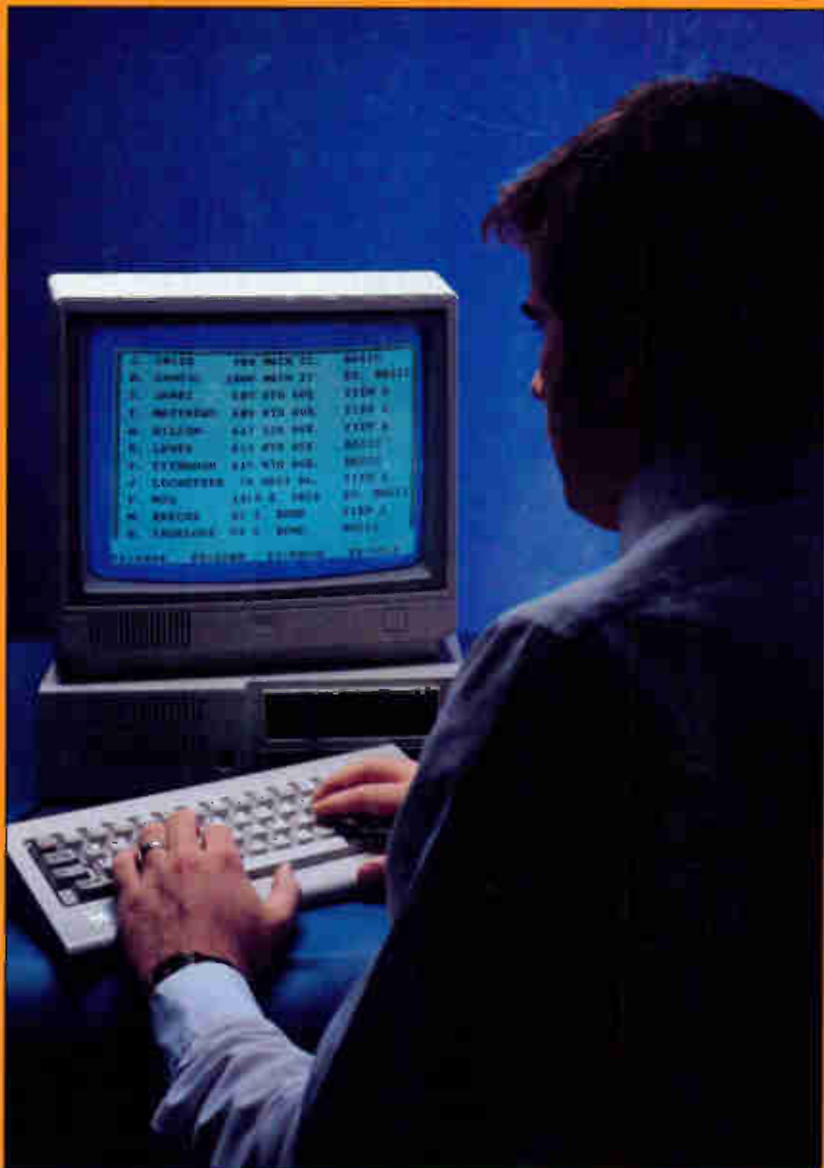
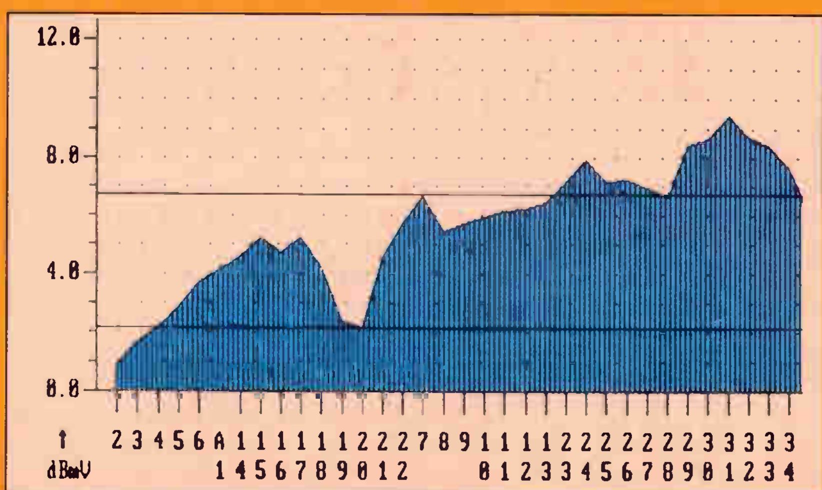
COMMUNICATIONS TECHNOLOGY

Official trade journal of the Society of Cable Television Engineers

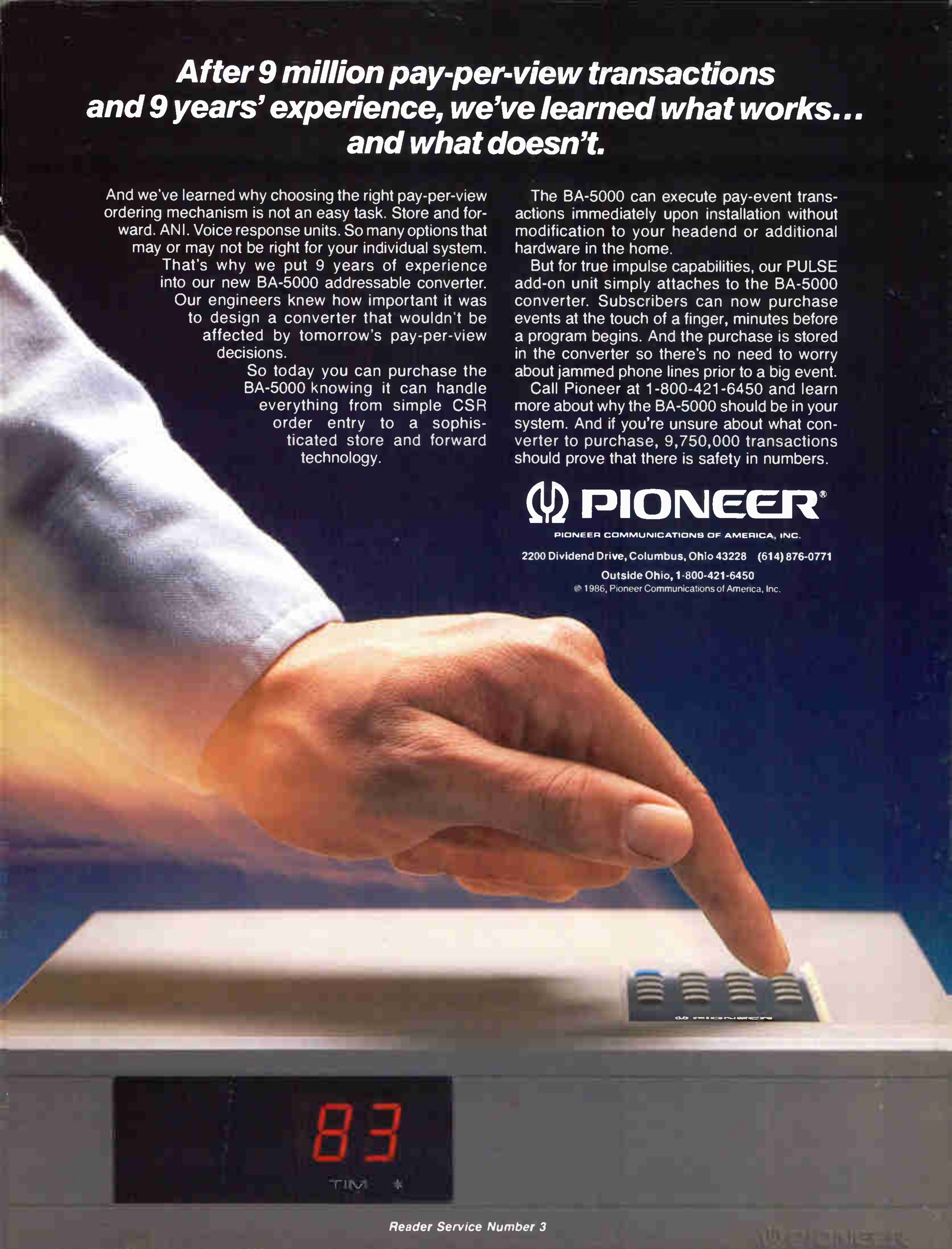


Addressing subscriber, system needs



Automated status monitoring

October 1986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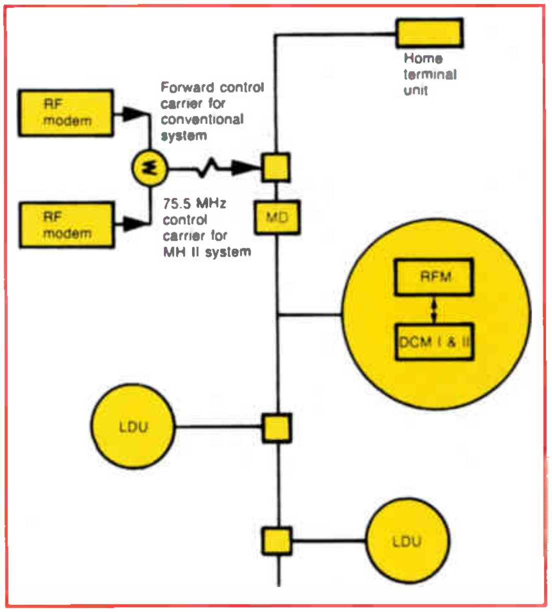

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A. Sight Selection
B. Antenna Performance
C. Signal Processing
D. Channelization Plans
Signal Quality ... Techniques

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GENERAL INSTRUMENT

Giant leap backwards

Recently, the FCC announced its new must-carry rules, which contain a requirement that CATV systems will have to provide free-of-charge a means for the subscriber to switch between cable and the outside antenna (i.e., an A/B switch).

According to a special report issued by the National Cable Television Association, "All systems (regardless of size) are required to install A/B switches for new subscribers at no additional cost. Existing subscribers must be offered the option of obtaining an A/B switch (and instructions for its installation) at no cost, or of having the switch installed by the cable operator (in which case the subscriber may be charged the operator's reasonable labor cost). Switches must be offered for every cable hookup and the offer renewed annually for five years. In addition, cable systems may not recommend the dismantling of antennas and must provide their subscribers with 'consumer education' information . . ."

C'mon guys, enough is enough! The thrust behind this action is political and mainly comes from the broadcasters.

"While potentially providing a 'political compromise' to the long unsettled must-carry issue," stated Robert Luff, "the FCC decision is potentially technically disastrous to a far more vital concern to the FCC and the cable industry than must-carry — harmful interference to safety-of-life, aeronautical and public safety radio services."

The problem's roots

The cable TV industry uses the same frequencies inside its cables as do airplanes and public safety services. Cable systems use shielded cables throughout the distribution plant to keep CATV signals from interfering with the other users of these shared frequencies. The FCC, ham operators, FAA and others have been extremely concerned about the potential for interference. FCC limits are very stringent and in a number of incidences cable systems have had a difficult time complying due to damaged cable, poor workmanship and loose connectors.

"Even with the appropriate labeling and public awareness information," stated Luff, "it is believed that many subscribers would not understand either how to properly connect an A/B switch or the importance of the possible interference they would cause.

"The new requirement for cable systems everywhere to provide a means for all subscribers to easily switch between cable and an antenna," Luff stressed, "is not bad for the cable industry other than the expense involved. The problem is this: It is all too likely in the days, weeks or months following the CATV installer's proper connection of an A/B switch that in the course of normal household functions, such as moving furniture, cleaning, dubbing VCR tapes, disconnecting the TV during an electrical storm or vacation, or adding a new video game or VCR, the homeowner will become confused and inadvertently end up with the CATV signal directly connected to the antenna, which will surely cause widespread interference, possibly to safety-of-life services, that the cable system will have to be responsible for and correct."

The bottom line is that once again the burden shifts to the cable TV industry. Not only do we have to educate the subscribers, but operators will become involved in time-consuming details to locate the leakage source and end up scheduling a second costly service call (inconveniencing the subscriber as well).

"The A/B switch requirement of the new must-carry decision is so out of step with the commission's just-finalized eight-year-long rulemaking attempts to minimize any potential for harmful interference to safety-of-life, aeronautical and public services from CATV (Docket 21007)," said Luff, "that one wonders just how much thought and critical technical input was involved in the decision process or if the different departments of the FCC ever communicate with each other!"

Etceteras

While reading through this issue of *CT*, you will notice the absence of "Luff's Comments." Bob asked for a one-month vacation while he relocated from the East Coast to Denver to join the ranks of Jones International as vice president of technology. While we'll miss his thoughts this month, we wish Bob well in his involvement in new projects and acquisitions for Jones and look forward to his return in the pages of our November issue.

Speaking of the November issue, we will present a complete index of articles and columns published since the magazine's inception in March 1984. This is a service done for our readers. After all, we are a service-oriented publication geared for a service-oriented industry. Also in our November issue, the editorial emphasis will be on headend performance and maintenance, and we're convinced our readers will find the information useful.

Toni I. Barnett

BOB ZEQUEIRA, JR., PURCHASING & CONTRACTS ADMINISTRATOR,
SELKIRK COMMUNICATIONS, INC.

Like many cable operators, Bob Zequeira found his system the victim of extensive cable theft. Cable thieves were connecting their own service by gaining illegal entry into the cable enclosures. Selkirk Communications' only recourse was to find a high security enclosure capable of restricting unauthorized entry.

But security wasn't Selkirk's only problem. The harsh South Florida coastal environment was another factor to be dealt with, since constant exposure to salt air can be highly corrosive.

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Corrosion-resistance has been a major factor in the purchase of cable enclosures since Selkirk established its system seven years ago. "We have used your apartment box for many years. We realized it was a very good product because of its finish. We tested it and installed it in buildings and areas where the salt concentration is the heaviest. We found it to last without any problems."

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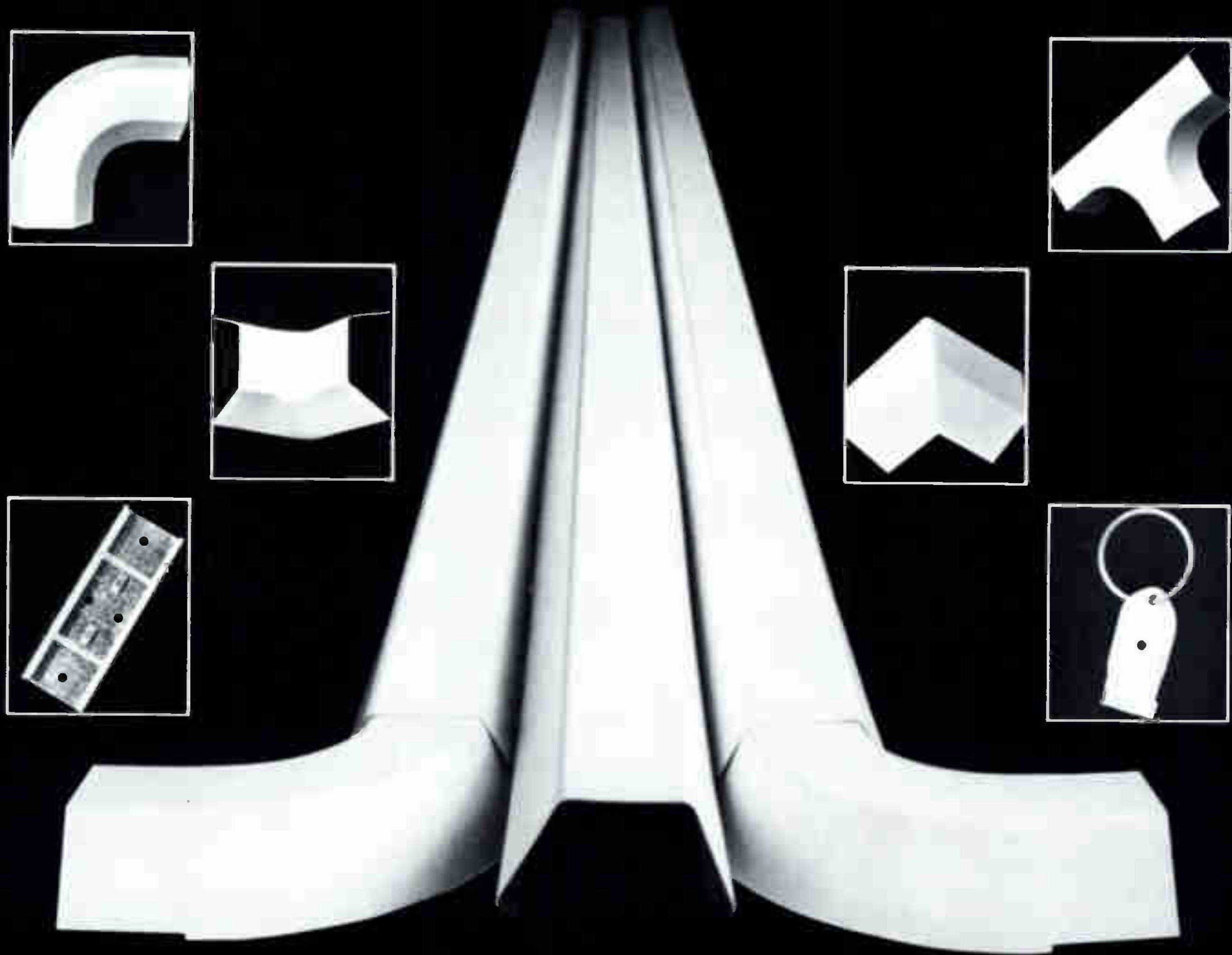

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Atlantic Show '86: 'Cable's on a roll'

ATLANTIC CITY, N.J. — With the theme "Cable's on a Roll," the 1986 Atlantic Show is scheduled to get under way Oct. 28-30 at the city's convention center. Technical, marketing and management tracks are planned, as well as displays from over 300 exhibitors, an increase from last year. Sponsored by the Maryland/Delaware, New Jersey, New York and Pennsylvania cable associations, the fifth Atlantic Show has gambled on an even greater attendance, topping last year's 2,600.

The show's agenda, featuring technical sessions, is as follows:

Tuesday, Oct. 28

11-11:15 a.m. — Ribbon cutting ceremony

11:15 a.m.-1 p.m. — Keynote program: "Cable's on a Roll . . . You Can Bet on It," panel discussion on entertainment and information programming, moderated by Jack Pottle of Browne, Bortz & Coddington

1-3 p.m. — Lunch

1-6:30 p.m. — Exhibits open

2-3:30 p.m. — "Technical considerations for 550 MHz cable systems," moderated by John Kurpinski, Wade Communications

3:30-4 p.m. — Coffee break

4-5:30 p.m. — "Interfacing consumer electronics," moderated by Randy Evans, chief engineer, Harron Cable Television

5:30-6:30 p.m. — Cocktail party

Wednesday, Oct. 29

9-10 a.m. — Associates meeting

10 a.m.-5:30 p.m. — Exhibits open

10 a.m.-3:30 p.m. — BCT/E Certification exams, walk-in testing for all available categories, moderated by William Riker, executive vice president, Society of Cable Television Engineers

3:30-5:30 p.m. — Exhibit time

Thursday, Oct. 30

9:30 a.m.-Noon — Exhibits open

10 a.m.-Noon — Technical open forum: question- and-answer panel moderated by Thomas Gimbel, vice president and systems manager, Comcast Cable of Philadelphia

NCTA issues call for papers

WASHINGTON — Proposals for technical papers to be presented during the 1987 National Cable Television Association convention May 17-20 in Las Vegas, Nev., are due Dec. 19 at the association's headquarters.

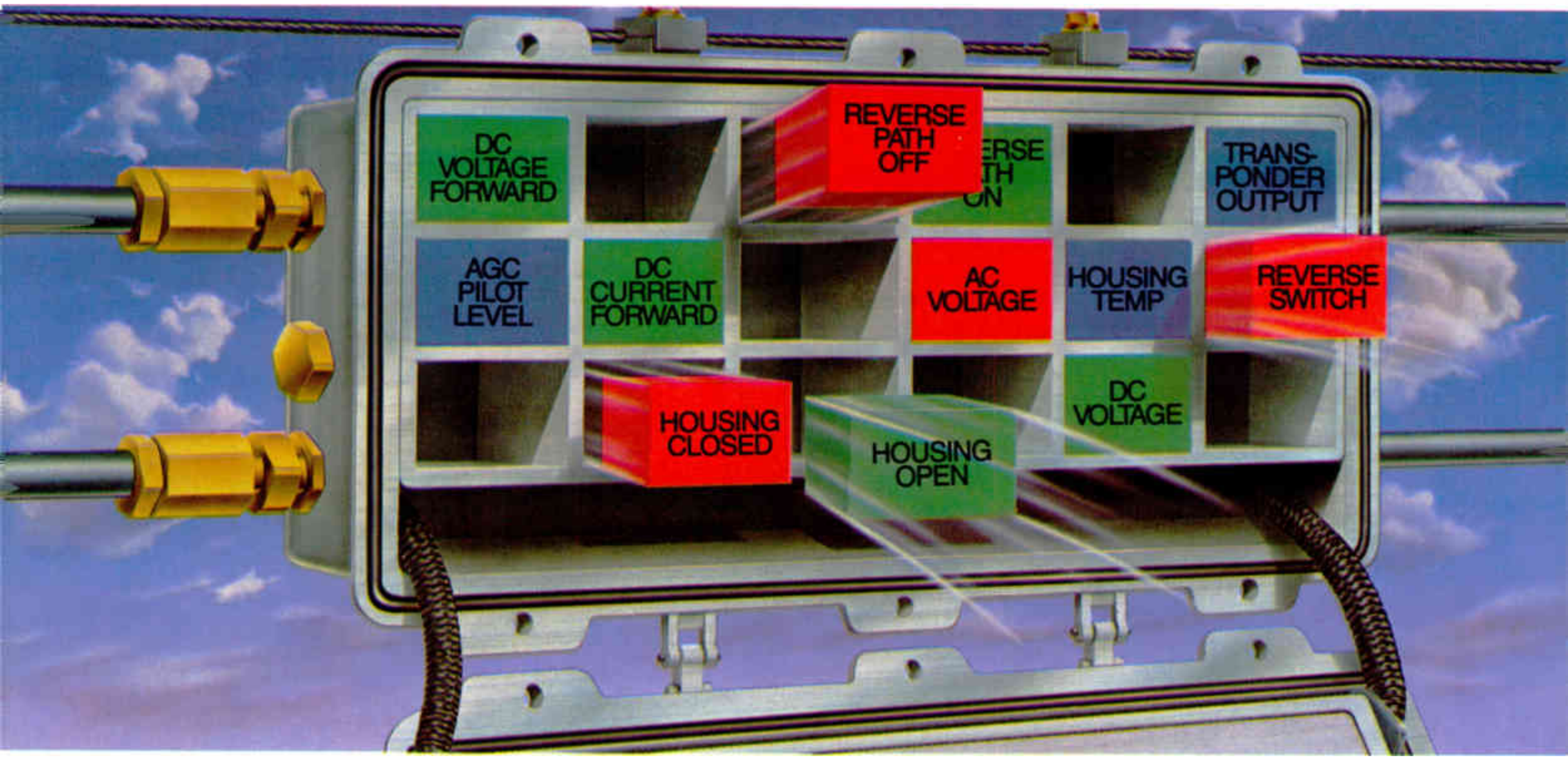
Persons interested in presenting original, non-commercial papers on communications engineering topics of interest to the cable TV industry should submit 250-word summaries to Wendell Bailey, NCTA, 1724 Massachusetts Ave., N.W., Washington, D.C. 20036.

The papers will be presented during the National Show's technical program and published in the conference proceedings text.

SCTE announces '86-'87 Directory, Yearbook

WEST CHESTER, Pa. — The Society of Cable Television Engineers has announced the start of production on its 1986/87 Membership Directory and Yearbook. It will include a listing of SCTE members, as well as committees, chapter and meeting group officers, a calendar of events, president and executive vice president reports and more. A wrap-up of the year in pictures also is planned.

SCTE directories are projected for distribution to all national members by year end.



