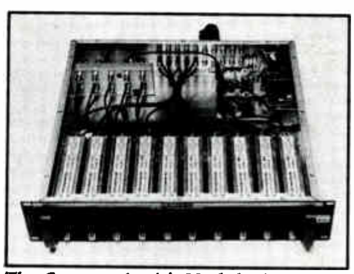

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Reader Service Number 34

One can safely say that cable's technical base will change over the next few years.

sales. Because of competition from Super-VHS and impending competition from the likes of HDTV, operators are being forced to look at the quality issue. Better signal-to-noise, improved distortions, and more bandwidth are all making operators look toward fiber as the answer.

One can safely say that cable's technical base will change over the next few years. With or without near-term fiber penetration into the distribution plant, more advanced technologies offering better distortion and noise performance will be increasingly preferred, especially as 450 MHz plant becomes the prevailing industry standard. Feedforward and parallel hybrid technology will become ever-more common throughout the industry.

These "advanced technology" amps now account for between 25 percent and 33 percent of all electronics sold today, and that number should increase, said S-A's Tanner. Even though operators don't want to wreck out a system that works well, most now have the foresight to plan new construction using 450 MHz gear.

"Operators want the channel capacity," said Wahl of Cable Services. So extensions are being planned to handle as many as 80 channels, even though the current plant only runs at 270 MHz or 330 MHz. Jerrold's Krisbergh concurs. "People don't want to rip out what they have in place; they just want to drop in new modules," he said.

There will be less concern about addressability and trapping as opposed and mutually exclusive signal control techniques. The surge in trap demand in late 1986, combined with Tele-Communications Inc.'s on-premise control system triggered anxiety that the industry might abandon or sharply reduce its reliance on addressability as a technology. The fears now appear to have been misplaced.

In fact, that's where the growth is now. After a demand for "plain vanilla" converters pushed the market last year, interest in pay-per-view and security have brought many MSOs back into the addressability camp, despite the problems with consumer friendliness.

Scientific-Atlanta expects sales of addressables to increase between 8 percent and 10 percent in 1989, to about 5.3 million units sold (industry combined). "There's still a lot of upward movement," said Steve Necessary. The increase in addressable sales, combined with a fall-off from the plain market will result in net sales roughly flat but the amount spent will increase because addressable boxes are more expensive, said Necessary.

—Roger Brown and Gary Kim

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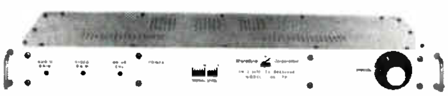

Since its introduction in 1984, the 1100 LPR LNA-type 4 GHz satellite receiver has become the reliable work horse in cable systems across the country. The LPR's single conversion, 24-channel frequency synthesized tuner has a stability of $\pm.001\%$, and its less than 8 dB threshold level delivers excellent performance, even in weak signal areas. It is also compatible with the VideoCipher™ scrambling system.

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AT&T

AT&T . . . .(314) 391-4123
WATS(National). . . . . . .(800) 443-0738
WATS(State). . . . .(800) 782-1202
1111 Woods Mill Road
Ballwin, MO 63011
PERSONNEL: Rich Barks, National Sales Rep.; Dan Stone, National Sales Rep.
DESCRIPTION: Provider of cable television support services including turnkey fiber optic projects, as-built maps, strand maps, system design, computer aided drafting, R.F. signal leakage testing, grounding of outside and inside plant.

BARKER CATV CONSTRUCTION, INC
★ 817 295-0454 ★

Barker CATV . . . .(817) 295-0454
Construction Inc.
145 N. Wilson
Burleson, TX 76028
PERSONNEL: James Barker, President
DESCRIPTION: Specializing in all phases of CATV construction, to include aerial and underground, total turnkey, newbuild or rebuild, upgrades, strand mapping, system design, activation, sweep and proof of performance. QUALITY CONSTRUCTION DOESN'T COST...IT PAYS.

Bigham
Cable Construction, Inc.

Bigham Cable . . . .(904) 932-6869
Construction Inc.
PO Box 903
Gulf Breeze, FL 32561
PERSONNEL: Harold Bigham, President
REGIONAL OFFICES: 738 NW Renfro, Burleson, TX 76028, (817) 447-1960.
DESCRIPTION: Need your system rebuilt, upgraded, or new build, call: Bigham Cable Construction, Inc.

Burnup&Sims
Cable Com, Inc.

Burnup & Sims . . . .(404) 482-7612
Cable Comm. Inc.
6440 Hillandale Drive
Lithonia, GA 30058
PERSONNEL: Robert Long, President; Larry Wallace, Sr. Vice President; Mike Gepford, VP/Western Operations; Phil McDonald, VP/Eastern Operations
DESCRIPTION: All phases of CATV construction: Aerial, underground, rebuild, newbuild, retrofit and turnkey.

CATV Subscriber Services, Inc.

CATV Subscriber . . . . . .(919) 273-5553
Services, Inc.
808 Summit Avenue
Greensboro, NC 27405
PERSONNEL: Raymond L. Galtelli, President; Fred Robertson, VP; Jerry Haisman, GM/construction; Tommy Butts, Director of Sales
DESCRIPTION: Contract Services: mapping, design/engineering, construction - aerial & underground, installations, marketing & door-to-door sales, audits, turnkey packages, signal leakage detection and prevention, various support services.

Cable Constructors, Inc.

Cable Constructors Inc. . .(906) 774-6621
WATS(National). . . . . . .(800) 338-9292
WATS(State). . . . .(800) 682-7140
105 Kent St.
PO Box 190
Iron Mountain, MI 49801
PERSONNEL: James A. Klungness, President; James Brandt, Executive Vice President; Charles Henry, Senior Vice President; John Jamar, Director of Marketing; David Sanders, Vice President/Engineering
REGIONAL OFFICES: 1903 Success Road, Suite 301, Auburndale, FL 33823, (813) 965-2847; 1550 Hubbard Ave., Batavia, IL, 60510, (312) 406-9443; 9527 W. Sahuaro Dr., Peoria, AZ, 85345, (602) 979-9090; 100 W. Brown St., Iron Mountain, MI, 49801, (906) 774-6678.
DESCRIPTION: Complete turnkey construction including computer design, mapping, aerial & underground construction through system sweep and activation. Complete turnkey project management.

Cable Services Company Inc.

Cable Services Co. Inc. . .(717) 323-8518
WATS(National). . . . . . .(800) 233-8452
WATS(State). . . . .(800) 332-8545
2113 Marydale Ave.
Williamsport, PA 17701-1498
PERSONNEL: John Roskowski, President; George Ferguson, Vice President; Robert Brantlinger, Dir. of Marketing; Harry Wahl, V.P./Turnkey Sales
DESCRIPTION: Complete turnkey supply and construction including pole walking, strand mapping, design, engineering and installations, both aerial and underground. Stocking distributor of all major manufacturers, plus on premise repair facility.

CABLE T.V. INSTALLATIONS AND CONSTRUCTION

Cable TV Installation . . .(713) 686-6880
and Construction
5891 W. 34th St.
Houston, TX 77092
PERSONNEL: David E. Pickartz; Gerry 'Woody' Woodruff; Dana G. Martin
DESCRIPTION: Complete construction services including aerial construction, underground construction, splicing, drop installation, apartment wiring and complete system turnkey services.

Cablemasters Corp.

Cablemasters Corp.. . . .(814) 774-2616
2184 Rice Ave.
Lake City, PA 16423
PERSONNEL: Bernie Czarnecki, President; Tom Dow, Vice President; Gary Morris,

Construction Manager
DESCRIPTION: Aerial and underground construction services residential and MDU installations, strand mapping, make ready engineering, Fiber Optics system design LAN networks. Turnkey available.

DINSMORE COMMUNICATIONS CORPORATION

Dinsmore Comm. Corp.. .(603) 436-6344
WATS(National). . . . . . .(800) 238-2338
Portsmith Circle Business Ctr.
Omne Road POB 3190
Portsmouth, NH 03801
PERSONNEL: Dennis G. Dinsmore, President; David G. Walters, Vice President
DESCRIPTION: Complete turnkey construction services for underground, aerial, and apartment pre/post wiring.

ENGLISH ENTERPRIZES A DIVISION OF GATOR TRANS INC

English Enterprizes. . . . .(305) 898-7134
Box 6494
Orlando, FL 32853
PERSONNEL: Gary M. English, President; William R. Sundvall, Operations
DESCRIPTION: Contract services to the Cable Industry: residential installations, underground audits, rebuild drop swings,as-built mapping & engineering, commercial installations, U/G and aerial construction. The Professional Choice.

EXCALIBUR CABLE

Excalibur Cable. . . . . .(703) 777-5905
Comm. Ltd.
WATS(State). . . . .(703) 451-7584
6 Loudoun St. SW
Leesburg, VA 22075
PERSONNEL: Konrad Poth, President; Terry Turner, Secretary/Treasurer; Christopher McCarty, Vice President; James Connors, Vice President; Glenn Allen, Regional Manager
REGIONAL OFFICES: 8906 Telegraph Road, Lorton, VA, 22079, (703) 339-8800; #6 Loudoun Street SW, Leesburg, VA, 22075, (703) 451-7584; 10805 Lanham Severn Road, Lanham, MD, 20706, (301) 262-2966; 2021B Shannon Place SE, Washington, DC, 20020, (202) 889-9670.
DESCRIPTION: Excalibur is a CATV contracting and construction company specializing in underground construction,balancing, splicing, field engineering and design work on apartment complexes, all types of installation, turn key capabilities.

Kennedy Cable

Kennedy Cable. . . . . . .(912) 557-4751
Construction, Inc.
WATS(State). . . . .(800) 841-4361
Hwy. 280 W
PO Box 760
Reidsville, GA 30453
PERSONNEL: Roger Kennedy Jr., President; Robert West, Vice President; Bob Skelton, Vice President; Frank Walker, Marketing Manager
REGIONAL OFFICES: Florida, (813) 439-3621.
DESCRIPTION: Aerial and underground line construction services, splicing and balance, strand mapping, engineering and design, splicing upgrades and rebuilds.

Lightning Electric of Pennsylvania, Inc.

Lightning Electric. . . . . .(717) 533-4983
of PA Inc.
RD 1
Box 148-B
Hershey, PA 17033
PERSONNEL: Joann Brong, President; Anthony Brong, GM/Lightning Elec. of PA Inc.
REGIONAL OFFICES: Walton Tower Inc., Road 1, Box 148-B, Hershey, PA 17003 (717) 533-4983; SE Cable Construction Corp., PO Box 177, Callahan FL 32011, (904) 879-1311.
DESCRIPTION: Construction services including new, rebuild, line extension, underground and tower work, also pole line, hardware, tap, traps and filters and house drop, installations, consultants in engineering, finance, earth stations, strand mapping and surge protection.

NaCom

NaCom. . . . .(614) 895-1313
FAX: (614) 895-8942
WATS(National). . . . . . .(800) 848-3998
1900 E Dublin-Granville
Columbus, OH 43229
PERSONNEL: Larry Linhart, President/CEO; Larry Brown, Vice President; Jerry Evans, Vice President; Joe Govern, Vice President; Les Lotte, Vice President
REGIONAL OFFICES: Albuquerque, NM; Baltimore, MD; Columbus, OH; Covington, KY; Fitchburg, MA; Houston, TX; Los Angeles, CA; Phoenix, AZ; Sacramento, CA; Stratford, CT;Washington, D.C.
DESCRIPTION: Full service telecommunication contractor providing strand mapping, drafting, design, make-ready engineering, aerial/underground construction, splicing, installations (including fiber optics), traps, audits, converter change-outs, pre/postwiring MDU's, SMATV and LANs.

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Professional Cable. . . . .(505) 275-3112
Contractors, Inc
300 Muriel N.E.
Albuquerque, NM 87123
PERSONNEL: Edmund Pedersen, President; David Howell, Vice President; Mike Templin, Operations Manager; Geary McConnell, Construction Manager
REGIONAL OFFICES: 5804 Saint Augustine Road, Jacksonvile, FL 32207, (904) 448-0647, Don Minner; 4301 N 82nd Drive., Phoenix, AZ 85033, (602) 849-4882, Rose Mary Pedersen
DESCRIPTION: Professional cable contractors specializing in the telecommunications industry. A full service contractor construction: newbuild or rebuild, installation and ordering.

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CABLE SERVICES, INC.

Pyramid Cable Services. .(419) 382-5152
of Ohio, Inc.
FAX: (419) 382-2938
WATS(National). . . . . . .(800) 433-1129
760-0 Warehouse Road
Toledo, OH 43615
PERSONNEL: Joseph McCool, Chief Executive Officer; Robert M. Abbott, President; Earle Davis, Vice President/ Marketing
DESCRIPTION: Complete turnkey contractor, installations, pre-wiring, post-wiring, underground and aerial construction, splicing, headend set up and earth station construction. Also have a complete engineering and design service.

R & L Cable Installation
702 E. Michigan Avenue
Lima, Ohio
(419) 229 3400

R & L Cable. . . . .(419) 229-3400
Installation, Inc.
702 E Michigan Ave.
Lima, OH 45801
PERSONNEL: Rodger Wauben, President; C. Lynn Wauben, Vice President
DESCRIPTION: Underground construction, aerial, underground and bore deep installation work, systems service work, postwires and prewires, drop rebuilds and system audits.

RTK
CORPORATION

RTK Corp.. . . . .(201) 678-2083
Seven Glenwood Ave.
East Orange, NJ 07017
PERSONNEL: Robert Bilodeau, Company Chairman; Richard Thomas, Installation President; George Tamasi, Construction President; Tom Polis, Construction Executive VP
REGIONAL OFFICES: Seven Glenwood Ave., Installation Services Div., E Orange, NJ 07017, (201) 678-2083; 235 East Gay St., West Chester, PA (214) 696-1800.
DESCRIPTION: Communications Construction Division: Full/modified/ management/BOM turnkey construction; strand mapping, make ready survey, system design, engineering/franchise/as built/ splicing services. Installation Services Division: Turnkey residential and commercial installations; audits rebuilds, converter changeouts and upgrades; MDU pre-and post-wire.

Schenck
communications

Schenck Construction. . .(206) 867-9694
15042 NE 95th
P.O. Box 3159
Redmond, WA 98073-3159
PERSONNEL: Edward A. Schenck, President; Bud Longnecker, VP/Aerial; Imel L. Wheat, Jr., VP/Underground
DESCRIPTION: Aerial and underground cable TV construction; turnkey.

Southeast Cable
Construction Corp.

