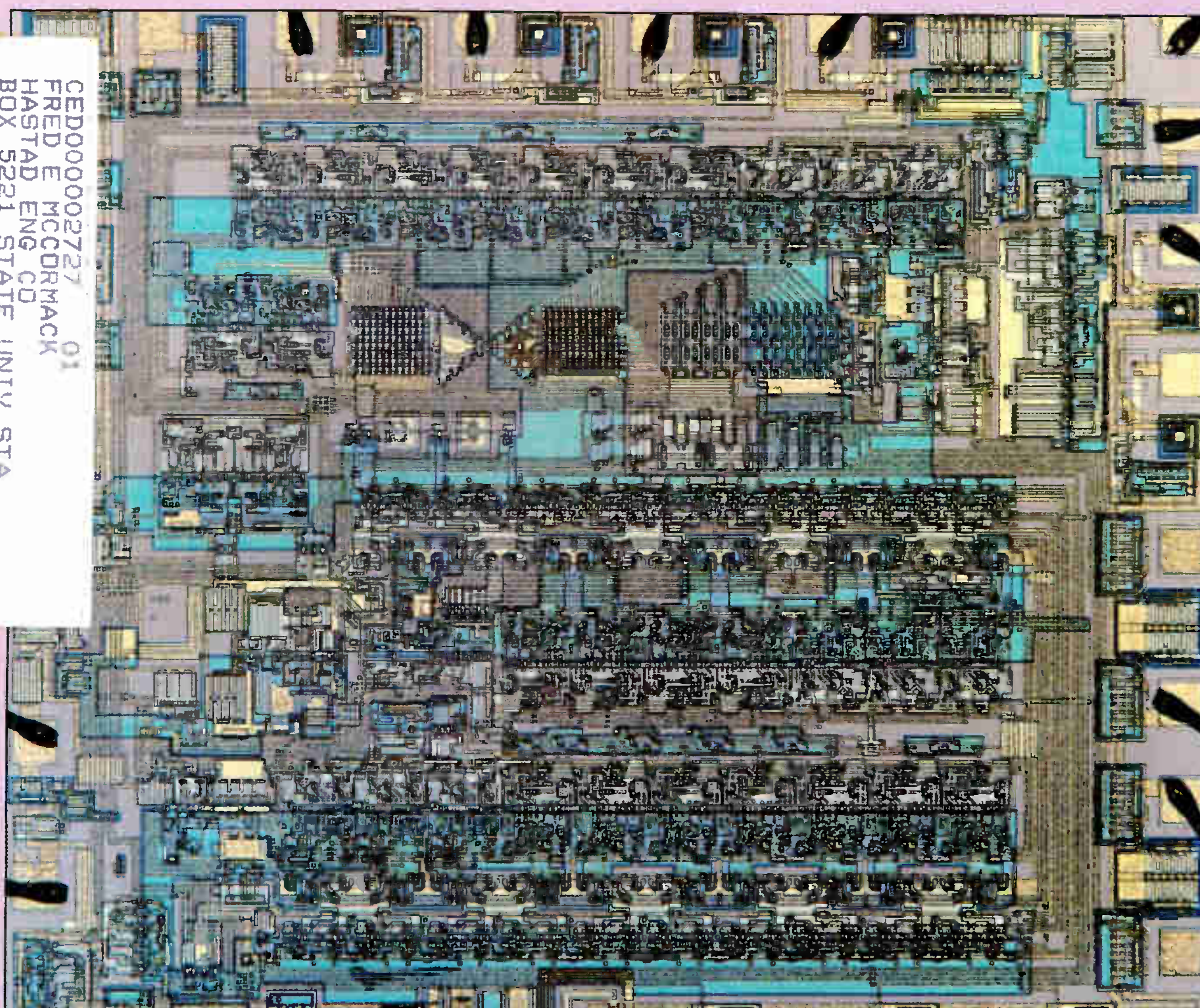
CED™

Communications Engineering & Design/The Magazine of Broadband Technology

May 1985

Modems, addressable set-tops



Crandall: PCM
Patrick: Data services
Large: MTS solutions
Marshall: Choosing equalizers
Taylor: Leakage limits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Reader Service Number 2

CED

May 1985

About the cover

Pictured is the Motorola MC145156 frequency synthesizer chip, a CMOS LSI used in the Zeta Laboratories T-1 modem. Photo used courtesy of Motorola Semiconductor Products Sector.

 CED. (USPS 300-510) (ISSN 0191-5428) is published monthly by International Thomson Communications Inc., 600 Grant St., Denver, CO 80203. © May 1985, Volume 11, Number 5. Subscriptions free to qualified industry readers. All other one-year subscriptions are $26, prepaid in U.S. funds only. Second-class postage paid at Denver, CO. *CED* is published on behalf of the cable television and broadband communications industries. POSTMASTER: Please send address changes to P.O. Box 5208 T.A., Denver, Colorado 80217. MEMBERS OF THE BPA.

BPA

Joseph Stern

Some in the industry refer to Joseph Stern as the godfather of the broadband modem. Many know he also holds a patent for the first addressable tap. Visionary, perhaps, but his 43 years in the business also have taught him to be practical —to look for black ink, not just blue sky.

Stern began his career as a communications engineer at RCA, Melpar, and in the Army Signal Corps. From there he went to CBS, where he worked in cable as well as broadcasting. "I was vice president of engineering in the television services division in the 1950s when CBS was part owner of cable systems in 12 Canadian cities. It was my responsibility to be the technical manager of the cable investments," said Stern. "I had a wonderful time throughout these jobs," said Stern. "We built 25 TV and FM facilities all over the world. We built a TV network in Venezuela, a studio facility in Buenos Aires and the TV network in Israel. It was great but I got to the point where I needed something different."

And with that, after 26 years with CBS, he resigned and started his own business. Stern Telecommunications Corp. is actively engaged in consulting for equipment manufacturers, private institutions, federal and municipal governments, cable TV operators, investment houses, banking institutions and specialized common carriers. Stern himself is a nationally recognized authority on broadband communications and emerging technology.

"If I had a specialty, it would be my involvement with the *overall* engineering in the cable system—that is, making practical applications of designs and equipment that already existed. Whenever there was a need for something that didn't exist, I tried to make sure it happened. If *I* couldn't, I tried to find someone else to design or build it."

For example, "I have a patent on the first addressable tap, licensed to Delta Benco of Canada. The "Intelligent Tap" was a response to the need for protection against theft of the cable system's product and the need to simplify system operations.

This is still one of his major concerns. Stern has been championing off-premises devices since 1973, along with cost effective two-way cable. He also served as chairman of the bi-directional cable system group for the FCC Cable Technical Advisory Committee.

"I've been encouraging use of two-way cable, institutional services and off-premises control. I guess those are the three things I've talked about most regularly. Wendall Bailey once asked if I was going to give my annual lecture on off-premise addressability. I've talked about that at so many NCTA conventions that it almost seems like a road show," he chuckled.

Since Stern started with cable, he has either spoken at, been a moderator for, or chaired a session at every NCTA convention. He's still exhilarated by the growth he has seen in cable. "But it's time for regrouping," he stated. "I look at the cable business as a very sound and stable method of delivering service to homes and institutions, and now it needs more solid financial analysis and marketing. Cable TV is in place and will keep its place as one deliverer of entertainment and services."

For those new engineers who will help cable, Stern advises, "Take a good look at how the system was designed and why it was designed that way. Try to reduce the amount of equipment and maintenance required while improving the quality of transmission." The goal is to achieve a more cost-effective system while delivering services the subscriber wants."

For the next decade, the cable industry will undergo many changes. But, according to Stern, it needs to be a maturing—not a growth. "I think many of the blue sky claims of what cable could and should do are interesting approaches, but not practical business reality. We must look at the best way to use our cable and its two-way bandwidth because there is another provider of services—the telephone—in the same homes, on the same poles, that can do some of the things we want to do even better and cheaper. The industry needs to shake down to a point where it is providing service cost effectively."

—Kathy Berlin

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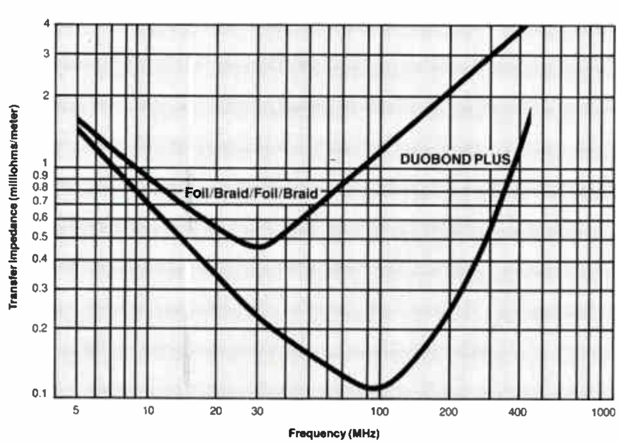
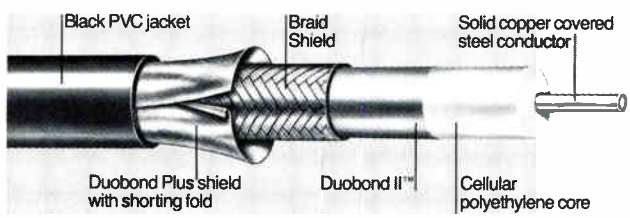


Belden's unique shield protection.



The inner foil of the DUOBOND PLUS shield is bonded *directly* to the core. Foil pushback and signal leakage problems are eliminated. Protection from shielding degradation is eliminated during installation–where most shielding problems occur.

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There is no equal.

Reader Service Number 4

COOPER INDUSTRIES **BELDEN**

A Final Note on CLI

By Archer S. Taylor, Malarkey-Taylor Associates

The Cumulative Leakage Index (CLI), described in the FCC Second Report and Order, is a new feature based directly on the procedures used by the FCC Advisory Committee in 1979 for ground-based measurements. At that time, FCC engineers measured signal leakage in four ways: 1) by fly-over in the airspace above the system, 2) on the ground with professional field intensity meter and calibrated dipole at 10 feet from both the cable and the ground, 3) by means of the peak reading meter of a Sniffer leak detecting receiver with vertical whip antenna, at 108.625 MHz and 4) by utilizing the same automated narrowband digital equipment on the ground as was used for the fly-over.

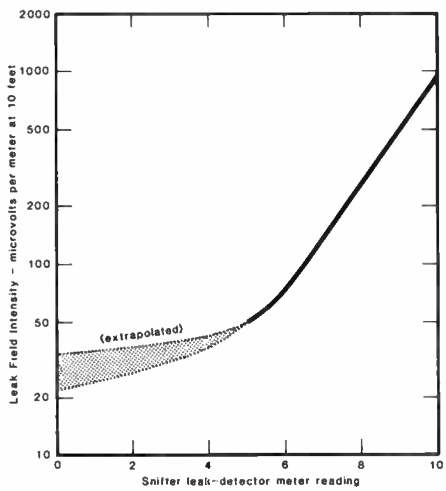
The Second Report and Order calls for leakage measurements to be made either by fly-over, as specified in Section 76.611(a)(2), or by any ground-based measurement technique that can be calibrated approximately in terms of field intensity in microvolts per meter at 10 feet. The accompanying chart, based on Figure H.1 in the Report of the Advisory Committee, is the calibration chart for the Sniffer used by the Committee in 1979, showing leak-detector meter readings against field intensity measured at 10 feet. As nearly as I could determine, the Sniffer monopole antenna was located on the roof of the vehicle which was driven "under the cable plant" for leak detection purposes. Although the distance between the leak and the Sniffer antenna varied considerably from 10 feet, the data in the calibration chart were obtained while the vehicle was relatively close to the pole line. The variations in distance were roughly averaged out by drawing a smooth curve through the scattered data.

Section 76.614 requires that the monitoring system be capable of detecting leaks producing field strength of 20 microvolts per meter or greater at 10 feet. Evidently, the Sniffer in 1979 would not meet that requirement. However, the current Sniffer II and the Wavetek CR-1B appear to be capable of meeting this specification at distances up to 70 feet or more. Moreover, in the new MM Docket 85-38, FCC proposes to raise the cable leakage limits to 50 microvolts per meter at 10 feet.

Discussions with FCC staff indicate that, for CLI purposes, the field intensity of leaks can be estimated properly on the basis of a calibration chart prepared by each operator for the particular leak detectors used, similar

CALIBRATION CHART

(Source: Fig. H.1 Final Report of the Advisory Committee on Signal Leakage, November 1979)



facility used by the Advisory Committee to the chart developed by the Advisory Committee. Other ways to accomplish this result with comparable accuracy also may be acceptable.

Regardless of how fearsome the rules may appear in print, however, it is my understanding that the intent is to assure that a reasonably conscientious effort will be made to detect and promptly repair leaks. The operative word is "conscientious," not "precise."

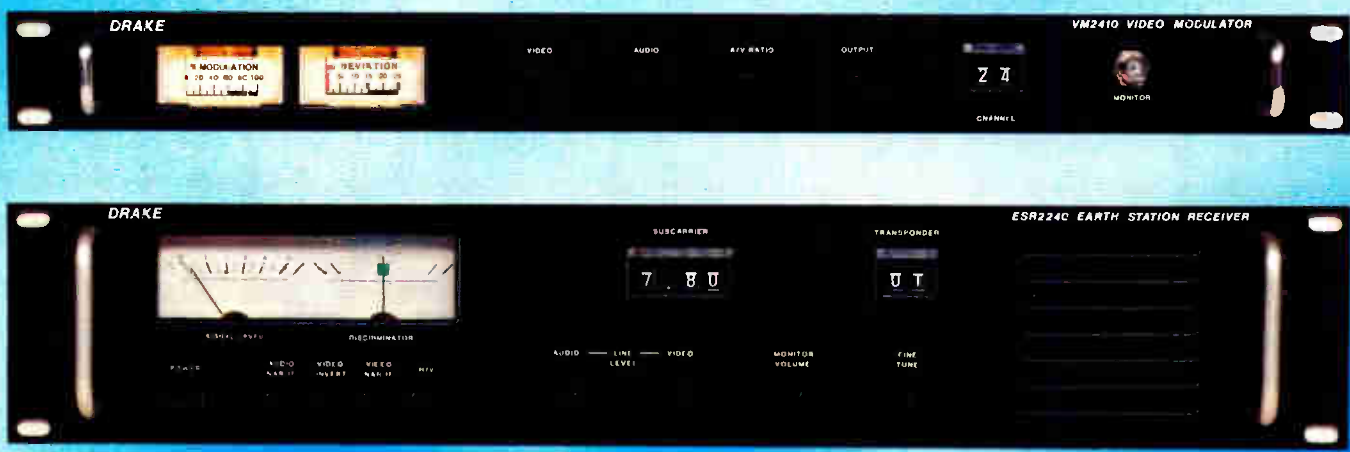
Remember, also, that only unrepaired leaks can contribute to the CLI. If all leaks recorded in the log have been repaired, large or small, representing at least 75 percent coverage in a reasonably short time period, the CLI will be zero. Compliance with the CLI criterion then could be certified without any measurements other than those necessary to determine that each leak had, in fact, been corrected.

No period of time is specified in the rules over which leakage fields are to be accumulated. The CLI must represent the condition of at least 75 percent of the total system mileage. Underground and backyard easements as well as streetside aerial plant must be included in the total mileage. Although "random" coverage may be used for quarterly monitoring, systematic coverage should be used at least once a year for the CLI determination.

The CLI may, indeed, prove burdensome for some older systems with unsleeved connectors, 60 percent braid drops, pressure taps and F-connectors with the 1/8-inch crimp ring, and may be a real problem in multiple dwelling units. It is, of course, the correction of just such leaky systems that the rules are designed to achieve.

For well-constructed systems with sleeved connectors and improved drop cable and connectors, leaks should be relatively rare. Monitoring will be routine. Repairing large leaks should be given first priority. Smaller leaks also should be repaired promptly, but they are unlikely to accumulate beyond the CLI limit. CED

DYNAMIC DUO



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NCTA
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Signal Leakage: John Wong, FCC; Ted Hartson, Cap Cities; Bob Dickinson, E-Com; John Ward, Comcast; William Homiller, Jerrold; Ralph Haller, FCC. Questions and answers about the new leakage laws.

