CED

Special Pull-out: 1992-93 CATV Frequency Chart

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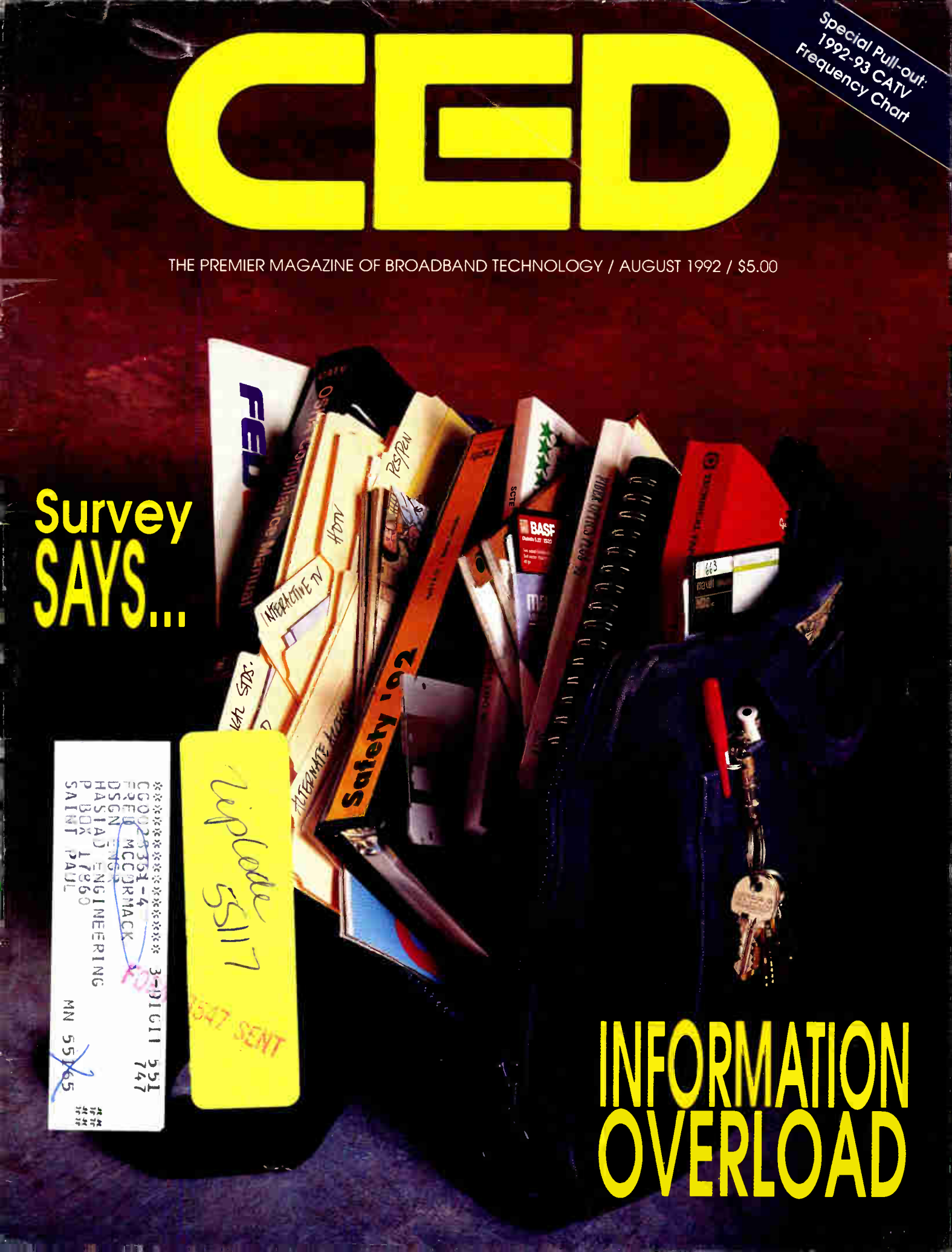

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August 1992

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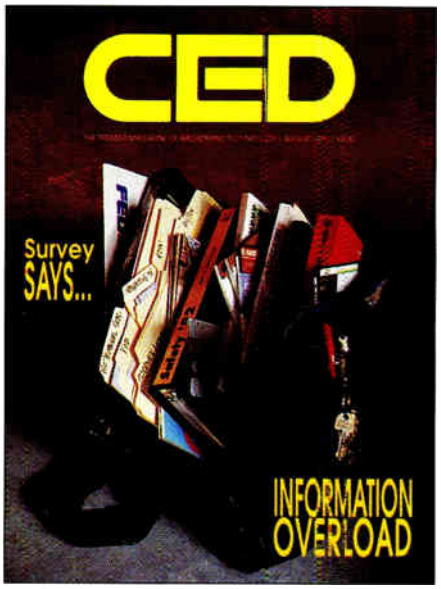
Volume 18, Number 9

CED. (USPS 330-510) (ISSN 1044-2871) is published monthly except twice in May by Diversified Publishing Group, a Division of Capital Cities Media, Inc., 825 7th Ave., New York, NY 10019. ©August 1992, Volume 18, Number 9. U.S. domestic subscriptions are $48. Outside USA, subscriptions are $69 for surface delivery or $96 for air speed delivery, prepaid in U.S. funds drawn on a U.S. branch bank. Second-class postage paid at New York, NY 10019 and additional mailing offices. CED is published on behalf of the cable television and broadband communications industries. POSTMASTER: Please send address changes to CED Circulation, P.O. Box 3043, South Eastern PA 19398. MEMBERS OF THE BPA.



About the Cover:
Keeping up with technology these days takes an inordinate amount of time and effort. Photo by Don Riley.

DEPARTMENTS

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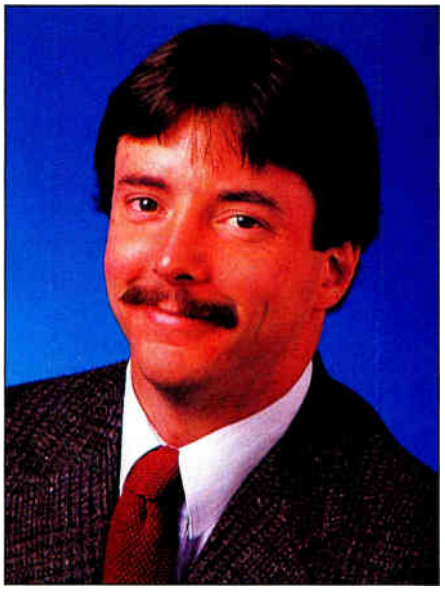
Thinking out loud

Prior to this decade, cable television long-term strategic thinking was simply an oxymoron—there wasn't any. Cable operators were still busy wiring America, hooking up subscribers, fighting for regulatory relief, battling each other for franchise rights and trying to make a buck or two during the process. Keeping creditors happy was a quarterly struggle. "Long-term" was defined as a year into the future; five years was an eternity, left for someone else to ponder.

As the cable business has grown, competition (or at least the threat of it) has come nipping at its heels. Telephone companies are working tirelessly to remove regulatory barriers into the programming content business, MMDS was revived by the FCC with favorable channel use regulation and, of course, the threat from DBS still looms, though its ultimate role remains cloudy. But the lack of a long-term cable "vision" made it easier for competitors to make inroads.



Perhaps its was that thought that motivated the original founders of organizations like Cable Television Laboratories. Cable television had no central clearinghouse to evaluate emerging technology. Some major MSOs had testing labs to evaluate existing product, but the findings were seldom if ever shared with other operators. Strategic thinking was left to the most senior engineers at MSO headquarters. The result: an industry spinning its wheels technologically.

Somewhere along the line, cable operators woke up to the fact they were racing on an oil slick. Some knew there were developments in other industries (i.e. computers) that could have profound effects on television and signal delivery. Something had to be done, the operators said.

When CableLabs was formed, amid a certain level of skepticism, it's probably fair to say many were doubtful it could last. After all, Canadian efforts in the early '80s to organize a similar undertaking resulted in a group that died nearly as quickly as it was formed.

But the national think-tank has been wildly successful. It's been criticized by some who wonder what it has accomplished, but this much is certain: there now exists a vision of where cable can go and what it will take to get there. Somehow, engineers and CEOs from divergent cable operations have built a consensus on how to sell the cable network to consumers, and now businesses.

The Canadians are back on board, too. The Canadian Cable Television Association recently outlined its plan to provide subscribers with what they want, when they want it (for details, see page 10). The plan specifically mentions fiber optics, video compression, interactivity, addressability and HDTV along with marketing, regulation and programming issues.

I guess the point is this: when cable television finally got around to thinking long-term, the benefits have been almost unbelievable. Giant computer companies have come as suitors seeking a multimedia pipeline, telcos are watching closely as PCN looks possible and video compression will provide vast bandwidth for new services. I'll go out on a limb and bet cable will be the first to offer HDTV programming regularly. Has there ever been a time in cable when so much has happened so fast? Keep thinking, guys—who knows what you'll think of next.

Roger J. Brown

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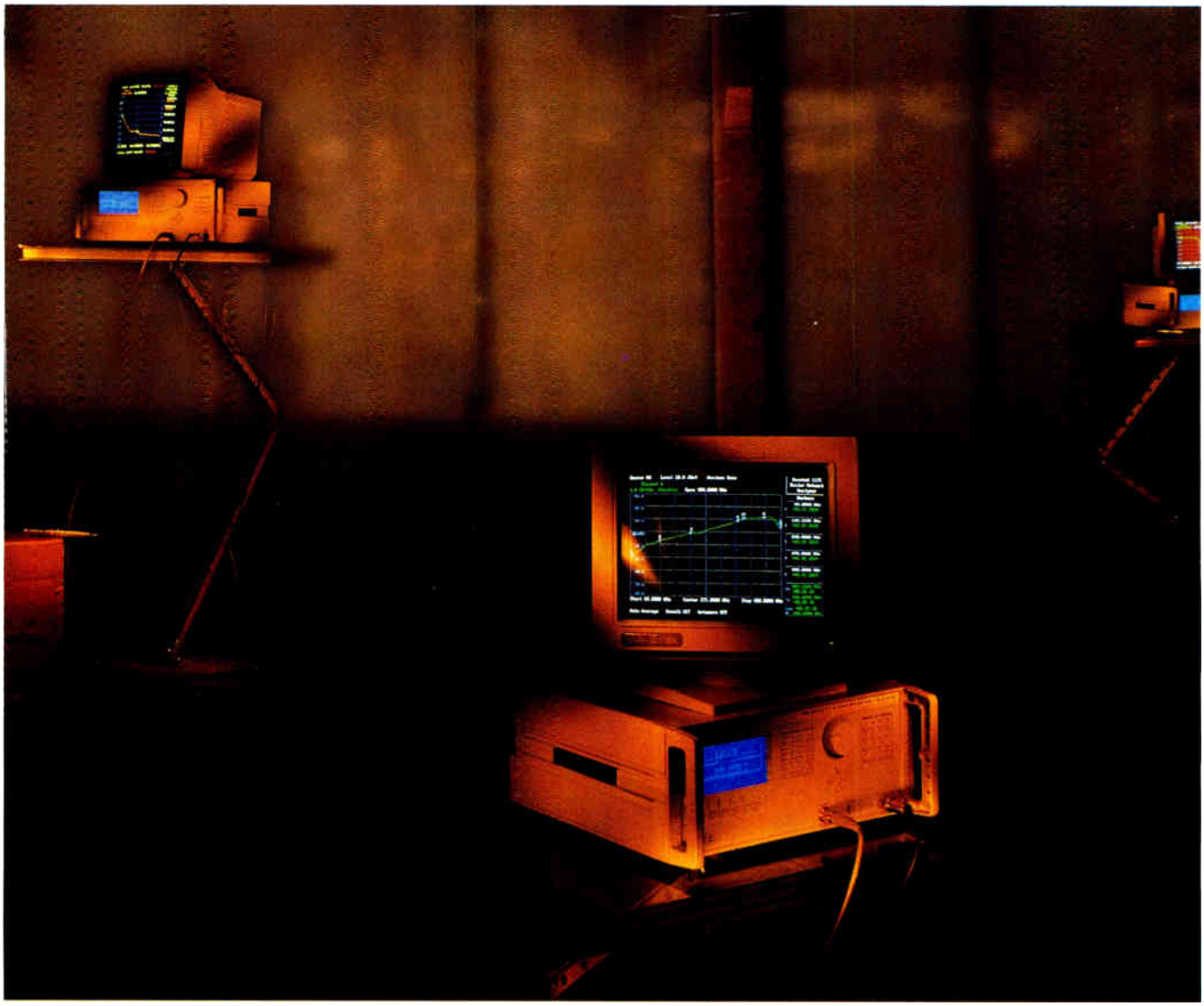

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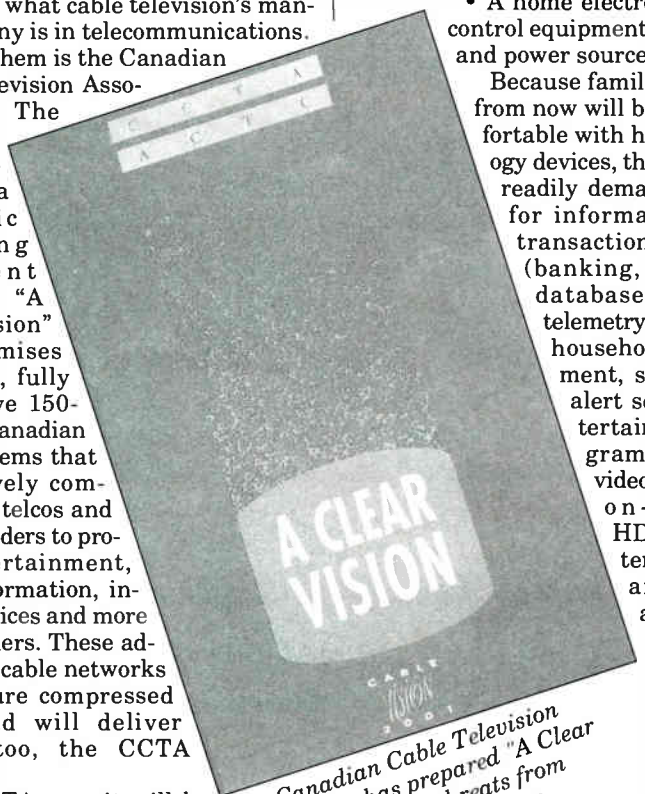
WAVETEK

Canada sets long-term goals; expects to spend $6B to upgrade

For an industry that just a few short years ago was accused of largely ignoring long-term strategic thinking in favor of short-term economic performance, there are now several organizations looking at what cable television's manifest destiny is in telecommunications.

One of them is the Canadian Cable Television Association. The CCTA in June released a strategic planning document called "A Clear Vision" that promises fiber-rich, fully interactive 150-channel Canadian cable systems that aggressively compete with telcos and DBS providers to provide entertainment, voice, information, in-home services and more to consumers. These addressable cable networks will feature compressed video and will deliver HDTV, too, the CCTA promises.



The Canadian Cable Television Association has prepared "A Clear Vision" to counter threats from promised U.S. DBS services.

The CCTA says it will be critical for the cable industry "to outgrow its traditional 're-broadcasting' role and become a provider of value-added, enhanced services" to ward off competitors and provide consumers with more choice.

But the CCTA warns that the new capability won't come cheaply: it will cost Canadian operators a minimum of $6 billion to improve their systems between now and 2001 and "that figure could easily double, depending on technology, partnerships and unknown factors," CCTA officials say.

Yet the improvements will be necessary, the association suggests, because the typical family in 2001 will have:

- Three TV sets, including a large-screen TV,
- Two VCRs,
- A CD player,
- An intelligent terminal for work-at-home and/or education,
- A fax machine,
- Several telephones, including a personal communications device,
- An answering machine,
- A camcorder, and
- A home electronics bus to control equipment, appliances and power sources.

Because families a decade from now will be more comfortable with high-technology devices, they will more readily demand and pay for informational and transactional services (banking, shopping, databases, E-mail); telemetry (energy and household management, security and alert services); entertainment (programming tiers, video- and audio-on-demand, HDTV and interactive TV); and value-added communications services (custom calling, etc.), the CCTA document predicts.

The document seems to echo the theme being loudly trumpeted by the U.S. cable companies, in concert with research performed by Cable Television Laboratories. Canada also has a Cable Labs facility, however, it's goals are to advance and transfer technology to cable systems—it doesn't attempt to set policy or get involved politically.

According to CCTA officials, the planning document was in part motivated by the "growth of the so-called 'deathstar' satellite projects (DBS) now being developed in the United States." To counter that threat, the CCTA suggests a renewed commitment to providing high-quality Canadian programming to subscribers north of the border. "We are here, we know our market and we are committed to providing excellent service to our subscribers," said Noel Brambrough, chairman of the task force that prepared the document.

Philips' unit chosen by T3

Cable operators can expect the first television ghost cancelers to go on sale later this fall now that the Advanced Television Systems Committee's T3 Technology Group has voted to approve a draft standard for a ghost canceling reference (GCR) signal. After a multitude of tests (and some internal squabbling), the T3 group unanimously recommended the Philips GCR, which will be marketed under the brand name Vector by Philips Broadband Networks (formerly Magnavox CATV Systems).

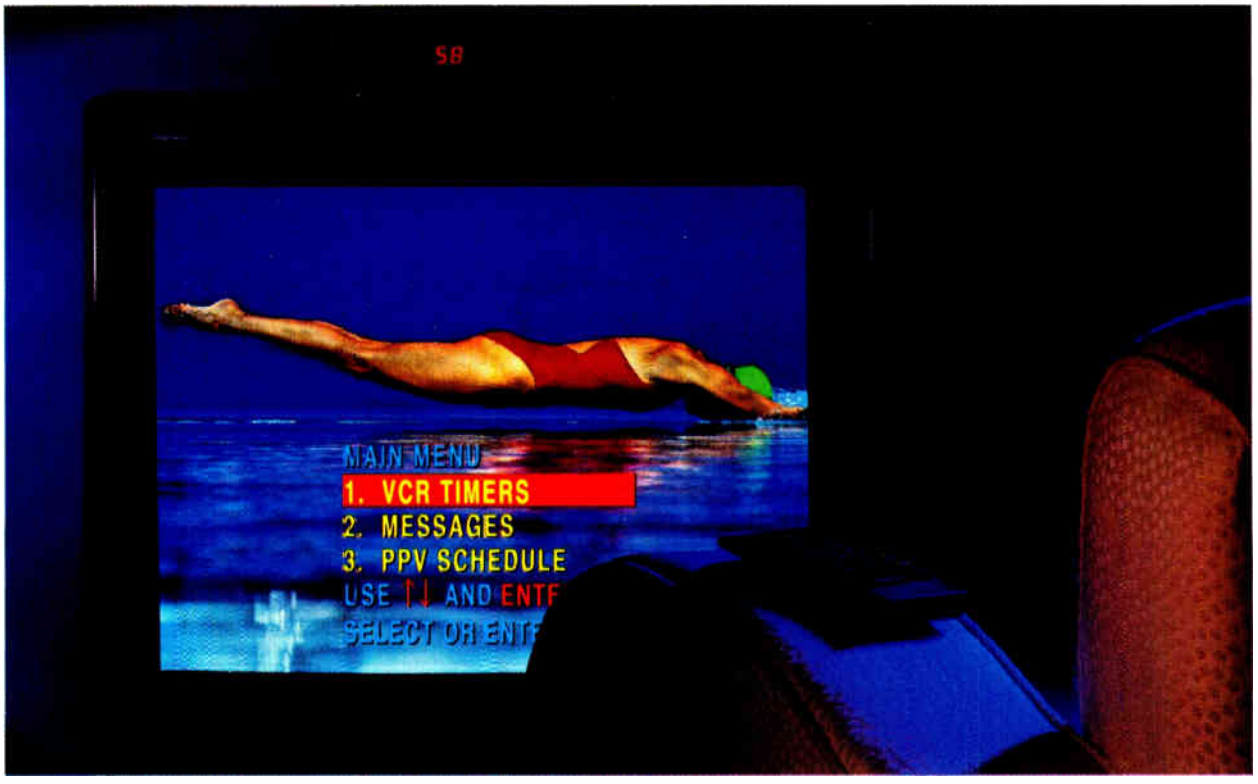
A series of well-publicized laboratory and field tests conducted by the National Association of Broadcasters and CableLabs under the auspices of the Advanced Television Systems Committee (ATSC) last fall in the Washington, D.C. area led the NAB to conclude that the Philips GCR was the best of all tested. The NAB released that information and Philips set in motion its product and promotions departments, which promptly began talk of product roll-out.

With that in mind, CableLabs got its dander up when the ATSC asked it to hurry its test report and then apparently edited several paragraphs that requested more time and additional tests related to close ghosts and equalization, which seemed to favor the GCR signal submitted by Sarnoff/Thomson.

ATSC relented and agreed to six weeks of additional tests. ATSC officials also asked both system proponents to work together to develop a "hybrid" product that would blend the best components of both systems. Once again, both the Philips and Sarnoff/Thomson systems were tested along with a hybrid of the two. Again, Philips came out the winner.

None could be happier than Uwe Trode, Vector product manager for Philips, who finally has the green light to sell cancelers to cable systems and broadcasters. The product now apparently will be ready in September and will cost broadcasters and cable operators about $4,000 a channel. Trode said interest by cable operators has been "incredible," especially on the West Coast, where television stations live in close proximity to large buildings and rolling (or mountainous) terrain.

The recommendation to adopt the



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Responsive

Philips standard now moves on the full ATSC membership, which is scheduled to ballot by letter by early August.

In the meantime, ATSC has filed a request for general waiver of the FCC rules to allow broadcasters to transmit and test GCR signals on line 19 of the VBI. Present rules restrict line 19 use to a vertical interval reference signal, which is apparently seldom used.

Philips, CLI strike deal

Separately, Philips announced it has jumped headlong into the race to provide hardware for digital video compression by contracting with Compression Labs Inc. to develop and build encoders and decoders for cable satellite uplink and headend applications.

The Philips/CLI agreement calls for Philips to provide CLI with $1.5 million in development funding and outlines purchase terms for the resulting products.

Testing of the satellite uplink to downlink portion of the system is scheduled to begin this fall, with product introduction slated for March 1993. Both Philips and CLI will market the system, which is based on the MPEG standard.

The digital compression effort involves several of the Philips organizations, including Philips Consumer Electronics, Philips Broadband Networks and Philips Laboratories.

The contest to provide cable operators with digital video compression/decompression hardware was sparked by an RFP issued by Cable Television Laboratories on behalf of Tele-Communications Inc., Viacom and Public Broadcasting. An announcement is expected shortly.

Data sent over cable

High-speed data was successfully transmitted over a live cable system without using the vertical blanking interval and without interrupting any programming, it was announced during the recent Digital World '92 conference. WavePhore Inc., based in Tempe, Ariz., used its technology to send digital medical images over TCI's Scottsdale system, said John Bringenberg, TCI manager of strategic planning.

The WavePhore technology uses a $15,000 encoder in the headend and transmits data at 384 kilobits per second, according to Charles Jungo, vice president and director of engineering at WavePhore. Existing television signals transport data from a host computer to multiple remote worksites at speeds eighty times greater than dial-up modems. Jungo said his company's system uses any video signal, whether it is broadcast, microwave, satellite or cable because it doesn't rely on the VBI.

Instead, WavePhore inserts the data at baseband between 0 MHz and 4 MHz, thereby avoiding the VBI as well as the front and back porches of the video signal.

Wavephore uses a $15,000 encoder and transmits data at 384 kilobits per second.

That's vital, according to Bringenberg, who said TCI must be convinced its signals won't be visibly degraded by WavePhore's product, especially when digital transmission promises dramatically better pictures over analog. Bringenberg said TCI is evaluating the product, but isn't ready to endorse it yet.

In Scottsdale, the signals were sent about eight miles over coaxial cable, through a microwave link and through several amplifiers, said Jungo.

Cable operators need to provide a minimum 40-dB carrier-to-noise ratio for the data to be recovered, Jungo added. He said operators can expect about a 3-dB noise penalty from the encoder, which should not pose a problem to operators of well designed and well maintained cable systems, Jungo asserted.

WavePhore plans to develop and offer an encoder and decoder operating at the T-1 standard data rate within the next 12 months, Jungo said. That product, combined with an MPEG compression chipset, would allow full-motion video to be sent in a similar manner. Jungo said this would provide cable operators with yet another way to provide pay-per-view or video-on-demand.

Contracts and PCS news

The PCS-via-cable research continues in earnest. In separate announcements, it was disclosed CableLabs has contracted with AT&T Bell Labs and consulting firm Arthur D. Little to research the necessary components for PCS delivery over cable systems while Cox Cable plans to test remote antenna drivers, which are touted as a way to reduce the cost of microcells.