Southeast Cable. . . . . .(904) 879-1311
Construction Corp.
PO Box 177
Callahan, FL 32011
PERSONNEL: Joann Brong, President; Anthony Brong, General Manager
DESCRIPTION: Construction for cable TV companies.

Taylor Tele-Communications, Inc.

Taylor Telecomm. Inc.. . .(216) 784-2960
2040 E Market
Akron, OH 44312
PERSONNEL: Sue Taylor, President; Sherry Taylor, Vice President; Rick Taylor, Marketing Rep
DESCRIPTION: Cable installation contractor; underground construction, aerial construction, apartment pre-wiring, residential installation.

TNT

Technetronics Plus. . . . .(914) 561-7880
198 Route 9W
New Windsor, NY 12550
PERSONNEL: Andrew Healey, President
DESCRIPTION: Full service communications construction engineering company. Specializing in rebuilds, upgrades, turnkeys and local area networks. All services available EFI.

White Mountain Cable. . .(603) 736-4766
Construction Corp.
PO Box 459
Epsom, NH 03234
PERSONNEL: Dennis Nolin, President; David Pouliotte, Vice President; William Hinton, VP of Operations
REGIONAL OFFICES: Wilmington, MA; Westerly, RI and Portland, ME.
DESCRIPTION: Cable TV and fiber optic cable construction. Splicing, engineering, strand mapping and system maintenance.

Wrubel
CONSTRUCTION CO OF INDIANA

Wrubel Construction. . . .(317) 271-9790
Company
PO Box 53140
Indianapolis, IN 46253-0140
PERSONNEL: Jay C. Wrubel, President; Joe J. Wrubel, Vice President; Ginger L. Auel, Office Manager
DESCRIPTION: Complete aerial and underground construction from strand map to activiation and system audit. Quality construction built to accepted industry standards and specifications in new build, rebuild or upgrade situations.

Improving reliability of drop wire connections

A timeless article on how to improve the #1 headache.

One of the weak links in CATV systems for years has been the 59/U drop connectors when they have been installed outdoors. This can be shown by the analysis of service call records and more recently thousands of radiation reports.

This presentation describes new connector concepts that are designed to reduce these problems. These concepts are applied to a new connector which has improved mechanical and electrical parameters with simple installation procedures for all weather conditions.

What is the cost of a more reliable system and improved reception to the subscriber?

How can the technical trade-offs be converted into dollars? The method of assessing the economics of this new connector are also discussed.

The demand for improved performance of subscriber drop "F" connectors is steadily increasing. The CATV industry is now utilizing the full bandwidth of the system. Frequencies outside the standard TV/FM band are now regularly being used for additional channels in the forward and reverse directions. RF integrity in the mainline hardware and coaxial cables in the past has been greatly improved to overcome egress and ingress problems. The weak link in the present CATV network remains in the drop wire "F" connector, and since this is an equally important connection the requirement to maintain integrity must be met.

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By John Hood, Comlink Systems Inc. (formerly with Cablesystems Eng.).

Historical background

One way to evaluate system problems is to maintain records that can assist in the review of past experiences and problems. Our radiation monitoring system has certainly indicated a problem in the connector area.

FIGURE 1

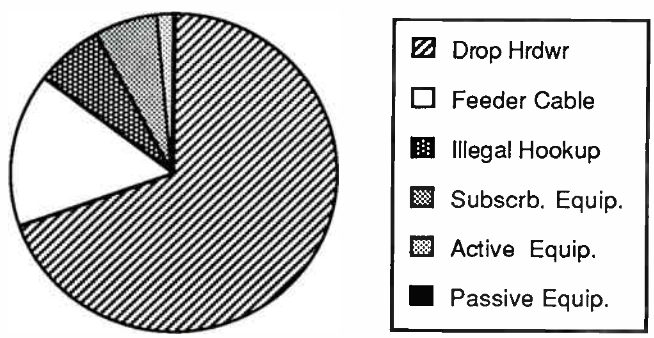


Figure 1 represents the data tabulated for over 3,000 cleared radiation problems that have been detected by this monitoring procedure. The chart is divided into six sections as follows:

Drop hardware. Consisting of connectors, splices, matching transformers, tap-off devices and drop cable. Seventy percent of the data reported in this section was due to connectors alone.

Feeder cable. Consisting of connectors, splices, sheath breaks and other problems that could be encountered on trunk and distribution cable. The problems reported in this section were mostly with connectors and splices.

Passive equipment. Consisting of splitters, multi-taps, wrong value multi-taps, matching transformers and other passive equipment. Problems reported were mixed with no definite trends.

Active equipment. Consisting of amplifiers and mostly reflects problems with levels set too high and loose housing lids.

Illegal hookups. Consisting of illegal extensions to FM/TV sets, or neighbour's sets with 300 ohm lead or other unauthorized connections with unshielded cables.

Subscriber's equipment. Consisting of internal and external antennas that are still hooked up and extensions made with 300 ohm lead or other unshielded cable to move the receiver. Approximately 60 percent of this section was due to subscriber antennas still hooked up.

The radiation monitoring system has indicated approximately 1,455 connectors requiring repairs. Radiation monitoring equipment has been operating in 11 of Canadian Cablesystems' licensed areas for three years now with one radiation receiver installed per

Cable Classics

Ask any cable television engineer to list his top three causes of reliability problems and the "F" connector is sure to appear in the answer. The same would have been true 10 years ago when this paper by John Hood was given at the NCTA Convention in 1978. Today's demands to minimize signal leakage only accentuate the demand for improved drop connections.

Dan Pike of Prime Cable submitted this paper for inclusion in the "Classics" series with the heading, "If we'd only paid more attention to this one at the time it was published."

Hood presents a description of the development of the "F" connector starting with the original F59 designed by Eric Winston of Jerrold in 1954. The paper outlines the environmental requirements for reliable connections, emphasizing the need for effective moisture sealing.

We could wish now that the pace of development of reliable drop connection technology had been faster; perhaps it would have been if more of the users of "F" connectors had read this paper carefully, realized the possibilities for reliability improvement and provided encouragement to all connector suppliers to incorporate better design solutions.

Graham S. Stubbs
Consulting Engineer

The next modification included the design of a sealing boot that could be easily installed.

vechicle for each 150 kilometers (94 miles) of plant.

In 1972 the demand for a more effective shielding for drop wire steadily became important to meet the requirements of systems with signals in the midband. The cable selected by Canadian Cablesystems is of the aluminum tape surrounded by braided shield. Specifically, the construction is an aluminum-polypropylene-aluminum-laminate tape, 0.0017-inch thick applied longitudinally with an overlap encasing the polyethelene dielectric with an additional braid with 55 percent of shielding.

Standard F59 connectors did not make proper connections to the aluminum foil; they caused more radiation and ingress problems than we had experienced with our 95 percent braided cable. This problem is specifcally related to the mandrel forcing the foil back or through oxidized contact mate rials and not making a proper connection.

A second problem of concern for many years had been that of weatherproofing connections. Weatherproof boots and other methods that have been used for many years have not been very successful. I am sure you have seen corroded connections at your line tapoffs. Totally sealed drop connections in the underground environment has been another problem not yet solved.

In search of a solution to this problem, one must examine the fundamentals.

Design philosophy

Proper operation and reliability of a connector depends to a large extent on how well it can perform while withstanding specified environmental conditions. The following are some of the most commonly encountered enviromental factors to be considered:

a) High and low temperature,
b) thermal shock,
c) mechanical shock and vibration,
d) rapid change in pressure,
e) humidity,
f) bacteriological growth and fungus,
g) presence of corrosive atmosphere,
h) salt spray,
i) dust and sand and
j) electromagnetic interference.

Not all of the above factors may be encountered in the same system, but sometimes a combination of several of them may create extremely critical situations. In addition to the environmental factors, other requirements must be considered in this design:

a) Compatibility with other fittings and hardware of the system.
b) Easy installation with minimum effort and inexpensive installation tools.
c) Producible at a reasonable and justifiable cost.
d) Exhibit a high reliability level and be readily maintainable.

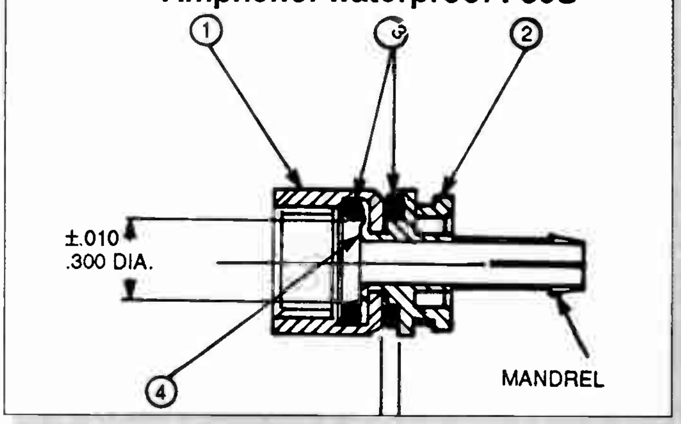
Improved connector assembly

In 1954, Eric Winston of Jerrold Electronics developed a solderless and easy to install connector called the F59.

This connector has been, and is still being used with a great deal of success for RG59/U type braided cables. However, when the foil braided cables came along, the standard "F" connector could not be installed without the foil being pushed back under the braid and jacket. In an attempt to correct this problem, Albert Stirling of Stirling Connectors, Canada, worked with Canadian Cablesystems to improve this problem. A solution was modifications to the standard F59 that consists mainly of slots in the mandrel and a flare inside the mandrel so that the connector may now slide over the foil and under the braid.

The foil could now be seen inside the connector's swivel nut fitting, assuring a good connection. One additional feature of this modification is that with a standard size crimp ring the mandrel will collapse down onto the foil making a mechanical and electrical connection, ensuring continuity of the shield conductor. The mechanical cable retention is increased by an additional 15 lbs. This improved connector has been in use in cable systems for three years with great success.

Amphenol waterproof F59S



The slotted mandrel connector also shows shielding improvement for bonded foil cables through the improved electromechanical connections. However, this does not solve our moisture ingress problem.

The combined efforts of Cablesystems Engineering and Amphenol of Canada Ltd. continued with the activity in attempting to solve the moisture ingress problem through the development of a waterproof F59S connector.

In the preceding section, the design philosophy which should be considered in this development was discussed. Simplicity is identified as having prime importance because of the desire to introduce few new installation practices or parts. For instance, the installation of the developed connector can be accomplished with the PL602 crimp tool and other standard tools found in your installer's tool kit. The number of parts that have to be handled is still three. This concept of simplicity has maintained an economical design.

The first modification was made to the connector body and the coupling nut as shown in Figure 2-(1). Two neoprene seals (3) have been added to the connector. The hex nut has to be changed to ½-inch to permit an increased shell size necessary to accommodate the addition of the seal inside the coupling nut. The seal is positioned inside the coupling nut (1) and (3) in order to maintain the same grounding contact of the shouldered contact (4) found in the standard F59.

The addition of these seals water-

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In order to compare the costs, a model system with 20,000 subscribers will be used.

proofed the connector, but they do not guarantee a seal from the body of the connector to the cable.

The next modification included the design of a sealing boot that could be easily installed on the cable and would slip over the body of the connector but would not interfere with the coupling nut. The body of the connector has an additional groove to accommodate the sealing boot shown in Figure 2-(2). This design approach allows the boot to remain on the connector during installation and disconnection. Three sealing rings are molded into the inside surface of the boot so that proper sealing is achieved around the cable jacket. See Figure 3.

Critical properties must be considered in the selection of the material for the sealing parts. They must have:

a) Long-term weather adaptability
b) non-solubility
c) resistance to corrosive reagents
d) non-adhesiveness
e) flexibility at low temperatures
f) low co-efficient of friction
g) stability at high temperature

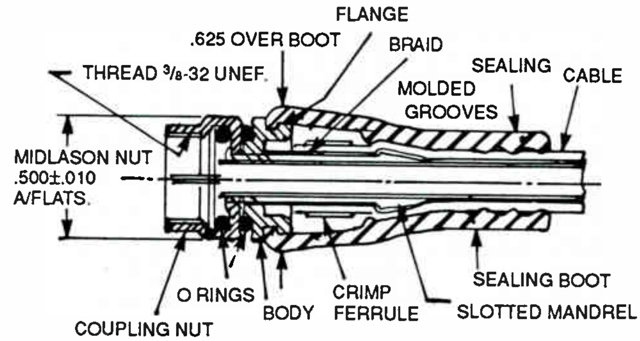
Neoprene was selected as the material most suited to these requirements. Figure 3 shows the final version of the waterproof F59S with the sealing boot installed. After finalizing the requirements for the connector, and the basic electromechanical design criteria, a set of performance specifications were formulated. They are as follows:

a) *Electrical:* i) impedance: 75 ohm nominal; ii) voltage rating: 500 volts peak; iii) dielectric withstanding voltage: 1500 volts R.M.S.

b) *Mechanical:* i) cable affixment: crimp ferrule 0.135-inch wide; ii) cable retention: 35 lb. maximum pull test of cable from connector.

c) *Environmental:* i) operating temperature range: −40°C to 85°C; ii) vibration: mated connectors will withstand vibration to MIL-STD-202 Method 204 (Test Condition D) (20 G. peak) over a frequency range of 10 to 2000 Hz. 12 times with connector mmounted in the horizontal position and vibration in the vertical mode for a period of eight hours; iii) corrosion: salt spray test in accordance with MIL-STD-202 Method 101 (Test Condition B) length of test 48 hours exposed to a salt

FIGURE 3
Amphenol WPF59S with weather boot installed



solution concentrate of 5 percent; iv) water pressure seal: mated connectors will withstand a differential water pressure of 5 p.s.i. No electrical degradation after testing.

d) *Materials:* i) connector body: zinc diecast; ii) coupling nut: zinc diecast; iii) crimp ferrule: brass; iv) plating: cadmium plate (all metal parts); v) sealing boot: neoprene per MIL-G-1149B Type 1-Class 1; vi) O-rings: neoprene per MIL-G-1149B Type 1-Class 1.

Prototype connections have been built to those specifications and have been subjected to and have passed the following tests:

a) Continuity: mating connector coupling nut and center conductor to cable.
b) Dielectric withstanding voltage: 500V DC for 5 seconds mated.
c) Waterproof: tested at 5 lbs. per square inch pressure for 60 days.
d) Physical vibration at −30°C - 20 G. peak 20-2 kHz, eight hours, mated followed by tests a), b) and c).
e) Physical vibration at 50°C - 20 G. peak 20-2 kHz, eight hours mated followed by tests a), b) and c).
f) Accelerated thermal aging at 85°C for 50 hours unmated.
g) Accelerated thermal aging at −55°C for 50 hours umated followed by tests a), b) and c).
h) Cable retention test: 30 lbs. axial pull force, followed by tests a), b) and c), mated.
i) Salt spray: as per MIL standard 202, Method 101 (test Condition B) length

of test 48 hours exposed to a salt solution concentrate of 5 percent.

