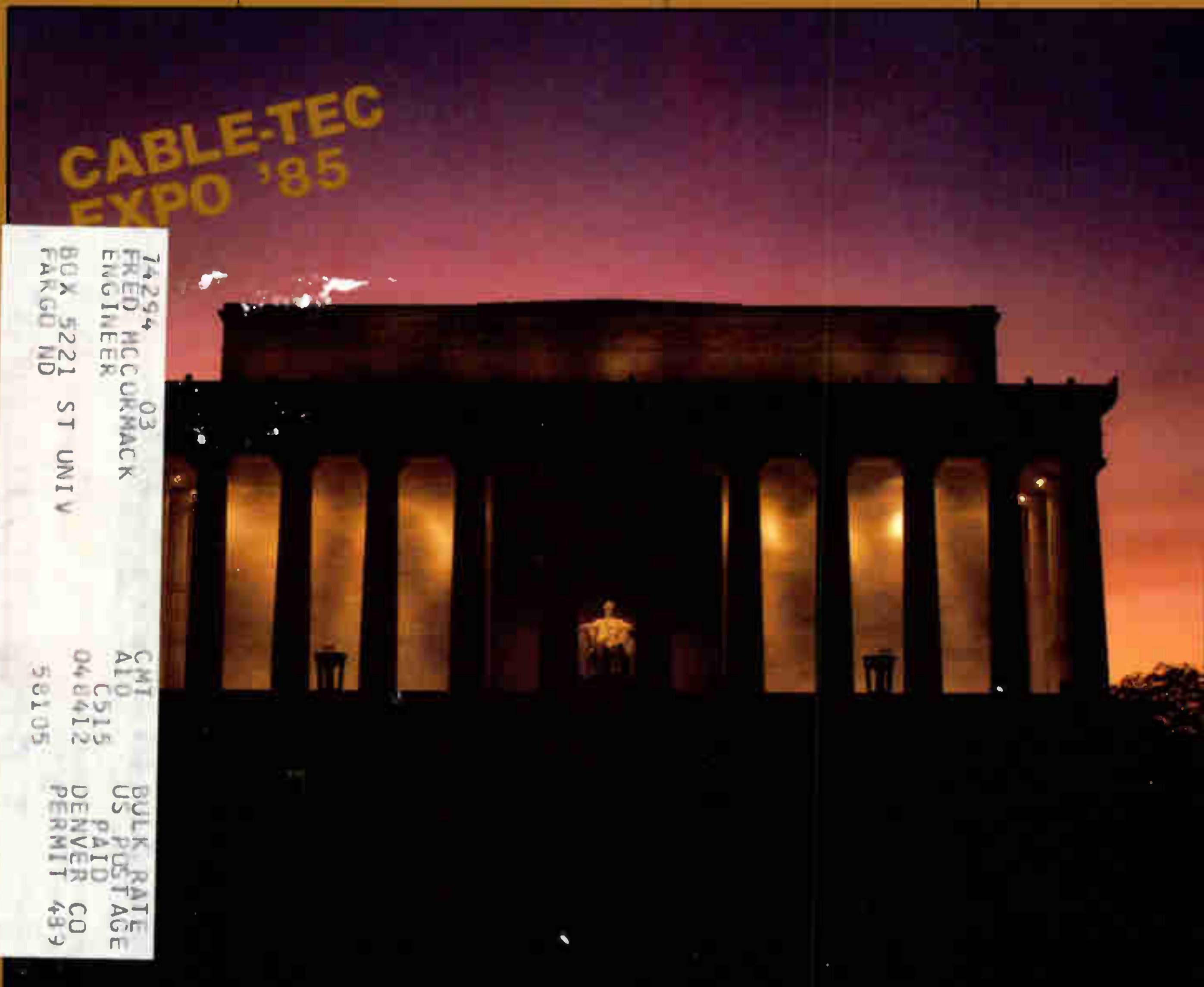
COMMUNICATIONS TECHNOLOGY

Official trade journal of the Society of Cable Television Engineers



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March 1985

ANNIVERSARY ISSUE


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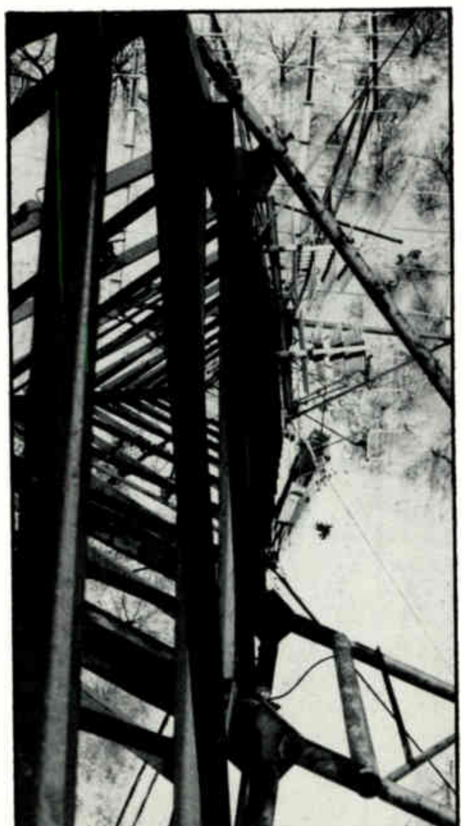

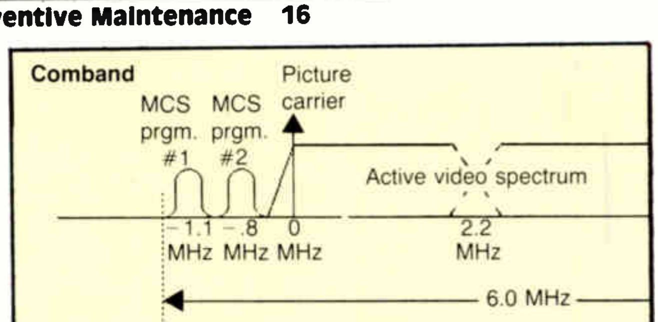

Features

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Remember, in cable's early days, when your system went down and you had that utterly helpless feeling knowing there was nothing you could do til morning? Back then, service meant plugging in a spare amplifier or waiting for assistance – usually half the country away. As an operator, you were virtually on your own. Recognizing this, Jerrold became the first manufacturer to supply operators with needed test equipment and strategically-located field engineers, thus providing the first on-site installation support and training. Even then, Jerrold was there.

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PUBLISHER'S LETTER

Onward and upward

This doesn't mean we are all heading into space to set up a national headquarters on the moon—with our TVROs and distribution centers for high-tech equipment. Rather, it describes the spirit of our industry's potential.

Growth—whether it occurs within an industry, a company or an individual—has as many facets to it as there are ways to measure it. And without support, growth cannot be achieved. In our own backyard, 1984 was a year that represented many changes in the technical publications field and the Society of Cable Television Engineers.

For *Communications Technology*, this is our first anniversary and we are more than encouraged by our growth record. A year ago to the issue, we had 7,747 subscribers; with this issue, our subscribing readers have increased 68 percent to 12,984. Our advertisers, too, have increased their support to the tune of 144 percent as compared to our premiere issue, while the page count increased more than 67 percent. Not bad for the new kid on the block.

And, as the saying goes, we've only just begun. The magazine is now in the progress of being audited, which we hope will not only solidify who our readers are, but also enable us to get *CT* to you on a more timely basis. As well, in this issue you will notice that we are introducing a new service: product information response cards. Toward the back of this issue is a fold-out card section designed for your convenience. Simply unfold the page and have a response card at your fingertips while you read *CT*. When you see a product of interest, just circle the appropriate number on the card. When you've finished reading the magazine, you'll find that you've also finished filling out the response card. Now, just drop the card in the mail and we'll take it from there.

For the SCTE, 1984 heralded major changes in its structure. It was the first year of full operation at its new headquarters in West Chester, Pa., a move that dramatically decreased headquarter operation costs.

At the outset, the SCTE membership was surveyed to provide their Board of Directors with the direction they would like to see the Society move. As the result of this survey the board followed an "action list," which included items such as chapter development, improved *Interval*, BCT/E certification, tele-seminars, better product list, lower cost seminars, better management and improved relations with other industry organizations.

During 1984, 10 new SCTE meeting groups were established, illustrating the growing need for local level interaction. At the Cable-Tec Expo some of these groups will receive full chapter status.

By incorporating the Society's monthly newsletter, *The Interval*, into *CT*, SCTE members are able to receive up-to-date information on both Society activities and technical issues in one document at no additional cost.

On the seminar front, the Cable-Tec Expo is the best example of progress in this area. By combining workshops, seminars and technical product exhibits in one annual function, the Society has been able to increase the effectiveness of learning and greatly reduce both cost and time lost. In cooperation with local chapters, plans also have been made for additional one- and two-day seminars across the nation to focus on specific issues of importance to technical operations and technical management.

With Bill Riker now in place as the Society's executive vice president, we all can look forward to vast improvements in the SCTE's day-to-day management. Riker comes to the Society with a warehouse of experience and knowledge and has already set in motion procedures designed to improve membership services, reduce cost and return more membership dollars to the members in terms of services.

On another growth note, and here I don't want it to appear that I'm touting particular companies, but it's interesting to see established cable entities embracing new markets—specifically, area networking. Both AM Cable and RT/Katek have established new divisions or services catering to this developing marketplace. RTK's PC/LANSTAL service (see "News," page 10) will offer turnkey solutions to a variety of networking problems. AM Cable's new Network Technologies Division, headed by AM Senior Vice President and Division Manager Bob Dickinson, will specialize in the design, development and operation of baseband, broadband and fiberoptic area network systems. It will offer its services individually on a contract basis or as a full turnkey project. Hats off to these two companies for illustrating that through change, growth can be achieved.

In summary, the past has been (and future will continue to be) a time of change with opportunities for growth. We thank all who have supported us, the SCTE and the industry in the past and look forward to the years to come.

COMMUNICATIONS TECHNOLOGY

Official trade journal of the Society of Cable Television Engineers

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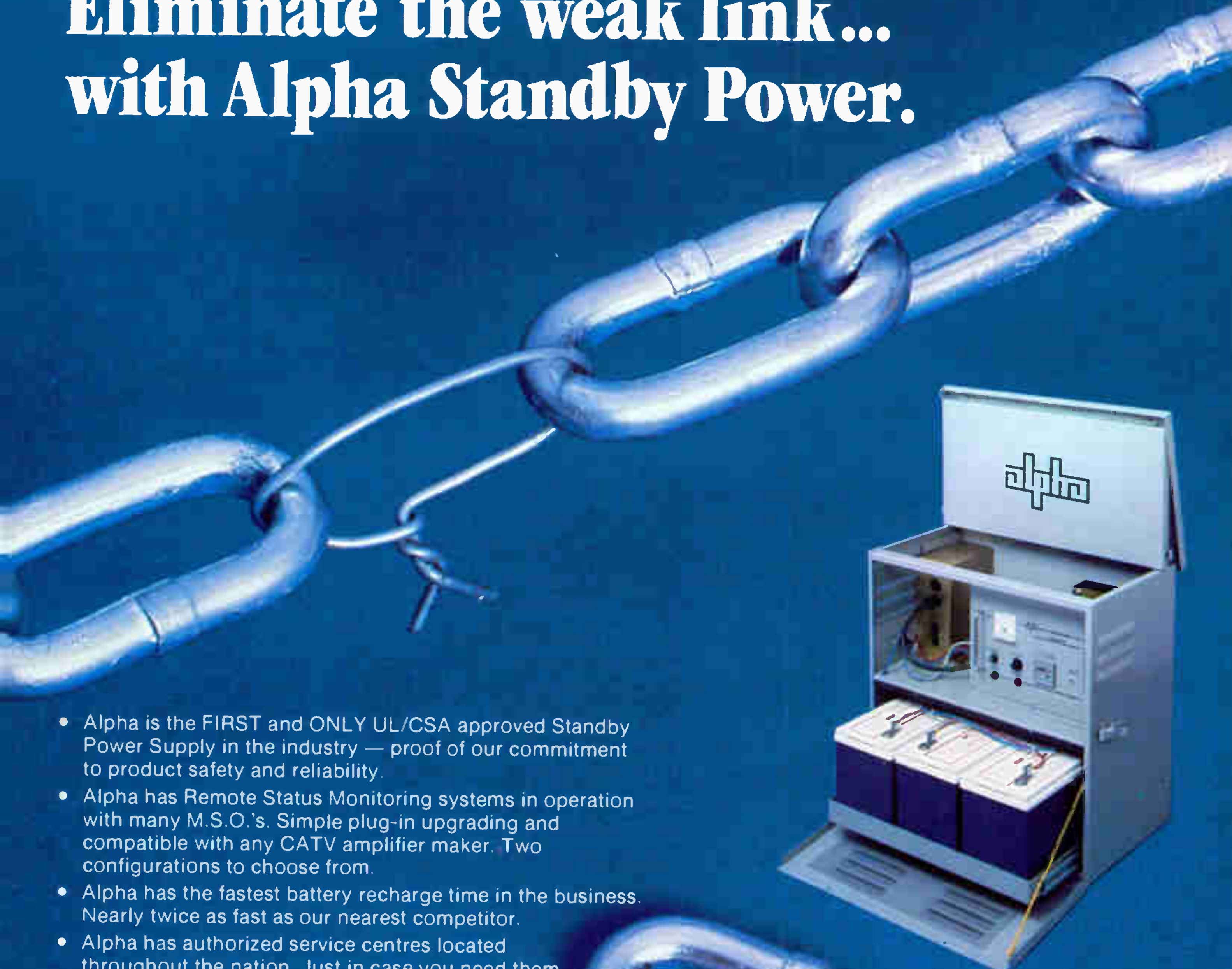

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SCTE Executive Vice President Bill Riker and President Jim Emerson.

SCTE show agendas

WEST CHESTER, Pa.—Included in this month's *Interval* is the Society of Cable Television Engineers' program of technical sessions and speakers for the Spring Engineering Conference and Cable-Tec Expo. Both the conference and the Cable-Tec Expo are taking place at the Sheraton Washington Hotel in Washington, D.C., March 3-6, 1985.

The ninth annual Spring Engineering Conference precedes the Expo. Its schedule of events:

Saturday, March 2

6-8 p.m.—Registration opens

Sunday, March 3

7:30-9 a.m.—Registration

9-10:30 a.m.—Opening remarks and Session A

10:45 a.m.-noon—Session B

12-2 p.m.—Luncheon, annual membership meeting with awards and keynote speaker: FCC Mass Media Bureau Chief James McKinney.

2-3:30 p.m.—Session C

3:45-5 p.m.—Session D

The Cable-Tec Expo will feature nine workshops. Over 100 exhibitors are expected and additional hands-on equipment demonstrations will be scheduled on the exhibit floor.

Sunday, March 3

5-8 p.m.—Registration

Monday, March 4

7:30 a.m.-4 p.m.—Registration

8:30-9:30 a.m.—Opening general session

9:45-10:45 a.m.—Workshop Period A

11 a.m.-noon—Workshop Period B

12-4 p.m.—Exhibit hall open

12-2 p.m.—Lunch served in exhibit hall (available at discount price to Expo attendees)

4-5 p.m.—Exhibitors' reception

6-11 p.m.—Hospitality suites presented by exhibitors

Tuesday, March 5

8 a.m.-4 p.m.—Expo registration

8:30-9:30 a.m.—Workshop Period C

9:45-10:45 a.m.—Workshop Period D

11 a.m.-noon—Workshop Period E

12-5 p.m.—Exhibit hall open

12-2 p.m.—Lunch served in exhibit hall (available at discount price to Expo attendees)

7-10 p.m.—Expo Gala Evening Wild West Gambling Casino and Buffet (casual attire)

Wednesday, March 6

8:30-9:30 a.m.—Workshop Period F

9:45-10:35 a.m.—BCT/E Professional Certification Examination "Distribution Systems" (technician level)

10 a.m.-noon—Exhibit hall open

12 p.m.—Organized trips to Smithsonian Institution, FCC, Capitol Building, etc.

Open house for SCTE

RESTON, Va.—Studioline Corp. of America is holding an open house for the Society of Cable Television Engineers on March 4, from 6-9 p.m. The open house, coinciding with the SCTE Cable-Tec Expo, will showcase Studioline's new cable audio programming facilities.

Studioline will provide transportation from the Sheraton Hotel in Washington to its offices in Reston, Va. Buses will shuttle people back and forth all evening with the first bus departing from the hotel at 5:30 p.m. Shuttle bus schedules will be available at the convention.

Representatives from Studioline's technical and programming staff will lead tours and demonstrate how the satellite-delivered music services are put together. Also, food, beverages and entertainment will be provided.

Call for nominations

WASHINGTON—The National Cable Television Association has issued its call for nominations for its National Awards, to be presented June 5, at the conclusion of NCTA's convention in Las Vegas. Booklets containing nomination forms were distributed the first week in February to association members. Nominations must be submitted to the NCTA Awards Committee no later than April 1.

The National Awards will be presented to persons who have made significant contributions to the cable industry and to the advancement of communications. NCTA members have been asked to nominate individuals in each of these categories:

Vanguard Award—the most prestigious of the National Awards, presented to a man and a woman (system or associate member) for outstanding leadership qualities and for significant contributions to the growth of cable television nationally.

Challenger Award—presented to a system or associate member 40 years old or younger for outstanding leadership qualities and significant contributions to the growth of cable nationally.

Associates Award—presented to an associate member for outstanding leadership qualities and significant contributions to the development of cable nationally.

Science and Technology Award—presented to a system or associate member involved in technical development and/or system operations for significant contributions to the continuing technical advancement of the industry through manufacturing, design, application or implementation.

State-Regional Association Award—presented to a member of a state or regional cable association for contributing to the development of a strong state or regional association and actively participating in effective state legislative and regulatory activities.

Marketing Award—presented to a system or associate member for leadership in developing marketing concepts that lead to significant consumer awareness of cable television and increased subscribership and for contributing marketing concepts that benefit the industry through industry-sponsored events and promotion by other means.

NCTA's national convention will take place June 2-5 at the Las Vegas Convention Center. "Cable '85: On the Move" is the theme for the event.

RTK offers service for local area networks

MIDDLESEX, N.J.—RT/ Katek Communications Group announced a nationwide service specializing in the implementation of local area networks (LANs). RTK's service, PC/LANSTAL, will offer turnkey solutions to a

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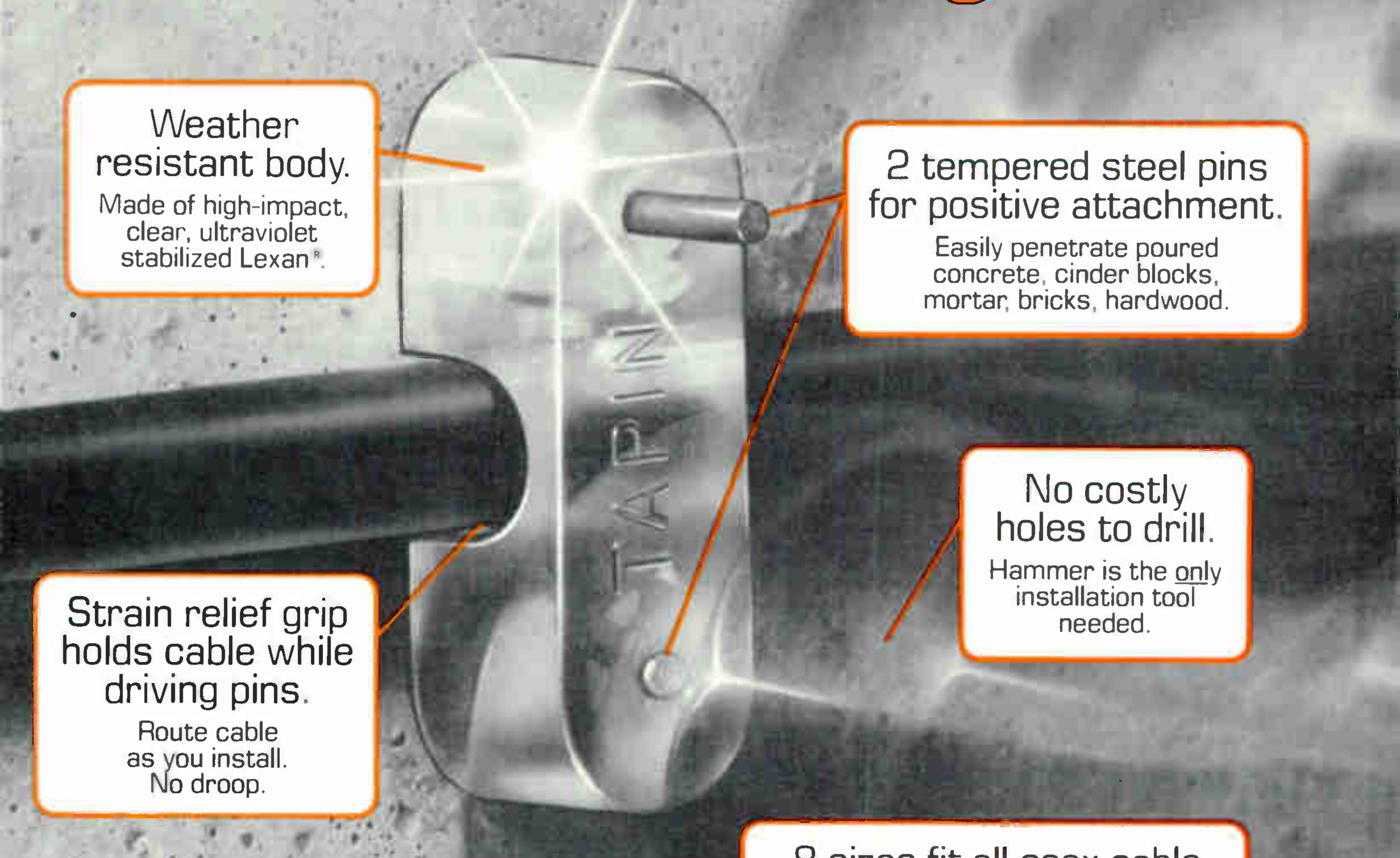

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variety of networking problems and will provide network systems design, construction, construction management, installation and maintenance services.

George Fenwick, RTK's Computer Services Division president, describes the forces behind the development of PC/LANSTAL: "In the past, the burden of implementation of a LAN, from a microcomputer standpoint, has fallen to various network interface manufacturers—manufacturers who don't necessarily wish to be in the installation business, but must because of the lack of companies specializing in installation services. PC/LANSTAL fills this void, and offers both manufacturers and users, who are concerned with LAN implementation, a more cost-efficient installation alternative."

Buyer, distributor for C-COR's data products

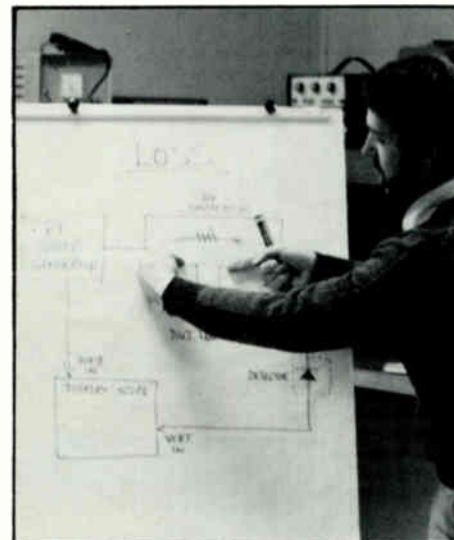
STATE COLLEGE, Pa.—C-COR Electronics Inc. is supplying RF data communications electronics for a dual cable data network for the United States Air Force in the Pentagon. Delivery of equipment has begun. Equipment being installed includes C-COR's local area network series amplifiers (with status monitoring, end-of-line status monitoring, active fail-safe and A-B switch) and C-COR's power supplies. The dual cable system will link computer terminals, hosts, printers and other segments of the office automation system, allowing for transmission of digital data, video and voice signals on the same network. The system was designed and is being installed by Allied Data Communications Group Inc. of Norcross, Ga.

Also, C-COR announced that Anixter Communications will distribute its complete line of data products in the United States, including split-band and local area network amplifiers, RF modems, main line passives and related accessories.

Midwest sale completed

EDGEWOOD, Ky.—Midwest Communications Corp. has finalized the purchase of the Communications Systems Division from Midwest Corp. This concludes the process that began with an initial offer in October 1983, followed by the signing of a purchase agreement on Sept. 14, 1984. The purchase price was in excess of $10 million.

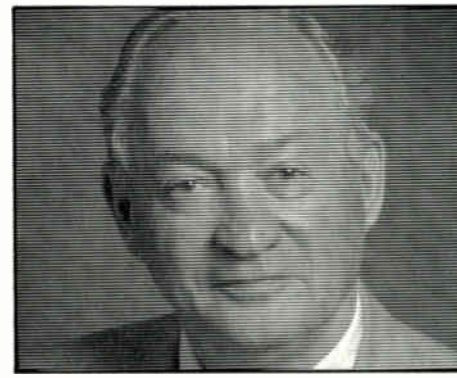
Midwest Communications is owned by key management personnel and outside investor Charles Kubicki. The new company's president and chief executive officer is David Barnes, who had been with the former company since 1976. Majority stockholder and Chairman of the Board Charles Kubicki is a leading Cincinnati commercial real estate developer.



A learning experience

SCTE chapters and meeting groups provide a local forum whereby cable engineers/technicians can fine-tune their techniques through workshops and hands-on demonstrations. Here, Ron Hranac of Jones Intercable explains bench sweeping procedures at the recent Rocky Mountain Meeting Group technical seminar. For more on SCTE chapter and meeting group developments, see 'The Interval.'

Too many engineers??



By Isaac S. Blonder
Chairman, Blonder-Tongue Laboratories Inc

To understand the headlines one must look behind the sources. Not in recent years, but periodically since WW II, cries of distress, predictions of long-term unemployment and fears of invasion by underpaid foreign engineers have been plastered across the pages of the engineering press, notably that of the Institute of Electrical and Electronic Engineers (IEEE). Who writes these stories; why are they reported so uncritically?

It is not my objective to expose the self-serving authors of these frantic fantasies, but to comment on the subject of education—American style.

My university experience took place during the great depression (1934-40). I entered college believing that the way out of poverty was education; to improve your value to society and thereby your income. Perhaps the greatest surprise ever to hit me was the real world of education I encountered.

Our freshman psychology professor conducted a survey of all the students, with particular emphasis on their reasons for gaining a university degree and their personal goals in life. Imagine our consternation (mine anyway) to find that in the midst of the highly publicized bad economic news, the majority of students attended school to avoid having to go to work! They also expressed the desire to do as little as possible while in school, and would search out and take the easiest courses.

Another surprise was the emphasis on athletics. Perhaps in those days, the blatant subsidies of today were not as gross, but the rewards offered to the muscle men were not only school honors of every shade, but financial rewards.

To summarize the educational quality of my school, the nonscientists, on the average, spent less than 20 hours a week in class or doing homework on subjects too simple to require much effort. The scientists usually spent three hours on homework for each classroom hour (or better than 60 hours a week) and had little spare time for athletics or other frivolities.

To defend this educational imbecility, we heard catchphrases like "The well-rounded education is a sound basis for any job," "Broad liberal foundation from which good judgments come," and worst of all, "Humanity comes from the humanity studies, not from science." How well-rounded and useful can be an education devoid of science?

Bleak outlook

Today, the decline in SAT scores shows a parallel disease in secondary education.

The first duty of any human society is survival; it is the strongest of our instincts. To understand the role of science in our country's capability for survival, let us evaluate these educational postures:

1) No science education whatsoever. If anyone disagrees that our civilization would collapse overnight, and that we would lie helpless before our enemies, he would be living proof of the harm caused by the lack of a science education.
2) We continue as we are. Shortage of scientists in every area and a nation-threatening balance of payment dilemma.
3) We eliminate the liberal arts degree and turn out only scientists. Yes, I can hear the protests from the good liberals, but they are a thin layer crushed by the majority of lazy parasites nurtured by our own hands. Of course, I favor this swing to science. We not only would assure an adequate supply of engineers but all management finally would have the education for leadership in a world based on technology.

Why does the liberal consider the scientist uneducated in the arts and humanities? Reverse the thrust, why does the liberal consider himself educated? Over and over again I have despaired conducting a rational discussion with the liberal—ignorant of even elementary science on the critical subjects of today.

Change needed

No, we do not have too many engineers but yes, we do have too many scientifically ignorant members of our society—lawyers, politicians, etc. Nothing is funnier and yet more tragic than a politician without a shred of technical education, pontificating on the MX missle and the B-1 bomber.

It is not too late for this country to designate a science education as the primary task for our schools and leave the entertainment to private enterprise.

It's all a state of mind

By Peter Carr, WB3BQO

Don Becker first met me when I got hired on by the local cable TV company as a technician. The manager wanted me to get the feel for the job and assigned his maintenance man to work with me. Don was three inches taller than me, had shoulders wider than a reel of trunk cable and looked like one of those guys in the Marine Corps posters. I was just out of the service and with all that technical school training was ready to move this cable system to a *much* higher technical plane! Don must have seen my type before because he just nodded hello and headed for the service van.

The first task was to fix a flickering problem on the cable tower near the top. Climbing didn't bother me but this tower was 500 feet tall. Watching Don put on his tools and climbing belt you thought we were going into battle. There were tie wires, bands and spacers, a butane torch, multimeter, TV signal meter and tubes of silicone rubber and grease hanging from the belt until it seemed he couldn't walk much less climb.

The trouble was at an end-mount antenna and was easily fixed. I was all set to start down, counting my good fortune, when Don said, "Where are you going?" I said something about the trouble being fixed and continued to unbelt for the climb down. "Wait one, I want to show you something," Don said. After settling back into the belt again I leaned forward to see where he was pointing. There in the cluster of cables was a sheath break in the .750 cable downlead. I was astounded! "How did you find that," I asked. Don just smiled and began to repair the connection.

On the climb down the tower we stopped at each antenna array looking for any mechanical faults and checking fittings for grease. As I watched Don work, we chatted about baseball, football and ladies. All the time his eyes were alert for any defect in the area. Loose cables were tie-wired tight, signal combiners secured with new wrap-locks, and the whole assembly made safe from the spring rains and wind. It soon became apparent that Don hated system defects like some people hate their Draft Board or the IRS.

Back on the ground I asked Don why we had done so much maintenance when only the single trouble had been reported. He just started for the five-meter satellite dish saying that we had prevented more trouble and that we were paid for that, too.

The dish was a Cassegrain type with the LNAs mounted at the rear. We set up ladders and began to check the connections, not taking too much time before getting each circuit back on the air. The power connections were separate from the signal cables and on one Don found a film of moisture. After drying the connection and greasing the inside, he reconnected the power. He said that AC voltage powered LNAs were not as much trouble as these DC powered types and that the combination of DC current and water would eat away the connection by electrolysis. I hadn't thought about electrolysis since high school and was amazed to find a foggy lesson in practice in the real world.

Five hundred feet up and looking down. If you are coming this far looking for trouble you may as well take the time to get it all and save yourself another climb.

Back in the van and headed for the next job, I found the front seat crowded with books and manuals on things like switching power supplies, feedforward amplifiers and headend troubleshooting. Don saw me scanning the titles and mentioned that it was more fun to work on the equipment if you knew what went on inside. He said that there were a lot of module changers in the business who thought they were maintenance techs. The true test was when a spare module wasn't available and they had to fix the bad one to get the system back on line. And even as he talked and drove you could see his eyes scanning the cables and poles as we passed by, looking for any visible defect.