The CableLabs agreement calls for Bell Labs to assist with information and technical assistance on PCS field trials while A.D. Little will offer analysis and a series of reports. The goals of the contract include examination of cable networks to identify its strengths as a transport medium for PCS, determination of the implications of integrating PCS with other cable services and analysis of whether these services can be integrated.

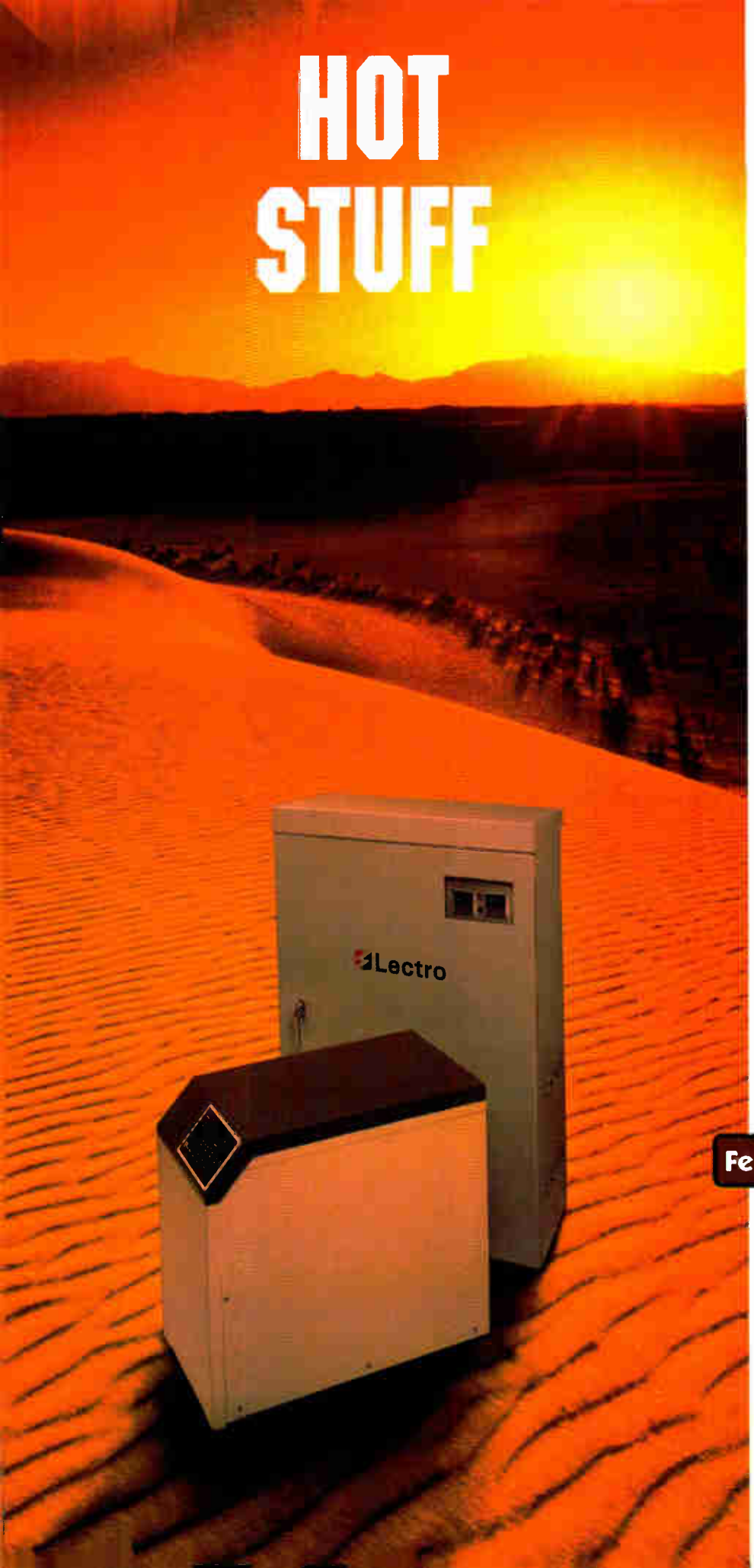
Meanwhile, Cox Cable in San Diego, a pioneer in PCS research, has struck agreements with Nexus Engineering and Omnipoint Corp. to test remote antenna drivers (RADs), which promise to extend the reach of a microcell by permitting multiple antennas to operate simultaneously over the same channel. Each microcell is connected to several RADs by distribution plant, creating, in effect, one larger cell.

The equipment promises to reduce the number of microcells needed and allow for less expensive handsets. The RADs, originally developed for telepoint-type applications in Canada, are being modified by Nexus to operate in the 1850 MHz to 1990 MHz frequency range.

Propagation tests of the Omnipoint equipment is slated for September and will gauge the expected coverage area; tests of the full system (radio and RADs) are slated to occur in September and October.

Finally, Cablevision Systems Corp. used RADs and a remote antenna signal processor (RASP) to utilize PCS technology in vehicles at speeds up to 50 mph. Spacing the RADs 800 feet apart, the base station coverage area was expanded to provide two-way voice-grade signals throughout the length of a 2,000-foot hardware corridor in Cablevision's Lynbrook, N.Y. system. Because all RADs in the corridor were using the same frequency, no signal "hand-off" was necessary. CED

By Roger Brown



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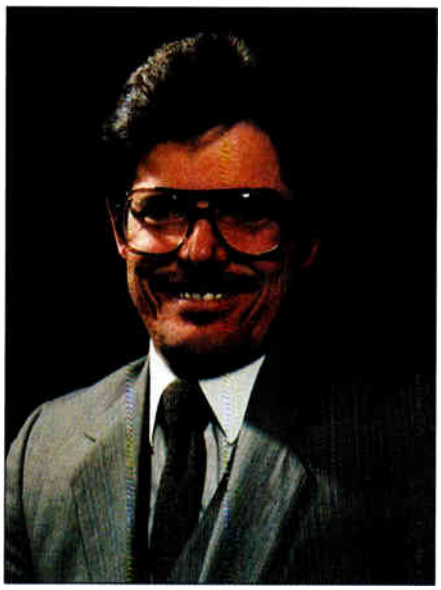

Rich Henkemeyer

Trainer, soothsayer, bartender

He throws chalk, he rants and raves, and he paces enough to make even Phil Donahue look mellow—all for the sake of training. Because for Rich Henkemeyer, technical training director of Paragon Cable in Minneapolis, Minn., this is the good stuff of cable.

He created the job himself, in an evolutionary kind of way. After starting with Paragon (then Rogers Cable) in 1984 and spending a few years as a main line maintenance technician and later a supervisor, Henkemeyer says he noticed a big gap in something he feels is important: Technical training.

The trainer

So, Henkemeyer gave up his management responsibilities and took over technical training full-time. Now, he trains all of Paragon's people in the Minnesota region, and even has an office that seconds as a mini-training center for a handful of students.

But technicians and installers aren't the only Paragon staffers that attend Henkemeyer's classes. Recently, as a part of parent-company KBLCOM's "Value in Entertainment" systemwide training program, Henkemeyer had an opportunity to get his training digs in on *all* of Paragon's employees.

The in-house program, Henkemeyer says, aims to train staffers on "everything it takes to do this (cable) job.

"The idea," he says, "is that if our people understand the value of our services, the customers are automatically going to see it, too."

Apparently, the program is working. Henkemeyer says he's seen a dramatic increase in customer contact, particularly with technicians. "I see our technicians' sales going way up. Where they used to have hardly any sales out in the field, well, now they're getting $100, $150 a week in bonus checks. It's great."

Henkemeyer also thinks cable's wealth of emerging technologies is great. In fact, his role in the Value in Entertainment program is to train Paragon staffers on the new stuff—which he enthusiastically says is one of his favorite topics. "No doubt about it, this is a really exciting time to be in cable," he emphasizes.

And he means it. He really *is* excited. This man of boundless energy and seemingly limitless goodwill could (and would) spend hours extolling the virtues of cable television, particularly its technology. One of his hottest hot buttons, though, is digital storage.

"I see so many things coming on," he continues. "Like the new massive storage parts—where you can store a gigabyte of information on a credit card-sized storage device, for less than $100. If you could build something like that into a convertor, you're talking about the ability to really do PPV on demand," he says.

The soothsayer

Although he didn't do it publicly, Henkemeyer says he made some predictions back in the mid-1980s that are coming true today. Mostly, he predicted that cable would veer toward data transmissions.

"We're seeing that happen now. The industry is starting to get inroads to the computer corridors," Henkemeyer says of his prediction. "It's coming true a lot quicker than I thought it would."

This time around, Henkemeyer's predictions relate to a sort of *a la carte* cable service, where subscribers can pick and choose what programming or other services they want on a monthly basis.

"I strongly believe that it's much better to make fast nickels than slow dimes—I'd rather have a little bit of something than a lot of nothing. And if we could get $5 or $10 a month from that customer, and it doesn't take a lot to service him, that's a good business," Henkemeyer says.

Henkemeyer's gusto for technology spills beyond training, too. Currently, he's working to implement a digital dispatch system which he boasts will make Paragon "essentially a paperless office." The portable system, which Henkemeyer hopes to have up and running later this year, will enable technicians full access to Paragon's database files at any time and any place—even if they're up on a pole or crawling behind a couch to get at a drop connection.

The bartender

Henkemeyer grew up in St. Paul, Minn. and says he's likely to stay in the Twin Cities area the rest of his life. (The only other place he'd live, he says, is Lake Tahoe.).

For quite some time, he tended and managed a bar—the North End Depot—in St. Paul, which he reshaped into the city's first sports bar back in the 1970s. "By the time I left, we had enlarged it to three stories with indoor and outdoor volleyball courts and two bars. The idea was to find a way to get the wives to come in, to kind of bust up the `I'm going drinking with the boys' mentality," Henkemeyer says.

But the bar business is tough, and Henkemeyer decided he wanted a career change. He got a tip from a friend about a cable television program at Dakota County Technical College, decided to look into it, and two years later walked out with degree in hand.

That degree has served him well. Henkemeyer has not only created his own niche at Paragon, but is the SCTE's Region 6 director. "That means I'm here as a resource to all of the chapters we have in Minnesota, Wisconsin and Dakota territories," Henkemeyer explains. "One of my objectives for 1992 is to get a few more meeting groups started in the northern part of Minnesota, to facilitate those folks." Henkemeyer is also the new secretary on the SCTE national board of directors.

He slices, he dices, he julienne fries

At home, Henkemeyer is a single father raising two children: Natasha, age 5, and Nicholas, age 6. He calls the experience "tremendously rewarding."

"I get up with them every morning, help them get dressed, do their breakfast—I know them so well now," Henkemeyer says proudly. "And actually, it's gotten to the point where we have such a good routine, it isn't burdensome."

As long as he doesn't throw chalk at home, it's highly probable that Natasha and Nicholas don't find the arrangement burdensome, either. CED

By Leslie Ellis

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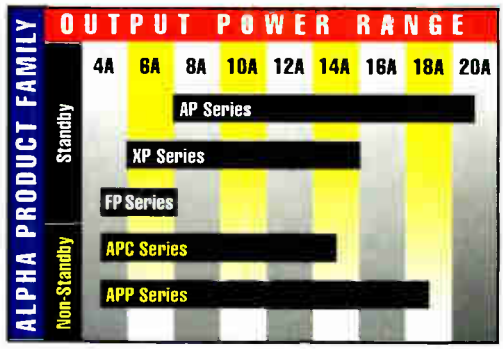

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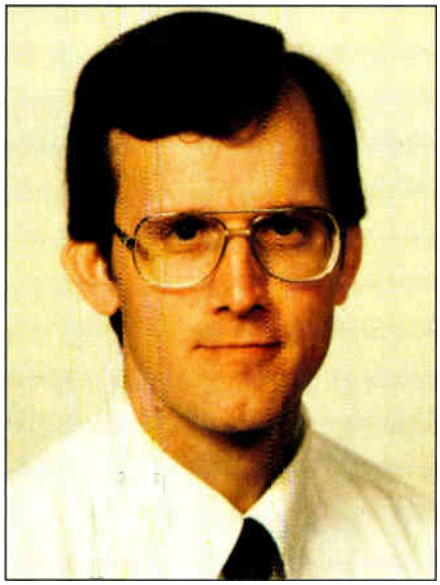

Digital telephony data heirarchy

My last few columns have dealt with the fact that as we look to the future, we can see many new technologies, applications and market opportunities on the horizon that will dictate how we should be deploying our networks today. A couple of these potential opportunities, namely competitive access and PCN/PCS, will take us deeper into the world of telephony—a world filled with new buzzwords and acronyms just waiting to confound the neophyte.

With that in mind, I thought it would be helpful to periodically examine the meaning behind a few of those buzzwords. This month, we'll look at the North American hierarchy of data rates for the transmission of digital telephony.

Conversion to digital format

In the world of telephony, a "voice-grade" circuit is defined as having an audio bandwidth of something less than 4 kHz. This is obviously not in the realm of "high fidelity," but is adequate for voice communications purposes. Note however, that prior to transmission, this analog voice signal must first be converted to some type of digital format. This is accomplished through a very simple analog-to-digital (A/D) conversion technique known as pulse code modulation.

By Chris Bowick, Group Vice President/Technology, Jones Intercable

In this process, the voice signal is first sampled at the rate of 8 kHz or 8,000 samples per second. This sampling rate of 8 kHz (2 x 4 kHz) satisfies the Nyquist sampling theorem which dictates that in order not to lose any information in the digitization process, an analog signal must be sampled at a rate of at least twice the highest frequency contained in the signal.

The output of this sampling process is a series of pulses, whose amplitudes correspond to the amplitude of the actual voice signal at the time the sample was taken. This initial step in the process is called pulse amplitude modulation (PAM).

Once these samples are taken, each is converted to an eight-bit word, through the A/D conversion process. Here, the amplitude of each sample, which can practically take on any analog value, is *quantized* by giving it an eight-bit digital code corresponding to its amplitude. In other words, each sample amplitude is forced to fit any one of only 2^8 or 256 discrete levels. In actual practice, however, one of these eight bits might even be reserved for "in-band" signaling (on/off hook, etc.) purposes, leaving only seven bits (128 levels) for quantization of the input signal. If "out-of-band" signaling is used, the full eight bits can be used for throughput.

Quantization noise

The quantization process is therefore nothing more than an approximation of the infinitely variable input signal. This approximation will manifest itself as noise, appropriately called quantization noise, that will ultimately show up when the signal is converted back to its analog form. One way of minimizing quantization noise is simply to improve the approximation by allocating more bits to each sample.

Allocation of nine bits (512 possible levels) rather than seven or eight would improve the quantization noise, but would also increase the transmitted data rate accordingly. Thus, there exists a tradeoff of quantization noise vs. data rate, and eight bits (seven, if one is used for signaling) was considered to be adequate.

In order to simplify the quantization process, sometimes a technique known as *companding* is used. Speech volume (input signal amplitude) will typically vary in normal conversation by as much as 40 dB (10,000 times). As we have seen, trying to quantize this wide variability into 256 discrete values is an inaccurate process. To help alleviate some of the difficulties associated with quantization, the PAM signals at the originating end are sometimes *com*pressed at the sending end such that the lower level signals are pre-amplified more than the higher level signals. On the receive end, the opposite process, called ex*pand*ing, occurs.

This has the effect of decreasing the dynamic range of the input signal, thus improving the performance of the quantization process.

Note that if each voice grade signal is sampled at 8,000 samples per second, and each sample is then converted to an eight-bit word, the data rate for each digitized voice-grade circuit will therefore be:

8,000 samples/sec x 8 bits/sample = 64,000 bits/sec

This base data rate for voice grade 64 kB/s is commonly referred to in telephony terms as a DS-0, short for digital signal level zero.

Digital hierarchy

The telco industry has standardized a hierarchy of such data rates. For example, if you multiplexed 24 DS-0s together and add 8 kB/s for overhead, this brings you to the next level in the data rate hierarchy, called DS-1. The DS-1 data rate is therefore equal to:

24 channels x 64 kB/s per channel + 8 kB/s = 1.544 Mb/s

The overhead bits are called framing bits and are used to synchronize the transmitter and receiver so that the receiver can sort out which bits correspond to which voice-grade channel. The table below summarizes some of the more commonly used data rates in telephony:

DS Name	Bit rate#	Voice-grade circuits
DS-0	64 kB/s	1
DS-1	1.544 Mb/s	24
DS-3	44.736 Mb/s	672

Note that the DS-3 data rate is not a simple multiple of either the DS-1 or DS-0 data rates. Overhead/framing bits are again the culprit.

Other data rates for electrical and optical transmission have been standardized in the industry as well (SONET). In addition, audio compression techniques such as adaptive delta PCM (ADPCM) will also potentially increase the number of actual voice channels within the data rate structure. Perhaps we'll cover these and other topics in future columns. CED

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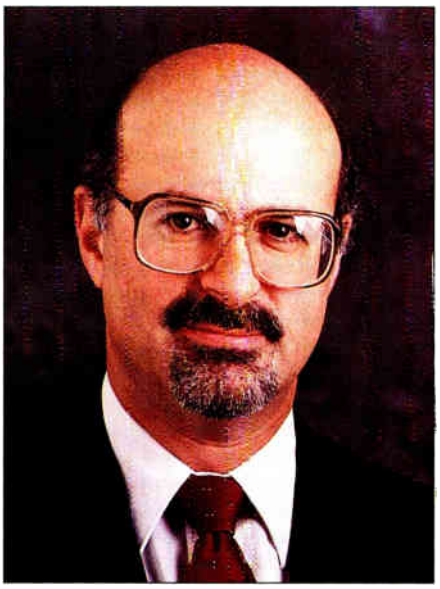

Tracking your truck fleet

Would you like to know where every one of your trucks is located, every minute of the day? Two new systems have recently been introduced to give you this information. One system uses a military satellite system, while the other uses networks of terrestrial receivers to track vehicles. These technologies are just now emerging; the services are not yet widely available.

Satellite-based fleet management

The NAVSTAR Global Positioning System (GPS) is a military satellite system, consisting eventually of 24 satellites, that transmits precise time and position information. GPS receivers can be mounted in vehicles and handheld versions are now becoming available. By receiving the signals from at least four satellites, a GPS receiver can determine latitude, longitude and altitude. The GPS signals are transmitted at 1575 MHz and 1227 MHz.

Recently, Trimble Navigation, one of the leading U.S. manufacturers of GPS receivers, has developed a vehicle tracking system. Among the first customers are the Minute Man Delivery Service of Los Angeles and the Denver and Milwaukee public transit authorities.

The vehicles are equipped with GPS receivers and land mobile communications transmitters that can transmit data back to a central control center. The GPS receiver calculates its location and sends that information back to the control center. At this control center, a dispatcher looks at a road map display to see the location of each vehicle.

In addition to Trimble, other U.S. manufacturers of GPS receivers include Coded Communications and Magellan Systems.

By Jeffrey Krauss, independent telecommunications policy consultant and President of Telecommunications and Technology Policy of Rockville, Md.

Terrestrial vehicle monitoring

Several companies in the U.S. have begun offering a vehicle tracking system using terrestrial networks. These operate in the 902 MHz to 928 MHz frequency band.

For these systems, each vehicle has a receiver and a transmitter operating in this band. When the dispatcher at the control center wants to know the location of a vehicle, a paging-like signal is sent to that vehicle, telling it when to transmit. The vehicular transmitter then sends out a specially-coded wideband pulse that is received by at least four receive sites. By precisely recording the times these signals are received, the vehicle's position is calculated. It can then be displayed on a road map display, or recorded.

There are at least two companies with plans to construct vehicle monitoring networks in major cities in the U.S. They are North American Teletrac and METS Inc. Teletrac operates systems in Los Angeles and other cities, and was recently chosen by the California Highway Patrol and the California Department of Transportation for use in Orange County.

Teletrac has been operating under "interim" rules adopted by the FCC in 1974. The rules have never been made permanent, which creates some uncertainty in trying to establish a nationwide service. As a result, Teletrac recently filed a petition for rulemaking at the FCC, seeking to create permanent rules for this service.

The 902 MHz to 928 MHz band is shared among many spectrum users. These range from high-power air surveillance radars on Navy ships to cordless telephones to retail store anti-shoplifting devices.

In order to provide the timing precision needed to calculate distances, the vehicle monitoring systems operating in this band must be carefully designed to be robust in the presence of other signals. The coding of the wideband pulse makes the system somewhat like a spread spectrum communications system with anti-jam properties. One effect of interference or jamming is degradation of the accuracy of the position determination.

Advantages and disadvantages

These two technical approaches, one satellite-based and the other terrestrial, have different advantages and disadvantages. The GPS system requires a smart mobile receiver that can do precise location calculations. In the terrestrial system, the location calculations are done at the control center; the mobile unit can be smaller and simpler.

A small, simple mobile unit can be hidden in the vehicle, and used for tracking stolen vehicles. This is one of Teletrac's most successful services. After the vehicle is reported stolen, the dispatcher simply signals the vehicle to start reporting its location, and then notifies the police. Numerous stolen cars and stolen truck cargoes have been recovered.

A small, simple, lightweight, battery-powered mobile unit is feasible for tracking lost children and Alzheimer's patients.

But a terrestrial system requires a terrestrial network of receive sites in every city. Teletrac has begun its construction, but is operating in only about four cities. Sparsely populated and rural areas may never be covered by these networks.

The GPS satellite fleet is now about 3/4 operational. Its signals can be received throughout the country, in rural as well as urban areas. For truck fleets operating in suburban or rural areas, GPS or other satellite-based service is the only choice.

Application to leakage detection

Cable Leakage Technologies (CLT), a Texas start-up company, has proposed a novel application of these vehicle location systems. In driving through a cable system checking for leaks, the normal mode of operation might be to stop and fix each leak as it is detected.

But it might be more efficient to drive through without stopping, recording the leakage information and the location information at the same time. Post-processing of the data can then pinpoint the locations of the worst leaks and help to set repair priorities. CLT is presently demonstrating its approach to various cable operators. **CED**

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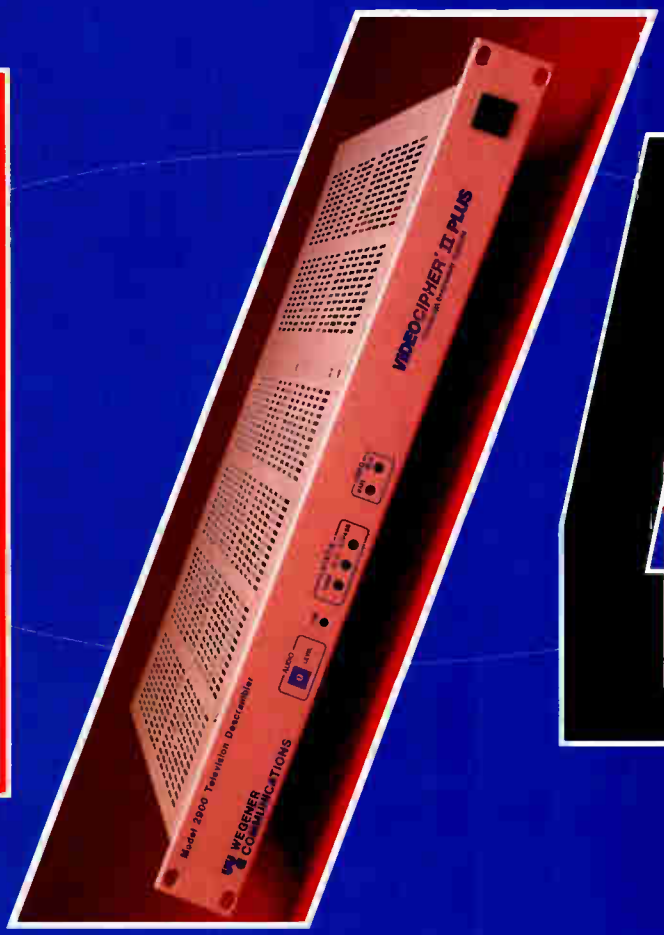

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Powering: The debate continues

It was with considerable amount of interest that I turned to page 90 in the June issue. Having been in the power supply business since August 1975, I know the author well and have always enjoyed discussing the power supply and cable business with him.

However, after reading the article, "Power supplies then and now," I am chagrined at the overt and somewhat blatant commercialism of the article. I have personally written several articles over the years (I believe two have been published in *CED*) and I have always tried to keep them generic, factual and as free of bias as possible. However, since most engineers generally believe their design concepts are superior to the competition, I realize that some bias is likely to creep into any article so written.