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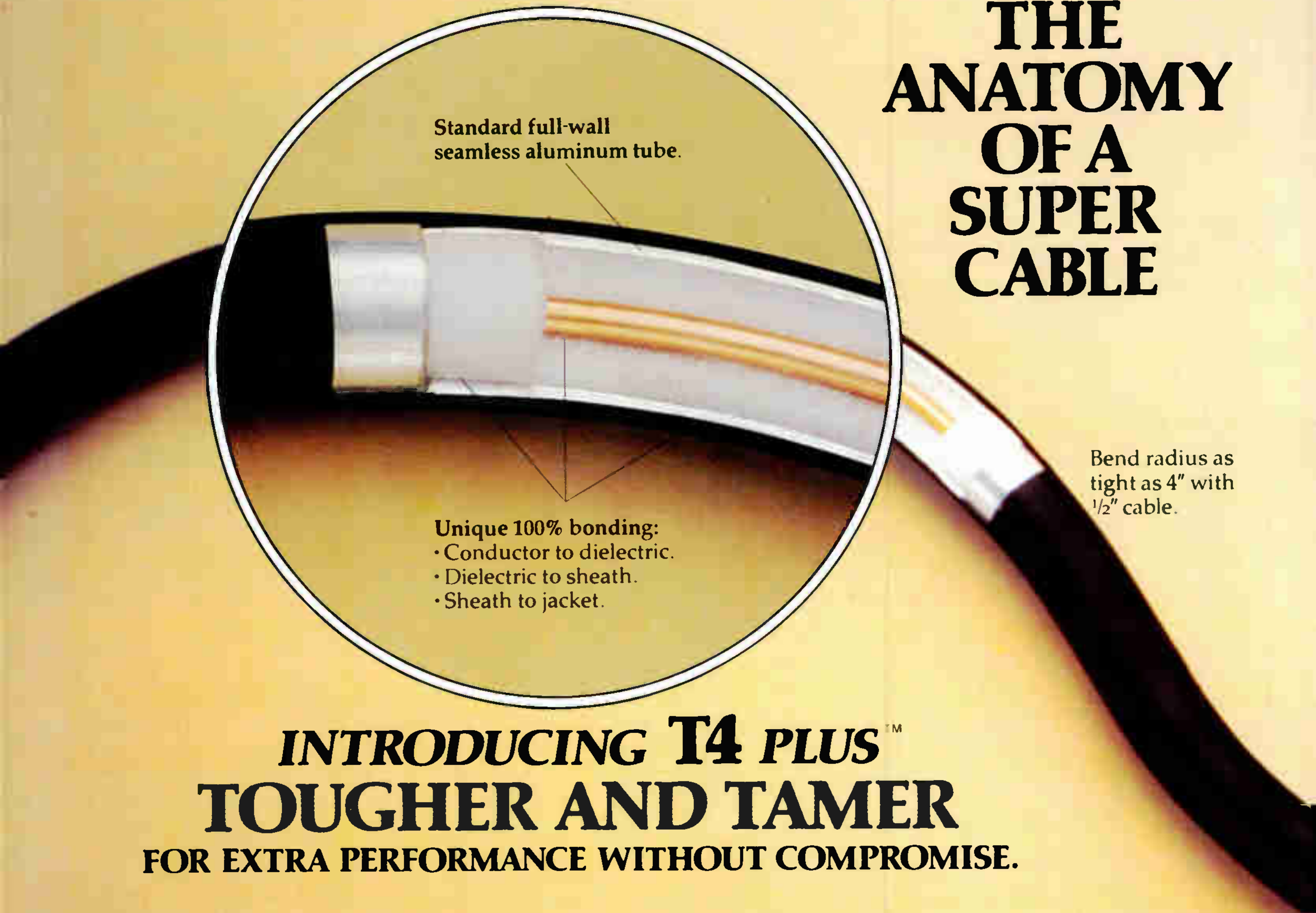
THE ANATOMY OF A SUPER CABLE



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Reader Service Number 10

The incompleat engineer

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

Let's hear it for the design engineer . . . Hip, Hip, Hooray! Go for the gold! Leave your competitors behind! Hip, Hip, Hooray . . . But the old sounds have faded, save for recurrent echos too weak to stir up the dust in the empty laboratories. The consumer electronics marketplace is teeming with new products, sales are setting new records daily, and prices are falling as fast as inflation is rising. The American public is well-served by our free economy and open borders. But is there a price to be paid for the demise of the consumer electronics manufacturers?

Our engineering education infrastructure is still intact and the quantity and quality of the courses are improving with time. The textbooks we were assigned in the '30s contained a mere fraction of the material now taught. Not that the quality of those professors and students were inferior, but simply that science seems to be exploding exponentially and, somehow, the same four years of college today covers many more topics than in my day.

Hard knocks

So, our engineer graduates with an adequate scholastic start on his career and, whether by chance or as a considered choice, chooses a career in consumer electronics. Jobs in the '30s were scarce for engineers and I considered myself fortunate to find work as a troubleshooter in radio factories. One plant was so impoverished that we were warned not to cash our paychecks for two weeks, since the boss had not been paid for the last shipment of $5 radios! Thus, I attended the school of hard knocks and production at the factory level. The factories now are offshore and today's engineer will not be able to sit at the end of an assembly line, cursing the poorly researched product he has to nurse past final test under the bloodshot eyes of the slavedriver who holds him personally responsible for the sins of the invisible design engineer. No textbook ever can be written nor can a course be programmed to approximate the environment your product encounters in the factory.

The best teacher and disciplinarian an engineer ever has is the factory quality control person, who appears regularly with yet another Gordian knot around your design, pointedly remarking that you are responsible for missed production schedules and imminent catastrophic shutdown and this time you had better make the fix permanent (or else . . .).

Service and sales experiences are replete with lessons on human engineering and human foibles taught only in the school of hard knocks. For instance, a large percentage of defective products sent to the service department are not defective at all. The customer either misread

> 'No textbook ever can be written...to approximate the environment your product encounters in the factory'

the specifications, installed it incorrectly or desired a refund. Just recently, I sent back a consumer product twice to the manufacturer as obviously being defective until I finally contacted an applications engineer who revealed that another product had to be attached with an umbilical cord for the first one to function properly. Not mentioned in the literature! (Or perhaps the translator was at fault.)

Unfortunately, even in the heyday of American electronics supremacy, the design engineer was isolated from the customer. The outside world is an experience no one should miss — instruction sheets are discarded with the packing, the plug goes in the socket before even the warning labels are read, the post office uses steamrollers to load parcels, every other shipping service drops the packages on concrete, and King Kong adjusts all the controls.

Erosion of engineers?

Research and development, where have you gone? Unless a designer is given the tools, the funds, the assistants and the objectives, few inventions and innovations will appear. Even in the digital arena, where there yet exist healthy, fully integrated American firms, the erosion to overseas production and design is apparent. Just about every new technology in consumer electronics for the past decade originated overseas; our design engineers now are functioning as consultants. Everyone knows that consultants are not inventors. (Sam, I'm only making a bad joke!)

What harm can befall the United States if the electronics is designed and made overseas and our engineers are confined to non-creative positions in service and application tasks? In time, all the old design engineers will be ashes along with our false prosperity. Unless we can train and employ fully rounded engineers, both the defense forces and the gross national income are endangered.

Is there an answer? Eventually, if our standard of living declines sufficiently, we may recapture some of the vanished factories. But that will be both distant and perilous to our survival as a democratic nation.

Better yet, if we all could resolve to buy American, work harder and save more, then design engineers might regain their former exalted status as the keystone of our past prosperity.

Off-premises switching: Alternatives in CATV control systems

At present, the delivery of pay television signals primarily has involved scrambling of protected signals. This method has several inherent problems, particularly in the area of program and equipment security.

The initial obvious solution was to employ off-premises control systems. These system designs are based on off-premises converters, which have proven to be less than the ideal answer. It appears that either off-premises addressable tap systems or hybrid tap/scramble systems may prove more effective in this application.

By Karl W. Poirier
Vice President, Corporate Development
Triple Crown Electronics Inc.

The ongoing discussions on the relative merits of off-premises control have suffered from a lack of functional definition. This lack of definition and, in particular, excursions into non-traditional areas of population, have generally led to system overcomplexity.

The functional requirement can be described under several categories: CATV control, including program access, normal pay control and pay-per-view (PPV) control; secondary service, including interactive services, telephony and text services; and convenience services, including channel selection.

These functional requirements can differ in motivation. For example, channel selection is a requirement in British systems where tuners are not incorporated in TV receivers, while in North America, channel selection is a by-product of the control technology employed.

Most attempts at systems to perform these functions are based on the obvious solution of remotely located converter or converter/descramblers. While this method appears at first to perform the majority of desired functions, the operational reality is somewhat less than perfect.

As attempts to implement these systems progress, several major constraints become apparent. Of particular note are:

1) the switched-star or off-premises converter system being extremely capital intensive;
2) the requirement for operator equipment in the customer home;
3) the inability to serve multiple receivers without duplicating the amount of dedicated hardware;
4) incompatibility with cable-ready TVs and VCRs;
5) physical mass of the system; and
6) overall system electronic complexity.

The primary cause may be that the switched-star or off-premises converter does its job too well and, in fact, undertakes functions that could be considered as beyond the domain of the CATV operator.

Proposed requirements

Perhaps we should digress slightly and examine the proposed functional requirements in the context of a CATV operator. Basic service control is a primary system requirement, pay television control is a primary revenue generator, and pay-per-view is a primary future potential. These are the obvious primary requirements of an off-premises system. Many systems also have designed-in capability for secondary services. The most commonly discussed optional capabilities are:

Interactive functions: These are best defined as two-way transactional services, such as tele-banking, tele-shopping, polling, etc. Up to now, experiments with this type of service have been just that — experiments. We have seen that, to date, these concepts have been technology driven as opposed to market driven (i.e., "How can we sell what we do?" as opposed to "How can we do what they want to buy?"). This technologically driven approach to product invariably has led to failure, because it is impossible to sell a technological means to which there is no market-driven end. CATV customers are not demanding tele-banking, tele-shopping and similar services, nor could they readily be convinced of their need for such services.

Text services: These have had success in several very limited applications. In particular, hearing-impaired captioning has proven viable, as has text delivery on a narrowcasting basis. Text service has been successful in remote areas, such as Western Australia, where it is normally the first print information to be delivered to the customers. The supply of text services as a revenue-generating vehicle on a broadcast scale has yet to be proven viable.

Telephony: The delivery of telephone communications via the CATV network has been considered primarily by European government telephone agencies. If we observe the operation of a traditional North American telephone system, especially in light of deregulation and diversification, we can observe one obvious effect: The local telephone network is not necessarily revenue self-sustaining. Traditionally, the telephone network has been self-subsidizing via long-haul revenue generation. To isolate the local telephone network, especially in the context of a CATV system, which is by nature a localized system, does not hold significant potential as a revenue-generating vehicle. In fact, the application of a CATV system to telephony has a somewhat reversing technological effect, in that we must build a telephone network carrying TV as opposed to a

Figure 1: Addressable descrambler technology

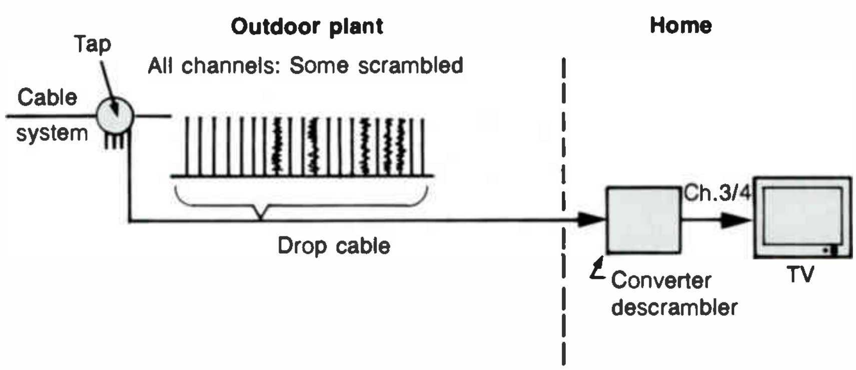
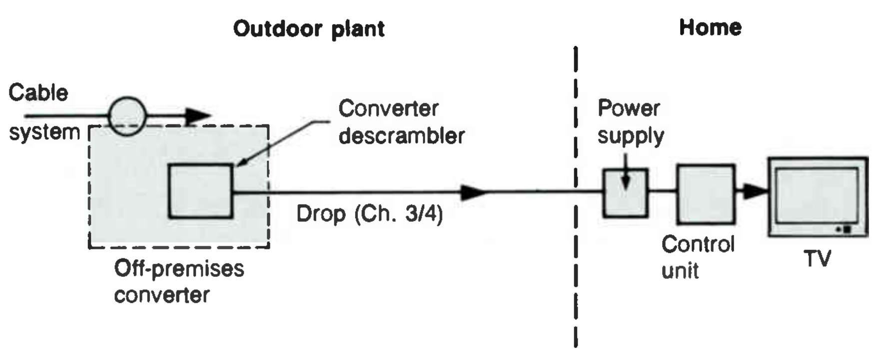


Figure 2: Off-premises converter

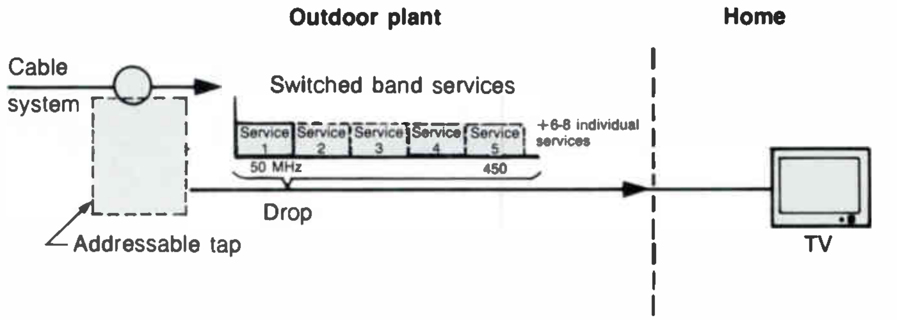


TV network carrying telephone service.

Channel selection: Most television receivers in Europe and the United Kingdom do not incorporate a multichannel tuner. All North American television receivers have at least a 12-channel tuner, and most medium- and high-priced receivers have full-tuning capacity. The European telephone companies, particularly the British, have taken the task of channel selection to be the responsibility of the CATV system as a marketing advantage position.

In North American systems, the function of channel selection has been provided as a by-product of the technology of remote converters, along with the inherent weaknesses of having only one channel at a time enter the customer's home. The overriding question remains: Is it the responsibility of the CATV operator to provide channel selection, or is the operator's primary responsibility limited to delivery of the signals?

Figure 3: Full-function addressable tap



In order to clarify this situation, the CATV operator must approach the problem from the viewpoint of "What must a CATV control system do?" as opposed to "What can be done with a CATV control system?" The critical requirements of a CATV control system are:

1) secure access to basic and premium programming;
2) reduce the cost of ongoing field service caused by basic connections, disconnects, pay churn, etc.;
3) provide a vehicle to support the sale of impulse programming and demand services; and
4) allow full use of customer-owned video and audio equipment at a reasonable capital cost.

These items require a careful analysis of the proposed control system, realizing that optimum design may result from a mix of technologies, as opposed to a single all-encompassing technique. It is much more critical that the system be *upgradable* than to try to allow for all possibilities at the outset.

Available options

When we approach the three primary functions of CATV control — basic service access, pay television security and potential pay-per-view — we have various technologies at our disposal.

It is primarily the pay-per-view requirement that complicates these options. When we were dealing with only basic and pay television, it was possible to employ totally static or passive methods; i.e., drop control and traps, or similar devices. Pay-per-view, by virtue of timing requirements, must use active or dynamic control systems.

Thus, in today's system we have these available options: addressable scrambling, off-premises converters, addressable taps or a combination of these technologies. We also have, with each method available, a potential for some or all of these problems: high capital cost per subscriber, customer access to secured programming, operator-owned equipment in home, field installation and VCR/cable-ready interface.

These addressable tap technology options are currently available: basic service (all band) switch, basic service plus pay tiers (e.g., low, mid, high, super, hyper), or basic plus tiers plus discrete channel control.

Options for hybrid systems (addressable tap plus addressable descrambler) are: addressable basic plus encrypted pay/PPV, or addressable basic plus addressable pay plus encrypted PPV.

If we examine several of these options on a capital cost vs. flexibility basis, we may see that the obvious solution is not necessarily the best.

Addressable scrambling: The most widely employed CATV control technology is the addressable scrambling system (Figure 1). Although the technologies involved vary widely between manufacturers, these systems are quite similar in concept and end result. There are however, several parameters that are relatively universal:

- scrambling usually requires little or no modification to existing plant;
- scrambled services are brought into the customer's home along with basic cable service;
- expensive operator-owned equipment is installed inside the customer home; and
- descramblers are largely incompatible with customer equipment, such as cable-ready TVs, stereo television and programmable VCRs.

Off-premises converters: A natural development of the addressable scrambling approach was to move the operator-owned converter out of the customer's home (Figure 2). While at first glance this may seem to be a solution to some of the problems posed by addressable scrambling, there are new limitations imposed by this technology. Among these are:

- a requirement to install at least the support structure (housings, power supplies, etc.) for all homes passed in the system;
- a requirement to separate the addressable descrambler/converter, so as to leave the channel selection circuit in the customer's home;
- a requirement to duplicate hardware in order to serve multiple televisions; and
- system still incompatible with most customer-owned equipment.

Full-function addressable tap: Many operators have found that addressable tap technology (Figure 3) can solve many of the problems encountered with an off-premises converter system. The addressable tap is considerably less complex than the off-premises converter with some particular advantages:

- no operator-owned equipment in the customer's home, except leased, low-cost converter (if required);
- full cable-ready and VCR compatibility;
- no disconnect/reconnect or equipment recovery manpower costs for basic service customers;
- no customer access to either secured programming or converter control interfaces; and
- particularly adaptable to high churn and transient residential areas (apartments, etc.).

Hybrid system: The use of a combination of technologies can provide better security, flexibility and cost performance than single technologies in some cases. In particular, the com-

Figure 4: Hybrid addressable/scramble

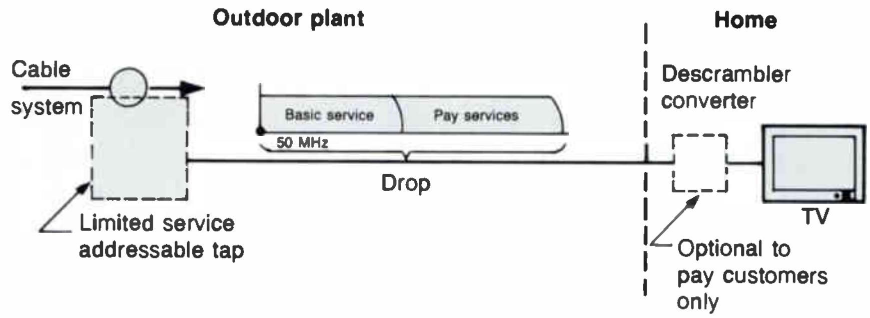
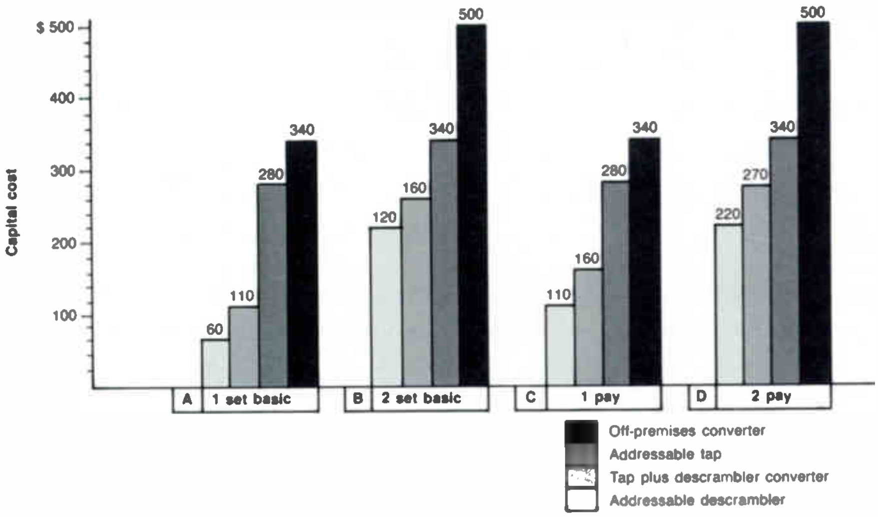


Figure 5: Capital cost of standard TVs using various technologies



bination of a limited-function addressable tap with addressable descramblers for pay service can have advantages in both operating cost and security. In this system (Figure 4), access to all programming is secured via addressable tap.

Even basic service customers do not receive encrypted pay services. Pay reception requires both a descrambler from the operator and the activation of the pay service tap. While this system retains some of the difficulties of normal addressable scrambling systems (i.e., operator equipment in the home), it does offer several distinct advantages. In particular, there are no service costs for basic reconnect/disconnect, as well as no access to secured programming by non-pay TV customers.

Capital cost analysis

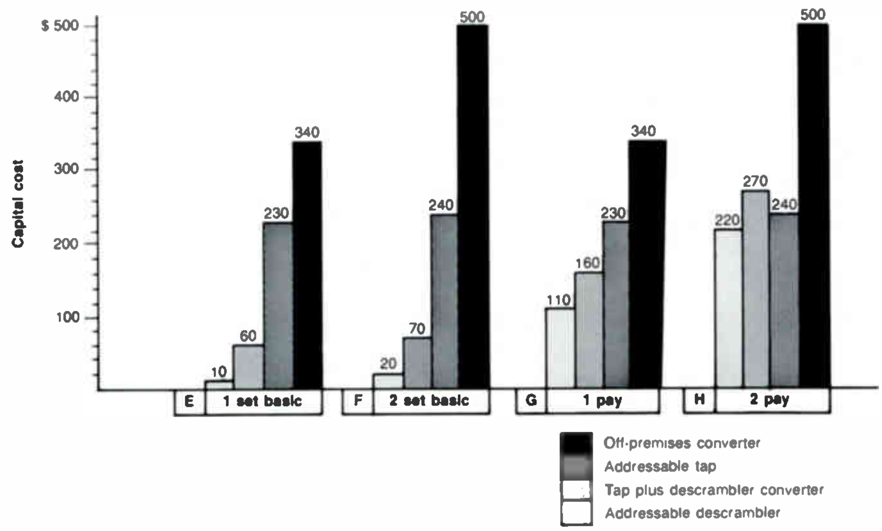
In order to properly analyze the comparative costs of various control technologies, it is necessary to examine several different customer applications. The following comparison deals with four different technologies: off-premises converter; full-function addressable tap, including converter where required; basic-function (basic plus pay TV) tap, including descrambler where required; and addressable descrambler.

These applications are analyzed: one basic, two basic, one pay, two pay, one basic (cable-ready TV), two basic (cable-ready TV), one pay (cable-ready TV) and two pay (cable-ready TV). The comparison assumes 50 percent penetration of basic, where the support structure (housings, power supplies, etc.) is installed for 100 percent homes passed, and amortized over the actual penetration.

Representative per-drop prices were developed from market analysis and employed in the comparison:

Off-premises converter	$290-$340
Full-function addressable	$230
Basic-function tap	$ 60
Addressable descrambler	$100
Basic converter	$ 50
Basic tap and hardware	$ 10

Figure 6: Capital cost of cable-ready TVs using various technologies



As can be seen by the comparison graphs (Figures 5 and 6), the effect of various applications can show dramatic variation in capital cost depending on technology employed. In comparison of Columns A and B:

1) The capital cost increase from single to dual outlet varies from $60 to $160, depending on the technology.
2) The actual capital cost for two basic sets varies from $120 to $500. In the basic service application, both the off-premises converter and the addressable tap have much higher costs due to having the pay service capability built-in. This can be seen in Columns C and D, where no increase is shown for addition of pay services with these technologies.

A major difference in the cost-effectiveness of technologies can be seen where the effect of cable-ready TVs is examined. All technologies except off-premises converters take some advantage from cable-ready TVs in the basic service application (Columns E and F). In the pay service modes (Columns G and H), only the addressable tap system gains a cost advantage from cable-ready sets.