'And even as he talked and drove, you could see his eyes scanning the cables and poles as we passed by, looking for any visible defect'

It was the next day that I was treated to an example of how not to take anything for granted. We had a trouble call of a single residence with snowy pictures. But the pictures were okay when we arrived at the house. Don told me to wait awhile when I began to write up the work order as "okay at visit." He slowly drove down the street, watching the strand. Suddenly he stopped the van and got out to stand under the strand looking straigjht up at the cable. Don said, "What do you see?" I had to confess that I didn't see a thing except for that small bump in the distribution cable. We set up a ladder against the strand and he had me climb up. There, not 10 feet from a directional tap (DT), was a sheath break where the cable had been kinked and then straightened while being lashed up. We spliced out the break and formed strain relief bends, then hand lashed the new cable back to the DT and hooked it up.

Back in the van I asked Don what caused him to look for the break and he said, "It's warmer now than last night and the wind has stopped." It would have been easy to give up on a problem that didn't seem to be there anymore. It could have been caused by a lot of things and anyone else would have let the customer call again with trouble. Most technicians think cable only breaks at the bends or at the pole and wouldn't have watched the mid-spans. Don didn't take anything for granted and found the trouble by looking for the little things.

It's been a long time since I've worked with Don. He got promoted to regional engineering and now handles the real head-scratcher problems that system techs can't. I'm now the maintenance man in the system and they just hired a new fellow for me to train. He's probably some hot shot from technical school ready to elevate this system to a *higher* technical plane. Now if I can just teach him to pay attention to detail and take nothing for granted and keep current on new equipment and techniques, he might someday be able to really elevate this system.

Don still hates system defects as much as ever but now he can design them out instead of preventing them at the local level. His attitude of attention to detail, expecting the unexpected and looking for more than easy answers is what a true maintenance man is all about.

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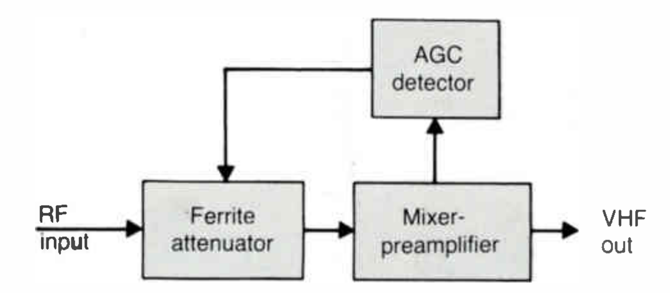
LNAs for multichannel microwave

The fade margin of any microwave path can be extended by reducing the noise figure of the receiver. Low-noise Ku-band gallium arsenide (GaAs) field effect transistor (FET) amplifiers and image rejection filters have been developed specifically for multichannel microwave receiver applications in the 12.7-13.2 GHz band. Incorporation of the amplifier into such receivers either as a retrofit or in new designs generally requires built-in automatic gain control (AGC) circuitry to control the signal level and optimize performance.

By Dr. Tom M. Straus
Chief Scientist
and Irving Rabowsky, P.E.
Senior Scientist
Hughes Aircraft Co Microwave Communications Products

Steady improvements in GaAs FET technology have led to the development of amplifiers with a noise figure on the order of 3 dB in the 12.7-13.2 GHz band. This type of LNA, if properly employed, can be incorporated into a multichannel microwave receiver with substantial system benefits. On newly installed paths, the improved receiver noise figure can be traded off against increased antenna diameter. Alternatively, longer path distances are feasible with acceptable system performance. For existing paths, the retrofit of a low-noise amplifier and image noise rejection filter into a receiver will lead to increased path margin to overcome rain and multipath fades.

Figure 1: Multichannel AML receiver simplified block diagram



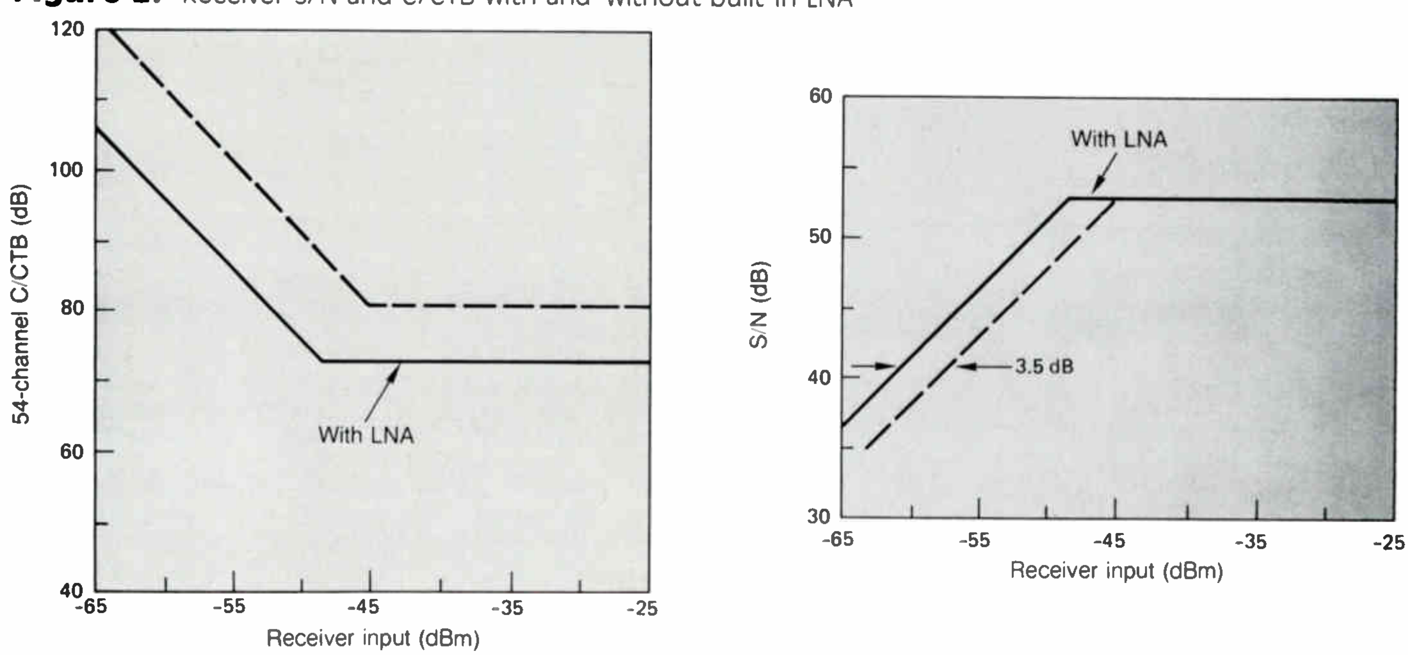
LNA within receiver

As a point of comparison, consider first a standard multichannel cable television relay service (CARS) band receiver operating without an LNA. The receiver is designed to maintain a constant signal level not only at its output, but also at the input to all circuits within the receiver capable of generating any third order distortion. Figure 1 is a simplified block diagram of such a receiver. Its noise figure is specified to be less than 10 dB. The AGC can maintain the VHF output constant over a 35 dB range of microwave input. Throughout this region, both the signal-to-noise ratio (S/N) and third order distortion are constant. One can be traded off against the other by adjustment of the AGC level.

For instance, the 54-channel carrier-to-composite triple beat ratio (C/CTB) is 81 dB for a S/N of 53 dB. At a 56 dB S/N, composite triple beat degrades 6 dB to 75 dB. Alternatively, at a 50 dB S/N, the composite triple beat is 87 dB. In any practical path, the maximum signal available at the input of the receiver is limited by fixed path losses. The difference between this maximum signal and the one at which the output signal starts to fall is the available AGC range. If rain or multipath attenuation exceeds this range, S/N at the output of the microwave receiver will be degraded.

This drop in S/N at low input levels is illustrated in Figure 2. The figure also shows the extension of the AGC range to a 3.5 dB lower input level by utilization of an LNA between the ferrite attenuator and the mixer as shown in Figure 3. The 3.5 dB improvement in available AGC range also shows itself as a 3.5 dB improvement in fade margin to an "outage level" S/N of 35 dB. The typical 3.5 dB improvements should not be confused with the 3.5 dB noise figure specification of the single-stage LNA. The receiver fade margin improvement, ΔF, is a function of both the LNA noise figure and gain, G, as well as the receiver noise figure before installation of the LNA. The higher the LNA gain, the greater, up to a point, the improvement in fade margin. However, in order to maintain the S/N within the AGC range at 53 dB, the AGC operating point must be raised by $(G - \Delta F)$ dB. This establishes the correct input level at the LNA. Note, however, that the mixer-preamp is driven harder than before. As a

Figure 2: Receiver S/N and C/CTB with and without built-in LNA



result the C/CTB is degraded by just 2 X (G-ΔF) dB. For single-stage LNAs, the gain, less filter loss, is typically 7.5 dB.

A dual-stage LNA with 15 dB of gain would further increase ΔF by 1.5 dB to 5 dB. At a S/N of 53 dB the 54-channel C/CTB would then be on the order of 61 dB, a value too low for most cable system applications. This is the reason why the LNA gain must be restricted in this configuration. On the other hand, for 21-channel applications the C/CTB would be approximately 72 dB and the built-in dual-stage LNA would therefore become a viable candidate.

Note that in all of the previous cases the LNA contributes negligibly to the composite triple beat. This is due to its high third order intermodulation (3 IM) intercept point; +21 dBm in the case of the single-stage LNA and +24 dBm for the dual-stage LNA. This high intercept point is achieved by means of a balanced design. It also should be pointed out that full advantage of the LNA's low-noise performance only can be obtained by providing an image noise reject filter as shown. This is particularly true with high LNA gain since the LNA is then by far the dominant source of noise at the output of the receiver. Since the LNA is a broadband device typically having full gain at the image frequencies, deletion of the filter would degrade the receiver sensitivity by as much as 3 dB.

Figure 3: AML receiver with integrated LNA

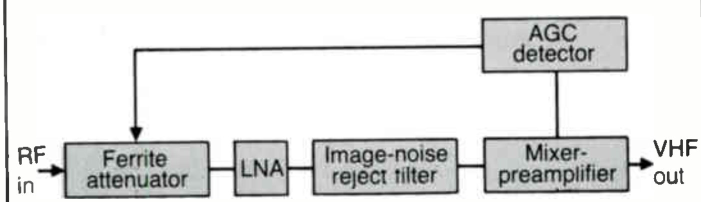
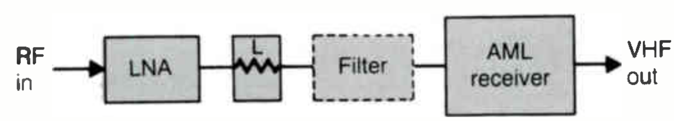


Figure 4: External LNA arrangement



External LNA configurations

In contrast to the arrangement shown in Figure 8, CATV systems often have installed an LNA preceding the broadband microwave receiver either with or without an image reject filter. The generalized arrangement is shown in Figure 4. The deleterious consequence of working without a filter already has been discussed so it will be assumed that the filter has been installed to obtain the largest possible fade margin improvement. Any waveguide loss between the LNA and the receiver is represented by the loss, L, in Figure 4.

If one was then to compare the fade margin performance of such a ground-mounted receiver with and without the antenna-mounted LNA, the improvement would be very dramatic, particularly if the waveguide loss is substantial. This is illustrated by Figure 5, which assumes the existence of 5 dB of waveguide loss. The improvement in fade margin is 9.4 dB.

The receiver AGC threshold is again set for a 53 dB S/N at an antenna input of −40 dBm (corresponding to −45 dBm at the receiver input in the absence of the LNA), but the S/N is not constant in the AGC range. As the signal level increases, the S/N at first improves dB for dB until the receiver AGC sets in. In this example, the AGC is set only ½ dB higher than usual with respect to the mixer-preamp input level. With this setting, the S/N rises to 53 dB at a −40 dBm antenna input. The gradual rise in the S/N is due to the fact that while the signal is kept constant after the −53.8 dBm antenna input threshold, the LNA's contribution to noise is increasingly attenuated by the ferrite attenuator.

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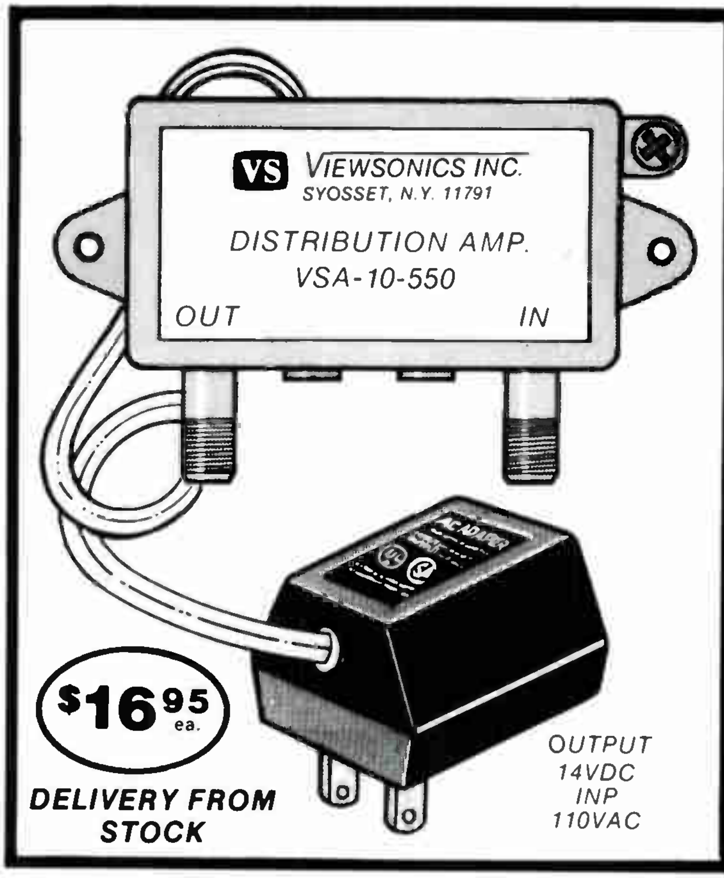

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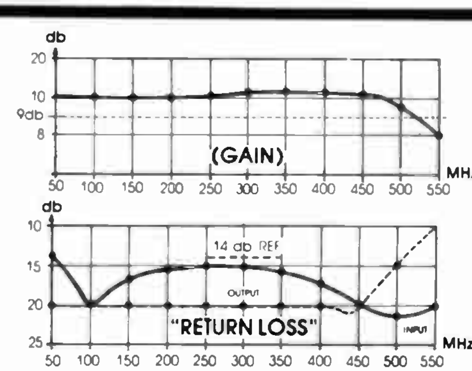

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Figure 5: Tower-mounted dual-stage LNA (5 dB waveguide loss)

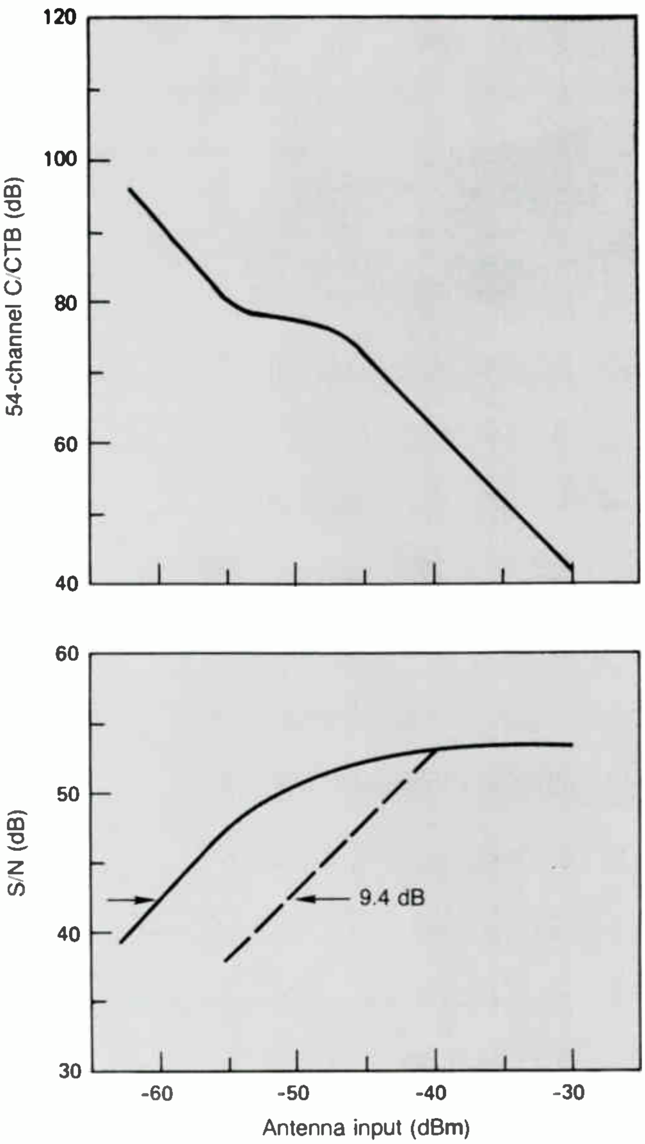
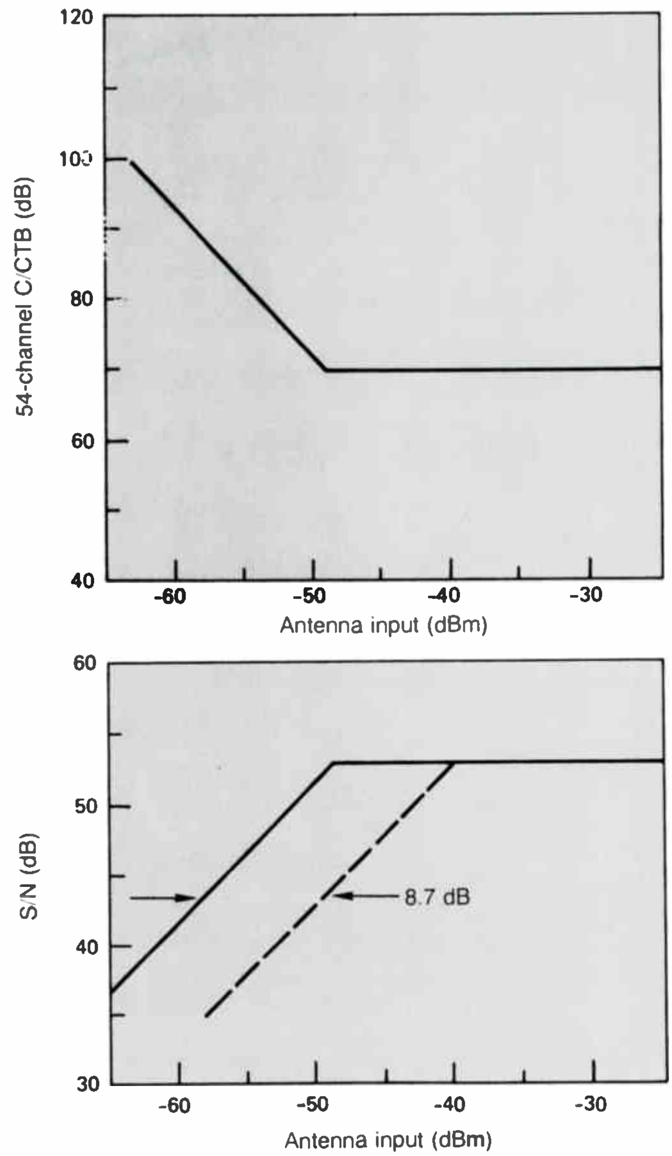


Figure 6: Tower-mounted LNA with AGC (5 dB waveguide loss)



mixer-preamp. However, at a −49 dBm antenna input, the contribution from the LNA equals that of the mixer-preamp whose distortion remains constant above the AGC threshold. As the antenna signal continues to increase the LNA's contribution to third order distortion dominates. The actual number depends on both the LNA gain and 3 IM intercept point. The lower the gain and higher the intercept, the better the C/CTB at the high signal levels. Nevertheless, despite the high +24 dBm intercept specification for the two-stage LNA, it is evident that third order distortion is unacceptably high for LNA input levels in excess of −40 dBm. Even a 62 dB C/CTB would hardly be "transparent" when added to the cable system were it not for the fact that LNA-caused intermodulation is likely to add on a power basis rather than a voltage basis to that of the cable system.

External automatic gain control

To extend the useful range of application for the tower-mounted LNA it is necessary to place the AGC function in front of the LNA as in the previous configuration. This is conceptually achievable by removing the ferrite attenuator from the AML receiver and mounting it instead in front of the LNA. Figure 6 shows the performance obtained. The fade margin improvement is 0.7 dB less for the same LNA and waveguide as in Figure 5 because the small signal insertion loss of the ferrite attenuator is now in front of the LNA instead of following it. The 8.7 dB fade margin improvement dictates that the AGC commence at −48.7 dBm at the antenna input. This translates to 5.6 dB higher than normal signal level at the mixer-preamp input to achieve the 53 dB S/N.

Even better performance could be obtained with a dual AGC control. In this case the ferrite attenuator remains inside the AML receiver but an additional ferrite attenuator is added in front of the LNA. At very low signal levels neither AGC is activated. At threshold, the attenuator internal to the receiver becomes active and maintains constant input level to the mixer-preamp. As the antenna signal level continues to increase, this attenuator takes on a fixed value and control shifts to the pole-mounted attenuator. Thereafter, a constant signal level is maintained throughout the remaining AGC range at the LNA as well as at the mixer.

Summary

LNAs can be used to increase fade margin on a microwave path. However, care must be taken to avoid excessive generation of third order distortion products. This is best done with AGC that maintains both S/N and C/CTB constant as with standard multichannel broadband receivers. If LNAs are used without AGC, the range of permissible applications is severely limited.

Reprinted from the 1984 National Cable Television Association convention technical papers.

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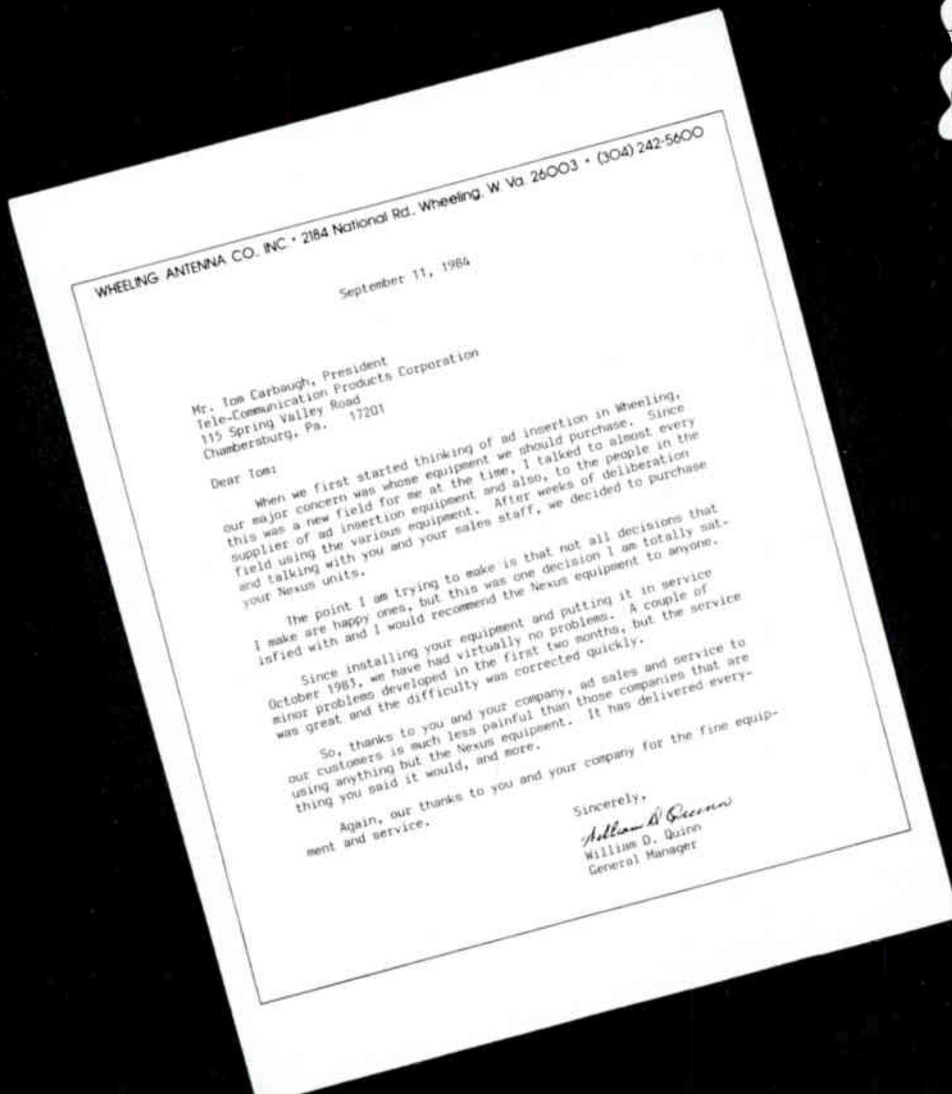

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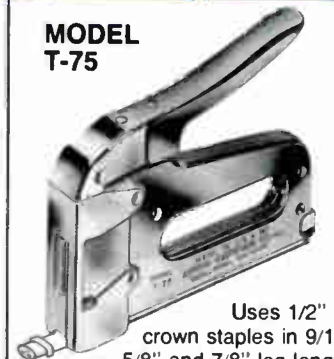

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AML microwave transmission theory

Amplitude modulated link (AML) microwave systems are used in cable television to take the place of "hard" cable for the transportation of signals from one place to another. Factors determining its use usually involve the economics of getting signals from here to there when the distance is too far to run trunk lines or when physical barriers exist that prohibit stringing cable. AML is not the answer in all cases. Sometimes it is the only solution and we must live with the problems it creates.

By Ralph Gillespie
Plant Engineer United Cable of Colorado

The transmission frequencies used in AML cable TV applications fall in the 12 to 13 GHz band, commonly referred to as the CARS (cable television relay service) band. Each channel to be transmitted will occupy a 6 MHz bandwidth and contain all the elements of the vestigial sideband VHF signal. Basically, it's a VHF signal heterodyned to microwave frequencies. Each channel must be licensed by frequency, type of transmission, power output, size of antenna and path coordinates. Prior to applying for a license it is best to have an interference and frequency coordination study done on your own. The Federal Communications Commission will issue a license as long as the transmissions do not interfere with existing paths; interference to the AML from already operating sites is your problem.

In the case of AML systems, we are dealing with amplitude modulated transmission. We are familiar with several forms of frequency modulated transmissions, most notably the satellite signals upon which the CATV industry has come to depend so heavily. Calculations for carrier-to-noise, signal strengths, and signal-to-noise take a different form when dealing with FM transmissions. Computations for AM transmission are much simpler.

The actual microwave transmitter equipment can take several forms. Individual high power units for each VHF channel to be transmitted are commonly used for systems requiring multiple receiving "hub" sites spread over a large geographical area. In this case each VHF channel is assigned its own transmitter with individual upconverters and klystron amplifiers. This results in the highest power output per channel available. A less expensive choice could be an arrangement where several VHF channels input to one klystron amplifier through individual upconverters. Since the output power capability of the klystron amplifier is spread over several channels, the level per channel output is less. However, for short hops or a small number of hubs, this could be a viable alternative.

Also available are units designed to be pole mounted and fed by signals directly from the CATV cable. These units are available in bandwidths exceeding 400 MHz and work well in point-to-point situations where it is not feasible to extend an existing cable system to serve customers in a "pocket."

Laws of physics

Space attenuation (SA) can be defined as the loss of signal taking place in the air space between the transmitting and receiving antennas. We can calculate this loss by using the formula, $SA = 96.6 + 20 \log F + 20 \log D$; where F equals the transmitting frequency in GHz and D equals the distance in miles between antennas. A look at the formula tells us that space attenuation increases logarithmically with frequency and distance; and some work with a calculator shows that we lose approximately 139 dB of signal over a 10-mile path. Since most transmitter arrays put out levels less than +20 dBm and receivers work with levels above −50 dBm, we can see that we need gain from somewhere.

Microwave antennas, while of various sizes, all have the same basic shape. They are parabolas or dish shaped and are known as parabolic antennas. This shape has been found to be the most efficient concentrator of RF energy. Various types of feed horn systems are in use today; these in conjunction with a parabolic reflector make up the components of a basic microwave antenna. The principle of operation is to take the energy radiated from the end of a feed horn and concentrate it into a narrow beam. Since most of the energy being transmitted is confined to a narrow beam, the antenna appears to have increased the strength of the signal. For receiving, this principle is reversed, energy from a large portion of airspace is concentrated into a very narrow beam and delivered to the input of the feed horn.

Antenna selection is determined by the amount of gain needed. The larger the antenna the more concentrated the transmitted beam and the more area looked at on the receive end. It stands to reason then that the larger the antenna the more gain it will have. Commercial 13 GHz antennas are available in sizes from 2-12 feet in diameter with gains in the 40-50 dB range.

Let's go back now and look at a theoretical 10-mile path. Choosing some figures for the sake of argument, let's say the transmitter output is +15 dBm and our antennas have 45 dB gain. The +15 dBm transmitter output will be increased to +60 dBm by the antenna. Space attenuation will decrease this level to −79 dBm ($[+60]-[+139]=-79$). The receiving antenna also has 45 dB of gain, so now the signal is increased to −34 dBm ($[-79]+[+45]=-34$). Except for one factor yet to be considered, this level now becomes the input to our receiver.

Transmission lines and other factors

The missing part in our discussion is the waveguide. Antennas are usually mounted out of doors on poles, towers or other supporting structures, while receivers and transmitters are placed indoors accessible for inspection, close to power and in a climate-controlled environment. Waveguide is the transport medium used to carry the energy between these devices, and although there are many different types of transmission lines, only two kinds are suitable for frequencies in the 13 GHz range. These being the elliptical and the circular waveguides.