Cost analysis

In order to compare the costs, a model system with 20,000 subscribers will be used. The assumptions in developing this model are as follows:

a) Cost of standard F59 with weather boot: $0.20
b) Cost of waterproof F59S: $0.50
c) Cost of service calls, overhead including truck, tool and expenses per call: $10.85
d) Service calls due to drop problems average 7.5 percent of subscribers per year with 80 percent of these calls due to connectors.
e) Assumed service call reduction of 50 percent is proposed for the waterproofed drop connectors.

Therefore, fixed cost for standard F59 will be:

FC_S = 20,000 x (a)
= 20,000 x 0.20
= \$4,000

Variable cost per year will be:

VC_1 = 20,000 x (d) x (c)
= 20,000 x 0.075 x 0.80 x 10.85
= \$13,020

Proposed waterproof F59S will be:

FC_P = 20,000 x (b)
= 20,000 x 0.50
= \$10,000

Variable cost per year will be:

VC_2 = 20,000 x (d) x C x 0.50
= 20,000 x 0.75 x 0.80 x 10.85 x 0.50
= \$6,510

Figure 4 indicates a breakeven point at the 12th month period and a cost savings in the second year. If some of the assumptions in this model do not agree with your experience, try your own maintenance costs.

Cost comparison

The above calculations have not

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I must point out that the above models do not take into account radiation problems.

considered depreciation, tax savings and present value since technical departments do not normally base their evaluations and comparisons on that type of calculation. However, I would like to model another analysis based on present value calculations. The data in developing this model is as follows:

a) The cost of a standard F59 with weather boot: $0.20
b) The cost of waterproof F59S: $0.50.

Therefore, the incremental investment in a 20,000 subscriber system = 0.30 x 20,000 = $6,000.

c) Service calls due to drop problems average 7.5 percent with 80 percent of these calls related to connector problems. The assumption that the proposed connector reduced connector related service calls by 50 percent as a savings of 20,000 x 0.075 x 0.80 x 0.50 = 600 calls per year is realized.
d) Cost of service calls, overhead including truck, tools and expenses per call: $10.85.

Therefore, yearly savings
= 600 x 10.85
= $6,510.

e) Tax rate	48%	
f) Capital cost allowance	30%	
g) Present value return rate	12%	= i
h) Life	10 yrs. = N	
i) Annuity factor	$\frac{1}{i}\left[1\ \frac{1}{(1+i)^{N}}\right]$	

j) Tax shield = $\frac{\text{tax rate x capital cost... ...allowance rate (CCA)}}{\text{CCA + return rate}}$

The net present value (NPV) can be obtained from the following formulae:

NPV = Investment x [1-tax shield] + yearly savings x [1-tax rate] x annuity factor

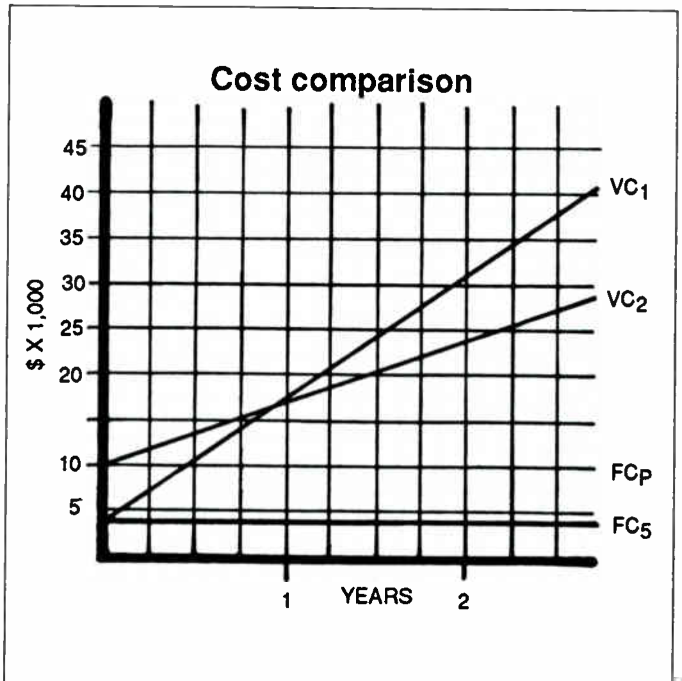
Therefore, NPV =

$$-6{,}000 \times \left[\frac{1-0.48 \times 0.30}{0.30 + 0.12}\right]$$

$$+\ 6{,}510 \times (1-0.48) \times 5.65$$
$$= \$15{,}184.38$$

Therefore, the waterproof connectors after recovering their increased costs provide a net saving of $15,184.

Now, if we wish to determine how many service calls per year we need to



break even on the incremental cost of investment over a 10-year period; i.e. set the net present value to 0.

NPV = investment x (1-tax shield) + (# service calls saved) x cost of service calls x (1-tax rate) x annuity factor

$$0 = -6{,}000 \times \left[\frac{1-.48 \times .3}{.3+12}\right] + \#\text{service calls}$$

$$\times\ 10.85 \times (1 - .48) \times 5.65$$

$$0 = -3{,}942 + \#\ \text{service calls} \times 31.88$$

Therefore, # service calls = 123.

Therefore, if more than 123 or 0.6 percent of subscribers have service calls due to connector problems then the extra cost of the new connector is covered and a net savings is realized in the 20,000 subscriber model system.

I must point out that the above models do not take into account radiation problems, since the subscribers normally don't call for a service call when their drop wire connector is exceeding FCC/DOC standards and regulations. Radiation problems have not been recorded in our service call analysis; therefore, additional expense allowances must be added to the above results for the added costs. Based on data recorded and indicated in Figure 1, this percentage can be quite high in the first couple of years when clearing radiation problems.

I believe that this cost analysis helps to indicate that improved drop line connections are required and can be justified. ■

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1. Mechanical Engineers Handbook, Lionel S. Marks p.636.
2. Winston, Eric, A Study of Aluminum Cable—Connector Interfaces and Their Effect on CATV System RF Ingress.

Agile modulator reliability

Can you really afford it?

Many headend equipment manufacturers have recently introduced agile television modulators. These products are attractive for manufacturers and distributors because they significantly reduce inventory costs. Agile modulators are also attractive to system builders because detailed headend designs and channel lineups are not required before the system is installed. Agile modulators are also more easily manufactured in low labor-cost countries because each product is identical and can therefore be manufactured in large production runs by people with a low level of product-specific training. These advantages have resulted in a significant increase in the number of headends built entirely with agile modulators. Unfortunately, as many operators are now discovering, a rack full of agile modulators is highly undesirable.

A headend using agile modulators exclusively will cost more to purchase, produce lower quality signals and cost much, much more to maintain. These negative factors result directly from the additional circuitry required for modulator agility. These disadvantages are inherent characteristics that apply regardless of the specific agile modulator and manufacturer. Previously, few system designers or operators have appreciated the significance of these disadvantages.

- **Circuit complexity.** Truly agile, adjacent channel modulators typically contain approximately twice as much circuitry and many more complex components than fixed frequency products of comparable performance. The technical details of frequency synthesized oscillators, dual-frequency conversions and tracking filters are beyond the scope of this article. Anyone who is interested can easily gain an appreciation for the relative circuit complexity of agile vs. fixed frequency modulators simply by taking the lid off products of each type. It will be immediately obvious that there are a much larger number of components and many more complicated and expensive components in the agile modulator.
- **Purchase price.** The larger number, and increased cost, of the components in an agile modulator results in a significantly higher purchase price as compared to fixed frequency modulators with similar performance. Many purchasers mistakenly associate the agile modulator's higher cost with higher performance.
- **Picture quality.** A headend built entirely with agile modulators will inevitably produce a lower quality picture. All agile modulators produce undesired outputs, including broadband noise and spurious signals. The undesired outputs from each of the agile modulators will be combined in the headend system combiner. In the case of the broadband noise, the amount of noise at the combined output increases in direct proportion to the number of agile modulators used. As a result, the picture degradations will become more and more serious as the number of agile modulators in a system is increased.
- **Reliability.** Even if a system operator were willing to accept the higher initial cost and lower picture quality resulting from a headend full of agile modulators, the additional maintenance costs which result from lower agile modulator reliability outweigh any perceived advantages. The reliability of any agile modulator is less than that of an equivalent quality fixed frequency modulator because of the additional circuitry and power dissipation required for agility. Even the best designers and manufacturing teams cannot compensate for this.

By Dr. Basil Peters, chairman and CEO; and John Hacker, research engineer, Nexus Engineering Corp.

Reliability study

As part of Nexus Engineering's continuing headend reliability analysis program, a comparison was made of the relative reliability of four modulators: two contemporary agile modulators, our Series 1 fixed frequency modulator (the VM-1), and a fixed frequency modulator from another manufacturer. The products chosen for comparison will be similar from a reliability point of view to the majority of popular products available in the marketplace today. As a result, even though every possible fixed frequency and agile modulator was not analyzed, the results of this study will generally be applicable to all manufacturers' products.

The basic method that was used to predict the reliability of the fixed frequency and agile modulators is contained in the U.S. Government MIL-217 Handbook.[1] This military standard is widely accepted as being the most useful reliability prediction tool available. It was originally designed to predict the reliability of military equipment but can also be used for predicting the reliability of commercial equipment.

This prediction method takes into account the number, type and quality of components, the operating environment and the electrical and thermal stresses to which the components are subjected to in the product. A complete analysis of an individual product is an arduous process which requires the number, type and operating environment of each component to be analyzed.

The MIL-217 Handbook contains base reliability statistics for a wide variety of electronic components. The base reliabilities of each component are then modified by factors which describe environmental, thermal and electrical stresses to which each component is subjected. The environmental factors include ambient temperature and operating environment (such as installation in a rack and whether the unit is mobile or airborne).

Because all cable headend equipment is intended to be rack mounted and operated in a room-temperature environment, the most significant environmental consideration is the temperature rise produced by heat dissipation within the product. The internal temperature rise within the product is, to a considerable extent, determined by the total power dissipation of the modulator.

Power consumption

The additional circuitry required to produce an agile modulator results in significantly higher power dissipation than the circuitry in a fixed frequency modulator. Table 1 shows the internal

Another disadvantage of higher power consumption is the additional cost of electricity to operate the headend.

power dissipation of the two fixed-frequency and two agile-frequency television modulators used in the study.

The power dissipation of the agile modulators is approximately three to five times greater than the Nexus fixed frequency modulator and approximately two to three times greater than the other fixed frequency modulator.

TABLE 1

Modulator Internal Power Dissipation

Modulator	Internal Power Dissipation (Watts)
Nexus VM-1	4.2
Fixed #2	7.2
Agile #1	11.7
Agile #2	22.2

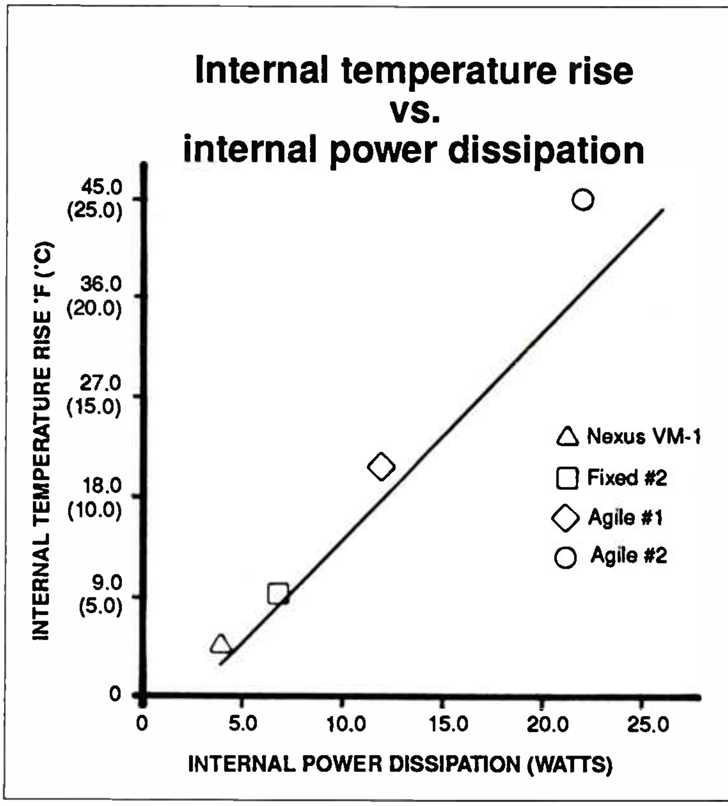
The Nexus VM-1 has less complicated circuitry, but it also dissipates less heat than the other fixed frequency modulator because the power supply is located outside the unit. The power supply is a major source of heat in any piece of equipment. Nexus removed the power supply from within the product to eliminate this major source of heat from the vicinity of the temperature-sensitive electronic components.

Another disadvantage of higher power consumption is the additional cost of electricity to operate the headend. A previous article[2] showed that the additional electricity costs to operate a high power-consumption headend could, in some areas, equal the entire purchase cost of the headend over a typical 10-year lifetime. Depending upon the electricity costs in the area in which the headend will operate, this could be a significant advantage when analyzing operating system economics.

Internal temperature rise

As part of the study, the internal temperatures within each modulator were carefully measured. This was done using several thermocouples inside each modulator enclosure. The modulators were mounted in a rack with other similar modulators and the entire rack placed in an environmental chamber. During these tests, the environmental chamber was maintained at a temperature of 113 degrees Fahrenheit (45 degrees Centigrade) to simulate a non-air conditioned building on a very hot day.

Average internal temperatures were recorded over a period of two to three days to ensure that the temperatures had reached equilibrium. Table 2 shows the average internal temperature rise for each modulator. This is the temperature difference between the outside ambient temperature and the temperature inside the modulator enclosure.



The data in Table 2 demonstrates the effects of the higher power dissipation in the agile modulators. The average internal temperature of the two agile modulators was 15.3 and 40.3 degrees Fahrenheit (8.5 and 22.4 degrees Centigrade), respectively, above that of the Nexus VM-1. In most situations, MIL-217 predicts that a 27 degree Fahrenheit (15 degree Centigrade) increase in temperature reduces a component's lifetime by half. It is, therefore, obvious that the agile modulators will be significantly less reliable than the cooler running, fixed frequency modulators.