PPV/Addressability: Graham Stubbs, Oak; Semir Sirazi, Zenith; Michael Ermolovich, Jerrold; A.E. Hospador, Jerrold; Tony Wechselberger, Oak. Profit possibilities, control channels, remote hubs.

Off-premises: Richard Kearns, Times Fiber; Joseph Preschutti, AM CATV; Nancy Kowalski, Jerrold; James Van Cleave, Jerrold; John Simons, Times Fiber; W. Sherwood Campbell, ATC. System design, cost models, powering, star networks.

Tests/Measurements: Dom Stasi, MTV Networks, Lance Katzfey, Oak; Ed Mitchell, Jerrold; William Kostka, Gill Cable; Michael Ellis, Scientific-Atlanta; Lamar West, S-A. Testing, sweeping second order distortion, CTB, X-mod, feedforward thermal characteristics.

Cable Stereo: Joe Van Loan, Viacom; Tom Stutz, Jerrold; William Thomas, ATC; Sruki Switzer; Arthur Vigil, Oak; Alex Best, S-A. MTS and headheads, digital audio, MTS overview, program distribution.

Fiber Optics: Brian Garrett, M/A-Com; Pieter Kerstens, Philips; Robert Hoss, Warner Amex; Michael Carr, Compucon; Jim Chiddix, Oceanic Cablevision; Lawrence Engdahl, Times Fiber. Supertrunking, private networks, analog/digital trade-offs, lessons from the Alameda build.

Cable-compatible Issues: Dave Large, Gill Cable; Joseph Stern, Stern Telecommunications; Larry Brown, Pioneer; Geoffrey Gates, Cox Cabe; James Cherry, Oak; Walt Ciciora, ATC. Interface devices, terminal compatibility, the new consumer environment, master-slave terminals, NCTA/EIA update.

Plant Design: Bill Riker, SCTE; Richard Thayer, Times Fiber; Robert Blumenkranz, Jerrold; Stanley Moote, Leitch Video; Dave Atman, Lindsay Specialty Products; Paul Brooks, United Artists. Feedforward amp design, cable attenuation, baseband video synchronization, CAD/CAM, mapping and maintenance tips.

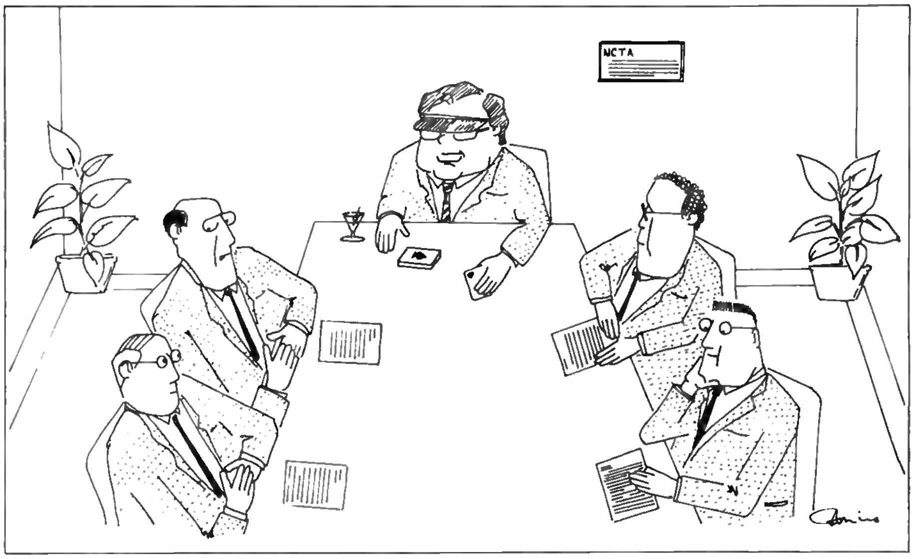
Customer Service: Larry Janes, ATC; Sharon Thompson, Warner Amex; Richard Clevenger, Cox Cable; Fritz Baker, Viacom; Gregg Nydegger, Cardinal Communications; Jim VanKoughnet, Manitoba Telephone. Total customer service, call measurement, status monitoring, service calls.

Signal Relay: Scott Tipton, HBO; Peter Vogt, Hughes Microwave; Preston White, S-A; Ned Mountain, Wegener; T.M. Straus, Hughes Microwave. Predistortion in AML, CAD of TVRO stations, transponder operation with video and multiple subcarriers, system design trade-offs.

Digital Transmission: Archer Taylor; Niraj Jain, Philips; Franc Stratton, Viacom; Gregory Baxes, ATC; Tony Wechselberger, Oak. Two-way systems, packet-switching, line segmentation scrambling, encryption fundamentals.

Vital Statistics: Advance registration ends May 10. Call (202) 775-3606 for details. Eleven sessions in total, 18 hours of information, 50 technical papers. Over 60 system engineers, manufacturers, designers and consultants. First-hand information from top FCC officials on the new leakage rules. Technical papers will be available for sale at the show—and the volume includes papers *not* presented during sessions as well. Discount prices available on bulk sales.

Wendell Bailey
VP, Science & Technology
NCTA



"Wendall seems a bit. . . eager!"

Splitting wires

The March 1985 issue of *CED* featured an article on "Cable Isolation" by Dr. Raymond Capek. Since members of my staff were involved in some of the testing of the device described by Dr. Capek, I was especially interested in his article.

There appears to be an error in the article that should be corrected in the interest of accuracy and safety. Dr. Capek states that a wire not smaller than #18 must be run between the cable ground and the power ground. However, a #18 will not satisfy the NEC code requirements for a bonding jumper. At section 820-22, sub h, the Code requires a bonding jumper not smaller than #6 copper or equivalent.

Kenneth Foster
Chief, Telecommunications Division
New York State Commission on CATV

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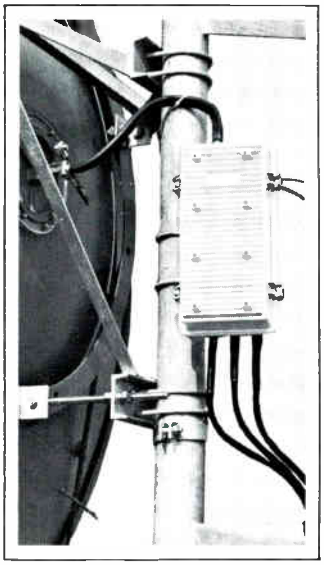

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Reader Service Number 6

Volume 11, No. 5

CED

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More bricks in your fortress

During the 16th century, the skies over Japan frequently blackened with arrows and rang with the clash of sword against sword as armies contended for supremacy on the narrow eastern plains. The contending warlords built massive fortresses as protection from their rivals.

All but one.

When asked why he hadn't built a stronghold, Takeda Shingen responded, "The people are the castle, the people are the walls, the people are the moat." Then, as now, the technology is only part of the formula for success. Neglect the human factor and everything is for nought.

So if you're still waffling about whether to attend the NCTA Convention June 2-5, think about the 1,040 ways it can increase your MTBF. Better hardware is one way. Better skills is the other.

For starters, at Cable '85 you'll find more than 50 original technical papers, written expressly for this show by some of the top talent in our industry, tackling today's issues and tomorrow's.

Issues like signal leakage, off-premises systems, cable-delivered stereo, cable-compatible TVs and VCRs, plant design, customer service, signal relay and fiber optics.

In short, how to do it and what it means. What it can do for *or to* you. Practical, bottom-line stuff.

More reasons: 990 minutes worth of sessions based on the technical papers—and a chance to ask that question you've been wanting an answer to.

And a wild card: a live videoconference between top management at the IEEE Consumer Electronics Show in Chicago and cable CEOs on the cable-compatible issue.

And don't worry about missing sessions because you're touring the exhibits—11½ prime-time hours have been set aside just for that purpose.

Of course, as technical managers, you will be interested in the management sessions as well. This year they'll focus on the impact of deregulation and how to plot a course through the new waters.

Put another brick in *your* fortress. Call (202) 775-3606 for details.

And on the subject of lessons, picture this: Your skis perch over a cornice. Below you stretches a mogul field littered with obstructions the size of Volkswagons—the slope so steep it looks convex. Slashing wind, swirling snow. You hesitate. Nervous? You bet.

Miss a couple of turns and your speed will be blinding. Sure, skill plays an important part in your descent. But the outcome often is decided before you make the lunge and accelerate into the first turn. Why? Because your physical responses will mirror your attitude. If you don't attack—if you're timid—you won't ski well.

The bottom line: In business as in skiing, technique isn't enough. Ya gotta go for it.

Case in point: Starcom Inc., a smart, heads-up private cable MSO specializing in hotel systems. A year ago, they acquired their first contract. Now they've got 13 systems up and contracts for 40 more in 26 states. They've got the technique: selling basic and premium programming as well as teleconferencing services.

It's a growing, well-managed company that understands its basic business well. And they didn't get there by hanging back. They attacked the hill. I'd watch them. I'd also learn from their example: not just technology—will.

Gary Y. Kim

Scientific Atlanta

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Scientific-Atlanta 8500 Series converters are ready right now. Competitors are offering a deluge of other options; stopgap attempts that *may or may not* suffice. And they're all expensive. Sidecars, for example—extra equipment and extra expense—are necessary for some converters to pass stereo. Most baseband units need sidecar additions for all signals. Some converters, when they're fixed internally, will pass stereo. Of course, that'll take a service call, time *and* money.

Scientific-Atlanta 8500 Series converters need no extra add-ons. They're stereo ready right now and they always have been. They give you stereo in one piece with no increase in price. That's a very good reason to buy Scientific-Atlanta. There are plenty of others.

The 8500 Series—8520 programmable, 8530 programmable with descrambling and 8550 addressable—enjoys a reputation for quality, signal security and reliability unmatched in the industry. Plus, Scientific-Atlanta backs them all with a *two year warranty*! There's no better warranty in the business.

Scientific-Atlanta and the stereo storm. We've seen it coming for some time now. We've prepared for it, so *you* can prepare. When it hits, just come in out of the rain and enjoy the show.

Call (404) 925-5057 for more information or send in the coupon below.

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Reader Service Number 3

May

14-15: A **Blonder-Tongue** SMATV/MATV/CATV/TVRO technical seminar will be held at the Ramada Hotel Airport East in Phoenix, Ariz. Contact Jim or Terry Umstead, (201) 679-4000.
21-23: C-COR Electronics Inc. will sponsor a technical seminar in Dallas. Contact Deb Cree, (814) 238-2461.

June

2-5: The **National Cable Television Association**'s annual convention will be held at the Convention Center in Las Vegas, Nev. Contact (202) 775-3550.
6-12: Montreux 1985, the 14th International Television Symposium and Technical Exhibition will be held in Montreux, Switzerland. Write, P.O. Box 97, CH-1820 Montreux, Switzerland.
16-18: Annual Northeast Technical Seminar, sponsored by the **New York State Commission on Cable Television.** Roaring Brook Resort, Lake George, N.Y. Contact Bob Levy, (518) 474-1324.
18-20: Jerrold Technical Seminar. Dallas, Texas. Contact Ann Pliscof, (800) 523-6678.
19: The **Delaware Valley Chapter of the Society of Cable Television Engineers** will hold a seminar titled "Basic System Prevention Maintenance" at the Fiesta Motor Inn in Willow Grove, Pa. Contact Beverly Zane, (215) 674-4800.

July

9-11: Jerrold Technical Seminar. Portland, Ore. Contact Ann Pliscof, (800) 523-6678.
10-12, 15-17: Magnavox Mobile Training Seminar. Detroit, Mich. Contact Laurie Mancini, (800) 448-5171.
23-25: C-COR Electronics Inc. will sponsor a technical seminar in Boston, Mass. Contact Deb Cree, (814) 238-2461.

August

7-9, 12-14: Magnavox Mobile Training Seminar. Syracuse, N.Y. Contact Laurie Mancini, (800) 448-5171.
13-15: Jerrold Technical Seminar. Minneapolis, Minn. Contact Ann Pliscof, (800) 523-6678.
21: The **Delaware Valley Chapter of the Society of Cable Television Engineers** will hold a seminar titled "FCC Rule Update/Field-testing Procedures" at the Fiesta Motor Inn in Willow Grove, Pa. Contact Beverly Zane, (215) 674-4800.

September

3-5: Jerrold Technical Seminar. Pittsburgh, Pa. Contact Ann Pliscof, (800) 523-6678.
11-13, 16-18: Magnavox Mobile Training Seminar. Worcester, Mass. Contact Laurie Mancini, (800) 448-5171.

October

2-4, 7-9: Magnavox Mobile Training Seminar. Atlantic City, N.J. Contact Laurie Mancini, (800) 448-5171.
8-10: Jerrold Technical Seminar. Atlanta, Ga. Contact Ann Pliscof, (800) 523-6678.
16: The **Delaware Valley Chapter of the Society of Cable Television Engineers** will hold a seminar titled "Technical Management" at the Fiesta Motor Inn in Willow Grove, Pa. Contact Beverly Zane, (215) 674-4800.

Pulse code modulation

By Kenneth Crandall,
Engineering Manager,
RF Modem Divison,
Zeta Laboratories Inc.

In 1820 Hans Christian Oersted deflected a magnetic compass needle with an electric current. This marked the dawning of the electronic communications era.

Twenty-four years later, Samuel Morse sent a message from Washington to Baltimore: "What hath God wrought?" It was one of the first digital communications messages on a commercial line.

In 1876 Alexander Graham Bell heralded analog communications with the immortal words: "Watson, come here, I want you."

But it was not until the late 1930s that the grand synthesis of digital and analog communications was made by A. H. Reeves of the International Standard Electric Corporation: the invention of pulse code modulation. A beautiful creation of the human mind—and so simple an idea that no one thought of it earlier!

The idea is simply to periodically sample the analog information source waveform signal level, code the sample measurements into numbers, then transmit the sequence of numbers using digital transmission techniques.

Reconstruction of the signal at the receiving end is performed by converting the number sequence back to the corresponding analog waveform.

The concept is similar to the reproduction of music from written scores. Rather than communicate the actual waveform, Bach sends us his music in coded form for our delight centuries later with full stereophonic fidelity! In other words, he tells us in coded form *how* to make his music. Our ability to interpret (read the code) gives us *what* the music sounds like.

Thus, reproducable information is very efficiently carried by digital coding instructions on *how* to make the item embodying the information using coded instructions—be it a voice or video waveform, a concerto or a newborn baby. This is the essence of pulse code modulation, where the building blocks are the signal level samples.

The invention of the transistor at Bell Telephone Laboratories in 1948 made PCM (pulse code modulation) commercially feasible. In 1956 Bell began design and development of the first commercial PCM system. Western Electric began substantial deliveries of this system, known as T1 Carrier, in 1962[1].

The T1 system uses pulse code modulation and time division multiplexing to digitize and transmit 24 voice channels

CATV has the potential of carrying not only entertainment TV signals but other forms of information such as digital voice and computer data.

simultaneously on a single twisted wire pair. A second twisted wire pair provides the receive path for full duplex communications. Regenerative repeaters spaced every 6,000 feet allow virtually unlimited transmission distances without noise accumulation. In addition, its digital format makes it far easier to switch than frequency multiplexed analog signals.

The original T1 equipment for analog/digital conversion and multiplexing has the D1 channel bank. It sampled each of the 24 channels 8,000 times per second, converting the sampled signal level into a 7-bit binary number. The 7-bit binary number quantizes the signal to one of 128 distinct amplitude levels. Along with signal compression, this allows sufficient dynamic range for toll quality speech waveforms.

After encoding the speech waveform, the 7-bit word is augmented with an additional bit for signalling off-hook/on-hook status. A PCM frame is formed by a sequence of 24 eight-bit words and one framing bit. Because frames are formed 8,000 times per second, the aggregate bit rate is equal to $8{,}000 \times [(24 \times 8) + 1] = 1{,}544{,}000$ bits per second. This is the fundamental line rate for digital transmission in North America and Japan.