Even though, the article mentioned above contains good useful information, it also contains partial truths, omissions and bias and "paints all competitive units with the same brush," a position that is simply not factual. With respect to positions taken in the article, I especially take issue with the following:

• Delay of up to 40 milliseconds in switching. Our products switch in approximately 10 to 12 milliseconds and our unique and exclusive "frequency boost during switching" concept eliminates any "phase shift delays" as described in the article. The frequency boost also provides additional safety and reliability not possible in any "common ferro" design. I am also unaware of any modern amplifier that will experience any "drop out" during such a 10- to 12-millisecond switchover.

• Figure 2 shows the leading edge spike and the article furhter describes the "very fast rise times often resulting in ringing on the leading and trailing edges" problem with the linear design. In fact, this is a characteristic of a "saturating inverter" design, not a linear design. Control Technology utilizes a "driven inverter" concept with rise times an order of magnitude slower than those alluded to in the article and completely devoid of the "overshoot" on the leading and trailing edges shown in Figure 2.

• On page 90, it is stated: "The inverter design, in most products today, utilizes a linear transformer that does not provide any significant filtering or regulation." Except for the fast rise times and overshoot described in the "standby/off line design" (which does not apply to the driven inverter concept), the acknowledged benefit of the "filtering" referred to in the article applies to noise on the power line and therefore operation in the primary mode, not the standby mode.

All designs currently offered in the industry use a ferroresonant transformer in the primary mode and therefore provide the filtering alluded to. On the other hand, to achieve regulation, we use a PWM regulation technique (patented 1982) that provides precise regulation at a higher level of efficiency than can be achieved with the common ferro design.

• I take issue with the entire discussion regarding the generation of transients during switching (page 90). The "lack of phase synchronization during switching" can certainly cause the generation of voltage transients with the common ferro design (the design used by the author's company) because of the fundamental properties of the ferro itself, but should not be a factor in the linear design with a properly designed inverter.

• The author ascribes a higher inherent level of reliability with the common ferro design. This cannot be backed up by actual fact because both types of designs provide voltage to the cable load through a magnetic device, i.e., either the ferro or a linear transformer. In actual fact, the synchronization of the waveforms is critical with the common ferro design because of the load presented to the inverter output power transistors; an out-of-phase switching condition will present an excessive load to the inverter output stage which can result in failure of the power transistors during transition.

Like all engineering considerations, the design of a standby power supply involves a number of trade-offs. The article implies that the simplest and most reliable design is the common ferro design. Actually, from a design standpoint only, the simplest and most reliable design is the saturating inverter with a linear output.

Unfortunately, the drawbacks to this 20-year-old technology (lack of regulation in standby mode, resulting in large variations in output voltage due to both declining battery voltage and unpredictable and changing loads; large variations in frequency with changes in battery voltage and load; fast rise times; leading edge spikes; etc.) far outweigh its benefits in both my opinion and the author's. However the common ferro also has its drawbacks which were totally ignored by the author. These include:

• Prone to "nuisance switching to standby" due to noise on the power line. Because the ferro is active in both primary and standby modes, power line loss detection circuitry must be located on the primary or power line side. In the linear output design, the AC loss detection should be located in the secondary side of the ferro. The ferro thus filters out noise sikes, "sub-cycle dropouts," etc. and unlike the common ferro design, should eliminate all nuisance switching to standby, and if properly designed, will only switch to standby on a true outage.

• Poor efficiency at light loading and less efficiency at all loading conditions (which translates into less standby time). Even though the author alludes to a "high efficiency ferroresonant transformer," the "workhorse" currently used in all existing units is considerably less efficient than a linear transformer and steadily declines in efficiency with lower levels of loading.

To my knowledge, there are no "truly successful" two-battery units of the common ferro design, as it becomes increasingly difficult to achieve an acceptable level of efficiency in standby mode with the common ferro design from a 24-volt (or two-battery) DC system.

I am aware of more efficient ferro designs using solid-state switching components (instead of the LC tank circuit) to drive the core of the ferro into saturation, which would achieve higher efficiency. There designs were introduced about 15 or 20 years ago but the ruggedness and reliability are reduced and cost is increased due to the higher level of sophistication with these techniques.

• Current foldback in short circuit. The inherent short-circuit protection of the common ferro design does protect the power supply itself, but the short-circuit current is approximately 150 percent of the normal rated load current, i.e., usually enough to blow fuses in power inserters and amplifier bypass networks. Both the saturating inverter (stops oscillating) and the driven inverter (instantaneous shutdown in each half-cycle) are normally designed to reduce the current to either zero or a low level (5 amps or less) under short-circuit conditions.

These two designs, when properly implemented, automatically switch to the

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standby mode and limit the current when confronted with a short-circuit condition. This is an obvious advantage over the common ferro design in most cases, since fuses will not be blown in other peripheral devices.

The discussion regarding tap interference is good, useful information which is currently being investigated on a number of fronts. I cannot speak for other power supply manufacturers, but Control Technology will be following this investigation closely and as in the past, will make any necessary modifications to its product design as the need dictates.

Charles Turner
President
Control Technology

Alpha's response

The authors respond to Mr. Turner's letter in the following manner:

Thank you for the opportunity to respond to Mr. Charles Turner's letter regarding our article that was published in the June issue of *CED*.

First, we would like to mention that we have always held Mr. Turner and his company Control Technology in high regard. As he mentioned in his letter, people of a technical nature quite often hold divergent opinions on product design issues. In our opinion, this diversity is the basis of healthy competition and drives technology forward. The industry and ultimately the subscriber benefit from this ongoing process.

We stand behind our statements in the article as accurate and factual as written. The intent of the article was to provide the reader with several specific comparisons of performance and reliability for some of the different power supply designs currently in use in the cable industry. Several important issues were raised that the cable operator should be aware of, especially in light of the rapidly changing reliability requirements for powering of networks that carry digital data, PCN and other services.

In response to Mr. Turner's first point regarding transfer time between AC and standby modes, an uninterrupted output during transfer is desirable for several reasons. The first being an elimination of power dropouts not only to the amplifiers, but fiber-optic receivers, laser transmitters and sensitive headend equipment as well. Even a 10- to 12-millisecond transfer dropout can cause signal interruption.

Most "split-module" designs wait for the output of the ferroresonant transformer to drop in voltage significantly before the transfer relay switches the cable system over to inverter output. As can be confirmed by anyone with an oscilloscope, the output of this design drops to low voltage prior to a 30- to 40-millisecond (or longer) outage before the inverter output starts.

It is important to consider the aging effect on the electrolytic capacitors in the amplifiers, especially in higher operating temperatures. Their hold-up capacity can decline significantly over time. In addition, amplifiers located near the end of the cascade operate continuously at a lower input voltage (due to the voltage drop of the cable) and have less hold-up capacity to sustain a brown-out or power interruption. The article simply states that if the power supply output is uninterrupted then signal delivery becomes more reliable. Both the computer and telephone industries adopted UPS powering over 30 years ago for reliability reasons.

Mr. Turner's second point regarding

power supply output waveform slew rates refers to the description in the article of the subscriber tap interference problem. This is caused by any power supply square wave that exceeds the slew rate threshold of each manufacturer's tap. As described, the majority of the two-module power supply designs produce a much "squarer" square wave in inverter mode than in utility operation. It is in this mode of operation that these power supplies produce significantly more harmonic energy than when in AC operation where the cable system is powered by the quasi-square wave output of the ferroresonant transformer.

The output wave shape of these inverters is defined by the switching speed of the transistor circuit as well as design topology, such as linear, saturating or pulse width modulated driven inversion. Even the common ferro design utilizes a crystal oscillator controlled "driven" inverter with a very square waveform.

The point put forth is that due to the filtering effects of the ferroesonant transformer, the output waveform is a low harmonic, quasi-square wave. Regardless of saturating or driven inverter the linear transformer provides no such filtering or regulation. "What you put in is what you get out" in terms of waveshape and voltage.

The comment in the article about overshoot and ringing is a characteristic of the leakage inductance and parasitic capacitance of the linear transformer reacting to the switching speed of the power stage. Again, regardless of inverter topology this will occur with high-speed power switching.

Mr. Turner's third point is an apparent misunderstanding of a comment in the article. We most certainly refer to the previously mentioned filtering ability of the ferroresonant transformer in both inverter and AC operation. We disagree with Mr. Turner's statement that the driven inverter is not subject to generation of overshoot and high frequency noise.

With the typical fast switching speeds used to minimize transistor power dissipation, and the previously mentioned stray inductance and capacitance, most of these inverter designs create unwanted harmonic energy. The point of the article is that the ferroresonant transformer filters this out while most of the two-module designs pass this on to the cable system when they operate in standby.

The PWM regulation technique mentioned by Mr. Turner is a solid-state circuit that modulates the "duty cycle" or conduction period of each half cycle of the 60 Hz inverter operation. This function increases the conduction time of each half cycle as the battery discharges to maintain a 60-volt average output. In our opinion, it is difficult to argue that this approach, with its required circuitry, offers inherently higher MTBF than the voltage regulation function of the two-component ferroresonant transformer. Consisting of a steel lamination core with two copper coils and a capacitor, this over-40-year-old design can achieve MTBF of 100,000 hours. No additional circuitry is required to provide line and load regulation and short circuit current limiting.

Points 4 and 5 refer to our discussion of the benefits of synchronization during transfer to and from inverter operation. As described, the common ferro design does not provide changes in output phase to the cable system during trans-

fer. Unlike the two-module design, which inherently creates a phase change due to the use of a relay to disconnect the cable system from one module to then connect it to another. Because the relay switches from one output to the other in an unsynchronized manner, there is no continuity in output phase.

Again, this can be verified by the use of an oscilloscope to observe the phase relationship of the output immediately prior to and after transfer in either direction.

The mention of transients during transfer again refers to the effect on the inductance and capacitance present in the actives and passives in the plant by rapid changes in output current phase.

The comment regarding the MTBF of the common ferro approach simply refers to the component count comparison with the two-module designs. These designs use two transformers instead of one and two enclosures and twice as many electrical connectors.

Synchronization of inverter transistors is critical in any design and is not unique to the common ferro approach. If opposing transistors in any inverter design turn on too slowly, out of sequence, or against each other, there can be a failure. The common ferro driven inverter uses solid-state current limiting of each transistor that shuts it off in a few microseconds if an overcurrent situation exists. Control Technology uses a very similar circuit in its products. However, many of the two-module designs in use today have no inverter current limiting and will fail upon application of a short circuit during transfer or in inverter mode.

Regarding Mr. Turner's discussion of the drawbacks to the ferroresonant transformer, first point; the common ferro design intentionally senses the status of the input line. It is the primary objective of the UPS to constantly monitor the incoming power quality and switch to inverter when necessary to protect the output load. This is the most effective way to provide an efficient uninterrupted output to sensitive equipment.

By sensing drastic frequency shifts, voltage swings, brownouts or complete blackouts on the utility input, the UPS can quickly switch to inverter operation before these disturbances are passed on to the output before it is too late. By sensing at the input and quickly switching to inverter, the stored energy in the resonant tank circuit of the ferro continues to provide output power during the 2- to 4-millisecond transfer sequence resulting in an uninterrupted output.

As Mr. Turner describes it, the AC detection circuitry on the output senses the disturbance the same time that the load sees it which is of course, too late.

The second point refers to operating efficiency. Both the common ferro and two-module designs operate 99 percent or more in AC line operation. Since they are both ferroresonant transformers in this mode, the operating efficiency is roughly equal, assuming a similar VA size and design.

In standby, assuming equally rated units of both designs, the efficiency of the inverter section is also roughly equal. They both use switching transistors with fairly equivalent losses, assuming the same output load and battery voltage. The ferroresonant transformer efficiency is about 8 percent lower than the linear transformer but we feel that this is a small price to pay for the inherent voltage regulation, noise filtering, harmonic reduction and current limiting benefits of this design.

Mr. Turner's comment about two-battery (24V) systems is not really a fer-

roresonant transformer issue, but an efficiency and reliability issue. For example, compare the inverter efficiency of a 60-volt, 15-amp output power supply (900 VA) operating on a three-battery system (36V). The losses in the transformer are about 10 percent (90VA). Assuming operation at 36 volts, 990 VA is required from the batteries to support the output load and transformer losses. 990 VA divided by 36 volts is 27.5 amps.

Assuming a fairly typical voltage drop across the inverter transistors of 2 volts, 2V times 27.5 amps is 55 watts transistor losses (1.5 amps). The total current required from the batteries is 27.5 + 1.5 = 29 amps, or a total of 1045 VA to provide output power, transistor losses and transformer losses.

Assume the same conditions again but with a two-battery (24V) system. Output power is again 900 VA and transformer losses are about 90 VA (actually will be a little more due to higher currents). 990 VA divided by 24 volts is 41 amps. 41 amps times the 2V transistor losses is 82 watts (3.4A). The total current required from the batteries is 41 + 3.4 = 44.4 amps, or a total of 1072 VA.

As you can see, the battery current is much higher for the two-battery version, (a higher discharge rate can reduce effective standby time), the transformer (linear or ferro) is less efficient due to copper losses from higher currents, the inverter transistors have to be rated for about 35 percent more current and resulting extra power dissipation as well, and all wires, connectors etc. have to be rated higher.

In large UPS systems for computer back-up where high output power is required, higher voltage battery systems are used to reduce inverter current and thus increase efficiency. In the electrical utility grid, the highest voltage possible is used for power transmission to reduce losses.

The same holds true for a cable television power supply, for the traditional 15-amp output standby supply either common ferro or two-module design, a three-battery system is more efficient, provides longer standby time, and due to lower component stress and power dissipation, can be more reliable.

The final point is current foldback. Typical ferroresonant current limiting is about 150 percent of the nameplate rating. In both the common ferro and two-module designs, this is true in AC line operation because both are using ferroresonant transformers. In inverter operation, some of the two-module designs use solid-state current limiting. Many over the years did not, and even the saturating self-oscillating designs could do significant damage to the transistors before they stopped switching.

The common ferro design has two forms of protection in standby: the foldback current limiting of the ferroresonant transformer, which actually limits peak currents to 150 percent of normal in addition to solid-state cycle-by-cycle current limiting which protects the transistors from extreme over current damage by turning them off quickly when a problem is detected.

To summarize, we feel our article is factual in its technical content and provided useful and timely information for the readership. We thank Mr.Turner for the time he spent to provide feedback and an alternate opinion.

Fred Kaiser, President
Tom Osterman, Director of R&D
Alpha Technologies

Taking fiber to the curb via optical repeating

Link budgets of 18 dB are now practical using direct modulation of distributed feedback (DFB) lasers to transmit AM-VSB video and FM modulated audio signals. Optical repeating of the signals in a hybrid AM supertrunk/star architecture can feed numerous optical receivers located as far as 30 miles from the headend optical transmitter, and still deliver high-quality signals at a level of reliability far exceeding that of typical coaxial distribution systems. Comparable "home run" optical architectures can cost substantially more to implement.

This paper presents the system design parameters and techniques which have provided more than 600 MHz of bandwidth over an 18 dB optical link budget with better than 50 dB carrier-to-noise ratio. No optical fiber amplifiers or external modulators are used in the system.

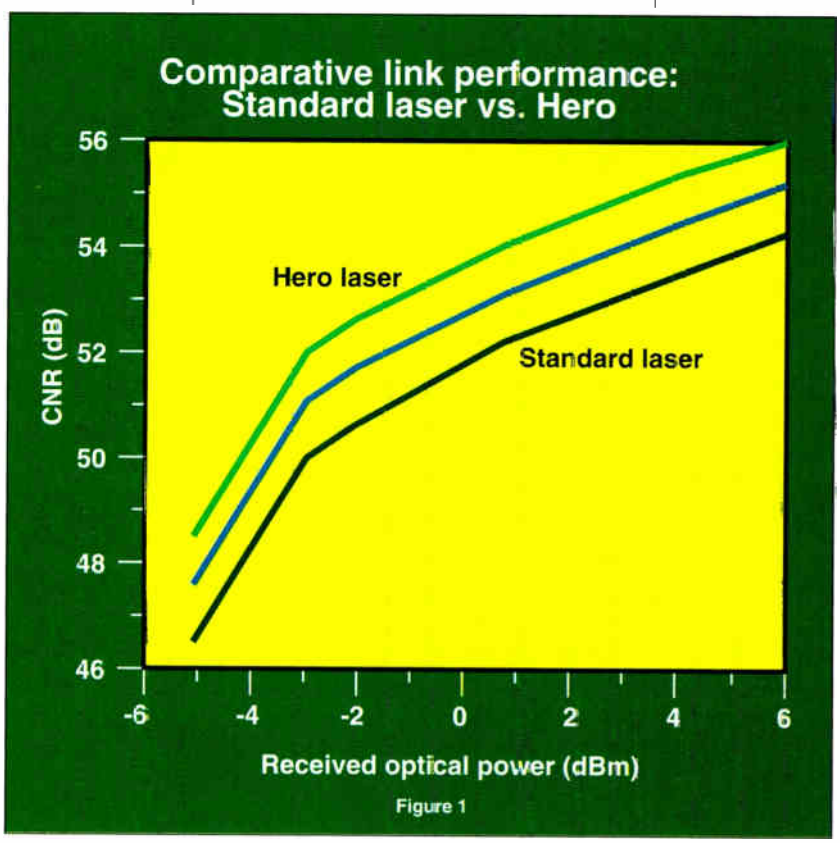

Figure 1

Smaller node sizes

Because of the availability of wideband low noise fiber optic systems, several cable systems are now using optical fiber to serve large density population areas. Typical node sizes are in the range of 2,000 or more subscribers per optical receiver. However, smaller node sizes are desirable in order to take maximum advantage of the often stated benefits of fiber transmission.

In order to reach smaller pockets of subscribers, or to serve several geographically dispersed concentrations of subscribers, an optical point-to-multipoint fiber hub optical repeater system was developed. Installed in cable TV plant in Europe, it has proven to be a logical and cost-effective architecture for installation of "fiber-to-where-you-need-it."

By distributing the optical network and thus sharing the cost of optical components over several subscriber neighborhoods, node sizes approaching 200 subscribers or less can be achieved. In some cases, *no* amplifier cascades are required. Reliability and picture quality is improved, resulting in higher levels of system availability and subscriber satisfaction.

Transmission bandwidth is 10 MHz to 610 MHz, which is capable of carrying 60 or more PAL or NTSC channels. CNR is automatically optimized in the laser transmitter as channels are added or deleted, and pilot tone AGC in the receiver compensates for system aging or other variations in the received optical power. The system can also be used in multiple fiber applications or to serve as "sub-headends," as well as in fiber-to-the-curb.

System tradeoffs

Most cable TV systems are now installing non-dispersion shifted fiber optimized for use with 1300-nanometer wavelength transmitters. Technical issues associated with the use of 1550-nm lasers on this type of fiber are well documented[1]. In order to minimize the complexity of system design and reduce cost, the 1310-nm wavelength was chosen for the first design, with the flexibility to adopt 1550-nm if required.

Directly modulated DFBs

To eliminate format conversion, the simplest method of transmission is to directly modulate the DFB laser with AM-VSB RF carriers. DFB lasers are chosen for low relative intensity noise (RIN), high linearity and narrow spectral width for use with non-dispersion shifted fiber. DFB lasers also provide sufficient output power (7 dBm or better) such that passive optical networks, based on singlemode couplers, can be used to feed more than one optical receiver.

The optical receiver is based on a PIN photodiode detector with a transimpedance amplifier front end. Automatic gain control is included to compensate for system aging or future splices. Two RF outputs of +34 dBmV are provided for local distribution.

In the optical transmitter, as discussed by Young, et al[2], the system designer is forced to trade high carrier-to-noise ratio for low distortion. This occurs

By Robert E. Chalfant, Paul Young, Mark Tucker, Andreas Nothiger, Lee Cummings and Franz Stocker, Ipitek

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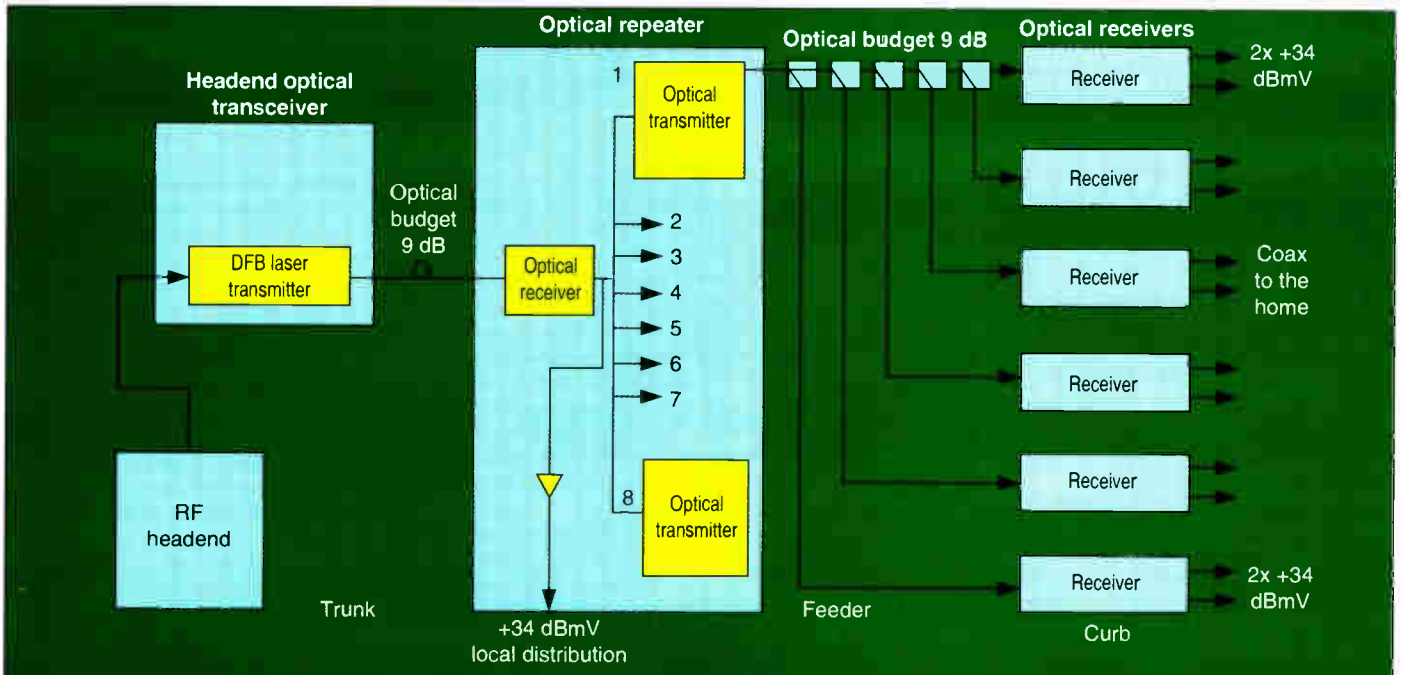

Optical repeater system downstream path

Figure 2

when the amplitude of the drive signal is increased to achieve high CNR. However, as the laser is driven harder, the optical modulation depth eventually falls below the lasing power threshold, which results in unacceptable distortion products.

In a system of this type, the optical modulation index (OMI) on a *per carrier* basis is the primary determinant of CNR. Further, the *composite OMI* is primary in determining distortion. OMI is defined as the fractional peak light power deviation from an average level. For a single carrier, the OMI is denoted by "m," where:

$$m = \frac{P_{Pk} - P}{P}$$

where P_{Pk} is the absolute maximum instantaneous light power when sinusoidally modulated; and P is the unmodulated average light power of the laser.