TABLE 2

Modulator Internal Temperature Rise

Modulator	Average Internal Temperature Rise °F	(°C)
Nexus VM-1	4.5	(2.5)
Fixed #2	9.0	(5.0)
Agile #1	19.8	(11.0)
Agile #2	44.8	(24.9)

This type of information is not new to most veteran headend engineers. It is easy to spot the technical veterans at any trade show. They're the ones who often place their hands on operating equipment and can be seen to sadly shake their heads when they feel headend equipment operating at high temperatures.

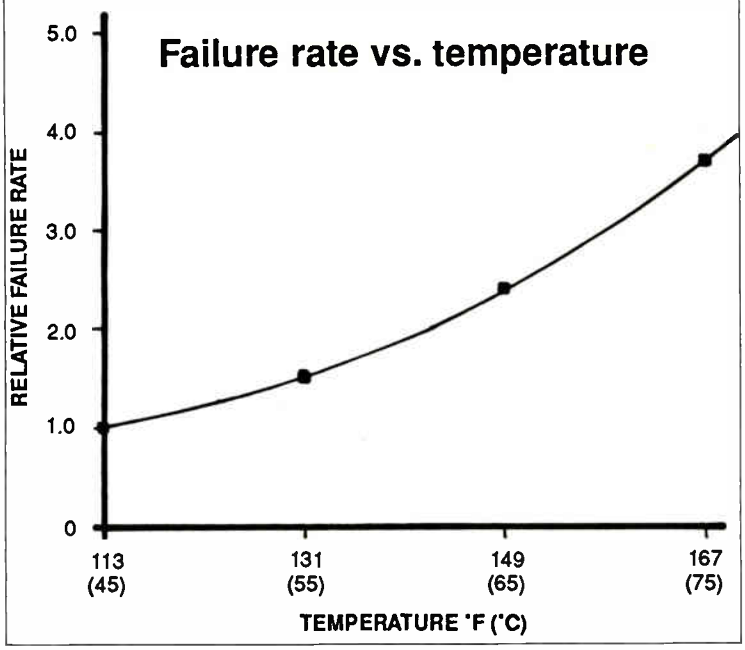
In another part of this study, the average internal temperature rise in a 1¾" rack mount enclosure was also simulated by dissipating predetermined amounts of power within a standard enclosure. The tests were conducted for adjacently mounted enclosures in a rack with enclosed sides and open back. The results from these tests are shown in Figure 1 along with the data from Table 2.

Reliability prediction

The MIL-217 Reliability Prediction

Reliability and maintainability are the two most important criteria for selecting headend equipment.

FIGURE 2



Handbook consists of 505 pages. A complete understanding of the mathematics and statistics involved in using this standard for product reliability prediction is, to understate it, somewhat arduous. The end result of the prediction process is the statistic known as the "mean time before failure" or MTBF statistic. A product's failure rate is the inverse of its MTBF. The complete understanding of this number in itself requires a detailed and mathematical explanation.

Rather than delve into the esoteric mathematics required to completely understand the statistics, the relative failure rate resulting from these analyses will be used in this article. For example, Figure 2 shows the effect of operating temperature on a hypothetical product's failure rate.

Similarly, Figure 3 shows the changing failure rate of a hypothetical product as the number of components is varied. These two graphs clearly show how a product's failure rate increases as the number of components or operating temperature increases.

Modulator reliability

The internal temperature measurements and the component numbers and types from each modulator were used as inputs to the MIL-217 calculation to predict the relative failure rate for each of the four modulators studied. The actual failure rate for each modulator will depend on the ambient operating temperature and temperature variations in the headend building. For this reason, and to avoid a detailed explanation of practical commercial MTBF, only the relative failure rate of the four modulators studied is presented in Table 3.

Table 3 demonstrates that the predicted failure rates of the two agile modulators were two to three times greater than for the Nexus VM-1. The results also show that the other fixed frequency modulator is only slightly less reliable than the VM-1. This study has also shown that the failure rate increases as the number of agile modulator channels in a rack is increased. The increased concentration of heat producing agile modulators results in even higher operating temperatures and consequently lower reliability.

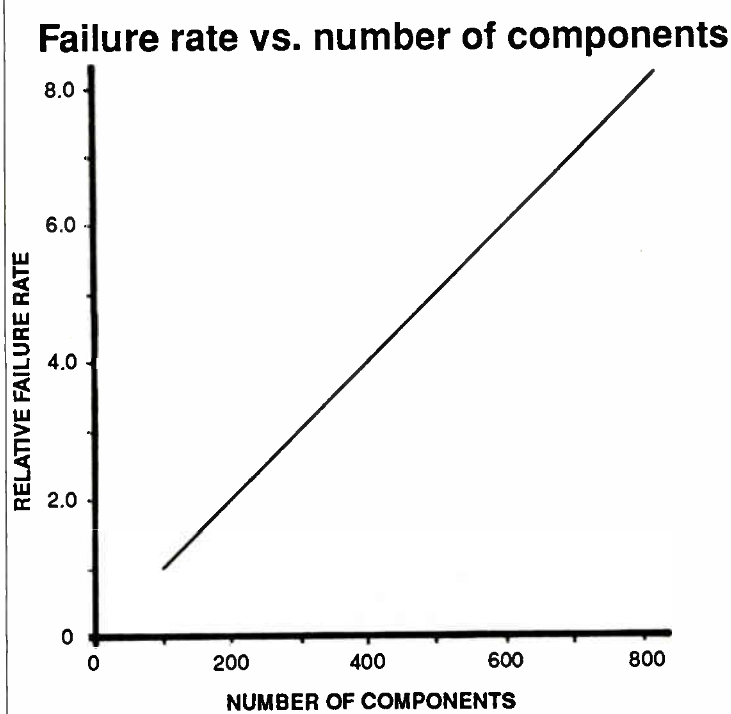
The tests showed that increasing the number of agile modulators in the test rack from three to nine resulted, in one case, in a substantial increase in temperature and therefore in failure rate. The final failure rate with nine agile modulators in the rack was six times that of the Nexus VM-1.

The inescapable conclusion is that agile modulators have predicted failure rates two to three times higher than fixed frequency modulators for similar performance. Even though only four products were actually analyzed in this study, the results with most other fixed frequency and agile television modulators would be similar.

Maintenance costs

Reliability and maintainability are the two most important criteria for cable operators selecting headend equipment.[3] Experienced cable operators know that the costs of maintaining a

FIGURE 3



A single agile modulator per headend for emergency backup use is a very good idea.

system are often many times greater than the initial purchase cost. Many headend systems operate for 10 years or more.

Each year a number of maintenance operations will need to be performed on a typical headend. The amount of maintenance will vary tremendously depending on the number and type of modulators, processors and satellite receivers in the headend.

The most important factor in determining the overall costs of maintaining a headend are the failure rate of the individual pieces of headend equipment. Other significant factors which determine the total maintenance costs are the distance and time required to travel to the headend location. Today many operators are building a large number of geographically remote headends. It is not at all uncommon for the most insignificant headend problem to require a technician to drive to a distant headend site.

TABLE 3

Modulator Relative Failure Rates

Modulator	Relative Failure Rate
Nexus VM-1	1.0
Fixed #2	1.1
Agile #1	1.9
Agile #2	3.4

Effects on other equipment

The extra heat created by the agile modulators is also a serious detriment to other products mounted in the same headend rack. If, for example, an otherwise reliable satellite receiver was placed above a number of agile modulators in a rack, the receiver would be subjected to a much higher ambient temperature, due to the agile modulators.

The agile modulators would in effect "cook" the satellite receiver and possibly result in it failing even before the agile modulators. For this reason, a single component in a headend can never be analyzed in isolation. The reliability of the entire headend must be analyzed considering all of the products mounted in the rack.

Satellite receivers

Our headend reliability engineers are frequently asked whether the same reliability considerations apply to agile satellite receivers. Surprisingly, the situation for satellite receivers is considerably different.

This is because little additional circuitry is required to produce an agile satellite receiver as compared to the number of components that would be required in a fixed frequency satellite receiver.

Total explanation of why this is true for receivers and not for modulators would require a complete discussion of the circuitry required to build both fixed and agile receivers and modulators. The operating advantages of satellite receiver agility far outweigh the small decrease in receiver reliability.

Conclusion

Agile modulators have some advantages, particularly for the manufacturer and distributor. However, a headend constructed entirely with agile modulators will have higher initial costs, lower picture quality and far greater maintenance costs. For the cable system owner or operator, these disadvantages far outweigh the advantages.

A single agile modulator per headend for emergency backup use, in the unlikely event that a fixed frequency modulator fails, is a very good idea. But agile modulators should never be used exclusively to build a complete headend. ■

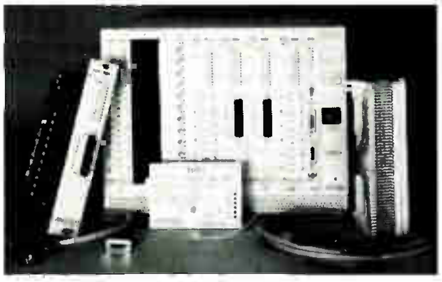
References

[1]"Reliability Prediction of Electronic Equipment", MIL-HDBK-217E Department of Defense, Washington, D.C., 1986.

[2]Solomon, G., "Controlling the Hidden Costs of Headend Power Consumption," Private Cable, Nov. 1985 pp. 38-42.

[3]Independent Survey Conducted Among Cable Operators, CATJ, June 1982 pp. 6-20.

Cabletron's big MMac attack occurs at Enterprise event



Cabletron Systems' MMAC unit

New Hampshire-based **Cabletron Systems** displayed its Multi-Media Access Center at the Enterprise Networking Event, held in Baltimore from June 5 to 9. The MMAC (in either a 3- or 8-card configuration) supports unshielded twisted pair, fiber optics, RG-58 coaxial cable, Ethernet and IBM data cabling.

The MMAC offers support for up to 87 network connections, each port complies with IEEE 802.3 and is repeated, retimed and re-generated regardless of media type, ensuring minimal data errors, "Remote LANVIEW." The unit allows the gathering of network statistics locally or remotely. It also allows users to mix and match unshielded twisted pair, fiber optic standard coax, etc.

Cost-per-connection varies from under $500 for twisted pair to under $900 for fiber optic. For information call Cabletron Systems, (603) 898-5988, or 332-9400.

C-COR Electronics Inc. released its Quick Alert version 4.0. The most significant change in the the new release of the broadband status monitoring system is its ease of use attained through the use of pull-down menus, color graphics and on-line help messages.

Version 4.0 features a horizontal bar graph display designed for quick and easy identification of single unit operation within user-specified tolerances. The status range consists of three levels: OK, warning and alarm. The respective levels are displayed in three different user-defined colors.

Quick Alert 4.0 monitors and controls C-COR's full line of broadband equipment: trunk amplifiers, standalone or end-of-line monitors, A-B switches and power supplies. Call C-COR, (814) 238-2461 for details.

Chipcom recently announced the availability of its new fiber optic Ethernet product line. The ORnet fiber optic system consists of two components: a 14-port active star coupler and fiber optic transceiver. The system operates at a full 10 Mbps data rate with 100 percent CSMA/CD performance. It also allows interconnection of Ethernet V2.0 or IEEE 802.3 devices within a 2.5 mile diameter network.

Chipcom's ORnet fiber optic system

The system is designed for easy installation and with growth in mind, said a company spokesman. It allows connection of up to 1,024 nodes without requiring repeaters between stars, which reduces the cost of connection. Standard IEEE 802.3 repeaters may be added at the transceiver to connect baseband, broadband or twisted pair Ethernet LAN segments. It also offers a full set of internal diagnostics and redundancy features for network reliability.

The 14-port ORnet star coupler is priced at $5,450. The transceiver is $545. Delivery is 60 to 90 days.

Also, Chipcom announced that it has entered into a distribution agreement with Anixter Bros. Inc. Under terms of the agreement, Anixter will market and stock Chipcom's line of Broadband Ethernet LAN connectivity products. Those products include: The Ethermodem III Series of 12 and 18 MHz broadband Ethernet transceivers, frequency translators, repeaters and remodulators, the DEMPR-compatible Ethermodem transceiver and Ethermodem III bridge. Contact Chipcom for more information: (617) 890-6844.

Coastcom recently announced a new delivery program for its T-1 product line. The new delivery strategy is called, "35 or 5" and guarantees product shipment within 35 working days after receipt of order or the customer will receive a 5 percent rebate on the purchase price.

The program is designed to insure shipment of Coastcom's software controlled D/I MUX II multiplexers and DXC-II digital cross-connect systems in any voice or data configuration. The program covers orders placed from May 17 through December 31. Equipment must be deliverable no later than March 31, 1989.

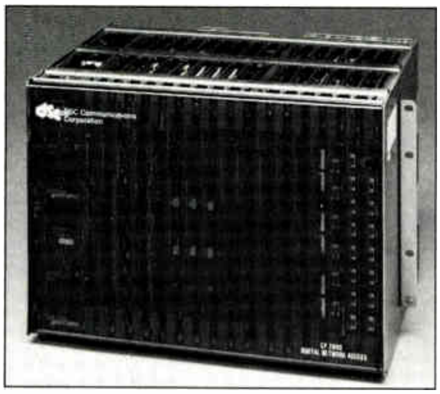
The company also recently announced an agreement with AT&T to support the United Network Management Architecture. Under the agreement, Coastcom will configure its networking products to conform to AT&T's specifications for its Network Management Protocol. NMP is an OSI-conforming protocol specification within the UNMA that allows customers easy interconnection of management systems from a variety of vendors. For more information call Coastcom, (800) 433-3433, 825-7500 in California.

John Deere's Dubuque Works will become the first manufacturing plant in the world to install an Allen-Bradley VistaMAP 3.0 bridge. The new bridge will enable a transition across a long distance from one high level protocol to another (from an 802.4 MAP network to an 802.3 network).

The system uses roughly two miles of broadband cable and spans 5.5 million square feet of manufacturing space. The installation will replace four VistaLAN/.3 Ethernet bridges, installed as an interim solution.

The Business Network Group of **DSC Communications Corp.**, in conjunction with its international affiliate, Granger Associates Ltd., announced its CEPT-compatible European interface for the CP2000 Digital Network Access System, making the CP2000 the first digital multiplexer with direct

Hewlett-Packard announced five new manufacturing network products that conform to the MAP 3.0 specification.



DSC Communications' CP2000

voice and data inputs to be fully network compatible in the U.S. and internationally. Availability is planned for the last half of this year.