Transmission of a 1.544M bPS signal over 6,000 feet of 22 gauge twisted wire pair is no mean feat, especially when it is bundled with scores of other twisted pairs. The solution is a three-level bipolar signal referred to as AMI (alternate mark invert) line transmission. A mark (logic 1) is transmitted as a shaped 325 nS pulse. A space (logic 0) is transmitted as no pulse at all, holding at center level. The polarity of mark pulses alternates to maintain zero DC on the line pair. When terminated with 100 ohms, the pulse amplitude is 3 volts. This results in a three-level 6-volt peak-to-peak signal centered at 0 volts. This is the DS-1 signalling standard and is defined in Bell Technical Reference PUB 41451[2].

Most of the rest of the world uses the CCITT standard of 2.048M bPS with 30 channels used for voice and two channels used for signalling and synchronization.

Solid state

In January 1976 the No. 4ESS electronic switching system was placed in service. With a capacity four times greater than the No. 4A cross bar (the prevailing electromechanical switch of the time), stored program control and direct connection to T1 lines, this became the mandate for digitized voice systems. Analog multiplexed signals required intermediate channel bank hardware for connection to the switch. Thus, there became strong financial incentive to multiplex digitally.

The solid state technology of the No. 4ESS switch is not the only reason for favoring an all-digital network. Bellamy[3] cites nine technical advantages of digital communications networks:

- Ease of multiplexing
- Ease of signalling
- Use of modern technology
- Integration of transmission and switching
- Operability at low signal-to-noise/interference ratios
- Signal regeneration
- Accommodation of other services
- Performance monitorability
- Ease of encryption

The increasing use of digital transmission for terrestrial and satellite microwave links is testimony to Bell's commitment to the all-digital network.

CATV link

The man on the street thinks of cable television as just that—television connected to a community cable and antenna system. However, CATV has the potential of carrying not only entertainment TV signals but other forms of information such as digital voice and computer data.

The bridge between the CATV system and, for example, the Bell T1 line is the radio frequency modulator/demodulator or RF modem. The use of such a device allows cable companies, universities, factories or any other institution equipped with broadband coaxial cable facilities to provide data and voice communications in addition to TV signals.

The use of coaxial cable for this function has been motivated by increasing rates for local telephone lines and T1 span line facilities. A tremendous opportunity exists for cable companies to turn this need into a profitable business.

The ZT1

The ZT1 RF modem mediates a DS-1 to broadband coaxial cable connection. This allows T1 span lines and channel banks to interface with CATV systems. The data rate is 1.544M bPS, and carriers can be spaced every one megahertz.

To achieve bandwidth compression, the ZT1 uses four-level vestigial sideband modulation. The modulation process is:

1. Convert DS-1 signal to binary NRZ data stream
2. Scramble NRZ data using 15-bit polynomial
3. Differential level encode dibits to one of four levels
4. DSB-SC modulate carrier
5. Filter out one sideband
6. Convert to desired transmit frequency

This method of modulation is exactly equivalent in bandwidth efficiency to 16-QAM and is 4 bits/Hertz. Prudent channel spacing for robust operation gives a net bandwidth compression of 1.5 bits/Hertz.

Several modulation techniques were tested at Zeta before 4-VSB was finally selected. A variety of system impairments were simulated including AWGN (additive white gaussian noise), phase noise, adjacent channel interference, frequency translation, clock frequency error, temperature and vibration. The winner was 4-VSB since it performed very well under all impairments and met the original design requirement of 1 MHz carrier spacing and fast carrier lock-up time.

Figure 1 shows the frequency spectrum of 4-VSB while running data at 1.544M bPS. Because the carrier is suppressed and the data is scrambled, the modulation looks exactly like bandwidth limited white noise.

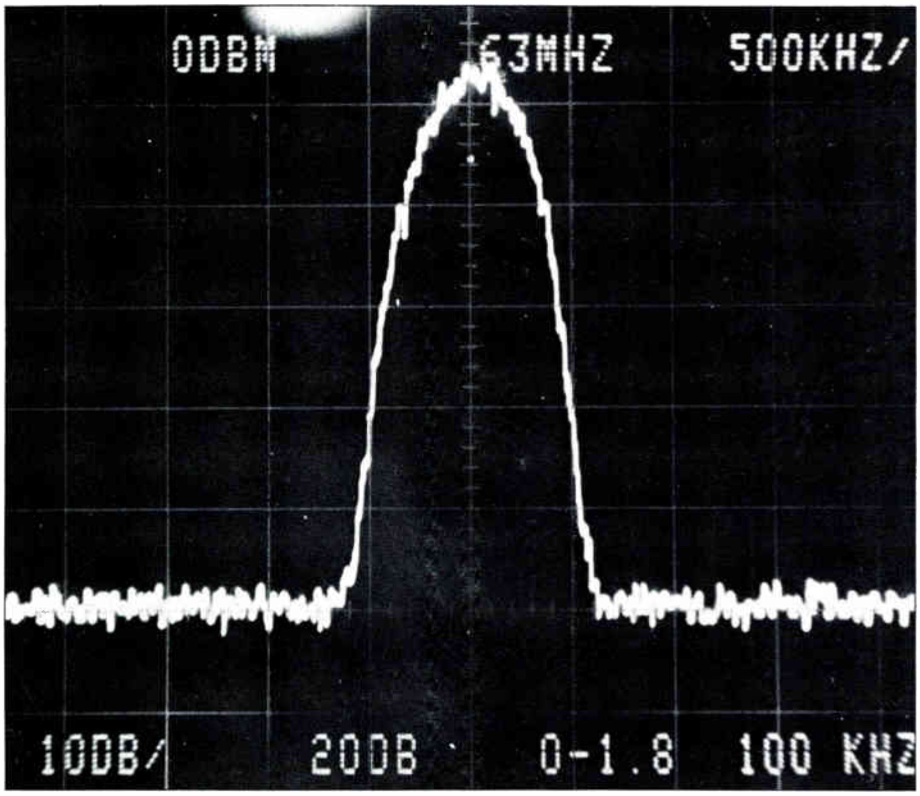

Figure 1 Four-VSB frequency spectrum

Figure 2 shows the demodulated eye pattern. This is the four level signal obtained after synchronous detection of the VSB signal. Wide eyes mean good data since the four levels are more distinguishable. A test point allows checking this pattern after installation to assess the quality of the channel.

The ZT1 allows both remote loopback and remote carrier control to facilitate maintenance by a cable operator. Often tests must be run late at night when access to user premises is impossible. Remote carrier control allows the operator to command a modem "off the air." Remote loopback allows bit error testing to gauge channel quality.

Sparing of modems is simplified due to broadband frequency agility. Thus, only a few spare modems are needed to spare hundreds of units that are in operation. Switches control the transmit and receive frequencies of the ZT1 thanks to frequency synthesizers—the most difficult part of an RF modem to design.

The introduction of digital telephony through T-carrier and electronic switching has created a revolution in the way telephone companies handle the network. In addition, data transmission for computer systems has created a demand for similar high-speed data com-

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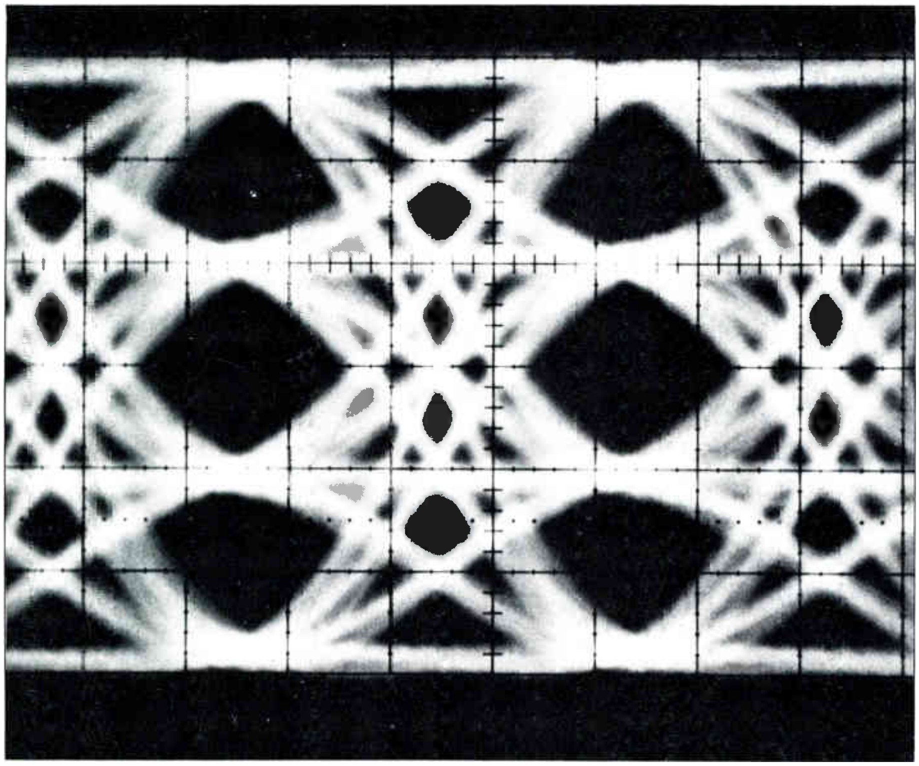


Figure 2 Four-level eye pattern

munications facilities. Particularly, CAD/CAM and LAN systems are pushing up data rates.

The two communities (telephone and data processing) are finding a common channel with T-carrier trunks—in particular the T1 service. The supply is getting scarce.

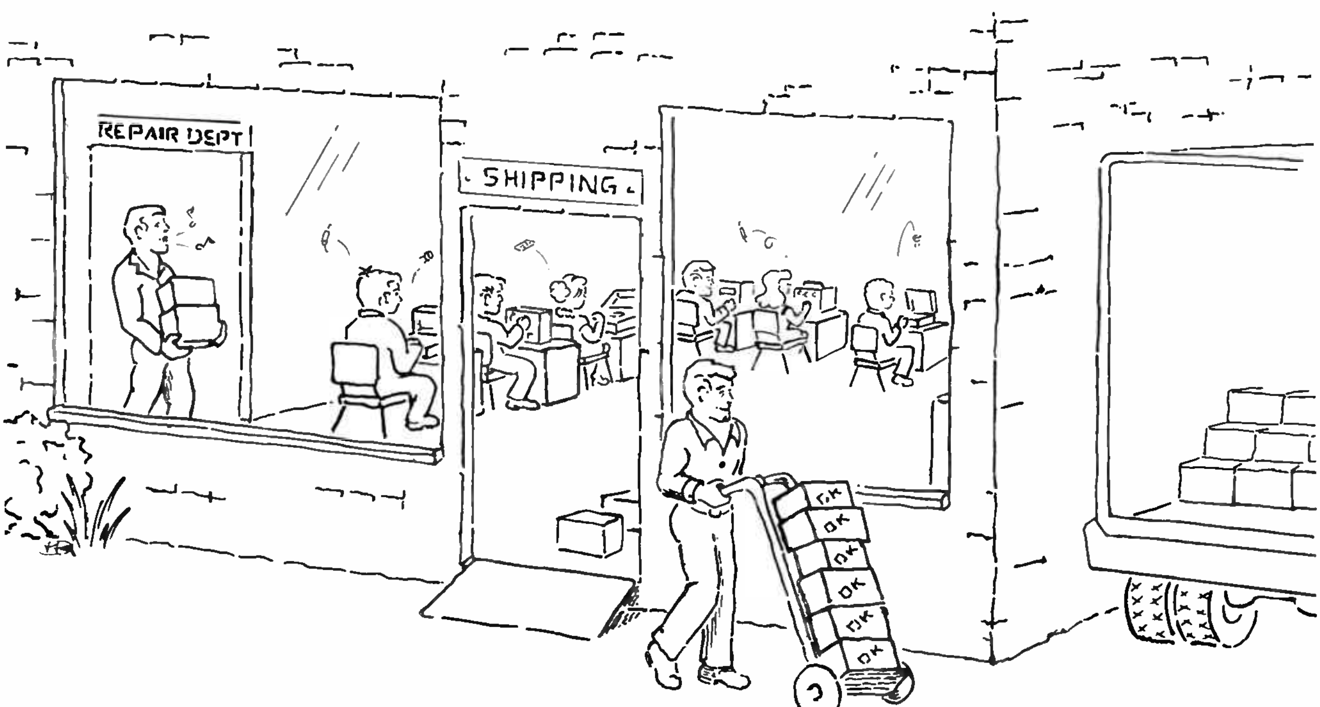
CATV offers an alternative for T1 service. The cable operator can offer faster service with better bit error rates and lower prices. The opportunity is there. Go ahead and take it! CED

References

[1] Frank Boxall, *"Pulse Code Modulation in Telephony,"* Vicom, 1969.
[2] *"High Capacity Terrestrial Digital Service,"* PUB 41451, AT&T, 1983.
[3] John Bellamy, *"Digital Telephony,"* John Wiley & Sons, 1982.

About the author

Ken Crandall is a typical over-worked engineer in silicon valley who would rather be designing modems than writing articles about them. He has two U.S. patents in modem and multiplexer design, and his primary interests are modulation theory and keeping his wife and daughter happy.



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Customers don't complain about its performance either.
Not one. (And that's no B.S.)

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In the year since MC^2 was introduced, we haven't had a single complaint. Because our product has lived up to our promises. When we promised superior flexibility, we delivered that flexibility. We patented a design of using air instead of foam to deliver less attenuation. We promise you'll save money on installations, connections, labor and on the cable itself. Also, MC^2 is extremely resistant to moisture ingress and migration because each cell is an hermetically sealed compartment.

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CATV DIVISION
A Unit of The Penn Central Corporation

People


S. Wagner

Steve Wagner has joined the Marketing Department of the Jerrold Distribution Systems Division as director of market-sales support. Wagner came to Jerrold in 1982 as district sales manager and advanced to western region sales manager in 1983.

Also announced was a geographical realignment of the Jerrold Sales and Service Division of General Instrument Corp. **George Fletcher** has assumed responsibility as vice president of Western Operations, whereas **Dan Hoy** has taken over as vice president of Eastern Operations.

Ed Harmon has been named regional sales manager for C-COR Electronics Inc. in the Rocky Mountain Region. He will handle sales of C-COR's complete line of distribution and digital electronics.

Alpha Wire Corp. announced the appointments of **Joseph Garcia** and **Christine Birkner**. Garcia will be the manager of industrial engineering, while Birkner joins the company as the benefits administrator.

Alpha also expanded their electronics field sales force with the additions of **Mark Carter** and **Dick Zaday**. Carter will be district manager for Metro NY/LI, and Zaday's territory will be Los Angeles/Central.

Jackson Enterprises has appointed **Joe Cost** to the position of national sales manager. Cost will be responsible for sales of all CATV and telecommunications products and services.

Barbara Lukens has been named division manager, construction, by American Television and Communications Corp. Lukens has been with ATC since 1974 as director of design and drafting.

Nova Systems has named **William Deegan** as national sales manager. Deegan will assume responsibility for all sales and marketing functions pertaining to Nova systems and its products. Prior to this Deegan was district sales manager for the Video Communications Company of SONY.

Broadband Engineering Inc. announces the appointment of **Sherwood Hawley** as national sales manager. Hawley joined Broadband in August 1981 as a design engineer. He was directly involved in the design and development of their line of CATV amplifiers.

Linda Arnold and **Susan Robinson** have been named account executives with the Arvis division of Adams-Russell. Arnold formerly was with Pioneer Electronics Corp. Robinson was previously with The Cableshop Advertising Service, an Adams-Russell enterprise.

Robert Hyers, Randall Rhea and **Nigel Seth-Smith** have been elected principal engineers at Scientific-Atlanta. The title is the highest technical rank in the company.

David MacDonald has been named vice president, cable, of the Times Company. MacDonald has been director of operations at New York Times Cable.