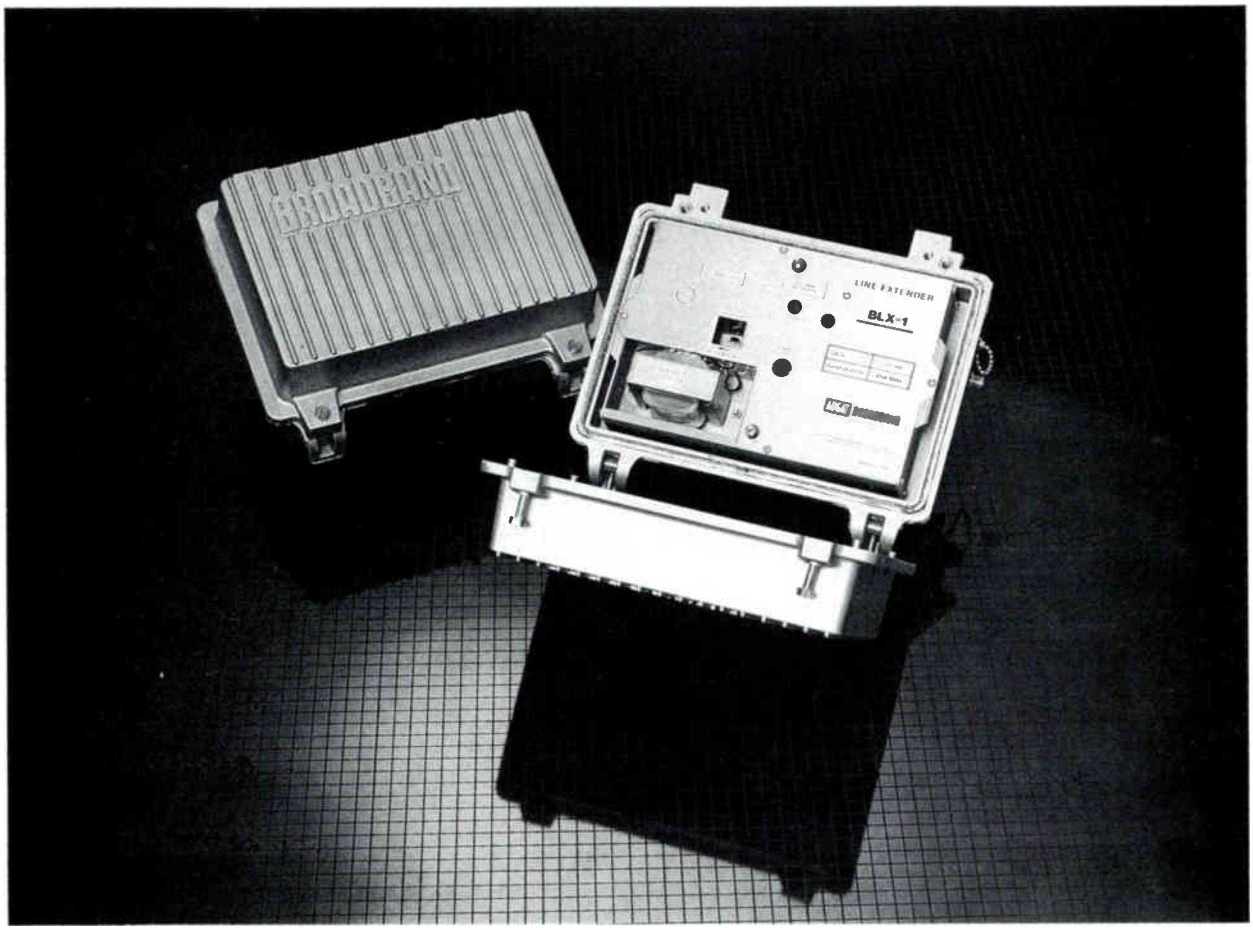
Circular waveguide bears a striking resemblance to large water pipe, and handles much in the same fashion. Although not flexible and quite expensive it offers the advantage of approximately 1.2 dB/100 feet attenuation.

Elliptical waveguide is a hollow tube shaped like an ellipse. It is bought in measured lengths, which come on rolls much like CATV cable. Advantages are: it is flexible and cheaper than circular waveguide. Disadvantage: loss is about 4.5 dB/100 feet, four times more than circular. The amount of loss a transmitting and/or receiving system can tolerate will be the determining factor as to which type of waveguide to use.

Let's take another look at our test microwave installation and plug in this new factor. Assume we have 100 feet of elliptical waveguide (4.5 dB loss) at each end. The transmitter output of +15 dBm will be decreased to 10.5 dBm through the 100 feet of waveguide. Transmit antenna gain of 45 dB now gives us an effective radiated power of 55.5 dBm. We lose 139 dB through space attenuation, so now we are down to −83.5 dBm at the receive antenna. The receive antenna adds 45 dB to give us −38.5 and waveguide loss of 4.5 dBm leaves us with an input to the receiver of −43 dBm.

Thus far, all the calculations have been pretty straightforward and certainly would be more than adequate for a feasibility study to be used in budget preparation or even final design of a short hop microwave path. However, as the paths get longer and the signal strengths get closer to the receiver threshold, other factors come into play that need to be accounted for before final design is approved.

Rain fade is a problem in some parts of the country. Raindrops present large amounts of attenuation to signals at 13 GHz causing from complete loss of signal to noticeable increases in noise level.



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Downconversion and carrier-to-noise

So, we have gone through the motions of engineering a 10-mile microwave path with some theoretical brand X equipment. Nothing has been said though, about the VHF signal after it passes through the receiver and is ready to be fed to customers.

Microwave receivers and CATV trunk amplifiers have a lot in common. Both take in RF signals and perform amplification, both have AGC (automatic gain control) capability, and both output RF signals in the VHF spectrum. A receiver, unlike an amplifier, however, must perform downconversion. To do this, some form of local oscillator is necessary. Narrowband systems use independent oscillators on each end and perform relatively well. Broadband systems must be a little tighter in their downconversion techniques. This calls for a "master" oscillator and pilot carrier on the transmit end and phase-locked oscillators on the receiving end.

This last portion of our microwave system is the active elements of the receiver. These are composed of: the preamplifier, mixer, post amplifier and AGC circuitry. Take another look at that −43 dBm signal we are feeding into the receiver. More specifically, look at the carrier-to-noise ratio. This is the ratio of power contained in the received signal to the power contained in ambient noise of comparable bandwidth and frequency. Since we are talking about television signal bandwidths, a 4 MHz slice at this point will yield numbers directly related to our carrier-to-noise ratio on the cable system after the receiver. Text books place the value of this noise power at about −108 dBm. With our signal at −43 dBm and the noise down at −108 dBm we are sitting pretty good with a carrier-to-noise ratio of 65 dB looking at the front end of the receiver.

High quality microwave receivers have a noise figure of 8 to 12 dB. As any good CATV engineer knows, with a cascade of one, the noise figure of the device is added directly to the level of input noise. So, our −108 dBm becomes −98 dBm and our carrier-to-noise ratio is now down to 55 dB. Also, we have been ignoring receiver AGC action. In order to maintain constant output and operate at levels through the active portion of the receiver, which gives minimum intermodulation products, the input must be held at a constant level below the level available at the input connection to the receiver. This is accomplished by an electronically variable attenuator *before* the first amplifier. This means that while the strength of the input signal is decreased by the AGC action, the noise floor does not change: it is set by the noise figure of the first amplifier.

Today's receivers operate with input levels around −45 dBm. With 2 dB less signal into the receiver our carrier-to-noise will be 2 dB less. Subtracting 2 dB from our calculated carrier-to-noise ratio of 55 dB gives us a system headend carrier-to-noise of 53 dB. This figure is a full 6 dB lower than that which we are used to having as the input to the first amplifier in a trunk cascade. This means design calculations for system noise must be very tight.

Another point in our theoretical path is the fade margin. How much can our received signal decrease in strength before we lose AGC action?

We have established a clear path signal of −43 dBm to the input of the receiver. AGC action attenuates this to −45 dBm, so we have a 2 dB fade margin. Once the signal fades beyond this 2 dB margin, an action familiar to all CATV technicians takes place. Signal output and carrier-to-noise drop at a rate equal to the change in input signal strength.

Pros and cons

Anyone designing a path such as this should have at least a 6 dB fade margin, higher if you can afford it. Slight misalignment of the antennas, rainfall, heavy fog, equipment aging, all can rob you of valuable signal.

AML is not for everyone. Like most things in our business it has its pros and cons. Cost per mile for construction is cheaper but then we must give up some quality in the signal delivered to the customer.

EXCLUSIVE

Technology to improve economics

This is the first installment of a two-part series describing General Electric's bandwidth compression technology. Part II will cover a field test/implementation of the Comband system.

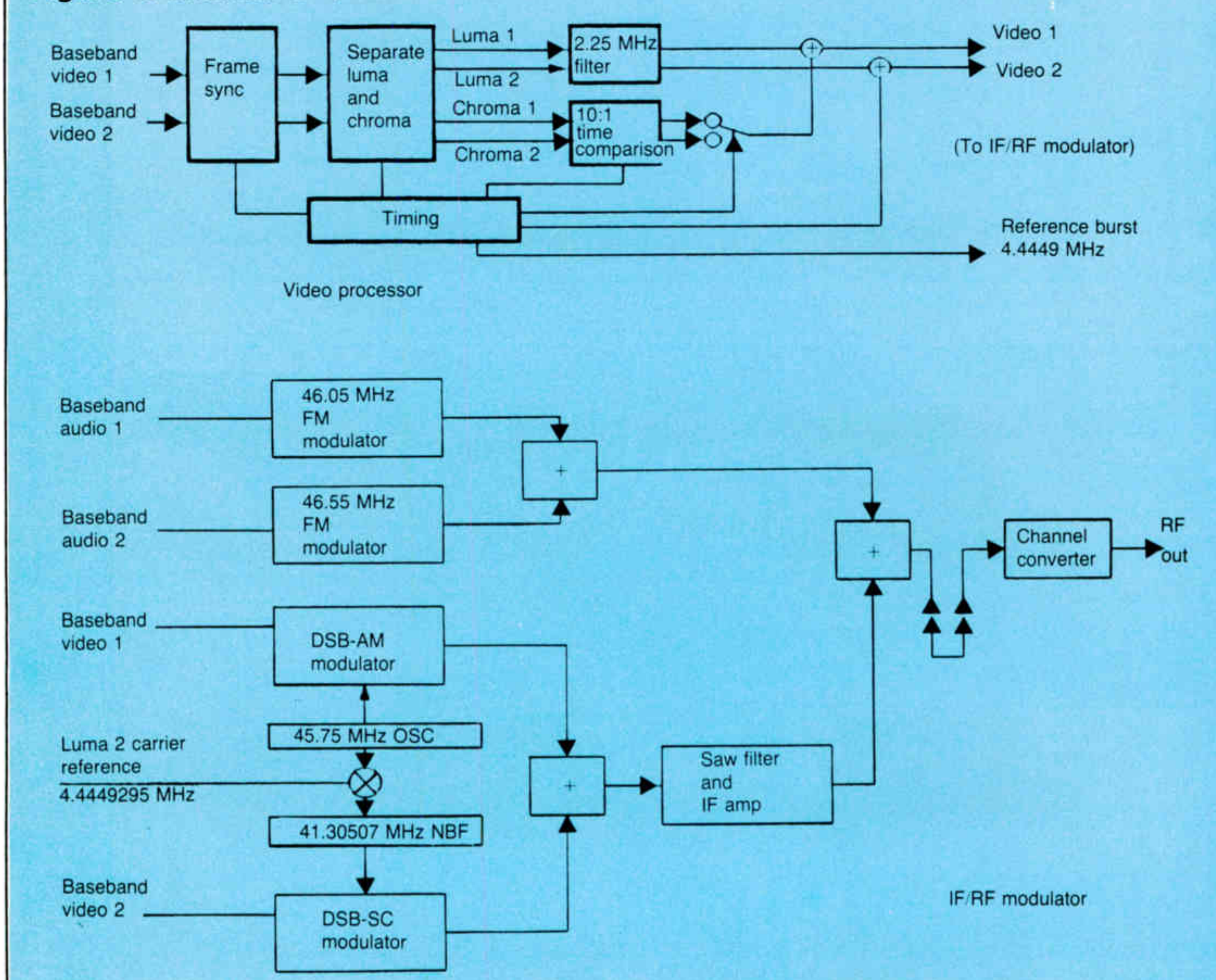
By Thomas A. Gilchrist
General Electric Co

Few cable transmission characteristics are as important as the dual needs of efficiently using expensive and often limited frequency spectrum, and protecting program material from unauthorized reception and usage. The obvious challenge to each cable operator then, is to maximize the number of programs available on his cable system while ensuring adequate security.

Recent technical advances in channel bandwidth compression may hold a valuable solution to the challenge. Such a system is under development by General Electric's Cable Products Group where two baseband video signals are encoded in a way that permits the scrambled results to be transmitted on a single carrier. The frequency and time compressed signal format is optimized to compliment CATV distribution requirements.

The new Comband system involves frequency and time division multiplexing (FTDM) techniques. Two composite NTSC video sig-

Figure 1: Bandwidth compression transmitter



'Recent technical advances in channel bandwidth compression may hold a valuable solution to the (channel maximization and security) challenge'

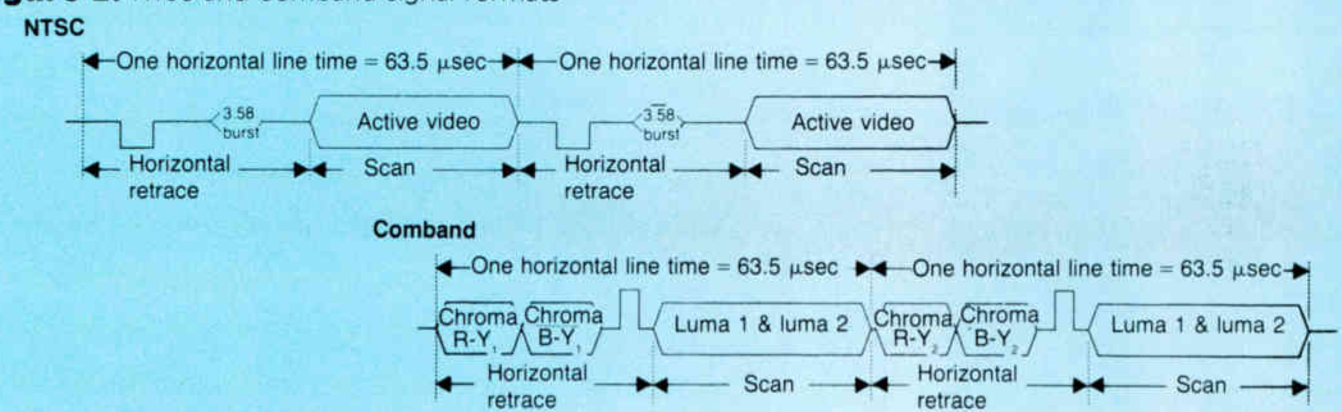
nals are combined at the transmitter, then returned to standard NTSC format at the converter. The system utilizes an interleaved process in which two composite video signals are separated at the transmitter into component elements of sync, luma and chroma and recombined into a single CATV channel bandwidth (see Figure 1). This encoding is made possible by removing redundant chroma information as well as by utilizing available bandwidth more efficiently.

The COMpressed BANDwidth waveform

In the transmitter, the luminance (black & white) information is separated from the chrominance using a comb filter. Each separated luma signal is processed for detail enhancement and then bandwidth limited to approximately 2.25 MHz to fit the total useable 4.5 MHz frequency spectrum. Luminance information from program source 1 is transmitted as amplitude modulation on an IF carrier of 45.75 MHz, while the second picture is transmitted as amplitude modulation on a suppressed carrier 4.5 MHz below the first at 41.30 MHz.

The separated chrominance information for both program sources is modulated on the main picture carrier but shifted in time to align with the region normally occupied by horizontal sync. Figure 2 shows chroma information for program source 1 being transmitted at the beginning of a certain line of video information, while chroma for the second program source on the following line waits, or is suppressed.

Figure 2: NTSC and Comband signal formats



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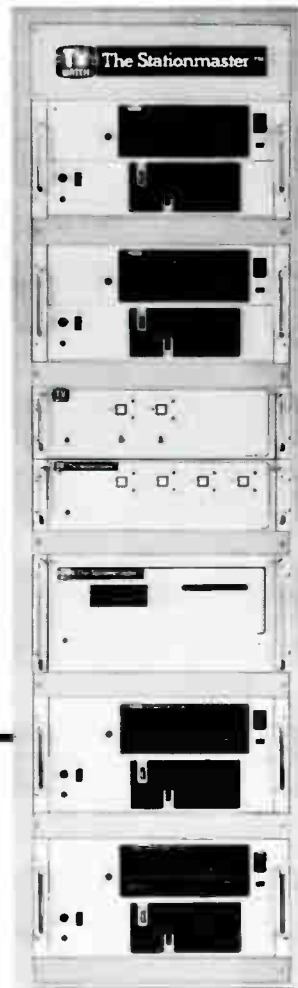

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Comband chronicle

First announced in October 1982, General Electric's Comband™ bandwidth compression system is the result of extensive research conducted by engineers at the GE corporate research and development center in Schenectady, N.Y., and at the consumer electronics business operations headquarters in Portsmouth, Va. In simplest terms, Comband technology allows cable TV operators to increase the number of channels offered to subscribers by electronically "squeezing" two video signals into the space normally required for one. The idea will allow cable companies, especially those with older systems offering just a few channels, to significantly expand their offerings without having to rebuild or upgrade existing systems.

Since the first announcement of the Comband system, the technology has undergone a number of technical revisions. The most recent version has been undergoing field testing at UA Cablesystems in Hattiesburg, Miss. The Comband system is scheduled to be available to CATV companies across the country in the fall of 1985.

A critical element in the tests is ensuring that the Comband system's picture is as good as the picture produced by conventional cable TV equipment. And along with providing cable companies an opportunity to double the number of channels offered to subscribers, Comband technology also offers stereo sound capability, computer-based addressability and security features to protect the system from cable TV pirates.

This alternating transmission of chroma occurs throughout the video frame.

To transmit chroma within the small amount of time available for retrace, it must be time compressed by a factor of 10:1. This time compression is achieved in the Comband system by means of a custom charge coupled device (CCD) storage integrated circuit. As chroma information requires a bandwidth of at least 450 MHz, a time compression of 10:1 will require a transmission bandwidth of at least 4.5 MHz. Therefore, during the time that the chroma information is being modulated on the main carrier, no video information is allowed to modulate the subcarrier. This measure gives the chroma information the necessary bandwidth to ensure adequate resolution. Note that the converter is required to duplicate the chroma information for each source on the alternating lines from which chroma is missing. This duplication or averaging of chroma is tolerated quite well by the human eye and is very similar to the effects that a comb filter has in a typical TV receiver.

Horizontal and vertical sync are obtained from pulses modulated on the main picture carrier during the portion of the horizontal retrace period that is not occupied by chroma. To ensure optimal stability of the reproduced pictures, complete line and frame synchronization is used. Sync pulses used in the system are different in two respects from typical NTSC pulses. The Comband pulses are 10 times narrower than those of conventional NTSC and they are positive going with respect to the video information. These factors contribute in making system signals impossible for standard TV receivers to achieve lock. Vertical sync is obtained by transmitting a series of horizontal pulses during one horizontal line of each frame.

RF spectrum and converter

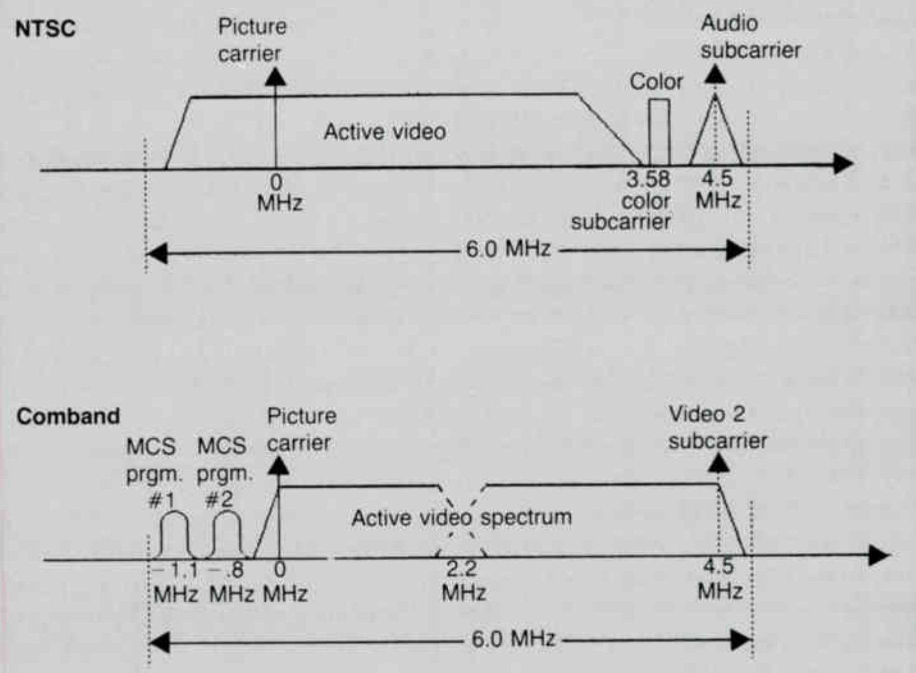
The frequency spectrum for the Comband composite signal is shown in Figure 3. To make more complete use of the RF bandwidth and to allow for compression of two program sources in a single 6 MHz channel, the active video spectrum is band-limited to approximately 4.5 MHz. The remainder of the channel, located below the picture carrier, is allocated to two 300 kHz bandwidth multichannel sound channels that provide stereo capability for both program sources. This spectrum below the picture carrier is normally allotted to the vestigial sideband of the standard NTSC format and is otherwise unused for transmission of video information.

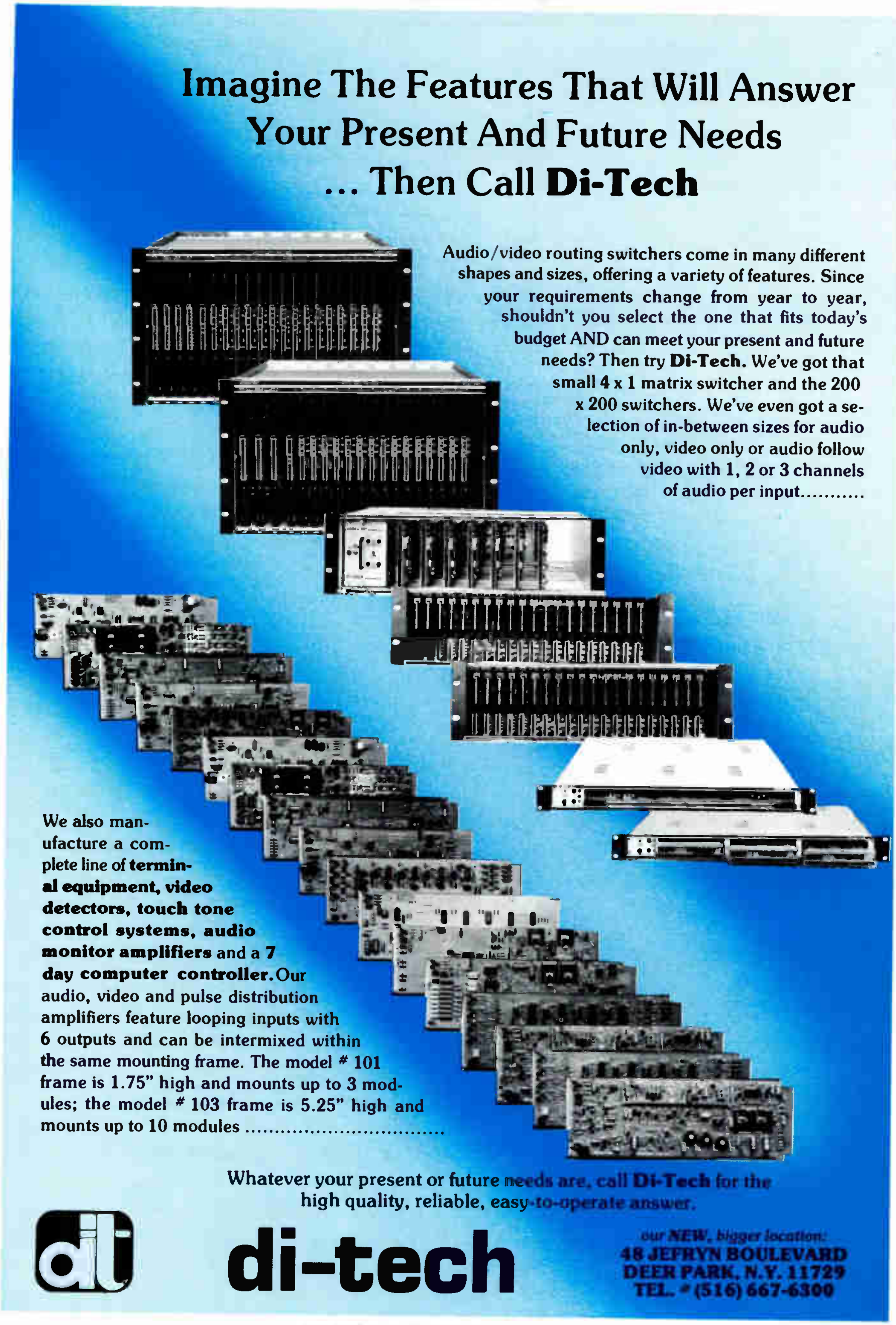
The Comband converter is a baseband design with tuner, IF, microprocessor-based one-way addressing and IR remote control, baseband video decoding and an RF modulator. It selects authorized channels and demodulates audio and video to baseband. The video IF design of the converter differs from conventional IF designs in that the video bandpass must be wider, skirt selectivity higher, and the vestigial sideband portion of the signal narrower to allow the video and audio information from two channels to be contained in the same 6 MHz channel width. Likewise, the audio portion of the converter presents unique design challenges. Special traps shunt the sound carriers away from the video IF signal thus preventing beats in the picture. The desired sound signal is frequency converted to 4.5 MHz and passed through a controlled bandpass filter to isolate it from the undesired sound channel. Following this filtering, the sound is demodulated to baseband and volume level controlled by microprocessor to allow subscriber control.

Comband in a CATV system

A Comband cable TV transmitter is a self contained unit configured for standard rack-mount installation. The unit accepts conventional baseband video and audio input signals. Upon conversion of the input signals

Figure 3: Comband vs. standard NTSC RF spectrum





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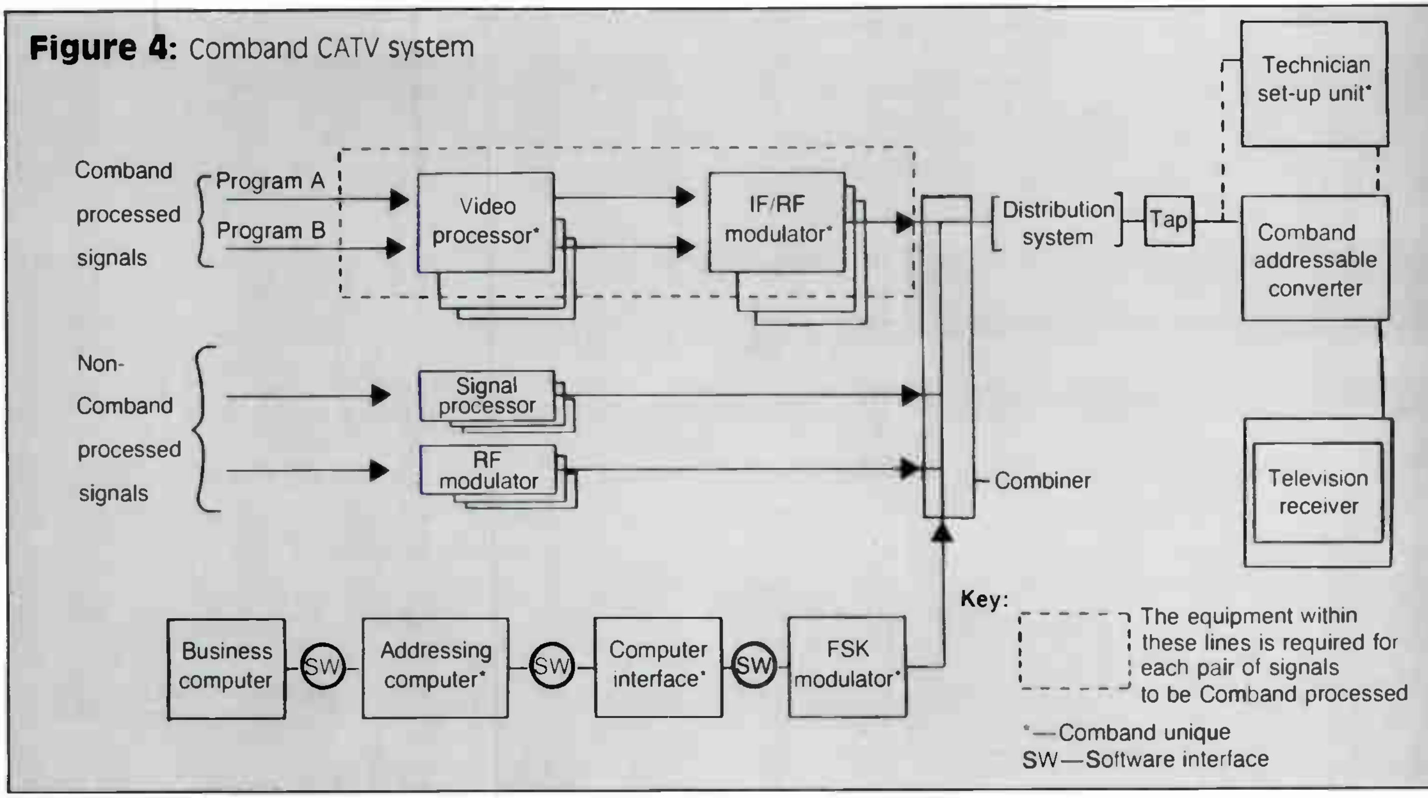


Figure 4: Comband CATV system

to the compressed format it provides composite 6 MHz output channels that are selectable within the frequency range of 50 to 450 MHz. Each Comband channel can be combined with all other standard NTSC channels in a conventional way and sourced to subscribers via the existing CATV plant and distribution (see Figure 4).

The Comband system under development by General Electric is an innovative alternative for the cable system operator to upgrade his system without incurring the high cost of a total system rebuild. Sample run versions of the new converters are currently under test in Hattiesburg, Miss.

Set-top converters vs. off-premises star-switched networks

By Rick Kearns
Marketing Director Mini-Hub II™

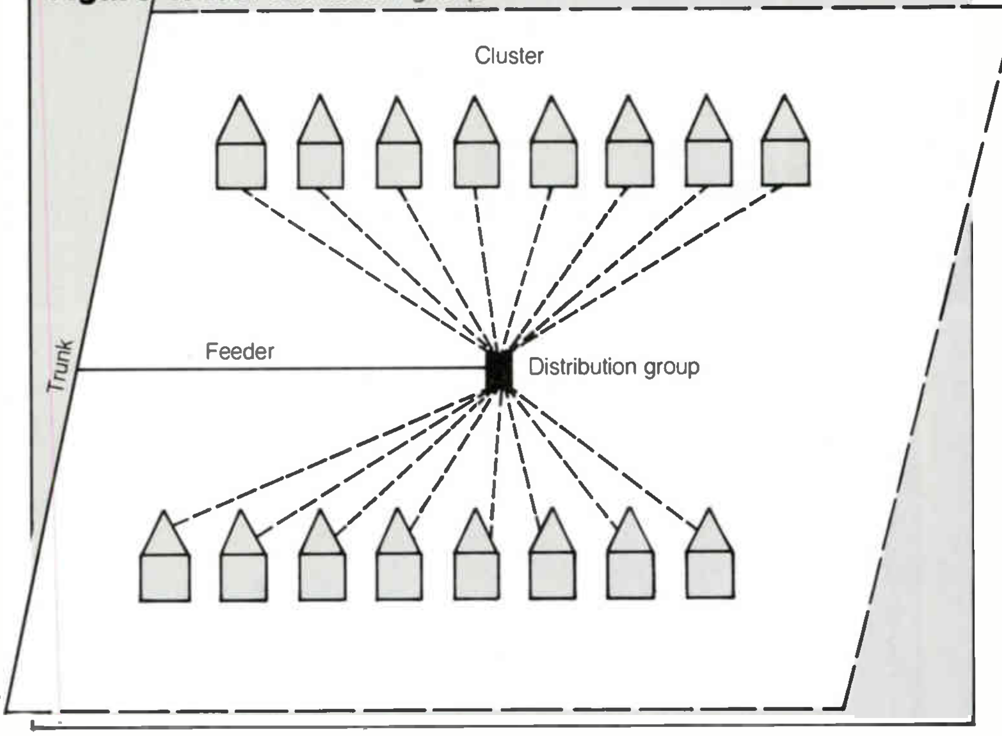
and Marty Gosselin
Technical Writer
Times Fiber Communications Inc

The employment of set-top addressable converter systems can be a cost-effective approach, as is reflected by their increased use in the cable television industry. The major reason for this acceptance is that set-top addressables give the system operator the ability to change a subscriber's service level from a central computer without ever having to roll a service vehicle, replace the converter, or add a decoder or descrambling device.