The equivalent optical power of one of the subcarrier multiplexed video carriers, P_{VC}, is computed as the root mean-square variation from the average laser power:

$$P_{VC} = (m/\sqrt{2})P$$

where P_{VC} is the RF carrier power in computing CNR. The depth of intensity modulation is determined by total laser OMI because of all carriers and the vestigial sideband modulation. Since CNR is proportional to m^2, it is apparent that

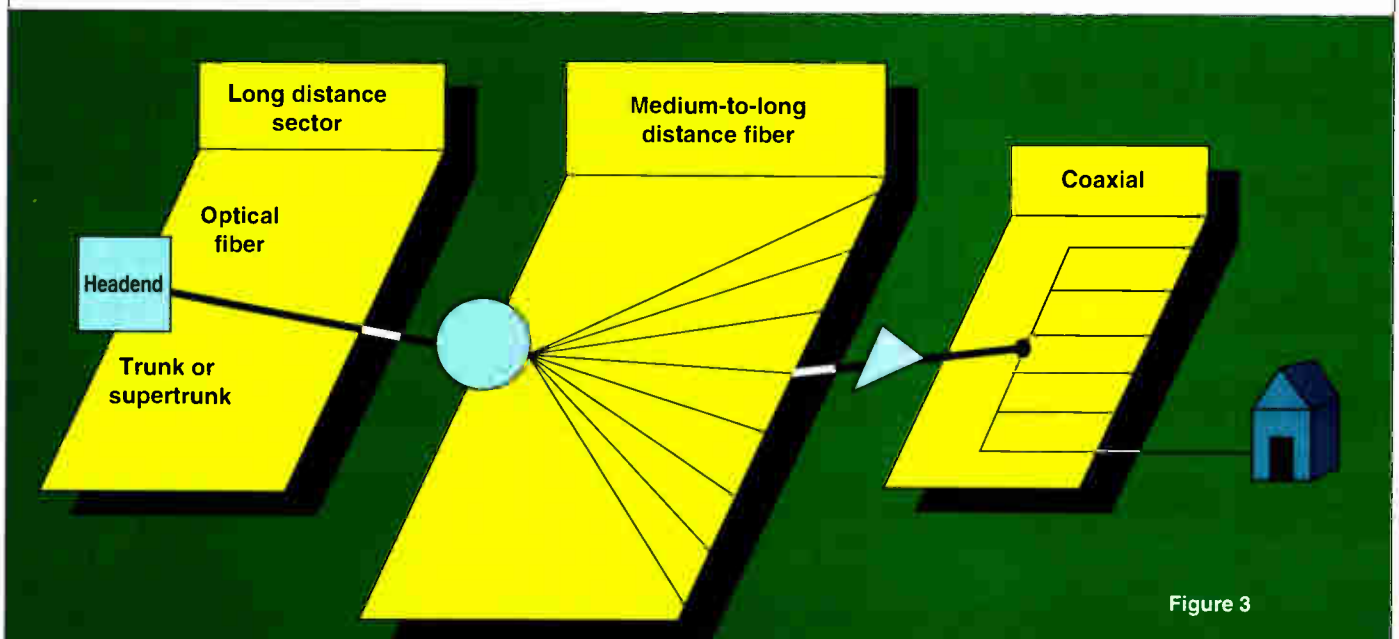

Figure 3

Broadband transmission network structure

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The race to keep up with technology

Engineers cite pace of technological change as number-one concern in 1992 salary and job satisfaction survey

It's happening all over the globe. People are saying they can't keep up with the rapid pace of technological change. One look at what's happened in the computer industry over the past three years is proof enough. Those state-of-the-art 386 micros purchased just a couple years ago are being replaced by better, faster 486s and 586s—why, the June 1, 1992 issue of *Business Week* featured an article on Intel that promised a 786 in the works. Indeed, it seems more and more that what's new today is obsolesced tomorrow.

So it comes as no big surprise that the pace of technological change is what cable's engineers, managers and technicians are citing as a major concern in *CED* magazine's fifth annual salary and job satisfaction survey. What is surprising, though, is that the mention of "keeping up" as a top concern marks a sharp turn from other worries cited just last summer. In fact, for the past five years, the struggle to keep up wasn't even a top-three concern.

Yes, where in years past technological developments took a back seat to training, re-regulation and competition fears, this year's survey revealed the race to keep up with change as the overwhelming concern among engineers *and* managers.

One engineer from Maine sums up his very full plate of technological concerns this way: "With the advent of fiber optics and upcoming advances in HDTV, PCS, alternate access, video-on-demand, stricter franchising agreements, tougher FCC technical standards, digital compression and safety, it's going to get over-demanding to be the system engineer and/or manager."

Another engineer, also from Maine, puts it a little more simply. "There's too much to read. It's all changing too fast."

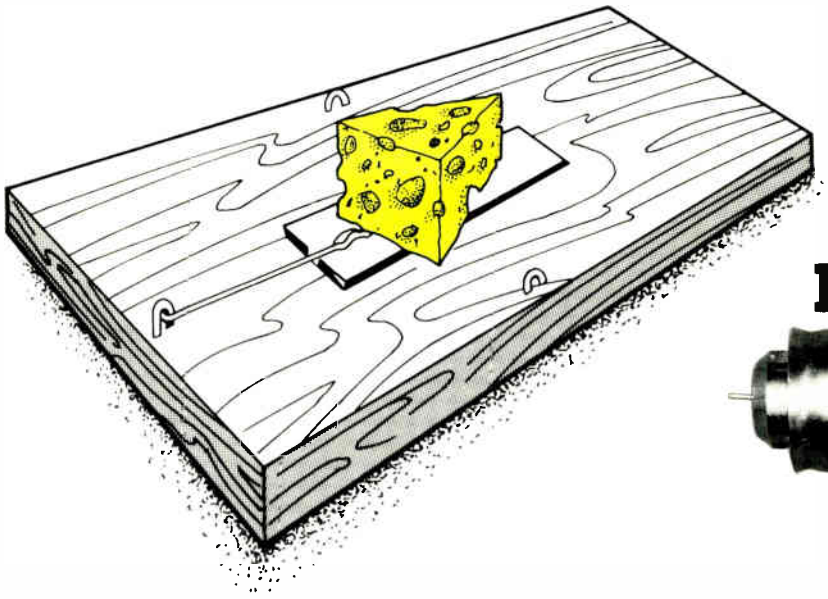
"It seems that the industry sometimes outgrows itself," writes an engineer in Kansas. "Before we have time to grasp a new idea, that idea is outdated. I think we need to concentrate on what the consumer wants, not what is newer."

Survey highlights

Some other interesting highlights from this year's survey include:

- **Job security is at an all-time high.** For the first time ever, all three respondent categories (engineers, managers and technicians) feel an above average comfort level when it comes to job security.
- **Customer service woes bother managers and engineers, but not techs.** The need for better customer service ranked high with the engineers and about

ALL TRAPS ARE CREATED EQUAL, NOT



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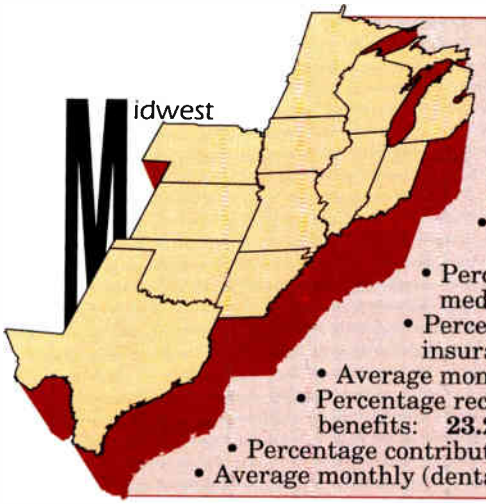
average with the managers. Interestingly (and unfortunately), the need for better service didn't even appear on the top-10 concerns list of cable's technicians.

• **System size impacts salary.** Predictably, there is a high correspondance between system size and salary: The larger the system, the higher the salary, and visa versa, in most cases.

• **Salary heft depends on where "home" is.** Engineers, managers and techs who live in the Northeast make the most money. Next are their counterparts who live in the Southeast, followed by those who live in the West. Those respondents living in the Midwest receive the lowest overall wages, on average, according to the survey.

• **Long CATV tenure is the norm, and that isn't likely to change.** Of the engineers, managers and technicians surveyed, 83 percent have been in cable for more than 10 years, and 92 percent say they're likely to stay another three years.

• **Most earned more than "cost of living" raises this year.** This year, the biggest raises went to cable technicians, who brought home an average of 13.1 percent more compensation than last year. Managers got a 10.2 percent raise, and engineers averaged 6.5 percent in added salary.



Average salary, 1992
Managers—$33,537
Engineers—$34,945
Technicians—$30,040

Overall averages (managers, engineers and technicians)
- Average number of people supervised: **8.9**
- Percentage receiving fully paid medical benefits: **24.63**
- Percentage contributing to medical insurance: **67.2**
- Average monthly contribution: **$74.22**
- Percentage receiving fully paid medical benefits: **23.26**
- Percentage contributing to dental benefits: **41.83**
- Average monthly (dental) contribution: **$15.75**

• **The recession has taken its toll.** Technicians are particularly disgruntled with budget cuts, and spend a lot of time grumbling about areas where they differ in opinion from the corporate brass. They wonder how far corporate will go with their "bottom line" obsession; the cutbacks in equipment spending are apparantly affecting day-to-day performance.

• **Hiring is down, but so is firing.** Overall, nearly two-thirds (59 percent) of the engineers, managers and techs surveyed said their company didn't add technical staffers this year. And while that may be bad news, it's notable that 86 percent said none of their technical co-workers had been laid off.

The engineer

This year's survey paints a portrait of

the "typical" engineer as a guy (no women responded in this category) who's a shade over 39 years old and works in a system with 10,000 to 20,000 subscribers.

He makes about $36,950, plus he takes home about $2,100 in bonus money. He's been with his local cable system for more than 10 years, but picked up a new role within the last three years. He's been in cable, though, for more than 15 years.

He supervises about 10 employees and gets 18 days of paid vacation per year. He pays about $80 each month for medical insurance. (Notably, engineers pay more each month than their management and technician co-workers, who pay $55 and $70, respectively. This fact makes us wonder if perhaps engineers have more kids. They pay less in dental insurance each month, though, which makes us wonder if those kids have teeth.)

Although a little less than half (48 percent) of the engineers surveyed say they're satisfied with their wages, they don't think highly of their company's advancement opportunities. Only nine percent said they thought opportunities for career advancements were high; 41 percent gave career advancement a low ranking.

Those low marks seem to echo a common grumble among the engineers surveyed: Corporate buyouts. A Pennsyl-

Survey methodology

This year's fifth annual salary and job satisfaction survey was sent directly to 500 randomly selected *CED* readers. The questionnaire was mailed in May to engineering titles, categorized as follows:

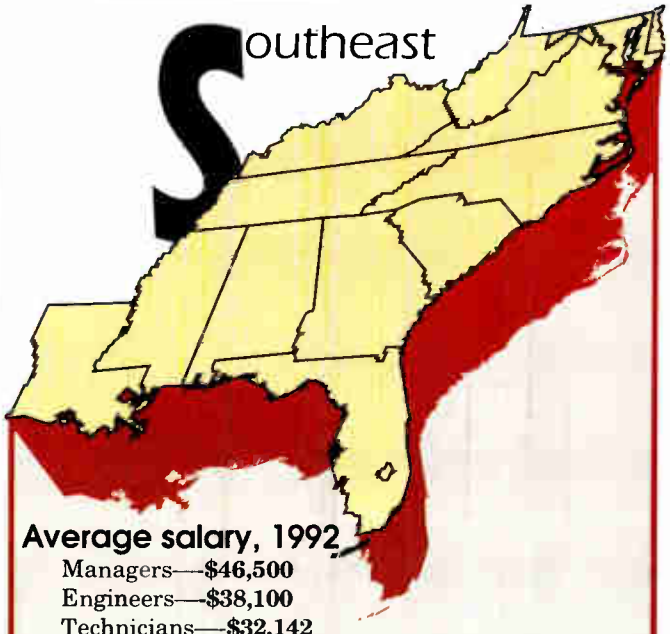
- Management: Plant manager, system manager, president, VP of engineering.
- Engineering: Chief engineer, system VP of engineering, staff engineer, district engineer, plant engineer.
- Technical: Installer, technician, technical manager.

In all, 110 responses were received for tabulation, which represents a 22 percent response rate. Separated by classification, 38 managers, 43 engineers, and 29 technicians filled out and returned the questionnaire.

The survey asked cable's engineering community a variety of questions, including:

- Salary (1992 and 1991, bonuses),
- Age,
- Duration of time in current position, with current employer,
- Length of employment in CATV
- Number of people supervised,
- Staffing,
- Number of subscribers (ranges),
- Job satisfaction levels (ranking, with "1" as low and "5" as high),
- Training satisfaction levels (ranking, with "1" as low and "5" as high),
- Benefits,
- Training programs,
- Vacation,
- Intentions to stay in cable TV, and
- Concerns.

By Leslie Ellis



Average salary, 1992

Managers—**$46,500**
Engineers—**$38,100**
Technicians—**$32,142**

Overall averages (managers, engineers and technicians)

- Average number of people supervised: **10.53**
- Percentage receiving fully paid medical benefits: **20.36**
- Percentage contributing to medical insurance: **70.1**
- Average monthly contribution: **$50.6**
- Percentage receiving fully paid dental benefits: **31.2**
- Percentage contributing to dental insurance: **38.9**
- Average monthly (dental) contribution: **$15.16**

vania engineer puts it this way: "It appears as though the industry is leaning toward a few MSOs owning all the cable companies in the future. When that happens, many good people will be (and are) out of work because of corporate staffing and the ability to run with fewer people at the system level."

Another, even more disgruntled engineer from Tennessee, who admits he'll probably bag CATV within the next three years, says he's looking for a "more stable" industry. "In 11 years, I have been in a system that has been bought and sold to other operators four times. Cable companies are bought and sold like stocks and bonds."

Still, though, engineers are high on job security. In the survey, a resounding 86 percent said they felt reasonably to very sure their job was secure; perhaps that points to a recognition of their value in the face of upcoming technological change.

Engineering concerns

Keeping up with change. Indeed, it's those technology changes on the horizon that are keeping more than a third (37.5 percent) of cable's engineers up at night. (The remaining 62.5 percent had concerns smattered over 15 separate issues, the top 10 of which are summarized and ranked on pg. 60). And true to their stereotype, today's engineers are not only worried about *what* is changing, but *how* to make it work. Their pleas for training are loud and numerous:

"The cable job force has a limited amount of training," writes an engineer in Kansas. "Even the SCTE doesn't provide training, only certification. With the fast advances in technology, we can't meet the services required for the future."

Another engineer writes: "It's difficult enough finding the time required just to do my job and maintain my systems in top shape. My concern is being able to keep up with the changes that are constantly happening in cable TV."

Training. When asked to rank technical training, engineers are, for the most part, happy. More than 50 percent of the engineers said they were reasonably to very pleased with the training they're received in basic technical topics, safety, management of others, business management and overall training.

Reregulation, competition, and service. Of course, as in years past, engineers were quick to point out reregulation and potential telco, DBS and MMDS competition as line items on their worry lists—but those concerns were generally voiced as one-liners. Rather, what they did take time to write about was cable's need for better customer service. It seems today's engineer is painfully aware of cable's image problems, and he's willing to pitch in to repaint the picture.

A Maryland engineer writes: "We have been caught with our pants down on a number of issues, namely signal leakage, by not cleaning up our act. Instead of positioning ourselves to keep competition from becoming an issue, we raise rates, provide average service and try to cover it with a facade such as 'Cable Cares.' We should be the consumers' choice for video and audio services, but we do nothing to enhance our ability to provide those services, based on our need to exceed cash flow—when our margins are already beyond the hopes and dreams of other businesses."

Similarly, a Texas engineer says he has significant worries about consumer interface issues. "Consumer electronics are too complicated, and cable equipment is not compatible or friendly to use," he writes.

And in Michigan, one engineer says, "There is a perception out there that cable companies are classic robber barons squeezing their customers dry. This puts lawmakers in a position to bash cable, to the glee of municipalities and phone companies."

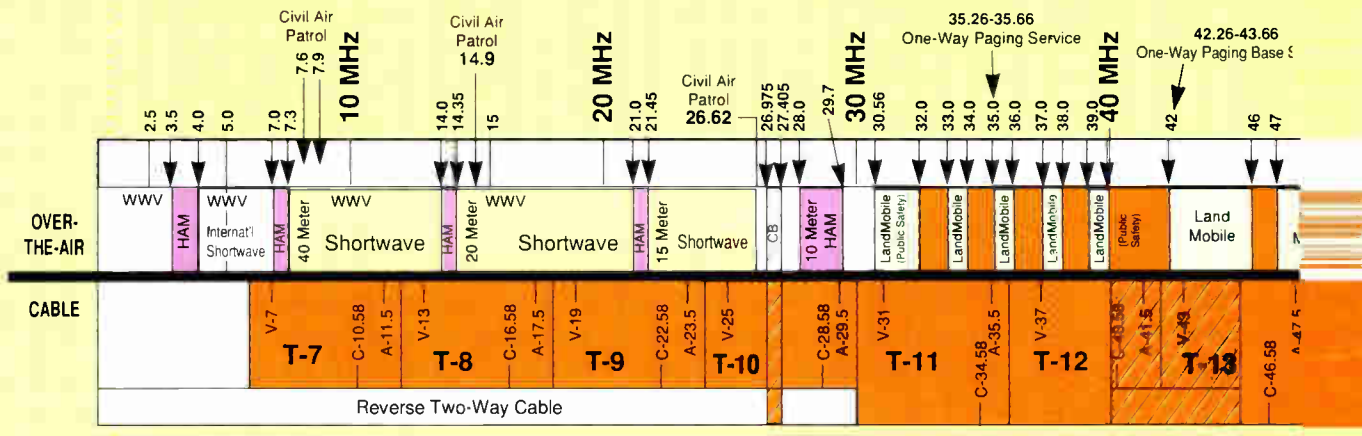
To remedy that and to get his digs in on corporate management philosophies, the same engineer says cable as an industry needs to spend more time on long-term planning. "Lack of vision is an issue with me," he continues. "The industry must have business plans covering 30 years—not 30 days. We need to put pricing and technology decisions in a long-term perspective."

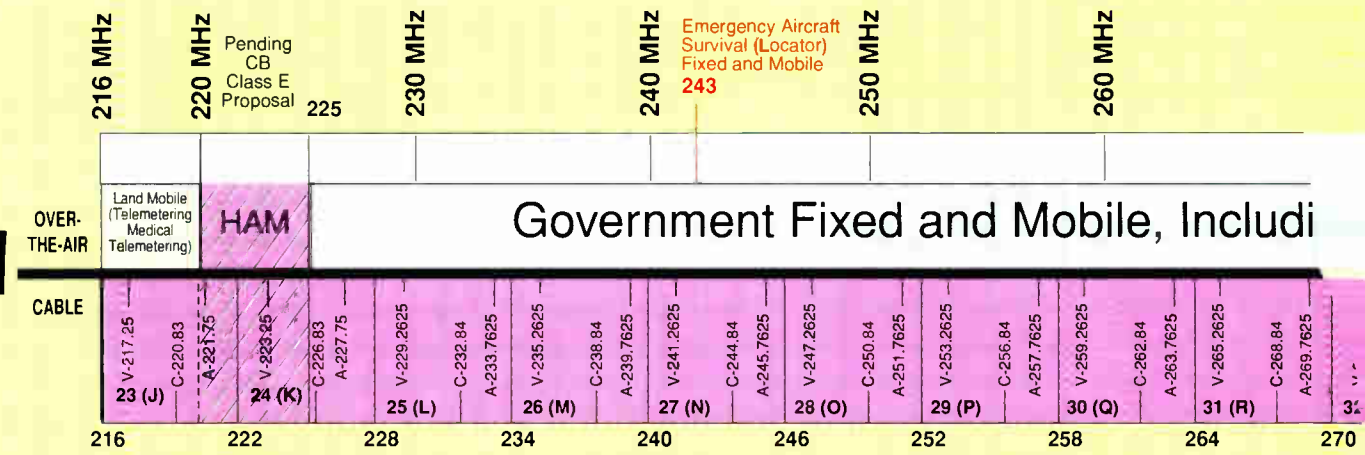
In keeping with the management-bashing, an engineer from Maryland says he's worried about corporate's concern for sales over technical issues. "Technical requirements continue to be put by the wayside," he writes. "It seems everyone is sell, sell, sell, and they hire more salespeople to do it. Whereas, if they were to maintain, maintain, maintain, they'd have to sell, sell, sell less and we wouldn't *need* all the salesmen. When are people going to start looking at the real picture?"

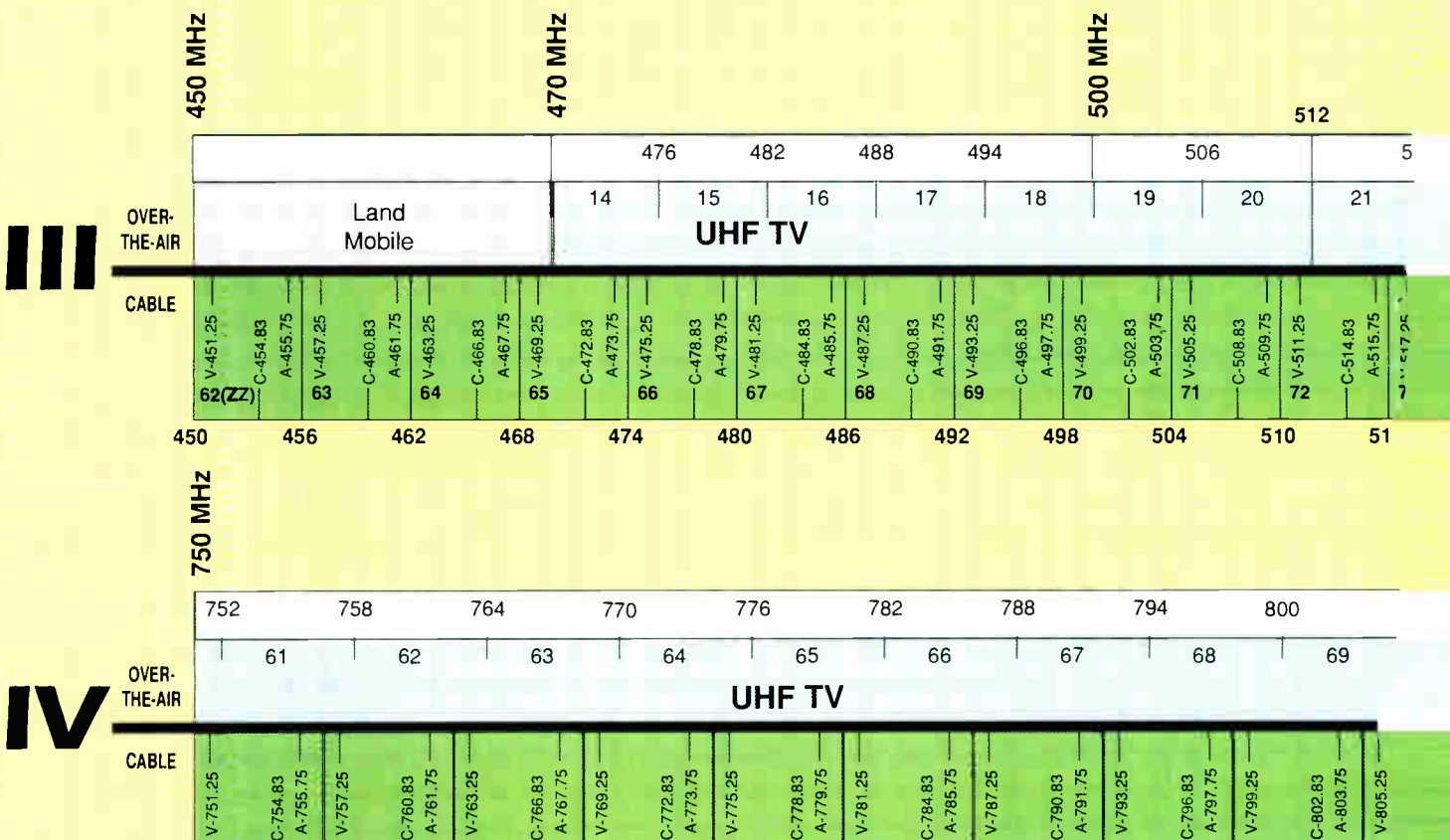
Managers

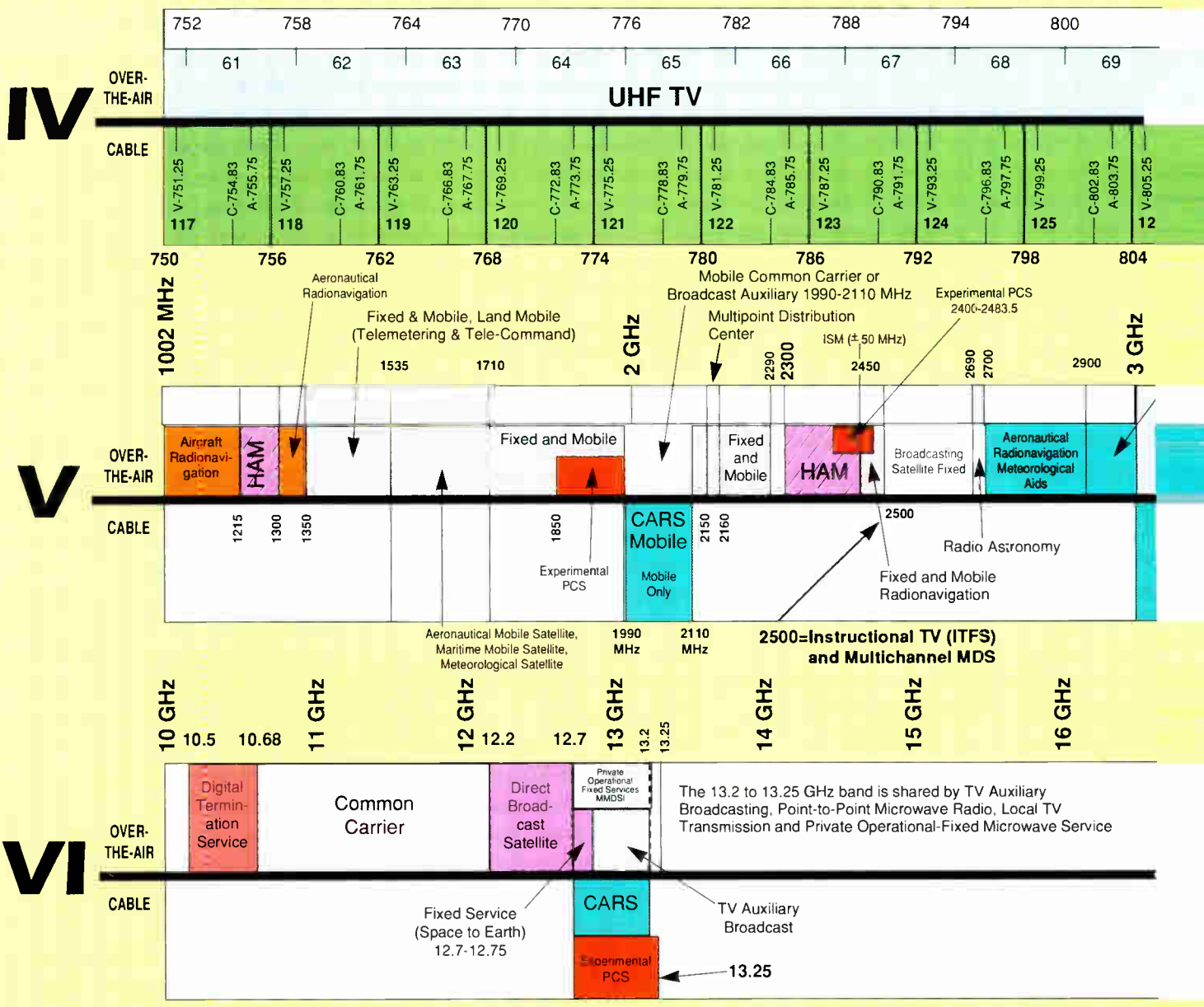
This year's typical manager—who represents cable's plant and system managers, presidents and VPs of engineering—is a little younger than his engineering counterpart, at 37.5 years old. He (no women responded in this category, either) brings home about