Final observations

The most significant observations from this analysis are:

1) The combined addressable tap/descrambler system compares favorably to the addressable descrambler system cost with the benefit of much higher security.
2) As both penetration of pay service and penetration of cable-ready sets increase, the cost-effectiveness of a full-function addressable tap system increases.
3) Off-premises converter systems gain no advantage from cable-ready TVs or multiple-set connections.

Author's note: Financial information for this article has been provided by Joseph L. Stern, Stern Tele-Communications Corp., New York.

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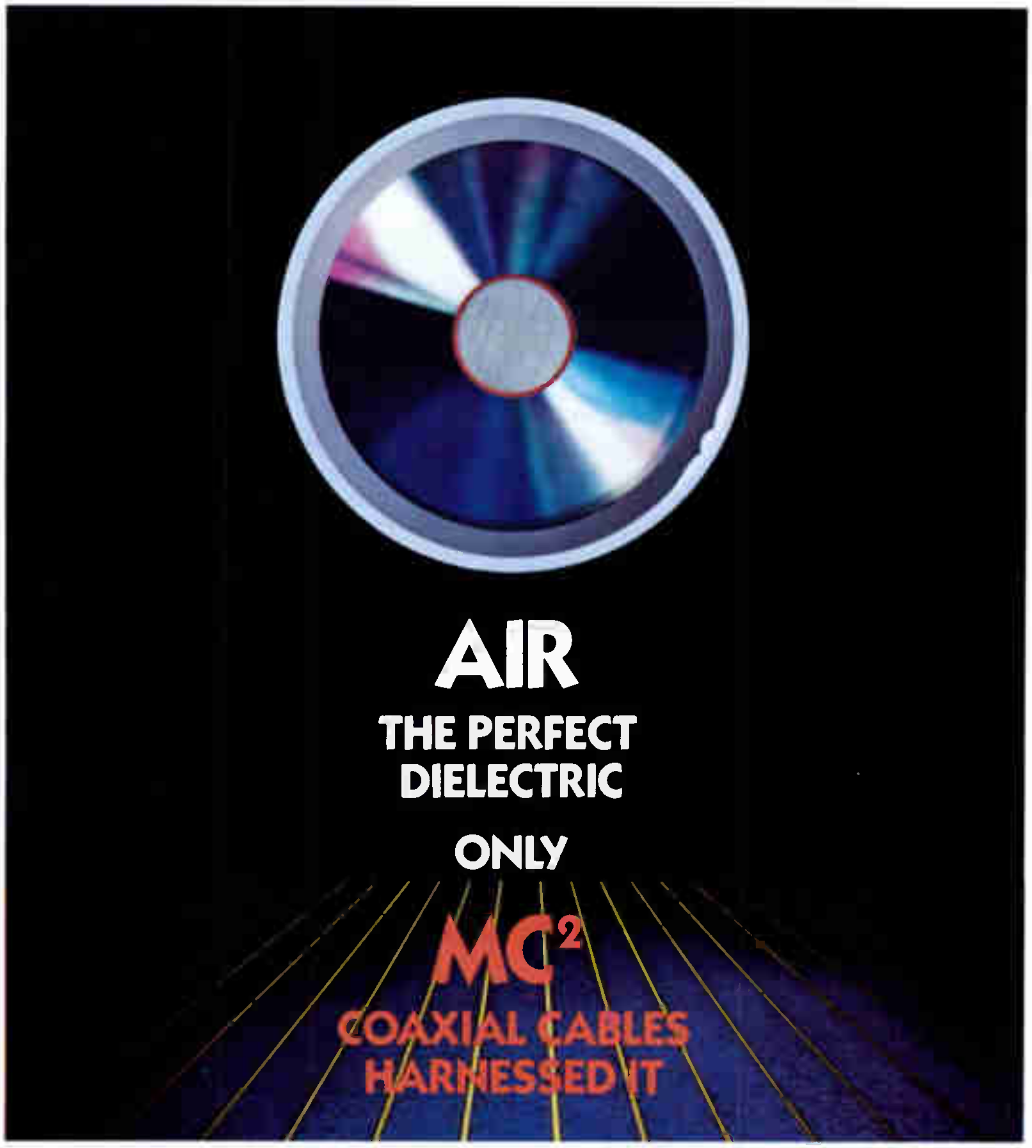

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Mass descrambling for hybrid addressable systems

The well-accepted advantages of an off-premises star-switched distribution system include security of signal and reduction of equipment theft. These advantages have prompted many cable operators to plan system expansions in a theft-prone environment such as multiple dwelling units (MDUs) by using the star-switched technology. This article reviews the issues of compatibility for implementing a hybrid addressable system comprised of conventional addressable set-top units and star-switched distribution nodes.

By M.F. Mesiya, N. Bunker and H. Lehman
Times Fiber Communications Inc.

Conventional CATV systems employ tree and branch network topology. The network structure was developed as a cost-effective way of distributing a number of TV channels using the VSB-AM/FDM (vestigial sideband-amplitude modulated/frequency division multiplexed) transmission format. The advent of premium programming created the need to control a subscriber's channel reception capabilities from an MSO's central office. Addressability and scrambling/encryption are used as the means of controlling the availability of multi-tiered premium services to CATV subscribers in the network. The demands for tighter security and the subsequent increase in the complexity of descrambling/de-encryption circuitry continue to increase the cost of home terminal units (set-top converters) on the subscriber's premises.

The expensive home terminal unit ($100 to $135) undoubtedly reduces the MSO's losses in the signal theft area. However, it exposes the operator to higher equipment theft losses in a high churn MDU environment, especially in metropolitan areas. This is why, in the existing builds in these areas, MSOs have not wired theft-prone MDUs with a conventional set-top addressable system. Providing service to these MDUs represents a major area of expansion and revenue growth potential for MSOs.

Unlike conventional addressable set-top distribution systems, an off-premises star-switched system achieves signal security by denying a subscriber access to the whole signal spectrum. Rather, the control over delivery of service is obtained by transmitting only one or two selected and system-authorized channels to a subscriber from a remotely located local distribution unit (LDU). The addressability/authorization function no longer resides within the subscriber-accessible equipment and does not require headend signal processing with the

Figure 1: Headend control system using separate computers for two systems

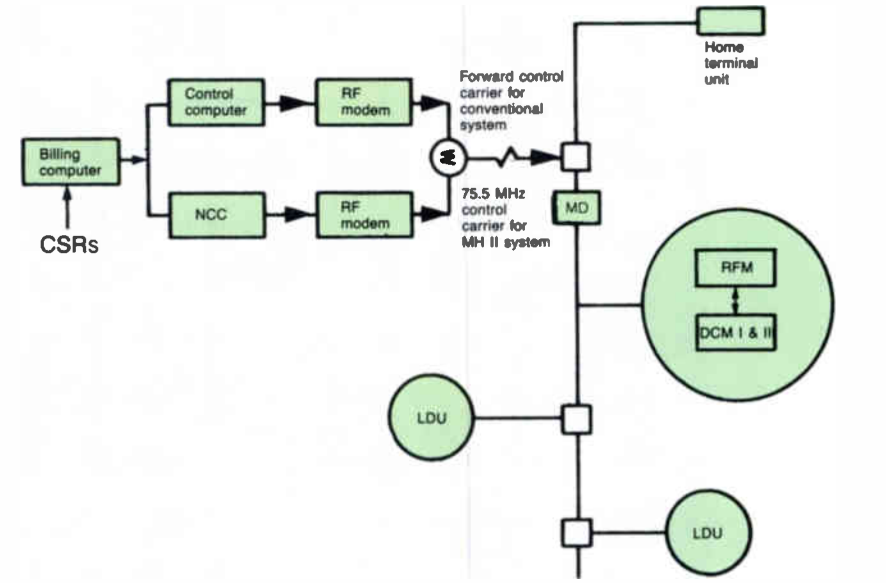
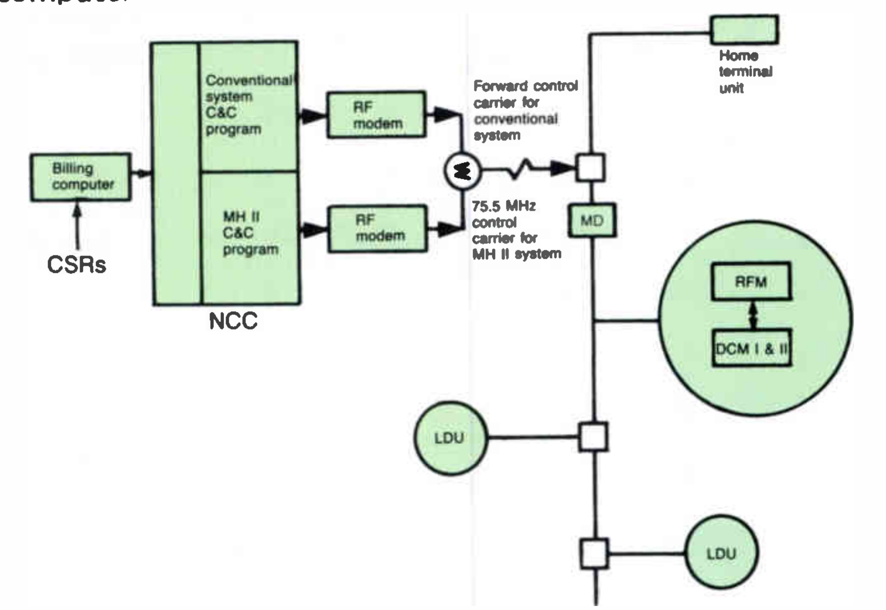


Figure 2: Headend control system with a common control computer



'Every addressable system follows a unique communication and control scheme to restrict the access of service to subscribers'

attendant possibility of degradation in signal quality or incompatibility with new advances in video services, such as stereo audio. The characteristics of the transmission format on the drop and the removal of expensive hardware from the subscriber's premises minimize in an optimum fashion equipment and signal theft losses. Thus, it is of great interest for MSOs to plan their system expansions into the MDU environment using star-switched off-premises technology.

Issues and alternatives

A hybrid system in which off-premises star-switched technology may be added to an existing tree-branch plant creates some compatibility issues; for example, descrambling of existing premium channels. Three possible methods of resolving this issue in such a hybrid system are clear trunk, per-subscriber descrambler and mass descrambler.

The clear trunk option means that a separate trunk from the headend carries all signals, including premium, in clear form for distribution to various nodes where LDUs are located. This may be an attractive solution if MDUs are concentrated in a geographic location in a city. This method does not put a limit on the number of scrambled channels. However, the cost of a separate trunk should be justified versus other methods.

The per-subscriber descrambler option implies that the selected channel on the drop for each subscriber is passed through an on-board or attached descrambler module in the LDU. Alternatively, the descrambler can be located in the subscriber's premises. Many MSOs are reluctant to provide an unaddressable descrambler in the subscriber's premises because it can be moved illegally in the franchise. Furthermore, there are many scrambling methods, and manufacturers of converters like to maintain confidentiality of their scrambling/encryption techniques as well as communica-

(Continued on page 28)

Steve Dewey; Purchasing Agent, Tribune United, Royal Oaks, MI

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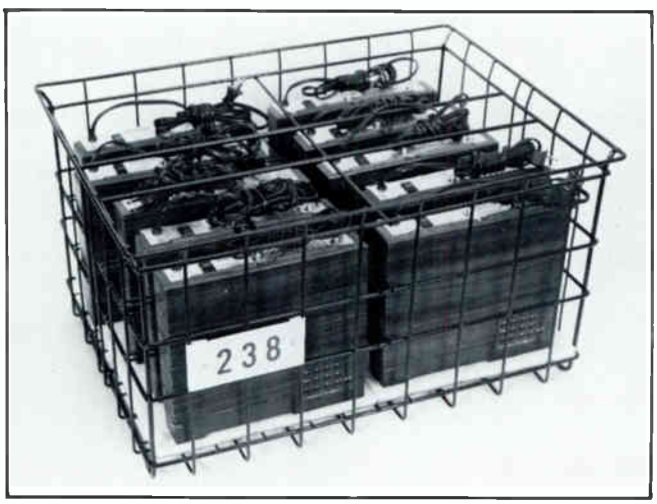

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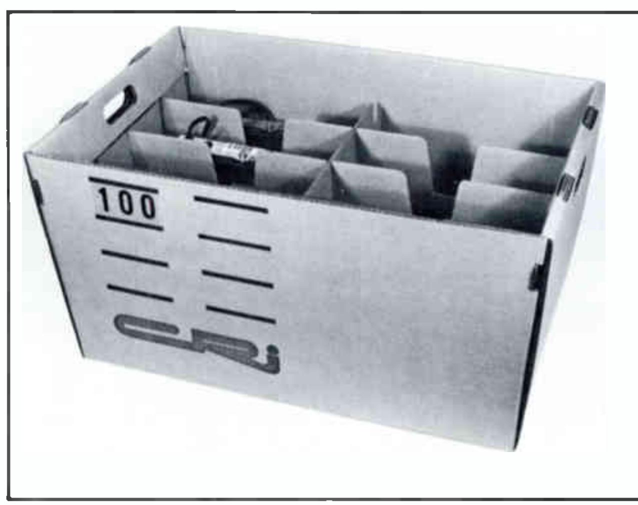

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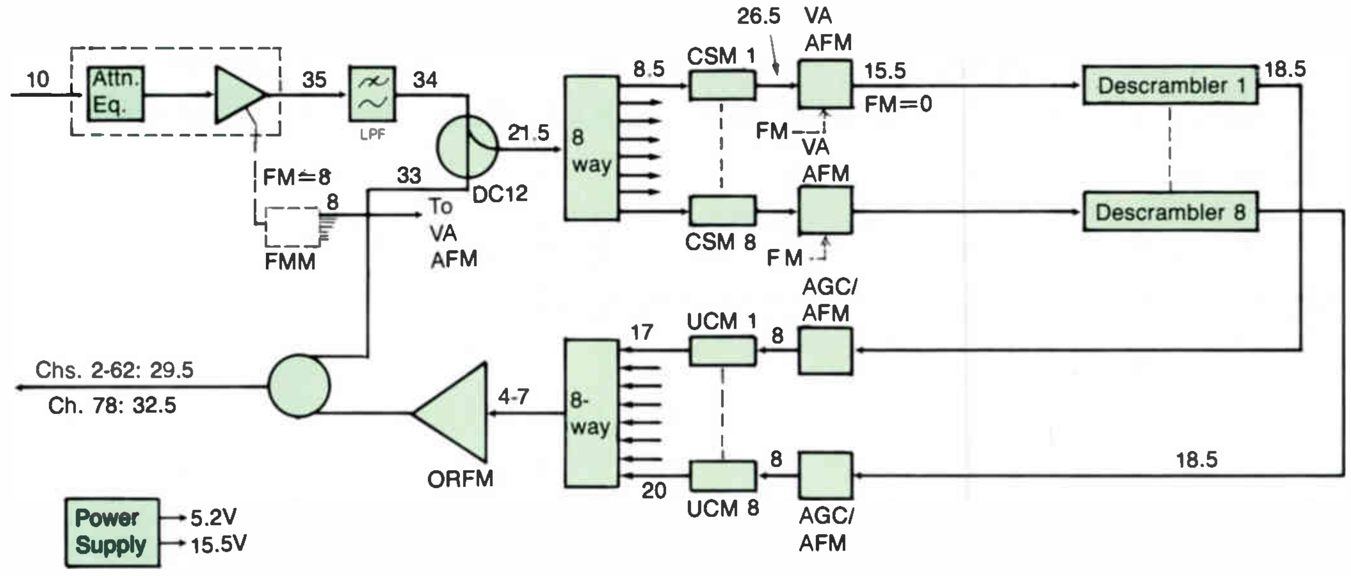
Figure 3: Block and level diagram of mass descrambler system



(Continued from page 23)

tion protocols. This makes it unfeasible to provide a cost-effective universal descrambler solution.

In a mass descrambling system, a number of scrambled channels are descrambled at a node and then usually upconverted with suitable guard bands to vacant frequency slots in the spectrum of the distribution system downstream from the node. The descrambled channels are not assigned in their original frequency slots ("drop and insert") because it is extremely difficult to adequately filter out the energy of scrambled channels without causing deterioration in the frequency response of adjacent channels.

The second compatibility issue is control and communication protocol. Every addressable system follows a unique communication and control scheme to restrict the access of service to subscribers. In a hybrid addressable system, the integration of addressability functions of constituent systems provides several options, depending upon how far deep into the system various functions are combined.

Level I — The block diagram of this alternative is shown in Figure 1. The billing computer drives the network control computer (NCC) of the off-premises star-switched system as well as the control computer of the addressable set-top system. The RF modems then generate forward control carriers at two different frequencies to communicate with respective addressable control modules at nodes or in subscriber home terminal units (in the conventional portion). This option does not require any hardware, software and/or firmware changes in either system, except, of course, for those changes necessary to ensure compatibility with the billing system interface and protocol. (The system described in this article employs integration at Level I.)

Level II — The integration process is carried out a step further, as shown in Figure 2. There is only one computer in the system in which the data base and screens are integrated. However, control and communication programs, as well as RF modem functions for the constituent systems, are separate. Thus, no hardware or firmware changes in either system's subscriber or off-premises equipment is required.

Level III — At this level, the communication and control protocols are integrated. Firmware changes now may be required in both systems to handle the unified protocol. If the RF modem function also is integrated, hardware changes may be required to achieve compatibility in modulation method and frequency.

Table 1: Mass distribution system specifications

Return loss (75 ohms)	
Input (50 to 450 MHz)	15 dB, minimum
Output (50 to 550 MHz)	15 dB, minimum
Input level (nominal at install)	10 dBmV lowest carrier level
Input level drift range	±5 dB
Signal conditioning range	Plug-in pads are available in 3 dB steps. 9 dB of positive true tilt and 15 dB of negative true tilt can be accommodated with plug-in fixed equalizers. These numbers correspond to 13 and 22 dB of cable, respectively.
Noise figure (10 dBmV input)	18 dB, maximum (C/N contribution = 51 dB)
Insertion gain	20 dB ±1 dB, 50 to 450 MHz, with 3 dB of tilt from 460 to 550 MHz
Distortion (15 dBmV flat input)	
Cross-modulation	−63 dB
Second order	62 dB
CTB and third order	62 dB
Frequency error and drift	±50 kHz plus descrambler drift
Bandpass with respect to fpix	
fpix −.75 MHz	−4.5 dB maximum
fpix + 4.5 MHz	−3 dB maximum
Operating temperature	0 to 50°C

System performance specs

The block and level diagram of the mass

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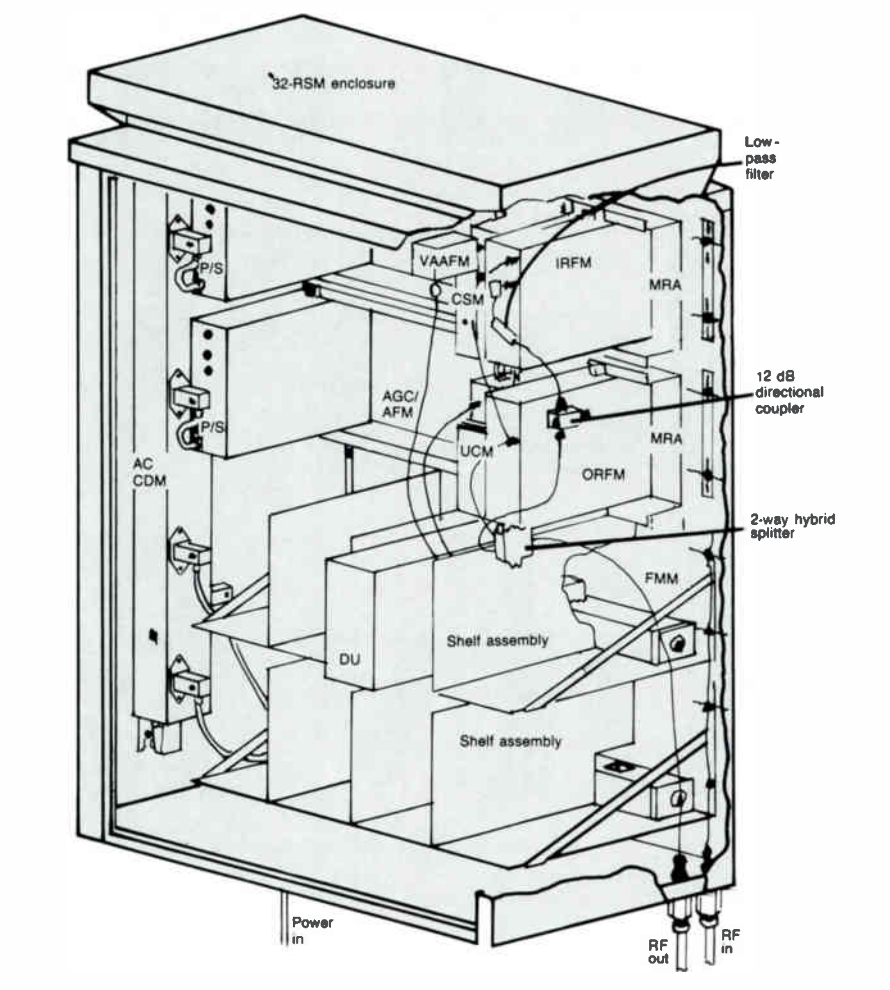
Figure 4: Physical construction of mass descrambler system



descrambling system is shown in Figure 3. The 50 to 450 MHz feeder input is looped through with up to 20 dB of gain for system extension. Each channel to be descrambled passes through a separate chain of downconversion, fixed channel descrambling and final upconversion. After combination, the block of up to eight channels is amplified with sufficient tilt to allow for 23 dB of cable loss at 550 MHz before levels fall below the 10 dBmV minimum required at the LDUs. There is a requirement for a 6 MHz guard band between channels to guarantee that adjacent channel spurious feedthrough falls below W-curve limits. The downstream distribution system and LDUs now have to be 550 MHz-compatible.

The mass descrambling system unit uses standard Times Fiber Mini-Hub II (MH II) hardware for the enclosure, AC distribution, FM band control carrier module, power supplies and backplane/signal distribution passives. The decoders or descramblers are provided by the MSO with possible modification to reduce unnecessary power dissipation and eliminate the channel change function. New modules, packaged in existing castings, were developed.

Input RF amplifier module (IRFM): This is a 25 dB gain, 50 to 450 MHz line extender quality amplifier with plug-in capability for signal conditioning. To coexist with the available 15.5-volt MH II DC supply, a custom hybrid was developed. The low-pass filter following this module serves to remove distortion products above the highest channel that have built up in the system.

Channel selection module (CSM): This module tunes to one channel in the 50 to 450 MHz band and outputs it on a low-band VHF channel dictated by local off-air conditions. It is a modification of the existing MH II subscriber module to accommodate DIP switch fixed channel programming in the field in 62.5 kHz steps. The standard MH II 18 dB conversion gain surface acoustic wave (SAW) filter/SAW resonator-based CATV tuner is used.

Variable attenuator auxiliary function module (VAAFM): This small add-on unit provides 20 dB of gain adjustment and allows the summing of a control carrier in the FM band with the downconverted channel.

Automatic gain control auxiliary function module (AGC/AFM): This module is required for RF descramblers where output tracks input on a dB-for-dB basis. By stabilizing the signal level to the upconverter, the system carrier-to-noise ratio (C/N) contribution can be maintained with drift of the descrambled channel level. Power is obtained from the upconverter module RF connector.

Upconverter module (UCM): This module accepts the descrambled low-band VHF channel and translates it to a vacant slot in the feeder spectrum usually above the existing carriers because of guard band requirements. The same fixed frequency selection technique as used in the channel selection module is employed. The critical element that had to be developed was a reverse tuner also using SAW technology that has adjustable gain for providing tilt in the final combined system output. This unique module is described in further detail later.

Output RF amplifier module (ORFM): This unit provides 29 dB of amplification for the combined translated descrambled channels to provide sufficient level for summation with the carriers in the 50 to 450 MHz band.

The design goal is to make the mass descrambling system as transparent as possible in the critical areas of added noise, distortion, frequency drift and gain fluctuations. The overall system specifications are listed in Table 1.