While this addressability does give the system operator an efficient and cost-effective method of changing service levels, it does not alleviate the following specific operator concerns:

- Signal theft—All channels are present on the drop at all times, allowing access to these signals by unauthorized personnel.
- Equipment loss—The subscriber has access to expensive equipment resulting in possible losses by theft or damage.
- Inaccessibility—Maintenance can be performed only when the subscriber provides access to the equipment.

Figure 1: Local distribution group



Off-premises systems that send only authorized channels down the subscriber's drop cable and remove all addressable equipment from the home provide an effective method of alleviating these three concerns. Moving the expensive addressable equipment away from the subscriber's home eliminates both signal and equipment theft and allows immediate access by cable company personnel. The value of such systems has been demonstrated, both in theory and in use, and more off-premises systems are being installed because new generations of equipment are cost-competitive with conventional systems.

The star-switched network

Of all off-premises systems marketed today, the star-switched design is unique. In order to understand the characteristics of a star-switched network and compare them to addressable set-top converters, a brief introduction to the star-switch concept is required. A star-switched network consists of three basic groups of equipment:

- Headend group
- Local distribution group
- Subscriber group

The headend group consists of the standard signal transmission equipment used in conventional tree and branch systems with the addition of the hardware used to control the addressable portions of the system. The *local distribution group* consists of all addressable equipment and signal distribution equipment including amplification and switching components. This group of equipment is centrally located to serve a cluster of subscribers in a suburban or urban environment (Figure 1). The *subscriber group* consists of an interface unit and a remote control unit that is used to change channels and perform optional operations such as pay-per-view, voting and shopping. The subscriber requests a channel using either the interface unit or remote control unit. The channel change request is sent up the drop cable to the addressable control module in the local distribution group. This control module determines if the channel is authorized and directs a switching module to forward that channel down the drop cable to the subscriber's residence.

A set-top addressable system supplies all channels and, frequently, the FM carrier frequency to each subscriber's residence at all times. Having the entire channel spectrum, even those channels not included in the subscriber's service level, and the FM carrier present on the drop cable permits easy access to unauthorized signals and control data by knowledgeable individuals. In a star-switched system, the selected channel is always sent to the subscriber's residence on the same carrier frequency (normally channel 2, 3, 4, 5 or 6), eliminating the possibility of access to unauthorized signals and control data. Another benefit is that the total frequency spectrum is distributed through a shorter cable plant. This occurs because a star-switched system has less trunk and feeder and the drop cable never passes signals greater than 108 MHz, reducing the occurrence of severe signal leakage.

For the most part, both set-top and star-switched systems are controlled in the same way. Both communicate with the addressable equipment by using a specific and unique address, but, because the control modules are shared in the clustered star-switched design, the amount of addressable electronics is greatly reduced, sometimes by as much as a factor of 16. The interface equipment in the home does not require a unique address thereby simplifying the cable operator's inventory. Each in-home unit can be substituted for any other unit but is operational *only* if that subscriber is authorized by the control computer.

One-way, two-way considerations

Once the control command has been sent, the operator of a one-way addressable system cannot immediately determine if the command has been accepted and acted upon. The inability to determine results of any control command is a drawback that holds true for all one-way systems. Subscriber interference is much easier in a one-way set-top converter system in

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which the equipment is accessible and may be tampered with. A two-way set-top converter is much more difficult to defeat, but the addressable equipment still remains accessible to the subscriber and in danger of theft and/or damage. In either a one- or two-way star-switched system, only the inexpensive interface unit is readily accessible to the subscriber. Because the interface unit cannot be altered to expand service, signal theft made possible by installing illegal converters or by tampering with cable company equipment that has been installed in a subscriber's residence is eliminated.

A major concern of today's cable system operators is the capital investment required to install an addressable system. In set-top addressable systems, both one-way and two-way, each residence served must have an addressable converter. This means that the microprocessors and demodulators (one-way) or modems (two-way) required for addressability must be contained in each converter. These components represent a large capital investment. In a star-switched system many switching units can be controlled by a single microprocessor, and a single demodulator or modem can serve an entire local distribution group. Sharing components not only makes addressing the system easier, but it also cuts component costs.

There is another significant advantage of star-switched clusters over set-top addressable converters: upgrading a one-way system to a two-way system. The ability to upgrade these systems to two-way without a major capital investment will be a concern of system operators when two-way interactive services become commonplace. For the most part, one-way set-top addressable converters must be replaced or individually retrofitted with two-way components to be upgraded to a full two-way system. This will require a major capital expenditure for equipment and labor costs. The time required for such an upgrade will be extensive because each subscriber's equipment must be retrofitted or replaced at the subscriber's convenience.

In a star-switched system, however, where the subscriber interface is the same for both one- and two-way systems, a one-way system can be upgraded easily to a full or selective two-way system when such action is convenient for the cable company. The upgrade requires the addition of only one modulator per local distribution goup and increased microprocessor storage in the control module, reducing both equipment and labor costs. In addition to related cost savings, the drop cables are completely isolated from the trunk and feeder system, which greatly reduces the upstream noise, a recurring headache for two-way operation.

Powering options

An important issue associated with all off-premises addressable systems is system powering. Off-premises systems, unlike set-top converters, offer the operator the opportunity of selecting from several alternative methods for powering. Each method has its advantages in a given circumstance. One method is powering off-premises equipment with power from the subscriber's residence. This would, in essence, have no impact on cable system power costs. Two other viable options of the system operator are to use the 60 VAC power already on line or install 110 VAC lines to each local distribution group. Ultimately, operators will question why they should pay for power that they have not paid for in the past. One answer may be that the benefits—no theft of signal, reduced theft and damage to equipment and greatly reduced maintenance costs—far outweigh powering considerations. From this point of view a tradeoff between system security and powering must be made when comparing addressablity in set-top converters and off-premises equipment.

Addressability in a star-switched network is made easier by combining the functions of many set-top microprocessors in one unit as well as reducing costs for equipment and labor. Also, the computer control is made simpler by the reduction of equipment addresses, adding a greater amount of flexibility to control and diagnostic functions. Addressability continues to evolve and grow in use (in 1984 more addressable converters were shipped than non-addressable ones). The off-premises star-switched system can be viewed as the next logical step, retaining the obvious advantages of addressablity while overcoming some of the problems.

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Reader Service Number 31.

Rebuilding for addressability

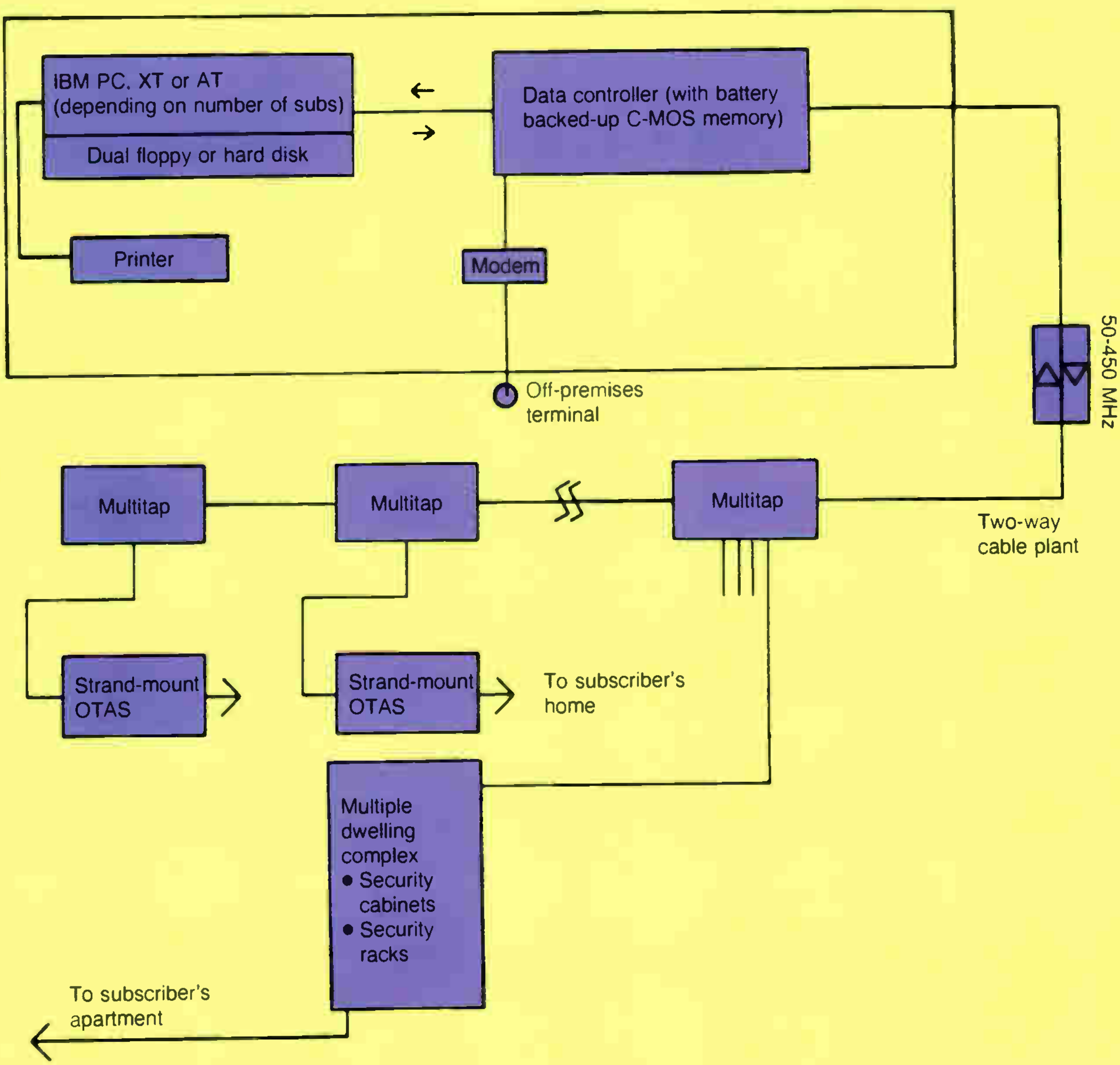
By James M. Quigley Jr.
Product Sales Manager, OTAS, Pico Products Inc.

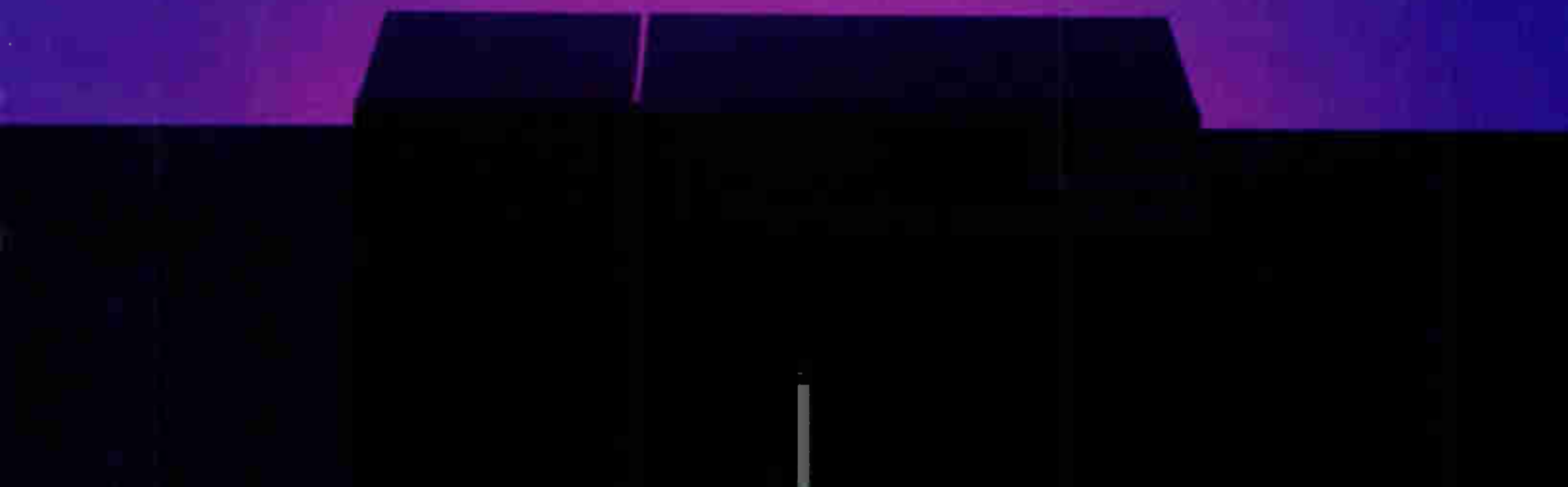
During early 1981, Pico began an extensive R & D study on the conceptual development of an off-premises addressable system. Assisting Pico's engineering department were outside consultants, coupled with input from Tele-Communications Inc. (TCI).

A prototype was developed and demonstrated to TCI. Based on Pico's continued product development, TCI agreed to commit time and cooperative effort to the product. As a result, a pilot test was established in the MSO's Lakewood, Colo., system in May 1983. Following the Lakewood test of the Outdoor Terminal Addressable System (OTAS), it was determined that it would provide full addressability and security for the planned rebuild of TCI's Delta, Colo., system. This site was selected because of the proximity to TCI's corporate headquarters, manageable system size and upcoming rebuild requirements.

During April 1984, shipments of terminals and subscriber modules to Delta began. Pico's support personnel were on-site to assist with the implementation of OTAS and to become familiar with the Delta system. In June 1984, the rebuild began. Final completion of the rebuild and installation of OTAS was accomplished by October 1984. A system proof

OTAS block diagram for two-way systems





was performed by members of TCI's corporate engineering department to determine the quality of the rebuild and evaluate OTAS performance as an integral part of the cable system. This culminated the first phase of the joint effort between TCI and Pico in the development of a dependable and viable off-premises addressable system.

Philosophy, design and development

From the beginning, Pico's and TCI's dual commitment helped shape the OTAS development and design scheme. Research and experience in CATV identified the operators long-term addressability requirements. The OTAS system needed to be cost effective, to have total security, off-premises addressability and compatibility with cable-ready sets and multiple sets.

TCI's CEO Dr. John Malone and Director of Engineering Dave Willis suggested the need for transparency, data communications and global command feature for pay-per-view (PPV). All of these were incorporated into the final product prior to production and shipment.

In addition, uplink satellite control from TCI's corporate headquarters is planned for subscriber addressing of Delta's rebuild. Dr. Gerald Bennington, TCI's vice president of information systems, is designing software for operation of remote uplink subscriber control. Full two-way and audit monitoring capabilities were incorporated to provide for any long-term needs.

System profile and installation

Delta is located approximately 200 miles southwest of Denver, across the Continental Divide, with a population of 8,000. TCI's Delta system serves 1,601 subscribers.

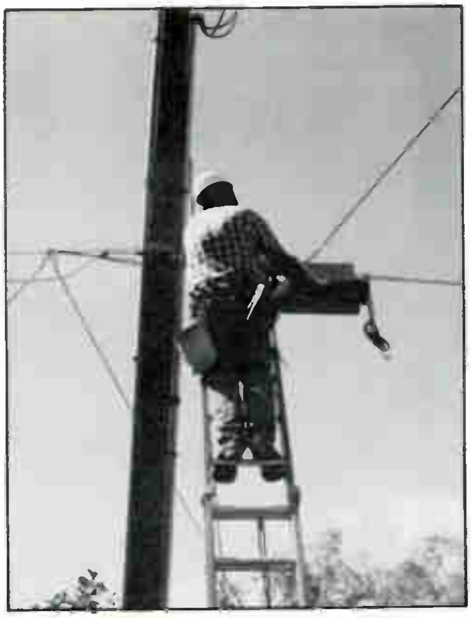
With the decision to utilize OTAS in Delta, channel selection of the active traps needed to be determined. Final channel alignment by TCI for the system contained active traps tuned for channels M, A through I, mid-band tier trap, J, K, L, 6 and channel N dedicated to pay-per-view in the global command position. The Delta operation was a classic 12-channel system prior to the rebuild. Rebuilt to 400 MHz, the system included 19 channels and utilized Jerrold JSX 36-channel converters. Four premium services are available.

To maintain quality assurance, Pico's on-site support team was responsible for training the system personnel on OTAS installation. A complete operation manual was developed as a result of the hands-on experience.

Subscriber terminals then were placed in the field on strand, pole, bracket, pedestal and multiple dwelling unit (MDU) configurations. To date less than one-half of 1 percent of all the OTAS equipment has needed repair, all of which is guaranteed for one year from the date of installation.

OTAS terminals are powered from the subscribers home utilizing a calculator DC power supply. Hence, any illegal non-power passing splitters in the line will cause the current limiting choke to cease operating. This will cause that subscriber to lose power to the terminal

Double bracket for two OTAS terminals.



OTAS strand-mounted terminal being installed.

and basic service Delta has experienced a 200 percent increase in added outlets that have resulted from converted illegals

During installation, salesmen went to subscribers homes to sell premium services, explain the new addressable system and install converters, power supplies and diplexers. This was coordinated with outside crews installing terminals Consequently, a smooth

OTAS system overview

The Pico subscriber control system is a system for communicating with subscriber control terminals or multiple dwelling security cabinets and pre-assembled racks Each terminal serves up to four subscribers and can control eight levels of service OTAS controls as many as seven tiers of pay, plus basic service for each subscriber Each tier can be single or multiple channels, including entire bands

The subscriber terminals cabinets and racks are addressed with a combination of binary and trinary bits that allow for a maximum of 157 464 subscribers per system Subscribers are addressed by means of an FSK modulated 103 8 MHz carrier They are addressed at the rate of 10,000 to 16,000 per minute for continuously re-addressing subscriber terminals in a one-way CATV system and 16 000 subscribers per minute when interrogating a two-way CATV system This data is returned to the central computer location on a 24 3 MHz FSK carrier

System components

The security housing unit provides security against signal theft and weather resistance and RF shielding It contains an RF modulator demodulator, a 9-bit address decoder and a square wave generator It is the housing unit not the subscriber module, that is assigned an address by Pico The computer "blows" the address "fuses" on the housing unit and prints the housing unit serial number, which is the same number as the address This procedure allows the subscriber modules to be shipped unaddressed

Subscriber modules

A subscriber module consists of an address command decoder, an 8-bit addressable latch, a 9-bit data encoder, a pin diode switch driver and eight-pin diode switches Subscriber modules may be placed in either the security housing unit (for strand pole or pedestal mount), multiple dwelling unit rack mounts or multiple dwelling security cabinets. Each subscriber module has the capability of handling seven tiers of service and receives its address upon being plugged into one of the three types of housing units Thus, subscriber modules are interchangeable without changing address. No knowledge of

'The long-term economics utilizing (an) outdoor terminal addressable system vs. addressable converters . . . shows the OTAS advantage in reduced costs'

transition occured for both TCI personnel and the subscribers.

For the 1,601 subscribers, the following equipment was required:

Terminals	585
Double pole mounts	40
Single pole mounts	270
Strand brackets	470
Apartment boxes	12
Data controller	1
IBM PC XT	1

The data controller and IBM PC were placed

(Continued on page 62.)

binary or trinary addressing is required by the installer. Therefore, incorrect and/or duplicate addresses are avoided.

Active trap

The OTAS scramble is accomplished with small active traps (patent pending) used to scramble each of the seven tiers. Each active trap is a two-pole phase cancelling trap. One pole is tuned by voltage applied to a varactor diode. This square wave voltage causes the varactor-tuned pole to pass through the frequency to which the fixed pole is tuned. Each time this happens (47,118 times per second, slightly less than three times horizontal frequency), the active trap will attenuate the picture carrier by 70 dB. When the poles are not tuned to the same frequency, the picture carrier is attenuated by 22 dB.

The 48 dB difference in picture carrier level between the electronically tuned then de-tuned condition of the active trap, results in a 99.6 percent amplitude modulation of the picture carrier with the 47 kHz scramble signal. Interfering carrier and sync suppression scramble methods depend on the TV set to cause the scrambled picture. The OTAS scramble causes a permanent "overwrite" of the video intelligence and sync signal of the channel. Once part of the video modulation, the scramble can never be removed.

In addition to the amplitude modulation of the picture carrier, the active trap also phase modulates the picture carrier with 47 kHz. This modulation is caused by the rapid phase changes that the active trap undergoes when it is tuning and de-tuning. After intercarrier detection, the TV set sees this phase modulation as frequency modulation of the aural intercarrier signal. The 47 kHz audio is above audible range and cannot be heard, so the 47 kHz tone is broken up with a 47 kHz frequency divided by 32, 64, and 4,096; tones that can be heard in the TV audio output causing an aural scramble.

Data controller

This unit, located at the system headend, is a self-contained subscriber controller that operates independently of other computer equipment. It contains a metal oxide silicon (MOS) memory and battery backup. Its function is to continuously address the subscriber terminals with data that has been stored in its memory by the file system of the work station. Although the data controller is designed for high MTBF (mean time between failure), should it fail, the subscriber terminals will maintain their memory indefinitely, as long as they are powered from the subscriber's home.

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It's available now with a band width of 550 MHz and any amplifier spacing you're likely to need. And, with a return loss of 30 dB or better and very competitive pricing, you'll earn big dB/$, mile after mile.

(Continued from page 50.)

in the business office and connected by a dedicated return line from the office to the headend several miles away. The data controller utilizes FM frequency to send binary and trinary addressing information. This was located on 103.8188 MHz in the FM band. From the business office full subscriber control of the addressing was accomplished.

The consideration of equipment placement, coordination of personnel, marketing of new services and education of subscribers afforded TCI and Pico a valuable education during the off-premises rebuild.

Summary

The Delta system has been proofed by TCI's corporate engineers and analyzed by corporate financial personnel to establish the OTAS factor as it reduces theft, eliminates churn costs, reduces equipment inventory (cable-ready compatibility) and increases revenue with addressable PPV capability. Dave Willis has compiled TCI's systems' parameters in order to assess the OTAS effect on each system for potential installation based on theft churn, cable-ready sets, etc.

As the financial worksheet indicates, the long-term economics utilizing OTAS vs. addressable converters over a 10-year period shows the OTAS advantage in reduced costs and better cash flow, and overall better profitability.

Frank Galik, Delta's system manager, explains that OTAS already has resulted in fewer service calls, reduced churn and has allowed him to improve on manpower utilization for system maintenance.

In the off-premises arena, the Delta system has become a showcase with MSOs visiting the system for a hands-on review of an operating OTAS system. As a result, other MSOs have committed to pilot projects and tests that already have been installed, and future pending tests with both cable and SMATV operators.

Two multiple dwelling enclosures for 16 subscribers.

Reader Service Number 41.

Addressability yields better service, more security

By Philip R. Patterson
Vice President General Manager Suburban Cablevision

Upgrading from a non-addressable to an addressable system has allowed Suburban Cablevision, in East Orange, N.J., to satisfy its customer requests for additional pay services while reducing costs.

Suburban currently serves 171,000 subscribers, in 42 cities, with a 39-channel system. The seventh largest cable system in the United States, Suburban is a division of Maclean Hunter Cable Television Systems Inc., itself a subsidiary of Hunter Ltd. of Toronto.

Negative trapping

Prior to phasing in Oak Communications' Sigma One subscriber control equipment in the fall of 1984, Suburban relied on non-addressable equipment. To secure its signals, it depended on negative and positive trapping.

Through negative trapping, signal frequencies were secured from nonsubscribers at poles located outside subscribers' homes. Traps were installed at the tap on each pole. Trapping provided good security but Suburban had its share of nonpaying subscribers who manipulated the traps and hooked themselves up illegally. At least with negative trapping, each trap could be measured for a signal and illegal connections removed.

It was better than using descrambling devices in the home. With these, an operator must enter the residence to determine if a box has been defeated or if a pirate box is being used. Suburban's primary problem with negative trapping was that it was impractical to protect more than three pay services at a time. And having decided to add three more premium channels to its existing three, Suburban had to find an alternative to the non-addressable, negative trap system.

Search for a system

A management planning committee was formed to investigate alternative technologies. This committee included John Rawcliffe, construction/special projects manager; Frank Yennie, service manager; Rick Cluthe, data processing manager; Bill McKissock, business operations manager; Frank DeJoy, operations vice president; and myself.

About a year and a half was spent investigating and testing the options, including positive trapping, addressable RF and addressable baseband technologies. The committee visited manufacturers to evaluate their product, support and manufacturing processes. It also visited other operators' sites to evaluate the different technologies in actual working environments.

The Suburban team eliminated positive trapping and RF scrambling technologies for security reasons. "Positive trapping wasn't secure enough. All it does is inject an interfering carrier signal in the middle of the video signal. If a customer wants a service, you provide him with a decoder trap to remove that interfering carrier. Anyone can purchase a decoder or positive trap and it doesn't have to be tuned to the frequency assigned to that service," DeJoy said. Another problem with positive trapping is that it tends to degrade picture quality.

Similarly, the committee didn't believe RF scrambling technology was secure enough. "We knew that descramblers for this sync-suppression technique were available through various illegal sources. And in some states, it's not considered illegal to sell or purchase them. Because it's easy to get one of these descramblers, the technique is obsolete, in our opinion, as a means of good, long-term security," according to DeJoy.

Final testing

The committee's final decision was based upon a six-week field test of two baseband addressable systems. For the test, each manufacturer installed a central computer and encoders at the headend, while converter/decoders were placed in the homes of Suburban employees. The employees evaluated everything from subscriber features on remote control handsets to video and audio output quality on authorized and unauthorized channels. Meanwhile, Suburban's engineers and technicians studied the scrambling techniques used on each.

The Sigma system was chosen because of its high signal security. As well, it completely removed the audio without degrading picture quality on authorized channels. This was a big plus because Suburban was planning to offer the Playboy Channel and, in addition to the video, wanted to eliminate the audio output to unauthorized subscribers.

The system secures the cable signal in three ways: digitizing and encrypting the audio portion of the programming, applying advanced baseband scrambling to the video, and then encrypting the video commands. Also, Sigma's encryption/decryption keys can be changed as frequently as once per second in real time. This means that breaking the code and signal before they change is nearly impossible.

Controlling theft of service

The installation of Sigma One addressable converter/decoders began on a town-by-town basis last November.

The system control and security commands are downloaded from the minicomputer at the headend, therefore, as more boxes are placed out in the field, this feature will cut losses due to piracy, which were thought to be about 10 per-

Suburban's computer room features an Oak Communication's control computer used as backup for Sigma One equipment and for accounting purposes.

cent for pay services and 1.5 percent for basic services while operating with non-addressable equipment.

And that's for someone like Suburban, which audits approximately 20,000 homes per year. The 10 percent may not seem like much, but when you realize the magnitude of Suburban's subscription base and figure that 10 percent of them are receiving at least one pay service without charge, each costing about $12 per month, the total comes to nearly $2 million in stolen services annually. Cable operators not auditing their systems will experience significant revenue losses due to theft of service.

Suburban's new capabilities

This same ability to download programming information from the headend eliminates having to send a technician to a subscriber's home to modify a decoder if a subscriber decides to change the programming mix. As well, if a subscriber doesn't pay, service can be disconnected remotely.

Oak facilitated this process by interfacing the billing system, which runs on Tandem business computers, through an IBM Series 1 computer running Oak's proprietary IAS software. This allows the Tandems to drive the converters so that when bills aren't paid, the converters are automatically shut down.

Another feature that is curbing unnecessary service calls is Sigma's self-diagnostic function. When a subscriber reports a problem with a box, he is asked to read a code on the box and then is given a few simple instructions to solve it. Often, the problem can be corrected over the phone.

As more Sigma boxes are placed in homes, Suburban will offer pay-per-view movies. As a

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Reader Service Number 42.

Bob Ritchie, manager of engineering services, adjusts the Sigma One addressable system.

revenue generator. PPV hopefully will offset some of the reductions in pay penetration that many operators are seeing today.

While many operators claim that videocassette rentals are swaying subscribers away from pay services, Suburban sees the VCR business as a potential partner to PPV. In fact, a person who owns a VCR is inclined to have more, not fewer, pay services. What is contributing to the erosion of the pay services market is cable operators trying to make it difficult for subscribers to use their VCRs with pay services.

Suburban used to have a monthly charge for a cable-connected VCR, but found that most people were stealing the service because they didn't understand why they had to pay for the connection. Recently, Suburban decided not to charge a VCR fee except for the initial installation. We want to encourage people to come to us and have the connection done right.

Marketing the services

Suburban is marketing its new services based on the "core packaging" concept in an effort to keep customers from changing their services too often. In addition to the various tiers of programming available, each package includes Sigma's remote control handset with volume control, parental control lock, variable-rate scanning, last channel recall and favorite channel memory (any of which can be offered separately).

Suburban is launching these new services on a hub site-by-hub site basis. Each hub, of course, serves several communities. If Suburban launched the new pay services and replaced all non-addressable boxes at once, it would have been inundated with calls.

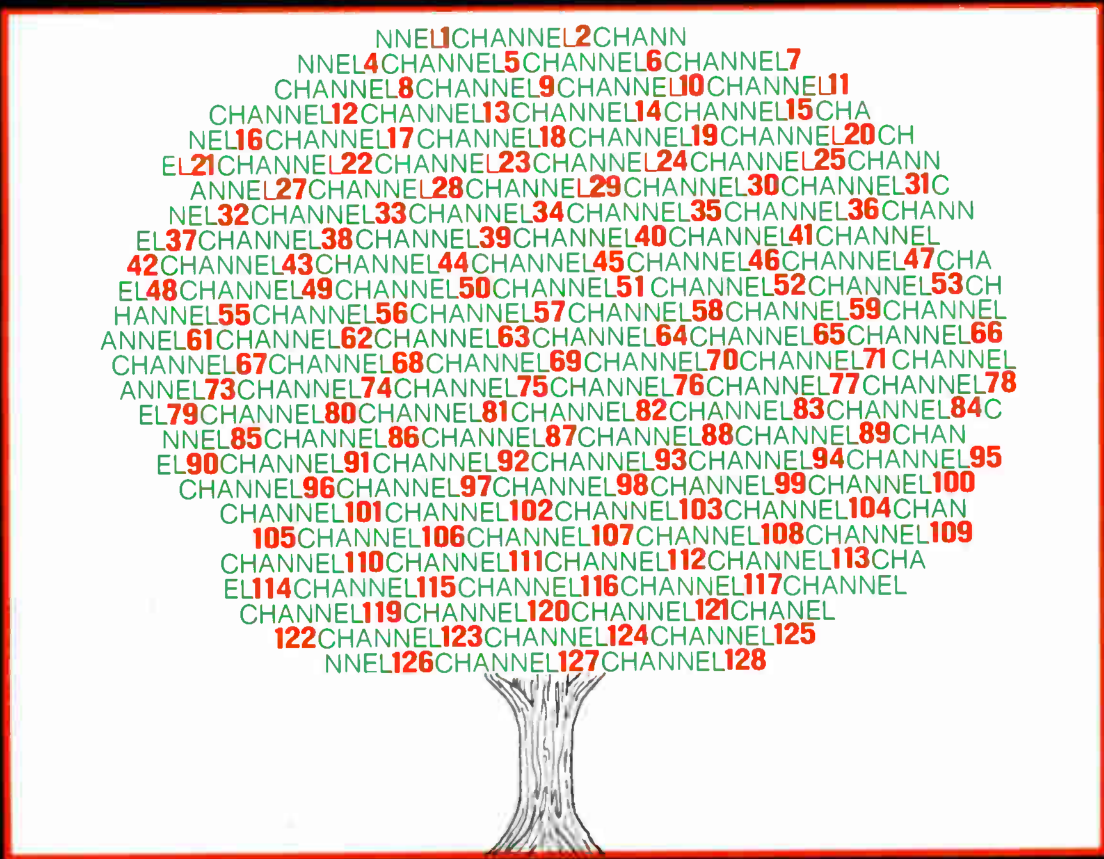
Subscribers are pleased with the new choices, and they're particularly happy with the remote control handset. The handset's volume control has been a big hit. And from Suburban's point of view, Sigma's performance has been outstanding. There has been a very low failure rate and, consequently, fewer service calls. Also, Oak has been cooperative and responsive to all of Suburban's needs.