CED 199









CATV channel designations reflect the Cable Television Channel Identification Plan recommended by a joint committee of the Electronic Industries Association and the National Cable Television Association. Former standard designations appear in parentheses. This chart shows channel assignments as designated by a draft revision of IS-6 (which extends the channel designations to 1 GHz). Operators should be aware that this revision has not been officially accepted by the joint committee and is subject to change. It should be noted that sor using phaselock IRC channel spacing avoid i and 6 as designated on this chart. Instead, th cies so the video carriers are at 79.2625 MHz respectively, and usually designate those cha other than 5 or 6. The joint EIA/NCTA Commi sen to give these channel spacings any nume

Also note that CATV channel designated ca

1992-93 CED CATV Frequency Allocation Chart

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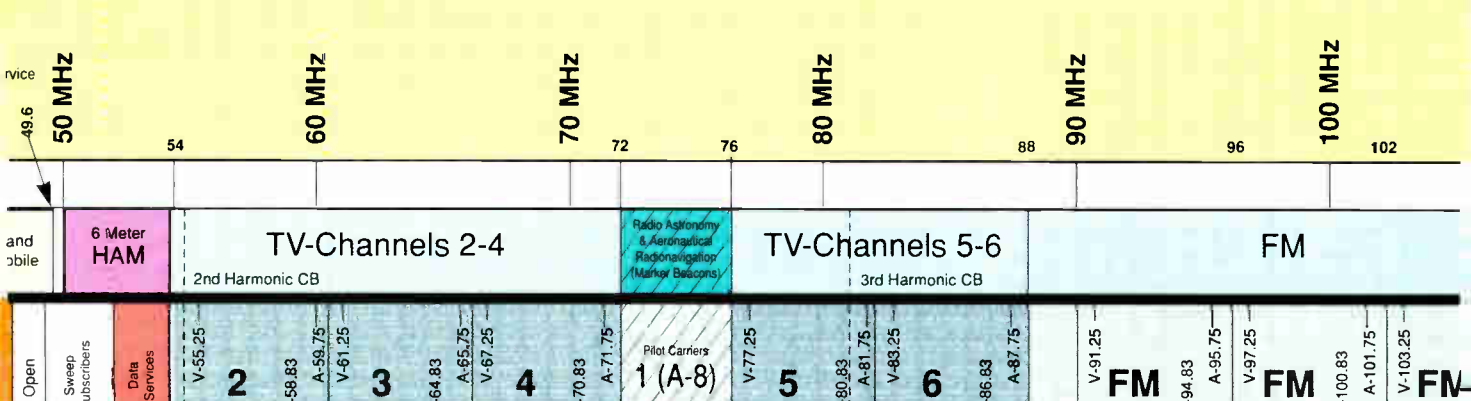
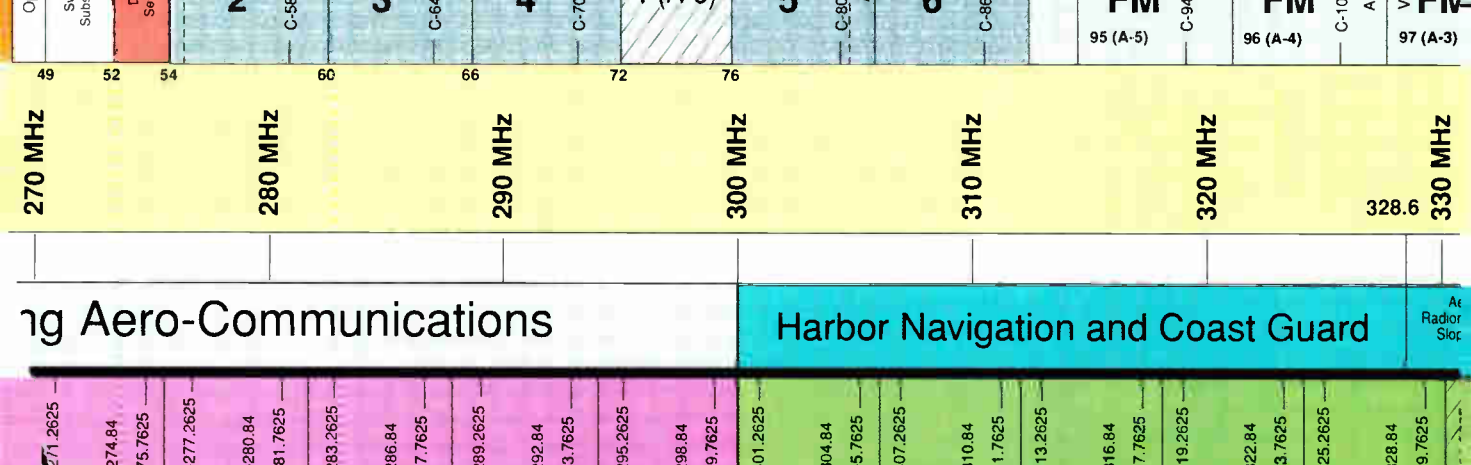
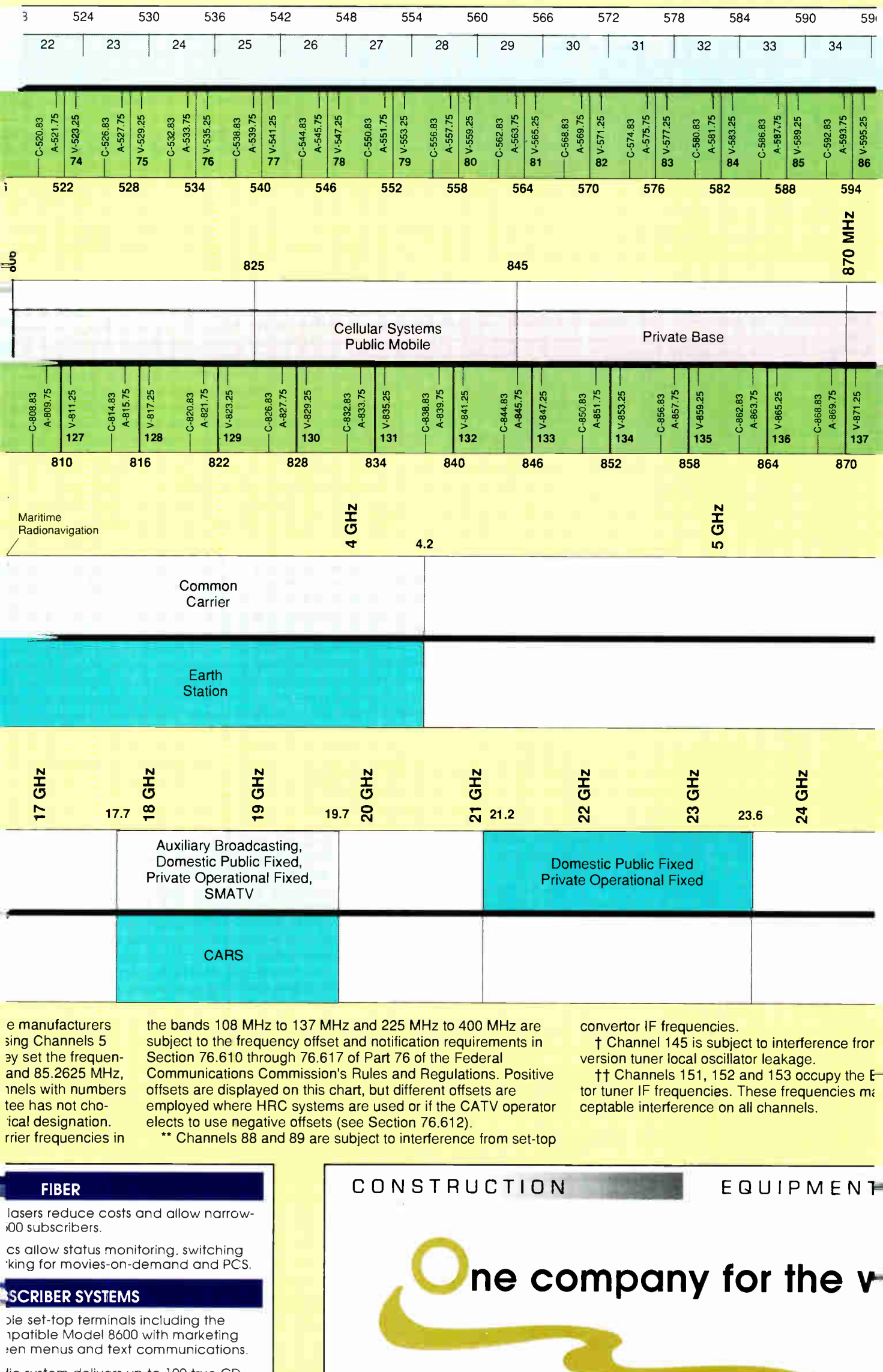
2-93 CATV







e manufacturers sing Channels 5 ey set the frequen- and 85.2625 MHz, nnels with numbers tee has not cho- ical designation. rrier frequencies in the bands 108 MHz to 137 MHz and 225 MHz to 400 MHz are subject to the frequency offset and notification requirements in Section 76.610 through 76.617 of Part 76 of the Federal Communications Commission's Rules and Regulations. Positive offsets are displayed on this chart, but different offsets are employed where HRC systems are used or if the CATV operator elects to use negative offsets (see Section 76.612).

** Channels 88 and 89 are subject to interference from set-top convertor IF frequencies.

† Channel 145 is subject to interference fror version tuner local oscillator leakage.

†† Channels 151, 152 and 153 occupy the E tor tuner IF frequencies. These frequencies ma ceptable interference on all channels.

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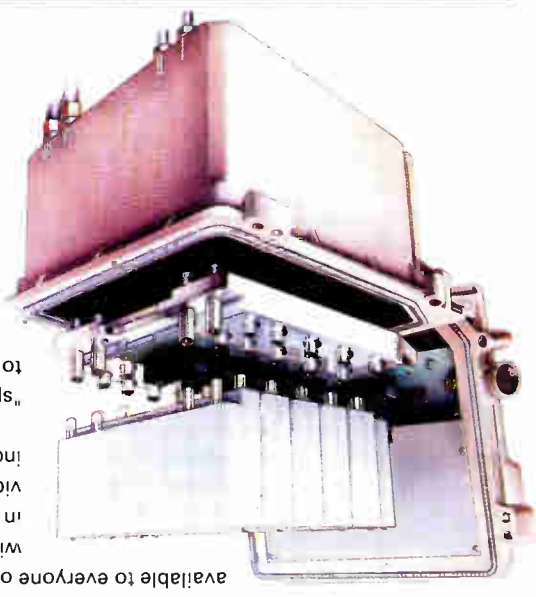

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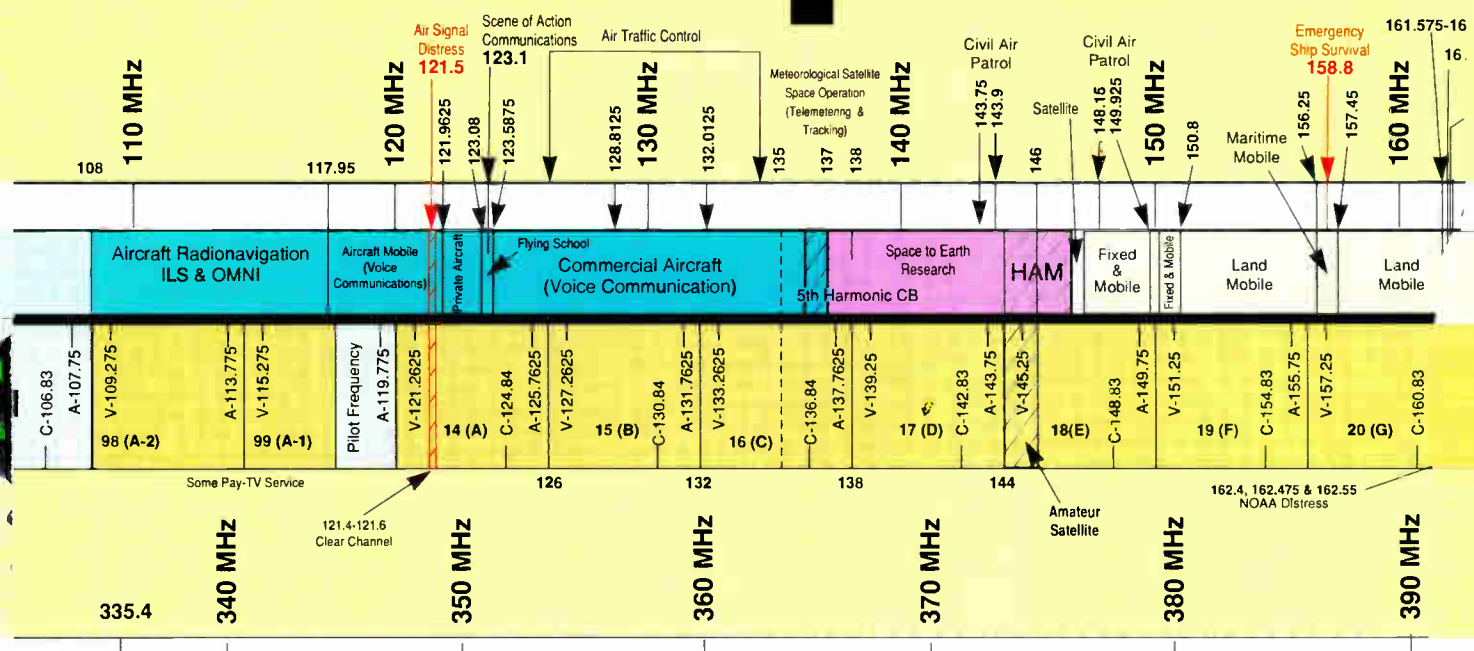

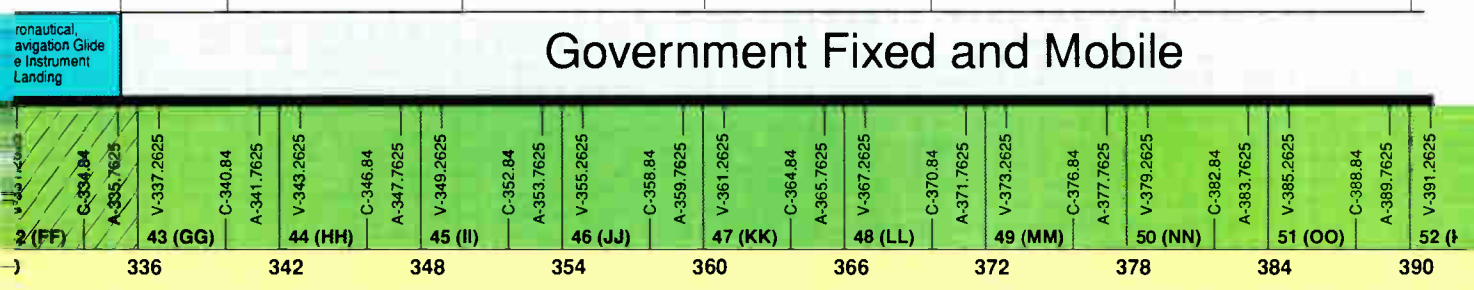

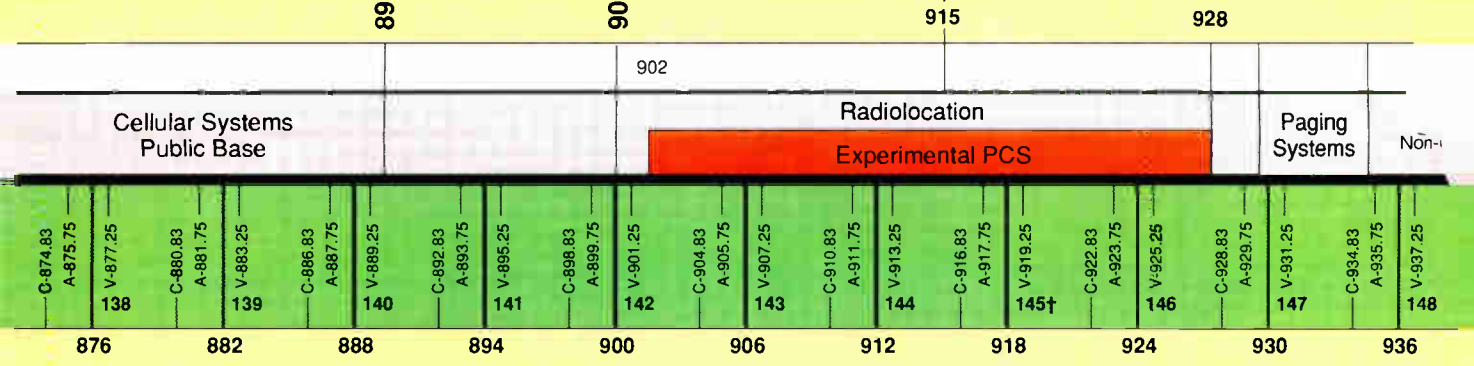

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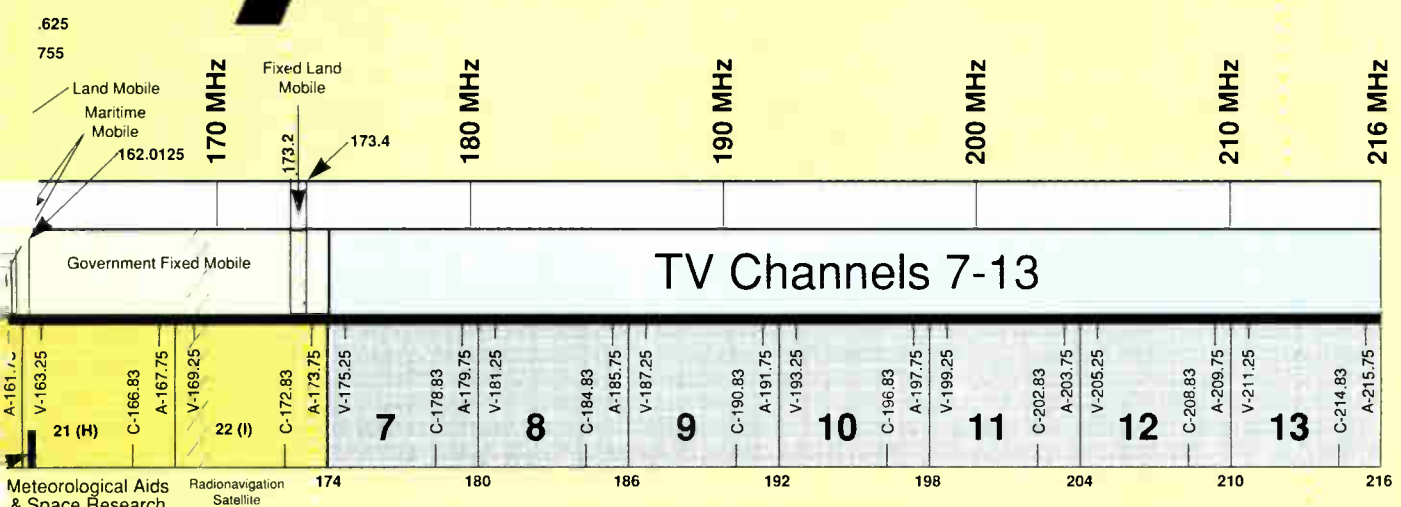