The system is a byte-interleaved multiplexer with an internal mini-DAX that will cross-connect up to 240 full-duplex DSOs (480 timeslots). The CP2000 can function as a CEPT-to-T-1 converter (in its simplest form). It can also provide direct interfaces to analog voice, low- or high-speed data, ADPCM voice compression and internal bridging for voice or video teleconferencing and point-to-multipoint data. It also offers a choice of three levels of network management. For more information, call (800) 322-3101, or (408) 982-1232 in California.

Hewlett-Packard announced five new manufacturing network products that conform to the MAP 3.0 specification for factory communications, and a high-performance VLSI technology that supports the seven layers of the OSI standard for multivendor network.

The first product HP announced was its MAP 3.0 MMS (manufacturing-message specification) software which provides an international, standards-based command language for programming MAP-compatible devices on the factory floor. The company also introduced MAP 3.0 FTAM (file transfer, access and management) software, which provides the ability to remotely transfer and access files across multiple computer systems.

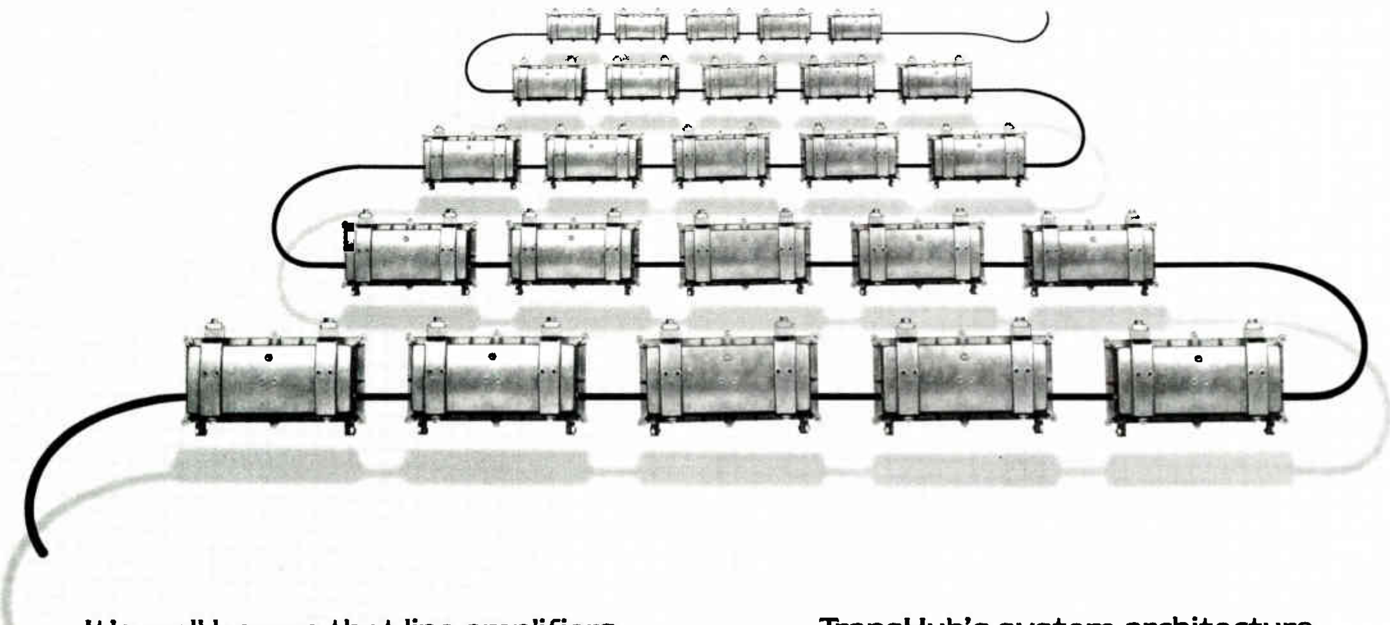
HP OSI Express MAP 3.0 is a high-performance interface that connects HP computers directly to the network via broadband or carrierband cabling, implementing the MAP portion of the OSI protocol. The company also introduced a new HP device-interface system which allows connection between any non-MAP, RS-232-C device and HP computers.

The fifth product HP introduced was the HP MAP 3.0 protocol analyzer, which decodes the seven layer OSI MAP protocol stack.

Agile Systems Inc. of Carrollton, Texas introduced a downloadable software option for its AgileNet Communication Units (ACU), AgileNet Broadband Interface Units and AgileNet Communication Cards.

—Greg Packer

NO SIGNAL SHOULD HAVE TO GO THROUGH ALL OF THIS



It's well known that line amplifiers directly diminish CATV signal quality. Yet today's cable distribution systems rely upon an architecture in which signals must pass through as many as 60 amplifiers before they reach a subscriber.

No signal should have to go through all of that.

Catel's TransHub fiber optic cable distribution system offers superior clarity, economy and flexibility while greatly reducing the number of amplifiers per cascade.

TransHub is an active multichannel audio and video processing hub combining fiber optic transmission and state-of-the-art signal processing techniques to increase systems capability and significantly reduce costs.

TransHub's system architecture effecively eliminates the number one problem associated with conventional cable television distribution systems: long casades of line amplifiers.

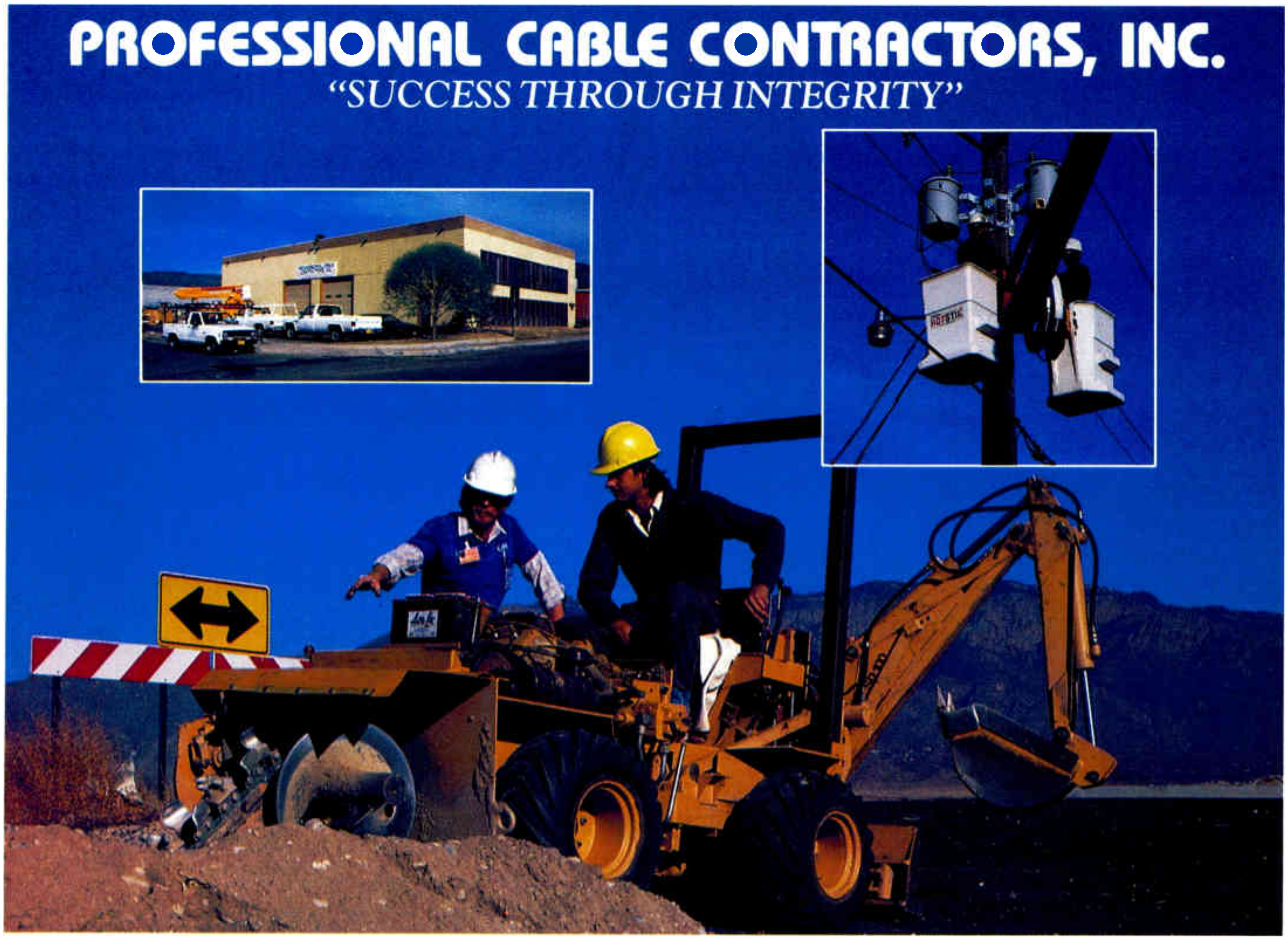
By reducing the number of amplifiers per cascade, TransHub allows the brilliant signal characteristics of glass fiber to extend "deeper" into distribution systems.

The TransHub marks the first step in an exciting evolution for the industry—an evolution that will eventually bring about total fiber-to-the-home cable systems.

When it comes to fiber optics for cable television, there's only one clear choice—Catel. Call Catel today at 1-800-225-4046 or (415) 659-8988 (in California).

CATEL
THE CLEAR CHOICE IN FIBER

Reader Service Number 43



In May of 1982, Professional Cable Contractors, Inc. was founded by Edmund J. and Rose Mary Pedersen as a sole-proprietorship.

In the first month of operation, a contract was successfully negotiated with Texas Cable Services of Dallas, Texas, for post and prewiring of apartment complexes in Dallas. During the period of May 1982 through June 1985, Professional Cable had completed contracts with Texas Cable Services of Dallas, Texas; Superior Cable of Phoenix, Arizona; and American Communications of Laurel Springs, New Jersey. Professional Cable is a full-service cable contractor doing both installation and new construction for Jones Intercable since June of 1985. In addition, new contracts now have been signed with Dimensional Cable of Casa Grande, Arizona, and Continental Cablevision of Jacksonville, Florida.

In 1984, Professional Cable, Inc., a division of E&R Pedersen, was incorporated in Arizona as a multi-state corporation. Today, Professional Cable has over 2 million dollars in sales, and 1 million dollars in assets. The formation and growth of this company is the culmination of hard work and dedication. Edmund, Rose Mary, and their staff will not accept anything less than the highest quality of work and business integrity, thus making their company motto...

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- Professional Cable has a full-time quality control staff, and we guarantee all of our work for 1 full year after completion.
- Everyone Professional Cable Contractors has done business for within our 5-year history would recommend our work:

ACI Communications, Laurel Springs, NJ
Jones Intercable, Albuquerque, NM System
Jones Intercable, Tucson, AZ System
Empire Communications, Albuquerque, NM
Dimensional Cable, Casa Grande, AZ

- Professional Cable maintains an in-house training program, and is always prepared to promote from within. Professional Cable has the ability to establish an office in a new location with minimal delay.

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Reader Service Number 44

Rural cable system technical operations

Our first two articles in this series (*Rural Cable System Headends*, May 1988, p.78; and *Rural Cable System Design and Construction*, June 1988, p.76), described technical and operational inspections of about 120 small, rural cable systems our firm conducted during 1987.

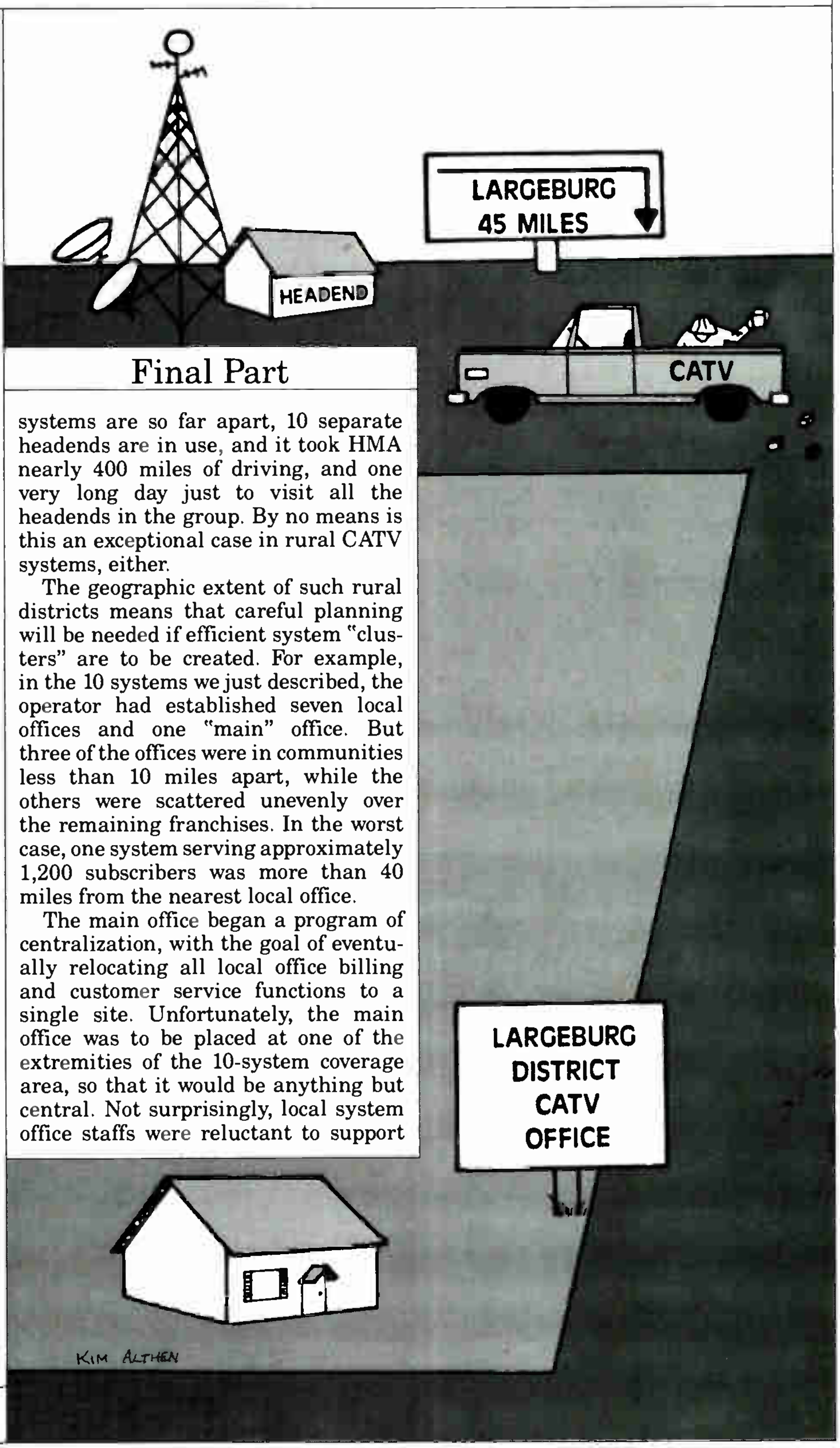
As we found in the headends and plant, rural system technical operations key on low-cost approaches. But low-cost approaches can also be cost-effective approaches, if these are carefully tailored to the market area to be served. The idea here is to determine what basic system technical needs are to be met and to develop a plan for accomplishing these that will make optimum use of limited staff and equipment. And while that last sentence may seem simple in concept, it often seems to be difficult in practice.