Future goals

Utilizing addressablity no doubt will contribute to Suburban's successful growth. The company has always prided itself as being among the best cable systems around in terms of providing the subscribers with alternative programming choices. The Sigma system allows Suburban to do just that, while boosting the subscriber base. And costs are reduced through less truck roll, fewer service calls and tighter security measures.

With new pay services to spur growth, Suburban expects to expand at a net rate of about 1,000 subscribers per month in the foreseeable future. In fact, I expect that in five years, Suburban will have grown to a 225,000-subscriber system.

128 ways to Cherry-Pick



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Reader Service Number 44.

Addressing future needs

By Wayne Robson
General Manager Wayne Cablevision

System franchising is coming to an end, and what is possible is slowly being replaced by what is practical. Systems that survived construction without being sacrificed on the altar of high technology are now in a position to analyze their real needs and make some practical decisions. Most importantly, decisions concerning technical purchases now can be made after evaluating products in the field instead of evaluating products on the drawing board.

At Wayne Cablevision, we have used the past year to determine how recent advancements in technology can support our marketing efforts.

History

Wayne Cablevision has been in operation in suburban Detroit since late 1980. It originally offered three premium services, secured using negative traps. As specialty services appeared, we became interested in expanding our premium channels. Our problem was security. Expanding to four trapped services was impractical because of the number of traps required to cover all the possible service combinations. Indeed this possibility had been discounted earlier when we had added a fourth service using a programmable converter. Expanding this programmable security, however, also was unsatisfactory. RF sync suppression does not afford adequate security, especially when considering the long-term capital commitment made when choosing a security system.

Our final decision was to invest in a technology advanced enough that we could spend several years growing into the product without facing obsolescence. New premium services would be launched using a new addressable converter, while our existing trapped system and associated services would remain in place. Our decoding converters, in very limited use on one service, would be changed over to the new system. The only element missing from our hybrid system would be the euphoria to total addressability.

We started evaluating addressable systems based on these requirements:

- Scrambling techniques sufficiently advanced to provide reliable long-term security
- Software capable of interfacing to business systems.
- A product with a track record for being compatible with past and future generations.
- User features, to encourage customer acceptance and generate revenue.
- Audio scrambling to protect subscribers from unwanted audio on R-rated channels and also eliminate access to audio on pay sports broadcasts.

After an extensive evaluation involving our sister company Suburban Cablevision, the decision was made to use the Sigma One (by Oak Industries), and we arranged a joint purchase for both systems. The Sigma system delivers encrypted video scrambling, encrypted audio, full feature hand remote and a software package that is complete and well researched.

We launched Sigma in October 1984, and after four months we have 6,000 boxes in operation with no major problems. Our satisfaction with the product has been enhanced by a less than 1 percent failure rate.

Addressable advantages

The ability to change a subscriber's status without leaving the office is the obvious advantage of addressability. From an operations standpoint, however, that is only the beginning.

Our Sigma system was installed with a business computer interface that saves the labor of double entry into both control and business systems and eliminates errors that often occur when entering data twice.

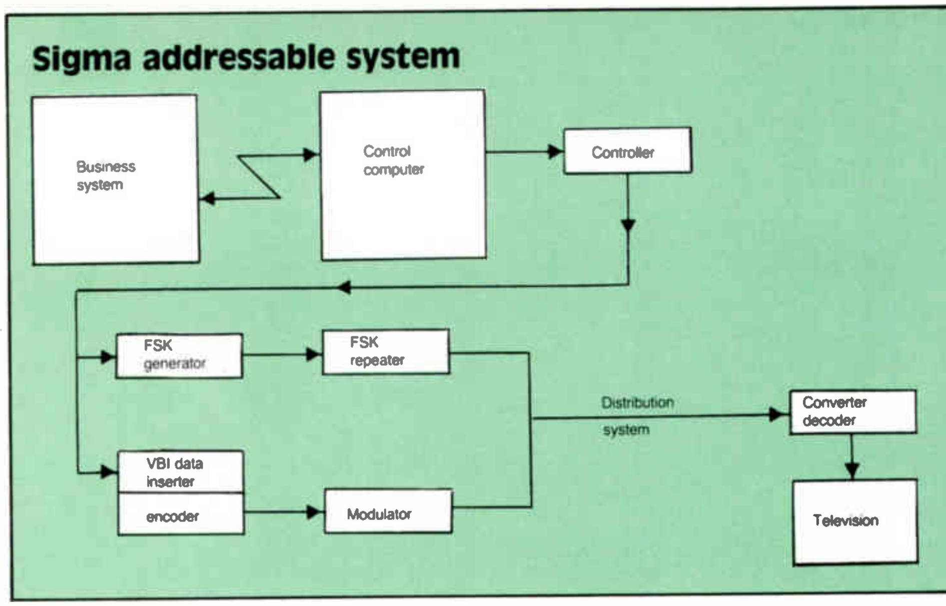
Sigma is capable of controlling 84 authorization levels. All levels and parameters are downloaded from the control computer.

Converters do not have to be opened or programmed prior to installations. A computer disk accompanies each shipment and is used to enter converter serial numbers and addresses

into the control system. Installation then, is as easy as entering the serial number into the customer's account and authorizing the appropriate service levels.

All hand remote features (including the activation of the remote itself) are downloaded from the control computer. This feature has proven valuable in helping us market the converter and remote as an individual part of a customer's service.

Several different conditions causing loss of service (loss of authorization, loss of data, etc.) can be diagnosed by codes displayed on the LED channel indicator. Many common problems therefore, can be solved over the phone or corrected from the headend.



Sigma addressable system

Security and dependability

Baseband scrambling completely eliminates both vertical and horizontal sync. The remaining video information is then randomly inverted by scene change. Recreation of this scrambled picture is difficult because decoder timing must be matched precisely to the encoded random inversion.

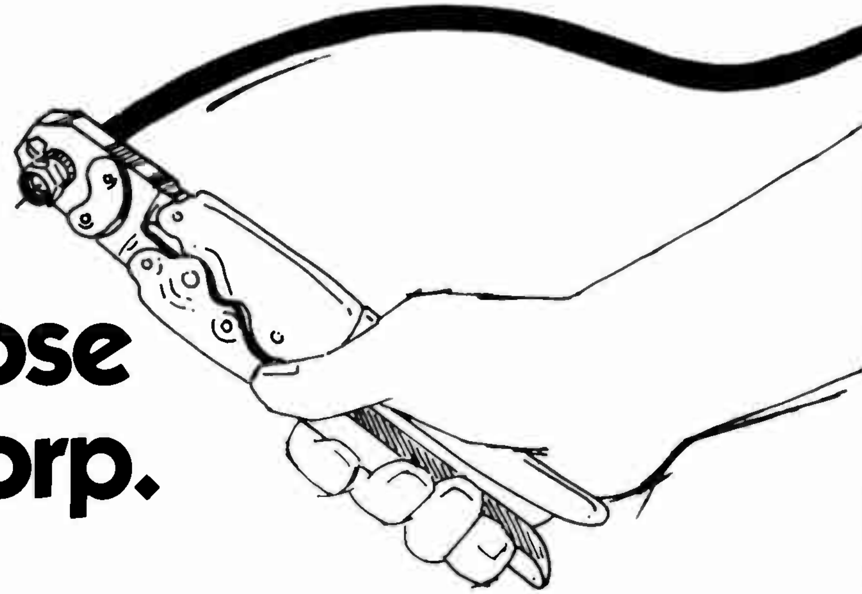
This approach to baseband scrambling is fairly standard. Sigma however, takes security another step. Descrambling information (vertical blanking interval data) is sent to the converter, digitized, encrypted and buried in the unused portion of the picture formerly occupied by the vertical sync.

In order to decrypt this data, each converter must be authorized and informed of the encryption parameters by the headend. The authentication information is delivered on the frequency shift keying (FSK) control channel, at 104.75 or 112.7 MHz. The control channel communicates information to both encoders and decoders. Control information must match the VBI data, creating a lock that prevents the decoder from being defeated by feeding it false information.

A second level of security is added by encrypting the digitized audio on scrambled channels. Because the actual audio information is encrypted, it is virtually impossible to defeat.

A major benefit of Sigma addressability is the reliability built into the computer control system. The control computer feeds an FSK generator that actually addresses the system. The FSK generator is backed up by an FSK repeater that will keep the system operating if either the computer or the generator should fail. Additional protection against outages is provided by the nonvolatile memory in each converter.

We at Wayne Cablevision have embarked on a technology that will allow us to invest our growth capital in a product that will serve us throughout the foreseeable future. Also, the level of security that has been implemented will affect premium revenues throughout the life of our franchise. If we wish to prevent the slow infection of our subscriber base, by illegals, we must be committed to security.



Power distribution in expanded frequency systems

By Thomas Polis
Executive Vice President
Communications Construction Division, RT/Katek

The purpose of this evaluation was to determine the effects of selective channel loading on the distribution of amplitude related disturbances in wideband CATV distribution systems.

It was thought that since a typical system will carry FM signals for both audio and data services, as well as the NTSC video envelope spectrum, frequency selection for these services could yield an overall performance improvement. The expected improvement would be in terms of real performance, thus would be additive to any subjective improvements given by the use of HRC or IRC techniques.

Since the two major limiting factors to state-of-the-art expanded band systems are carrier-to-noise (C/N) and third order composite beats, these parameters were selected for the evaluation.

Scope

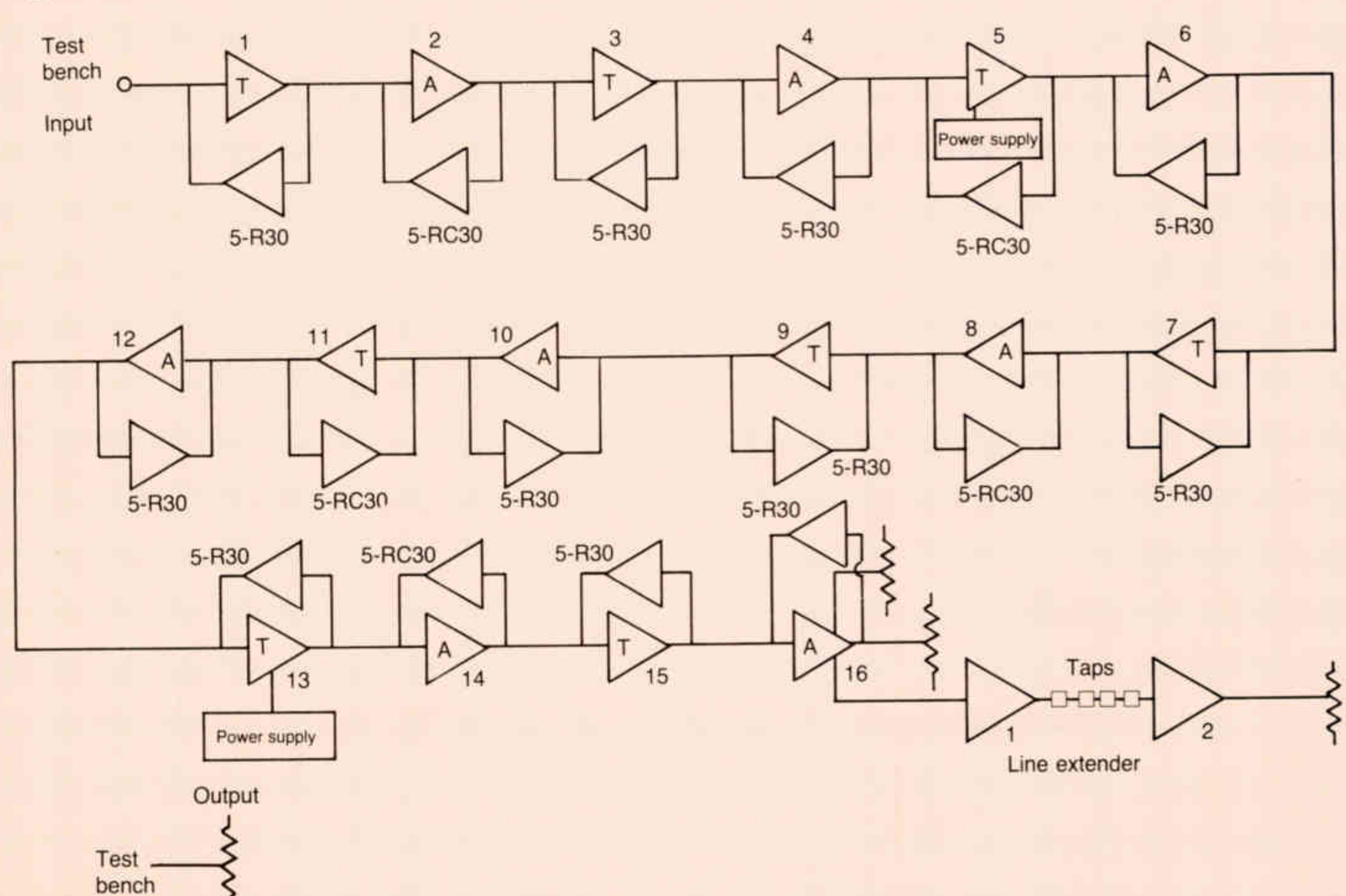
The scope of the evaluation was to simulate an actual cascade of trunk, bridger and line extender amplifiers under normal but controlled conditions and then measure, on a closed loop basis, the noise and composite beat parameters under various channel carrier loadings. By using 31 measurements across the entire passband, a graph could be developed to show the distribution curve of the composite beat parameter. By using the fully loaded passband as the starting point, the resultant graphs could be superimposed for direct comparison.

As a starting point for channel selection, consideration was given to those frequency bands most susceptible to deletion under §76.610 of the FCC rules, with the thinking that it might be possible to solve two problems at the same time.

The tests

The tests were conducted at the Magnavox CATV Systems Inc. Technical Services Facility, in Manlius, N.Y. Although temperature

Figure 1: Block diagram of Magna 440 cascade (using Mobile Training Center chamber)



If you've had to bear the expense of replacing your entire mainstation every time you needed to add new features, that's too bad.

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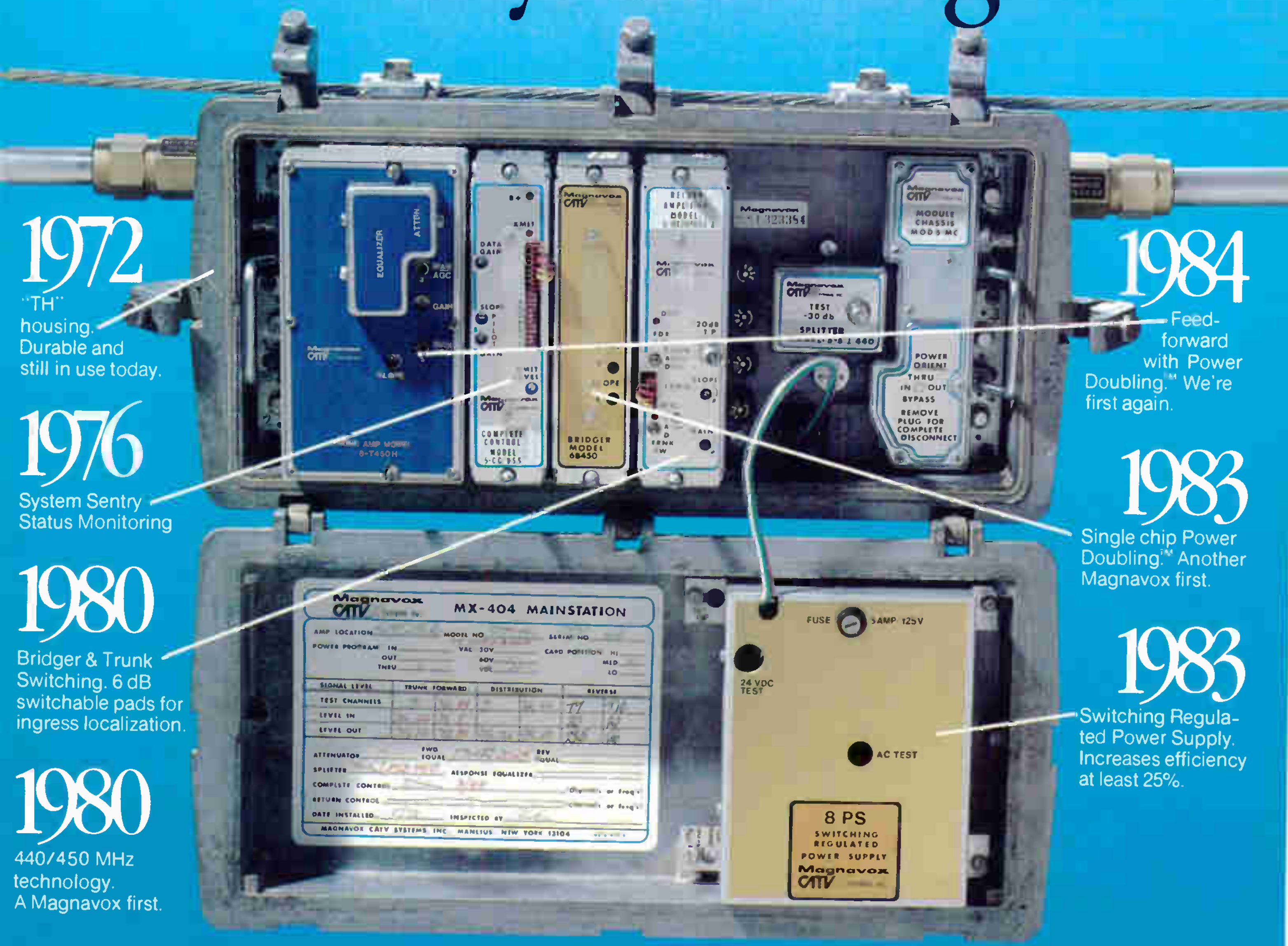

See us at our Mobile Training Center.

Reader Service Number 49.

was not a consideration of this evaluation, the thermal chamber was used as it best simulated an operational system and both ends of the cascade could be reached for closed loop testing.

The cascade consisted of 16 Magnavox 5-MTCB and 5-MTB trunk amplifiers, with the output of the bridger in amplifier station #16 feeding two 5-LE-440 line extenders in cascade configuration (see Figure 1).

The trunk spacing was 22 dB at 440 MHz. The line extenders were spaced at about 16 dB of cable loss at 440 MHz, with 11 dB of flat passive loss to yield a total of 27 dB.

A TRS-80 program was used to select the optimum operating levels to yield the desired composite beat and noise floor reference levels.

The cascade was set up to these levels and the gain vs. frequency response was optimized for normal operation. At the conclusion of this procedure reference data was taken for future comparison.

One of the major problems with the type of detailed testing that is involved in this type of evaluation is the possibility of human error, both in the actual data taking and the documentation. To eliminate this factor and assure that the results were reliable, an automated data acquisition system was used.

The test system consisted of an HP 9835A desktop computer driving both an HP 8568A spectrum analyzer (85662A display and IF section and 85680A RF section) and the matrix signal substitution and measurement equipment. The resident program in the HP 9835A was such that the desired channel blocks could be dropped and the data points remeasured.

The output results were directed to a plotter and a 180 CPS printer. The total system was capable of level measurements, CTB measurements and C/N measurements, with an accuracy of ±.01 dB.

Test methods

The composite triple beat (CTB) measurements were taken using the "noise-in-slot" method of spectrum analysis. Unmodulated carriers at standard frequency assignments were used. Bandpass filters were used to prevent analyzer overload and ensure accuracy of the results.

The ratio of CTB-to-carriers was a direct comparison of peak interference-to-peak carrier. The program iterated a number of points to assure peak-to-peak measurements were achieved.

Analyzer settings were programmed as follows:

Resolution bandwidth	30 kHz
Span width	2 MHz
Attenuation	0 dB
Sweep time	1.5 seconds
Video bandwidth	100 Hz

A post amplifier was used after the bandpass filter to assure that the level of measurements were sufficiently above the noise floor of the analyzer so that the contribution of the test equipment was negligible. A reference of the noise floor was taken prior to each test to assure the required ratio.

The C/N measurements were taken in much the same way as the CTB. The major differences were in the analyzer settings and the fact that the measurement point of the noise level was offset by 25 KC to ensure that the CTB peak was not the point of reference.

The analyzer settings were as follows:

Resolution bandwidth	100 kHz
Span width	5 MHz
Attenuation	0 dB
Sweep time	1.5 seconds
Video bandwidth	100 Hz

Based on the effective bandwidth setting of 100 kHz (120 kHz shape factor) and the log averaging correction factor of +2.5 dB, a total correction of 17.7 dB was made to each reading.

A reference analyzer noise floor was taken before each test to determine additional correction factors for noise-in-noise measurements. Since a post amplifier was used, only minimal corrections were required (i.e., less than 1 dB).

Data points

All data collected was at the output of the last active device in the system. Thirty-one channels were measured for each parameter at each channel load configuration.

6	K	U	OO
A	M	W	PP
E	O	BB	RR
I	P	DD	UU
7	Q	EE	WW
9	R	KK	LL
11	S	MM	C
13	U	NN	

Magnavox Mobile Training Center demonstration

Standard operating levels for environmental chamber specifications

Desired channels	58
Trunk spacing	22 dB
Maximum bridger gain	37 dB
Maximum line extender gain	27 dB
Estimated trunk cascade	16
Maximum line extender cascade	2
Temperature	68°F
Desired cross-mod	–51 dB
Desired noise	–44 dB
Desired second order	–65 dB
Desired third order	–65 dB
Desired composite beat	–51 dB

Optimum operating levels (dB)

Item	Trunk	Bridger	Extender
Input	9 dBmV	15.5 dBmV	15 dBmV
Gain	22 dB	29.5 dB	27 dB
Output	31 dBmV	45 dBmV	42 dBmV

Operating block slope = 6 dB
AGC/ASC located every two trunk stations
AGC line extenders located every 0 station

System performance (dB)

Item	Trunk	Bridger	System
Noise	–44.96	–44.92	–44.78
Cross-mod	–64.55	–58.77	–55.32
Composite beat	–58.05	–53.8	–50.95
Second order	–74.96	–71.45	–68.7
Third order	–82.92	–77.88	–74.71

Distortion at 68°F.

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Maybe you've seen our competition boiling our cable. Or chopping it up. Or crushing it with a 2000-ton truck. Or doing something else outrageous with it. We agree, it makes a great demonstration. But it doesn't prove a thing about MC² Coaxial Cable. Because these aren't real-world situations.

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Honestly, we don't know of a single real-world test that MC² couldn't handle. To prove it, we invite seriously interested persons to tour our test facilities. Just call toll free 1-800-526-4385. No other cable outperforms MC² in the environment that counts most....the real world. That's a promise.

Not one complaint in one year.

Reader Service Number 51.

See us at the Cable-Tec Expo booth number 300

General Cable Company CATV DIVISION

A Unit of The Penn Central Corporation

- Test 1 represented the reference point of 58-channel loading.
- Test 2 deleted only the top six channels of the 400 to 440 MHz system.
- Test 3 deleted only channels A to F in the low-band frequencies.
- Test 4 deleted only channels N to S in the low super-band frequencies.
- Test 5 deleted only channels KK to PP in the hyper-band frequencies.

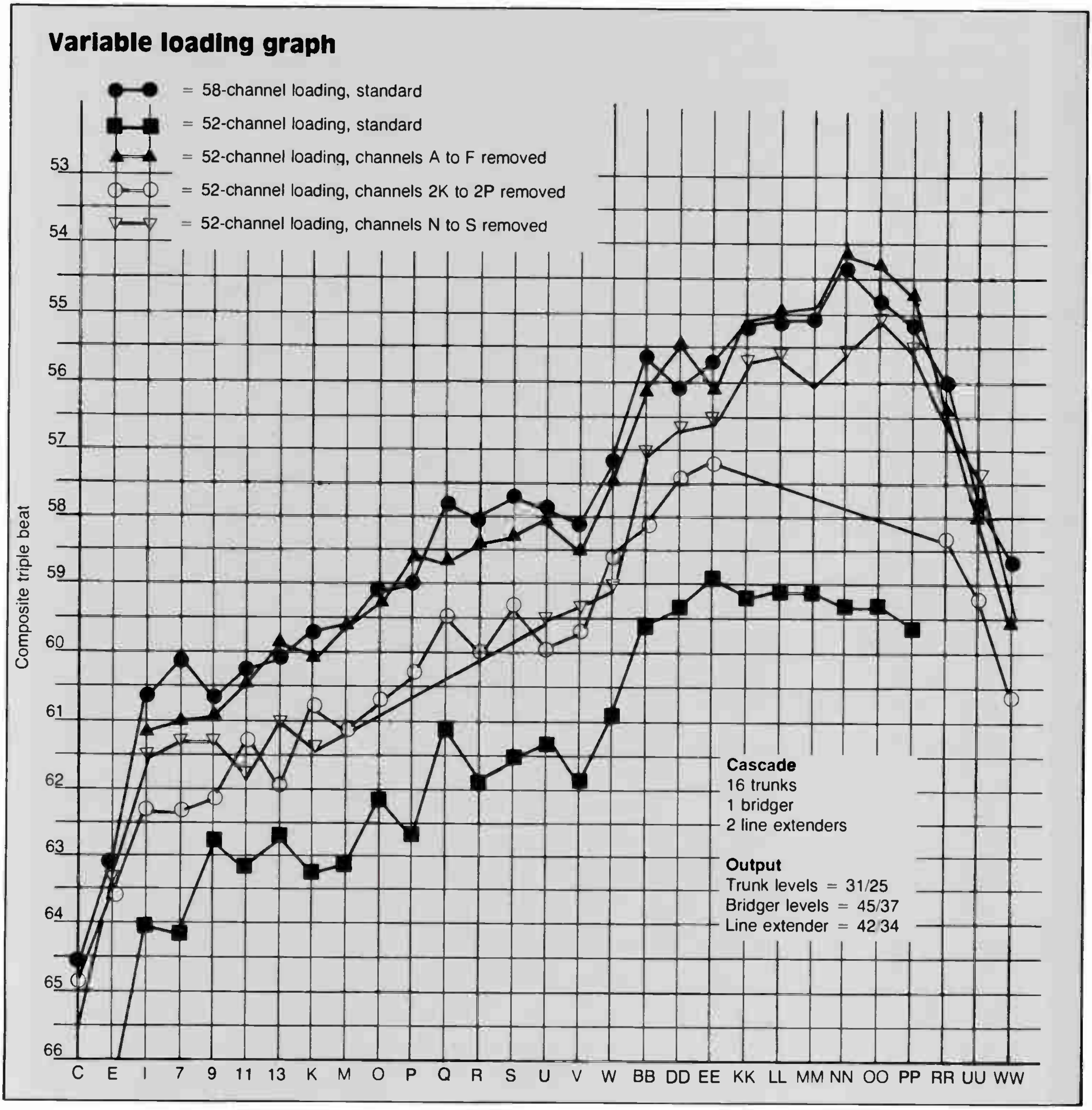
The results of each test were plotted on a linear X, Y graph to display each test for comparison.

These tests were conducted to enhance our understanding of the nature of composite triple beat in CATV systems and to allow us to selectively use the available frequency spectrum to the best advantage for all services to be provided.

The tests also have confirmed the previously made mathematical models presented by TRW and Motorola. It confirms that the IC CTB performance vs. frequency and the nature of the beat (i.e., A + B-C or 2A ± B) as well as the number of beats per channel have major implications on the power distribution of the beats.

Based on these findings, the following plan has been established.

1) Extend the maximum cascade from 16 amplifiers to 20 amplifiers, which will minimize the number of hubs required in a major build.
2) Use an IRC channelization plan that will be closer to normal FCC channelization of off-air signals.
3) Relocate the FM band from 88-108 MHz to 400-420 MHz. This will create the need for a block converter at the FM subscriber terminal, but based on current saturation the cost will be minimal.
4) Load in additional channels in the now available slot between 4 and 5 and in the FM band to the channel A band edge. The



tests have shown that channels in this frequency spectrum do not have a meaningful impact on the overall beat power distribution.

5) Carry all pay channels in the lower frequencies to take advantage of this available "best performance" location, thereby helping to off-set scrambling degradations.
6) Use 420 to 440 MHz as data channels to extend limited institutional services beyond the normal institutional trunk areas. By interweaving these data channels with the residual CTB bundle, the levels can be lowered without sacrifice to the bit error rate and minimal impact will be felt in the beat power distribution.

Since the C/N parameter remained flat throughout our testing, we can assume no additional problems in this area. In fact, the C/N of the total system was somewhat better than calculated.

Previously made subjective testing has shown that certain picture scenes will be more susceptible to the effects of third order distortion. Low average picture levels such as dark scenes (average modulation of 50 percent) will display the worst case distortion effects. Saturated backgrounds, such as those found in the automated channels, yield the least effect.

It would follow then that the automated channels should be placed in the frequency bands with the highest levels of CTB and the entertainment channels should be placed in the least effected frequency bands.

Detailed test equipment list

Quantity	Description
1	Desktop computer with CRT; 50k bytes R/W memory and tape drive.
1	Option 110: I/O system consists of 98332A Gen I/O ROM; 98339A assembly development and execution ROM; 128k R/W memory.
1	98337B: graphics plotter ROM for 9835A/B.
1	98331B: mass storage ROM for the 9835A/B.
2	98034B (Option 4): HPIB interface card for 9825/35/45 desktop computers.
2	Option 335: use with 9835.
1	2631B: 180 CPS printer; EIA RS-232C I/F with 103 modem control; includes modem cable; pedestal not included. See 26097A for pedestal.
1	Option 835: for use with 9835A/B. Includes option 4. 98034A cable must be ordered from DCD.
1	9872T: graphic plotter; HP-IB interface; 8 pen stables; HP-GL instruction set; automatic paper advance; 11x17 inch or A4 chart size.
1	Option 45: used with 9845 desktop.
1	9895A: dual drive master disk; must be ordered with interface option. Must also order option 1 if 50 Hz is needed.
1	Option 35: the 98034 HPIB interface card and 9835 mass storage ROM for the computer needs to be ordered separately if required. This option also includes flexible disk utility software for the 9835.
5	10631A: HP-1B cable; 1 meter.
2	10631B: HP-IB cable; 2 meters.
1	8568A: high performance bench and HP-IB system spectrum analyzer; 100 Hz to 1500 MHz; consists of one each 85662A display IF section and 85680A RF section.
1	Option 1: 75 ohm input impedance RF input #1.
1	3497A: data acquisition/control unit includes real time clock; front panel display and keyboard; HP-IB interface. Cardcage can hold DVM and up to 5 plug-in assemblies.
1	Option 1: 5½ digit DVM and I source; DVM is fully programmable and has 1 microvolt sensitivity. Makes four terminal resistance measurements using the current source.
1	Option 20: relay multiplexer with thermocouple compensation; software compensation for any thermocouple or hardware compensation for B:E:J:K: R:S or T thermocouple.
2	Option 110: 16-channel actuator/digital output assembly; switches higher current signals and can be used as digital output.