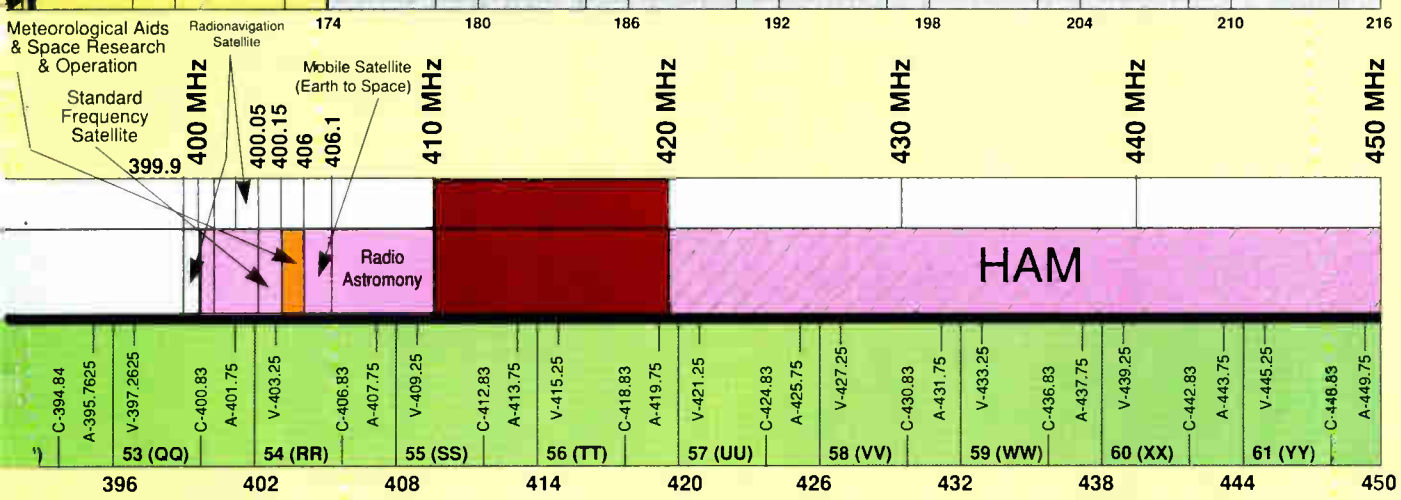

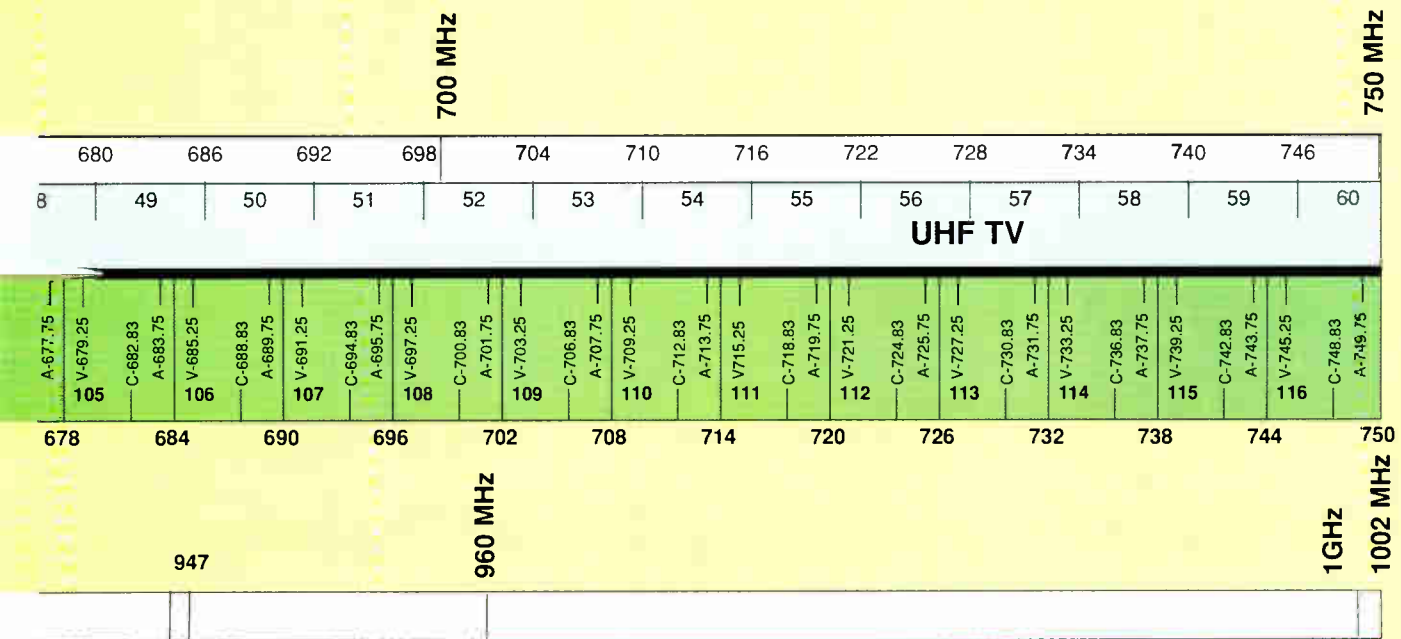

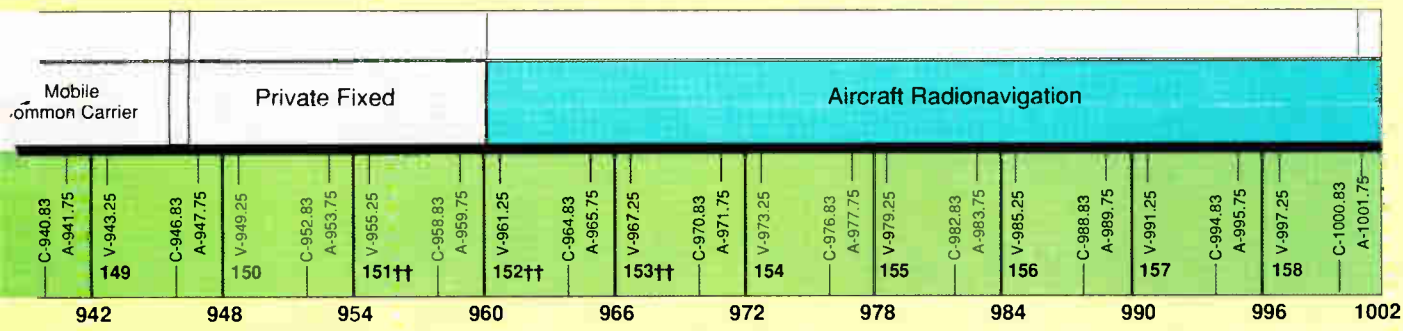

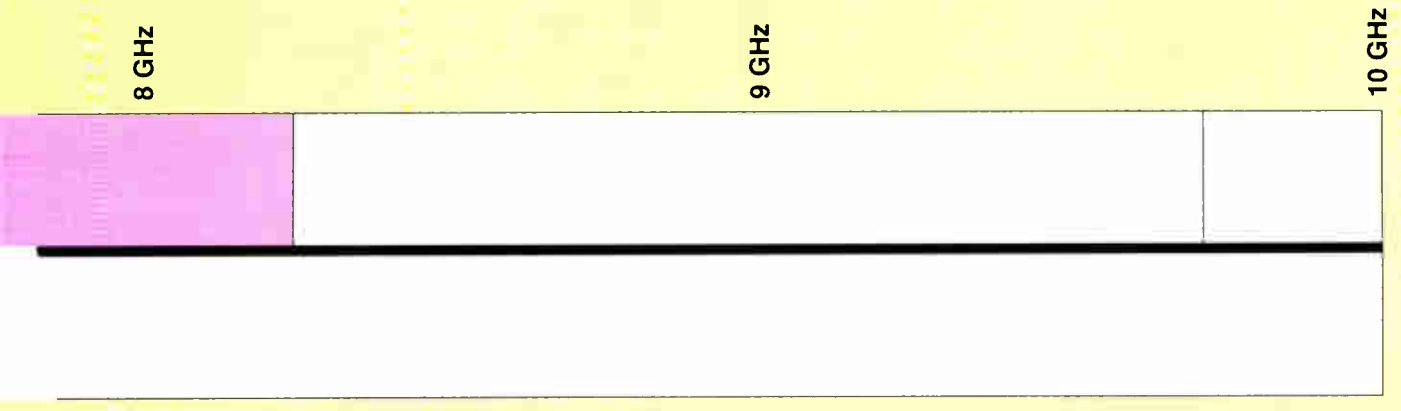

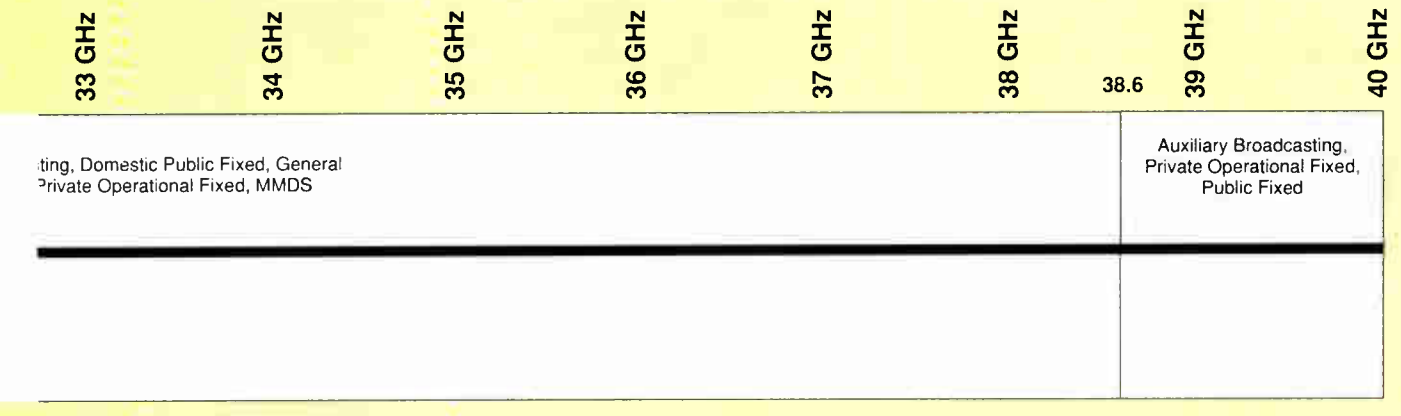

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$42,300 a year in salary, which marks a 10.2 percent raise over last year's wages of $38,394. Plus, he'll get close to $3,000 in spiff money this year. This "average" manager supervises about 12 people in a system with 10,000 to 20,000 subscribers.

Apparently, he's a man on the move. Although the average manager has been in the cable business for more than 15 years, responses on tenure were evenly split. Managers, when asked how long they've worked in their current systems, split between one-to-four years, six-to-10 years and over-15 years. They were split again when it came to the time spent in their current role—half said one-to-three years, half said four-to-six years.

He pays just a bit more than $55 a month for medical insurance, and $21 a month for dental. Each year, he gets two weeks (14 days) of paid time off.

Management concerns

Keeping up with change. Like the engineers, managers this year are worried about emerging technologies first and foremost. One engineer of a small system (1,000 to 5,000 subscribers) in Kentucky writes: "Being a small, independent system in a rural area, I am concerned that with all the new technical advancements to systems—multi-PPV, multiplexing, two-way—we cannot economically justify such technical capabilities. I'm afraid we will be perceived by our subscribers as not up to standards with larger systems."

Another manager in Oregon likens his fears of technology to an old-fashioned buggy ride. "Things are going *too* fast, with *too* little training, technical staff and time to think and plan," he writes. "We so often get caught up at being the best at everything—quality, capability or customer service—that we forget to hook up the horses before we attempt to take a buggy ride.

"Production (connects and disconnects), sales and customer fire extinguishing require so much of our time that we don't give our people the information (or the time to get to use it) and expect them to know the questions to ask," he continues. "We have done this for so long that if anyone doesn't understand the first time around, they're out of luck. The end result is mistakes and customer problems."

Re-regulation. Running a close second to technological change is concern

For the first time ever, all three respondent categories (engineers, managers and technicians) feel an above average comfort level when it comes to job security.

about regulation. Again, though, like the engineers, managers are non-specific when it comes to clearly defining *how* regulation will adversely affect them. Perhaps it's because they just don't know.

Still, a Massachusetts engineer writes that rate regulation would put "huge constraints" on the ability of his system to spend money on technical projects. One of those projects, he says, is fiber deployment—and if rate regulation is imposed, those future fiber projects could be put in jeopardy.

Competition ranked third on managers' worry lists this year—but not without some tongue-in-cheek cable bravado. "The phone companies are a real threat," writes an Indiana manager. "But when the consumers realize what they will be charged by telcos for a transfer, or to get hooked up to a convertor box, or get a service call for something like putting the TV back on the correct channel, those people won't pay what the phone companies charge to do these same basic things today.

"I paid $84 for a transfer four years ago, and my grandmother got charged $54 a month ago when a telephone technician had to run to her house to plug in a telephone," he criticizes.

A Maine-based manager says that competition would be good, but "only on an even playing field. If the phone company is allowed into our business and we can't effectively get into theirs because of barriers of entry—be it capital or otherwise—it would put this industry at a serious disadvantage. I believe the customer would bear the brunt of that decision."

Customer service. Customer problems again are a common thread weaving today's engineering managers together. A manager from Tennessee sums it up by blaming corporate management: "MSOs are lacking vision in regard to customer awareness," he writes.

In Oklahoma, a manager says his concerns revolve around one thing: Rate increases. "We pass (rate increases) off onto our customers with nothing to show for it. Cable's reputation isn't great as it is, and this alone should be looked upon more seriously."

Another manager from Tennessee blames the whole customer service problem on MSO selfishness. "I have been pleased with my career so far," he writes, "however, I see what seems to be greed on the part of some MSOs. I would like to see the industry return to customer awareness as was the climate 10 years ago."

Yet another manager from Maine says the whole industry is missing the point on customer awareness. "Cable at large is lacking a coherent, industrywide coordinated plan to react to problems like the consumer interface," he writes. "It really concerns me that some operators don't care about the industry. its image or its future."

Job satisfaction. Despite the written complaints, managers are *real* optimistic when it comes to compensation, job advancement and job security. A whopping 86 percent are reasonably to very satisfied with both compensation and job security, and 75 percent say their chances for advancement are good or better.

However, a manager from Massachusetts voices this concern regarding job advancement: "I am concerned that eventually we may end up putting ourselves out of work. I am currently in the process of eliminating my second headend with a fiber link, while also linking a 'sister' headend, which will leave them with no headend.

"Am I going to have to compete with my counterpart for a job in the near future? I am told no, but my business

System size versus 1992 salary

Engineers

System size by # of subs	High Salary	Low Salary	Average Salary
80,000+	High: $63,900	Low: $42,000	Avg: $53,580
40,000-79,999	High: $55,000	Low: $32,400	Avg: $45,433
20,000-39,999	High: $46,000	Low: $25,000	Avg: $34,750
10,000-19,999	High: $44,000	Low: $25,000	Avg: $35,292
5,000-9,999	High: $29,533	Low: $25,200	Avg: $29,533
1,000-4,999	N/A	N/A	N/A

Managers

80,000+	High: N/A	Low: N/A	Ave: N/A
40,000-79,999	High: $70,000	Low: $36,400	Avg: $51,880
20,000-39,999	High: $51,000	Low: $29,800	Avg: $43,094
10,000-19,999	High: $88,000	Low: $28,000	Avg: $38,500
5,000-9,999	High: $42,000	Low: $33,000	Avg: $38,533
1,000-4,999	High: $41,000	Low: $27,500	Avg: $33,600

Technicians

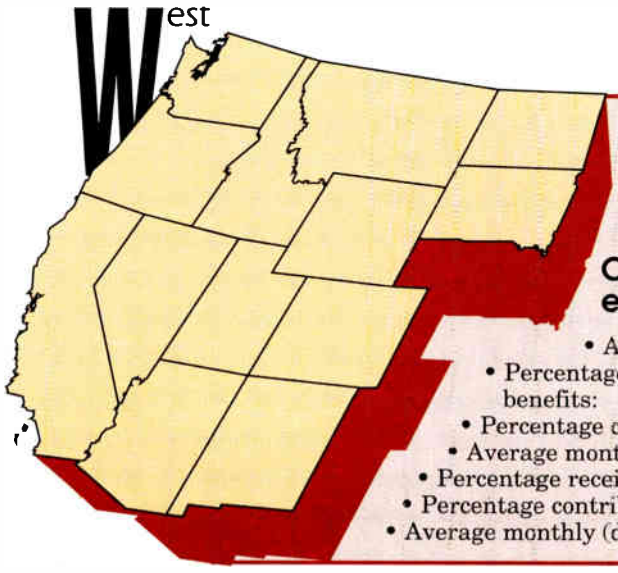
80,000+	High: N/A	Low: N/A	Avg: N/A
40,000-79,999	High: N/A	Low: N/A	Avg: N/A
20,000-39,999	High: $39,000	Low: $19,800	Avg: $29,750
10,000-19,999	High: $34,000	Low: $22,800	Avg: $29,500
5,000-9,999	High: $37,000	Low: $26,000	Avg: $30,565
1,000-4,999	High: $35,000	Low: $21,600	Avg: $29,900

Engineers, managers and technicians who live in the Northeast make the most money compared to other geographic regions.

sense tells me differently," he writes. "Don't get me wrong—I'm very happy with my job. I just want growth, and opportunities are limited now, so I feel stuck!"

Other than that, though, it seems today's managers are downright pleased with just about everything, according to a series of ratings scales. In addition to the high marks given to job satisfaction issues, managers are largely pleased with the training they've received: 81 percent say they were reasonably to very pleased with basic technical training, and 78 percent gave the same rating to safety training.

Another 75 percent are pleased with personnel management training, and 76 percent say their overall training experiences have been good or better. Indeed, the only weak training area appears to be in business management training, where 71 percent say their training was weak to satisfactory.



Average salary, 1992

Managers—**$38,909**
Engineers—**N/A**
Technicians—**$30,250**

Overall averages (managers, engineers and technicians)

- Average number of people supervised: **6.6**
- Percentage receiving fully paid medical benefits: **30.3**
- Percentage contributing to medical insurance: **69.7**
- Average monthly contribution: **$72.75**
- Percentage receiving fully paid dental benefits: **22**
- Percentage contributing to dental insurance: **52.25**
- Average monthly (dental) contribution: **$18.00**

Today's technicians

The 1992 "average" technician is about the same age as his management cohort, at 37.5 years. He makes about $31,100 a year, not including about $1,400 in bonus money. The 1992 salary alone represents a 13.1 percent increase from last year's salary, which rang in at about $27,400. He's been in cable for 10 or more years, and has been working for the same employer in the same role for four to six years.

He supervises an average of 8.5 people in a medium-sized system of 10,000 to 20,000 subscribers. Each month, he pays about $70 for medical insurance and another $20 for dental. He gets two weeks (14 days) of paid vacation each year.

Interestingly, the one female survey respondent falls into the ranks of the technicians. She's in her mid-30s and works in the western region. Apparently, she changed jobs this year, because she now supervises a dozen workers and received a whopping $11,000 raise since last year. From the looks of her survey, she's pretty upbeat—she gave high or satisfactory marks to the

> "Cable at large is lacking a coherent, industrywide coordinated plan to react to problems like the consumer interface."

1992 Top 10 issues of concern

Management

1. Keeping up with technological change
2. Reregulation
3. Competition (DBS, telco)
4. Better/more training needed
5. Job security/compensation
6. Better customer service needed/staffing concerns(tie)
7. Gripes with corporate management
8. Bad overall cable industry image
9. Not enough time to do job
10. Technical standards/franchise renewals (tie)

Engineering

1. Keeping up with technological change
2. Better/more training needed
3. Competition (DBS, telco)
4. Better customer service needed
5. Reregulation
6. Job/system stability (too many takeovers)
7. Compensation
8. More long-term planning needed
9. Morale/stress
10. New FCC technical standards

Technicians

1. Gripes with corporate management/budget cuts (tie)
2. Reregulation
3. Signal leakage
4. Compensation
5. Keeping up with technological change
6. Better/more training needed
7. Safety practices
8. Staffing
9. Competition
10. New FCC technical standards

training she's received in all categories, and says she plans to stay in cable for a while. Her biggest concern, she writes, is re-regulation, because "it could create hardships within the industry."

Technician concerns

Beefs with corporate management. It seems the 1992 technician just doesn't see eye-to-eye with his corporate leaders. Gripes like this one from a technician in Oregon are common: "The company doesn't understand the total complexity of the system level operations," he writes. "Too much of the time, reports and logs are required that there isn't enough time to compile."

Another Oregon tech says he feels let down by understaffing. "There aren't enough people to complete the work corporate wants done—CLI, proof of performance and testing," he writes.

And in Georgia, a concerned technician writes: "There's no commitment from corporate management to solve signal leakage problems. It's like there's no time or money to spend on leakage. I'm told my system had better not be fined by the FCC, and if it is I will be fired—but when I ask for manpower or a rebuild to solve leakage problems, my requests fall on deaf ears."

Compensation and benefits. As in years past, technicians still spend a fair amount of time grousing about the thickness of their wallets, despite the fact that this group received the highest overall percentage raise this year. In this year's ranking of compensation, two-thirds—67 percent—said they were dissatisfied to moderately satisfied with their wages.

An example of many complaints about wages comes from this Indiana tech, who perhaps had a few too many late-night pole climbing sessions for his taste when he wrote this: "I get paid too little money for the amount of stress involved. Managers expect you to eat, live and breathe CATV and do not want to compensate you for it."

> "We so often get caught up at being the best at everything...that we forget to hook up the horses before we attempt to take a buggy ride."

We had to take a second look when we read this response from a technician in Arkansas—apparently, he has a different idea when it comes to telco intervention. Instead of seeing the potential competition as a threat, he writes: "I feel it (telco entry) will help my benefits."

Re-regulation. Although the uncertainty of what "re-regulation" will mean led to many techs just mentioning the word as a one-liner, a technician from Kentucky had this comment: "Regulation could stifle technical advancements and drive rates up to the point that many customers couldn't afford our product."

Budgets and the future. One common concern among the technicians was the effect of budget cuts on their day-to-day business. Writes this Arizona hand: "At this point, I'm concerned that our system will not have sufficient budget to meet the new technical standards."

Following that line of thinking is a New Jersey-based tech, who says: "I'm hoping the company will be able to invest in new and cost effective equipment. I'm also hoping that the company will be able to stay cost effective and make money. That way, I can keep my job and continue to grow technically and professionally."

Career advancement and job security. Like the engineers and managers, technicians have few qualms about job security. In fact, 85 percent of the technicians surveyed said they feel reasonably to very comfortable about their job's immunity.

The flip side of the security coin, career advancement, also got high scores from the technicians—78 percent gave

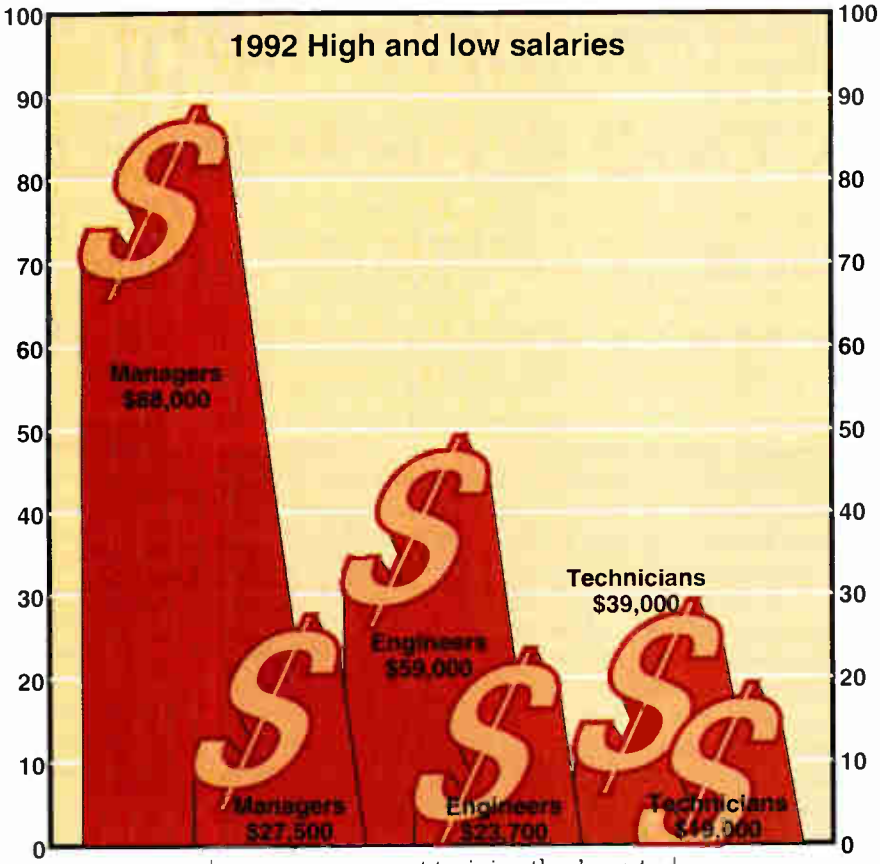
the category a satisfactory to high rating. This marks a radical change from what technicians said five years ago. Back then, technicians rated their chances for advancement and growth within their companies as below average.

Training. Interestingly, none of the technicians surveyed gave the highest rating (a "5") to their overall training experience. The majority said their training was about average, and a quarter (25 percent) said the overall training they've received over the years is less than satisfactory.

Specifically, techs say the basic technical training they've received is average to slightly above average. Only one respondent gave glowing remarks to technical training; 78 percent said technical training was average or slightly above average. A little under a fifth, or 17 percent, are dissatisfied with the technical training they've received. Safety training also got satisfactory to above average ratings from the technicians, at 75 percent

But technicians aren't particularly happy with the management training they've received. Keeping in mind that the "average" technician supervises about eight people, a shade under half of the techs surveyed (42 percent) said the personnel management training they've received is below average. Almost a third (28 percent) ranked that training as about average, and the remaining third gave above average ratings to the training.

Business management received resoundingly bad marks from the techs. More than half, at 57 percent, said their business management training experiences have been less than satisfactory. A third rated the training "satisfactory," and the remaining 14 percent said the business management training they've gotten is above average. None of the technicians surveyed, though, gave business management training the highest ranking ("5").



The worm turns

Undoubtedly, the cable engineering community has made some interesting shifts and turns over the past five years. In the early years of this survey, for example, engineers and technicians cited low wages and lack of training as their biggest complaint.

Those grumbles have slacked off to some degree in recent years, perhaps indicating the maturation of the industry. After all, the engineering crowd has consistently been paid more money over the past five years—and while those increases may not yet be financial nirvana, apparently it's enough to whet appetites to stay in cable.

Competition and regulation continue to appear as a nagging, ever-present worry to the cable engineering folks, and usually appear in the top three industry concerns lists. Last year, though, training topped the list, as the engineering staffers presumably wanted more and better training to increase their chances for improvement.