Coverage areas and clustering

Rural cable systems, serving areas with low household densities, generally cover broad areas. A logical plan would be to develop clusters of these systems so that economies of scale can develop, similar to those found in more densely populated areas. But when clusters of several rural systems are formed, the geographic spread of the operation can be difficult for the urban or suburban system operator to comprehend. To illustrate this difference, the United Artists Cablesystems Corp. system that serves the northern New Jersey suburbs, includes more than 50 franchised municipalities and portions of four counties. The 150,000 or so UACC-NJ subscribers are located in an area approximately 25 miles long by 15 miles wide at its boundaries, so that the system averages well over 400 subscribers per square mile. This entire system is efficiently served by a single master headend and seven AML hubs.

In contrast, a group of 12 rural cable franchises HMA visited in one midwestern state serves about 12,000 subscribers in an area about 100 miles long by 60 miles wide, giving an overall density of about *two* subscribers per square mile. Because the individual systems are so far apart, 10 separate headends are in use, and it took HMA nearly 400 miles of driving, and one very long day just to visit all the headends in the group. By no means is this an exceptional case in rural CATV systems, either.

By Alan Hahn, president, Hickory Mountain Assoc.



Final Part

The geographic extent of such rural districts means that careful planning will be needed if efficient system "clusters" are to be created. For example, in the 10 systems we just described, the operator had established seven local offices and one "main" office. But three of the offices were in communities less than 10 miles apart, while the others were scattered unevenly over the remaining franchises. In the worst case, one system serving approximately 1,200 subscribers was more than 40 miles from the nearest local office.

The main office began a program of centralization, with the goal of eventually relocating all local office billing and customer service functions to a single site. Unfortunately, the main office was to be placed at one of the extremities of the 10-system coverage area, so that it would be anything but central. Not surprisingly, local system office staffs were reluctant to support

As rural systems are clustered to gain operational efficiencies, service vehicle usage can rapidly get out of hand.

the "central main office" concept, especially since spare parts stocks and technical dispatch functions would then have to be relocated as far as 90 miles from the systems needing them.

Centralized billing and service dispatching would create other problems as well. For example, subscribers found that what were formerly local phone calls to the system office had now become toll calls to another town many miles away. The main office manager "solved" this problem by establishing a toll-free "800" phone line, but then found that his 12,000-subscriber base rapidly overwhelmed it, especially when trouble call volume grew during major outages. Adding to this communications logjam was the fact that no service or maintenance vehicles had (as yet) been equipped with two-way radios.

A better approach is to do a more thorough analysis in the first place, and to determine the most readily accessible "centers of gravity" in the area to be served. And this accessibility should not be limited to vehicles only—access by phone must be equally good for any centralization plan to work. Then, the logistics of the moves must be laid out and discussed with local system staffs so they may provide valuable input to the centralization process. And, finally, if large-scale centralizations are proposed, efficient use of technical staff will almost certainly require two-way radio-equipped vehicles.

As rural systems are clustered to gain operational efficiencies, service vehicle usage can rapidly get out of hand unless technician productivities and service areas are well-matched. For example, the operator of one Midwestern system cluster had a rule of thumb that each service technician could (or should) service 1,200 subscribers. And the operator employed this rule relentlessly, too, so that his most heroic technician was required to cover literally hundreds of the most sparsely-populated square miles in the overall service area, in order to accumulate his 1,200 subs! Of course, our overworked service technician could either try to carry out his impossible assignment, or he could leave. You can guess which path he chose.

The point is that rural clusters require *extremely* careful planning of service technician coverage areas. System operator's rules of thumb, based on numbers of subscribers per service technician, or numbers of miles of plant per maintenance technician, were generally developed for relatively dense, compact suburban areas. Those rules must be requalified and modified for sparsely populated and widely separated rural systems.

Rural systems will always be relatively remote from "guaranteed-overnight-delivery" population centers. This means that major system spares

Major system spares should be stocked to higher levels than might be appropriate near central cities.

(i.e., power supplies, trunk, bridger and line extender modules, and headend gear) should be stocked to higher levels than might be appropriate near central cities. Redundant (i.e., frequency agile) headend spares, on-site and ready for use, are a very good idea. Slightly degraded pictures on one particular channel will always be preferable to none at all, especially if the condition lasts for several days.

In general, then, rural system technical operations can be effectively clustered if careful attention is given to defining realistic service areas within the cluster; developing a detailed plan for centralizing administrative functions; providing enhanced radio and telephone communications to support these centralized functions; obtaining appropriate spare parts stocks to support the systems to be served; and (always) involving the local system staffs in developing the centralization plan.

Technicians and test equipment

In rural areas, it will often be a much simpler task to purchase electronic test equipment than it will be to find qualified technical personnel to operate it. Although technician training is always a problem in CATV operations, in the sparsely-populated rural areas it is even more severe. Nevertheless, some of the rural systems we visited did have excellent technical staffs, but we found that nearly all of these systems had, at best, only the most rudimentary test equipment, and usually very little of that.

This really surprised us, since so many of these systems were involved in electronic upgrades to varying degrees. In one system we visited, a major electronic refit had increased operating bandwidth from 216 MHz to 300 MHz. When HMA examined signal levels at the end of the longest cascade with a modern 450 MHz signal level meter, the local chief technician asked if he could have a copy of our data. It seemed that he had been required to upgrade and maintain what had been a 21-channel system and now had become a 35-channel system, with an outdated, split-band 12-channel signal level meter! He told us that he had always wanted to know "how channel J and the others up there were doing!" Surprisingly, they all looked pretty good.

It goes without saying that this technician had little other test equipment at his disposal. He had nothing that would assist him in resolving headend reception, interference, or distortion problems; no system sweep equipment; no signal leakage detection equipment; and no means of verifying plant grounding. Naturally, his task will become much more challenging in the future (after addressable converters are added to this system, it had been proposed that he be promoted to chief technician for the entire seven-

We found serious inconsistencies in the skill levels of the technical support staffs from system to system.

system district).

Sadly, this story was repeated over and over, with only minor variations, in many of the rural system clusters we visited. The general rule seemed to be to utilize the barest minimum of test equipment, with either little or no calibration, to maintain what are becoming increasingly complicated networks. We understand that the new owners of many of these systems are investing heavily to correct these deficiencies, and of course HMA has visited only about 6 percent of all the rural systems in the U.S. But if the other 94 percent are similar, we hope that the test equipment salesmen will head for the rural areas to everyone's benefit.

As new owners form centralized clusters of rural systems, some opportunities arise to use automated, remotely-controlled test equipment to very good advantage. For example, many pieces of system test equipment available now may be remotely commanded, by radio or phone line, to report their readings via standard (RS-232 or similar) data interfaces. This is not new technology, to be sure, but it is a far cry from the obsolete split-band SLM we described earlier. Remote headends and the end points of long rural system cascades can really be cost-effective places for remote-controlled monitoring technology. Interestingly enough, we saw little or no evidence that rural system owners had considered such approaches, despite high technician workloads and excessive truck mileage.

Just as the need for more and better test equipment characterized most of the rural systems HMA visited, we found serious inconsistencies in the skill levels of the technical support staffs from system to system. Technician experience levels were unfortunately usually on the low side, and this, coupled with the lack of adequate test equipment, often resulted in simple system problems compounding into major ones.

One example, from another Midwestern location, involved a cracked trunk cable and resulting signal ingress into a system serving a village of about 350 homes. Since the village was fairly remote from nearly all TV broadcast stations, subscriber penetrations were very high. The company boasted nearly 300 subscribers in this village, and it turned out that the ingress problem affected most of the town, so that isolating it should not have been difficult. But the lack of technician experience, and a total lack of suitable test equipment (not that much should have been needed) caused this problem to remain unresolved for nearly two months, during which time approximately 15 percent of the subscribers disconnected in disgust. At the time of our visit, the local area manager was trying to decide how best to "re-market" systems which had experienced problems like this. We told him to examine the technical staff first, and to make plans to introduce signal leakage detection equipment as soon as possible.

In another case, the local system technician knew what to do, but all his repair parts and support equipment seemed to be in the wrong places. He began his day by investigating what proved to be a signal suck-out problem in a town about 40 miles from the area office. Arriving on the scene, he found that subscribers' addressable converters would not descramble signals, although his converter would do so at the headend. The subcarrier bearing the address information seemed to be at its normal level. The technician decided that his next step would be to connect a converter and TV set at successive points downstream from the headend until the problem reappeared. So far, so good.

But the technician's truck had no AC generator, as was typical of all service vehicles in this district. So back to the area office he came (40 miles) and, with a portable AC generator now on board, back he drove (40 more miles) to the troubled system. By now it was time for lunch (I'm not making this up) and, after a suitable break, our man went into action with converter, TV set and AC power source. Although it still seems a little unlikely, the problem was eventually traced to a bad splice. When this was repaired, all the addressing and descrambling problems were corrected. But now (you guessed it) our man had to return the AC generator to the area office. When this was done, he had driven 160 miles, taken up six hours and solved but one system problem. Probably the worst of it was that this happened while we were "technically evaluating" these systems!

The last major complication we found in rural systems concerned recordkeeping—especally system mapping. In far too many cases, system maps were inaccurate or nonexistent. How some of these systems had been "upgraded" we'll never know, but the results, out at the end of the line, often showed that something had been missed.

Our advice to the rural system operator is simple. If you have not already done so, provide yourself with accurate system maps, equipment lists, inventories and other pertinent records. Your prospective system purchaser will need these, and we have seen more "deal-closing complications" arising from these categories than we can count.

We are well aware of the time, staff and financial constraints faced by the rural system operator and we make no quarrel with the difficulty he experiences in balancing all these factors. On the other hand, his property will be valued partly by the condition it is in, and by the costs of keeping it in that condition. Where systems are being upgraded, maintenance and service capabilities must increase to match the increased bandwidth now available. While 12-channel systems could not interfere with aeronautical radios, for example, the addition of mid-band channels creates an entirely different situation.

We found that many rural operators did not seem to realize this, and their scanty arrays of electronic test equipment certainly showed it. The need for full CLI compliance in 1990 is just around the corner. Selling the system only highlights the problem, and the new purchaser will have to discount the value of potentially non-compliant property.

In summary, if you plan to cluster, or to sell, your "upgraded" rural systems, we hope this series of articles has provided a useful punchlist for you. Much of the difference between the $1,250 per subscriber rural system and the $1,950 per subscriber rural system should be found in the articles you have read. ■

GREAT NEWS FOR BROADBAND LOCAL AREA NETWORK OPERATORS!

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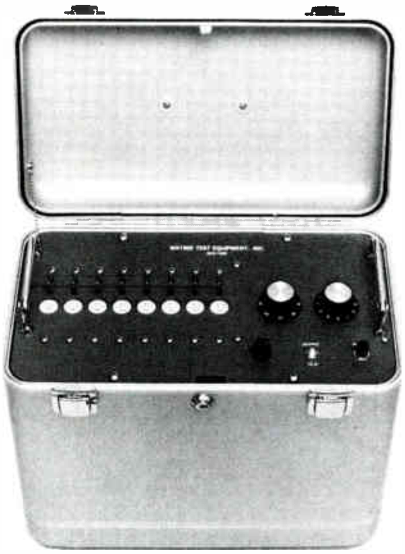

Model PSX-6

The Model PSX-6 Multiple Frequency Signal Generator is an ideal addition to every Broadband LAN. Providing a distortion-free signal source, the Model PSX-6 can be used to set-up, maintain, and repair any Broadband LAN.

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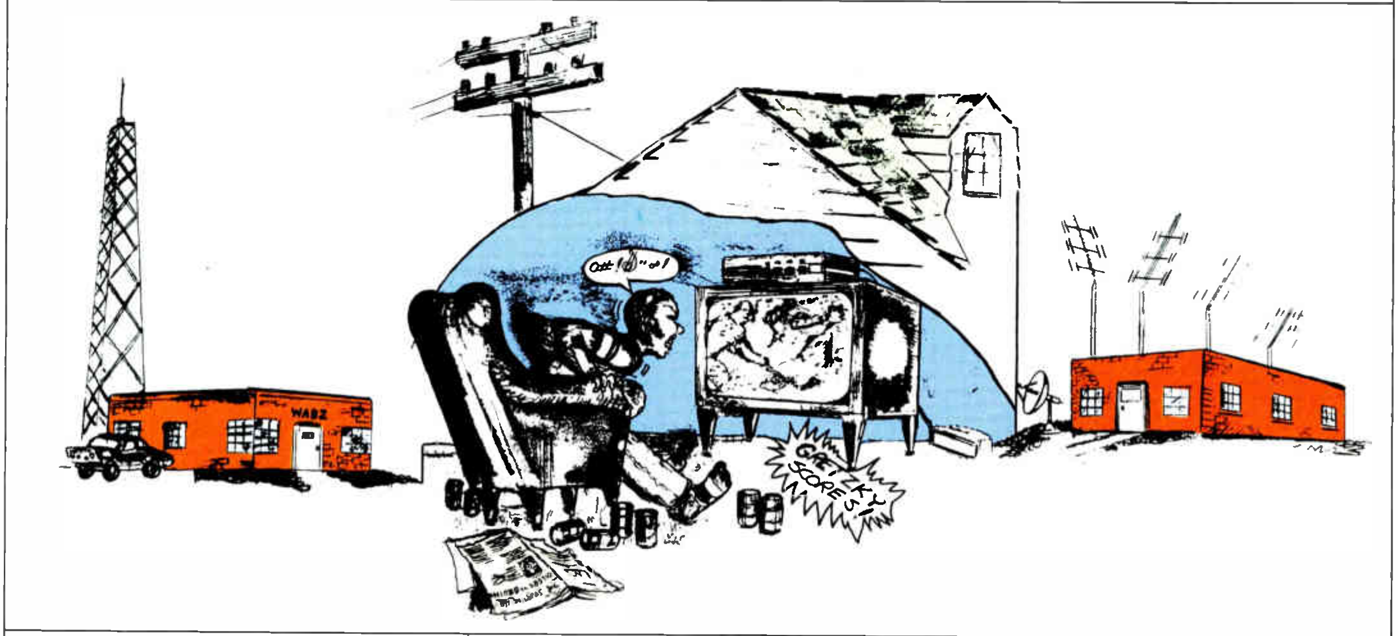
Reader Service Number 48

Curing off-air interference from adjacent channels



This series of articles shows how to diagnose problems and apply the appropriate filters in three types of situations: off-air interference from a number of radio services, premium channel security and ancillary filtering of operating equipment to cure malfunction or to reduce noise.