Distortion measurements: Output of the second line extender

Temperatures: TP #1 = 73.62, TP #2 = 76.63, TP #3 = 73.89

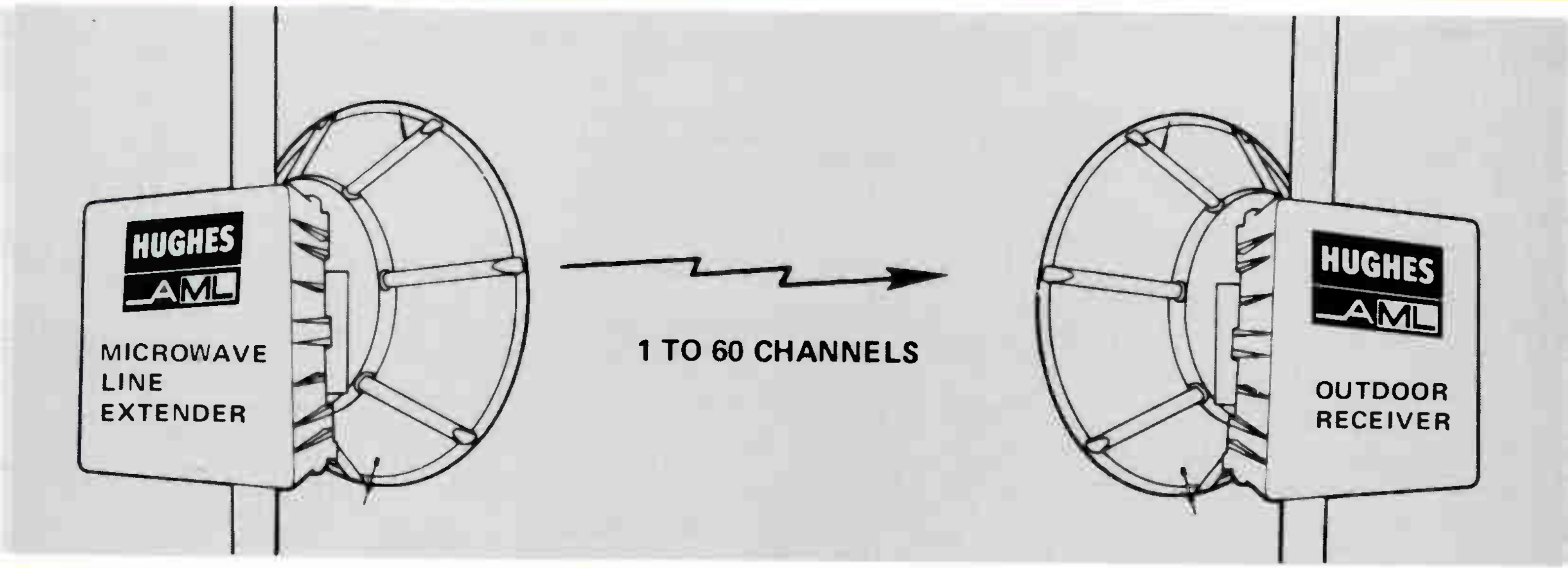
Channel	CTB	C/N
6	–68.60	47.30
I	–60.60	48.40
13	–60.10	48.20
P	–59.00	46.90
U	–57.90	47.40
DD	–56.10	47.40
MM	–55.10	45.90
RR	–56.00	46.40
A	–66.50	48.10
7	–60.20	48.80
K	–59.70	49.30
Q	–57.80	46.70
V	–58.10	48.10
EE	–55.70	47.70
NN	–54.30	46.20
UU	–57.80	48.50

Channel	CTB	C/N
C	–64.60	50.30
9	–60.70	48.40
M	–59.60	49.80
R	–58.00	53.00
W	–57.20	47.00
KK	–55.20	46.90
OO	–54.80	45.10
WW	–59.20	47.80
E	–63.20	47.80
11	–60.30	49.30
O	–59.20	47.60
S	–57.70	47.40
BB	–55.60	47.30
LL	–55.10	47.00
PP	–55.20	47.60

Temperatures: TP #1 = 73.89, TP #2 = 77.17, TP #3 = 74.38

Channel	CTB	C/N
6	–68.80	47.50
I	–64.10	48.00
13	–62.70	48.10
P	–62.70	46.90
U	–61.30	47.30
DD	–59.30	47.30

Our new low cost microwave line extender can extend your service and your profits



The new Hughes AML® line extender can solve a lot of problems which may be costing you money. Problems with natural barriers. Problems with long amplifier cascades. Problems serving small pockets of potential subscribers. Our microwave line extender can make it easy and economically attractive to offer cable services where cable can't go.

These new line extenders are multichannel transmitters which block upconvert one to 60 channels. They accept combined VHF input in the 54 to 440 MHz range directly from your cable. They allow you to reach new subscribers that have previously been uneconomical to serve.

Not only can they offer new services, they can protect your existing services during planned and unplanned interruptions. Our microwave line extender makes an excellent, frequency-agile hot standby. The Hughes AML line extender is cable powered, can be mounted indoors or out, and has a temperature regulated enclosure for extra stability and reliability. It shares spares and service techniques with all AML transmitters and is compatible with all Hughes AML receivers.

For more information write **Hughes Microwave Communications Products,** Bldg. 245, P.O. Box 2940, Torrance, CA 90509-2940, or call toll-free **(800) 227-7359.** In California (213) 517-6233.

Hughes AML® Microwave Systems

AML—ANY MODULATION LINK

See us at the Cable-Tec Expo booth number 737

Reader Service Number 52.

HUGHES
AIRCRAFT COMPANY

MM	–59.10	46.40
RR	.20	–12.00
A	–67.90	48.40
7	–64.20	49.20
K	–63.30	48.50
Q	–61.20	47.20
V	–61.80	47.50
EE	–58.90	47.10
NN	–59.30	46.00
UU	–.40	–12.30

Channel	CTB	C/N
C	–67.30	49.90
9	–62.80	48.70
M	–63.10	50.20
R	–61.90	52.90
W	–60.90	46.70
KK	–59.20	46.90
OO	–59.30	45.50
WW	.60	–14.80
E	–66.60	48.10
11	–63.20	49.10
O	–62.20	47.00
S	–61.50	47.10
BB	–59.60	47.70
LL	–59.10	46.90
PP	–59.60	47.80

Temperatures: TP #1 = 74.63, TP #2 = 77.55, TP #3 = 74.94

Channel	CTB	C/N
6	–68.40	47.20
I	–61.20	48.00
13	–59.80	48.20
P	–58.60	46.90
U	–58.00	47.20
DD	–55.40	47.60
MM	–54.90	46.30
RR	–56.40	46.50
A	–.10	–15.40
7	–61.00	48.90
K	–60.10	49.00
Q	–58.70	47.00
V	–58.50	47.50
EE	–56.10	47.30
NN	–54.20	46.20
UU	–57.90	48.60

Channel	CTB	C/N
C	.30	–12.70
9	–60.90	48.90
M	–59.60	50.30
R	–58.40	52.80
W	–57.40	46.70
KK	–55.10	46.80
OO	–54.30	44.90
WW	–59.50	47.70
E	.30	–13.10
11	–60.40	49.50
O	–59.30	47.10
S	–58.30	47.70
BB	–56.10	47.40
LL	–55.00	46.70
PP	–54.70	47.70

Temperatures: TP #1 = 74.08, TP #2 = 77.80, TP #3 = 74.79

Channel	CTB	C/N
6	–68.50	47.40
I	–62.30	47.90
13	–61.90	48.30
P	–60.30	46.90
U	–59.90	47.50
DD	–57.40	47.70
MM	.20	–10.30
RR	–58.30	46.30
A	–66.30	48.10
7	–62.30	48.70
K	–60.80	49.00
Q	–59.50	46.90
V	–59.70	47.80
EE	–57.20	47.50
NN	–.70	–9.60
UU	–59.20	48.60

Channel	CTB	C/N
C	–64.80	50.10
9	–62.10	48.50
M	–61.10	49.80
R	–60.00	53.20
W	–58.60	47.10
KK	–.80	–9.20
OO	–.80	–11.00
WW	–60.60	47.70
E	–63.60	47.80
11	–61.30	49.30
O	–60.70	47.40
S	–59.30	47.50
BB	–58.10	47.60
LL	0.00	–8.80
PP	–.30	–7.50

Correction factors for measuring problems

1) Noise power reading correction factors

100 KHz BW IF for HP-8554L

- Shape factor yields 120 kHz effective BW

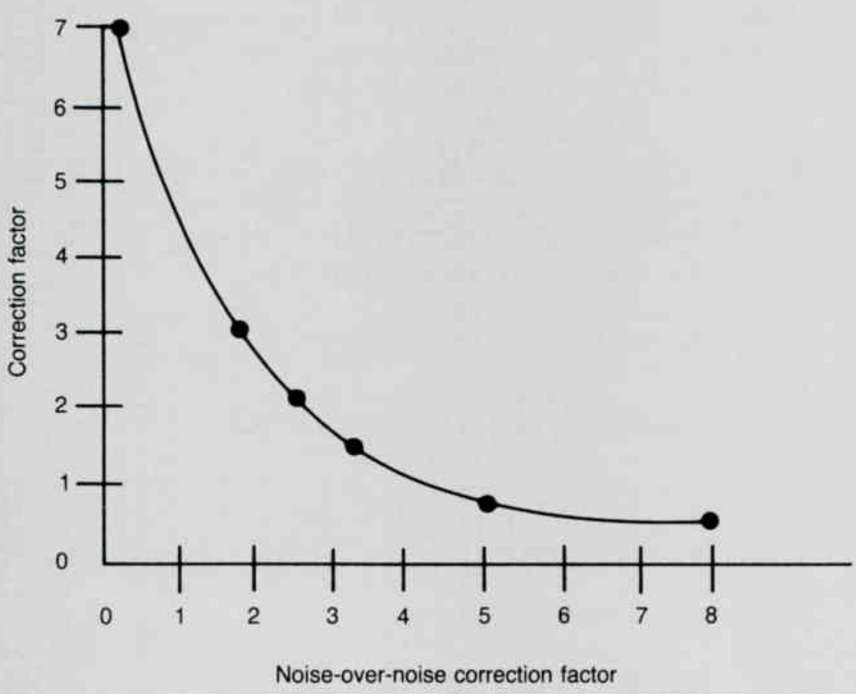
$$\text{BW Ratio} = \frac{4\text{ MHz}}{.12\text{ MHz}} = 33.3 = +15.2\text{ dB}$$

- Log averaging correction factor = +2.5 dB

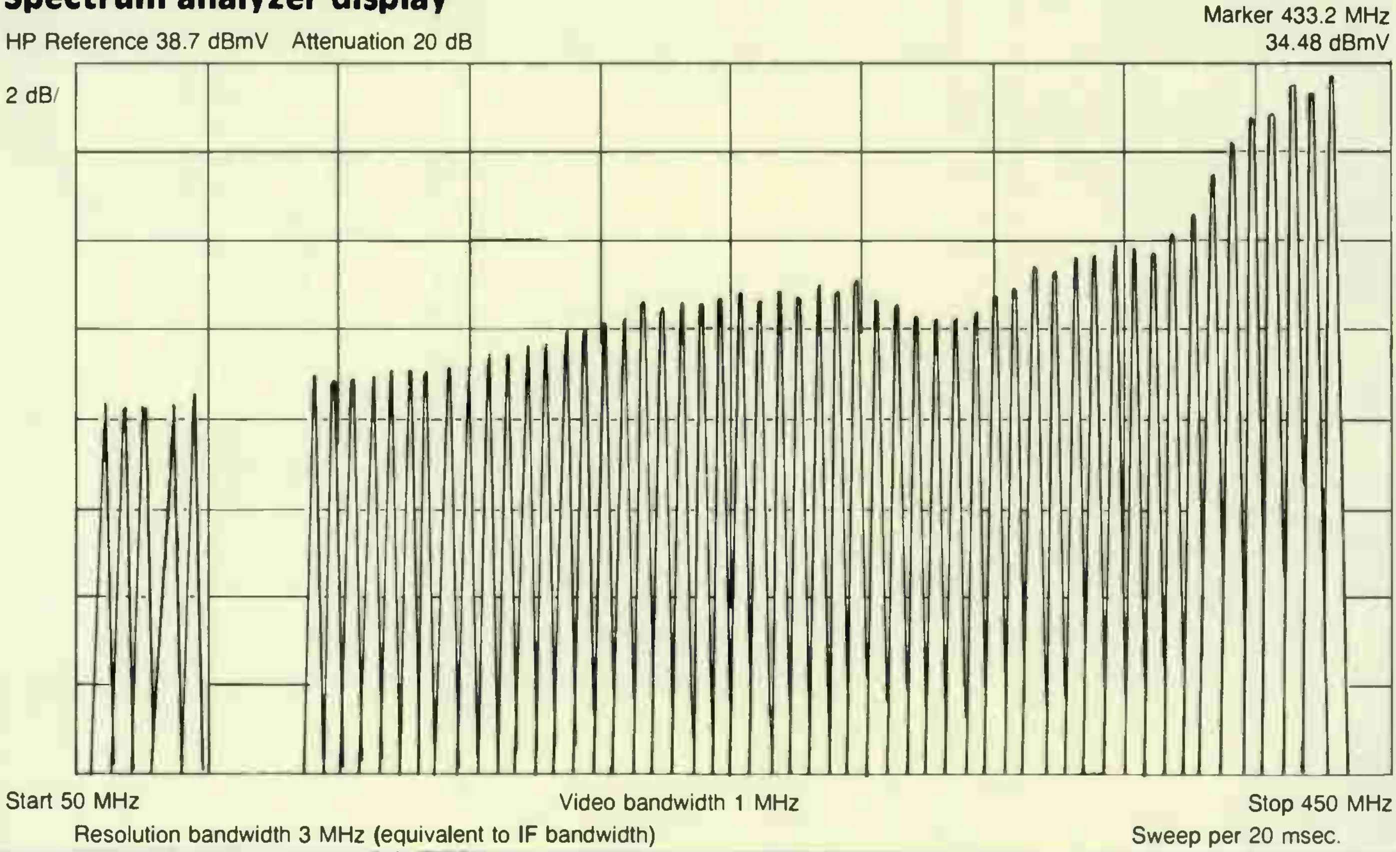
For noise power in 4 MHz band, add 17.7 dB to log averaged reading in 100 kHz scale.

2) Noise measured in noise

Difference	Correction factor
1 dB	3.0
2 dB	2.0
3 dB	1.0
5 dB	.5
8 dB	—



Spectrum analyzer display



Temperatures: TP #1 = 75.02, TP #2 = 78.03, TP #3 = 75.02

Channel	CTB	C/N
6	–68.60	47.60
I	–61.50	48.10
13	–61.00	47.80
P	–.30	–11.70
U	–59.50	47.10
DD	–56.70	47.60
MM	–56.00	46.50
RR	–56.50	46.20
A	–66.80	48.50
7	–61.30	49.40
K	–61.40	49.20
Q	.40	–11.20
V	–59.40	47.70
EE	–56.60	47.50
NN	–55.50	46.30
UU	–57.40	48.40

Channel	CTB	C/N
C	–65.50	50.20
9	–61.30	48.70
M	–61.20	50.00
R	.10	–4.80
W	–59.00	46.80
KK	–55.70	47.00
OO	–55.10	45.20
WW	–59.50	47.80
E	–63.40	48.10
11	–61.80	49.30
O	.20	–11.60
S	0.00	–10.40
BB	–57.10	47.40
LL	–55.60	46.90
PP	–55.50	47.40

Output levels of 16th amplifier

Temperatures: TP #1 = 73.81, TP #2 = 76.42, TP #3 = 73.59

SS	29.83
WW	31.05

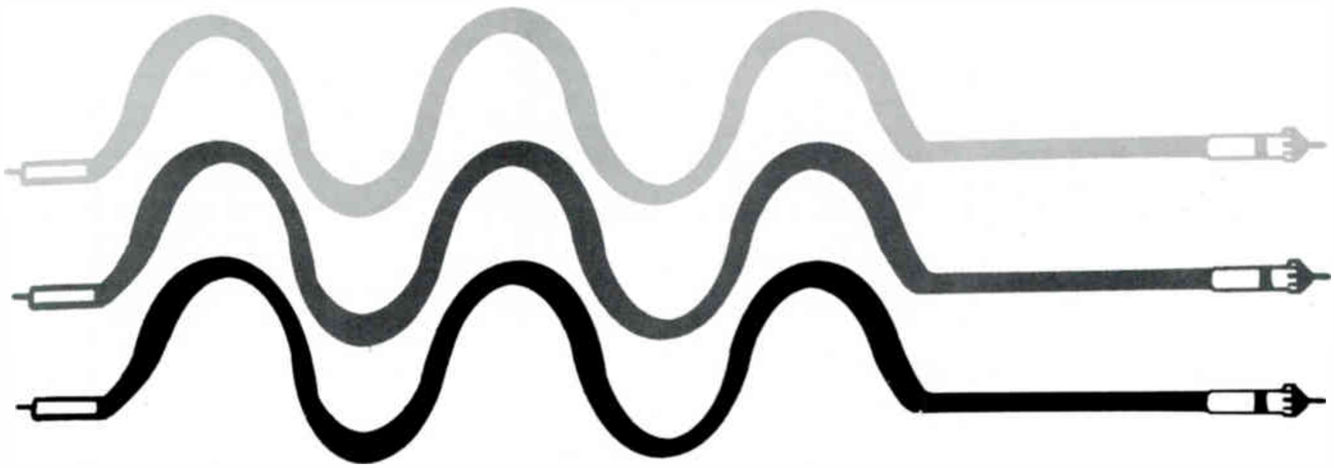
Channel	Carrier level (dBmV)	Channel	Carrier level (dBmV)
2	24.93	4	24.81
6	24.93	B	24.97
D	25.15	F	25.27
H	25.35	7	25.67
9	25.81	11	26.11
13	26.35	K	26.67
M	26.79	O	26.89
Q	26.97	S	27.01
U	27.37	W	27.21
BB	26.63	DD	26.67
FF	26.89	HH	27.13
JJ	27.27	LL	27.31
NN	27.05	PP	27.81
RR	29.29	TT	29.89
VV	30.45	5	24.77
3	24.81	C	25.13
A	25.07	G	25.25
E	25.29	8	25.59
I	25.41	12	26.11
10	25.81	L	26.63
J	26.37	P	27.11
N	26.79	T	27.45
R	27.17	AA	27.03
V	27.71	EE	26.79
CC	26.57	II	26.87
GG	26.77	MM	27.19
KK	27.19	QQ	28.57
OO	27.45	UU	30.51

Output levels of second line extender

Temperatures: TP #1 = 73.11, TP #2 = 76.34, TP #3 = 73.51

Channel	Carrier level (dBmV)
2	34.65
6	34.85
D	35.27
H	35.37
9	35.89
13	36.43
M	36.87
Q	36.93
U	37.15
BB	36.47
FF	36.97
JJ	37.91
NN	37.91
RR	40.43
VV	41.57
3	34.53
A	35.27
E	35.39
I	35.49
10	35.97
J	36.47
N	36.83
R	37.15
V	37.31
CC	36.43
GG	37.09
KK	37.93
OO	38.31
SS	40.91
WW	41.95

Channel	Carrier level (dBmV)
4	34.55
B	35.11
F	35.35
7	35.73
11	36.21
K	36.79
O	36.87
S	36.93
W	36.85
DD	36.49
HH	37.63
LL	38.13
PP	38.77
TT	40.93
5	34.61
C	35.25
G	35.33
8	35.65
12	36.17
L	36.79
P	37.09
T	37.31
AA	36.79
EE	36.71
II	37.43
MM	38.03
QQ	39.63
UU	41.63



Triple beat distortion

By The Engineering Staff
ComSonics Inc

In the past few years the subject of triple beat distortion in CATV systems has received much more attention. This is due to the increase in system channel carriage that came with the advent of new subscriber services. The composite beat performance requirement of the modern CATV amplifier has increased because, as the number of channels carried by a CATV system is increased above 12, the predominant distortion limiting system performance changes from cross modulation to composite beat products.

These beats are caused by third order distortion in an amplifier, including: signals resulting from three carriers or triple beat ($f_1 \pm f_2 \pm f_3$); signals resulting from two carriers or intermodulation ($2f_1 \pm f_2$); third harmonic ($3f_1$); and cross-modulation, which is a special case of third order distortion. In dealing with composite triple beat, we are concerned with triple beat and intermodulation since these produce undesired components or beats at frequencies very close to the input visual carrier frequencies. Assuming equal input levels, intermodulation product levels are 6 dB lower than triple beat levels, but must be included to define the effective or equivalent total number of triple beats per channel; hence the term composite triple beat.

Reasonable calculation

Computers have facilitated the calculation of all the possible combinations of TV carriers to produce triple beat products for various numbers of channel carriage. This information has shown that the center channel in any group of channels will be the "worst case" channel for the number of spurious beats. This channel varies from channel 8 to channel 10 depending on the number of channels ranging from 12 to 30. These worst case channels have been used by several firms in the industry for subjective testing to determine the threshold of perceptibility of composite triple beat distortion—the central question in defining acceptable system performance. Such tests have determined some usable numbers of required system triple beat performance relative to the number of channels being carried.

There is a present consensus of how these measurements are to be made, however, there is currently no accepted industry standard. Most field tests are conducted using unmodulated carriers, a worst case condition since visibility threshold varies with modulation content. This increases required triple beat performance by 3-5 dB, a figure whose calculated value has not been consistently supported by subjective testing. Another factor is that like cross-mod, triple beat distortion levels are dependent on amplifier output levels, and in normal system operation signal tilt is employed. This greatly complicates what is an acceptable amplifier triple beat figure. Also, an amplifier's triple beat performance is not always constant over its operating frequency range, so the choice of measurement frequencies becomes very difficult.

In the midst of all this uncertainty, several facts and conclusions have emerged. Since triple beat distortion is a third order distortion, its level should follow the two-for-one rule: for every 1 dB change in amplifier output level, triple beat level changes 2 dB. Its effect, as viewed on a TV receiver, is the "busy background" many times seen but not recognized as third order distortion. Increasing channel carriage from standard 12 to 30 channels increases the required system triple beat performance approximately 8 dB. A great deal of additional work is being done to develop industry standardized measurement techniques of both amplifier and "real life" CATV system carrier to composite triple beat ratio. Perhaps special instrumentation soon will be developed, dedicated at least in part to the measurement of this parameter of growing importance.

Causes of beat interference carriers

Composite triple beat interference is generated within amplifiers used to provide signal carriage. Similarly, beat frequencies are capable of being generated in each piece of single-channel headend equipment. Without proper alignment, the equipment will begin a problem

'We are concerned with triple beat and intermod since these produce undesired components . . . at frequencies very close to the input visual carrier frequencies'

that only can get worse downstream.

Headend equipment performs the task of pairing two predominant carriers, visual and aural, for injection into the plant. Defining the causes of beat interference carriers will allow an understanding of how two carriers can generate triple beats.

Intermodulation in a nonlinear transducer element, tube or transistor, is the production of frequencies corresponding to the sums and differences of the fundamentals and harmonics of two or more frequencies transmitted through the transducer.

Triple beat is the sum and difference frequencies produced from the product of three frequencies.

Third order intermodulation is the resultant beat or beats from three frequencies ($f_1 \pm f_2 \pm f_3$). Also, two frequency beat ($2f_1 \pm f_2$), or third harmonic ($3f_1$).

The most accessible and as a result perhaps most predominant, triple beat generated in headend equipment is the third order intermod product, defined ($2f_1 \pm f_2$).

All amplifying stages that television carriers pass through are termed "linear." It is a fact however, that each could be termed "nonlinear" as well. Linearity becomes a question of how much nonlinearity can be tolerated and at what operating level. Operating level is the key. Linear amplifiers will perform to low distortion levels provided they are not asked to work too hard. Output required from a processor or strip amplifier may be as high as +60 dBmV. In most cases internal band passing will add some loss requiring that the output amplifying state be operated somewhat higher. There is a point in output levels where distortion characteristics turn sharply for the worse. Aging and improper alignment will lower this point. Picture quality will degrade slowly as a result of increasing intermod products.

Because the picture carrier normally is carried 15 dB above the sound carrier, $2f_1 \pm f_2$ may be further defined. The visual carrier will be represented by f_1 whose second harmonic level still will be significant, and f_2 will be the aural carrier. Consider for example, a typical output stage operating at channel 3. The picture carrier is 61.25 MHz and the sound carrier 65.75 MHz.

$2f_1 + f_2 = 122.5 + 65.75 = 188.25$ MHz

$2f_1 - f_2 = 122.5 - 65.75 = 56.75$ MHz

Output filtering characteristics are such that the beat resulting at 188.25 MHz will be attenuated sufficiently to avoid interfering with channel 9. However, 56.75 MHz falls within an area offering little attenuation, thereby creating the possibility of interference with channel 2. A beat falling 1.50 MHz above the picture carrier must be attenuated approximately 50 dB to avoid visibility. Even though the example is given for channel 3, this beat can occur in any standard channel with the exception of channel 4.

A very similar beat occurs in the mixer section of output converters of many processors. The picture IF (45.75 MHz) again is 15 dB higher than the companion sound IF carrier (41.25 MHz) allowing picture carrier second harmonic dominance. Applying the same procedure, i.e., $2f_1 \pm f_2$, yields: $(2 \times 45.75) - 41.25 = 50.25$ MHz. When processed by the output converter the beat produced again is 4.5 MHz below the desired 1.5 MHz above the lower adjacent channel picture carrier.

Intermod distortion

As a rule, due to inherent nonlinearity, the greater the demand for output level, the greater the third order intermod distortion level, resulting in increased interference to the lower adjacent channel. Both described sources of lower adjacent channel beat generation always are present. When properly functioning, aligned and operated, intermodulation levels will be very low and will not cause visible interference. Headend devices should never be operated with output levels greater than recommended by the manufacturer. Beat levels can increase from 2 to 4 dB as a result of a 1 dB increase in ouput level. When possible, remove padding from the processor or modulator output and reduce its output level to lower recommended levels. This will lighten the burden on the output converter and reduce its intermod components.

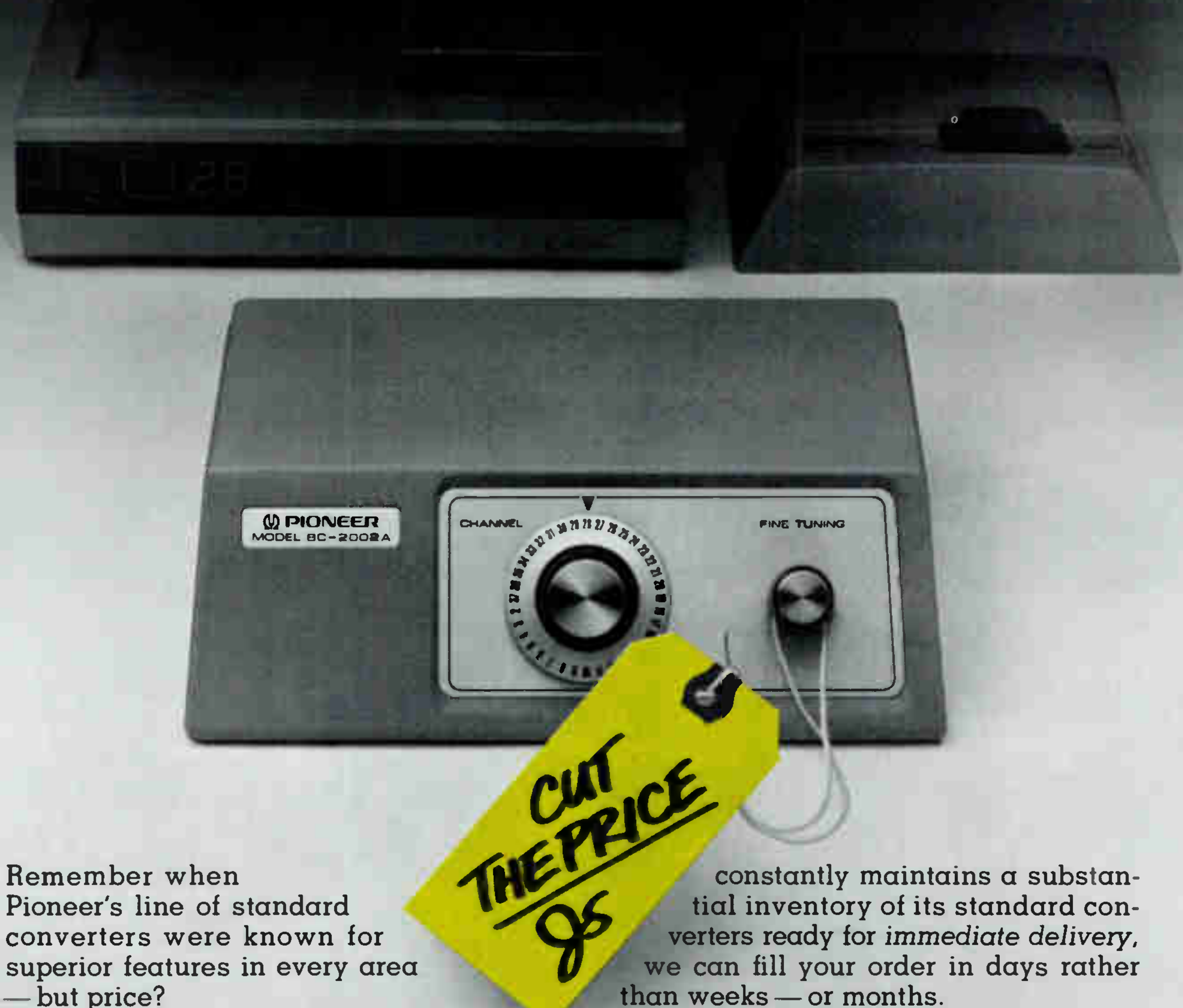
Another potential source of intermod distortion is processing equipment input stages. Each is designed for optimum noise figure and very low input signal levels and, as a result, are subject to overload. For the most part, channel selectivity is handled by IF band shaping in processors. Because of noise figure requirements, minimum prefiltering is utilized ahead of the input stages.

Given the case where it is desired to pass channel 3 with off-air channels 2 and 4 also available, antenna selectivity is not sufficient to reject unwanted carriers by any great amount. Sound carriers of off-air signals are somewhat higher (3-10 dB) than those carried on the system and as a result can cause significant beats, i.e., $(2 \times 65.75) - 67.25 = 64.25$ MHz, and $(2 \times 61.25) - 59.75 = 62.75$ MHz. These two intermod components now have been permanently affixed within the channel 3 passband and cannot be removed.

In the event that strong adjacent channels are causing interference, antenna orientation may offer some relief. In some instances a preamplifier exhibits superior bandpass and/or overload capability. And as a last resort, high quality traps may be used ahead of processing equipment to remove interfering carriers.