And now, this year, it's that race to keep up with change—the first time it's been the top concern. It's interesting to note that just five years ago, engineers *did* say they were concerned with keeping up with emerging technologies, but identified those technologies as animals such as "fiber optics." (My, how times change.)

Obviously, issues such as fiber optic deployment are well under control these days, which illustrates one more time the lithesome nature of cable television. With technologies like digital compression, alternate access and PCS—just to name a few—seemingly right around the bend, it will be interesting to see just how limber cable's engineering culture can be.

Maybe in another five years, we'll be chuckling at the current uncertainties about these technologies. We'll just have to wait and see . . . . **CED**

By Leslie Ellis

Number one rated concern, 1988 - 1992

	Managers	Engineers	Technicians
1992	Keeping up with change	Keeping up with change	Tie between budget restrictions, gripes with corporate management
1991	Training	Reregulation	Reregulation
1990	Reregulation	Reregulation	Reregulation
1989	Competition	Training	Compensation
1988	Competition	Training	Compensation

ternal to the test bed is a 32-channel headend made up of Jerrold Commander 6™ agile modulators. On the Commander 6 modulators, the frequencies have been all offset by +12.5 kHz from the nominal carrier frequencies. There are a few wide-tolerance carrier frequencies, and if they are discarded, the standard deviation of the remaining frequency errors is found to be 192 Hz. This low standard deviation represents very tight frequency control.

Figure 2 is a bar graph of the deviation from nominal frequencies of 32 channels in the Matrix (formerly Dix Hills) signal generator located at the CableLabs facility in Boulder, Colo. The frequency alignment of the individual channels in the Matrix generator was more conventional, and the standard deviation of the frequency error was found to be 1260 Hz, after the few wide-tolerance carrier frequencies were discarded. The carrier frequencies are all nominal on the Matrix generator.

The CTB for the test bed is generated by a cascade of five Jerrold trunk amps. The CTB in Boulder is generated by a cascade of eight Magnavox trunk amps, a bridger and two line extenders.

If only the interfering composite triple beats generated by each set of carriers is presented in the time domain, the result is shown in Figure 3 and Figure 4 for the Jerrold headend and Matrix signal generator, respectively. The CTB data was captured on channel 12. Only continuous wave (CW) carriers were used to generate both CTB vs. time diagrams.

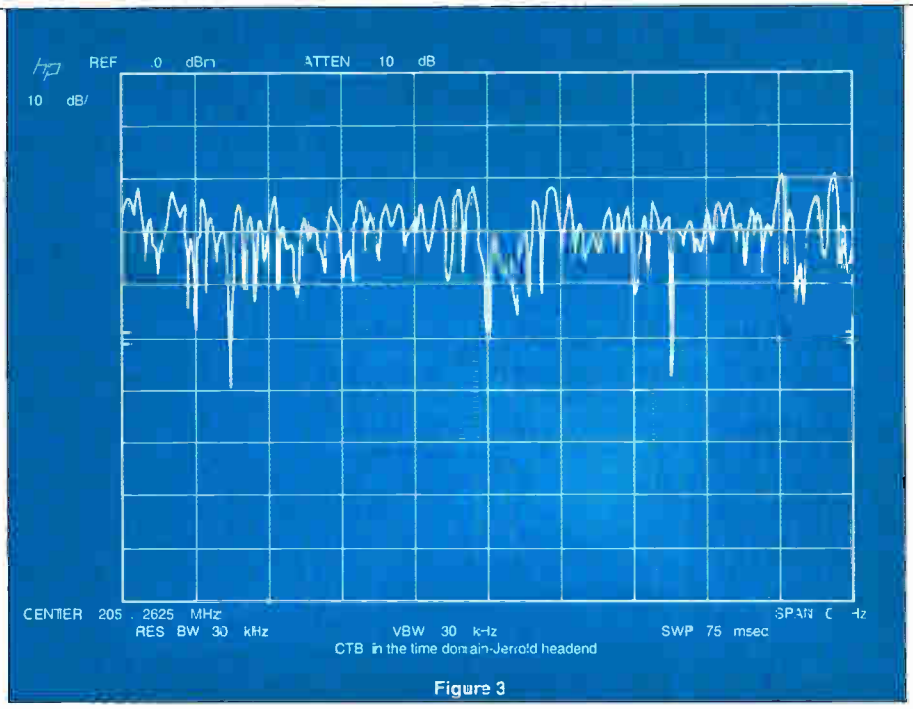


Figure 3

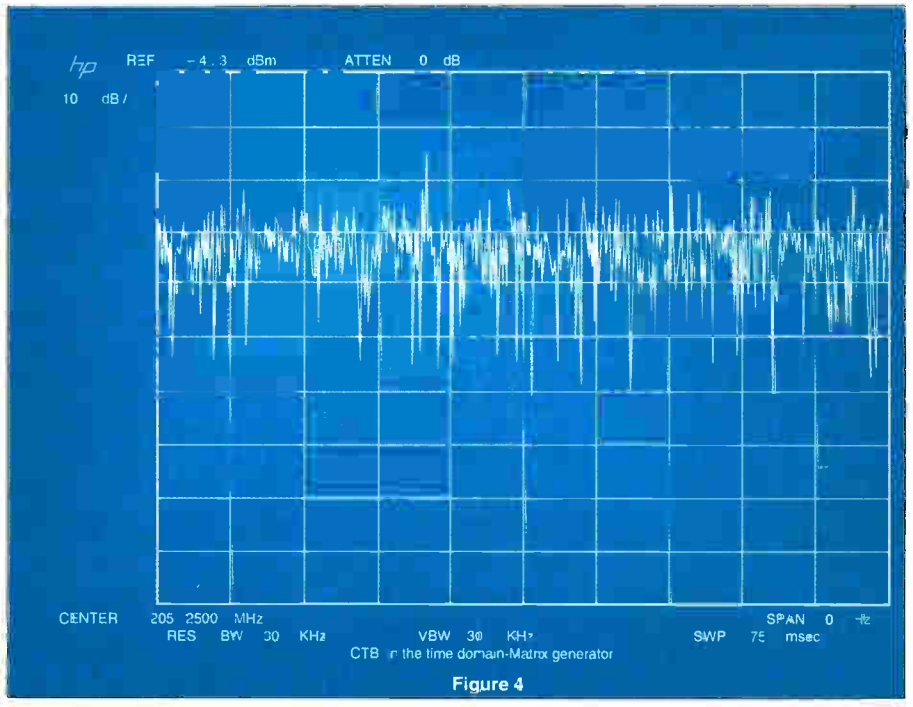


Figure 4

Readers may not have seen this type of plot before, because the NCTA *Recommended Practices* method calls for a frequency domain sweep, with 10 Hz video filtering and a resolution bandwidth of 30 kHz. Both Figure 3 and Figure 4 use zero span and a 75-millisecond sweep time, 30 kHz resolution bandwith, 30 kHz video bandwidth, and 10 dB per division vertical scale. The note that the Matrix generator originated CTB produces faster amplitude fluctuations.

Visually, CTB looks like moving dark horizontal streaking lines when interfering with an NTSC transmission. The lower frequency CTB of a very accurately aligned headend produce thicker (vertically) dark lines, and this impairment appeared somewhat more objectionable than the finer dark lines generated by a headend with less accurate frequency alignment. However, this observation was not quantified by any rigorous subjective analysis.

A model of CTB

In an effort to understand the nature of the CTB distortion, a computer program was written to model the beats with vectors. This program generated a number of beat-simulating phasors with constant Gaussian distributed amplitudes and constant Gaussian distributed rotational frequencies, combined them to a vector sum, and then plotted the sum in both the time domain and as a vector diagram.

Box-Muller algorithm

The Box-Muller algorithm, a method to make Gaussian distibutions from uniform ones, was used to generate the distribution. The number of carriers was variable, but above about 20 carriers, the visual appearance of the time domain plot is about the same (note that with real CTB, using a headend with many channels, the number of beats

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could be in the thousands). A Gaussian distribution was chosen for the magnitude and the phase rotational velocity as a first-order approximation. The standard deviation of the angular velocity of the phasors was chosen to be the same as the measured data (192 and 1260 Hz respectively)

Equations (5) and (6), respectively, give the real and imaginary components of the sums of all of the component beats.

$$(5)\qquad Ei(t) = \sum_{n=1}^{m} A(n)\cdot\cos(\omega(n)t)$$

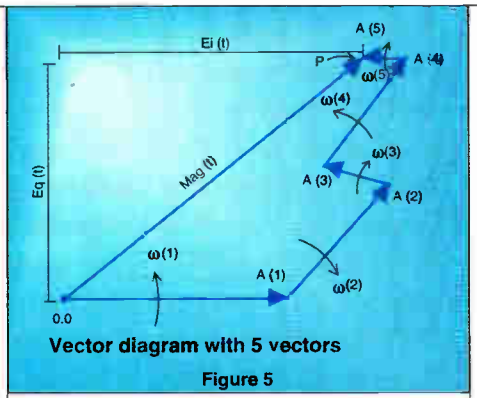
$$(6)\qquad Eq(t) = \sum_{n=1}^{m} A(n)\cdot\sin(\omega(n)\cdot t)$$

where A(n) is the amplitude of each respective beat, and $\omega(n)$ is the frequency of the beat, and m is the total number of participating beats.

The magnitude plots are given by:

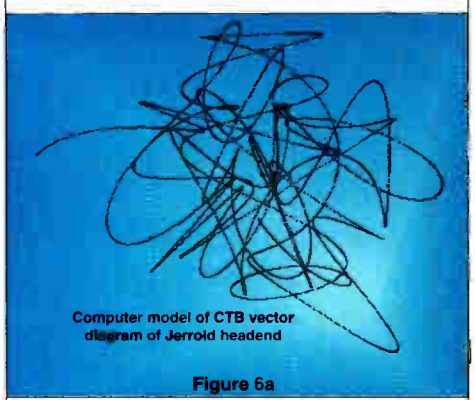
$$(7)\qquad Mag(t) = \sqrt{Ei(t)^2 + Eq(t)^2}$$

A simplified graphical vector representation of equations (5)-(7) is shown in Figure 5. For illustration purposes, only five vectors are plotted, each with a randomly chosen fixed amplitude, and a randomly chosen fixed angular rotation. What is interesting about these vector diagrams is the trajectory that point P takes as a function of time. The trajectory, or path, appears to meander aimlessly in vector space, like scribbling on paper. However, the vector path is not random; it is deterministic and the vector sum of the many individual beat components.



Vector diagram with 5 vectors

Figure 5



Computer model of CTB vector diagram of Jerrold headend

Figure 6a

Comparing the model to measured data

Figure 6 and Figure 7 are the computer models that mimic the tightly aligned Jerrold headend. Figure 6A is a vector diagram produced by 20 phasors with randomly chosen but fixed amplitudes and phases, and a standard deviation of 192 Hz. The trajectory taken by the vector sum shows the characteristic scribble path. Figure 6B is the corresponding magnitude vs. time diagram.

Figures 7A and 7B are computer models that model the more conventionally aligned Matrix generator. Figure 7A is a phasor diagram, and Figure 7B is a magnitude vs. time plot, but the standard deviation is 1260 Hz. If Figure 3 (measured) is compared to Figure 6B (computer model) and Figure 4 (measured) is compared to Figure 7B (computer model), the results are seen to be comparable.

Observe that when the trace on the phasor diagram passes close to or through the origin, the magnitude plot drops to a very low value. If the vector diagram of Figure 6A is compared to Figure 7A, it can be observed that 7A has a lot more ink. The reason is that the higher frequency component of the CTB allows the vector to move around the chart many more times in the 75-millisecond simulation time period.

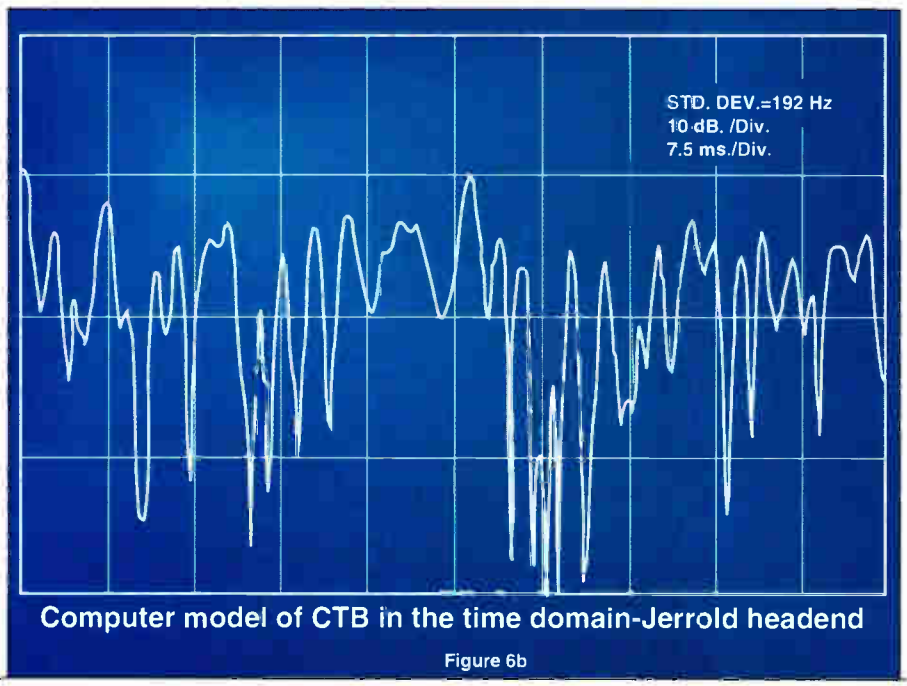
Note that a headend built with many channels on nominal frequency and many others offset by +12.5 kHz, with the channels all very tightly aligned, would have spectral energy of CTB clustered around at least two frequencies. Some of the energy would be around the nominal channel frequency, and some around the offset channel frequency.

What's the use?

Although it is fascinating to watch the phasor diagram plot out its trajectory on the computer display or vectorscope, one might ask of what use is this analysis technique.

The first thing that comes to mind is the ability to take a look at the system's CTB and know approximately the channel alignment standard deviation, a statistic about how well the headend is aligned.

The second observation is that this low frequency CTB has a noticeably different visual appearance when interfering with an NTSC transmission, and this look may become more common as the frequency accuracy of headends is improved.



Computer model of CTB in the time domain-Jerrold headend

Figure 6b

Effects on digital transmissions

It is important to note that the CTB impairment being discussed here is generated by CW or NTSC carriers with a CW component. This discussion does not apply to CTB generated by numerous digital carriers. The digital carriers are expected to be noise-like and not to have a strong CW component in their spectrum.

The distribution of the CTB energy

Computer model of CTB vector diagram of Matrix generator

Figure 7a

should be first examined to predict the effect on a digital transmission. Figure 8 contains an actual measured amplitude distribution, as well as a computed distribution. The measured data were

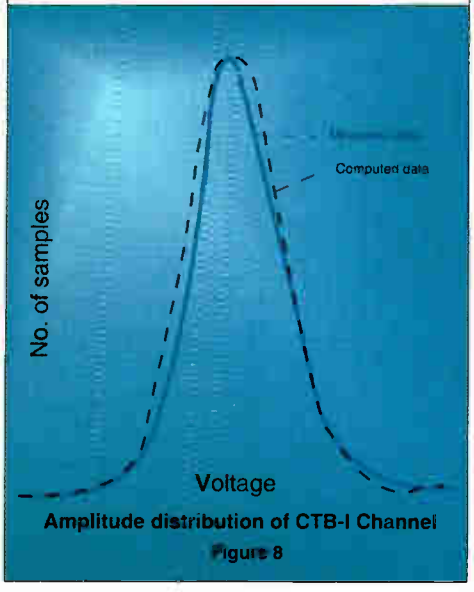
A view of CTB in the time domain and a phasor analysis should help predict the effects of CTB.

taken on only the in-phase component of the CTB. The CTB was generated using the Jerrold headend and distribution gear in Alexandria. These data were sampled using a HP8981A vector modulation analyzer under computer control. For comparison, the dotted line is the in-phase distribution from the computer model using 80 random carriers.

A visual examination of the spreads shows the peak was somewhat narrower for the measured data, possibly indicating that a lot more than just 80 beats were participating in the vector sum of the measured CTB. A rigorous analysis was not done on this distribution.

On digital transmissions, one effect that might be expected of an NTSC-induced CTB impairment is that, because of the nature of its amplitude distribution, the sharp failure thresholds associated with Gaussian noise probably will not apply with CTB. Also, the low frequency content of the CTB energy may give the digital error correcting codes some problems due to the large number of adjacent symbols that will be affected when a CTB induced error event occurs.

Unlike Gaussian noise, the magnitude of the maximum value of the CTB

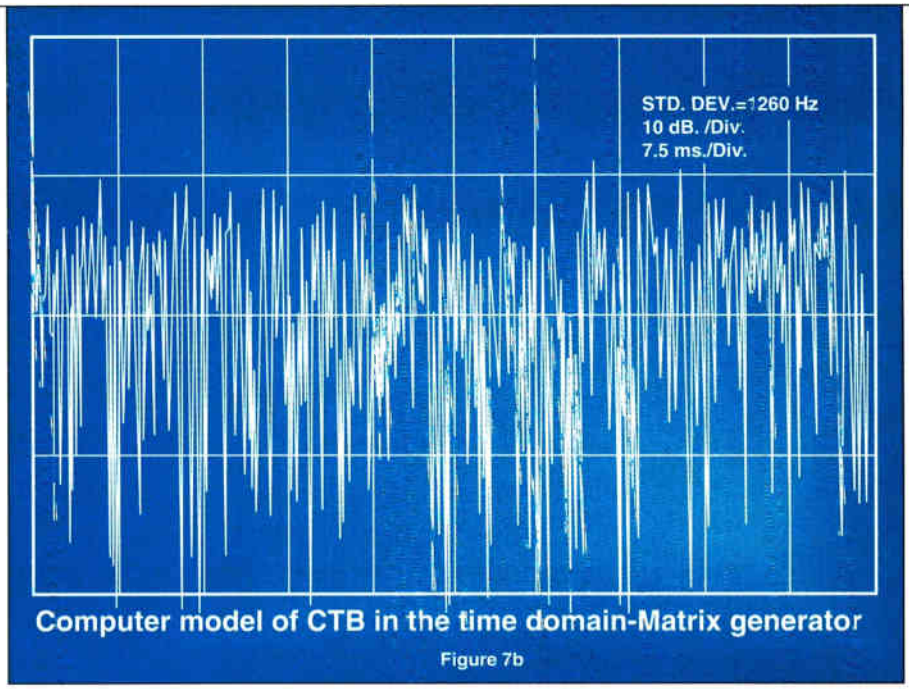


Amplitude distribution of CTB-I Channel

Figure 8

distortion is bounded. It can never get any greater than when all of the vectors are aligned, although one might expect that the peak to average levels or peak to rms levels will vary with the number of beats, and that the very near peak values may occur infrequently in time.

Another observation is that the CTB phasor has a peak which is higher than the number measured by the video-averaged NCTA *Recommended Practices* method, and that this high instantaneous interference level could cause errors with digital signals, at least more than would be expected by examining the conventional CTB specifications for a system.



Computer model of CTB in the time domain-Matrix generator

Figure 7b

For example, on the CTB generated in Boulder, the rms power in the beat was only 4 dB greater than the NCTA *Recommended Practices* measurement, but note that the peak power (over a 60-second measurement period) was 24 dB above the NCTA *Recommended Practices* measurement! The interference, of course, depends on the statistics of the CTB phasors, the type of digital transmission, and the level the digital carrier is being carried on the cable system, etc.

Composite second order distortion (CSO) can likewise be analyzed by this technique, however the number of beats making up the vector sum will be much smaller.

Summary

Presented here is a different way to look at an old distortion. A view of CTB in the time domain and a phasor analysis should be useful in predicting the effects of the CTB impairments on digital carriers. Additionally, it will help explain any changes in appearance of this distortion in an NTSC environment. CED

Ad Index

DSL technologies: new hope for telcos?

Lately, there has been considerable excitement in the telephone arena concerning enhancements to the telco's digital subscriber line (DSL) technology. These enhancements offer methods of achieving high bit rates over existing copper plant. Known as asymmetrical digital subscriber line (ADSL) and very high ADSL (VHDSL), the technologies have emerged as leading candidates for the distribution of video to the home over existing twisted-pair cable.

To better understand how these technological enhancements will impact competition, it is necessary to examine and understand the telephone company's existing infrastructure. From there, an examination of the DSL technologies and their applications will be explored. It is hoped that cable operators and technical personnel will have a better understanding of what the technologies can do—and whether they actually represent potential competition.

The local loop

Our examination will focus on the local loop (see Figure 1). This section of the local loop originates at the customer's premises and terminates into a piece of digital multiplexing equipment either in the central office (CO) or located at a remote terminal site. The local loop plant contains a variety of splices, different gauged twisted pairs, and bridged taps which cause transmission characteristics to vary from loop to loop. These variations generally do not affect the voice channels used for telephone services, but are significant when attempting to deploy high bit rate digital transmission.

Added to these variations, the local loop also uses load coils for equalization of the voice band on long distribution runs—another serious impediment to digital transmission. These long distribution lengths resulted in the introduction of the carrier serving area (CSA) guidelines in 1980. These guidelines called for the shortening of the distribution loop lengths to enable telcos to provide digital services in the 64 kilobit region. The CSA guidelines were instituted for the digital loop carrier (DLC) system.

DLC systems were initially installed to allow the telcos to more effectively use their existing plant. Because load coils are required on distribution links that exceed 18,000 feet (18 kilofeet), the CSA guidelines required links to be designed to less than 18 kilofeet.

At about the time the CSA guidelines and DCL systems were being introduced and implemented, interest in integrated services digital network (ISDN) began. Exploratory work on ISDN led to the existing architecture of two bearer (B) channels of 64 kilobits (kb/s) each and a delta (D) channel of 16 kb/s. The D channel would be used for packet data applications (transmitting "packages" of data) and for signaling control applications.

The local loop plant contains a variety of splices, different gauged twisted pairs, and bridged taps.

The digital subscriber line (DSL)

It is important to understand that exploratory work on ISDN helped digital subscriber line (DSL) technology become a reality. ISDN basic at the DS1 rate (1.544 mb/s) led to the concept of HDSL (high digital subscriber line). HDSL will use two twisted-pair wires to transmit 1.544 mb/s data signals within a CSA. This is primarily intended as a T1 service for business customers. HDSL equipment is now being deployed by future-oriented telcos.

HDSL is not suited for residential use because of its high cost and specialized line code (2B1Q). A more promising DSL technology known as asymmetrical digital subscriber line (ADSL) has emerged as a leading candidate for residential deployment.

ADSL promises much

ADSL would use one twisted-wire pair to provide a 1.544 mb/s signal and lower bit rate channels. It has the capacity to cover the entire local loop including businesses–whereas HDSL is for business use only. ADSL technology uses one 1.544 mb/s channel which rides on top of a lower speed, full duplex voice channel (64 kb/s); and an upstream, low speed control and maintenance channel (16 kb/s) that allows a subscriber to change TV channels and send messages to a database.

ADSL's ability to deliver MPEG (Moving Picture Experts Group)-based video is of great consequence to the cable television industry. MPEG specifies standards for the compression and decompression of motion video, optimized for a data rate of 1.5 mb/s. (While 1.5 mb/s is considered VCR quality, it does not provide the same picture quality as a 3-mb/s to 5-mb/s compressed NTSC picture.) This multimedia standard will not only allow the cable and telco industries to provide compressed video, but will also enable computer firms to include video routinely in computer systems. This MPEG compression standard was the "door-opener" in the telcos' quest for extremely high bit rates, via DSL technology.

Another benefit of ADSL's asymmetrical nature relates to the cost of deployment. Because residential markets require low cost per subscriber in order to be a viable business, the ability of ADSL to cover the non-loaded portion of the plant with one pair is important. The average number of pairs at a residential home equals 1.3 lines, which means ADSL would not require addi-

By Andy Paff, President, Optical Networks International, and Al Watson, Network Systems Engineer, Antec

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TCI rolls out addressability

Imagine what it would be like to pilot a speeding sports car down an open highway—and then suddenly shift it into reverse. That's probably how it felt for Tele-Communications Inc. when it reversed its long-standing belief that pay-per-view was something less than a real business.

But shift TCI has—in a big way. The company that in the 1980s publicly eschewed addressable descrambling convertors has spent more than $40 million for convertors while rolling out addressability to a majority of its estimated 1,200 headends over the past year. So far, TCI has placed more than 400,000 convertors in the field, just in time for the summer Olympics—arguably the most anticipated pay-per-view event of the year.