With this issue, *CED* welcomes **Kathy Berlin** as associate publisher. Previously, she held the position of production director for International Thomson Communications Inc., publisher of *CED, CableVision* and four other technical journals. In her new role, Berlin will work closely with *CED*'s publisher, Gary Kim, on financial, production and editorial matters.

Ron Upchurch is now engineering manager for United Cable's Denver suburban system.

Craig Kemper has been named manager, direct sales for Blonder-Tongue Laboratories.

Neil DeCostanza is now national sales manager for the Sprucer Cable Television Division of Kanematsu-Gosho (USA).

Del Beccaro is now controller for the Jerrold Subscriber Systems Division.

Michael Solomon has been promoted to divisional sales director with RMS Electronics.

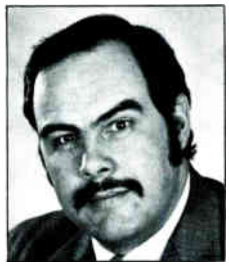
Jim Walcutt is the new vice president and general manager of Wavetek Indiana.

Edward Campbell is now vice president, construction, with Warner Amex Cable. **Bruce Massey** has become president and general manager, WAVE Cable, while **James Daley** moves to president and general manager of WA's Houston system.

First Data Resources has announced **Rusty Rau**'s appointment as director of operation for the Cable Services Division.

Times Fiber Communications has appointed **William Fanning** vice president, sales, for the Communication Systems Division.

Fairchild Data Corp. has made **Louis Harper** president. He was formerly senior vice president and assistant general manager with Comtech Data Corp.



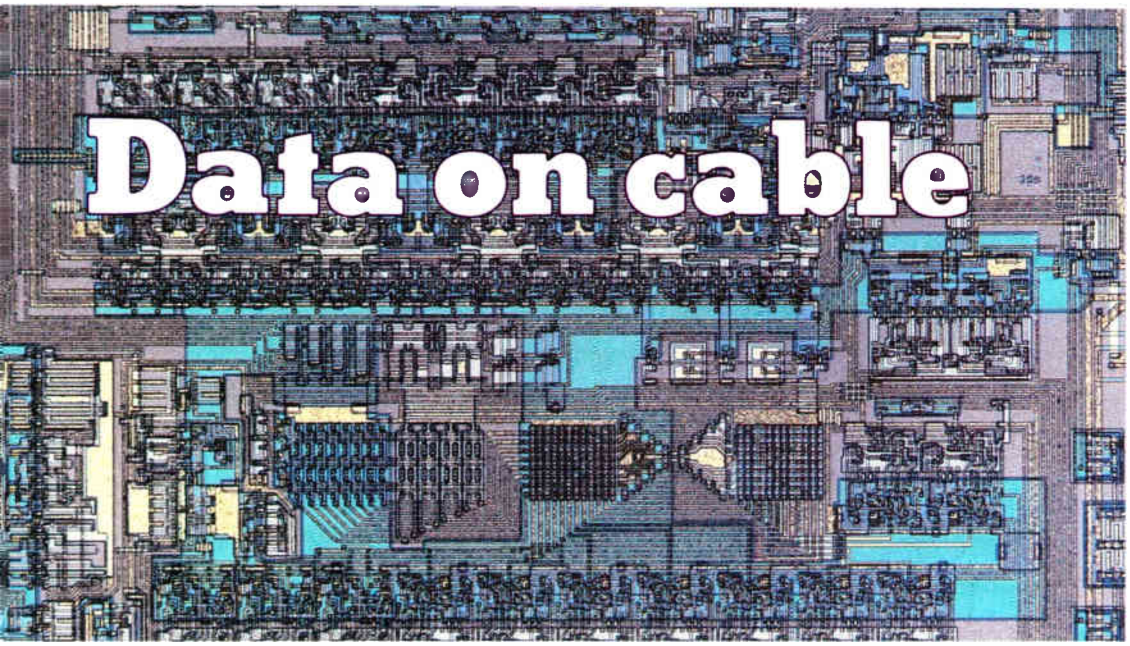
Augat Broadband announced the appointment of **Richard Paynting** to vice president group engineering. Paynting was the manager of research and development for Augat/Vitek Electronics in Edison, N.J. He also was associated with CBS Electronics in Secaucus, N.J.

Correction

In the April issue of CED, the diagram that appeared on page 18 was, unfortunately, reversed. The sync-suppressed signal is at the top, with the normal signal below.

Within the same article, the sentence beginning on page 16, column 3, line 4, should read: "Because of this relationship, it is **possible** *to derive the synchronization frequencies by counting down from a multiple of the color subcarrier frequency."*

Our staff apologizes for any confusion or inconvenience these errors may have caused you.



Data on cable

By Robert Patrick,
Director, Business Communications,
Cox Cable

The local communications marketplace is virtually the last frontier of competitive communications, an arena where the established telephone local exchange companies (LECs) and established cable television operators reign supreme in the provision of their respective portions of data, video and voice communications needs. This is a story about one cable TV operator's foray into providing services in the grey area that lies between the two camps—the area of wideband business data services.

In 1981 Cox Cable Communications decided to start a trial business of local commercial data distribution in one of its franchise areas. It sensed that flexible, economical wideband data transmission was an underserved market and that these services could be carried over a coaxial cable plant not dissimilar from the traditional tree-and-branch residential networks. It decided to investigate service in a market with an existing institutional cable requirement. After some preliminary screening, Omaha, Neb., was chosen as the test site. Omaha represents a moderate sized MSA (number 75), is a regional center with a stable business environment and has a diverse number of business types and sizes. It also is the home city of Northwestern Bell Telephone Co., one of the best Bell operating companies in the nation. All signs pointed toward a good test of a local data communications business.

From the start, Omaha was planned to be a test of citywide business. This meant that the traditional cable TV business communications service of building dedicated, point-to-point cables to serve a very few large clients was not done. Rather, we attempted to build a comprehensive, citywide network that would allow business customers at almost any point in Omaha to communicate with virtually any other point in Omaha.

This placed a premium on successful market research to get specific answers to the following questions:

- Where are the businesses in Omaha located, and where do they need to communicate?
- What communications services do they need?
- How much potential is there in the whole market (in terms of existing business and growth)?
- What unserved market needs are there?
- What kind of business approach should be offered to insure success?
- What relative market share could be expected?

Decisions on network construction and topology, staffing, promotion, service and even whether or not to continue development awaited the outcome of the research.

Market research

Extensive research was conducted for four months in 1981. Several focus groups were used to gather general information on the local attitudes toward communications, existing service providers, pricing and service points, and also to help validate a portion of a pending telephone questionnaire. Focus groups were conducted with large users, smaller users, and the traditional "institutional" users—hospitals, city-county government, universities and schools.

A telephone survey was conducted next, reaching over 250 Omaha users of communications. The survey list was a census of a previously stratified sample of businesses and other users chosen on the basis of their size, sales, multi-location topographies and other likely communications indicators. Because the concept of institutional cable was a bit nebulous, the survey was conducted in two parts.

Part one was a standard survey instrument eliciting responses on current communications uses and needs, perceptions of existing communications service providers, service locations, forecasts of future growth and rankings of important service features. The second step involved mailing a picture-and-word brochure to all survey respondents showing a proposed form of institutional cable service. A follow-up telephone call was made and the respondents went through the book with the interviewers, stating their reactions to the overall service concept, as well as specific pricing, service and organizational features of the proposed business. Over 175 of the original 250 contacts completed the whole questionnaire associated with the booklet.

The third part of the market research was a series of personal interviews with users *not* reached in the telephone survey, representatives from local commu-

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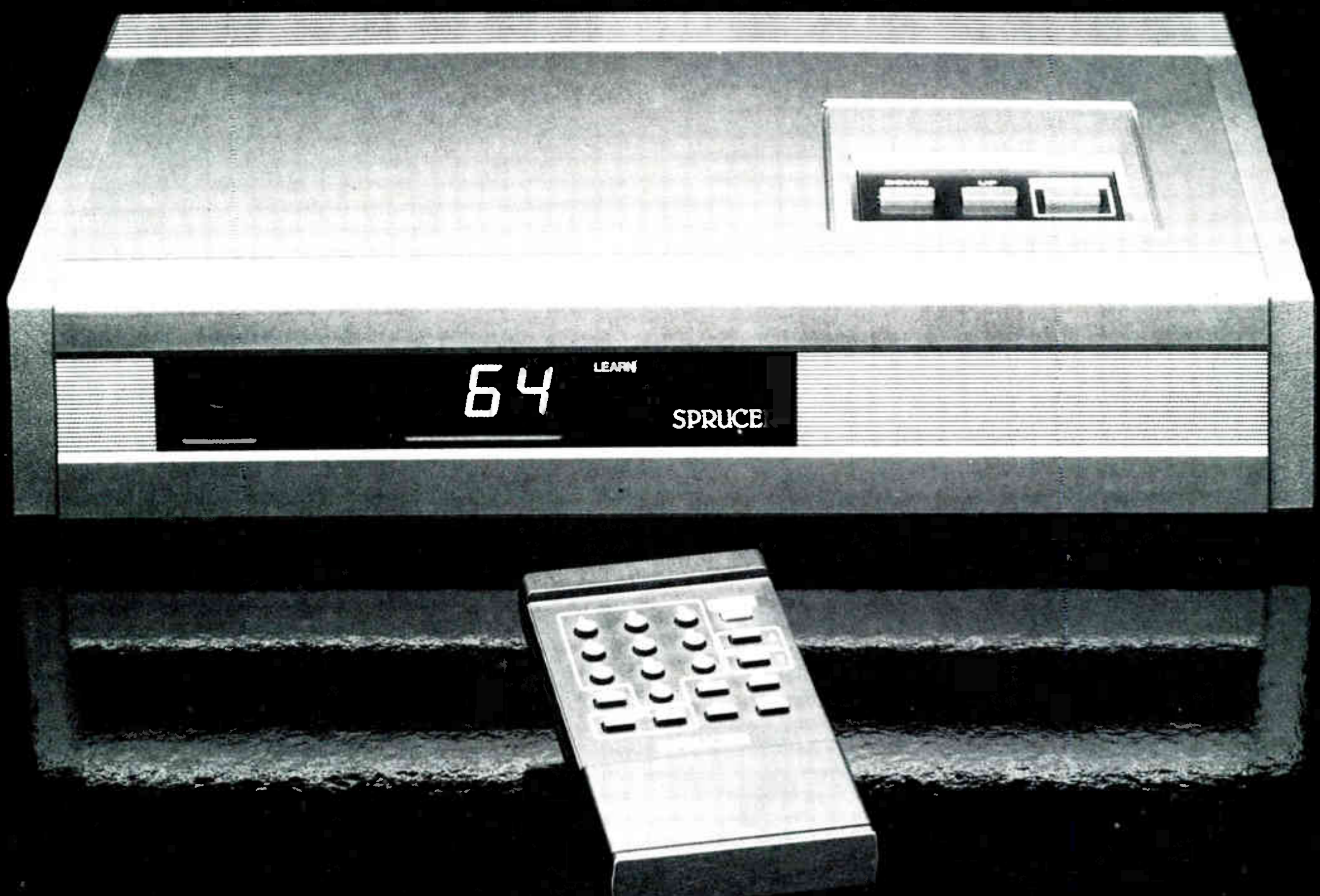

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nications associations and local vendors of peripheral communications products like computers, display terminals, multiplexers and PBXs. Thirty-five to 40 interviews were successfully conducted, with the same questions asked that were on the telephone survey. Additional information was gained on perceptions and tendencies that can only be gathered in personal interviews.

The resultant information measured the attitudes and conditions of from 80 percent to 90 percent of the Omaha target market. Cox felt that sufficient information had been gained to fully answer the questions that had prompted the market survey. The information was:

- All of the major businesses and business areas had been identified. This was doublechecked by referencing planning commission, Chamber of Commerce and other business association documents.
- The overall market for communications services had been growing by an average of 15 percent per year. Higher speed (above 4.8 KbPS) data services were growing at over 20 percent per year. Very high speed data services (over 19.2 KbPS) were nonexistent.
- There was an opportunity for a data service provider who could offer quality service, reasonable and understandable rates, and rapid installations.

Cox made the decision to proceed with the business and to use Omaha as the test market.

The next task was to figure out exactly what type of business organization and cable plant to create to attack the intended target market. Cox used information from the market research, as well as an understanding of data communications on cable and the legal and competitive environment to make these critical decisions.

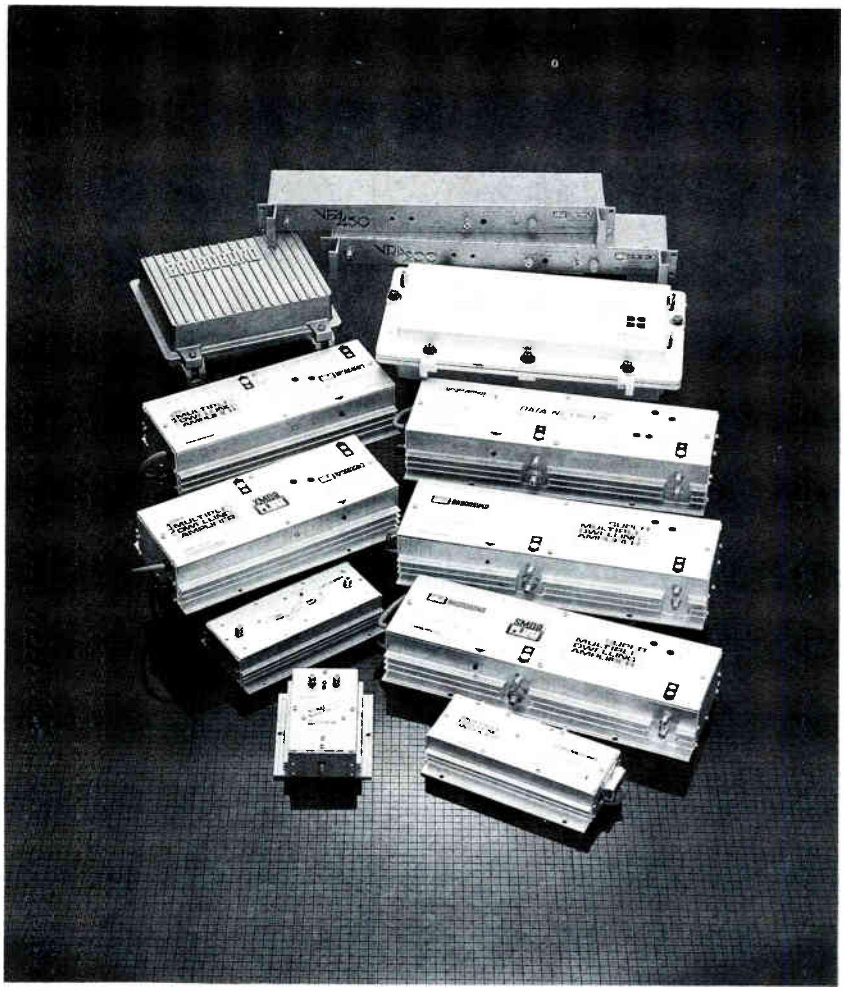
The cable plant was constructed in a classic tree-and-branch topology to pass those areas identified in the market research. Cox drew on its knowledge of data over cable gained from its experience in its INDAX project, its observation of the fledgling broadband LAN industry and from input from a selected few communications consultants to design the network and specify the characteristics of the attached equipment.

The business was run by a separate organization because that was the best way to develop a business so potentially different from traditional cable TV. This separate organization was attuned to the business and competitive environment and took much of the burden off the basic cable business, which was at the time fully involved in building the Omaha residential cable system. It also defended against charges of cross-subsidization and, perhaps, insulated the basic cable operation from the threat of potential regulation.

The business concentrated on providing high quality and flexible data communications service between points in Omaha. We offered predominately high speed (at 9.6 KbPS and above) data services and the potential for customers to safely and inexpensively craft multipoint circuits at speeds of 9.6 KbPS and above.

The service rates were based on the cost of providing the service, not artificially pegged to competitors' rates. This helped avoid the charge of cross subsidy, and provided a truer test of the worth and viability of the business. Moreover, the rates to customers were stated unambiguously—as per cable drop prices for connecting any number of points in town, regardless of mileage or proximity to hub sites.