Always ensure properly operating and aligned headend processing equipment. Forcing a low gain unit to produce required output levels by increasing IF levels will cause increased intermod products. Whether or not they cause visible system interference depends on the initial severity and other system operating characteristics.

AFTER ENGINEERING FINISHED WITH OUR STANDARD CONVERTERS, ACCOUNTING SUGGESTED ONE MORE IMPROVEMENT:



Remember when Pioneer's line of standard converters were known for superior features in every area — but price?

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Reader Service Number 57.

Distortion analyzer

Matrix Test Equipment Inc. has introduced its Model R-75 signal strength and distortion analyzer. The R-75 (7½-inch x 17-inch x 14½-inch) measures CATV distortions of cross-modulation, composite triple beat, composite second order beat and discrete second order and discrete third order. Distortions are displayed on a 3½ digit display with a 0.1 dB resolution.

The unit comes factory-programmed to receive all CATV frequencies from channels 2 to H31, using standard, IRC or HRC carriers. It can be field-programmed by the user to receive additional frequencies.

The unit weighs 28 lbs., operates over a range of −5 to +75 dBmV and is available with an optional IEEE 488 bus interface that permits operations to be controlled and monitored remotely. The unit also can be equipped with an optional parallel printer port (Centronics type) allowing all available data to be output at the touch of a button.

For more information, contact Thomas Warren, Matrix Test Equipment Inc., 160 Oser Ave., Hauppauge, N.Y. 11788, (516) 435-0925.

Ad insertion equipment

Abiqua International announced its Ugly Box series of automatic ad insertion equipment designed for small cable operators.

By using a 35mm Kodak Carousel slide projector and video camera as the ad source, and automatically inserting the video into satellite-delivered programming sources, the small operator can net significant revenue from local ad sales, according to the company.

In addition to the slide projector and video camera, components of the system include an Ugly Box 3 projector controller (one per system) and an Ugly Box 1 DTMF decoder/timer/controller (one per channel).

For complete information, contact Abiqua International, P.O. Box 100, Silverton, Ore. 97381, (503) 873-4181.

Power supply

The Powerguard Model NS-60/15-0 ferroresonant power supply developed by H & H Cable, will be the first of a series of non-standby and standby power supplies to be manufactured by Audioguard Inc. (H & H Cable was merged into Audioguard on Feb. 15, 1985).

The Powerguard Model NS-60/15-0 features a proprietary transformer design coined the KOOL-1. Tests indicate a 20-year or more projected life, according to the firm. All active components, including options of heavy duty input and output surge protection and turn-on time delay, are located on the plug-in module.

Other features are: built-in 10 Joule MOV input surge protection, short circuit and overload protection, power company approved quick disconnect auxiliary AC convenience outlet, incandescent status light and positive position circuit breaker. Fast installation is accomplished through modularity and the compact size of 8"W x 8"D x 11"H with a weight of 40 lbs.

For additional information, contact the Powerguard Division, Audioguard Inc., P.O. Box 549, Hull, Ga. 30646, (404) 354-0306.

Programmable set-top terminals

Scientific-Atlanta Inc. announced two additions to its 8500 series of set-top terminals. The Model 8520 is an electronic, microprocessor-based programmable set-top terminal. The Model 8530 set-top terminal incorporates the same standard features as the 8520 and, in addition, offers virtually unbreakable signal security, according to S-A.

Both the 8520 and the 8530 are microprocessor controlled. The terminals operate at frequencies up to 450 MHz and can deliver 128 channels in a dual-cable system. A remote control receiver is built into both units for use with the optional remote unit.

The Model 8530, with descrambling, offers dynamic switched sync suppression. This development gives CATV operators signal security plus compatibility with the gated sync scrambling techniques used by Jerrold and Sylvania.

For additional information, contact Scientific-Atlanta Inc., 1 Technology Pkwy., Box 105600, Atlanta, Ga 30348, (404) 925-5057

Color video camera

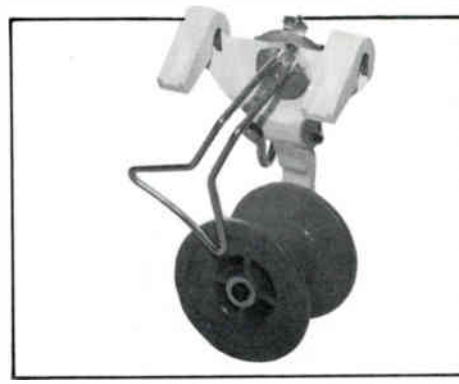
Panasonic Industrial Co. unveiled a color video camera developed to withstand professional applications. The WV-890 incorporates ⅔-inch Plumbicon (S4803) tubes for color reproduction and an eight-bit digital memory for images and color balance when shooting for long periods of time.

The camera uses a middle-index F1.4 prism optics system and a low-noise preamp with signal-to-noise ratio of 59 dB and one touch gain switch, allowing the selection of either +9 or +18 dB. It produces sharp pictures in lighting as low as four footcandles (+18 dB at F1.4) and image boundaries are well defined due to a two-line vertical aperture correction device, according to the firm. Horizontal resolution is as high as 600 lines at center.

Additional standard features include Y-I/Q output for M-format recorders, auto beam (8x), adjustable knee and gamma correction circuits, LED diagnostics and serial data transmission to a RCU.

With the addition of an optical remote control unit (RCU), 5-inch viewfinder and up to 1,000 feet of cable, the camera is effective in the studio. The RCU allows control of the master pedestal, iris adjustments and all automatic functions.

For complete details, contact Panasonic, 1 Panasonic Way, Secaucus, N.J. 07094, (201) 348-7183.

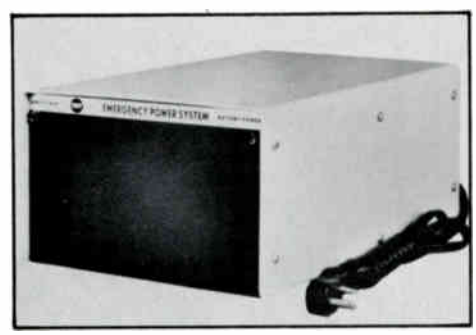


Construction tools

Jackson Tool Systems has introduced the wire raising tool (part no. 1108) to its line of aerial cable tools. The tool is constructed of 13-gauge tubular steel and 7/16-inch diameter steel rod, and is designed to fit Jamison and GMP lay-up sticks.

Jackson also introduced a new style single cable block for fiberoptic and paired cable use as well as coaxial cable. The block (part no. JP-12) features a special retainer over the open side of the roller to keep small size fiber and cable from jumping out. This single roller cable block will accommodate fiberoptic cable as small as ⅛-inch and paired and coaxial cable up to 2¾-inch. The strand brake on this block has been designed for ¼-inch, 5/16-inch and ⅜-inch strand.

For more information, contact Jackson Enterprises, P.O. Box 6, Clayton, Ohio 45315, (513) 836-2641.



Battery backup system

Tripp Lite, a Chicago manufacturer of self-contained emergency power systems, has released a new, full function 1,000 watt battery backup system. This system has a 55 ampere/hour gel cell battery, DC to AC inverter, regulated battery charger, audible alarm, automatic transfer switch, built in surge suppression and external circuit breaker.

In the event of a power outage an audible alarm signals the operator allowing time for an orderly shutdown of computer equipment, without the loss of data. When power is restored, the regulated battery charger automatically starts recharging the battery to full stand-by power. Tripp Lite's BC1000 comes with a one year warranty.

For further information, contact Tripp Lite, 500 N. Orleans, Chicago, Ill. 60610, (312) 329-1777.

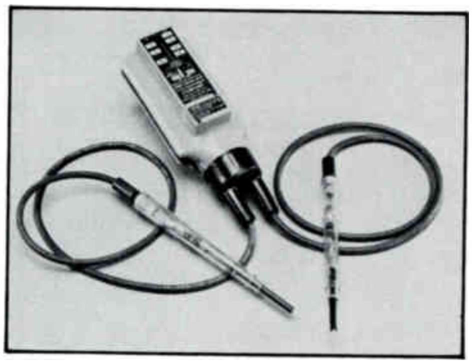
Security seals

Tyton's ELC security seals are designed to make undetected tampering impossible. They are applied with the integral plastic or metal sealing strip. The seal consists of a capsule and anchor insert of non-gluable polypropylene. When closed, the anchor is permanently retained inside the capsule.

A sequential or unrepeated, random seven-digit, alpha-numeric code can be molded into each seal in high relief. This molding prevents duplicating embossed or stamped numbers on an unmarked blank.

Available in six colors, the seals can be personalized with corporate logos on both sides of the capsule.

For literature and samples, contact Tyton Corp., P.O. Box 23055, Milwaukee, Wis. 53233, (414) 355-1130.



Voltage tester

A new audible voltage/continuity tester is available from Etcon Corp. The VT155 tester features see-through prods for identification of blown fuses, solenoid vibration sensing and indicator lights for AC and DC testing. It offers positive indication of AC and DC voltages from 6 to 600 volts, 60/40 Hz, with automatic continuity testing through 300K ohms. A neon lamp shows DC voltage polarity.

Retractable, locking spring-loaded shrouds protect the metal probes, with a strain relief guarding the test leads against excess tension. The sealed case, made from high-impact, self-extinguishing plastic, serves as a prod holder for one-hand operation, and provides storage for the prods when not in use. A leather carrying case (VT154LL) is available.

For further information, contact Etcon Corp., 12243 S. 71st Ave., Palos Heights, Ill. 60463, (312) 361-0360.

Pedestals

Specifications data flyers detailing its line of aluminized steel pedestals designed for the cable television industry are available from CWY Electronics. The free flyers contain complete specifications and detail drawings for CWY pedestal Models PED-45, PED-58, PED-69, PED-77 and PED-1014. All CWY pedestals include rectangular design for maximum use of interior space, replaceable 11-gauge hasps, hingeless cover removal system, multiple equipment mounting knockouts, knockouts for optional cam locks, heavy baked enamel finish and 14-gauge galvanized steel stakes.

For further information, contact CWY Electronics, 405 N. Earl Ave., P.O. Box 4519, Lafayette, Ind. 47903, (800) 428-5796; in Indiana, (800) 382-7526.

Catalog supplement

A two-page supplement to the Line Tamer™ Power Conditioner Technical Catalog that features a listing of available receptacle configurations and a circuit breaker selection chart is now available from Shape Magnetronics Inc. The catalog supplement's receptacle chart lists 74 of the most commonly used receptacles. It provides a diagram of the configuration, the NEMA identification code, and the amperage and voltage rating of each receptacle listed.

The circuit breaker chart provides a reference for those applications that may require circuit breaker protection. The chart provides information on the size breaker needed for the different sizes of single-phase Line Tamers.

For a copy of the Line Tamer Technical Catalog Supplement, contact Shape Magnetronics Inc., 901 DuPage Ave., Lombard, Ill. 60148, (312) 620-8394.

KEEPING TRACK

C.J. Waylan has been named president of **GTE Spacenet.** Waylan served as executive vice president and general manager of Spacenet since 1982 Previously he was with the U S Navy Space Project Office where he established and managed the leased satellite communications (LEASAT) program

In addition **Susyn Conway** has joined GTE Spacenet as business promotion manager Previously Conway was manager of marketing services at Computer Network Corp in Washington D C She also has worked in account services at the Washington office of J Walter Thompson and in various positions with several Florida advertising agencies Contact 1700 Old Meadow Rd McLean Va 22102 (703) 790 7700 or (703) 790-7782

Bailey

Richard Bailey has joined **Mycro-Tek** as vice president of marketing He will oversee product marketing and marketing communications for the firm's graphic arts and video product lines He also will concentrate on expanding its product applications in new markets Previously Bailey was with AT&T His background there includes systems design and analysis software development MIS EDP management production supervision and all areas of technical services Contact P O Box 47068 Wichita Kan 67201 (800) 835-2055 or (316) 945 5087

Integral Corp. announced the appointment of **C. Dean Taylor** as vice president-telecommunications Previously Taylor worked with General Cable Corp for five years Prior to that he was with Times Fiber Communications first as eastern sales manager then as vice president product manager Phoenix Division Contact 1424 Barry St Dallas Texas 75223 0629 (214) 826 0590

Brown

Calabro

Pioneer Communications of America Inc. announced the promotions of **Larry Brown** and **Tom Calabro.** Brown who was general manager engineering has been promoted to vice president new business development A 12-year veteran of cable he first started his career as a senior field engineer for Theta-Com CATV

Calabro who was general manager sales has been promoted to vice president sales Calabro started his career in cable with Theta Com as its turnkey project manager in the early 1970s From there he was the construction manager for Peoples Cable in Rochester N Y before joining Warner Amex's Qube operation in Columbus Ohio Con-

AD INDEX

tact: 2200 Dividend Dr., Columbus, Ohio 43228, (614) 876-0771

Bottazzi

First Data Resources announced the promotion of **Roger Bottazzi** to vice president of sales and marketing for the Cable Services Division. Bottazzi, who formerly was the director of national accounts for the cable division, now will be responsible for marketing, sales and customer support. Bottazzi joined First Data Resources in 1982 after 12 years of service with Xerox Corp. Contact: 7301 Pacific St., Omaha, Neb. 68114-5497, (402) 399-7000

Sirazi

Zenith Cable Products, a division of Zenith Electronics Corp., has named **Semir Sirazi** director of CATV Communications Products. Sirazi joined Zenith in August 1981 as a project engineer within the Cable Products Division. He was promoted to section manager in February 1983. Before becoming associated with Zenith, Sirazi was associate director of software engineering at Medical Office Services, Burlington, Ill. He was a research fellow at Philips International Institute and Philips Data Systems from 1977 to 1978. Contact: 1000 Milwaukee Ave., Glenview, Ill. 60025, (312) 391-8181

Gregory Baer has been appointed manager of Microwave Communications Products at **Hughes Aircraft Co.**'s Microwave Products Division. Baer, who first joined Hughes 18 years ago, was previously manager of solid state manufacturing for the division. Earlier he had served in the Hughes Torrance Research Center, and prior to that was with the company's Missile Systems Group.

In a related move, **Jeffrey Paul,** was named manager of the engineering department for Microwave Communications Products. A 10-year veteran at Hughes, he has served with the company's Electron Dynamics Division and Missile Systems Group.

Also, **Henry Merhoff** has been named assistant manager of engineering for the product line. Contact: 3100 W. Lomita Blvd., Torrance, Calif. 90509, (213) 648-2345.

C-COR Electronics Inc. announced the promotion of **Colin Horton** to director-new business development. In this newly created position, Horton will seek out and make recommendations for pursuing opportunities in selected markets. In 1978, Horton joined C-COR as manager of the systems engineering department, the position he held until his recent promotion. Contact: 60 Decibel Rd., State College, Pa. 16801, (814) 238-2461.

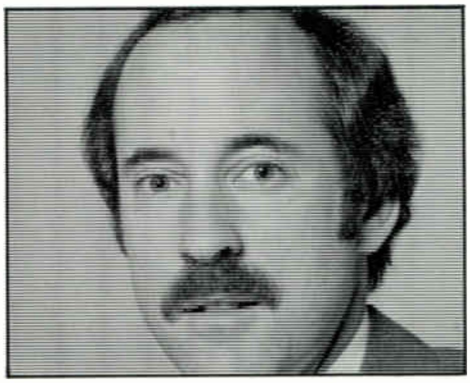
Deborah Morrow has been promoted to general manager of **Ben Hughes Communication Products Co.** Morrow has been with the company two years.

Rosalind Lubrano-Crotty has been appointed production manager. She has been with the company five years. Contact: 304 Boston Post Rd., Old Saybrook, Conn. 06475, (203) 388-3559.

Glenn Tongue has been appointed manager-new business development for **Blonder-Tongue Laboratories Inc.** He joined the company full time last year following several years of part-time work while attending college. Contact: One Jake Brown Rd., Old Bridge, N.J. 08857, (210) 679-4010.

Using taps and splitters in addressable systems

By Michael Holland
Vice President Macom Industries/OEM Enterprises



The increasing use of addressable systems within buildings and multi-unit complexes calls for a better understanding of the power passing and low frequency capabilities of splitters and taps. Though many manufacturers of addressable systems have had splitters and taps designed for their particular application, most users are still forced to use an off-the-shelf product.

These additional capabilities are required in splitters and taps that perform with the new addressable and line amplified systems:

1) Low frequency signal passing—Some systems use the 1 MHz and 15-25 MHz frequency ranges to forward and reverse data. The 25-35 MHz range also is used for premium program transmission.

2) Power passing—Some systems vary their low frequency line power to address and power an addressable tap. This requires extra power handling capabilities and linearity when the frequency is shifted.

3) FM transmission—Systems that use the FM band for data transmission, require an FMTV tap or splitter to pass these frequencies. This is not always the case with off-the-shelf products.

4) Line power passing—Due to the large size of an addressable system, often extra line amplifiers are required. This requirement of the splitters, which can pass 1-3 amperes of DC or 30-60 VAC (60 MHz), is not common and can cause hum modulation if the ferrite cores saturate.

The following common off-the-shelf passives will meet some of these requirements:

1) Standard VHF-only, CATV quality splitters—Not power passing, shorts power to ground.

2) Standard UHF/VHF splitter—Passes DC (or low frequency AC) to all ports. Has 0.5 to 1 ampere capability. Note: Though 2 amps can be run through these splitters, core saturation is possible at lower levels.

3) Directional couplers (single or multi-port), indoor type—Non-power passing to taps or through port; shorts DC to ground. This is inherent to their design, which uses a transformer winding to ground to provide "RF bucking" that gives the desirable reverse direction isolation. Power passing directional couplers require a special by-pass circuit.

4) Back-matched taps (BMT), UHF/VHF—These pass power to the through port and block power to the tap. This is a good off-the-shelf device to use for line amplified distribution systems in that no ferrite cores are used in the through line, which eliminates the possibility of saturation.

5) Power passing (to one port) splitters—These devices were developed during the peak of the multipoint distribution service (MDS) days and are good for addressable systems. They pass 1 amp to only one port, and block power to the others. Note that any device specified to pass DC also will pass 60 Hz AC. Those addressable systems such as Delta Benco Cascade's, which use a frequency shift in their power line, can use a standard power passing port to successfully pass the data as well as power.

6) Resistive taps—These pass power to the through-line, but have a resistance to the tap. This could load down the system and is not recommended for these applications.

7) Terminators—A standard 75 ohm terminator cannot be used to terminate an RF line when DC is present as would be the case with a BMT or UHF/VHF splitter. A voltage blocking coupler (VBC) should be used in front of the terminator. This blocks DC, 60 Hz AC, and allows the RF to pass.

8) High isolation A-B switches—It should be noted that the better high isolation A-B switches terminate the unused port with a 75 ohm resistor. A VBC also should be used for the same reasoning as in item 7. The resistor is a ¼-watt device that will burn out with an input over 5 volts.

The preceding distribution components mentioned also are compatible with powered 450-950 MHz block converted satellite distribution systems. For this application, UHF devices such as BMTs or DSU-2s (UHF/VHF splitters) would be required.

'Though many manufacturers of addressable systems have had splitters and taps designed for their particular applications, most users are still forced to use an off-the-shelf product'

A common related problem: Hum

A problem that is occuring regularly in large distribution systems where multiple buildings are involved, is hum modulation. In many cases this can be caused by poor electrical system grounding in the different buildings. When this occurs, the coaxial cable shield provides a path for electrical leakage in the building with greater electrical usage to pass to another ground. This leakage, sometimes a few volts, can induce the 60 Hz into the center conductor of your cable. Measuring this leakage is very difficult in that a common mode scope is required.

An easy solution can be tried. Insert voltage blocking couplers at each end of the connecting trunk cable between floors, etc., and add additional grounding with a grounding block, ground strap or rod. The grounding will not necessarily work alone if the AC is induced into the center conductor.

So far we have used the term "AC induced 60 Hz." It is important to know how this turns into hum bars rolling through a TV screen. The explanation will shed light on similar problems that occur when using power passing splitters and taps.

Ferrite cores—the basis of RF passives—have one very important characteristic: If too many turns of wire are used around them, or too much current is passed through those turns, the core will "saturate." This is a similar effect to a short circuit at RF frequencies. Normal RF levels alone (0-1 volt) will not saturate a core. The problem is created when one places additional line power with the RF exceeding the ampere-turn limit for that particular core material and size.

As the 60 Hz line power, or induced 60 MHz from poor electrical system grounding go through the splitter or taps core, it can saturate (short) on the peaks of the 60 Hz. This essentially results in the RF signal being turned off for a moment, 60 times per second, causing a hum bar scanning the TV screen.

As was mentioned earlier, the poor grounding problem is compounded when using splitters intended to pass low frequency signals. To avoid these problems, look carefully at maximum currents to be used through the system, many addressable manufacturers have had passives made for them with extra large chokes to avoid saturation.

Off-the-shelf components can be used successfully if one is aware of the problems and plans for worst-case situations in the system layout and product selection. Good luck!

While the designer fiddles!

By Anthony J. DeNigris
President, Nationwide CATV Services Inc

To set the course straight right from the start, this article is not about some CATV system designer named "Nero." However, as I think about some of the cable system designs I've had the displeasure of working with or seeing produced during the past 12 years, as well as what I still see happening today to some degree, I can't help but wonder how much of Rome will be allowed to burn before somebody decides to put out the fire. Naturally, I don't mean city or fire literally, but I might as well be talking about burning money. As I see it, the effect is the same; for it is cold cash that I've seen (and still see) wasted in the midst of the heat of putting a cable system together on the designer's board.

Of course, these words are not directed at all designers. Many are extremely efficient and produce viable, cost-effective and systematically engineered precise cable plant. I am constantly reminded through exposure to design prints of various systems and types of design, however, that these highly critical and sought after designers are few and far between. One might say at this point, "This guy is looking for perfection and that is not realistic." To which I would respond, "It's about time that we all stop accepting less than we pay for, and go beyond what may appear to work fine within specifications (signal-wise).

Laying the ground rules

What requirements must a cable TV designer possess in order to fill the void that I have just expressed? Let's start by identifying some of the problems that become visible in reviewing finished design prints. It then will become obvious what a designer should know before he can feed information into a computer (calculator).

One of the most serious points to consider when laying a system out prior to the actual designing of the electronics, is the trunk routing. The layout of the trunk within a system is of paramount importance for a couple of reasons.

First, it must carry the signal through an area and efficiently allow for the tapping by way of bridgers to the distribution network (feeder). It is the designer's job to make the most of the capabilities of the trunk system electronics while at the same time keeping the length of the intertwining network of trunk to a minimum. Quite simply, this means laying the trunk system out in a strategic pattern, trying to divide the area into sections and placing a single trunk through that area to feed it. Amplifiers are necessary when signal levels warrant the placement of an amp, but they are not necessarily governed by that fact alone. The designer, therefore, has to consider the routing of the trunk at the same time he is looking for appropriate tap-off points (intermediate bridgers or amplifiers with bridgers if necessary) in order to get full usage from the trunk equipment.

I have seen countless situations where a trunk layout will come in through an area of a city and feed it from two bridger ports at an amp location; and in order to reach all the areas the designer has in mind, line extenders will be utilized unnecessarily, without thinking in the best interest of the system being designed. When this happens, dollars are being thrown away. And in scrutinizing this type of situation, I frequently have discovered that all four bridger ports could have been utilized and a few line extenders could have been spared (see Figure 1).

Figure 1

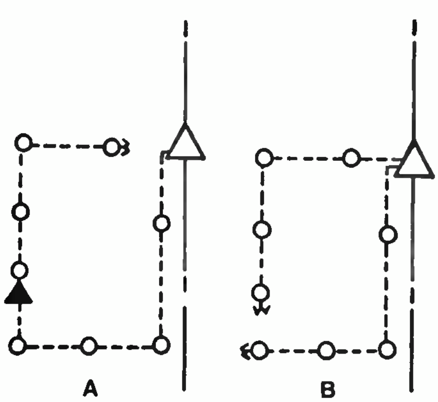


Figure 1A shows misuse of bridger port availability, and the placement of a line extender to accommodate the design. Figure 1B shows proper utilization of bridger ports and spares a line extender as well as accommodating the design.

The second reason is that the ratio of trunk-to-feeder within a system design must be as low as possible vs. the feeder in order to get the most from the trunk system. This translates into highly efficient design, but the real benefit comes in the physical sense, down the road, and represents good business thinking. Since trunk cable costs more than feeder, an immediate cost efficiency can be realized if it is kept to a minimum. Feeder also costs less to construct, less to maintain in the future and less to provide powering for from the onset. In large builds the length of the trunk network is extremely important when it comes to picture quality however great the electronics are; and one might be surprised at how much length could be reduced with an efficient design.

Costly extras

One of the most flagrant violations in system designs that I keep seeing is the situation where a signal path approaches an intersection in which the signal must be split and then turn down both directions. I have seen the error both in trunk and feeder. If the signal level is approaching the point where amplification is going to be needed, and the designer is not looking ahead (designing blind, or pole-by-pole so to speak), he will place a splitter at the intersection and will quite often place an amp on the next pole in either direction. This is uncalled for (see Figure 2). It shows the limited knowledge of practicality on the designer's part and beyond that it becomes evident that the computer-aided system software is not programmed to think ahead.

I have heard of numerous design programs that boast of flawless behavior and cost efficiency, but never have I heard of any software system promise to think on behalf of the designer. That is, with the exception to the system we employ in our design software—my own program that I developed some years ago. Simplistic errors cannot occur with our system because the designer is warned consistently of obvious design blunders prior to their possibly taking place. For instance, the specific incident previously described would cause a halt to the routine programming and a warning on the monitor as follows: "WARNING! Insertion at this point of any splitter would cause the output to fall within or below amp specs. Place amplifier prior to use of a splitter." If the designer chose to ignore the warning due to some unknown necessity or other reason, he would have to bypass the program with a code and then continue. This type of system keeps the designer constantly aware.

It is sad to say that this is not happening more, after such a consuming period of growth in the industry to date. I am certain many readers will say, "Wait a minute my design is great," and justly so; but what I am saying here is that there are still many people producing costly and stupid mistakes in system design that are being placed in the systems anyhow. I can't help but feel aggravated everytime I think of the instance where I pointed out such abuse to a project manager we were working with on a system build. When I offered to redesign the plant, he didn't want to hear of it. His answer was: "Hey, they got it done this way, it works and it's going to go up that way; we have no time for redesign, got to get the plant built!" I cannot say where this

Figure 2

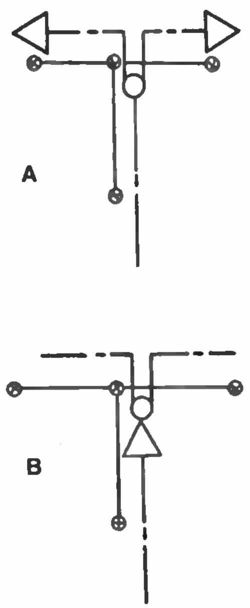


Figure 2A shows impractical designing and a waste of an amplifier. Figure 2B shows the proper placement of the amplifier in conjunction with a splitter. Note: The signal is obviously weaker in both directions in B as compared to A, however, not enough to justify the usage of an extra amplifier in most cases.

took place, but I will say that the system actually lost thousands of dollars (probably well into six figures) in all of the 1,700 miles that were built. All in extra electronics!

Who's to blame?

If I were an MSO, the hurt really would begin to settle in at this point, because it just so happens that the system in the preceding example was designed by the supplier of electronics for the build, all for free! Hmmmmm, I know some of you will undoubtedly know what I am talking about here. It's ironical however, that so many people, engineers and managers alike, have commented to me on the subject of "loading up" on the electronics designed for free by manufacturers, without really doing anything about it. Bear something in mind here; ethics prohibits me from making any direct accusation towards any manufacturer. However I can, if challenged, lead certain people to situations they would have a difficult time explaining. But, in order to be a nice guy about things, I will attribute what I call atrocious blunders in design to the relative inexperience of those hired to sit and punch in footages and house counts day after day. And as well, to those who are ultimately responsible for scrutiny of each design and the allowance of it to be implemented within the system to be constructed.

This means that there is no excuse for corporate engineers and project managers who lay the blame for the final waste on the designer or the company doing the design. The responsibility ultimately lies at the end of the line, and if it is you who allows it to take place, it doesn't matter who did it. It is now your problem!

Forward or backwards?

Some time ago, a principle of design came into strong use. (As far as I'm concerned, a little too strong.) What I am referring to here is the tactic of backfeeding portions of the distribution system with a second cable carrying signal in the opposite direction from that of the first cable passing through an area. In a normal straight forward design, subscriber taps would be placed in a consecutive in-line pattern with tap values getting lower until signal levels warrant a line extender, and then all over again with the taps and so on. Many times a problem arises when approaching a dead end street and the design is already through two line extenders. System specs don't allow for three line extenders and the signal is about to run out, yet there are three more spans of cable to go and three more taps to be placed in order to feed homes. By use of the principle of backfeed design, the homes can be accommodated and the third, undesired line extender will be spared.

One of the biggest factors responsible for the signal weakening along a run of taps is the insertion loss of the taps themselves. Without being lengthy, let me just say that the lower the value of the tap, the larger the insertion loss (signal-wise) is. Therefore, if low value taps can be eliminated to a certain degree, then there should be more signal left to play with. It all makes good sense so far, so let's look at backfeed design.

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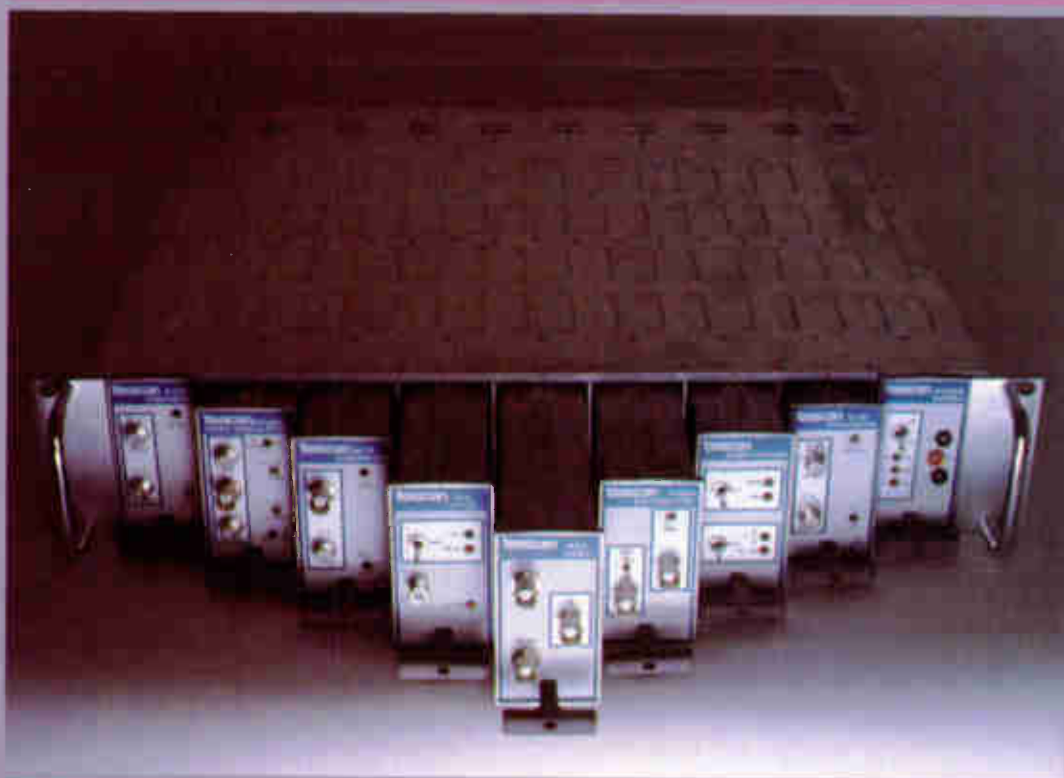

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The most common technique is to go back along the design run to the last line extender and through the preceding few taps before that line extender as well. Then the designer would eliminate the required number of taps (for the sake of this example, let's say three taps), and thereby continue forward again only calculating cable loss and not inserting taps. This would have the effect of lengthening the run prior to the mandatory amplification of the signal (placement of the line extender further along the run than before), and therefore allowing the end of the street to be reached without running out of signal and without the use of that unwanted third line extender.