Although the noise figure of the input RF amplifier module is 9 dB, maximum, which would lead to a C/N contribution of 60 dB at 10 dBmV input, the specification is 51 dB, as this is the C/N contribution of the system for the descrambled channels.

The noise figure for a single channel to be descrambled can be derived by following its path through the loop of Figure 3. Using the data in Table 2 for an RF descrambler scenario, the cascaded noise figure equation yields 17.4 dB with the major contributor being the channel selection module noise figure/distribution loss term. Different decoder/descramblers would require readjustment of the AGC/AFM and upconverter module settings. The data in Table 2 for a baseband decoder yield a system noise figure of 17.5 dB. In this case the AGC/AFM would not be used.

The physical layout of the units within a 32-subscriber MH II enclosure is shown in Figure 4 for the case where the descrambler is a small stand-alone unit with stable output. The upper two racks hold the common amplifiers, the eight pairs of converter modules and the required power supplies. The descrambler shelf assemblies contain AC power strips and metal partitioning shields for isolation between descramblers that may contain local oscillators and, therefore, be susceptible to ingress. The bottoms of these assemblies are slotted to allow proper air flow within the enclosure for cooling.

If the MSO chooses to use a full-size set-top converter to perform the descrambling function, then a companion 16-unit MH II enclosure must be used to hold four set-tops. Bulkhead F connectors passing through knockouts in the bottom of the enclosures then are used for the two interconnecting cables required per descrambler.

Upconverter module (UCM)

The UCM design objective requires performance transparency (approaching that of a headend heterodyne processor) as well as low cost, which was achieved by utilizing the packaging techniques of the MH II hardware. The UCM (Figure 5) contains two separate

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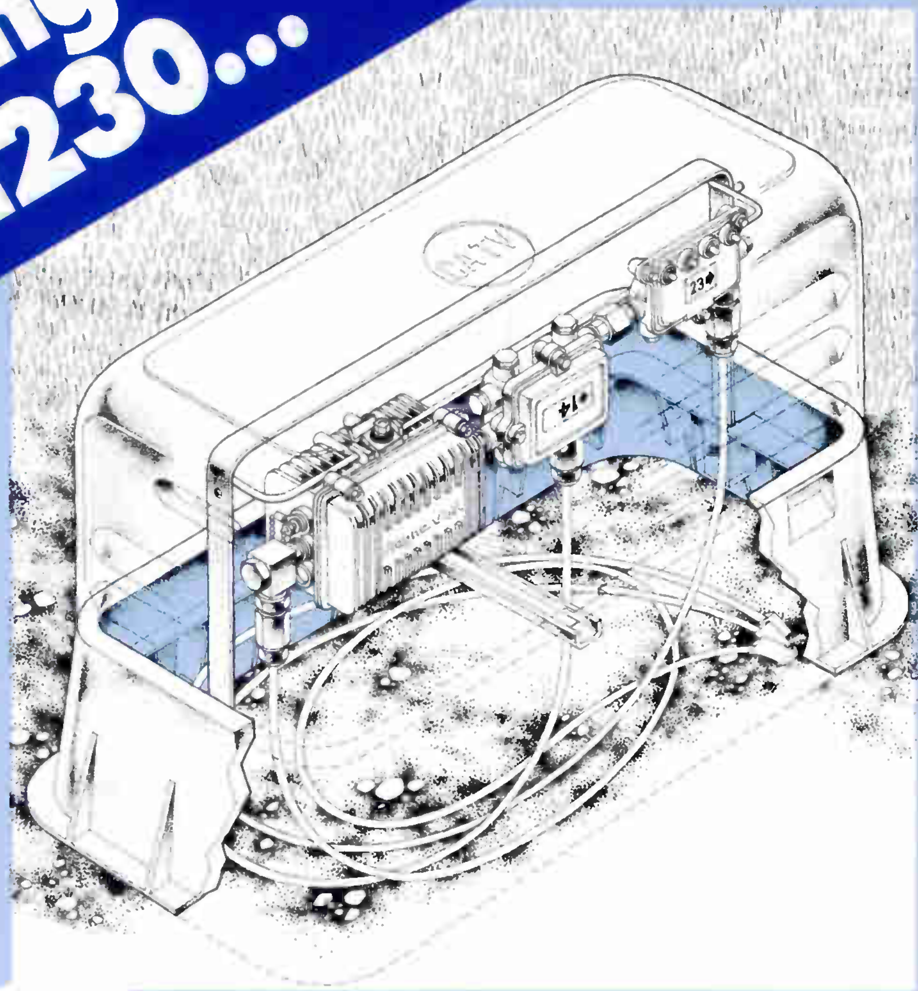

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CPH-1016

Houses tap, splitter and line extender combinations, or small amplifiers.

Dimensions: 10″ diameter, 21″ - 25″ above grade.

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CPH-1022

Houses tap, splitter and line extender combinations, or amplifiers.

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Figure 5: Upconverter module block diagram

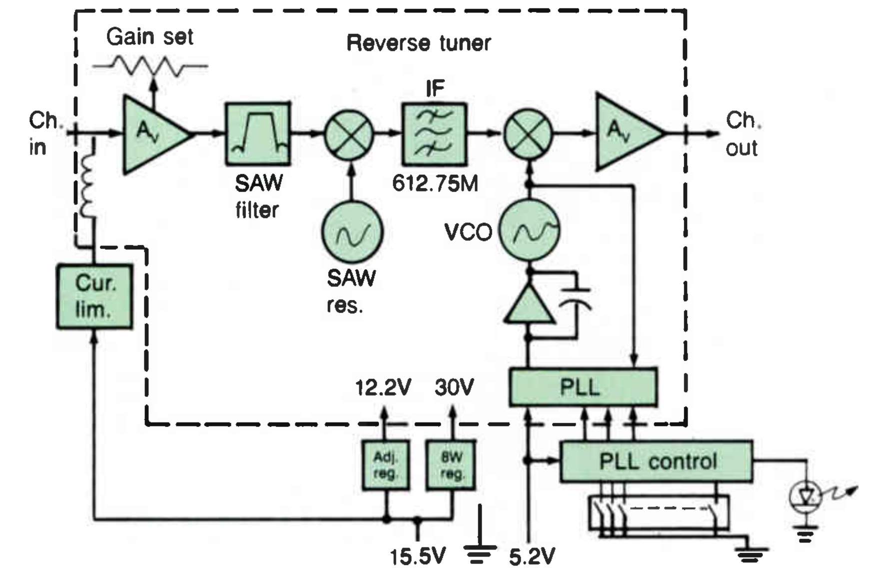
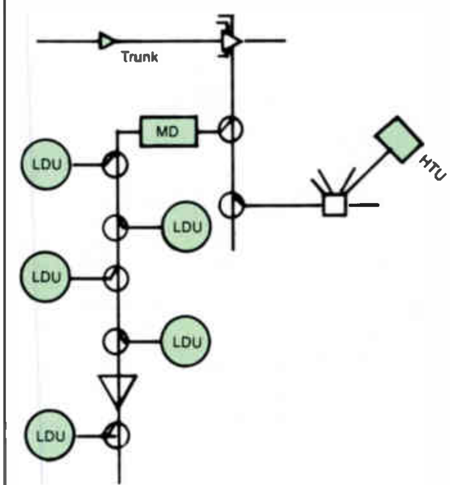


Figure 6: Typical mass descrambling distribution system layout



subassemblies: a tuner and a controller PCB requiring a total of 3½ watts. The module is capable of frequency shifting a low-band VHF channel to any slot in the 300 to 550 MHz range with negligible degradation of the channel quality. The reverse tuner, like the conventional version, uses a double heterodyne technique for image rejection and elimination of in-band local oscillator (LO) spurs. The order of the fixed and variable LOs simply is reversed. The second LO is a varactor tuned-type controlled by an onboard phase lock loop (PLL), which uses a dual modulus prescaler to produce a stable broadband selection capability.

The PLL circuit uses a 512 divider to produce a 7,812.5 Hz phase comparison frequency from the 4 MHz crystal oscillator output. Because this frequency is half the horizontal line rate, it minimizes video degradation from residual phase modulation. The PLL uses a fixed ÷8 prescaler at the VCO input, which then feeds the dual modulus counter. The combination produces a resultant frequency selection resolution of 62.5 kHz.

The first local oscillator is selected to be 612.75 MHz above the fixed input fpix and employs a frequency stable resonator using a SAW device. There is a SAW bandpass filter at the input for adjacent channel rejection. For final setting of conversion gain, the input amplifier has more than 10 dB of externally accessible adjustment range.

The reverse tuner, having only a single channel at the input, has been optimized for noise performance. The only output spur of significance in the present design results from residual first LO signal mixing with the second LO and producing a spur at fpix frequency below the output channel. This beat is maintained at greater than 65 dB below the minimum anticipated output level.

The primary distortion component of the tuner is the in-band 920 kHz video beat resulting from the $f_{audio} - f_{chroma} + f_{picture}$ frequency components. This is held to 60 dB below picture carrier level. Finally, the broadband noise output must be limited such that seven other UCM outputs can be combined without appreciably degrading the noise performance of the channel.

The remaining assembly in the UCM provides the reverse tuner with the PLL commands necessary to tune to the selected output channel. The channel is programmed via a series of DIP switches for use by the MSO at the time of installation. These switches usually are not altered after installation.

The operator looks up the channel selection code and selects the DIP switches accordingly. When the UCM is powered on, the data, clock and load commands periodically are fed to the reverse tuner PLL and a front panel indicator is lit to indicate this activity.

The reverse tuner, having a varactor-tuned second LO, requires a clean 30 volts at low current. This is provided by a flyback switching supply using a UJT relaxation oscillator. The RF circuitry uses the bulk of the power, which must be tightly regulated for the tuner's transparency requirement. A three-terminal adjustable regulator meets this requirement well. The remaining 5-volt bus simply is filtered for high-frequency rejection, since the PLL and control circuitry already have good noise immunity.

Table 2: Mass descrambling system stage noise figure and gain

Module	RF descrambling Noise fig. (dB)	RF descrambling Gain (dB)	Broadband decoding Noise fig. (dB)	Broadband decoding Gain (dB)
IRFM	9	25	9	25
LPF/DC12/8-way	26.5	−26.5	26.5	−26.5
CSM	12.5	18	12.5	18
VAAFM	11	−11	11	−11
Descrambler (Ch. 3)	12	3	12	− 8.5
AGC/AFM	10.5	−10.5	—	—
UCM	8	12	8	13
8-way	13	−13	13	−13
ORFM	6	29	6	29
2-way	3.5	− 3.5	3.5	− 3.5

Hybrid system guidelines

From the transmission performance point of view, a mass descrambler appears to the system as a line extender with gain of about

22 dB. The cost of descrambling a channel is around $200 to $250 in such a unit. Assuming that a system has eight scrambled channels, the mass descrambler unit may cost from $1,600 to $2,000. Consequently, it is desirable that mass descrambler units are strategically located to feed clear signals to a number of LDUs to minimize the descrambling cost/subscriber. The input signal requirement of a MH II system is 10 dBmV for a 32-unit LDU. A typical system layout in a high-density metropolitan environment is shown in Figure 6.

The 22 dB loss budget may allow three to 10 LDUs (96 to 320 subscribers) to be supplied from the output of a mass descrambler, depending upon the losses in the feeder cable and directional couplers. Of course, a line extender can be added to extend the range of the system. The operating output levels of the line extender should be suitably derated to meet the worst case performance objectives of the franchise.

An attractive solution

A hybrid CATV distribution system using addressable set-top converters for single family homes and an off-premises star-switched system for MDUs offers a very attractive solution to MSOs for secure delivery of premium services in metropolitan areas. Although the hybrid architectural concept does not provide the total optimization of a backbone trunk/feeder plant, it may be the only rational choice when offering service to MDUs in the theft-prone MDU marketplace in existing builds.

Undoubtedly, compatibility issues are raised in the areas of headend control and techniques for dealing with the scrambling required by the latter system for security purposes. These issues are resolved in a cost-effective and practical manner by the integration of control and communications functions under the billing system and by mass descrambling at key locations in the franchise area.

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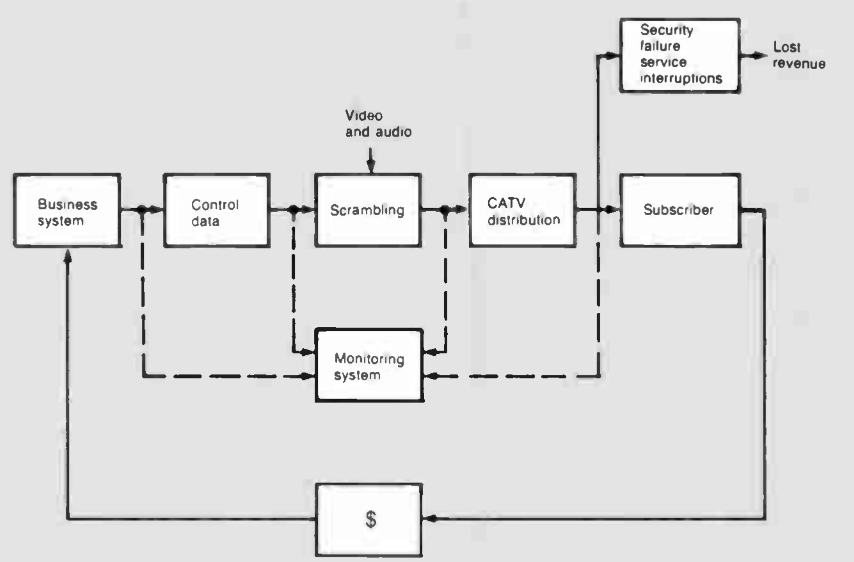
Data integrity in addressable systems

By James P. Ackermann
Director, Field Systems, Oak Communications Inc

The importance of good integrity of the video and audio signals in the CATV operation is quite evident. They form "the product" for which the subscriber is willing to pay. In a non-addressable pay system another element enters the picture: the scrambling technique. An addressable system adds a fourth element: the control data. For optimum security the data and scrambling subsystems are integrally related to each other. They serve to control the delivery of the product to the customers.

Scrambling and data are not elements paid for by the subscriber for the subscriber's gratification. They are there only to serve the operator. When these elements are functioning properly, the customer is at best unaware of their existence. Malfunctions only can be a detriment to customer satisfaction by interrupting paid services. When a malfunction of the data system fails to withhold services from a non-paying viewer, lost revenue occurs. Customer complaint monitoring serves only as a gross check of performance to paying customers. However, viewers receiving free services are unlikely to complain, so additional monitoring measures are required.

Figure 1: The control data system



The ability to supply or withhold the product upon command is a fundamental requirement of an addressable system. Thus, control over the descrambling decoder is the control data system's primary purpose. Interface to a business system for billing purposes and control of pay features and other services are

Figure 2: FML data distribution

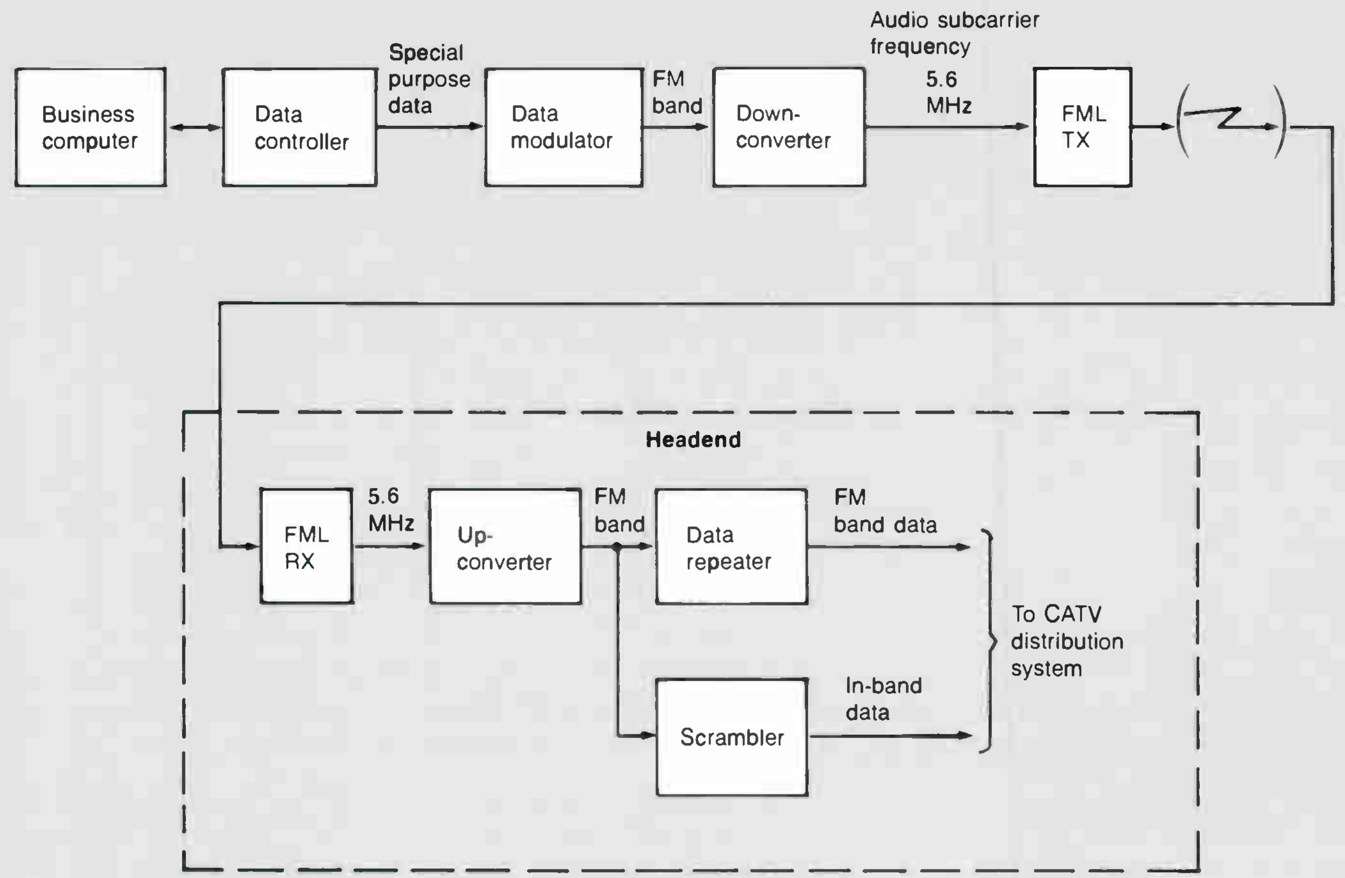


Figure 3: AML data distribution

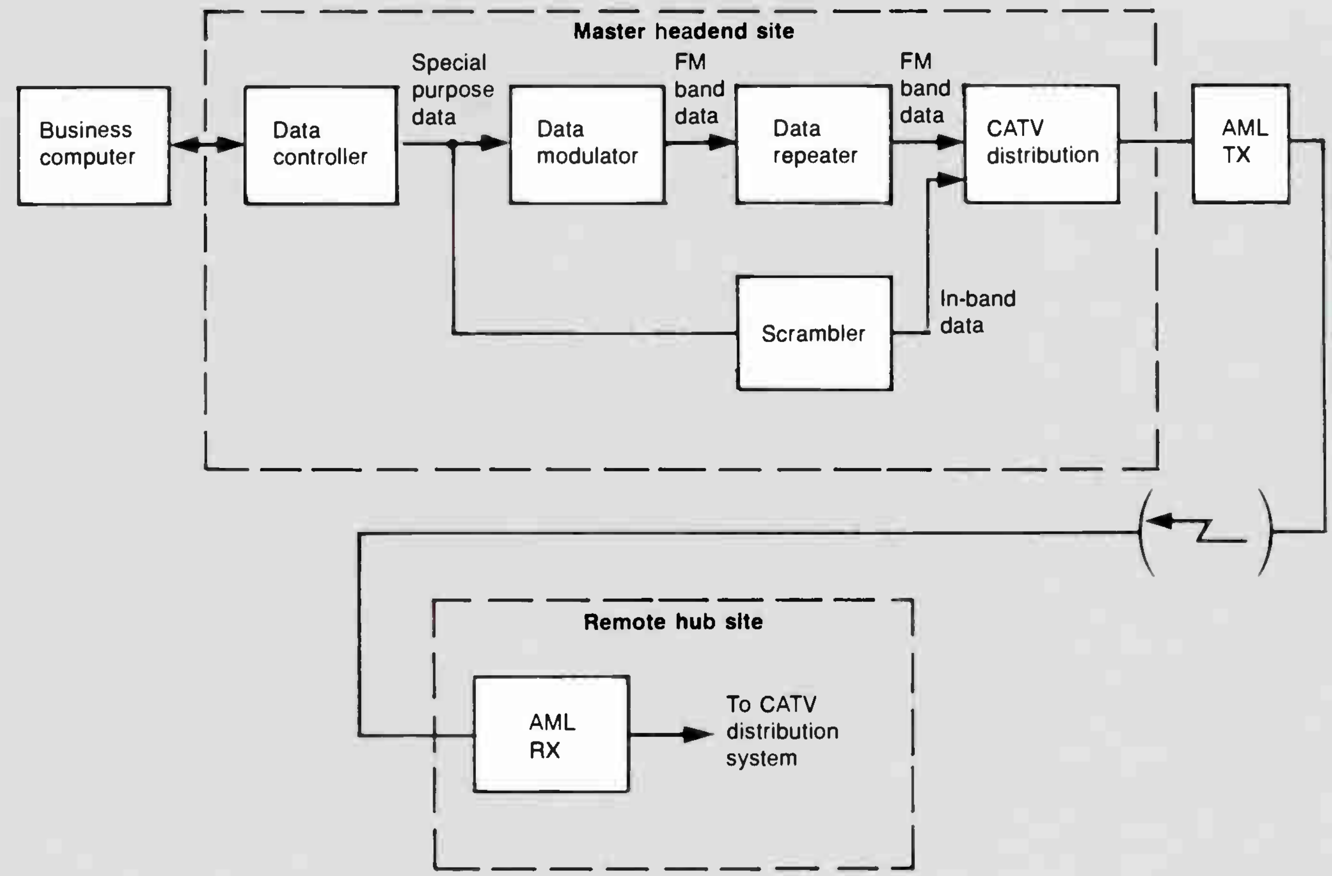
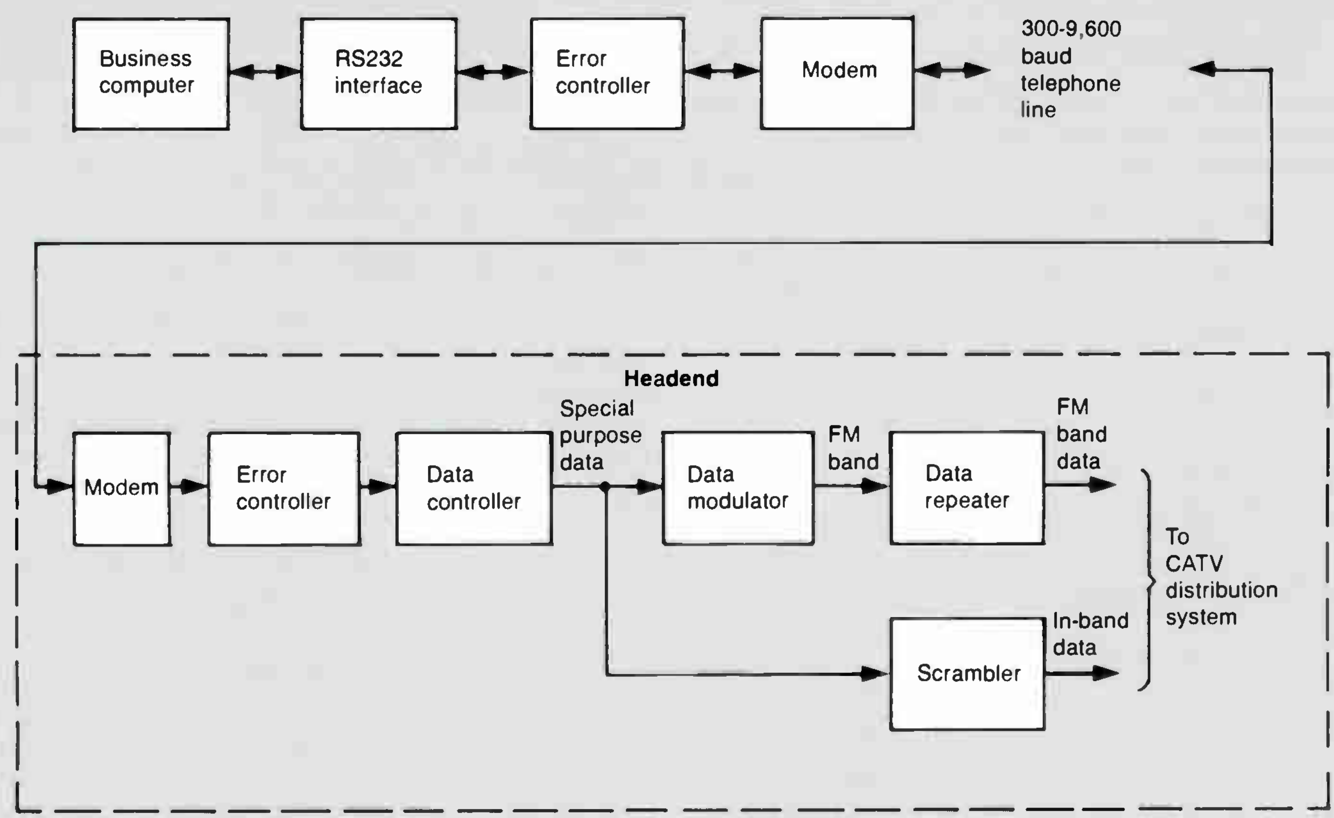


Figure 4: Telephone data distribution



ancillary functions.