The business was cast as a friendly, concerned and honest enterprise, willing to work with customers to solve their communications problems, will-



ing to admit its own mistakes and work diligently to solve them. This was not as trite as it may seem. Market research had uncovered a groundswell of customer dissatisfaction with the LEC's tendency to adopt a "take it or leave it" attitude and with fingerpointing among communications service vendors when problems arose.

The business lived and breathed service. Customer problems received a response within one-half hour, and a technician was on-site within one hour, if necessary. The technician remained on site until the customer's problems were solved. This service was maintained 24 hours a day, seven days a week.

Customers were protected from service interruptions. Plant work was scheduled at night and on weekends after careful coordination with customers.

Care was taken to present the business as an ongoing, professional communications concern. The business was given a formal name, Commline, which was put on all trucks, stationery, business cards, proposals for service, lapel pins and technician uniforms. Data communications technicians (the inside men) wore blazers to give an aura of professionalism and standardization.

Construction of the network began in January 1982. The first staff was hired in April of that year. Service began to the first customer in July. We're now in our fourth year of operation, and the network has grown to 300 miles of two-way cable, servicing over 40 clients at 178 locations by a Commline staff of 17. Services include analog video and data at rates from 4.8 KbPS to 2.5 MbPS. Commline also provides two interstate carriers with local digital connections.

Lessons

The development of the business, although carefully planned, has not been a smooth affair at all. Cox has piled up a trove of lessons learned about the business of running a true metropolitan area network—mostly learned the hard way. Some of these are:

- The network must be built with excruciating care, far and above that required for even a top-notch residential cable system. Incorrect splices, kinked or deformed cable, improper grounding and marginally correct installation procedures for drops, amplifier electronics and data circuit terminating equipment (DCE)—the modems and modulators—can cause system problems that are debilitating and hard to find. Plant done marginally had to be torn down or dug up and redone until it was perfect. This means that much of today's institutional cable plant is not adequate for comprehensive business communications services without extensive rehabilitation.
- Status monitoring is a must for active plant components, power supplies, headend electronics and, potentially, even the DCE. This reduces response time to outages but, more importantly, provides early warning against potential failures and allows the tracking of system dynamics.
- Redundancy in all signal concentration points is necessary to preclude catastrophic outages. Redundant headend data translators and redundant diversely-routed inter-hub supertrunk are the absolute minimum.
- Cable drops are completely different from the usual residential drops. Omaha Commline's average drop costs averaged in excess of $1,300, and each drop was complex and different enough to demand individual design and engineering. Most drops were constructed from 0.500 cable, not RG-6, and some even contained their own line extenders. Drop installation became a business unto itself, with a small dedicated staff designing, contracting and managing the drop installation. Cus-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tomers, conditioned by the ridiculously low installation rates historically offered by the LEC, more often than not balked at paying the full costs of the drop. This resulted in a bit of speculation in drops, where subsequent services and revenues were anticipated from the same customer or different customers in the same location to eventually recover the drop costs that were not immediately recovered. In a great number of cases, this assumption proved correct, but most drops were a gamble nonetheless.

■ Almost all non-cable plant equipment was totally inadequate for the job of reliable data communications. This included every data modem and data transfer available in 1982. What worked acceptably on an internal local area network would degenerate into abject failure on a more heavily loaded metropolitan area network. Only recently has the suitability of equipment begun its tortuous climb to respectable quality levels, but the state of the art coaxial cable equipment still is considerably behind the state of the art telephony equipment.

■ Sales of local data communications services were harder than anticipated. Telecommunications managers were reluctant to sacrifice their careers to try new ways of doing things that worked acceptably the old (telephone plant) way. Problems with the network in the early going only added to this difficulty. Market research had predicted a small initial available market, as most data transmission needs were routinely handled by dialup business telephone circuits, which were very economically priced at flat rates. Growth in the market came with customer upgrades in hardware and software designed to support higher data speeds.

True and untrue stories abound about shoddy residential cable performance that make cable business communications services a hard sell.

■ The major intermediate customers, the interstate carriers, were harder than expected to get on the network. Early in 1981 Cox began to approach the long haul carriers (MCI, Sprint, Satellite Business Systems, American Satellite and others) to offer local data distribution of their long haul signals. It took one and a half years to get the first long haul carrier-to-Commline link established, MCI's inaugural Cablephone service. Expansion of that service has been hampered by early reliability problems, a lack of cable terminating equipment necessary to do local distribution of voice economically and effectively, and procedural problems for the interstate carrier in that using cable is so operationally different from using the LEC.

■ Regulation was expected to be a

Reader Service Number 27

problem and, as explained previously, Cox strategized the Commline business in anticipation of regulatory strife. The true extent of the problem was revealed shortly after the inauguration of the first Cablephone service in November 1982—conflict with the Nebraska Public Services Commission.

Regulation

Cox Cable decided from the beginning to try to cooperate with the regulatory agencies at all levels. The City of Omaha government was kept abreast of the development of Commline, and formal presentations on Cox's intentions were given to the Nebraska Public Services Commission (PSC) in late 1981 and in 1982. The presentations stressed Commline's unique nature: a purveyor of wideband data services not generally offered by the LEC that worked out individual rates and terms with customers (contract carrier) and planned extensive links with long haul carriers (primarily an interstate carrier). In all presentations Commline was positioned as a service that regulators did not have to worry about.

There was no regulatory objection to Commline and its business until the public announcement of the first Commline-MCI Cablephone link in December 1982. Within one week of that announcement, Commline and Cox Cable were served with summons to appear before the Nebraska PSC to explain: 1) why they should *not* be classified as a common carrier, and 2) why they *should* be allowed to exist.

The testimony took place over the next four months, with Northwestern Bell Telephone attorneys acting as the inquisitors. Commline maintained: PSC concern was not justified as Commline posed no threat to NW Bell viability; Commline was operating as a contract carrier, *not* a common carrier; and any regulation to be done must come from the FCC because Commline intended to carry a preponderance of *interstate* signals on its network.

The PSC was not swayed. At the end of April 1983, it handed down a requirement that Commline cease operations until it filed for a Certificate of Convenience and Necessity to operate as a Nebraska common carrier. The language in the order also strongly suggested that Commline would not be authorized to operate as a common carrier in Nebraska if Commline's petition for a certificate was filed, making the requirement for compliance a *de facto* cease and desist order.

Commline immediately filed a suit in the Seventh U.S. District Court against the PSC and the State of Nebraska charging that:

- The PSC had overstepped its authority in trying to regulate an *interstate* service that was clearly under federal purview.
- The PSC was trying to extend regulation to a firm that clearly was not a common carrier and never had any intention of being so.
- The PSC was violating Commline's constitutional rights in attempting to unilaterally forbid its operation.

The parties involved agreed that Commline be allowed to continue its Omaha operation until the suit was decided.

Commline also filed a petition with the FCC seeking federal pre-emption of two-way cable services in the furtherance of competition and in declaration of the FCC right to regulate interstate traffic over coaxial cable metropolitan area networks.

In August 1983 the federal District Court judge remanded Commline's suit back to the Nebraska PSC, with instructions to reconsider Commline's arguments about not being a common carrier and being firmly under the federal purview. The judge also retained the

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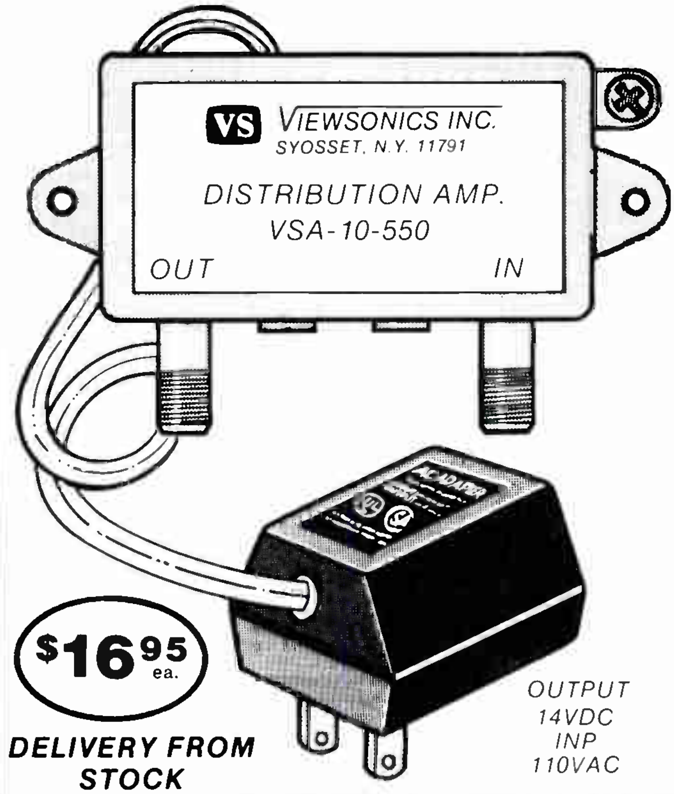

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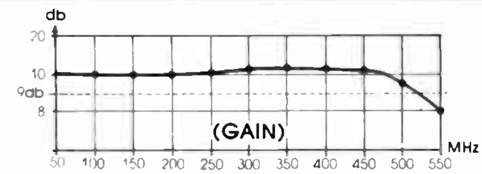

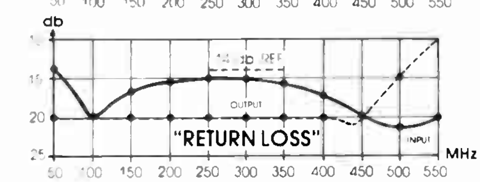

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authority to step back in and reconsider the issue, if necessary.

Today, two years later, the PSC has not yet reached a decision on the matter, although additional testimony was heard in March 1985.

The FCC petition also has not been acted on at this time, although action is expected sometime in 1985.

Conclusions

The final answer concerning the business potential of citywide "institutional cable" remains elusive. There are several very large clouds looming on the horizon. Despite all of the legal work, FCC lobbying and PSC and federal court appearances, the regulatory situation definitely is not resolved.

Cable telecommunications hardware still has not matured sufficiently to allow a full-fledged institutional cable to provide enough needed services with adequate reliability to turn a profit. Manufacturers generally have yet to realize this industry as one with potential for significant hardware sales and, therefore, have not made truly concerted efforts to produce quality equipment.

Telecommunications users still tend to view a coaxial cable-based communications alternative provided by a cable TV company with skepticism. True and untrue stories abound about shoddy residential cable performance that make cable business communications services a hard sell.

LECs do not and will not take the threat of competition lightly. They have shown surprising resilience in combating the incursions of PBX (interconnect) vendors and other telecommunications service providers by slashing prices and improving their own service quality. A coaxial cable network provider will have to attain near service perfection and participate in aggressive, informed pricing and service positioning in order to succeed.

Finally, the cable TV operator who decides to try the service must be prepared to create an organization with a service orientation that would bankrupt his company if employed on a residential cable system. It also must know the dynamics and terminology of a very different business. This requires the hiring of additional, specialized people or the extensive retraining of existing staff.

Is there really a market out there for alternative local distribution? Yes, definitely; it is small but growing rapidly. The market research and Cox's experience in Omaha have proved that. If nothing else, the local telecommunications market is growing faster than the capability of any one service provider to sustain it.

Can a cable TV provider tap into it as a metropolitan network provider (and avoid building dedicated facilities)? Maybe. It requires hard work, specialized skills, the patience to allow the business to develop, and an attention to communications issues completely *outside* the scope of cable TV. Such a commitment must not be taken lightly.

Will those looming clouds on the horizon dissipate and make the possibility of success more certain? Possibly, but cable TV operators must understand that uncertainty is a way of life in the communications industry. CED

About the author

Robert Patrick, Director of Business Communications Services for Cox Cable Communications, has worked on the development of Cox Cable's institutional cable business for the past four years. Before that he worked on Cox's videotext, home security and energy management projects. Patrick has an MBA in Marketing and an MS in Decision Sciences from Georgia State University.

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Reader Service Number 33

Equalizer selection

By David L. Marshall
Director of Engineering,
Advanced Communication Services Inc.

Would you deliberately place incorrect equalizers in your line amplifiers? The fact is, you might be doing just that without realizing it if you are following the instructions some manufacturers provide. It wasn't too long ago that a system designer could lay out an effective network while paying relatively loose attention to such items as passive tilt, but those days are gone. The manuals continue to indicate that the best way to select an EQ is by looking at the high frequency cable loss, but a quick reference to the tap loss table shows that tilt is contributed by devices other than cable. Look at your equipment catalog if you don't believe it.

The problem

Your observation should speak for itself. In a 400 MHz system, it would be typical to see 0.3 to 0.4 dB of tilt per tap. In 440 and 550 MHz applications, that number might venture as high as 0.6 or 0.7 dB per tap. It doesn't matter which manufacturer is showing you tap specs because this tilt is inherent to the devices' design. In fact, virtually all passive devices show some tilt, especially visible in the higher bandwidth designs. This tilt is the very reason that a designer who uses the highest frequency losses and neglects low frequency losses is likely to have level problems as the low-end signals creep up and up and up.

EQ selection based on dB of cable at high frequency does not take into account any of the tilt introduced by passive devices. It is fairly easy to illustrate ambiguity in this cable equivalency method of selection. For the sake of illustration, I have chosen to use the 1985 400 MHz book-value losses for Scientific-Atlanta devices and cable, but I stress that the same phenomenon occurs to varying extents with Jerrold, Theta Comm and Magnavox passive equipment.

A 0 dB tap window is assumed to apply in this example. The tap window is the amount the designer will allow the low frequency signal level to creep above the high level at a tap. (Actually, I prefer to carry this one step further and also consider the drop. After all, we feed homes, not poles. But in this case, we will stick to tap levels.) In our example, we assume that we insert an in-line equalizer when the 54 MHz level exceeds the 450 MHz level or, in other words, when we have closed our 0 dB window.

In addition, some compensation must be made for the inclusion of an in-line equalizer prior to an amplifier. The in-line provides correction to system tilt just as the equalizer in an amplifier does. Therefore, it stands to reason that any equalization accomplished by the first device must have an effect on the latter.

It also is important to note that the face value of an equalizer often is not the amount of tilt which that equalizer corrects for. In circumstances where the face value is given in cable equalivalency, the actual correction in dB will be less than the face value. If such an equalizer accurately corrects for cable losses (and they generally do), Formula 1 will yield the real value of the equalizer.

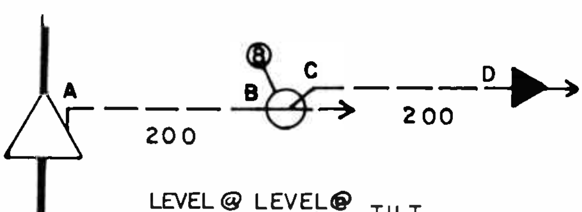
Formula 1 (cable equivalency to dB of correction):

$$V \times \frac{(H-L)}{H}$$

where:
H = Cable loss at high frequency (dB per unit length)
L = Cable loss at low frequency (dB per unit length)
V = Cable equivalency (face value) of EQ

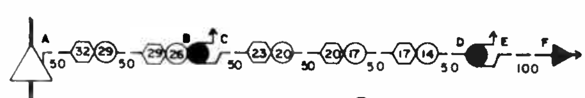
Figures 1, 2 and 3 compare three design nodes that are "equivalent" with regard to high-frequency cable loss. These nodes are real, although extreme, cases. Figure 1 might be typical of a rural area, whereas Figures 2 and 3 could be seen in high-density underground design. I have selected these particular nodes to emphasize the equalizer problem. In reality, any good designer would try to avoid a +30 dBmV input to a line extender, but there are circumstances where this might be necessary.

All of the nodes space a single cascade line extender at 400 feet from a single output bridger amplifier. By the cable equivalency method of selection, all of these extenders should have the same equalizer, namely the one whose value is closest to the loss of 400 feet of cable—in this case, 6.6 dB. If you look at the actual levels at amplifier inputs, however, you will see a wide variance in tilt. All of the nodes have 4.44 dB of tilt contributed by cable, which accounts for all of the tilt in Figure 1. (Actually, the DC-8 probably would contribute, but we are using book-values so we don't know how much.)