Now, I haven't overlooked the spans of cable left without taps to serve customers from (see Figure 3), however, by simple insertion of a directional coupler immediately after the pushed forward line extender, I can "backfeed" those spans to insert the required taps. The magic here, lies in the fact that we have allowed ourselves the luxury of working with higher signal levels and, subsequently, higher tap values, therefore causing less signal weakening. In turn, this enables the use of the directional coupler and its insertion loss without a problem.

Backfeeding cable can be extremely rewarding and economical insofar as what it can accomplish if used properly. But here I go again, using that word "if." Well, as usual, there are examples of so called designers out there abusing a good intention. All you have to do is seriously scrutinize a bunch of designs and chances are that you will see backfeeds employed where they absolutely should not be. For one thing, it costs money for that extra cable and splitter used in conjunction with the practice. Besides, it makes for a big mess when someone uses the principle all over the place, thinking that he or she is doing a lot of good. When it comes time for actual construction, sometimes it becomes a grueling experience to decipher what the designer was attempting to do.

Placing things in their proper perspective, I believe that the principle of backfeeding is a valuable design tool; but I also feel that CATV designers must learn to use their left hand as well as their right. In acting in the best interest of the system one is designing, the proper mix of methods usually will result in the most efficient and cost-effective design. After all, if that isn't the goal of a system designer, then Rome might as well be burning.

Figure 3

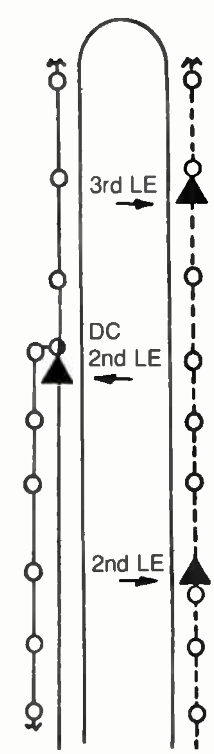


Figure 3B shows straight line placement of taps and an unwanted third line extender. Figure 3A shows elimination of the third line extender by eliminating the taps as shown and pushing the location of the line extender forward, utilizing the backfeed.

March

March 4-6: Society of Cable Television Engineers annual convention, Cable-Tec Expo '85, Sheraton Washington Hotel, Washington, D.C. Contact (215) 692-7870.

March 6-8: Arkansas Cable Television Association annual convention, the ArkanShow 1985, Statehouse Convention Center, Little Rock. Contact (501) 374-3892.

March 11-12: Waters Information Services Inc. conference on stereo television, Hyatt Islandia Hotel, San Diego. Contact, Dennis Waters or Merrill Oliver, (607) 770-1945.

March 12-13: The Yankee Group seminar on "Data Communications in the Factory," Chicago. Contact (617) 542-0100.

March 13: QV Publishing seminar on "Two-Way Tomorrow: Planning Today for Tomorrow's Services," The Yale Club, New York. Contact Amanda Murillo, (914) 472-7060.

March 13-15: Magnavox CATV training seminar, San Antonio, Texas. Contact Laurie Mancini, (800) 448-5171; in New York, (800) 522-7464.

March 15-16: SCTE South-Central Chapter first official meeting, NBC Annex Building, San Antonio, Texas. Contact Larry Flaherty, (512) 648-4903.

March 18-20: Magnavox CATV training seminar, San Antonio, Texas. Contact Laurie Mancini, (800) 448-5171; in New York, (800) 522-7464.

March 19-21: C-COR Electronics technical seminar, Columbus, Ohio. Contact Debra Cree, (814) 238-2461 or (800) 233-2267.

April

April 1-3: Security Equipment Industry Association and **National Burglar & Fire Alarm Association** "ISC Expo 85," Los Angeles Convention Center. Contact Ann Feltes or Bill Campeau, (818) 965-7454.

April 9-11: Canadian Cable Television Association annual convention, 'CABLEXPO,' Toronto Metro Convention Center. Contact Christiane Thompson, (613) 232-2631.

April 10-12: Magnavox CATV training seminar, Denver. Contact Laurie Mancini, (800) 448-5171; in New York, (800) 522-7464.

April 14-17: National Association of Broadcasters annual convention, Las Vegas, Nev. Contact (202) 293-3500.

April 16-18: Magnavox CATV training seminar, Denver. Contact Laurie Mancini, (800) 448-5171; in New York, (800) 522-7464.

April 18: SCTE Rocky Mountain Meeting Group meeting on preventive maintenance, Sheraton Hotel, Denver. Contact Bruce Catter, (303) 740-9700; or Joe Thomas, (303) 466-7376.

May

May 1-3: Magnavox CATV training seminar, St. Paul, Minn. Contact Laurie Mancini, (800) 448-5171; in New York, (800) 522-7464.

May 6-8: Magnavox CATV training seminar, St. Paul, Minn. Contact Laurie Mancini, (800) 448-5171; in New York, (800) 522-7464.

May 21-23: C-COR Electronics technical seminar, Dallas. Contact Debra Cree, (814) 238-2461 or (800) 233-2267.

June

June 2-5: National Cable Television Association annual convention, Las Vegas (Nev.) Convention Center. Contact (202) 775-3629 or (202) 775-3606.

Planning ahead

April 9-11: Canadian Cable Television Association annual convention, "CABLEXPO," Toronto Metro Convention Center.

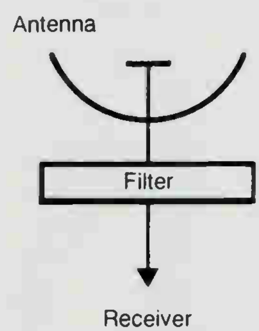
June 2-5: National Cable Television Association annual convention, Las Vegas (Nev.) Convention Center.

June 17-19: Community Antenna Television Association, CCOS '85, The Opryland Hotel, Nashville, Tenn.

Aug. 25-27: Annual convention of the Southern Cable Television Association, the Eastern Show, Congress World Center, Atlanta.

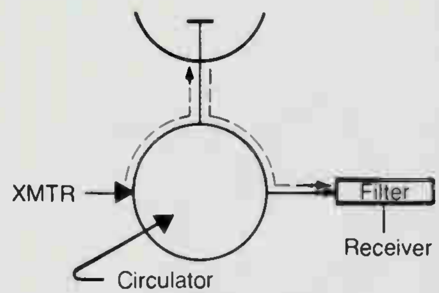
Sept. 18-20: Atlantic Show, Atlantic City, N.J.

Figure 1A



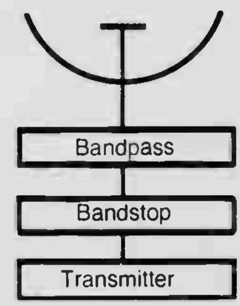
Filtering interference from off-air reception. The filter is usually a channel bandpass unless interference is adjacent channel. Then a bandstop is usually more economical. If two or more channels are received from the same antenna, the bandpass filter is correspondingly wider.

Figure 1B



Due to antenna return loss, transmitter power may reach the receiver as shown. If the two frequencies are close, a bandstop filter is indicated, otherwise a channel bandpass filter for the receiver frequency is indicated.

Figure 1C



A wide band (multi-channel) transmitter usually requires a bandpass filter to suppress the spurious (out of band) emissions which are usually present. Because of the wide passband, the bandpass may not be sufficiently selective to suppress emissions at frequencies immediately below the first and above the last channel transmitted. Hence separate bandstop filter may also be needed.

Filtering CARS band interference

By Glyn Bostick
Microwave Filter Co. Inc.

A simple filtering strategy, using only two kinds of filters, suppresses most cases of microwave interference to CARS (cable antenna relay system) band off-air receptions.

The original CARS band of 12.7-12.95 GHz (now 12.7-13.2 GHz) was allocated for point-to-point transmission between CATV headends. This spectrum lies within the lower portion of the "K" band, 10-15 GHz, which is used for a number of other microwave radio transmissions (see Table 1). Specific CARS band channel designations, for TV channel and FM transmissions, are shown in Table 2.

CARS band receptions have potential interference from other transmissions within the 12.7-13.2 GHz band (the TV pick-up band—Table 1) and from several sources adjacent to this band (many of the latter emitting high power). Consequently, it is possible for a given CARS band reception to experience interference from a frequency in close proximity to the CARS band channel (from the TV pick-up band) or powerful nonadjacent interference. The former would give general symptoms similar to those of adjacent channel interference to a CATV VHF channel, while the latter would resemble receiver front end overload.

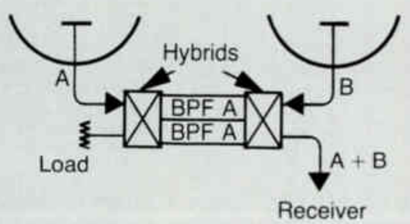
Table 1: Transmission allocations in and near the CARS band

Frequency in GHz	Allocated activity
10.55-10.68	Operational fixed and mobile radio
10.68-10.70	Radio astronomy
10.70-11.70	Point-to-point common carriers
10.95-11.20	Fixed satellites
11.45-12.20	Fixed satellites
11.70-12.20	Point-to-point common carriers
12.7-12.95	CATV system relay
12.7-13.20	TV pick-up: intercity relay transmission; studio-transmitter links
13.25-13.40	Airborne Doppler radar
13.40-14.00	Coastal radar and other tracking systems
14.00-14.50	Fixed satellites
14.40-14.50	Space research transmissions
14.50-15.35	Reserved for armed forces

Filter technology, situations and strategy

All CARS band interference problems can be suppressed substantially, using only two types of filters: bandpass and bandstop. Since the 12.7-13.2 GHz CARS band spectrum lies within the operating range of WR75 waveguide (10-15 GHz), all designs can be fabricated in this size waveguide. The bandwidth range of

Figure 1D



One may wish to combine (or separate) two channels. This can be done with a pair of identical bandpass filters (corresponding to one of the channels) connected between two waveguide 90 degree phase shift hybrid splitters.

such filters is compatible with widely known and realizable design practice for WR75 waveguide. This size guide, .75 x .375 inside dimensions, is available in a number of materials, the most useful of which is low loss copper and temperature stable Invar. The less expensive copper guide is used to fabricate designs intended for controlled-environment installation, where the temperature does not depart from 72°F by more than a few degrees. Invar construction is used where the filter must maintain its response function when subjected to wide swings in environment temperature. In a single-channel bandpass filter for 13 GHz, for example, the center frequency will detune 1 MHz with a temperature deviation of about 4°C if the material is copper, whereas a deviation of over 40°C will be required for Invar construction.

Figures 1A through 1D are representative of the many different situations requiring filters to suppress unwanted receptions.

For a given problem, one makes a judicious choice between the two types of filters—bandpass or bandstop. Some selection rules that affect (minimize) costs are:

1) To suppress a *nonadjacent* channel interfering carrier or one with a narrow spectrum, the cost is approximately equal between the two types.
2) To suppress an *adjacent* channel interference carrier, the circuit complexity and cost, will be lower for the bandstop filter.
3) Where interference is nonadjacent, but there is more than one discrete interference signal, the bandpass filter usually will be less costly. One would need to use only one bandpass filter but several bandstop filters.

Sources for CARS band filters

Standard transmission line for CARS band equipment is WR75 waveguide. Therefore, almost any microwave components manufacturer that includes filters in its line of products can supply standard channelizing bypass filters and perhaps special bandpass and band-reject filters to specification. The recommended first stop, in looking for filters, is the producer of your AML equipment. It will usually supply standard bandpass filters. If it does not make custom bandpass or bandstop filters it may be able to refer you to a firm in the microwave trade that does. →

Table 2: TV channels

CARS band AML frequencies

			CARS group C			CARS group D			CARS group E			CARS group F		
CATV channel	VHF boundaries in MHz		FCC desig.	Microwave boundaries in MHz		FCC desig.	Microwave boundaries in MHz		FCC desig.	Microwave boundaries in MHz		FCC desig.	Microwave boundaries in MHz.	
2	54	60	C01	12700.5	12706.5	D01	12759.7	12765.7	E01	12952.5	12958.5	F01	13012.5	13018.5
3	60	66	C02	12706.5	12712.5	D02	12765.7	12771.7	E02	12958.5	12964.5	F02	13018.5	13024.5
4	66	72	C03	12712.5	12718.5	D03	12771.7	12777.7	E03	12964.5	12970.5	F03	13024.5	13030.5
PT	72	76	C04	12718.5	12722.5	D04	12777.7	12781.7	E04	12970.5	12974.5	F04	13030.5	13034.5
5	76	82	C05	12722.5	12728.5	D05	12781.7	12787.7	E05	12974.5	12980.5	F05	13034.5	13040.5
6	82	88	C06	12728.5	12734.5	D06	12787.7	12793.7	E06	12980.5	12986.5	F06	13040.5	13046.5
FM1	88	94	C07	12734.5	12740.5	D07	12793.7	12799.7	E07	12986.5	12992.5	F07	13046.5	13052.5
FM2	94	100	C08	12740.5	12746.5	D08	12799.7	12805.7	E08	12992.5	12998.5	F08	13052.5	13058.5
FM3	100	106	C09	12746.5	12752.5	D09	12805.7	12811.7	E09	12998.5	13004.5	F09	13058.5	13064.5
FM4	106	108	C10	12752.5	12754.5	D10	12811.7	12813.7	E10	13004.5	13006.5	F10	13064.5	13066.5
AUX1	108	114	C11	12754.5	12760.5	D11	12813.7	12819.7	E11	13006.5	13012.5	F11	13066.5	13072.5
AUX2	114	120	C12	12760.5	12766.5	D12	12819.7	12825.7	E12	13012.5	13018.5	F12	13072.5	13078.5
A	120	126	C13	12766.5	12772.5	D13	12825.7	12831.7	E13	13018.5	13024.5	F13	13078.5	13084.5
B	126	132	C14	12772.5	12778.5	D14	12831.7	12837.7	E14	13024.5	13030.5	F14	13084.5	13090.5
C	132	138	C15	12778.5	12784.5	D15	12837.7	12843.7	E15	13030.5	13036.5	F15	13090.5	13096.5
D	138	144	C16	12784.5	12790.5	D16	12843.7	12849.7	E16	13036.5	13042.5	F16	13096.5	13102.5
E	144	150	C17	12790.5	12796.5	D17	12849.7	12855.7	E17	13042.5	13048.5	F17	13102.5	13108.5
F	150	156	C18	12796.5	12802.5	D18	12855.7	12861.7	E18	13048.5	13054.5	F18	13108.5	13114.5
G	156	162	C19	12802.5	12808.5	D19	12861.7	12867.7	E19	13054.5	13060.5	F19	13114.5	13120.5
H	162	168	C20	12808.5	12814.5	D20	12867.7	12973.7	E20	13060.5	13066.5	F20	13120.5	13126.5
I	168	174	C21	12814.5	12820.5	D21	12873.7	12879.7	E21	13066.5	13072.5	F21	13126.5	13132.5
7	174	180	C22	12820.5	12828.5	D22	12879.7	12885.7	E22	13072.5	13078.5	F22	13132.5	13138.5
8	180	186	C23	12826.5	12832.5	D23	12885.7	12891.7	E23	13078.5	13084.5	F23	13138.5	13144.5
9	186	192	C24	12832.5	12838.5	D24	12891.7	12897.7	E24	13084.5	13090.5	F24	13144.5	13150.5
10	192	198	C25	12838.5	12844.5	D25	12897.7	12903.7	E25	13090.5	13096.5	F25	13150.5	13156.5
11	198	204	C26	12844.5	12850.5	D26	12903.7	12909.7	E26	13096.5	13102.5	F26	13156.5	13162.5
12	204	210	C27	12850.5	12856.5	D27	12909.7	12915.7	E27	13102.5	13108.5	F27	13162.5	13168.5
13	210	216	C28	12856.5	12862.5	D28	12915.7	12921.7	E28	13108.5	13114.5	F28	13168.5	13174.5
J	216	222	C29	12862.5	12868.5	D29	12921.7	12927.7	E29	13114.5	13120.5	F29	13174.5	13180.5
K	222	228	C30	12868.5	12874.5	D30	12927.7	12933.7	E30	13120.5	13126.5	F30	13180.5	13186.5
L	228	234	C31	12874.5	12880.5	D31	12933.7	12939.7	E31	13126.5	13132.5	F31	13186.5	13192.5
M	234	240	C32	12880.5	12886.5	D32	12939.7	12945.7	E32	13132.5	13138.5	F32	13192.5	13198.5
N	240	246	C33	12886.5	12892.5	D33	12945.7	13951.7	E33	13138.5	13144.5			
O	246	252	C34	12892.5	12898.5	D34	12951.7	12957.7	E34	13144.5	13150.5			
P	252	258	C35	12898.5	12904.5	D35	12957.7	12963.7	E35	13150.5	13156.5			
Q	258	264	C36	12904.5	12910.5	D36	12963.7	12969.7	E36	13156.5	13162.5			
R	264	270	C37	12910.5	12916.5	D37	12969.7	12975.7	E37	13162.5	13168.5			
S	270	276	C38	12916.5	12922.5	D38	12975.7	12981.7	E38	13168.5	13174.5			
T	276	282	C39	12922.5	12928.5	D39	12981.7	12987.7	E39	13174.5	13180.5			
U	282	288	C40	12928.5	12934.5	D40	12987.7	12993.7	E40	13180.5	13186.5			
V	288	294	C41	12934.5	12940.5	D41	12993.7	12999.7	E41	13186.5	13192.5			
W	294	300	C42	12940.5	12946.5	D42	12999.7	13005.7	E42	13192.5	13198.5			

NOTE
Group C channels add 12 646 5 MHz to VHF frequency
Group D channels add 12,705 7 MHz to VHF frequency
Group E channels add 12,898 5 MHz to VHF frequency
Group F channels add 12 958 5 MHz to VHF frequency

CARS band FM frequencies

CARS group FM A		CARS group FM B		CARS group FM K			
Desig.	Microwave Boundaries (in MHz)	Desig.	Microwave Boundaries (in MHz)	Desig.	Microwave Boundaries (in MHz)	Desig.	Microwave Boundaries (in MHz)
A01	12700.0-12725.0	B01	12712.5-12737.5	K01	12700.0-12712.5	K21	12950.0-12962.5
A02	12725.0-12750.0	B02	12737.5-12762.5	K02	12712.5-12725.0	K22	12962.5-12975.0
A03	12750.0-12775.0	B03	12762.5-12787.5	K03	12725.0-12737.5	K23	12975.0-12987.5
A04	12775.0-12800.0	B04	12787.5-12812.5	K04	12737.5-12750.0	K24	12987.5-13000.0
A05	12800.0-12825.0	B05	12812.5-12837.5	K05	12750.0-12762.5	K25	13000.0-13012.5
A06	12825.0-12850.0	B06	12837.5-12862.5	K06	12762.5-12775.0	K26	13012.5-13025.0
A07	12850.0-12875.0	B07	12862.5-12887.5	K07	12775.0-12787.5	K27	13025.0-13037.5
A08	12875.0-12900.0	B08	12887.5-12912.5	K08	12787.5-12800.0	K28	13037.5-13050.0
A09	12900.0-12925.0	B09	12912.5-12937.5	K09	12800.0-12812.5	K29	13050.0-13062.5
A10	12925.0-12950.0	B10	12937.5-12962.5	K10	12812.5-12825.0	K30	13062.5-13075.0
A11	12950.0-12975.0	B11	12962.5-12987.5	K11	12825.0-12837.5	K31	13075.0-13087.5
A12	12975.0-13000.0	B12	12987.5-13012.5	K12	12837.5-12850.0	K32	13087.5-13100.0
A13	13000.0-13025.0	B13	13012.5-13037.5	K13	12850.0-12862.5	K33	13100.0-13112.5
A14	13025.0-13050.0	B14	13037.5-13062.5	K14	12862.5-12875.0	K34	13112.5-13125.0
A15	13050.0-13075.0	B15	13062.5-13087.5	K15	12875.0-12887.5	K35	13125.0-13137.5
A16	13075.0-13100.0	B16	13087.5-13112.5	K16	12887.5-12900.0	K36	13137.5-13150.0
A17	13100.0-13125.0	B17	13112.5-13137.5	K17	12900.0-12912.5	K37	13150.0-13162.5
A18	13125.0-13150.0	B18	13137.5-13162.5	K18	12912.5-12925.0	K38	13162.5-13175.0
A19	13150.0-13175.0	B19	13162.5-13187.5	K19	12925.0-12937.5	K39	13175.0-13187.5
A20	13175.0-13200.0			K20	12937.5-12950.0	K40	13187.5-13200.0

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When evaluating a prospective employee, you probably consider several factors, such as: Past Experience, Track Record, Education, Attitude and References.

When considering a prospective supplier, shouldn't you also evaluate the company's qualifications?

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Texscan Corporation wants to be your company supplier. References are available throughout the Cable TV industry.

We can be reached at:
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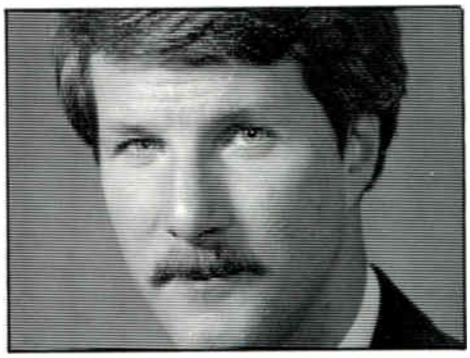
Which road shall we take?



By Bob Luff
Vice President, Engineering, United Artists Cablesystems Corp

Robert Frost's *The Road Not Taken* tells of a man who, in his journey through life, has come to a fork in the road and must decide which of two life paths to take. He chooses the one less traveled. The cable television industry has come to a similar divergence in its technical and business development and must decide which of two paths to choose—continuing complete technical compatibility to all existing and future over-the-air broadcaster's signals while foregoing cable's ability to do better; or, embarking on a deliberate path toward non-standard, over-the-air technical schemes in order to provide far superior, quality video and audio to our subscribers. As well, we could competitively extend our greater direct business role in the exploding home consumer electronics industry by nature of desirable, non-standard "interfacements" available only via cable. Is it time for the cable industry to take the path less traveled?

The decision will have a monumental impact on our industry.

Compatibility

Compatibility, to the agreed over-the-air NTSC standard, still offers many advantages to the cable industry and our subscribers. Since television sets universally remain designed for the NTSC format, basic level cable signals can be delivered in that format, directly to subscribers, without expensive and cumbersome set-top converters. This point should not be taken lightly. Also, the NTSC format lends itself to several simple reversible techniques that allow a medium level of pay signal security with a relatively inexpensive set-top descrambler. Thus, the cable industry is able to collect, duplicate and retransmit a wide range of over-the-air and pay programming for an attractive fee.

Additionally, the relatively inexpensive cost of cable's NTSC-based set-tops has allowed other features to be incorporated that have provided the industry and subscribers with new options such as addressability and lucrative remote control revenues.

Unfortunately, the path of compatibility, for all its virtues, has two very strong limitations—it relegates the cable industry to the secondary role of waiting for the over-the-air services to launch new video and audio technologies before new cable services and revenues can be achieved; and, such over-the-air services may be less than fully achievable through the cable medium due to inherent technical differences between the two delivery systems.

Cable's inability to do justice to the over-the-air BTSC multi-channel sound (stereo) is just one example that illustrates cable's secondary role and medium differences. These differences could severely limit cable's ability to remain compatible, and jeopardize the sacred long-term quality and quantity edge that cable has in signals, over all its would-be competitors.

The path less taken

Perhaps the cable industry should recognize the long-term limitations of compatibility, and develop its own products and services more uniquely suited to the strength of the cable medium.

Using the previous example of television multichannel audio, the cable medium's wider flexibility of revenue collection, additional spectrum and existing need for host set-top descrambling devices, could give rise to a number of alternative cost-effective analog or digital schemes to deliver television multichannel audio with CD equivalent specifications. Indeed, several such systems were demonstrated at the recent SCTE multichannel sound seminar and were available for purchase at the Texas Show.

Similarly, using superior satellite modulation schemes such as Scientific-Atlanta's B-MAC, modified headend equipment, and a new generation of set-tops, the cable industry quickly could realize benefits equivalent to pseudo-high resolution or at least "enhanced NTSC." This was suggested in an article by Surki Switzer.

The marketplace

But before choosing the apparently fruitful path less taken, we should carefully review the marketplace signs. Pipe dreams stir the heart, but the marketplace pays our salaries.

The industry is full of companies and technologies that took the path less taken—Qube, Indax, NABU, multiple teletext and videotex companies, and fire and alarm services. The marketplace, however is only yet demanding pay-per-view and most full two-way services. Why did the companies lose their way? Ken Gunter asks, "Is the marketplace trying to tell us something loud and clear; and are we listening?"

Are the preceding companies, cases of the industry shooting its arrows before the birds are in sight, or is the marketplace telling us that the market is the well traveled path of "over-the-air" type video and audio services? Of course, we each must answer these questions for ourselves. While each of these fallen technologies and services can be subject to individual interpretation (poor financing, poor management or engineering), the pattern taken as a whole is difficult to dismiss lightly. Accordingly, a total industrywide venture down the path less taken, should be approached with caution and careful consideration.

Both paths

Robert Frost's story is of a traveler that only could select one path. Cable systems have bountiful capacity and could, in fact, travel both paths.

Perhaps we should divide the discussion between cable's two-channel carriage distinctions: collecting and retransmitting signals of others (Class I signals), which suggest compatibility; and, what we should do with our own total end-to-end distribution capability of satellite or other cable pay services.

It is with this second group that the industry would have the greatest common interest to work together for a better technologically competitive product. The cause would both improve revenues, and shield our Achilles heel from future arrows shot from the inherent technical edge of direct broadcast satellites.

Time for decision

Again turning to the BTSC broadcast example, if the over-the-air broadcasters can inspire a new valuable service such as stereo TV sound for their industry, why can't cable do the same for its own mutual benefit. No one just handed the broadcasters the stereo technology on a platter; they had to organize and work for it. And if they had not acted, the stereo "ball" may have been taken away from them by other competing technologies. The cable industry also should be worried about standing too long at the fork making up our minds about which road to take. We may get rear-ended by other competing delivery technologies such as DBS, VCRs or broadcasters, while we wait for solutions to the final non-standard link to our subscriber—the NTSC television set.

New advancements in consumer electronics, such as the digital TV and NCTA/EIA cable-ready interfaces, may shorten the distance of the road less traveled for us as well as others.

Perhaps the key to the question of which road to take, is not which of the two roads, the familiar or the unfamiliar path, but that a direction is ultimately taken and pursued. Robert Frost's traveler does not end his journey at the divergence because he is confused or there is not a clear sign as to which path to follow. Likewise, the cable industry cannot just sit quietly at the fork in the road, waiting for a fellow competitive traveler to come along to point the right direction. It is up to all of us to make a decision, and aggressively pursue and develop the opportunities of the path finally taken.

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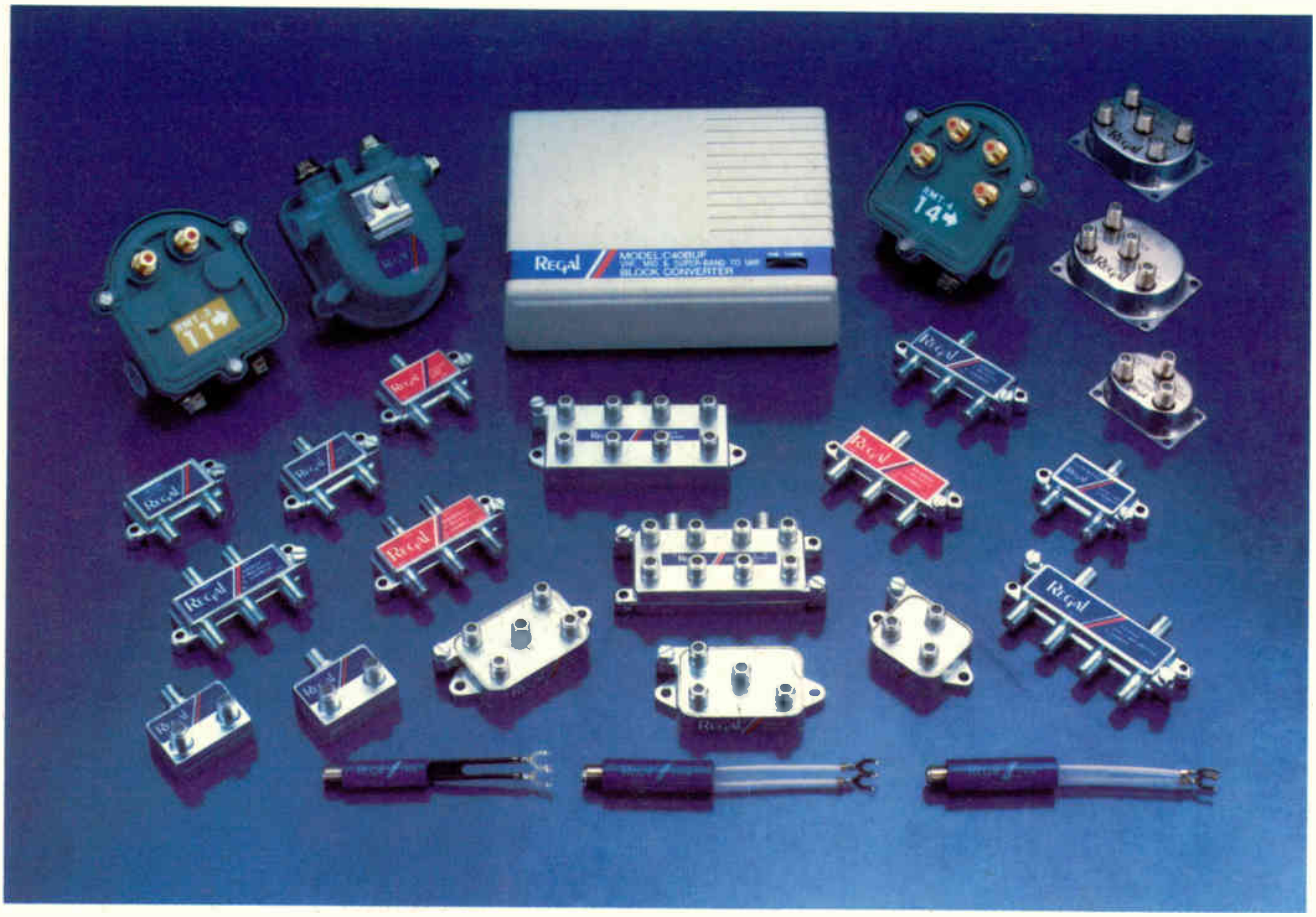

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