Pre-amp or processor overload

Reception of a desired FM or TV channel is often degraded by a strong adjacent channel. The symptom is usually a snowy picture similar to that seen when receiving a weak or "faraway" signal (or noisy audio for FM). The pre-amp or processor front end is biased by the strong, adjacent signal and loses the ability to amplify other signals, including the desired channel.

FM/FM overload

FM/FM overload is defined as the condition of a strong FM channel interfering with the reception of a desired FM channel. Where the two stations (desired and interfering) are separated by at least 2 MHz, the solution is simple: trap the interfering channel. Some manufacturers of low cost pay-TV negative traps will specially tune one of these to the offending FM channel frequency. Characteristically, they will notch the interference about 60 dB and have a bandwidth of about 4 MHz. Hence, if the two FM channels are separated by at least 2 MHz, the desired channel will suffer only minor attenuation from the trap. If the frequency of the offending channel is not precisely known, a commercially available tunable trap can be used, and experimentally tuned until the interference disappears.

If the frequency separation of the two FM channels is closer, this type trap may give too much loss to the desired channel and it may be necessary to procure a very narrowband cavity type trap. Because these are usually custom made, they tend to be expensive.

If there are several strong FM stations impacting the desired channel, both above and below and closer than about 2 MHz, it may be necessary to isolate the desired channel by bandpassing it with a very sharp FM bandpass filter.

In the extreme case of "next channel" interference—the desired and interfering channel separated by only 200 kHz—none of the above filter schemes is feasible and one must resort to the "phasor," or phase cancellation method.

In this scheme, a second FM antenna is used to capture an independent sample of the interference with which to cancel the original interference on the master antenna. The acquired sample is passed through a "phasor"—a series combination of variable phase shifter and attenuator—and then inserted into the downlead of the master antenna. The controls on the "phasor" are adjusted until the interference disappears. At the proper settings, the amplitude of the acquired sample is equal to the original interference and its phase is 180 degrees different. The two interfering signals cancel one another out at the pre-amp or processor. Since these have identical modulation envelopes, nothing is "left over" to degrade the desired signal.

This method works best if there is a reasonable difference of pointing angles of the two antennas. Otherwise the "test" antenna may pick up a significant amount of the desired signal and, in the process of phasing out the undesired signal, total strength of the desired signal may also be reduced. A separation of 30 degrees or greater is usually suitable, although quite frequently the method works well on smaller angles. The two antennas should have different elevations, about 10 feet or greater, to avoid antenna-to-

By Glyn Bostick, president, Microwave Filter Co. Inc.

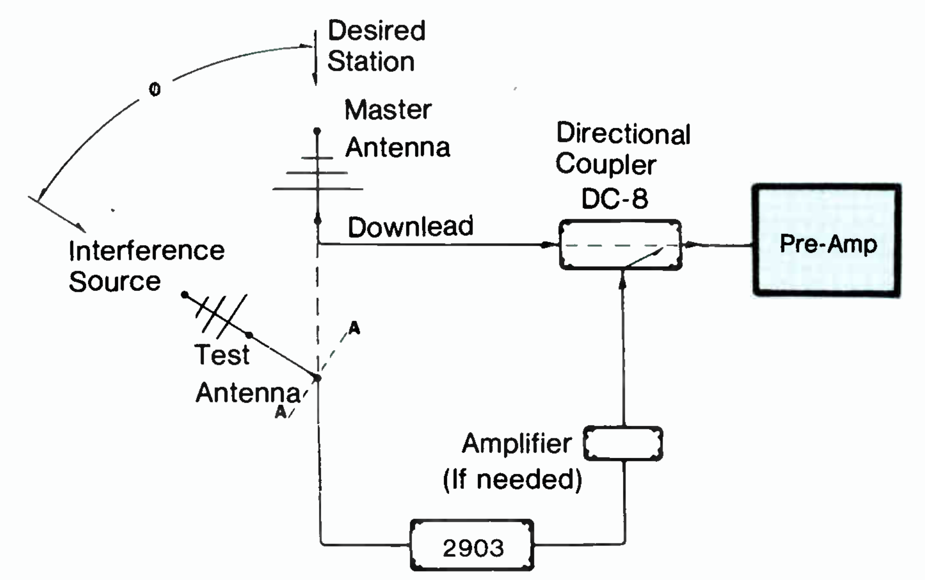
Where no FM reception is desired, the solution is simple: trap the entire FM band with an FM band trap.

antenna coupling. Headend installation of the phasor is advised, to allow "tweaking" the controls to compensate for occasional changes in arrival angle as weather conditions change.

FM/TV overload

Although strong FM has been known to cause overload to all TV channels, it usually occurs on channel 6—the channel closest in frequency to the FM band.

FIGURE 1



Where no FM reception is desired, the solution is simple: trap the entire FM band with an FM band trap. These are available in a small, weatherized tube from most manufacturers of pay-TV video and tiering traps. These traps typically suppress the commercial FM band (92 MHz to 107 MHz) 50 dB or more.

Where the offending FM channel is in the 88 MHz to 92 MHz segment of the FM band, or where selected FM channels must be received, one of the trapping schemes described above (under FM/FM overload) should be used.

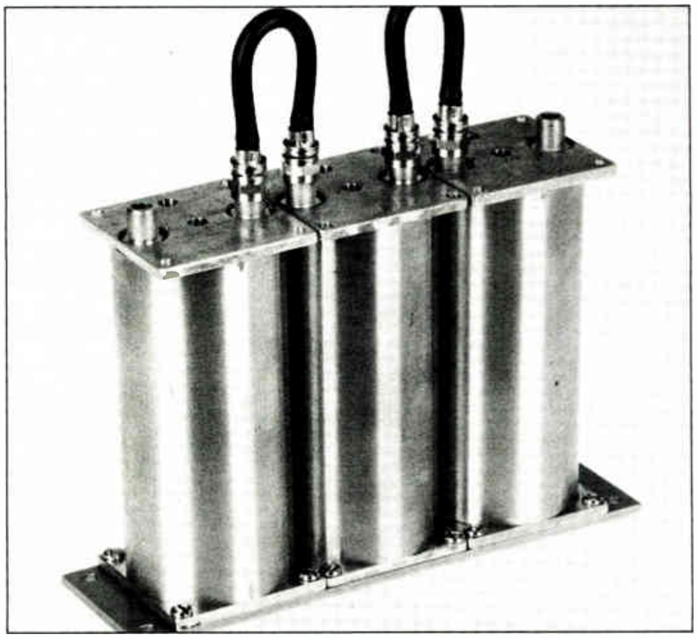
TV/TV overload

Here a strong, unwanted TV channel is degrading reception of an adjacent, desired TV channel whose signal is weak. This often occurs when trying to bring in a desired, far-away channel and there is a strong, adjacent channel broadcasting locally.

The adjacent signal doing the damage is usually the video carrier which is transmitted at higher power than the audio carrier. The solution is often very simple: insert a pay-TV negative trap corresponding to the offending channel between antenna and pre-amp (or processor, if there is no pre-amp). This works well for all off-air channels if the offending channel is below the desired one: the trap gives little loss to the desired video carrier. If the offending channel is above the desired one, such traps will attenuate the desired audio carrier. This is usually tolerable for lowband channels (2 through 6).

However, pay-TV negative traps have wider bandwidth the higher the channel frequency and too much audio loss might be experienced for the high band channels (7 through 13). But this low-cost approach works in many cases even for the high band and should be tried before considering more expensive solutions. If this approach doesn't work because of excessive loss of audio of the desired channel, a selective channel bandpass filter should be substituted for the trap. A number of filter manufacturers produce channel bandpass filters with at least 30 dB suppression on the offending upper video.

Co-channel interference is caused by the reception of two TV programs on the same channel, one local and the other distant. Because their frequencies are identical, this interference cannot be removed by conventional filters. In this case the phasor method works quite well in most cases.



Notch filters used for adjacent FM stations

Placement for best effect

In all cases, filters for curing overload should be placed ahead of "first electronics"—the pre-amplifier or ahead of the processor if there is no pre-amplifier. Filters placed further down the line will have no effect on the overload condition. ■

The next article will discuss cures for off-air interference from other radio services, such as amateur radio, paging and mobile radio.

CATV and LAN ingress management

Ingress, as applied to broadband communication systems such as MATV, CATV and LAN networks, is customarily defined as the intrusion of signals into a closed distribution system from the electromagnetic environment surrounding the electronic distribution plant. Generally speaking this phenomenon results from insufficient shielding integrity. Experience has shown that the sources of shielding flaws are numerous and sometimes surprising. Given that there are shielding flaws in the plant, how does one minimize these flaws, and how are they detected and remedied as they occur?

It is generally accepted that the ingress problem is more serious in the upstream portion of the typical trunk/branch coaxial network due to the architecture which adds the system ingress from all potential ingress sources throughout the plant. However, it is not the only means by which the ingress problem affects the typical distribution system. This writer has seen many instances where the downstream carriage was seriously degraded by ingress due to the frequency allocation and power of a high powered transmitter in the outside environment. By example, the distribution system may pass quite close to high powered FM transmitters, requiring very high shielding integrity in the plant to avoid signal degradation.

While downstream ingress is important, for the moment, consider the upstream portion of the network only. Experience has shown that for most tree/branch networks, the majority of the system shielding flaws are to be found in the system boundary beyond the trunk/bridger ports due to the larger number of possible shielding flaws. A variety of schemes have been proposed to deal with this problem, some for protection from and others for detection of unwanted ingress signals.

For protection, opening the system circuit at the bridger ports except when data is being transmitted or activating a pad in each individual bridger system path where the upstream signal is connected into the trunk has been used with some success. While such schemes do work, and are a useful adjunct to the system upstream maintenance, they do not deal with the principal problem, that of localization of the loss of shielding integrity.

By Warren Braun, P.E., ComSonics Inc.

A simple method to detect shielding integrity flaws uses two technicians, one to patrol the system, keying a transmitter such as a Citizen's Band while the second individual looks for the presence of this signal in the system's components at the "headend" reverse signaling path terminus. However, this method of detection does not allow for accurate quantification or specific localization of the ingress source.

Although both methods serve their purpose, the constant threat of shielding integrity loss has brought about the development of more aggressive preventive techniques. One such technique incorporates selective bandpass switching filters in the bridger and trunk ports. While these minimize the effect of the ingress problem by reducing the frequency range to be transmitted at any particular moment in time, it seriously decreases the available bandwidth on a continuing basis.

In view of the limitations of the various schemes discussed, the author's firm developed a specialized upstream architecture which separates the system return signaling into separate, discrete return trunks for each 2,500 subscriber terminals (approximately 10 miles of plant). This system is called "segmented return" and has a substantial advantage of breaking the return network into optimally sized circuits which signals are then returned on a common "return only" trunk. The author's staff developed this system concept after determining that approximately 10 miles of return plant or 2,500 subscribers represented the optimum compromise of ingress management. These numbers were based upon actual field experience. In ComSonics' patent 4,494,138, a further refinement of this concept is described, reducing the need for multiple return cables and greatly enhancing network reliability.

However worthwhile these system management techniques may be, they fail to provide a simple, direct system of monitoring ingress. The author is indebted to Jim Wright, former chief engineer of the Rockford, Ill. cable TV system who discovered there was an excellent correlation between ingress and egress in the typical system. His technique needed roughly half an order of magnitude greater testing sensitivity for proper results than was currently being used for such detection. In this concept, one monitors the system egress (radiation) and for each system radiation location there will be a matching ingress point. This is based upon the general theory behind the "Bethe Hole" coupler concept[1] which is well understood and developed.

Although it can be successfully argued that upstream and downstream system shielding integrity flaws are in a different frequency range, it is also true that all shielding flaws tend to be remarkably similar over a wide frequency range from 5 MHz to 400 MHz notwithstanding the occasional "trapping" phenomenon. This author's firm has conducted long-term, detailed analysis of connector/cable integrity[2] which prove the similarity of connector/cable integrity flaws over a considerable frequency span.

It should therefore be possible to determine the upstream system ingress susceptibility by monitoring the downstream system egress (radiation). Field tests have shown that in the vast preponderance of cases this is true, with one major exception, the measuring system sensitivity required to make this a truly viable concept. That exception is a system monitoring sensitivity which is to be adjusted to 5 μV/m as opposed to 20 μV/m required for FCC compliance in the radiation testing. Achieving this increased tangential sensitivity requires a more sophisticated receiver than would be required of the usual communications devices. Such devices are available[3] with the appropriate sensitivity. Utilizing this device, coupled with appropriate system signal sources, provides an effective, rapid method of system ingress location and quantification by monitoring the system egress. More will be said of the implementation of this methodology later.

Making the initial measurements of system ingress using this technique can be quite frustrating if insufficient care has been taken in its initial design. By example, drop cable of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Special attention must be paid to the type of 'end-of-line' devices connected to the system.

marginal shielding integrity simply will not yield the required ingress isolation. Unfortunately this may be true at the ingress frequencies while the shielding integrity may be adequate at the downstream carriage frequencies. This is particularly true of systems which use sub-low return for reverse carriage. At the very minimum the drop cable in such a situation should be of dual shielded (or better) format. An excellent paper by Ken Smith[4] covers the required format for achieving the requisite shielding integrity.

Cable composition is just part of the equation; the proper connectors must be used at all points in the system. Obviously the mechanical makeup of connectors must be such as to provide the required initial integrity with the appropriate tightening of all connectors within manufacturers prescribed torque limits. If the system is located in an outdoor environment, all such connections should be sealed with shrink sleeves to assure longevity of the connector integrity.

Special attention must be paid to the type of "end-of-line" devices connected to the system. For instance, monitors or receivers with marginal shielding integrity can pose severe shielding integrity loss problems, as can inadequately shielded transponding devices in LAN networks. Obviously the radiation testing method described in this paper will quickly ferret out such marginal shielding integrity problems.