	LEVEL @ 54	LEVEL @ 450	TILT
A	38.5Ø	45.5Ø	7.ØØ
B	37.42	42.2Ø	4.78
C	28.92	33.7Ø	4.78
D	27.84	3Ø.4Ø	2.56

Figure 1



	LEVEL @ 54	LEVEL @ 450	TILT
A	38.5Ø	45.5Ø	7.ØØ
B	36.26	4Ø.55	4.29
C	32.66	36.5Ø	3.84
D	26.38	25.7Ø	Ø.68
E	22.78	21.65	-1.13
F	22.24	2Ø.ØØ	-2.24

Figure 2

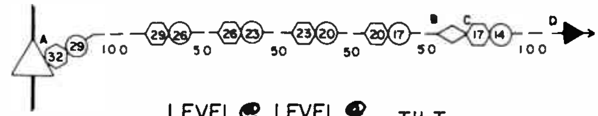
Figure 2, however, shows a passive tilt contribution of 4.8 dB, which is not considered in the cable equivalency method. Likewise, the node in Figure 3 has a passive tilt of 4.7 dB, but an in-line equalizer subtracts that figure past zero to a passive tilt adjustment of -2.6 dB, also not considered in the cable equivalency method.

Many manufacturers would have you select the same equalizer for all three extenders, when closer analysis reveals a 7.4 dB variance in the actual input tilts. It's easy to see why you've had to go back up the pole to change EQs, all the while grumbling at the designer.

The solution

There is a fairly easy solution to this vexing problem. Since the purpose of an equalizer is to correct input levels to what the amplifier likes to see, the answer is to set your equalizers according to the levels at amp inputs. One method is to extend the *apparent* length of the cable by adding footage to the original—proportional as passive tilt is to cable tilt. This method works well enough, but the solution centers around having to figure what portion of your tilt was cable-caused and then subtracting that from the overall tilt. If you ever do production-based design, believe me, you don't want to take the time to do all of that.

There is an easier way. Take the equalizers your manufacturer provides and create a table of their actual correction values—either by using Formula 1, by bench-testing the EQs or by asking your manufacturer's representative. (You'll have better luck with eye teeth.) Having completed your table, all you need to do is compare your actual input tilts with your table to find the closest matching EQ. In addition, if you desire to "center-balance" your equalizer choice around the required number, you may do so.



	LEVEL @ 54	LEVEL @ 45Ø	TILT
A	38.5Ø	45.5Ø	7.ØØ
B	31.38	31.15	-Ø.23
C	23.Ø8	3Ø.15	7.Ø7
D	2Ø.Ø4	25.2Ø	5.16

Figure 3

A word of caution is in order. There are several considerations which will alter your final outcome if not properly applied. First, you should remember to take into account the *original* tilt at the output of the last active when you are deriving the number to compare to your table. If you are in a feeder system operating with a positive 7 dB of tilt, you must remember that flat inputs mean you have already encountered 7 dB of tilt. Therefore, use Formula 2 to derive your "compare number."

Formula 2 (computation of encountered tilt):
(LT—HT) + (HL—LL)
where:
LT = Low frequency input of this amp
HT = High frequency input of this amp
HL = High frequency output of last amp
LL = Low frequency output of last amp
Note: (HL—LL) is the operating tilt

The other consideration is factory-preset equalization. Certain manufacturers build some equalization into their amplifiers, and you must account for this in your selection of an equalizer. It is important to note whether the preset number given by the vendor is stated in actual tilt or in cable equivalency. If the number is actual tilt correction, just subtract it from your compare number before comparing it with your equalizer table. (If you net a negative number, you need a cable simulator.) If the vendor's number is in cable equivalency, you must use Formula 1 to adjust it to actual tilt correction, then subtract it from your compare number.

In summary, the process of proper amplifier equalizer selection requires the analysis of the true system tilt. Equalizer selection based purely on cable loss yields somewhat unpredictable results and, therefore, should be avoided. The method of equalizer selection shown is tested and reliable and ensures consistent, accurate results if the designer takes proper precautions. CED

About the author

David Marshall is the Director of Engineering for Advanced Communications Services Inc., an Atlanta-based CATV services company whose specialty is field engineering and design. A former member of Cox Cable's design group, he participated in the design of conventional and experimental projects, including Commline and fiber optic network analysis for Edinburgh, Scotland. In addition to seven years experience in CATV design and software development, his background includes broadcast radio engineering, CARS microwave and headend engineering, and plant maintenance.

Marshall also is president of DLM Enterprises Inc. and has developed micro-based CATV engineering software products. His accomplishments there include the development of the "D3" graphics-based CATV network design package for the IBM PC.

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- **Product Profiles: Addressable converters, data modems**
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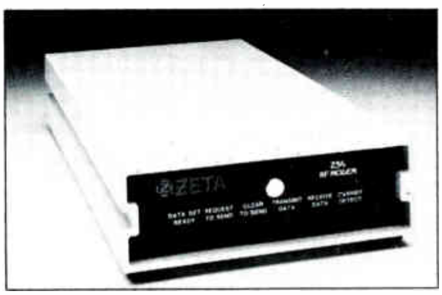


The Zeta Z56 RF modem.

Oak's Sigma Three addressable baseband converter/decoder.

Implementing MTS

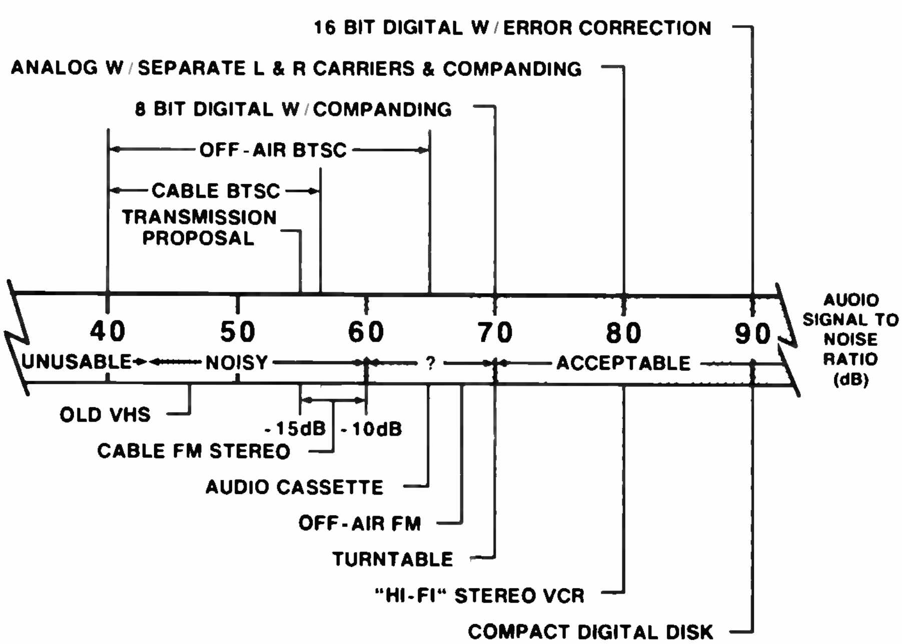
An examination of the audio quality, cost and user-friendliness of the various options operators have for providing stereo to their customers.

By David Large,
Vice President, Engineering,
Gillcable

A great deal has been said and written in the past few months concerning the compatibility of broadcast stereo television and cable television equipment. The broadcasters feel that multichannel sound is an integral part of their product and should be protected under the FCC must-carry rules. The cable industry has estimated that the cost of complying with a strict must-carry interpretation could be as much as 700 million dollars and that there are alternate technical solutions which could be implemented more economically. Further, it is argued that marketplace demands will result in cable systems carrying stereo by some method anyway. Some of the alternate solutions proposed for carrying stereo sound are FM simulcasting, advanced analog out-of-band systems and digital transmission.

Out-of-band systems are proposed primarily because the most serious problems with cable carriage of broadcast stereo (or BTSC, as it has come to be known) are caused by incompatibility with scrambling systems and baseband converters. Moving the multichannel sound out of the normal TV channel solves these problems.

Not always considered in these debates of alternate solutions has been the acceptability to our customers of the final product. Specifically, the quality of the resultant sound, the ease of installation and use, and the complexity and cost of the equipment required all need to be considered carefully.



AUDIO QUALITY COMPARISON CHART
Figure 1

Trends in consumer audio equipment

Figure 1 was produced as a means of comparing various consumer audio equipment. The scale is calibrated in signal-to-noise ratio (actually signal to "crud" ratio) with very noisy performance on the left and nearly perfect on the right. The data from which this graph was derived have come from numerous different sources and should, therefore, not be taken as gospel, but only as indicative of general performance capabilities. Other parameters such as separation and distortion also are important in stereo sound, but generally follow in the same order as noise levels.

Along the lower side of the scale have been plotted various home electronics components that are available today. At the high end is the compact digital disk. This equipment has dropped in price from over $1000 to under $300 in less than one year and is expected to replace the turntable as the means for playing pre-recorded material in the future, principally because of its noise-free output.

At 80 dB we find the new "hi-fi" VHS and BETA video cassette players. This is a much more significant development for cable operators to watch for two reasons: first, because the market is rejecting the old VHS audio performance (plotted at around 47 dB on the scale) in favor of the higher performance and second, because this superb sound is *video related.* The cable customer who rents a tape and plays it on his VCR will make a side-by-side comparison to his local cable operator's product. Considering the effect that VCR rentals have had on sales of premium services already, this could be a serious detriment if our radio is noticeably poorer in quality.

Most home audio equipment falls into the 65-70 dB range. A new turntable with a clean record typically will deliver near 70, while off-air FM will be slightly worse and cassette players are at the bottom. Even though they are noticeably noisy to all but the most casual listener, cassettes thrive in the market because they often are used in relatively noisy environments such as cars and because they are the only low-cost names for recording from other sources.

Significantly lower in quality is cable's simulcast FM service. Operators following the normal practice of carrying FM stations at the same level as TV aural (15 dB below channel 6 video) are probably not delivering better than 55 dB at the far reaches of a typical cascade. Raising that level by 5 dB allows a level of 60 dB, which is subjectively much superior, though "hiss" noise is still quite apparent in stereo mode.[1]

Given the above trends, the graph has been divided into ranges which represent the author's judgment of how consumers might judge stereo TV sound. The divisions between "acceptable" and "questionable" at 70 dB and between "questionable" and "noisy" at 60 dB also correspond with the analysis of the designers of the BTSC stereo system who said, "For high fidelity sound reproduction. . . the signal to noise ratio should be at least 60 dB, preferrably 70 dB, or better. . . "[2] While that might be true today, the trends in VCRs and digital disks suggest that it might not be adequate in the near future.

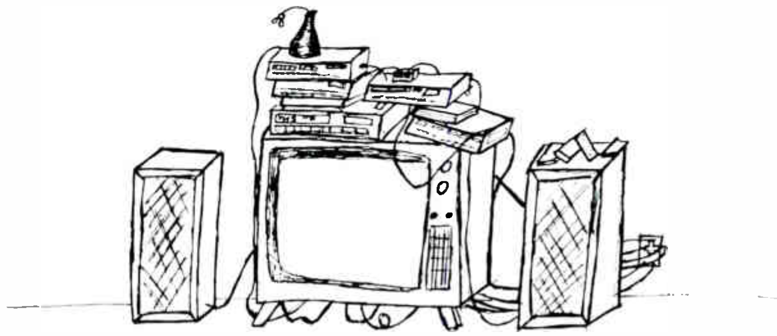


Figure 2 Box Proliferation

At the low end, there is a point around 43 dB, below which even the most casual listener will be irritated by the noise level. Significantly, the NAB has suggested to the FCC that any point above this noise level will not represent "significantly degraded" BTSC sound![3]

BTSC stereo format

Consistent with this low expectation of the quality of BTSC stereo is the proposal made by the EIA to the FCC for setting standards for BTSC transmission. In this proposal, the suggested requirement for S/N *at the transmitter* was only 55 dB, with stereo separation requirements of 30 dB and distortion levels of 4 percent. [4]If accepted, this would allow the TV station to transmit a signal which would fall fully 5 dB *below* the minimum quality needed for "high quality sound reception."

Assuming that the transmission equipment delivers a noise-free signal, how will it sound in a TV viewer's home? To attempt to determine that, the EIA conducted a series of "back-to-back" tests of the complete BTSC system, including both stereo encoding and companding for noise reduction. The results for TV sets using conventional quasi-parallel or Nyquist aural detectors for sound are plotted under "off-air BTSC" on the graph. These results are for a "city-grade" or very strong signal. The highest quality resulted from a perfectly adjusted transmitter and a blank black screen.[5] As effects of Incidental Carrier Phase Modulation, multipath, and a complex video source were added, the "crud" increased until it was only 40 dB below the video.[6] Under active video, it would be expected to vary somewhere within this range.

Although this same test was not performed through an actual cable transmission system, it was run under "grade B" signal conditions (defined as 30 dB carrier/noise ratio) resulting in a maximum of 58 dB S/N ratio with a blank white screen and 62 dB with a black screen.[7] After scaling that up 6 dB to reach the equivalent of a cable end-of-line at 36 dB C/N ratio and down by 8 dB to account for cable running the aural carrier at the depressed level of 15 dB below video, it is predicted that the level at a cable system end-of-line would be only 56 dB stereo S/N ratio under the optimum blank screen conditions given above. The low end which is dominated not by noise but by "buzz" caused by video products should not change. Obviously, the high end will be improved to the extent that any given cable system exceeds FCC minimum specifications on video S/N ratio, but even a more typical 40-42 dB will barely reach into the "questionable" area.

Note that the above analysis assumes that the BTSC signal is not "bruised" by headend equipment, scrambling processes or converters, and that the only degradation is caused by distribution system noise build up.

Alternate delivery systems

If the author's admittedly pessimistic analysis of the potential quality of BTSC in a cable system is anywhere near the actual performance, operators are going to have to ask themselves some hard questions about what quality level will be acceptable to their customers. Certainly if cable stereo is degraded below off-air to a degree that is obvious, it could affect sales.

Alternate systems are available to deliver significantly better sound. At the high end of the quality scale, at least three vendors have equipment available that will transmit stereo sound with performance comparable to digital disk systems. The tradeoff is that such systems use a great deal of bandwidth, typically 1 MHz per stereo pair. A 54 channel cable system would have to use 66 channels to carry stereo sound for the other 48 channels using this scheme!

Advanced analog systems offer nearly the same performance at a significant reduction in bandwidth—more like 300-400 kHz per stereo pair. They achieve significant performance advantage over conventional FM stereo by avoiding multiplexing losses and by extensive companding. It is possible to "fit" the sound for a 54 channel system into the FM band and the adjacent bandwidth below channel "A" so that no video channels are lost.

A third possibility is to use a digital transmission system that conserves bandwdith by transmitting a "lower fidelity" signal. It is possible to meet a goal of 70 dB dynamic range (though not S/N) using a system that transmits only half as many bits as the premium system but uses companding. This system conceivably could be transmitted as part of the video signal rather than out of band and, thus, be simpler to "track" to the tuning of the video. If the format were chosen carefully, it also should survive the process of being recorded and played back by a home VCR.

The tradeoffs

Given that cable can use its greater bandwidth to solve the stereo quality problem, why not proceed posthaste? Unfortunately, there are significant costs and complexity associated with all the solutions:

BTSC—Assuming that the quality is found to be adequate, processors can be modified to not seriously damage the BTSC signal. Subscribers having no converters or simple RF converters then will get stereo if they have stereo sets. Most descrambler manufacturers seem to be coming out with add-on boxes in the $50 price range that will decode the BTSC signal and deliver left and right audio signals to external sound equipment.[8] This is an advantage in that a subscriber can be upgraded to stereo without having to buy a new TV set, but adds complexity by requiring at least one additional piece of equipment to be installed—more if audio amplifier and speakers are required. Furthermore, the subscriber who already has a stereo TV probably will not be amused by the notion that he sould help pay for the extra box.