In its broadest sense, the data system (Figure 1) consists of the business system controlling a data channel that controls the scrambling system, which in turn controls the video and audio to the paying customer. The capability to monitor performance at all points in the system is essential. The ultimate function is the maximization of revenues from satisfied subscribers while minimizing lost revenue through security failures or service interruptions.

Data distribution

In general, an addressable scrambling system has two data channels. The out-of-band channel carries the addressing and control data to configure the decoder to its authorized mode. The in-band data carries channel-specific information, including tier level and any time-varying scrambling commands. Some systems operate with only one data channel but most likely sacrifice security or data integrity or both in the process.

Figures 2 through 5 show typical data distribution systems where remote operation is required. It is assumed that the out-of-band data is transmitted remotely, while the in-band data originates from the specific channel scrambler at the headend site. The special purpose data terminology reflects the fact that the data from the controller to the decoder is not typically a standardized format (such as RS232) but a special format for one-way, asynchronous message transmission over a noisy communication path. A data repeater is used as the last line of defense, transmitting pseudo-data to keep the decoders operating in the event of complete loss of data.

FML: In a frequency modulated link system (Figure 2), baseband video (0-4.2 MHz) is combined with FM subcarrier audio channels (e.g., 5.6, 6.2, 6.8 MHz) and transmitted over a single FML carrier. A reliable interface with this equipment utilizes one audio subcarrier slot (e.g., 5.6 MHz) for data modulated and downconverted to the subcarrier frequency for direct addition to an FML transmitter. At the receive site the subcarrier then is upconverted back to the data carrier frequency (usually in or near the FM band, 88 to 108 MHz). No additional modulation/demodulation is required to utilize the FML, and little opportunity exists for developing data errors.

AML: In an amplitide modulated link system (Figure 3), all channel, FM and data carriers are transmitted in the exact frequency spectral relationship that they will be carried on the CATV system. The data modulation is done at the master headend site so the data carrier is transmitted intact. If the carriers are configured as on the CATV system, no significant degradation should occur over the AML. There is a slight reliability benefit to locating the data repeater at the receive site to guard against failed AML hardware carrying the data. The repeater hardware then must be duplicated at each hub and additional filtering is required.

Telephone: The special purpose data for transmission over the cable system is not RS232 modem-compatible as required for distribution via telephone. It is necessary to have a system configuration in which an RS232 data link can be split. In Figure 4, an additional RS232 interface is shown; it is assumed that the data controller is RS232-compatible. The main shortcoming of this configuration is the high likelihood of injecting noise via the telephone line. The error controllers are intended to protect the data from noise. The subject of noise will be discussed in more detail later.

Upstream cable: When the CATV system passes the business office after leaving the headend, it may be possible to use upstream processing (also referred to as subtrunk processing) to accommodate the data carrier (Figure 6). This approach is similar to the FML case, except that the frequency conversion is made compatible to the upstream equipment (below VHF TV channels, 5-40 MHz).

Other: In other data distribution systems, such as optical fiber, the specifications of the particular equipment must be matched to the data characteristics to determine the best transmission method. An approach similar to the FML case may be feasible. A video channel may be dedicated to the data signal, although special precautions must be observed in regard to clamp circuits.

In many systems the implementation may involve a combination of several of these approaches. For example, the subtrunk scheme may be required from the office to a master headend followed by FML to supplemental headends. In this case it may be possible to choose a common conversion frequency to minimize hardware.

Sources and avoidance of errors

Most errors may be categorized as occurring from human error or tampering, software error, hardware failure, and/or noise or interference. A distinction must be made between bit errors and message errors. A message is the command that causes the decoder to take action. The digital message is composed of a number of binary bits. Depending on the design of the individual elements of the system, varying susceptibility to errors may occur. If one of the causes of errors results in a bit error, a message error still may be avoided through automatic error detection or error correction.

For example, one of the simplest forms of error processing is to transmit duplicate messages sequentially. With the data receiver designed to respond only if two identical messages recur, most bit error combinations are detected and the bad message is not acted upon. Of course, the correct message does not get through either. If the same bit errors occur in each word, the process fails to work and a message error would occur.

If three messages are transmitted sequentially and the receiver requires two out of the three to be identical, some bit errors may occur and the correct message still could get through. Modern data communication design techniques allow much more efficient and powerful error detection and correction procedures. However, these two examples illustrate the general principle.

The special purpose data in Figures 2-5

(Continued on page 59)

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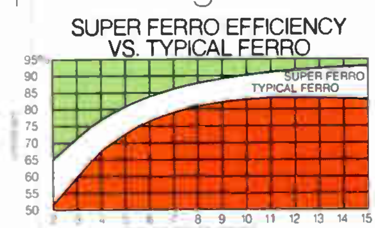

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(Continued from page 40)
presumably is designed for error detection and/or correction since it must be transmitted over a noisy, interference-prone CATV distribution network. It therefore is a good candidate for transmission to remote sites. This data, however, is not formatted for easy interface to standardized equipment and typically has a bandwidth requirement beyond audio circuitry specifications. In the FML, AML and upstream CATV applications, the data is sent as a modulated carrier.

In the telephone system, sending a carrier or the special data format is not possible, so developing standardized RS232 data is required. From a purely technical point of view, using a telephone line is the least desirable approach for transmission of the addressable control data. Besides slowing the communication speed, a new vulnerability to noise is interjected into the system. But unless a microwave link or alternate communication link exists for other purposes, it is probably not economically justifiable to provide one to handle data only. Thus, unless an extremely good communication design has been done within the control data subsystem, external error processing is required. Figure 4 shows the addition of error controllers for error processing of the RS232 data stream.

In addition to optimizing the system design and configuration, maintenance of all equipment involved in the data system must be performed diligently. The objective must go beyond repair of catastrophic failures to maintain calibration within specification and avoid introduction of errors.

The third area for error avoidance is monitoring, including hardware functions, software routines and persistent testing. Monitoring is the means by which data problems become evident and forms the cross-check on inadequacies in design and maintenance.

Monitoring methodology

Monitor methodology is any effort taken, either hardware, software or procedural, to detect and isolate problems within the data system.

Software: Monitoring for human errors, tampering and software errors is a nebulous topic to discuss in a general sense. It entails the integral workings of the business and control software and the scrambling system. The designers must be mindful of these eventualities and build in checks to guard against them.

Testing is relevant as a means of detecting loopholes in the system. A printer-logging capability of all messages sent to decoders is useful but requires tedious perusal of data. The ability to select a subset of conditions under which the printer logging occurs is an extremely valuable way to trap a suspected occurrence. Running global addressing cycles, including a negative global, is a means of correcting certain errors that may occur. A global cycle sends the current authorization state to every decoder, including those that should be deauthorized. It occurs at random times to thwart efforts to defeat it by disconnecting the decoder at a prescribed time.

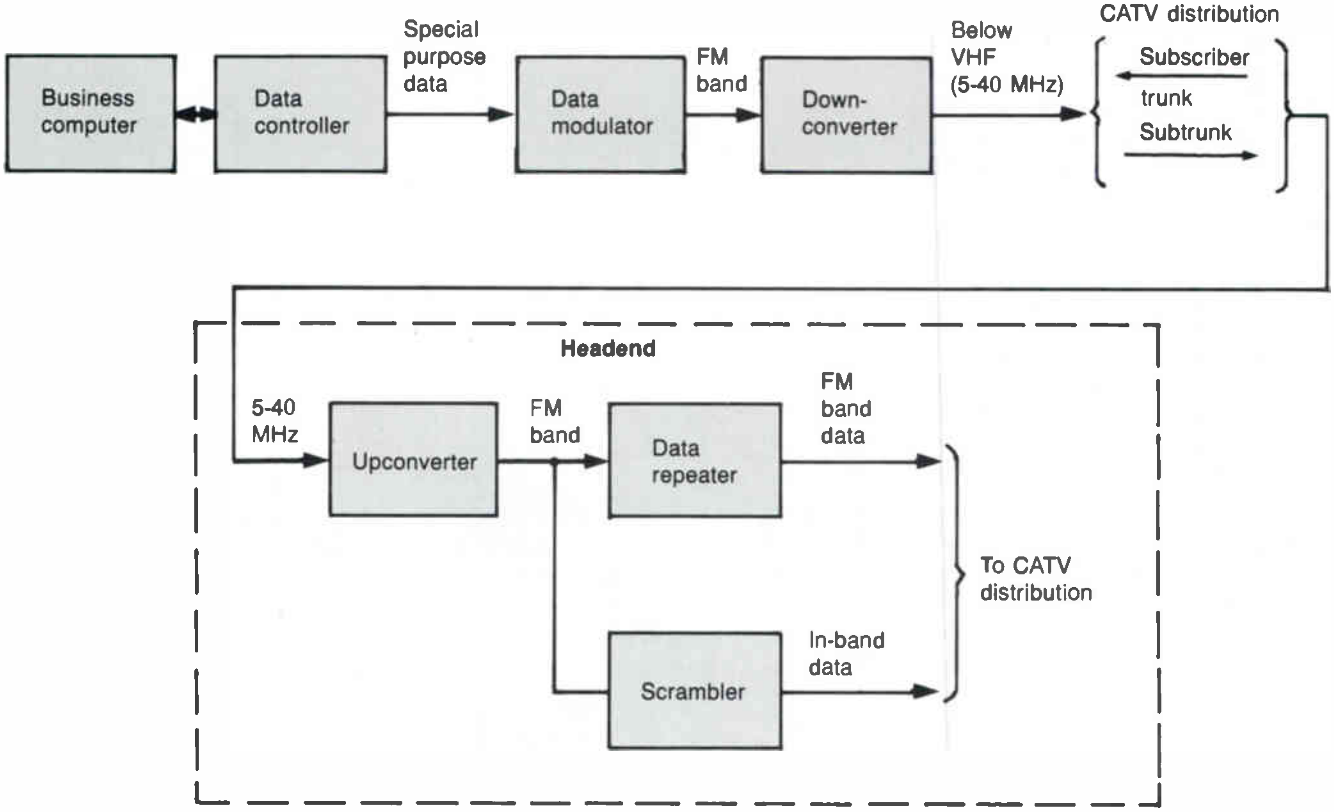
Hardware: With hardware there are devices and techniques that should be used to isolate and correct errors: monitor decoder with oscilloscope, RS232 data scope, data message analyzer, spectrum analyzer for data carrier, and bit and message error rate testing.

One of the simplest monitor aids is a standard decoder modified to allow the out-of-band and in-band data signals to be displayed on an oscilloscope. While not a monitor of message intelligence, it does allow quick and easy perception of gross noise, interference or carrier degradations and loss of data. This technique should be implemented at the control computer center and each headend site.

An RS232 data scope is a standard instrument to monitor the messages passing between computers or other hardware devices. It should be on-line to monitor transactions and made available for troubleshooting other areas of the system as needed. It is particularly important in a system operating remotely via telephone modems.

A data message analyzer is a special purpose device, typically designed by the scrambling system manufacturer, to capture and display the messages in the special purpose data format sent to decoders via the control data channel. If the message structure includes global commands to communicate with all decoders simultaneously, the analyzer should capture them continuously. For other decoder-specific commands, the operator selects an address of a decoder that he wishes to investi-

Figure 5: CATV subtrunk data distribution



gate. When that decoder is hit with data, the analyzer traps and displays it.

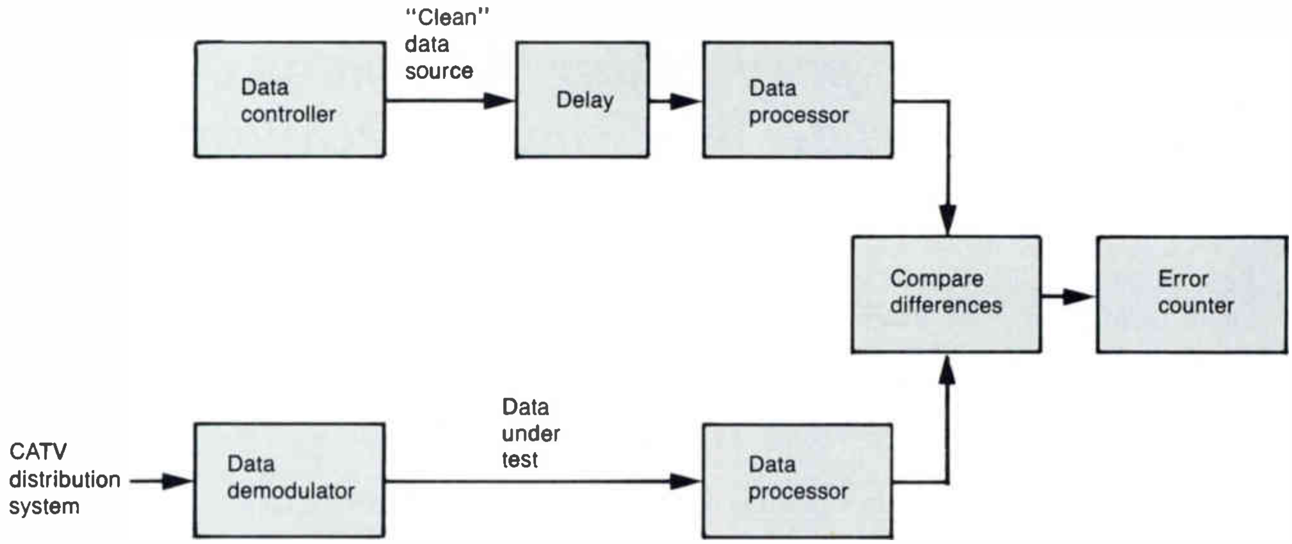
The data analyzer for Oak's Sigma system is implemented with a data demodulator and special purpose data processor driving a smart terminal. It may be utilized at any point in the system where it can be supplied by the data carrier. This powerful analytical tool is most useful for verifying complete end-to-end system performance including software functions. Since it processes data with the same error routines as the decoder it is a valid indicator of real message errors.

A data analyzer for in-band data has less value for analyzing system problems. Since the in-band data is channel-specific and is generated in the scrambler, an in-band analyzer checks only from the scrambler forward. It is usually sufficient to use an oscilloscope or spectrum analyzer for these types of problems.

A spectrum analyzer is an indispensable tool for calibrating, monitoring and troubleshooting the RF portions of the system. It is used to set and maintain the data carrier amplitude to specified limits, verify proper data modulation and identify sources of noise and interference.

Bit error rate (BER) testing is the most precise way to monitor the overall system for data performance in the presence of noise. Message error rates may be measured by the same technique. Figure 6 shows the simplest interpretation of the bit or message error rate detector. Known "clean" data is delayed and compared with actual system data. Any differences on a bit-to-bit or message basis are attributable to noise in the system. All systems will have

Figure 6: Bit or message error analyzer



some bit errors. A particular system bit error counter may show six bit errors in a one-minute time period or 0.1 errors per second. If the data transmission rate is 10,000 bits per second there is one error for every 100,000 bits, and the BER is expressed as 1×10^{-5}.

The data processor in Figure 6 must be the same as the bit or message processor in the decoder with all of its automatic error detection and correction to allow the most accurate representation of the actual system performance. While message error rate testing gives the best picture of system problems resulting in communication errors, bit error rate testing is the most precise measure of threshold noise problems. As with the data analyzer, error rate test equipment is special purpose equipment supplied by the system manufacturer. BER testing should be done periodically to check for subtle system degradations. Or even more preferable, implement a message error detector as a warning indicator to be on-line and running continuously. If a predetermined number of message errors occurs in a specified time period, an alarm occurs to warn of a new source of interference or other degradation.

Monitoring procedures: There are many

monitoring procedures that should be part of the normal routine. Customer service monitoring is an important source of information but, as discussed earlier, not sufficient to catch all trouble scenarios. Additional procedures involve conducting tests on a frequent basis to attempt to seek out suspected or hypothesized problems. Ideas for trial testing can come from creative thinking, "grapevine" information or real-time tests with employees in their homes. Information regarding system defeat mechanisms can be gained through the grapevine. Installation and repair technicians usually know the techniques to defeat the system through personal contacts outside of the company.

A continual real-time field test with employees could uncover failure modes resulting in free services to customers. In order for this to be effective, the number of homes involved must be significant without being unwieldy (probably 20 to 30 is the right size). Though motivated to participate and provide information through the incentive of free service, the billing functions must be left as though the employee is a paying customer. The actual bill can be cleared later. As many combinations of services as possible should be covered to simulate the real customer base. Since some installations will get more services than others, periodic rotations should occur, as well as exercise the addressability functions more regularly. Disconnect scenarios also should be checked (the employee may be provided with an additional authorized decoder during this period).

Avoiding losses

Equipped with a thorough knowledge of the data system, a motivation to avoid lost revenue and the resource allocation for requisite monitor systems, the CATV operation can do much to avoid losses as the results of data system malfunctions. Even with the best system and software designs, it is highly improbable that all prospective trouble scenarios can be anticipated and avoided in the initial design. However, the fact that changes in the system are inevitable can be anticipated and flexibility for that change can be designed in.

The addressable system is immensely more complex to design and to operate than a nonaddressable one. The factors resulting in maximum profits are more elusive and dictate more applied creativity to optimize, although the potential for profit is higher. It is only through the combined efforts of two partners, the manufacturer and the operator, that full realization can be achieved. The manufacturer must provide a good system design including monitoring capability, good documentation and training, and support of the operation of the system in the field. The operator must apply the system within its design limits, utilize the training and monitoring methodology, be creative and diligent in actively seeking problems and solutions, and commit the resources to accomplish these ends.

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Automated measurement of selected signal parameters

By Jack Hooper
Vice President, Operations

And Dewayne Lipp
Vice President, Engineering, RF/Superior

The application of low-cost personal computers to controlling and monitoring cable TV operations has progressed to automated systems designed specifically to measure and record technical performance. Until recently, application to technical aspects of cable has been primarily in status monitoring of line amplifiers. Other computer applications were mainly consumer-oriented (e.g., security services, addressability, etc.). New developments have added overall system measurements and the monitoring of specific operating parameters to the tools the engineer has at his disposal to ensure optimum performance of the cable plant.

Controlling parameters

An important control of a cable system that is consistently presenting quality product to its subscribers is accurate and frequent measurement of the levels and of the frequencies of the carriers in the system. This must, of course, start in the headend, but also will extend to the extremities of the distribution lines. With conventional equipment this is a tedious and time-consuming task. As a result, these critical performance parameters are often given the short end. Computerization has completely changed this. Originally, automated testing for FCC proof of performance provided an economical method of making the required annual measurements accurately and quickly. Subsequent measuring systems primarily provided carrier level measuring for cable operators. Now, we are able to test for the increasingly important element of frequency in the following basic measurement capabilities:

- levels of carriers,
- frequencies of modulated carriers,
- temperature at point of measurement,
- time and data of measurement, and
- measurement location.

The goal in developing our computer-aided test (CAT) system was to provide a simple to use, but accurate and reliable method to measure and record these parameters while using minimum operator time. Once established, the data can be used in many ways: conformance to established standards can be checked; variations over a time period can be recorded; system performance with temperature differential can be observed; etc.

Of equal importance was the necessity to make the system capable of making remote measurements — time spent in traveling from one site to another is non-productive, and not all headends are easily accessible, especially during inclement weather.