TAC

Responsibility for controlling a good number of those convertors falls to a small group of employees and a powerful computer housed in a modest facility located in a southern suburb of Denver. Known as "TAC" (for TCI addressable center), the facility recently underwent an expensive and lengthy upgrade to make it capable of supporting TCI's new direction.

To get some idea of what TAC Manager Terry Wolf and his crew had to go through, a little history is called for.

Industry veterans will recall that TAC was built to support TCI's companywide roll-out of The Disney Channel in 1983. Because TCI owned so many systems with headends that served a small number of subscribers, the MSO simply couldn't afford to buy hundreds of addressable controllers (which cost about $50,000 each). Furthermore, each controller required manpower and expertise to maintain them. TCI ran the numbers; it was obvious that the hardware costs couldn't be offset by the revenue generated from pay TV services (remember, there wasn't any pay-per-view then).

The TAC concept worked, but the growth of pay-TV hit a wall. PPV came along, but TCI officials were skeptical about its viability as a business. The company refused to sink any more money into addressable convertors because of their inherent ability to complicate the interface to consumer electronics. Instead, TCI senior engineers championed an "on-premise" addressable approach, which called for the installation of addressable traps on the side of subscribing homes.

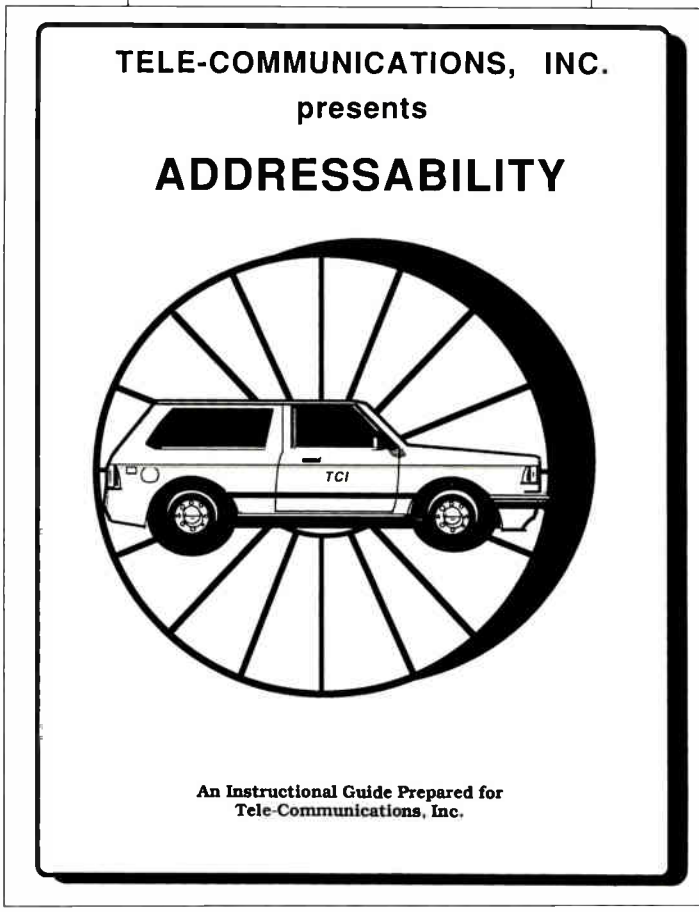
As a result, TAC was put into "maintenance mode," according to Wolf. Each year, less funding was provided than the year before and the number of TCI headends tied to TAC never grew beyond a couple hundred.

In the meantime, other operators were making a killing in special pay-per-view events. A series of heavyweight boxing title bouts brought millions into cable coffers in exchange for very little capital outlay. Those events, combined with the announcement in late 1989 that NBC and Cablevision Systems would make the 1992 Summer Olympics a pay event, spurred TCI in January 1991 to decide internally to roll out addressability to a majority of its systems.

Immediately, an internal addressability audit was launched. It had to be determined which systems already had addressability and where, how it was implemented, what hardware was in place and what it would take to bring the remaining systems on board. A few months later, TCI contracted with Probita, a small Boulder-based systems integrator, to add a relational database and help make the switch from batch reporting to a real-time interface.

This upgrade allowed TAC to access every subscriber record in a variety of ways instantly. Furthermore, it allowed cable viewers to order events via ARU or ANI and have them authorized immediately or within minutes. Previously, TCI customers had to wait at least one day to change service.

Today, TCI can support "pay-per-event" and has used occasions such as big boxing and wrestling events to test its capabilities before the Olympics were kicked off. Presently, TAC can support 30 events per month.



TCI distributed addressability handbooks with the roll-out

PPV became a business

After the 1991 acquisition of the United Artists properties, TCI officials looked into the revenue UA's movie-driven PPV service generated and were impressed. "Pay-per-view looked like it made sense," says Art Lee, TCI vice president of operating divisions. It was then that the TCI brass decided to endorse PPV.

In order to support full PPV ordering, TAC needs another upgrade beyond the one already completed for event-based buys. Wolf again sought out Probita to write software that would support higher order rates and a significant increase in the number of "events" that

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Ops lukewarm on MIS

While more than eight vendors vie for management information systems business from cable operators, interest remains lukewarm, according to a recent Cable Poll© survey. In the Poll©, conducted in January, 205 general managers said their primary usage of MIS-type systems is to handle customer invoices and customer service/installation requests. Interest remained weak for computer-handled PPV tracking, ad sales monitoring, marketing research and audience demographics.

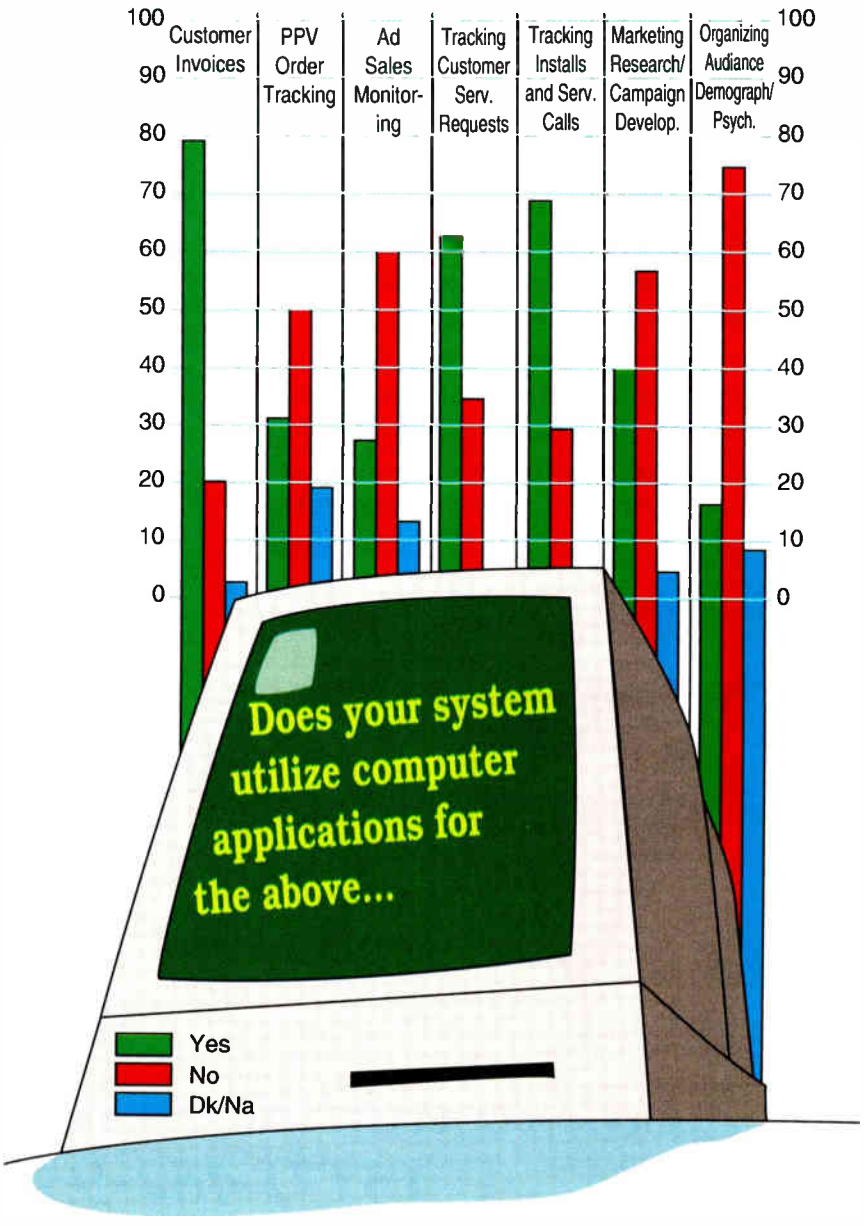
Specifically, 79 percent of the GMs polled said they use an MIS system for invoicing subscribers. Tracking customer service requests and installation/service calls weighed in at 63 percent and 69 percent, respectively.

Half of the GMs said they don't use MIS systems for PPV tracking (a shade north of a third, at 31 percent, said they did; the remainder didn't know.) More than half of the GMs (60 percent) said they don't use computer-controlled tracking for ad sales monitoring, marketing research (57 percent) or demographic information (75 percent.)

Which systems are used

Cable Data took the lead in vendors supplying MIS-type systems, with 22 percent of the GMs polled saying they use the California-based supplier. Twenty percent of the GMs reported using their own, in-house MIS system; another 20 percent uses an "other" system not mentioned in the Poll© question.

American Express Cable Services Group took eight percent of the Poll© responses; Toner and Computer Utilities of the Ozarks tied at four percent. A sliver of the operators polled, at one percent, reported using an MIS system



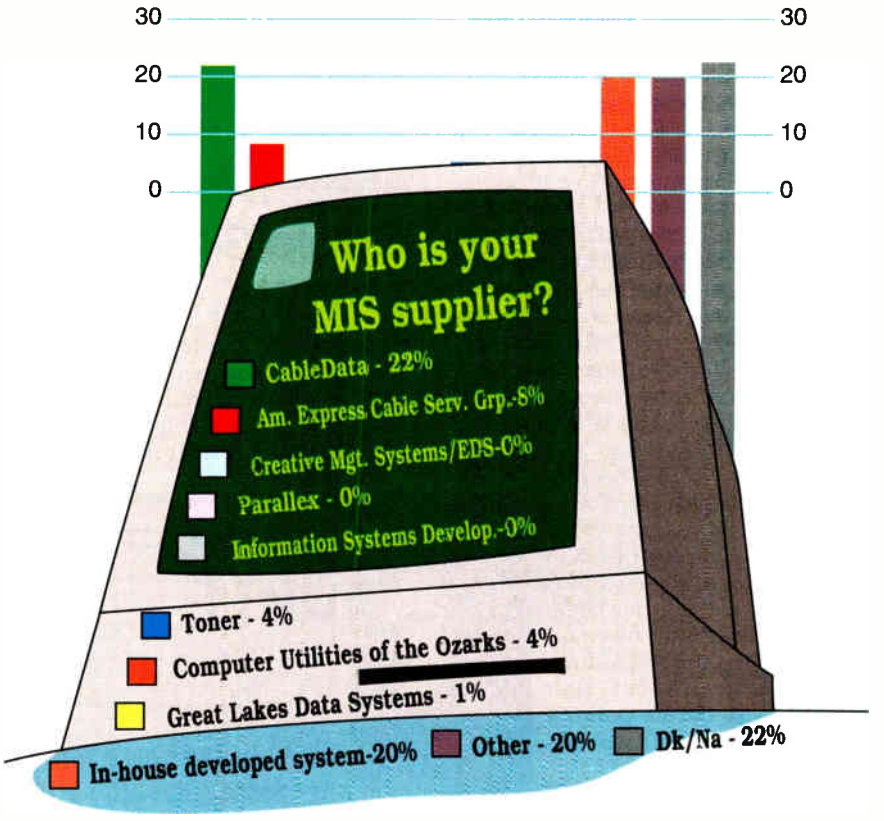
developed by Great Lakes Data Systems. None of the GMs apparently use systems from Creative Management Systems/EDS, Parallex and Information Systems Development.

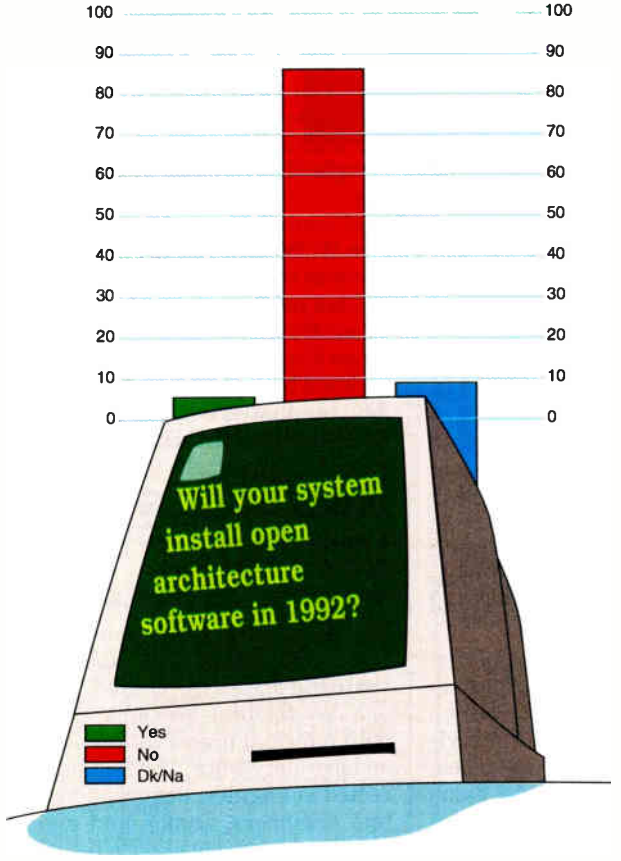
And, despite the hubbub about the topic of open architectures—or the ability of MIS providers to interface their systems to other systems—most operators, at 64 percent, reported that their system is unable to provide an open architecture. Further, 86 percent of the GMs polled said that an update to an open architecture isn't likely to happen this year.

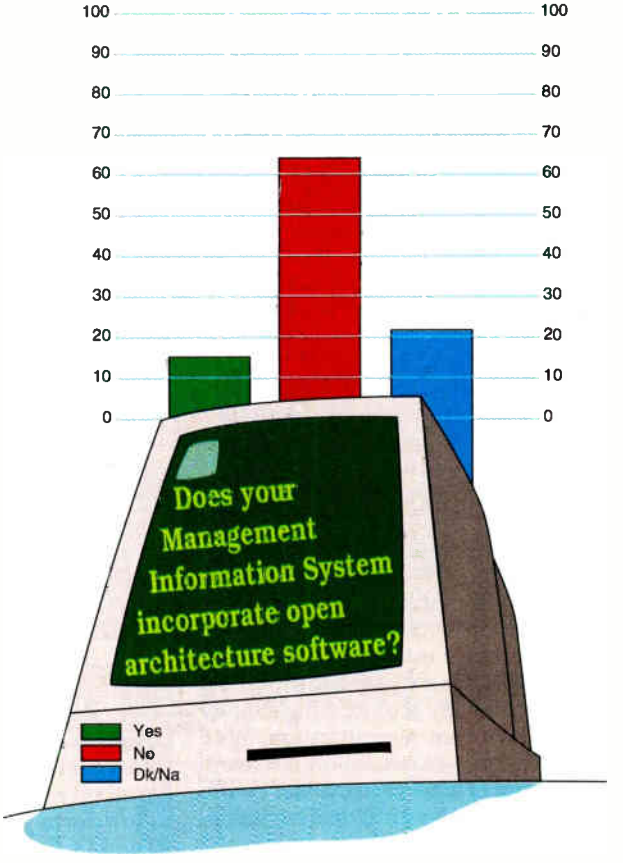
More than half of the GMs polled, at 67 percent, said they won't purchase software from another supplier this year. Four percent cited new purchases as very likely; nine percent said the possibility of a new MIS system is somewhat unlikely. **CED**

By Leslie Ellis

Cable Poll© is conducted for Midwest CATV, CableVision, CED *and* Multichannel News *by Ryan McGinn Samples Research, Inc. Telephone interviews were conducted between January 13-17, 1992 with a random sample of 205 system management personnel obtained from the CableFile Research database.*







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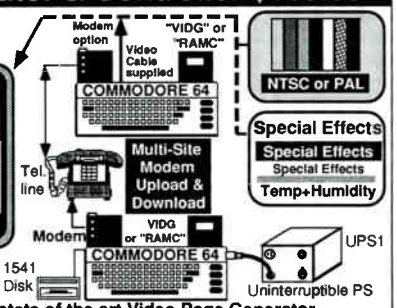
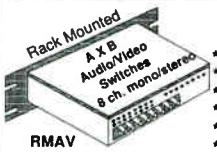
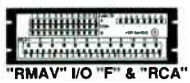




RMAV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Video dial-tone

Your bowling league meeting has just been canceled and you are scanning through the cable TV programs for an unexpected evening of viewing. Nothing appeals. So you dial eleven digits on your telephone, enter your access code (parental control?) and a menu display code. You tune the TV set to channel 00 and follow the text prompts which lead you through an array of movie titles and real time events. You select something interesting, hang up the phone, and settle back for an evening of entertainment.

The key is price

Presently, a caption appears warning that after a 10-minute preview, a charge of $2, or maybe 95 cents a minute, will be added to your telephone bill for this program. You hardly blink at $2; but 95 cents a minute for a 90-minute movie! No way!

Pricing is precisely the issue that will determine whether video dial-tone (VDT) competition could be a serious threat to broadband, multichannel cable TV. Should it cost any less to distribute a movie than to handle a 900-number call?

If VDT were delivered over an optical fiber broadband integrated services digital network (BISDN), or any other digital fiber network, the customer premises equipment (CPE) would necessarily include: optical receiver, electronic amplifier, demultiplexer, digital-to-analog converter and VSB/AM modulator. A dedicated transmission path transporting four to six multiplexed program channels would be required between a switching point and the customer premises.

Whether the switching function would be centralized at local exchanges or decentralized in outlying cabinets or kiosks would depend on the balance between the cost of locating switching equipment in uncontrolled environments against the cost of a hierarchy of multiplexed subcarriers. In either case, although costs are certain to decline sharply, they appear destined to exceed the costs of traditional tree-and-branch topology.

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

Is ADSL the answer?

The telco problem is exacerbated by the existing copper wire subscriber loop plant. Apparently, the ADSL (asynchronous digital subscriber line) and HDSL (high bit-rate digital subscriber line) present the prospect of delivering VCR quality, full-motion video at DS-1 bit rates (1.544 Mbs) on unconditioned copper pairs at distances less than two miles. This technology will probably support marginally acceptable quality on NTSC TV sets. It is certainly unlikely to support enhanced or high resolution signals.

The cable industry needs...to give greater freedom of choice in customizing program tiers.

Video dial-tone will also encounter the intrinsic incompatability between a switched, single-channel service and broadband, multi-channel consumer TV sets. VDT cannot provide the luxury of non-premium basic programs. VDT customers would have to "dial-up" two separately switched (and billed) programs for picture-in-picture or to record one program while viewing another. VDT could provide features like favorite channel recall, or last channel recall by means of suitable software for remotely controlling facilities at the switching center, just as the telcos are now offering for telephone customers. But, at what cost? Certainly more than is required for the cable TV infrared remote control.

The ideal VDT viewing terminal would be a video monitor, with built-in switching controls and transponder. Since such a facility would be useless for over-the-air "free" broadcast reception without a set-top tuner, it would seem to be a hard sell. Cable TV is painfully aware of the customer response to using only one channel on an expensive TV set capable of selecting 100 or more channels, with many popular convenience features made useless because of the convertor. VDT proponents may be blissfully unaware of this hazard.

If voice, data and video are integrated in a single digital network, the allocation of capital cost between regulated services and competitive services takes on critical dimensions. The dangerous implications of cross-subsidization seem to be widely recognized by regulators and legislators. How to keep the cost allocation from becoming predatory is not so readily established.

Where the telcos are headed

For the near term, which Bellcore does not define but might be a matter of five to eight years, the telephone industry expects to concentrate on such services as:

- interactive video games and services,
- tele-education,
- library retrieval,
- video mail box,
- limited transactions (e.g. catalog and groceries), and
- video on demand.

The impact of video dial-tone competition will be most grievously experienced when full-motion entertainment is offered by VDT without the "buy-through" requirement that subscribers pay for basic tiers as a prerequisite for subscribing to premium programs.

If the price is right, video dial-tone will have strong appeal to subscribers who want to pay only for selected programs, and are aggravated by first having to pay for one or more unwanted tiers.

The cable TV industry needs to find ways to give greater freedom of choice in customizing program tiers to suit the customer while fulfilling the operator's obligations to program providers, and to its own bottom line.

This is more a problem for marketing, supplier negotiations and rate structuring than for technical innovation. There is no easy answer. Competition may force the solution. CED

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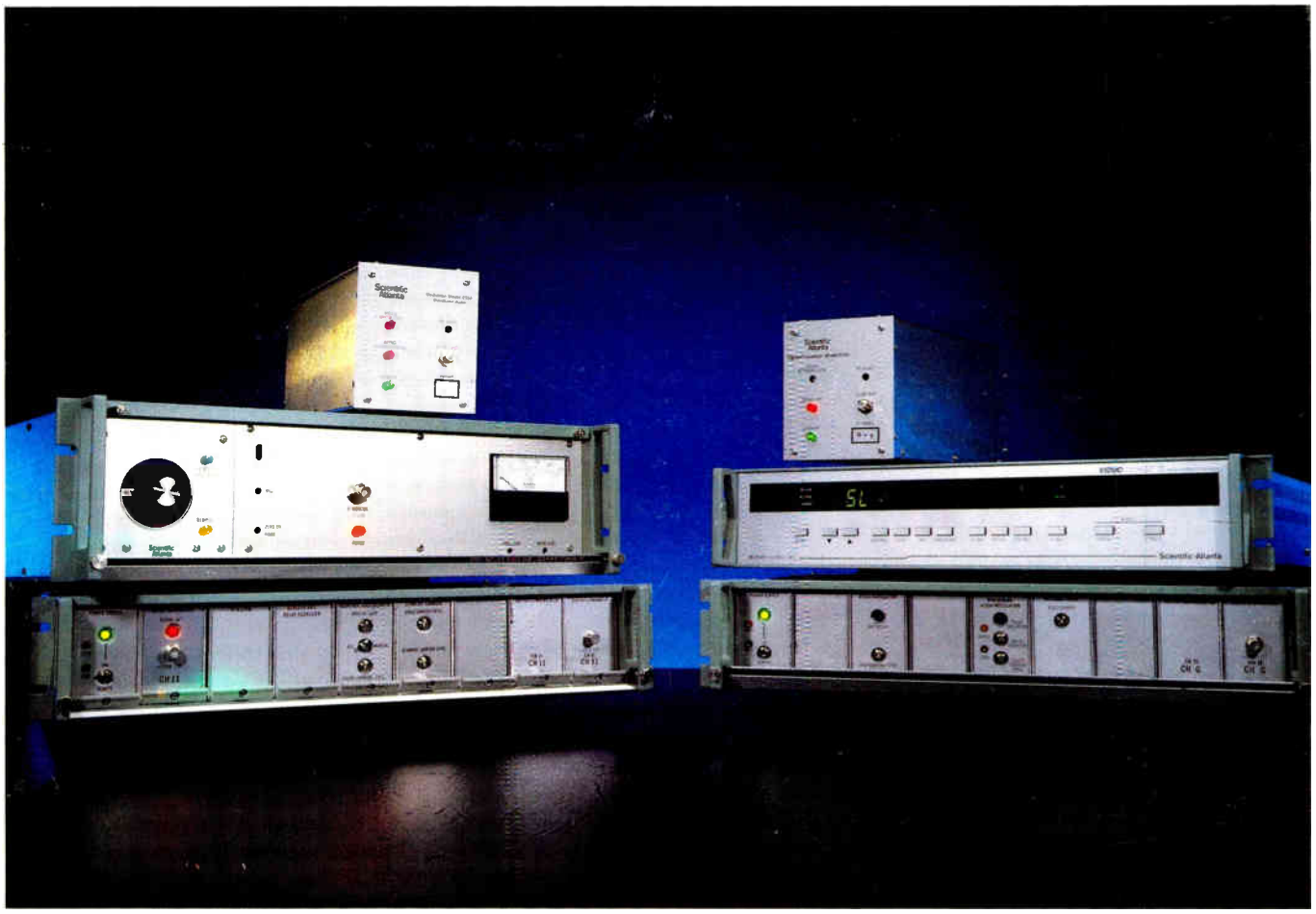

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