Figure 2 is a somewhat whimsical view of this problem of proliferating boxes. Our mythical subscriber has added to his TV a VCR, descrambler, video switching box, stereo sound decoder, amplifier and speakers. The four wireless remote controls are on top of one of the speakers! As technical people we may find this amusing, but neither our salespeople nor our customers do.

An alternate solution proposed by the baseband box manufacturers is to simply pass the BTSC signal around the processing circuitry and to the TV set. Unfortunately, this also eliminates the remote volume control and mute functions and should be rejected along with any other "solution" that results in a downgrading of current capabilities.

FM Simulcasting—One low-cost alternative to BTSC carriage is to simulcast stereo TV sound in the FM band or, alternately, in the 108-136 MHz band and use a block converter ahead of the customer's TV set. The simplest solution of FM band usage suffers from the dilemma shown in Figure 3. This poor customer is consulting his cable guide to find out where to find the sound to go with his TV program. Many years of experience in the Gill system have proven this concept unworkable. Other vendors, however, are proposing systems whereby the problem of tuning the audio signal in concert with a converter is solved by "tagging" each channel at the headend and then recovering the tag at the converter output and electronically tuning the FM tuner to the appropriate channel. These special tuners are expected to sell in the $50-$100 range.

Such solutions, however, do little to solve either the quality problem or the complexity of the installation. The qual-

Figure 3 Non-tracked Simulcast Stereo

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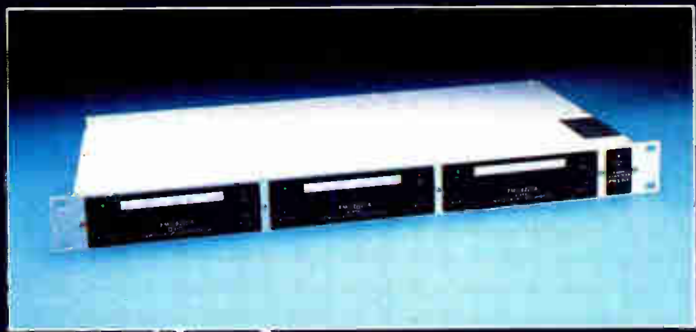

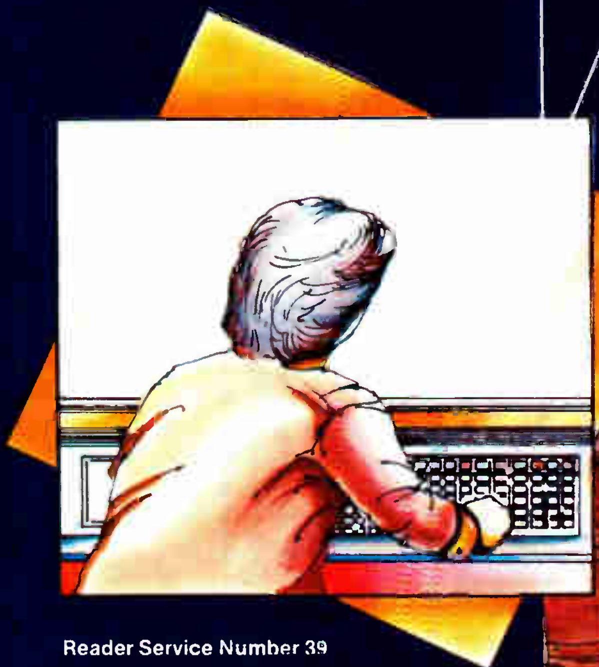

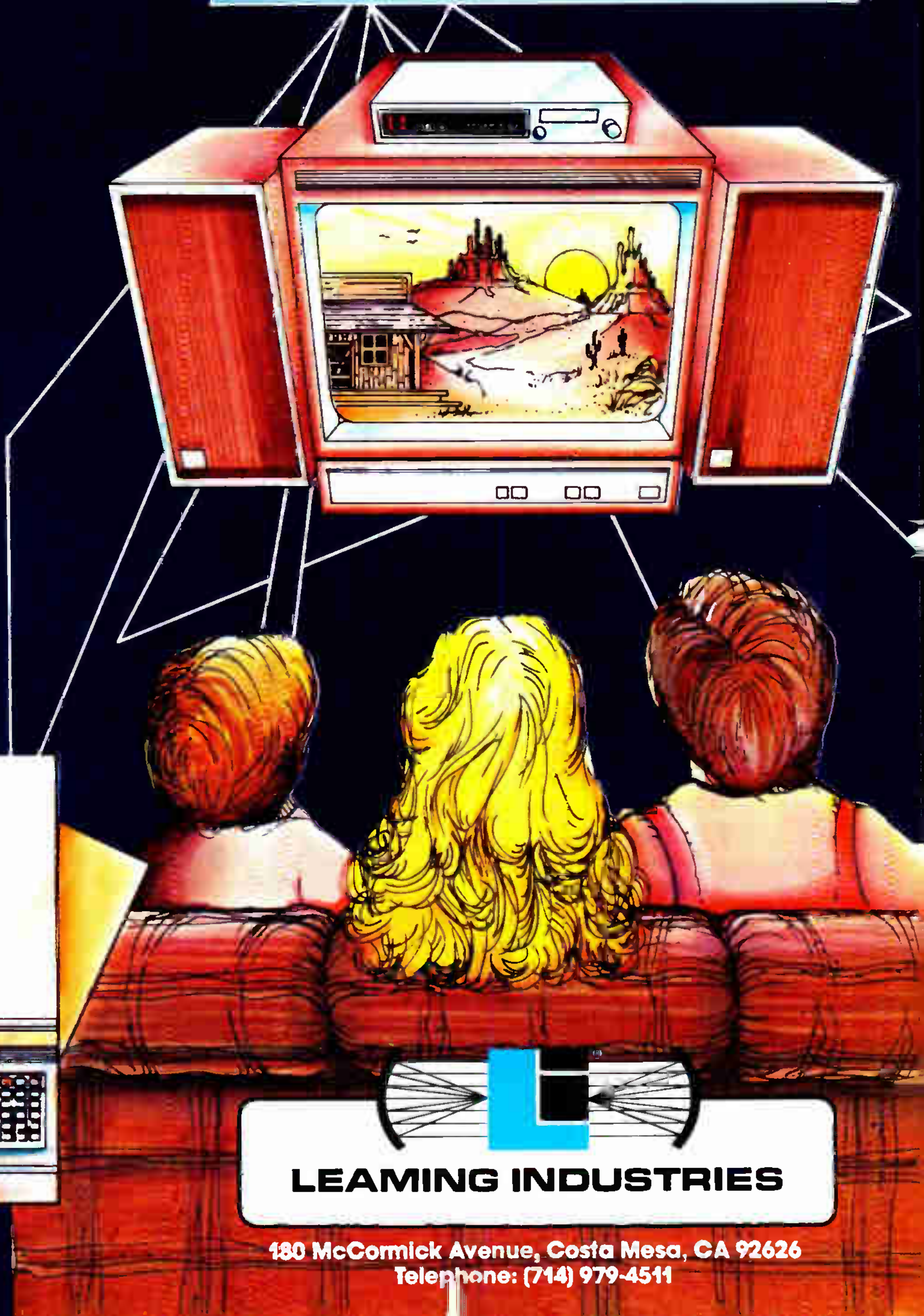

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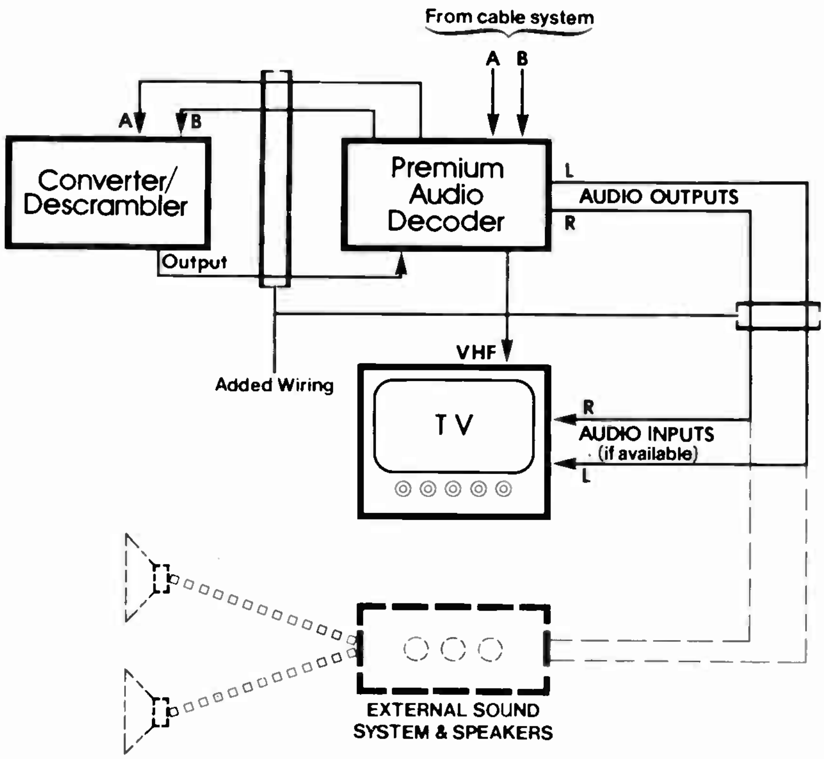

Figure 4 Typical Installation of Out-of-Band Stereo Decoder

ity of cable FM transmission is marginal at best, as we have seen. Furthermore, the installation requires even more jumpers than the BTSC add-on box for a descrambler because both the input and output cables from the descrambler/converter must be "looped through" the audio decoder. Furthermore, external audio equipment still is required.

Premium out-of-band systems—Either digital or analog premium out-of-band systems certainly are capable of solving the quality problem. The cost of the solution, however, is to be found in hardware price, complexity of installation and, perhaps, bandwidth requirements. Depending on the technology chosen, the decoder boxes sell in the \$120-\$200 region and still depend on external sound amplification equipment. Not all vendors have solved the problems of tracking the tuning and other features of a cable converter.

Installation typically is the same as for the tracking FM tuner system. Both the input and output cables to the normal converter or descrambler must be routed through the audio decoder because the channel tag is recovered on the converter's output, while the out-of-band sound signal must be accessed before the converter. In a dual cable system, that means a minimum of five additional jumper cables will be required (Figure 4).

Note that in order to effect tracking, all of the out-of-band systems use some form of channel tagging which then is recovered after channel conversion. This does not solve the problem, however, if some or all of an operator's subscribers do not have converters. In this case, either independent channel selection will be required or an outboard converter must be added with its extra cost and complexity.

In-band digital—At this time, no vendor has produced an add-on system utilizing in-band digital sound, although one vendor sells an integrated system whereby digital sound is combined in a single box with a proprietary scrambling system. While that may be an option to be considered for an operator just installing addressability, it is not a retrofit solution. Also, it has the limitation of the out-of-band systems since all subscribers must have the full addressable installation and doesn't provide for those with just converters or TV sets.

Long-range solutions

Perhaps the best hope for in-band digital sound is that eventually the broadcasters may adopt some form of video-embedded sound for stereo TV, thereby solving problems of quality,

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tracking and recordability in one step. The FCC's ruling specifically did not lock in BTSC as the only method that could be used.

A shorter-term solution may lie in the work of the EIA/NCTA Joint Committee which, among other activities, is close to defining a standard accessory jack for all TV sets. If implemented, this would allow many extensions to the use of a TV set without needless duplication of hardware. Descrambling could be performed at this port with hardware costing a third to a half of what an integrated tuner/descrambler costs and without the subscriber losing any of the features of his TV set.

Of particular interest to the stereo issue, pins are included on this connector which would allow either decoding of BTSC stereo or decoding and insertion of audio from an out-of-band system. To date, all vendors relying on channel tagging have chosen tagging methods which will survive the processing in a TV set and arrive unscathed at this external port.

Many operators are faced with solving the compatibility problem in months—not years. For those operators, the first critical question will be whether BTSC stereo can be provided at a quality level satisfying to the bulk of his subscribers. Certainly for non-descrambler equipped customers, provision of BTSC stereo is the simplest solution and, for at least some scrambling methods, adapter boxes for BTSC will be available at less cost than out-of-band hardware.

On the other hand, given the increasing quality of consumer audio and audio/video hardware, many may feel that BTSC simply won't be adequate. On a competitive note, the cable industry should be aware that the proponents of DBS are considering several transmision methods capable of delivering very high quality sound.

Operators considering out-of-band options should make clear to vendors that certain requirements are a must:

- A *minimum* of 70 dB audio S/N ratio at the end of our longest cascade.
- Sufficient internal amplification to drive small speakers directly, plus output jacks for external sound equipment.
- Simplified installation by either direct connection to converters or single, multiwire jumper.
- A tracking method compatible with the EIA accessory jack.
- A solution for non-converter-equipped subscribers.

Cost also is an issue. In today's market, with only a handful of stereo TV sets installed, the cost of even the most expensive out-of-band stereo decoders is far less than a stereo TV set and is competitive with stereo adapters for existing sets. On the other hand, as the installed base of stereo sets grows, the market will become very cost sensitive. The premium quality out-of-band systems also offer an opportunity to market stand-alone audio services as well as stereo TV. To the extent that it turns out to be a viable market, that may help to underwrite the cost of the hardware.

Perhaps the most viable solution is a hybrid installation whereby the operator recognizes that all of his subscribers do not have the same expectations for audio quality. BTSC may be offered as a basic solution which will provide stereo at least cost, while premium audio may be offered in a "package" along with stand-alone services for those with the taste and funds to afford it.

There certainly are no easy answers to the stereo issues, but as the market matures some defined choices are emerging. It is in the interest of operators to let manufacturers know the realities of the market so we can avoid technically elegant solutions that have fatal retailing flaws. CED

References

[1]Ned Mountain, "Cable Stereo: Some Basic Information on Satellite Delivered Services," *CED*, February 1982.

[2]EIA Broadcast Television Systems Committee, *Multichannel Sound: The Basis for Selection of a Single Standard* (Washington D.C.: NAB, July 1982), vol 1, p. 51 (Zenith Rationale for System Choice).

[3]NAB and MST, "Further Comments on Docket 21323," submitted to the FCC October 4, 1984, p. 25-26.

[4]EIA/BTS Multichannel Sound Committee, "Recommended Standards for the BTSC System," Revised March 16, 1984, submitted to the FCC on Docket 21323 March 20, 1984, p. 10.

[5]EIA Broadcast Television Systems Committee, *Supplement to Multichannel Television Sound Reports*," (Washington D.C.: EIA, December 1983), p. 51.

[6]EIA Broadcast Television Systems Committee, *Report on Multichannel Television Sound*, (Washington D.C.: EIA, November 1983), p. 25.

[7]EIA Broadcast Television Systems Committee, *Supplement to Multichannel Television Sound Report*, (Washington D.C.: EIA, December 1983), p. 51.

[8]Note that such equipment would not be allowed if the FCC were to adopt a strict "must-carry" interpretation for multi-channel sound since BTSC encoded signals are not delivered to the customer's TV set.