As to the detailed system flaw analysis, one assumes that the technician has the appropriate shielding integrity monitoring apparatus previously described and has a far field (dipole or monopole) aperture, which is then used to locate the gross areas of signal leakage. When such leakage areas have been found, the "antenna" must then be switched to a "near field" (special magnetic or electrostatic field) probe to locate the actual leakage source. With minimum experience it is possible to locate which of four ports on a four-way tap are leaking using this technique.

At the time of the original proof of performance both of these techniques can be used to help isolate poor system installation practices and the resulting ingress problems before the plant is placed in use. ■

[1]H.A. Bethe, Cornell University, "Theory of Diffraction by Small Holes," *Physical Review*, October 1944
[2]W.L. Braun, ComSonics Inc., "A Reliable and Reproducible Technique for Evaluating the Shielding Effectiveness of CATV Apparatus," 1978 NCTA Convention paper, p.99.
[3]ComSonics Sniffer III System, by example.
[4]Kenneth L. Smith, "Drop Cable RF Leakage Throughout 20 Years of Service," NCTA paper 1981.

New satellite receiving equipment unveiled by Pico Macom, Antenna Tech

Pico Macom's CR-2000 receiver

A new C-/Ku-band satellite receiver has been developed by **Pico Macom**. Model CR-2000 features switchable IF bandpass from 30 MHz to 22 MHz to help reduce terrestrial interference, dual aduio for stereo or subcarrier operation and phase lock loop digital tuning in a small, rack-mountable housing.

The unit also sports switchable AFC and fine tuning and is also descrambler compatible and works with all 950 to 1450 MHz LNBs. For information, call (800) 421-6511; in California, (818) 897-0028.

Antenna Technology Corp. has introduced a new 70-degree capture angle Simulsat satellite antenna. The new dish can receive up to 35 C-band and Ku-band satellites, simultaneously, from Spacenet 2 to Satcom 1R. Previously, the Simulsat was limited to viewing only 25 satellites at the same time.

The new antenna eliminates the need for an antenna farm or a steerable antenna. Call (602) 264-7275 for details.

A new message generator developed by **Multiplex Technology** will overlay time, date and changing and/or fixed text on any video picture. The new Channelplus Genlock Message Generator, Model GLM-1.00 consists of keyboard, computer and software that utilizes on-screen prompts for ease of use.

Text can be overlayed onto video from any video source, including cameras, satellite receivers, VCRs, computers and laser disc players. It also accepts inputs from one or two video sources. Messages can be programmed to appear at preselected times and intervals. The unit is priced at $660. For info, call (800) 423-0584; in California, (714) 680-5848.

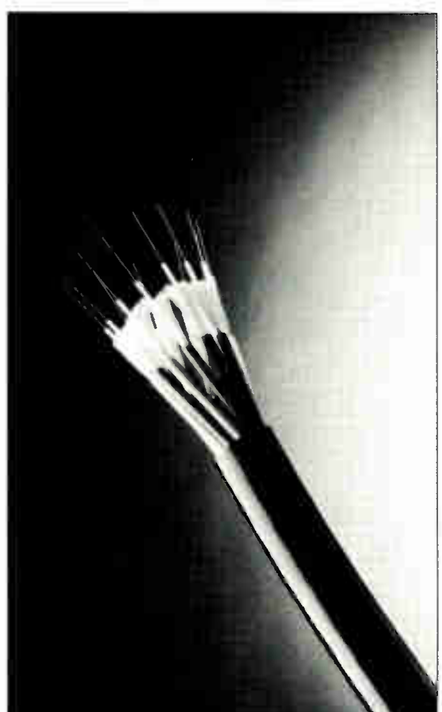
New filters have been developed by **Microwave Filter Co.** The Model 6024 is used on television translators to notch out intermodulation carriers. It features a 15 dB minimum notch at 760.75 MHz and 774.25 MHz. Passband is 764 MHz to 770 MHz. Price is $950.

Also, Microwave Filter's new 3378-66/74 highpass filter allows systems to delete channels 2 and 3 to reinsert new programming. For information about any of these products, call (315) 437-3953.

Field equipment

Master Bond has a new low viscosity flexible UV curable casting and bonding compound, called UV10FL. The single component system requires no mixing and cures quickly under UV light. For details, call (201) 343-8983.

A hydraulic Pole-Heister designed to remove utility poles with a minimum of manual effort has been developed by **General Machine Products**



OCC's new breakout cable

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Co. The Pole-Heister provides up to 42,400 lbs. of hydraulic pulling force. The heavy-duty piston's exclusive inverted design keeps it clear of the pole and pulling chain at all times. Unlike conventional pullers, the body, not the piston, moves upward to raise the pole.

To remove a pole, the user positions the long edge of the base as close to the pole as possible, puts the hydraulic unit on top and wraps a chain around the pole. The self-aligning action of the foot and mating body hinge compensates for sloping terrain. For info, call (215) 357-5500.

A new line of crimping tools is being offered by **Nemal Electronics International**. The tools offer full cycle ratchet operation with machined dies and combine multiple hex sizes in a single fixed die. For information, call (305) 893-3924.

Optical Cable Corp. is now manufacturing UL-listed type OFNR B-series breakout riser cables with up to 50 fibers. The National Electrical Code now requires type OFNR cables for use in building risers.

The cables are designed for applications requiring a fiber run from an upper floor of one building to an upper floor in another building. They can be used outdoors as well as indoors, which eliminates the need for splicing. For info, call (703) 389-9900.

Subscriber products

A new set-top converter which offers

Continued on page 83

Product Showcase

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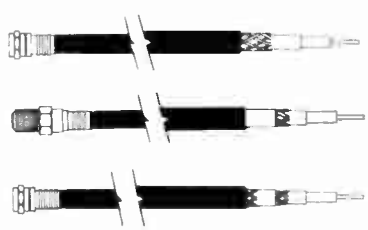

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Circle 62

Long Systems Inc. has released version 1.2 of its Leakage Evaluation System software.

Continued from page 79
133-channel tuning and includes a separate input for a home UHF antenna is available from **Qintar**. Model CV-133S features a remote control unit which performs volume up/down and mute functions; includes favorite 12-channel memory, RF channel 3 or 4 output and baseband audio and video outputs.

Other remote features include TV on/off, channel up/down, fine tuning, last channel recall and cable/antenna select. For details, call (800) 252-7889 or (805) 523-1400.

Test equipment

Long Systems Inc. has released version 1.2 of its Leakage Evaluation System software. The new release allows cable operators to select which leaks to repair and calculate the new Cumulative Leakage Index before actually repairing the leaks.

The software also converts dBm, dBmV, or µV to µV/m upon data entry; features expanded reporting capability and optionally tells which leaks must be fixed in order to meet CLI compliance standards. A version of the software is also now available for the Apple Macintosh. Call (619) 530-1926 for information.

A new hand-held test instrument with the capabilities of five different instruments has been unveiled by **B&K-Precision**. Called the Test Bench, the model 388-HD is a 41-range voltmeter/ammeter/ohmmeter that also is a frequency counter, tests capacitance, logic, continuity, transistors and diodes.

The tester features an LCD display, reverse polarity protection, overload protection ans is priced at $139. Call (312) 889-1448.

A new digitizing oscilloscope was introduced by **Hewlett-Packard Co.** The HP 54501A is HP's first low-cost general purpose scope. Features include autoscale, 16 automatic pulse-parameter measurements, advanced logic-triggering capability, hardcopy output and HP-IB (IEEE-488) interface for programmable data acquisition and control. The unit is priced at $3,465. For info, call your local HP dealer.


HP 54501A oscilloscope

Leader Instruments Corp. has developed a video level meter designed for complex and high-volume measurements and documentation needs. The LVM-9042A can be preset for up to 100 test conditions that address arbitrarily preset locations within the video frame

Faroudja Laboratories will test its SuperNTSC system on two TCI cable systems in California.

and readout and store measurements of sync and burst levels, luminance, chroma level and phase.

Test can be performed individually in the manual mode or through a menu-driven software program. Price is $9,500. Call (800) 645-5104; in New York, (516) 231-6900 for info.

A Super-VHS time base corrector has been developed by **FOR-A Corp.** The FA-300 corrects time base errors from S-VHS VTRs that interface Y/C 358 component signals as well as composite signals from ¾-inch and ½-inch heterodyne VTRs.

The Chromacor Y/C delay adjustment corrects horizontal color displacement and a sensitive auto chroma level circuit helps minimize color distortions during playback. For info, call (617) 244-3223.

People on the move

Daniel Karvonen has joined **Maratech Corp.** as president and CEO of Maratech Communications Companies. Karvonen comes from Wavecom Ltd.

Dan Moloney has been named director of product marketing for **Jerrold's Subscriber Systems Division**. His top priority will be to market products for interactive television. Moloney has held a variety of positions with General Instrument since 1983.

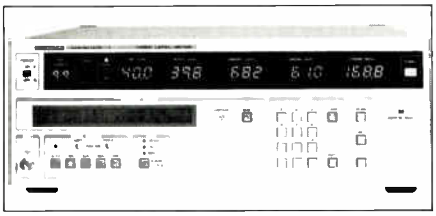
Texscan Instruments has announced two promotions. **Charles McLaughlin is now group manager-instrument products and R. Michael Richardson** has been named sales manager-instrument products.

Gerard Stoesser has been appointed sales manager for Leaming Industries. He was formerly employed at Pico Products and Oak Communications.

Nicholas Kapusta has joined **CATV Services Inc.** as part of the sales engineering force.

Three new sales representatives have been added by **Midwest CATV. Walt Van Lue** will relocate to Michigan and cover a several-state area in the Midwest; he comes to Midwest from Multimedia Cablevision in Edmond, Okla. **Mark Vawter** will join the Central Region's headquarters in Lafayette, Ind. as a telemarketer; he comes from Comcast Cable in Indianapolis. **Doug Huston** will join the Southern Region as a sales rep.

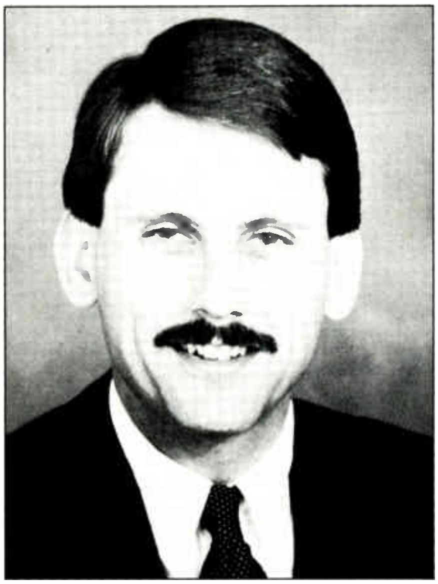
Three new positions were also announced by **ComSonics. Tom Jorgensen** has joined the firm as manager of sales and marketing; he comes from Sperry Marine. **Cindy Tasker** was named sales executive for the Northeast territory. And **Gary Wilson** will join the Midwest sales team as a sales executive.



LVM-9042A video level meter

Pioneer Communications has added **Mack Parkhill** to its sales staff as Mid-Atlantic account manager. He will be based in Columbus, Ohio. He comes to Pioneer from Channel Master.

Finally, **John Lay** has joined **CompuLink Systems** as a programmer. He comes to CompuLink from Channelmatic.



Dan Moloney

News briefs

Faroudja Laboratories will test its SuperNTSC system on two TCI cable systems in California this summer. The system, which improves NTSC pictures by combining pre-processing at the transmitter and post processing at the receiver, is entirely compatible with 6 MHz-wide NTSC signals. The tests will be undertaken under the auspices of the NCTA's Technical Advisory Committee on High Definition Television.

Pirelli Cable has formed a task force to introduce fiber optics-based systems to cable systems and local telcos. The force will focus strictly on the local loop, according to Pirelli officials. The effort will be headed by Michael Ricciardi, product manager, and Dean Bogert, systems engineering manager will provide technical support.

A new option has been added to the Matrix system, an off-premise addressable system developed by **Syrcuits International**. The additional protection option completely disables and disconnects a customer in the event of attempted bypass. This way, tampering with the unit results in a total shut-off of cable service.

In late May, **RMS International** announced its intent to acquire Eastern International. Those talks have since broken off and the acquisition decision has been terminated.

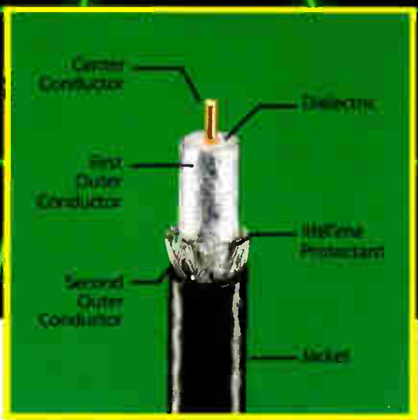
Pico Products settled its litigation with Eagle Comtronics. Eagle paid past royalties in the amount of $550,000 to Pico. Additionally, Pico granted Eagle a license to manufacture and market certain pay TV security products.

dB Associates has organized an advisory board consisting of the following persons: Wendell Bailey, VP Science and Technology, NCTA; Ken Gunter, executive VP, Columbia International; Fred Kaiser, president, Alpha Technologies; Gary Kim, publisher, *CED* magazine; Bob Luff, group VP/technology, Jones Intercable; Ellen J. Myers, Ph.D., peak performance counselor; Shellie Rosser, VP, new business development, Anixter Manufacturing; and Don Sutton, director Mind Extension University, Jones Intercable.

Digitrace has entered the converter parts manufacturing business.

Nexus Engineering has extended its two-year warranty to five years for all Series 1 and Series 5 products.

—Roger Brown



A cutaway of lifeTime cable.

More than three quarters of all signal leakage can be traced back to drop cable problems. Allowing RF energy to escape into the atmosphere not only can incur financial penalties from the FCC, but also degrades customer picture quality. New regulations concerning system radiation have been passed and will be in force by July, 1990. The CLI rules have been legislated in order to protect aircraft navigational and emergency airwave systems from disruption. Environmental interference from cable systems must be controlled.

Most signal leakage occurs due to poor shielding, faulty connections, and improper handling or installation of drop cable. An important step in assuring system integrity is specifying the best drop cable available. That is Times Fiber Communications' T4 drop with the exclusive protectant, lifeTime.™ lifeTime increases the capability of the cable to endure the rigors of handling and to remain operative within temperature extremes. Its protection against corrosion caused by moisture extends cable life and vastly reduces signal leakage. T4 drop cable's lifeTime protectant enhances connection reliability, which decreases the incidence of connector related RF interference.

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