The benefits of such a system are many:

- By making repeated measurements, trends and anomalies of headend equipment can be identified. Those that could become system problems can be corrected before they affect the operation to a point where it would be detected by viewers.
- The computer is capable of making all the measurements — a technician's time is not required except for a few minutes at the start of the procedure. Indeed, the measuring process can be mastered by nontechnical personnel in a few minutes, which would free the technician for analysis of reports and productive work such as repairs or maintenance as needed.
- With the power of the computer, the number of measurements made is practically unlimited. You will get to know how your system really operates and how it responds to temperature and time differences.
- Anything you measure can be printed, which allows you to keep a hard copy of your system's performance. Trends that develop over extended time periods can be easily identified.
- Using the remote measuring capability, several systems or multiple sites within the same system can be monitored from the same central location, eliminating the time and expense of travel. The telephone system was chosen as the transportation medium for this feature to preclude any costly capital expenditures to upgrade cable plant. It also allows, in most instances, an immediate turn-on, as telephone lines are generally

Figure 1: Connections for remote operation

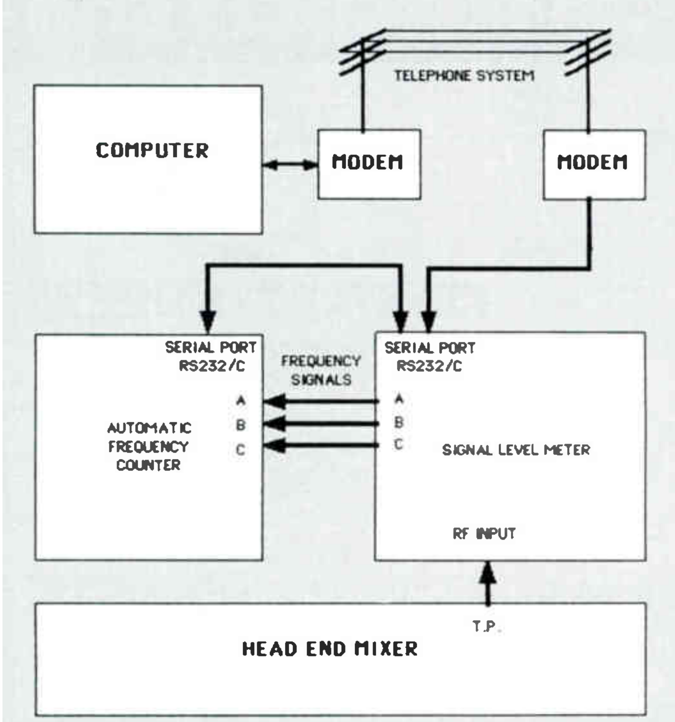
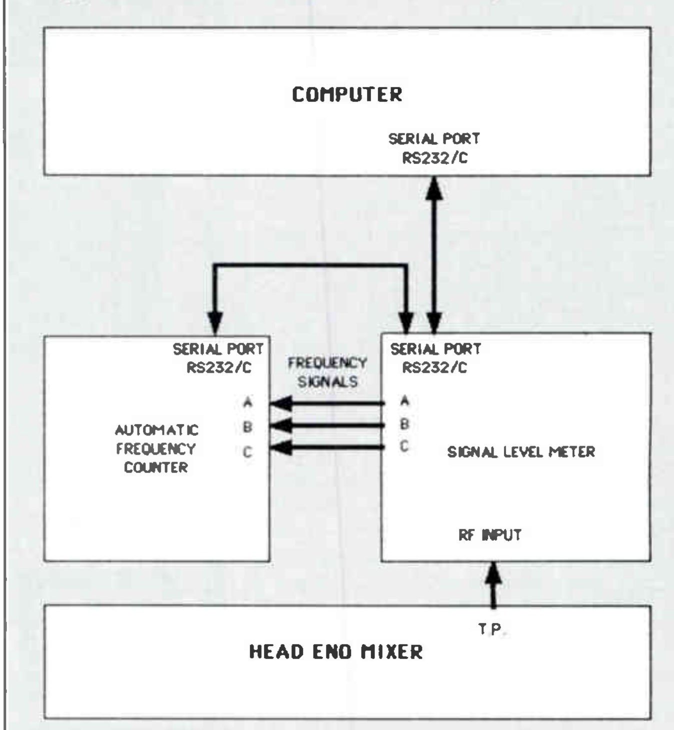
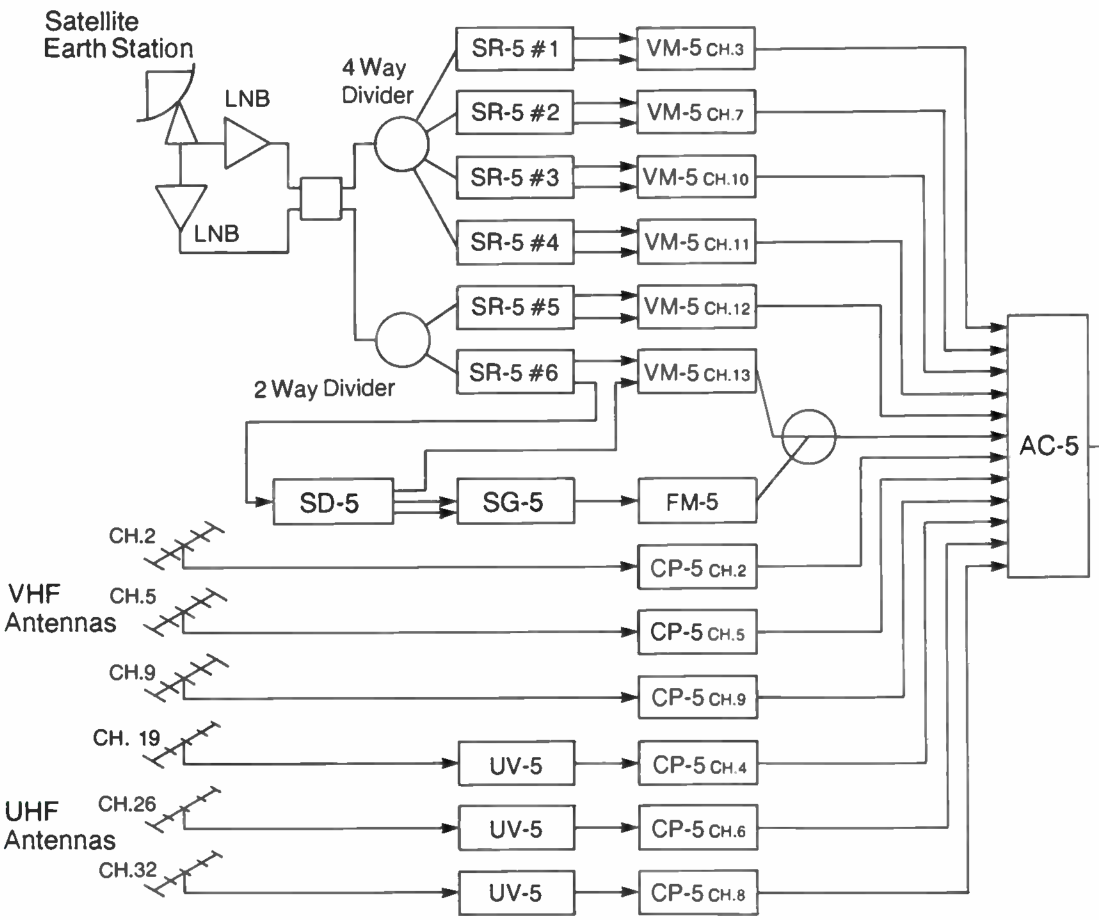


Figure 2: Connections for local operation



has it all.

Block diagram for the headend shown on the left.



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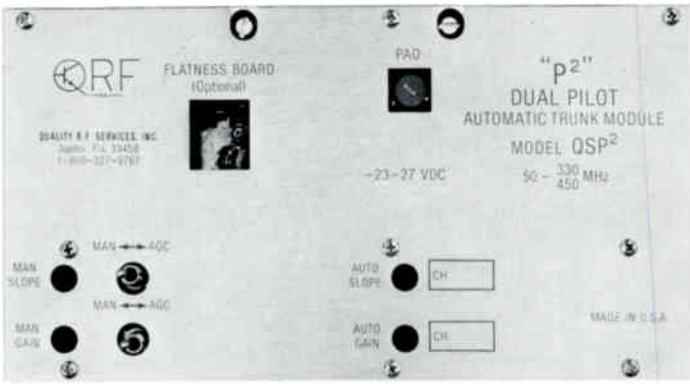

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Passband MHz	50-300	50-300	50-330	50-330	50-400	50-400	50-450	50-450
Flatness ± dB	0.2	0.2	0.2	0.2	0.25	0.25	0.25	0.25
Min. Full Gain dB	29 or 30	29 or 30	29 or 30	29 or 30	30	30	30	30
Gain Control Range dB	8	8	8	8	8	8	8	8
Slope Control Range dB	-1 to -7	-1 to -7	-1 to -7	-1 to -7	-2 to -8	-2 to -8	-2 to -8	-2 to -8
Control Pilots ASC: Turned to Ch.	"Q"	"Q"	"W"	"W"	"W"	"W"	"W"	"W"
Oper. Range dB	Selectable	Selectable	Selectable	Selectable	Selectable	Selectable	Selectable	Selectable
AGC: Turned to Ch.	4	4	4	4	—	—	—	—
Oper. Range dB	Selectable	Selectable	Selectable	Selectable	Selectable	Selectable	Selectable	Selectable
Return Loss dB	16	16	16	16	16	16	16	16
Noise Figure dB	6	6	6	6	6	6	6.5	6.5
Typical Oper. Level dBmV	34/30	34/30	34/30	34/30	35/30	35/30	35/30	35/30
Distortion at C/CTB	-93dB	-88dB	-92dB	-87dB	-91dB	-86dB	-89dB	-84dB
Typical Oper. XMod	-94dB	-89dB	-93dB	-88dB	-91dB	-86dB	-89dB	-84dB
levels 2nd order	-85dB	-82dB	-85dB	-82dB	-85dB	-82dB	-85dB	-82dB
DC Requirement mA at -23 VDC Note 1	630-730	420-500	630-730	420-500	650-750	430-500	650-750	430-500

Note 1: DC requirements are stated as typical to maximum.
Note 2: Specifications should be referenced to the modules, not the connector chassis.

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Figure 3: Master menu

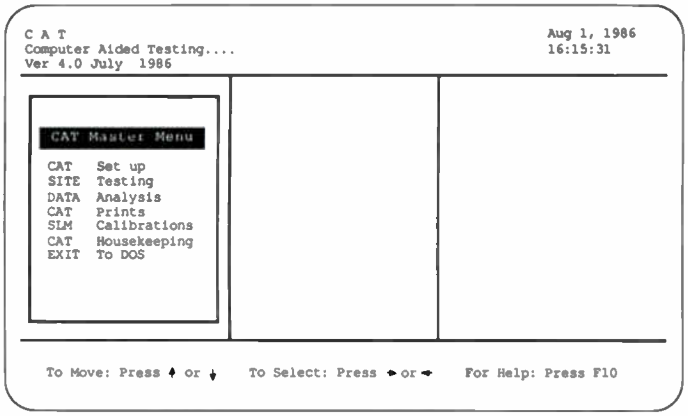


Figure 4: Specifying channels

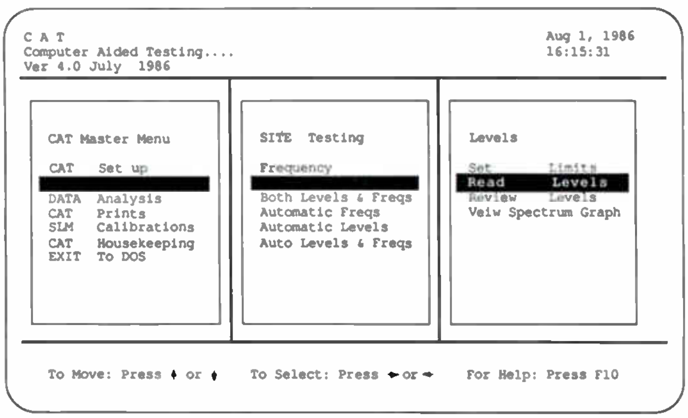
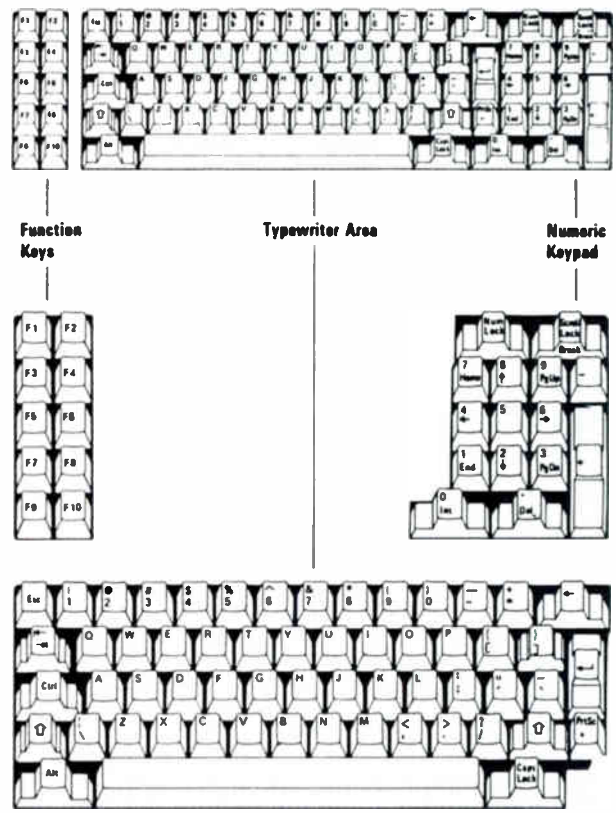


Figure 5: The keyboard



available at all desired measuring locations.

- You have a means of making an operational record of several headends or of a headend and its hub sites on a daily basis (or at any desired time interval) with practically zero time expended.
- The measurements can be performed or reviewed by managerial personnel with very little time input, thus affording them additional control in ensuring optimum system performance.
- Direct cost savings can be computed, but they would not be as notable or realistic as would the financial impact of maintaining your customer base because you are providing quality service that is troublefree. It is preventive maintenance, the correction of minor problems before they become discernible to customers or to some regulatory agency, that will afford the greatest benefit.

Hardware and initial setup

The equipment required to operate the CAT system is comprised of four basic components: a signal level meter, a frequency counter, an IBM or Compaq computer, and CATPAK software.

The signal level meter (SLM) is programmable and has an RS232 connector for computer interfacing. (Current modules being used include RF Superior's HE 4550 and Wavetek's Sam IIID, Sam IV series and RACC.) The frequency counter is connected to the cable system at all times. This on-line operation means that it must be capable of measuring the frequency of modulated carriers. (The CAT system uses the Model AFC-1A manufactured by RF Superior for this purpose.) The computer can be the IBM PC, XT or AT or it can be a Compaq. Specific requirements of the computer include: 512K of random-access memory (RAM), a graphics card and a modem card. An Epson printer completes the computer package. The software that ties everything together is written specially for application in measuring technical parameters in cable systems.

In many systems, the headend and the office are not at the same location, and in this situation communication between the computer and the measuring instruments is via telephone, using dial-up modems. If the SLM does not have a modem built-in, an external one will be required. However, if the headend and the office are in the same building, a direct hookup can be made if so desired.

A CAT system is activated by interconnecting the equipment for either remote or local operation as shown in Figure 1 or Figure 2, and installing the software, after which you are ready to enter data and to request measurements. The system is menu driven and, after a few operations, becomes a routine procedure.

Site definition

Before making a set of measurements, whether you do it with a computer or if you do it manually, it is necessary to define which site you wish to access and what parameters you want to measure. Start with the master menu shown in Figure 3. As you select an item from the first column, it becomes the heading for the second column. And selections from the second become the heading for the third. See Figure 4 for an example of specifying channels for a given site.

A minimum number of keys is used to operate the system and the keyboard functions utilized are shown in Figure 5. Additionally, there is a help screen describing these key functions that can be accessed by striking F10 on the keyboard.

The first menu item is "set up." This part of the program defines the site to be measured, categorizes it as local or remote, selects the frequency plan and specifies the active channels to be measured. To define a site, select "input system info" and the screen shown in Figure 6 will appear. Input the name and address. If this is to be a remote measurement, insert the telephone number in the appropriate space. The system design will accommodate either tone or pulse dialing and a routine has been incorporated so that it is useable in any PBX or other office exchange system.

The next step is "CAT set up/channel selection," which will first ask you what site you wish to define channels for. After site definition, you

Figure 6: Site definition

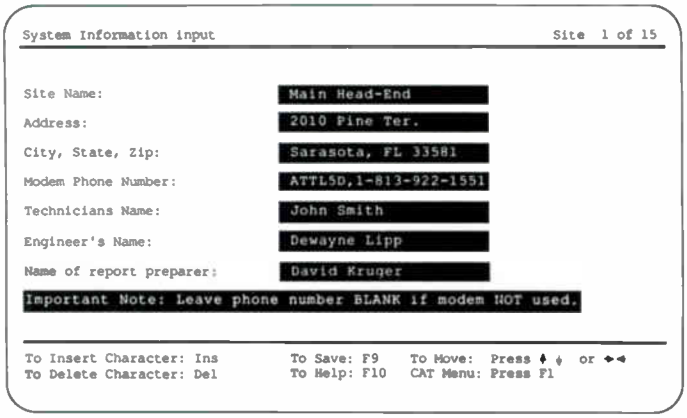


Figure 7: Programming channels

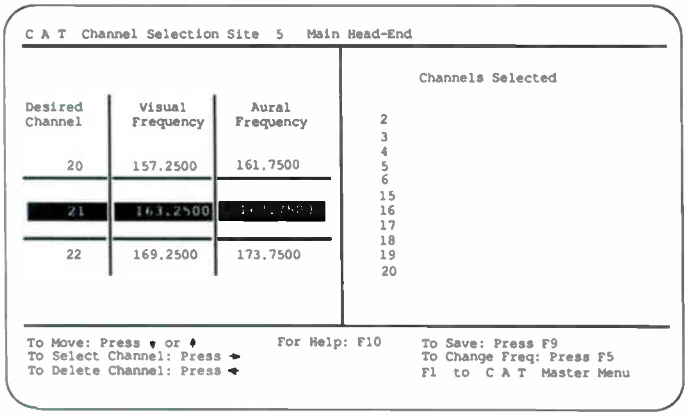


Figure 8: Defining SLM type

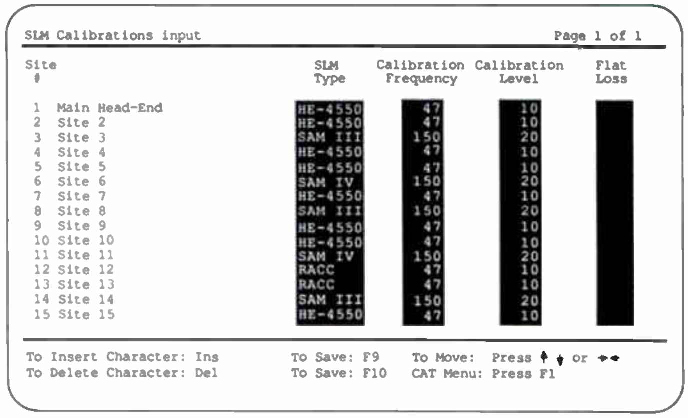
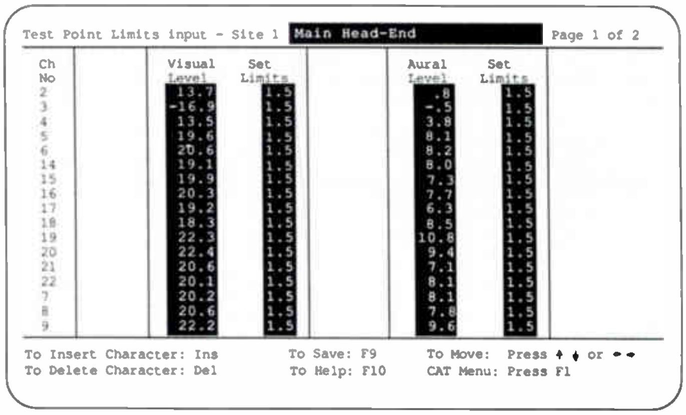


Figure 9: Specifying normal levels



will be offered a choice of four built-in frequency plans: NTSC, HRC, NTSC+12.5, and NTSC−12.5; after which the channel numbers and the video and audio carrier frequencies will be displayed.

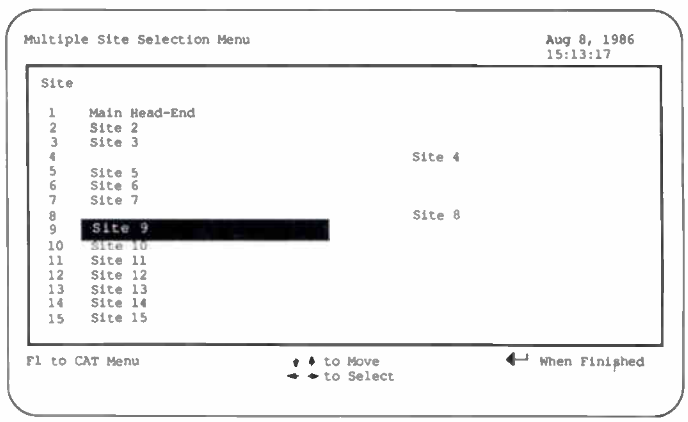
Programming the actual channels for a site is done by striking the right arrow key when the channel you need is displayed in the highlighted area (Figure 7). The channels you do select are automatically entered into the "channels selected" box and will be measured anytime you access that particular site.

Any offset channel is accommodated by clearing the channel frequency with the F5 key and then entering the correct value. This feature also is used to measure other frequencies, such as data carriers in an addressable system. Thus, the channels are loaded by channel number, not by frequency, and you have the flexibility to accommodate any carrier that does not match a standard frequency plan.

Signal level meters do not have common calibration frequencies and levels. You must therefore define the type of measuring instrument for each site location using "SLM calibrations" in the main menu, and entering the model description (Figure 8). This input is necessary to activate the CAT system's periodic automatic recalibration, which allows a maximum accuracy when reading levels.

The last step in setup is to specify the normal levels and frequencies and their tolerances using "site testing/levels (frequencies)/set limits." "Normal" can be set in two ways: the design parameters for the system can be entered; or alternately, a set of measurements that represent actual and acceptable operating conditions can be transferred into the "normal" file. The tolerance you set on levels is that which you define as necessary to optimize performance. Typically, this might by ±2 dB. The tolerance on frequency, however, is preset to FCC guidelines of ±25 kHz for the video carrier and ±1 kHz for intercarrier. Provision is made for modification of these tolerances if, for example, you are carrying channels in an aeronautical band and must observe a 5 kHz limit (Figure 9). Tolerances are required so that the computer can visually notify you when channels exceed their set parameters.

Figure 10: Site selection



Measuring levels and frequencies

Sequential selection of "site testing/levels (frequency)/read levels (read frequency)" will bring up a screen (Figure 10) listing all sites that can be accessed for measurement. The site(s) to be measured are moved from the left column to the right column using the arrow key. The final step is to strike the "enter" key and the measurement process will start. In addition to levels (or frequencies), the system records time, date, temperature, SLM power supply voltage, attenuator setting and the site being measured.

The time required to measure is eight seconds per channel for levels and 33 seconds per channel for frequencies. Thus, in a 60-channel system, levels are measured in eight minutes and frequencies in 33 minutes. But the operator's time used will be less than one minute.

Current software will process 15 sites, which is the capacity of a dual

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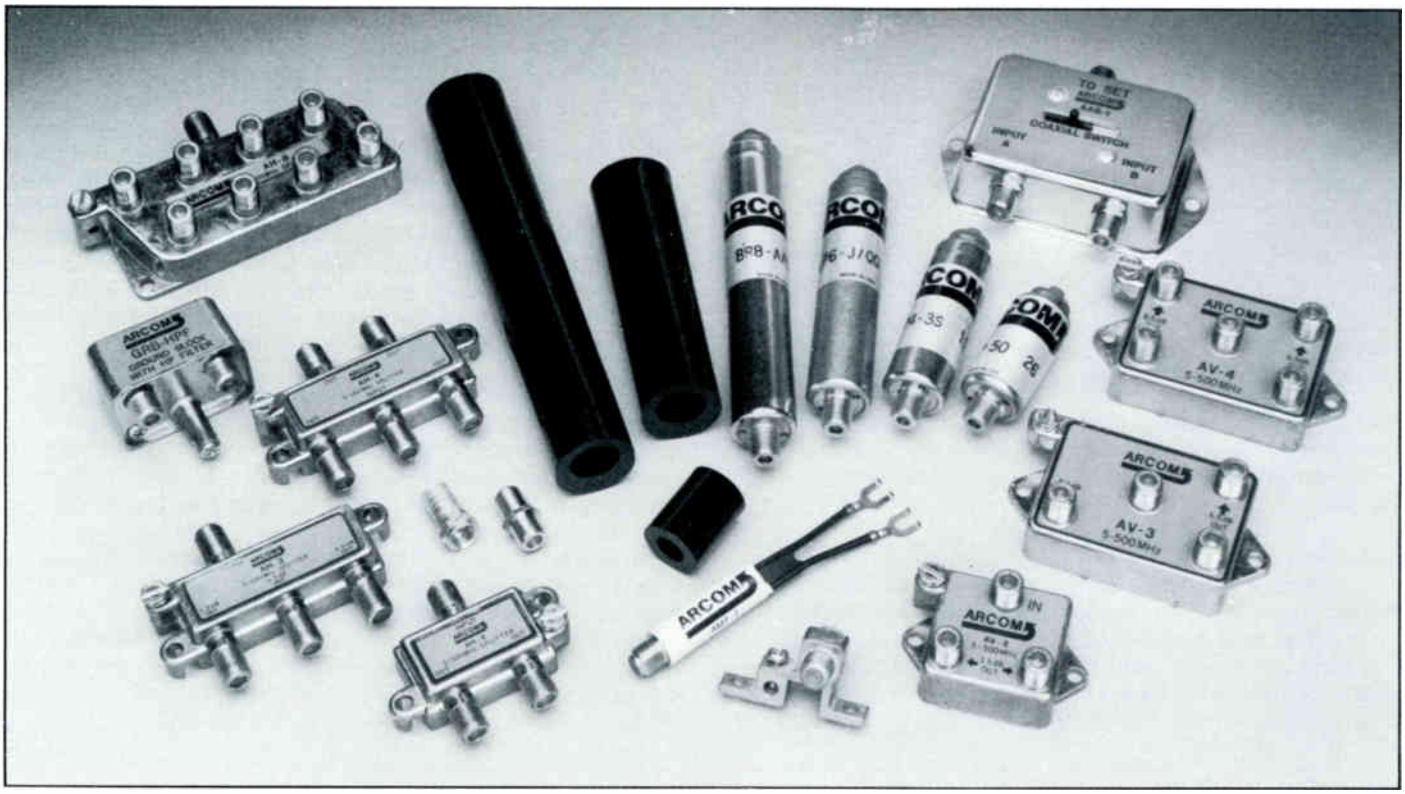

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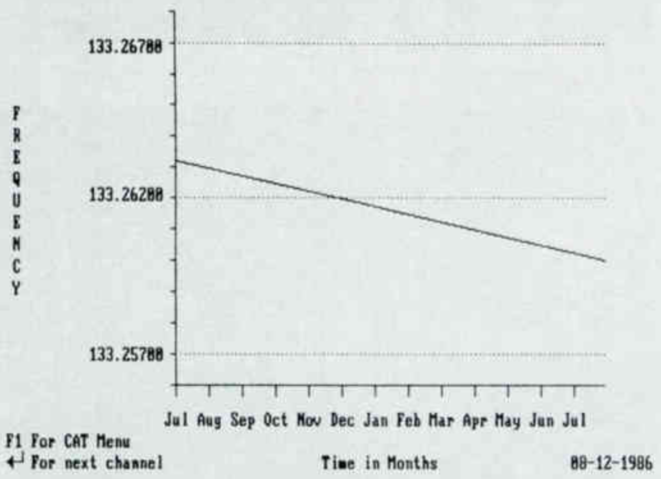
Figure 11: Frequency measurement



floppy drive for the IBM or the Compaq. Additional sites can be programmed for personal computers that utilize a hard disc, and by using more than one set of floppies you can expand your number of measuring sites in multiples of 15.