Addressable Converters

Model	Input frequency/ channels	Input level	Noise figure	Gain	Data carrier	Scrambling method
Jerrold Starcom V	54-550 MHz; 82 channels	−5 to +15 dBmV	9dB max	constant output	frequency: 106.5 MHz: level: 10 dB below channel 6 video	random dynamic baseband. sound privacy. 6/10 sync suppression
Jerrold Starcom VI	54-450 MHz; 66 channels	video: 0 to +15 dBmV sound: −15 dBmV min	12 dB nom 13 dB max	0 dB min 8 dB max	frequency: 106.5 MHz; bandwidth: 400 kHz std FM; level: 10 dB below channel 6 video	pulse, sync suppression, 6 dB 10 dB, 6/10 dB
Kanematsu-Gosho Sprucer II	54-444 MHz; 64 channels, 128 channels with A/B switch	−6- +15 dBmV	9 dB max.	(differential) ± 10% max. @ 3.58 MHz	FSK transmitted on 73 MHz	random turn-over of video signal polarity for each field and sync shift
M/A COM 3025	450 MHz, 64 channels	−6 to +15 dBmV	10 dB max	N/A	FSK; 119.75 and 107.75 MHz; ± 50 kHz deviation; sensitivity; −23 to +19 dBmV	sine wave sync suppression; 2 modes
Magnavox Magna 6400	50 – 450 MHz; 64 channels: 128 channels w/ A/B switch	−6- +15 dBmV	13 dB max.	0-6 dB	N/A	horizontal square wave sync suppression or encryptic encoding
Oak Sigma	50-450 MHz	−6- +15 dBmV	12 dB typ.; 14 dB max.	(differential) 8% max.	either 104.75 or 112.70 MHz	random video inversion, elimination of horizontal and vertical pulse information, digital audio encryption
Pioneer BA-5000	50-450 MHz	−5- +15 dBmV	12 dB typ	5 ± 5dB	FSK; 110 MHz: level 15 dBmV below adjacent video	integrated scrambling for Pioneer, Jerrold, Hamlin and Oak compatibility
Regency Roman	450 MHz Std. 550 MHz optional	−0 - +15 dBmV Std. −10 to +20 descramble	12 dB typ.	0-10 dB	106.5 MHz; level: 10 dB below video carriers, min. guard band: ±200 kHz	Video: Dual level sync suppression Audio: Vertical interval Intercarrier Jamming
Scientific-Atlanta 8550	54-450 MHz; 64 channels	−7- +20 dBmV	13 dB typ.	0- +9 dB	N/A	dynamic switched sync suppression
Telease MAAST	54-440 MHz and UHF	−6 to +15 dBmV	8 dB typ 11 dB max	N/A	in the vertical internal of video signal	video inversion, vertical and horizontal sync removal, audio channel hopping cryptographic data scrambling
Tocom 5503	54-450 MHz; 66 channels	−6 to +14 dBmV	11 dB typ 13 dB max.	N/A	inband VBI data	random dynamic baseband scrambling
Tocom 5501	Ch 2, 3, or 4	−5 to +15 dBmV	6 dB max.	N/A	inband VBI data	random dynamic baseband scrambling
World Video Library TM-1	450 MHz; 64 channels	−5- +15 dBmV	11 dB nom 13 dB max	N/A	FSK at 109 MHz	Pseudo-random baseband
Zenith Z-TAC	50-450 MHz	−6- +14 dBmV	≤9 dB	N/A	N/A	video inversion, suppressed synchronization, suppressed audio (optional scrambled audio)

Composite triple beat	Second order distortion	Cross modulation	Hum modulation	Spurious signals	Output frequency stability	Return loss
−57 dB	−60 dB	−58 dB	AM: −60 dB FM: 20 kHz	input: −10 dBmV max. output: −60 dBmV max inband	± 10 kHz	input: 6 dB min. output: 8 dB min.
−56 dB	−60 dB	−57 dB	AM: −50 dB max. FM: 20 kHz max.	input: −10 dBmV max. output: −60 dBmV max. inband	± 50 kHz	input: 7 dB min. output: 8 dB min.
−60 dB @ 15 dBmV	−58 dB @ 15 dBmV	−58 dB @ 15 dBmV	−50 dB @ −6 dBmV	input: −35 dBmV output: −30 dBmV, outband	(visual carrier) ± 25 kHz	input: 6 dB min. output: 14 dB min.
−58 dB min.	−58 dB	−58 dB	−48 dB min.	input: −50 dB no visible influence output: −40 dB below video	± 75 kHz	12 dB min.
−57 dB	−57 dB	−57 dB	N/A	N/A	N/A	input: 8 dB min. output: 12 dB min.
N/A	N/A	−60 dB	N/A	N/A	(accuracy) ± 70 kHz	input: 6 dB min.
N/A	−60 dB max.	−58 dB max.	AM: −54 dB max. FM: ± 10 kHz max.	input: −40 dBmV nom. output: −60 dBmV nom. in band	N/A	input: 7dB min. output: 12dB min.
−57 dB	−57 dB	−57 dB	± 5 kHz FM −46 dB AM	input: −34 dBmV output: −57 dB	± 150 kHz	input: 6 dB output: −14 dB
−57 dB	−57 dB	−57 dB	N/A	input: −37 dBmV output: 57 dBmV	(frequency stability: ± 100 kHz)	input: 8 dB min. output: 12 dB min.
N/A	N/A	N/A	N/A	input @ −12 dBmV output @ −55 dBmV	± 60 kHz	input: 9 dB min. output: 14 dB min.
−55 dB max.	−55 dB max.	−55 dB max.	−55 dB max.	input: −37 dBmV max. output: −55 dB max.	± 60 kHz	input: 6 dB min. output: 12 dB min.
N/A	N/A	N/A	N/A	input: N/A output: ± 55 dB max.	± 60 kHz	input: 6 dB min. output: 12 dB min.
−60 dB	−60 dB	−60 dB	−55 dB	−57 dB max.	± 50 kHz nom.	8 dB
(composite beat ratio: ≥ 55 dB)	≥ 55 dB	≥ 55 dB	N/A	input: −26 dBmV @50-450 MHz output: 60 dB below visual carrier, inband	± 100 kHz	input: >6 dB output: >12 dB

Data Modems

Model	Operating mode	Operating channels	Data format	Data rate	Bit error rate
C-COR 7130 7140	full- and half-duplex, simplex, multidrop	transmit: T7 - 4 + receive: T11 - TVO	asynchronous synchronous	1200 - 19.2 Kbaud	1 part 10^{-8} @ 16 dB C/N
Comtech M505	full duplex	100 kHz-400 MHz	synchronous	56 Kbps-10 Mbps	1 x 10^{-9} @ 30 dB C/N
E-COM TRM-202	N/A	0 to 250 MHz	synchronous asynchronous	50-9600 bps	$< 10^{-7}$
EF Data BCM-101	full duplex or polling	5-400 MHz in 50 kHz steps	synchronous	56 KB/s to 6.3 MB/s	10^{-9} @ 22 dB C/N
Jerrold Metronet 1000	full- and half-duplex	input: T-7 to T-13, 1A, 2A, 60, 61, 14 to 16 Output: 156.25 or 192.25 MHz adder	synchronous asynchronous	110 bps 19.2 kbps	10E-10, @ 26 dB S/N
Radyne CMS-1200	full duplex or constant carrier, with or w/o translator	5-40 MHz	synchronous	32 Kb to 15 Mb	10^{-9} @ 19.5 dB
Scientific-Atlanta Series 6400	full-duplex	transmit: 5-120 MHz receive: 162-440 MHz; programmable freq.	synchronous	56 K-1.544 Mbps	$< 10^{-9}$ @ 33 dB C/N
Sytek LocalNet/20	full-duplex	A: 70-76 MHz E: 94-100 MHz L: 10-16 MHz	asynchronous	128 KB/s	> 1 in 10^{12}
3M 960	full- and half-duplex	transmit: J thru N receive: T-10 to T-14	synchronous	1.2-76.8 Kbps	1 x 10^{-9} @ C/N of 30 dB in 200 kHz
Ungermann-Bass 5405A	N/A	transmit: channels 3-6 receive: channels P thru T	synchronous asynchronous	5 Mbps ±0.01%	10^{-9} @ 26 dB S/N
Zeta Labs Z19	full- and half-duplex, multidrop	transmit: T7-2[1] receive: H thru O, others opt.	synchronous asynchronous	50—19,200 bps	10^{-9} @ 25 dB S/N

Spacing	Spurious level	Carrier detect level	Transmit level	Receive level
50 kHz, 19.2 Kbaud; 25 kHz, 9.6 Kbaud	60 dB below carrier output	-20 to +20 dBmV	+15 to +45 dBmV	-20 to +20 dBmV
50 kHz	(output) -80 dBc/Hz modulated, -50 dBc unmodulated @ +50 dBmV output	N/A	+30 to +50 dBmV	-12 to +5 dBmV
200 kHz	N/A	N/A	+20 to +40 dBmV	-20 to +10 dBmV
0.6 times data rate	50 dB below carrier	-12 dBmV to 0 dBmV	30 to 50 dBmV	-15 to +5 dBmV
50 kHz	-50 dBc	-30 dBmV, factory set; 0 to -30 dBmV adjustable	+30 dBmV, factory set; +15 dBmV to +35 dBmV, adjustable	-16 dBmV ± 10 dB
0.6 times data rate	at least 50 dB below carrier	N/A	+25 to +52 dBmV adjustable	-15 to +5 dBmV
750 kHz	-50 dBc	N/A	+20 to +50 dBmV	-10 to +10 dBmV
300 kHz	50 dB below carrier output	-16 dBmV	+46 dBmV	-16 to +42 dBmV
800 kHz	50 dB below carrier	N/A	+30 to +45 dBmV, adjustable	-15 to +10 dBmV, adjustable
6 MHz	60 dB below maximum output level	N/A	+30 to +50 dBmV, adjustable	-7 to +13 dBmV
50 kHz	50 dB below carrier @30 dBmV or greater	-25 dBmV adjustable	+30 dBmV, adjustable ±10 dBmV	-25 to +5 dBmV

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S-A releases

Scientific-Atlanta has released new modem and converter products. The 6403 and 6403M RF modems use a GASK modulation, an inverted frequency scheme and RF channel spacing of 750 kHz. High-speed T1 communications between a 6403 and the company's 6402 broadband modem are possible without use of a headend frequency translation. Bell DS1 T1, CCITT V.35, EIA RS-449SR and RS-449DT interfaces are available. The 6403M is designed for microwave transmission.

S-A also has announced a 3-year warranty on its model 6780 set-top converter.

In addition, two new set-top terminals have been added to S-A's line: the 8520, a 450 MHz programmable unit and the 8530 featuring dynamic switched sync suppression scrambling.

The 8530 and new 8550 terminals are compatible with the Hamlin scrambling method.

Contact: Scientific-Atlanta, One Technology Parkway, Box 105600, Atlanta, Ga. 30348, (404) 441-4000.

Phasecom processor

Phasecom has introduced a new 1300 stereo heterodyne processor combining stereo capability with SAW filter and modular input/output converter features.

Contact: Phasecom Corp., 6357 Arizona Circle, Los Angeles, Calif. 90045, (213) 641-3501.

LRC block, crimp, shield

An improved aluminum grounding block has been introduced by LRC Electronics. It is available with or without a pipe clamp attachment.

Also available from LRC is a new one-piece crimp on BNC connectors. For use with the crimp is a BNC security shield which eliminates tampering and unauthorized changing of connectors.

Contact: LRC Electronics, 901 South Avenue, Horseheads, N.Y. 14845, (607) 739-3844.

Panasonic MVP-100

The MVP-100 video player system by Panasonic, now in final field testing, offers automatic random access commercial spot insertion, program sequencing and editing. System equipment includes an IBM PC with two drives, a master transport system driven by a Z-8 micro, eight transport controllers, readers and transports; two time base correctors, two video monitors, a waveform monitor, an audio monitor and switching devices. Up to 16 additional transports, servos, controllers and time code readers can be chained to the MVP-100.

Contact: Panasonic Industrial Co., One Panasonic Way, Secaucus, N.J. 07094, (201) 348-7000.

Security seal

Telecrafter Products Corp. is distributing the Converter Warden Security Seal, which covers screw holes and seals converter top to base. Attempted removal provides positive proof of tampering.

Contact: Telecrafter Products Corp., P.O. Box 30635, Billings, Mont. 59107, (800) 548-7243.

Cable locators

Progressive Electronics has introduced new tracers and locators. The 77A Tracer and companion 200A Line-Aid amplifier can identify CATV service wires. The 2003 Pulser is a self-contained earth ground fault locating tool. The $850 unit can locate faults on bur-

ied conductors faulted to earth ground up to 10 megaohms. The 50B Mini-Tracker uses the null method of locating cable, wire and pipe. It sells for $169.
Contact: Progressive Electronics, 325 S. El Dorado, Mesa, Ariz. 85202, (602) 966-2931.

Wee Wah Weapon

Lemco Tool Corp. has introduced a cable straightener. Used ahead of the lasher, the M-2180 eliminates wee wahs. It's available in 2-, 5-, and 8-hole models for 1- and ¾-inch trunk cable.
Contact: Lemco Tool Corp., R.D. #2 Box 330A, Cogan Station, Pa. 17728, (800) 233-8713.

Budco adds Lemco

Budco Inc. has added Lemco tools to its product line.
Contact: Budco Inc., 4910 East Admiral Place, Tulsa, Okla. 74115, (800) 331-2246.

RF modems

A high-speed broadband modem ignoring vibration, translator and synthesizer noise will be distributed by EF Data Corp. The BCM-101 is the first of the new line.
Contact: EF Data, 1233 N. Stadem Drive, Tempe, Ariz. 85281, (601) 968-0447.

CWY rack

A new rack shelf designed for equipment without an attached rack mount panel is available from CWY Electronics.
Contact: CWY Electronics, P.O. Box 4519, Lafayette, Ind. 47903, (317) 448-1611.

Anixter adds Catel

Anixter Communications has added the Catel TM-1400 and TM-2400 modulators to its line.
Contact: Anixter Communications, 4711 Golf Road, One Concourse Plaza, Skokie, Ill. 60076, (312) 677-2600.

ISS modulators

ISS has begun shipping its GL-2500 SMATV and updated GL-2600 modulators. The GL-2500 is available in all standard CATV channels. The GL-2600 will synthesize over 105 frequencies in standard, HRC or IRC channel spacing.
Contact: International Satellite Systems, 2225 Sharon Road #224, Menlo Park, Calif. 94025, (415) 854-8987.

Verification unit

Falcone International has introduced a new verification unit for its autoserter commercial insertion unit. The SVP-650 will hold 15 days of verification for 4 channels, print out data at the headend, hold information or dump by modem to a central location.
Contact: Falcone International, P.O. Box 3067, Marietta, Fla. 30060, (404) 427-9496.

Remote INFO/gen

A remote version of the INFO/gen character generator system is now available from Cable Graphic Sciencies. The software and RS-232 interface for Atari home computers costs $499 in single quantities. INFO/gen remote features 4 regions, 54 pages of memory, 3 text sizes, mosaic graphics in 3 colors, an international character set, variable dwell time, simple animation, 16 background colors, random or sequential display, a clock/calendar and a 480-character crawl. INFO/gen remote-equipped machines communicate using telephone modems.
Contact: Cable Graphic Sciences, 12345 Lake City Way N.E., Seattle, Wash. 98125, (206) 622-1888.

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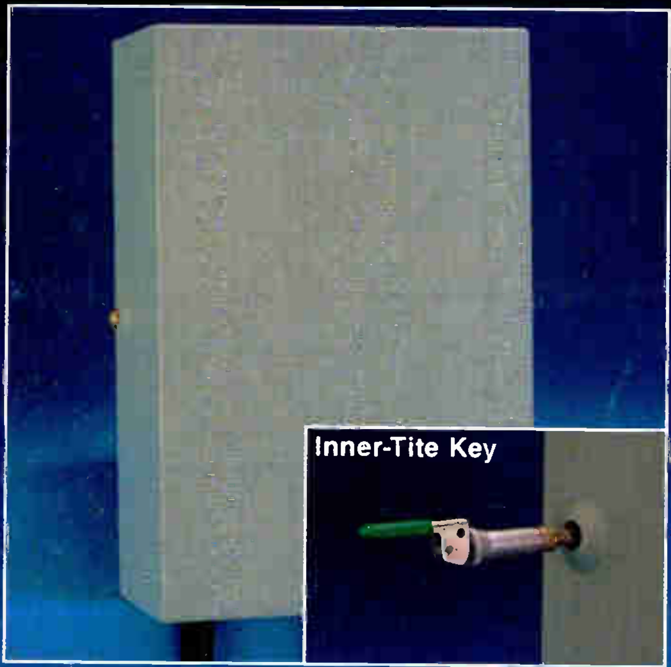

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