Data analysis

Data is but a first step — interpretation and action when necessary are required to make effective use of information that is collected. The "frequency" data is presented in two forms. The measured carrier frequencies can be reviewed in tabular form, which lists channels, normal frequencies, measured frequencies, variation from norm and presents a visual flag if the measured value exceeds the established tolerance. This data can be reviewed on the monitor screen or it can be printed and stored in a permanent file. Figure 11 is a typical print out of a frequency measurement.

One of the other important advantages of a computer system is its ability to predict trends based upon historical data. Measurements are stored in a drift file, which has the capacity to record one frequency measurement a day for each channel on your system for one full year. The computer analyzes the accumulated data and, using straight line projection techniques, draws a trend line and predicts if and when a particular channel will exceed your established limits. This is very useful, especially when you have to use 5 kHz limits on some channels. Figure 12 is a typical frequency drift print out.

The frequency counter has a resolution of 10 Hz, and an accuracy of .0001 percent, which allows the instrument to correctly determine intercarrier to 1 kHz and critical aeronautical band offsets to the required 5 kHz. The frequencies of a cable system's carriers are critical, but they are normally quite stable and, therefore, it is not necessary to check them as frequently as it is levels. Level data also is available in both tabular and graphical form. Figure 13 is a copy of typical data showing measured levels, normal levels, variation from norm and out of limit flagging.

The data also is available in a spectrum display, showing each carrier and its absolute amplitude. This allows for rapid evaluation of the relative levels for system phenomena such as slope, rolloff and suckouts. The graphics are not limited to displaying current operating levels, but by measuring at different times, temperatures and places you can build a profile of your system's characteristics.

While discussion so far has been restricted to headend measurement sites, if you incorporate measurements at various points including end of trunk lines, your knowledge of system performance is greatly enhanced. For example, if you take a set of readings at point A in the middle of the day and repeat the measurement in the middle of the night, you can, using the computer, derive a level/temperature profile of the system from the headend to point A. This is programmed as "system stability"

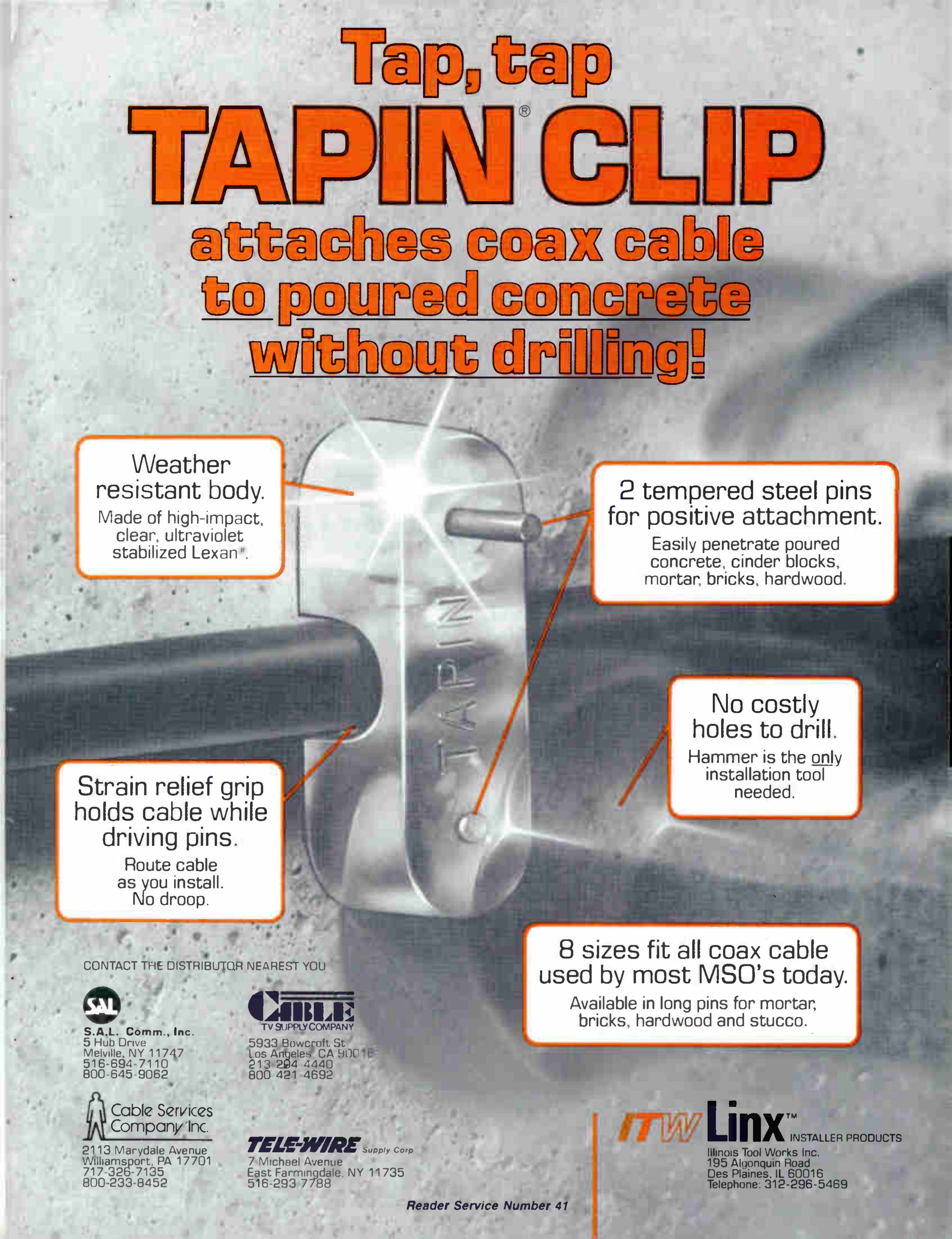

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Figure 12: Carrier frequencies

Main Head End Home Town USA

Telephone:
Attenuator: -5 to 5 dB
Voltage: 15.1 vdc

Date: 11-18-1985
Time: 14:54:15
Temp: 76.4 F

Cable Channel	Visual Frequency Reads MHz	Visual Frequency Error KHz		Aural Frequency Reads MHz	Intercarrier Reads MHz	Intercarrier Error KHz		Cable Channel
2	55.25187	1.87		59.75194	4.50007	0.07		2
3	61.25019	0.19		65.75020	4.50001	0.01		3
4	67.24769	-2.31		71.74937	4.50168	1.68	Out	4
5	77.24864	-1.36		81.74830	4.49966	-0.34		5
6	83.25180	1.80		87.75175	4.49995	-0.05		6
14	121.04387	-206.13	Out	125.54371	4.49984	-0.16		14
15	127.12583	-124.17	Out	131.62570	4.49987	-0.13		15
16	133.27209	22.09		137.77213	4.50004	0.04		16
17	139.23809	-11.91		143.73778	4.49969	-0.31		17
18	145.25017	0.17		149.75008	4.49991	-0.09		18
19	151.24696	-3.04		155.74702	4.50006	0.06		19
20	157.24860	-1.40		161.74883	4.50023	0.23		20
21	163.25129	1.29		167.75110	4.49981	-0.19		21
22	169.24282	-7.18		173.74264	4.49982	-0.18		22
7	175.25112	1.12		179.75111	4.49999	-0.01		7
8	181.24036	-9.64		185.74031	4.49995	-0.05		8
9	187.25178	1.78		191.75176	4.49998	-0.02		9
10	193.24016	-9.84		197.74014	4.49998	-0.02		10
11	199.25401	4.01		203.75408	4.50007	0.07		11
12	205.24331	-6.69		209.74340	4.50009	0.09		12
13	211.24049	-9.51		215.74049	4.50000	0.00		13
23	217.24865	-1.35		221.74841	4.49976	-0.24		23
24	223.24556	-4.44		227.74551	4.49995	-0.05		24
25	229.24666	-3.34		233.74642	4.49976	-0.24		25
26	235.24971	-0.29		239.74964	4.49993	-0.07		26
27	241.24795	-2.05		245.74765	4.49970	-0.30		27
28	247.24873	-1.27		251.74877	4.50004	0.04		28
29	253.43044	180.44	Out	257.93043	4.49999	-0.01		29
30	259.24899	-1.01		263.74914	4.50015	0.15		30
31	265.24097	-9.03		269.74098	4.50001	0.01		31

Figure 13: Visual and aural signal levels

Last Trunk Amp West 5th Ave 2

Telephone:
Attenuator: 5 to 15 dB
Voltage: 15.4 vdc

Date: 11-15-1985
Time: 22:04:52
Temp: 76.3 F

	Visual level in dBmV				Aural level in dBmV				Diff in dB		
Cable Channel	Normal Level	Actual Level	Error +dBmV		Normal Level	Actual Level	Error +dBmV		Actual Diff	Error +dBmV	Cable Channel
2	28.0	27.1	-.9		13.0	13.6	.6		13.5	-1.5	2
3	28.0	27.7	-.3		13.0	14.3	1.3		13.4	-1.6	3
4	28.0	28.2	.2		13.0	14.8	1.8		13.4	-1.6	4
5	28.0	28.7	.7		13.0	15.3	2.3		13.4	-1.6	5
6	28.0	29.5	1.5		13.0	16.2	3.2	Out	13.3	-1.7	6
14	29.5	31.7	2.2		14.5	18.7	4.2	Out	13.0	-2.0	14
15	29.5	32.2	2.7	Out	14.5	19.2	4.7	Out	13.0	-2.0	15
16	29.5	31.6	2.1		14.5	18.6	4.1	Out	13.0	-2.0	16
17	29.5	32.0	2.5		14.5	19.0	4.5	Out	13.0	-2.0	17
18	29.5	30.8	1.3		14.5	18.0	3.5	Out	12.8	-2.2	18
19	29.5	29.0	-.5		14.5	16.1	1.6		12.9	-2.1	19
20	29.5	28.7	-.8		14.5	16.1	1.6		12.6	-2.4	20
21	29.5	31.0	1.5		14.5	17.7	3.2	Out	13.3	-1.7	21
22	31.0	32.0	1.0		16.0	19.7	3.7	Out	12.3	-2.7	22
7	31.0	32.7	1.7		16.0	19.7	3.7	Out	13.0	-2.0	7
8	31.0	33.0	2.0		16.0	20.6	4.6	Out	12.4	-2.6	8
9	31.0	33.0	2.0		16.0	20.7	4.7	Out	12.3	-2.7	9
10	31.0	33.2	2.2		16.0	21.0	5.0	Out	12.2	-2.8	10
11	31.0	33.4	2.4		16.0	21.1	5.1	Out	12.3	-2.7	11
12	31.0	33.0	2.0		16.0	22.2	6.2	Out	10.8	-4.2	12
13	31.0	33.4	2.4		16.0	21.7	5.7	Out	11.7	-3.3	13
23	31.0	34.0	3.0	Out	16.0	22.2	6.2	Out	11.8	-3.2	23
24	31.0	34.7	3.7	Out	16.0	23.2	7.2	Out	11.5	-3.5	24
25	31.0	33.7	2.7	Out	16.0	22.2	6.2	Out	11.5	-3.5	25
26	31.0	33.7	2.7	Out	16.0	22.6	6.6	Out	11.1	-3.9	26
27	31.0	33.4	2.4		16.0	22.2	6.2	Out	11.2	-3.8	27
28	32.5	34.5	2.0		17.5	23.2	5.7	Out	11.3	-3.7	28
29	32.5	36.2	3.7	Out	17.5	25.2	7.7	Out	11.0	-4.0	29
30	32.5	36.2	3.7	Out	17.5	25.1	7.6	Out	11.1	-3.9	30

Visual Peak-to-Valley: 9.9 dB

under the "data analysis" section in the software. Figure 14 is a typical example.

Similarly, if you measure the headend and then measure a point out in the system, the computer will subtract the two, normalize the result, and display it as "system response." This should not be confused with a true swept response, but it is a response based upon video carriers and will show any gross abnormalities. "System response" files are found under "data analysis" in the menu and an example is shown in Figure 15.

Preset time measuring

Previously, the concept of measuring a system in the middle of the night was brought up, which is both inconvenient and disruptive of your normal work routine if the measurements have to be made manually. The CAT system makes this easy with its automatic measuring routine. You can preprogram any site (or any combination of sites) to be measured at any time of any day for levels, frequency, or both and the measurement can be repeated at any given time interval.

The designation of sites to be measured can be done in two ways:

- Event measuring — The first method allows you to input site, measurement, date and time of start. This can be done for each site, and each can be preset for up to 10 measuring events.
- Repeat measuring — Secondly, you can specify the parameters, start date and start time for a site and then enter a repeat interval. Using this method, you can make a series of measurements to either create a periodic log of your system's performance, or you can record data over a given time period to determine an operation versus temperature and time profile. The preset time of measurement function is this flexible to allow you maximum use of the computer's data gathering and processing power.

Application notes

The system is useful in more ways than routine monitoring of levels and frequencies.

1) The accuracy and the resolution of the measuring equipment are enhanced by the computer's recognition of fractions of a dB and fifth-decimal point frequencies. You will document your system as tightly as is practically possible.

2) Developing problems have been identified and corrected before they became critical (e.g., a klystron that was losing power in an AML transmitter was isolated and replaced before it became visually noticeable).

3) Limited troubleshooting is possible. In one instance, a modulator had an unstable output at the system level, but when checked by itself operated normally. The variation was minor and most probably the problem would not have been detected — the output level would have been adjusted as required when making system checks until there was a catastrophic failure. The real problem? One of the cables connecting the unit into the system was intermittent.

4) At least one cable system, US Cable of Lake County (in Waukegan, Ill.), has mobilized its CAT system, putting it into a specially equipped van that allows measurements to be made at any point in the plant. This has added a new dimension to the measurements and to the system response and stability information they can gather and interpret.

5) The dependability of long distance measuring has been proven

Figure 14: Level/temperature profile

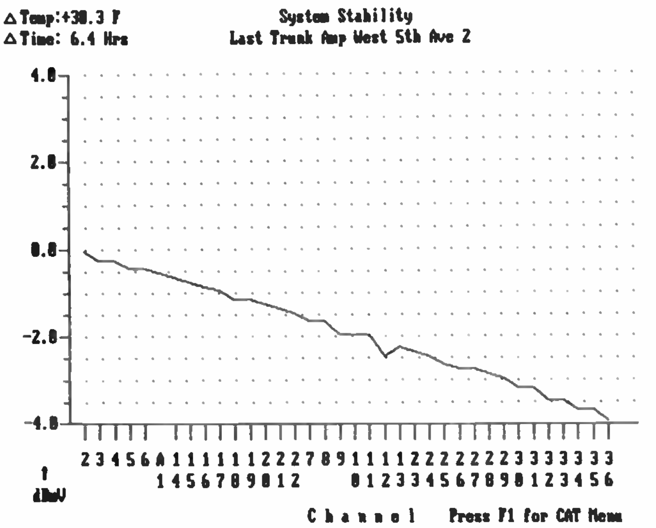
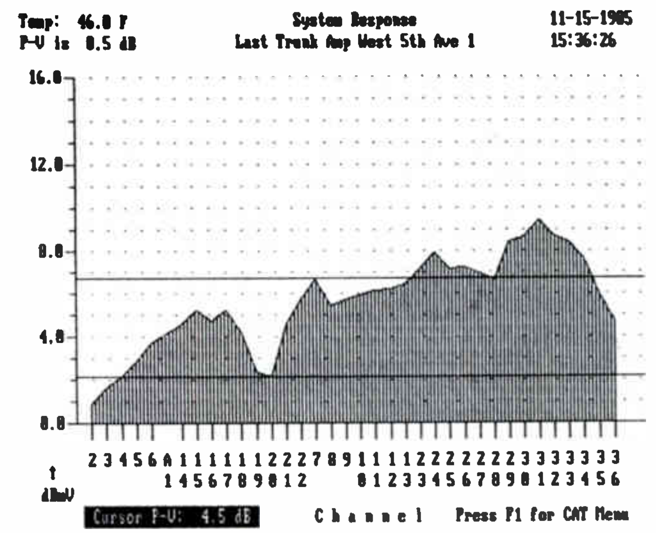


Figure 15: System response



by repeated successful accessing of Bellevue, Wash., from Sarasota, Fla. Practical applications of this feature have included measuring to Sarasota from Anaheim, Calif., Fenton, Mich., and Pittsburgh; and from Sarasota to Phoenix, Ariz. Obviously, regional monitoring is a practical and real benefit.

Getting to know your system

The practicality of computerized measuring of cable system parameters has been demonstrated by one and one-half years of successful field application. Two key parameters can be checked at any time from virtually any place and the time required to make these measurements is no longer a factor in deciding how often they will be done. The recording is done by a printer driven by a computer — incidental errors in translation or in interpretation of meter readings are eliminated. The hard copy from your printer is the most accurate presentation of cable system parameters that is practical on a frequent measurement cycle.

The direct cost savings is computable — the indirect savings will probably vary from system to system. But the satisfaction of your subscribers can only increase as you come to know and control your cable system more effectively.

Status monitoring system considerations

The simplest and most common form of status monitoring in CATV today is probably the customer who calls to complain about poor reception or an outage. The size and complexity of modern cable systems — and especially the deregulation issues facing our industry — are causing many operators to take a second look at status monitoring. This article highlights the basics of status monitoring and things to think about when considering a status monitoring system.

By Ron Hranac
Corporate Engineer, Jones Intercable Inc.

An effective status monitoring system can be a useful tool to improve the reliability of a cable system. It simplifies fault finding and is capable of spotting potentially catastrophic problems through trend analysis. When used in conjunction with bridger switching, it also can be a diagnostic tool for locating and controlling ingress.

Status monitoring is the continuous monitoring of the operating conditions of active devices in a cable system, such as trunk amplifiers and standby power supplies. The key elements of a basic status monitoring system (Figure 1) include a control computer, cable system interface, the transponders located in the devices being monitored and a two-way path between the interface and the transponders.

How it works

The computer polls a transponder in an amplifier or other active device by first sending data to the interface. The interface, which is actually a radio frequency (RF) modem, converts the outgoing computer data into an RF signal. This signal is combined with others in the headend, then sent downstream.

The transponder modules in each active device have their own unique data address. When the transponder being polled "hears" its data address, it responds with an upstream RF signal containing data that corresponds to the operating conditions in the active device (for example, RF levels, AC and DC voltages, temperature, and bridger switch status).

The upstream RF signal returns to the headend, where it is routed to the interface, which converts this incoming signal into computer data and sends it to the computer. The computer analyzes the incoming data and determines if the active device just polled is operating within predetermined parameters. After verifying the operating conditions of the device, the computer then can notify system personnel if a fault exists via printout or audible alarm. In most cases, the type of problem and its location can be identified by the computer.

Limiting considerations

Practical status monitoring systems have limitations that must be considered prior to selection and installation. Among the most important are: functions monitored and controlled, the number of devices that can be monitored, polling rate, control computer software, and expansion capabilities.

State-of-the-art status monitoring systems are capable of both monitor-

Table 1: Status monitoring functions

Amplifiers	Power supplies
Functions monitored	
• Forward RF levels	• Line voltage
• Reverse RF levels	• Cable voltage
• DC power supply	• Current draw
• Temperature	• Cabinet tampering
• Feedforward operation	• Standby switchover
• AGC/ASC pilots	• Charger operation
• Redundant module status	• Battery voltage
• Standby/AC operating mode	• Inverter operations
• AC voltage	• Charger/inverter malfunctions
• Trunk/bridger reverse switch status	• Temperature
• Trunk/bridger reverse attenuator status	
• Housing closure	
Functions controlled	
• Trunk/bridger reverse switch operation	• Switch to and from standby operation
• Trunk/bridger reverse attenuator operation	
• Return RF level	
• Trunk reverse bypass	

Figure 1: Basic status monitoring system

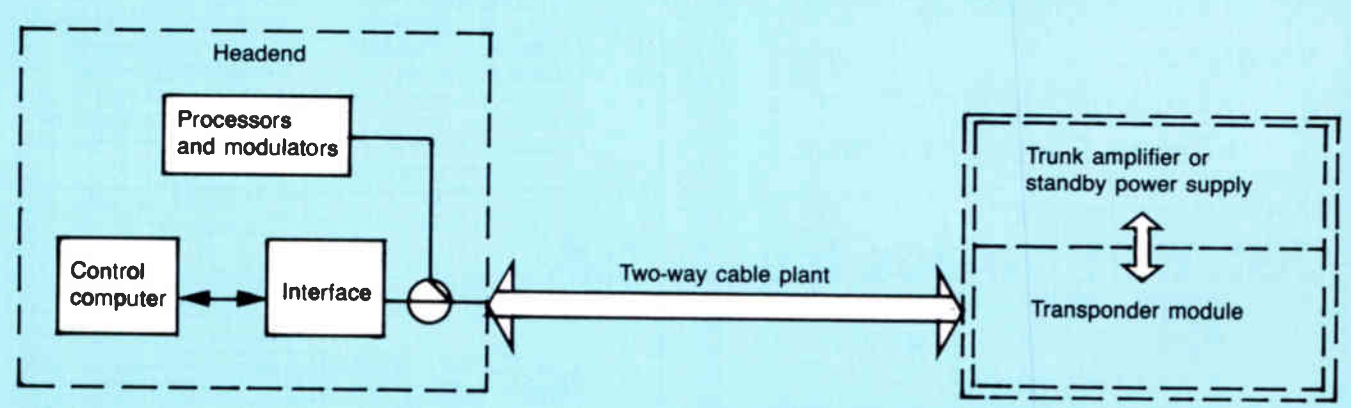


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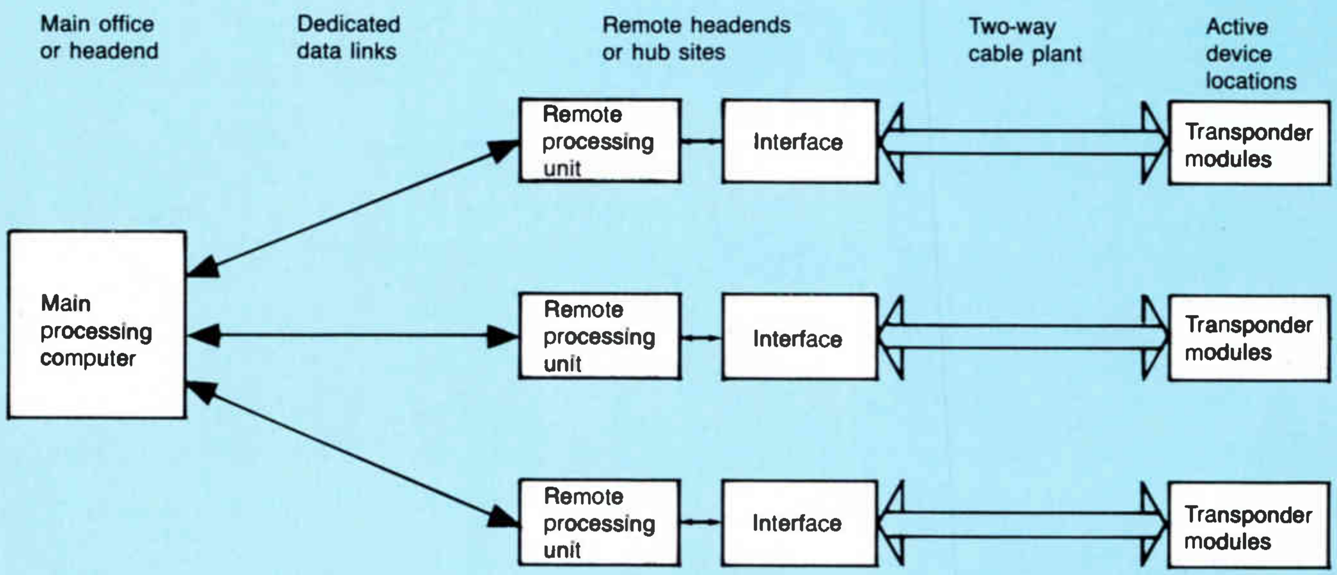
Figure 2: Multiple processor status monitoring system



ing and controlling a number of functions. Table 1 highlights many of the monitoring and controlling features available. These capabilities can provide a cable operator with tremendous flexibility, and a well-planned status monitoring system actually will help to reduce plant maintenance costs. A cable operator can monitor the operational status of the entire cable system, immediately identify and locate problems, and remotely disconnect reverse trunk or feeder paths to eliminate ingress in the reverse system.

It's also important to consider the monitoring and control capabilities under adverse conditions. The headend interface and device transponders should have the necessary dynamic range to receive data in very weak signal conditions — for example, when a trunk amplifier fails. The downstream and upstream data also must be extremely rugged and contain some form of error detection/control to avoid improper data addresses and responses.

A status monitoring system's address capability should be selected as a compromise between too few (which will limit the number of devices that can be monitored or controlled) and too many (which increases the equipment's fault response time). In some cases, it may be necessary to consider a status monitoring system using multiple processors (Figure 2).

The speed at which an entire cable system can be polled will depend upon several factors. The number of transponders being polled, the data rate, data word length, complexity of error checking and response verification, computer program execution time, processing speed, and processor architecture (i.e., single or multiple processors) all will affect the polling rate. Each of these must be considered when evaluating a status monitoring system.

The software that operates the control computer should be user-friendly in its management of the status monitoring system. Trend analysis is a feature available in many software packages, one that will help the cable operator identify potential problems before they become catastrophic. Good software packages also will identify the nature and location of problems in the plant and, in many instances, prioritize the problems. Historical recordkeeping is another useful software feature.

As the cable system grows, it's important that the status monitoring system grow with it. The abilities to add more monitored devices and software updates and perhaps to expand from a single processor to a multiple processor configuration need to be considered before installing status monitoring.

Putting it together

There is no magic involved with status monitoring. A well-planned system can help improve service reliability and reduce maintenance costs. Consideration of a cable system's present and future needs is a must when planning for the installation of status monitoring. As cable systems continue to grow in size and complexity, effective status monitoring systems will be necessary components of that growth.

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In the last year, SPRUCER's 2-way addressable system helped NYT Cable TV, Cherry Hill, NJ, record new milestones in cable- and pay-TV.

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Reader Service Number 46

Fiber-optic tool

G&H Technology announced its BFT-101 universal fiber-optic cleave tool kit, designed to work with most optical fibers or fiber-optic connectors. The kit is supplied in a carrying case and contains a cleave tool assembly and all necessary accessories to perform fiber cleaves. The tool has a solid metal frame with a ceramic alignment sleeve. According to G&H, it takes only seconds per cleave with pre-stripped fiber. The adjustable tool comes with calibration instructions to accommodate different fibers.

The cleave tool is said to provide precise, mirror-finish quality cleaved endfaces with angles typically less than one-half degree from the perpendicular. A diamond stylus performs a scribing motion at the circumference of the fiber while the fiber is under longitudinal tension; it transfers energy into the fiber, causing it to break cleanly.

For more information, contact G&H Technology Inc., 750 W. Ventura Blvd., Camarillo, Calif. 93010, (805) 484-0543; or circle #86 on the reader service card.

One-man trencher

Brown Manufacturing Corp. has upgraded its one man-operated Trenchmaster series with the Model F-1200. The unit, which is powered by an 8 HP Briggs & Stratton industrial-commercial engine, will dig 10 to 30 feet per minute leaving a trench 12 inches deep and 3 inches wide, with all the dirt piled beside the trench for ease of refilling. The F-1200 weighs 200 pounds and features all-steel construction with replacable steel alloy tips.

For more details, contact Brown Manufacturing Corp., Route 3, Ozark, Ala. 36360, (205) 795-6603; or circle #83 on the reader service card.

Ground rod driver

The Model GRP 1 ground rod driver from Wyecliffe Products is said to allow the user to install up to 5/8-inch diameter rods. Its design permits maximum power to be transmitted to driving the rod without damage when using a sledgehammer.

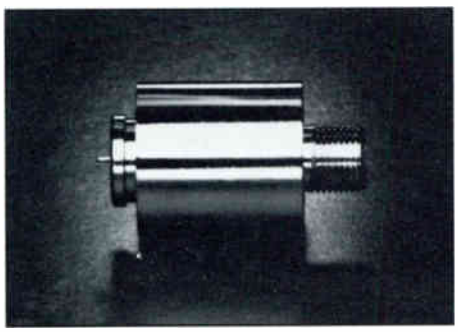
For more details, contact Wyecliffe Products & Services, P.O. Box 2032, Wapakoneta, Ohio 45895, (419) 738-8577; or circle #99 on the reader service card.

Time domain reflectometers

Lanca Instruments Inc. has introduced a new line of digital time domain reflectometers (DTDRs). The L series allows customers to select hardware and software options to configure a DTDR that will meet their primary or complete range of coaxial, twinaxial, multiconductor and twisted pair test requirements.

In a stand-alone mode, the DTDR is said to provide an instantaneous display of cable conditions on a 16-character LCD. User-selectable cable conditions are displayed as: "Open," "Short" or "OK TO" in feet, meters or nanoseconds. An analog test mode allows the product to be used in conjunction with most dual-channel 60 MHz (or greater) oscilloscopes, to test for hard-to-find faults or for sweeping cable on the reel. Selectable test pulse widths are 15 ns, 150 ns, 1,100 ns and 37 microseconds. A calibration mode programs any velocity of propagation speed or calculates an unknown velocity of propagation.

For more information, contact Lanca Instruments Inc., 1350 Johnson Lane, Round Rock, Texas 78664, (512) 388-1195; or circle #84 on the reader service card.



Voltage protector

Passive Devices Inc. announced its Model SE-1 Surgender RF voltage protector, designed to guard all types of coaxial connected equipment from lightning damage. It is said to be able to protect CATV converters and decoders, TVs, VCRs, satellite receivers, FM receivers and LAN computers.

According to the company, the surge protection attack time is 100 nanoseconds; the maximum surge current is 5,000 amps. Its surge life is 200 surges of 500 amps. Normal resistance across coax is 10 megaohms and surge resistance is approximately 0 ohms. Power passing capability is 50 volts of DC or AC peak-to-peak. Approximate dimensions are 1.385 inches long by .815 inches in diameter.

For more information, contact Passive Devices Inc., 5120 NE 12th Ave., Fort Lauderdale, Fla. 33334, (305) 493-5000; or circle #100 on the reader service card.

Frequency translator

LanTel Corp. has introduced the 192CRU central retransmission unit for broadband (CATV) networks using 192.25 MHz as a translation frequency. The product is said to be an efficient, single-channel frequency translator available for five video channels from 83.75 MHz to 113.75 MHz (North American standard CATV Channels 6', FM1', FM2', FM3' and A2).

According to the company, the unit offers excellent selectivity, with drop-off down 60 dB in a standard 6 MHz channel. The model is 1.75

inches high, occupying minimal space in a standard 19-inch rack.

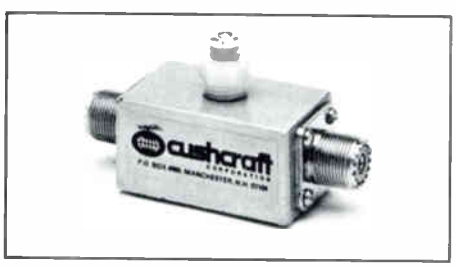
For more information, contact LanTel Corp., 3100 Northwoods Place, Norcross, Ga. 30071, (404) 446-6000; or circle #93 on the reader service card.

Fiber-optic multiplexer

A new fiber-optic data multiplexer, originally developed for military applications, is being offered commercially by Balboa Systems. Model BSCI-FODM-7-001 is said to be capable of transmitting and receiving seven channels of asynchronous RS232-C data at independent transmission rates of up to 19.2 kilobaud.

According to Balboa, the unit can be connected in a loop with up to seven stations, each station transmitting data to and receiving data from any other station. LED indicators are provided for synchronization, data transmit and data receive indication for each channel.

For more information, contact Balboa Systems Co. Inc., 1050 Pioneer Way, Suite E, El Cajon, Calif. 92020-1943, (619) 440-8077; or circle #91 on the reader service card.



Lightning arrester

According to the Cushcraft Corp., its coaxial lightning arresters feature fast action gas discharge elements. There are four models with choices of 200 watt or 2 kW power handling and type N or UHF connectors and are manufactured to give low insertion loss from 2 to 1,000 MHz. Replacement cartridges are available. Dimensions are 3.5 inches by 1.375 inches by 1.875 inches.

For more information, contact Cushcraft Corp., 48 Perimeter Rd., Manchester, N.H. 03108, (603) 627-7877; or circle #88 on the reader service card.

Power supply

Power Guard has introduced a modular, 90 percent efficient at 18 amps, AC non-standby ferroresonant power supply for use in CATV systems that require higher operating current. The Model NS-6018-0 measures 8 inches by 9 inches by 11 inches. Features include a three-year warranty, simple installation and maintenance, convection cool operation, total modularity, surge protection, status light, and varied housing configurations.

The power supply also is available with options such as heavy-duty 120 volts AC input metal oxide varistor surge protection, transzorb surge protection on the 60 volts AC output, output time delay module and resettable power outage counter module to account for power failures.

For more details, contact Power Guard Inc., P. O. Box 549, Hull, Ga. 30646, (404) 354-8129; or circle #89 on the reader service card.

Broadband modem

EF Data has announced new, low-frequency operating range capabilities for its BCM-101 broadband cable modem. This feature is said to be advantageous to microwave system operators who put data above voice and for converting analog microwave radios for data transmission. According to the company, the modem is fully synthesized from 1 to 400 MHz in 50 kHz steps with data ranges from 200 kBPS to 6.3 MBPS.

For more information, contact EF Data Corp., 1030 N. Stadem Dr., Tempe, Ariz. 85281, (602) 968-0447; or circle #92 on the reader service card.

A/B switch kit

Viewsonics Inc. now offers an A/B switch hook-up kit, Model VSABS. The kit consists of one A/B push-button switch (Model VSCSW-3A) with 95 dB isolation, which allows selection of either cable or antenna signals to the TV set; one reverse matching transformer (Model MT85-4), which connects antenna with the A/B switch; one jumper cable, which connects the A/B switch to the TV set; and instructions on the header card.

For more information, contact Viewsonics Inc., 170 Eileen Way, Syosset, N.Y. 11791, (516) 921-7080, (800) 645-7600; or circle #82 on the reader service card.

A/V modulator

R.L. Drake has introduced a frequency agile audio/video modulator with access to 60 channels, including all standard and cable channels up to 400 MHz. Model VM2410 is a vestigial sideband unit with synthesized visual and aural carriers, said to provide total system flexibility. According to Drake, the product makes it easy for cable companies to move from one channel to another, since all the user has to do is

WAVETEK

Wavetek Report 2: LAN Distortion

The effects of LAN RF distortion are increasingly obvious.

In time, every Local Area Network is a candidate for distortion. It's an elusive problem that gradually worsens.

At best, distortion vacillates between slight and obvious. Accelerating bit error rate. And in general being a nuisance to accurate transmission.

At worst, it can take the system down if left unchecked.

LAN distortion is most commonly caused by component aging. It takes many forms.

Carrier-to-noise.

When a carrier has gradually drifted too near the noise floor, a weakening in signal occurs. Causing demodulation problems.

Transmissions that were once crisp and clean are muddled. Affecting data transmission in much the same way video snow affects broadcast quality.

Carrier-to-hum.

Every LAN introduces a certain amount of low level hum. Usually 60 to 120 Hz. Usually coming from power supplies. Usually kept in check by filters.

But when a filter fails or a power supply ages, hum modulation can occur. Causing a degradation of data directly traceable to the level of hum.

Intermodulation.

When fundamental carriers mix, they create spurious carriers at a new, different frequency.

If that new frequency is already occupied, you experience distortion inside the modem. Two carriers, in effect, battle for the same frequency.

Second order intermodulation, $1F_1 \pm 1F_2$, is where two carriers mix. *Third order*, $1F_1 \pm 1F_2 \pm 1F_3$, is where three mix.

Cross modulation.

Indigenous to CATV, cross modulation is not very likely in LAN.

Still, it *can* occur.

Especially if you heavily load your LAN with video carriers. Information on one carrier crosses over into another. A sure sign of diminished power handling capacity.

Relative group delay.

When sideband components arrive at different times in respect to their instantaneous modulation times, high speed, single channel formats suffer relative group delay. Causing errors during the demodulation of the original signal.

It's effects are intersymbol crosstalk and smearing. Both of which can literally destroy information.

The cure: preventive testing.

Routine maintenance can help in the early detection and prevention of RF distortion.

Wavetek can help, too.

We can help establish testing habits.

And we can supply you with a complete line of testing instruments. Manual or automatic. (A status monitor isn't sophisticated enough here.)

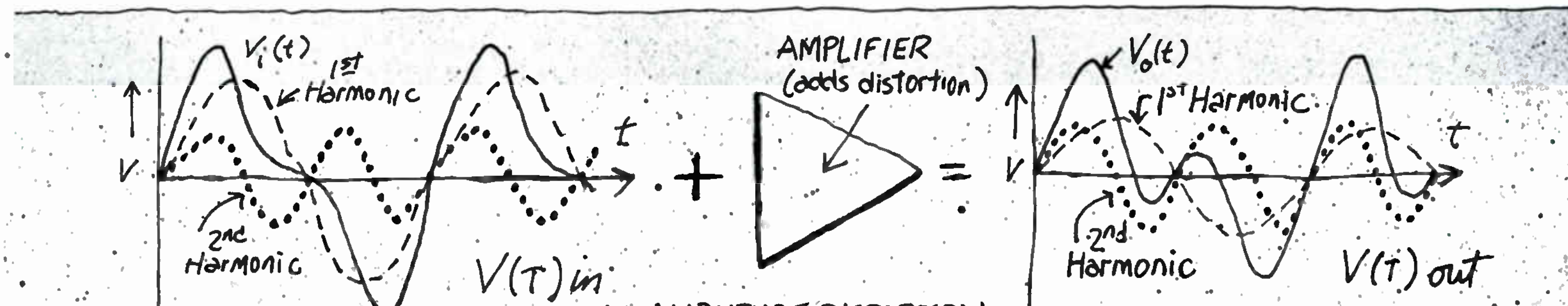
More than equipment, though, we offer LAN support. Applications engineers man the phones for trouble-shooting. Technical writers publish periodic applications papers. Sales engineers advise on-premise.

The resources and technology are out there. Don't let distortion compromise the integrity of your LAN.

For more information on distortion or other broadband LAN performance testing, and for our free booklet, Testing LAN Performance, *write Wavetek Indiana, Inc., 5808 Churchman, P.O. Box 190, Beech Grove, Indiana 46107.*

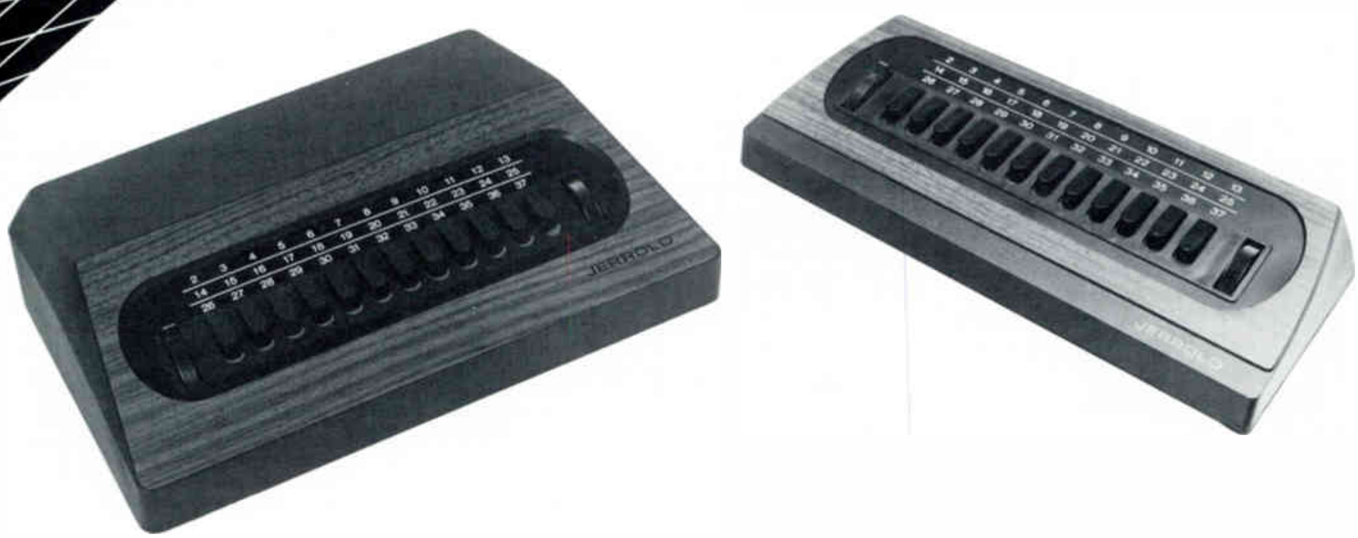
Or call toll free 1 800 622-5515. In Indiana, 317 788-5965.

COMING NEXT: *The effects of LAN leakage.*



AMPLITUDE DISTORTION

WE'VE GOT IT BRAD®/



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9 customer service
representatives
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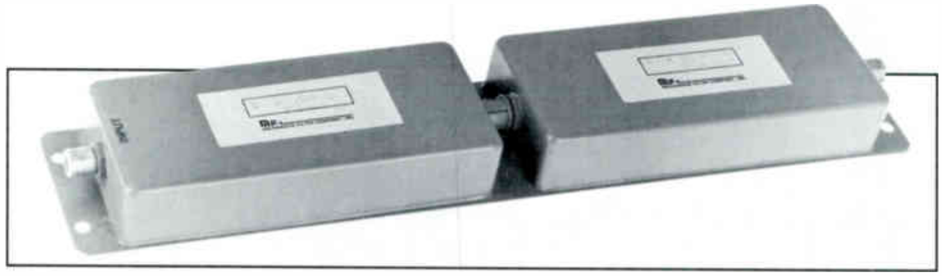
dial up the desired channel.

The modulator is said to provide access to multiple channels while eliminating adjacent channel interference, due to its video low-pass filter and IF SAW filter. It accepts standard sync-negative video inputs of 0.7 to 3 volts peak-to-peak. Its audio input design allows either balanced or unbalanced input without switching. Level controls and metering are provided on the front panel.

For further information, contact R.L. Drake Co., P.O. Box 112, Miamisburg, Ohio 45342, (513) 866-2421; or circle #87 on the reader service card.



Bandpass filter

Microwave Filter has announced its Model 5119 cable and LAN bandpass filter, which isolates the FM and data bands 88.5-118 MHz. According to the company, selectivity is 50 dB minimum at 83 MHz and 125 MHz. Passband loss is 3 dB maximum, impedance is 75 ohms and connectors are type F.

For more information, contact Microwave Filter Co. Inc., 6743 Kinne St., East Syracuse, N.Y. 13057, (315) 437-3953; or circle #85 on the reader service card.

One-way converter

Pioneer Communications has announced its BA-5000 one-way addressable converter. According to Pioneer, the product can be integrated into any system currently using Hamlin descrambling converters and encoders. Without removing any existing converters, it can be phased into a system to decode the Hamlin scrambling method.

The BA-5000 reads the incoming Hamlin signal and appropriately descrambles it in the subscriber's home. It also is said to decode Jerrold trimode, Sylvania, and Oak A and B modes, depending on the method designated by the operator at the headend.

For further information, contact Pioneer Communications of America Inc., 2200 Dividend Dr., Columbus, Ohio 43228, (614) 876-0771; or circle #97 on the reader service card.

TI filter kit

Pico Products has introduced the T.I. Kit, which includes three types of filters that suppress terrestrial interference from mild to severe occurrences. Each kit contains an improved notch filter, a dual switchable filter and a SAW-70 bandpass filter.

According to Pico, its improved notch filter removes a wider portion of the interfering signal's waveform, creating a U-shaped notch instead of a deep and narrow one. The dual switchable filter combines two standard 60 MHz and 80 MHz notch filters and suppresses mild to moderate interference. The SAW-70 bandpass filter suppresses mild to severe occurrences in single or block conversion systems and also can be used as a receiver threshold extension filter.

For more information, contact Pico Products Inc., 103 Commerce Blvd., Liverpool, N.Y. 13088, (315) 451-7700; or circle #96 on the reader service card.

Stereo decoder

The Model V-7640 MTS decoder and 140-channel converter from Universal Security Instruments includes an amplifier and shielded speakers. According to the company, a full 140 channels of VHF, UHF and cable tuning are user-programmable with favorite-channel memory. Full-function remote control features include random access tuning, volume control with muting and SAP (separate audio program) with stereo/mono selection. Fine tuning also is included for HRC/standard cable signal tuning.

For more details, contact Universal Security Instruments Inc., 10324 S. Dolfield Rd., Owings Mills, Md. 21117, (301) 363-3000; or circle #94 on the reader service card.

Microwave link system

International Microwave Corp. has introduced a 23 GHz microwave link system for paths up to 10 miles. The ICM 2123 FM link carries broadcast-quality video, audio and data signals and is said to accommodate up to four audio and/or data subcarriers along with full-color video.

The system may be configured for two-way, full-duplex operation for transmission of T1 or T1C. According to the company, up to 12 T1s can be transmitted with the addition of external multiplex units. Weatherproof, tower-mounted RF sections connect directly to 18-inch, 24-inch or larger antennas. The system operates from 21.2 GHz to 23.6 GHz under FCC Parts 21 (common carrier) and 94 (private user).

For more details, contact International Microwave Corp., 65 Commerce Rd., Stamford, Conn. 06902, (203) 323-5599; or circle #98 on the reader service card.

Converter tote

Cable Resources has announced its Converter Tote, a double-wall corrugated container that is said to simplify the storage, transportation and handling of converters in repair, customer service and business office areas. Each container features individual converter compartments to prevent cosmetic damages. According to the company, the scoop-shaped dividers make grasping individual converters easy. The product is available in various compartment sizes to accommodate all types of converters. It snaps together, requiring no tools or tape to assemble.

For complete details, contact Cable Resources, 156 Porter St., Suite 200, East Boston, Mass. 02128, (800) 752-2288, (617) 567-1600; or circle #95 on the reader service card.

C-COR Electronics has announced several new appointments and promotions. **James Wonn** has been appointed vice president, engineering. He will be responsible for directing corporate research and product development activity and managing field engineering and repair support groups. Prior to this, Wonn was vice president, engineering operations for Group W Cable in New York.

Roger Dagen has been promoted to manager, strategic planning and marketing services. He will coordinate and facilitate implementation of operational strategies of the company's corporate three-year plan. Dagen formerly was manager, marketing administration for C-COR.

Jeffrey Harrison has been named manager, power products department. He will be responsible for the development and implementation of a marketing plan for the company's power products. Harrison most recently was marketing support manager for the electronics division of Cohu Inc., San Diego.

Richard Taylor has been appointed Northcentral region account executive and will handle sales of the company's products for cable systems in several states. Prior to joining C-COR, Taylor was Eastern zone manager for Texscan Corp.

Finally, C-COR has named **Dan Trayler** as regional sales executive for the Northwest region. He will handle sales of the company's line of cable TV distribution and power products in seven states. Contact: 60 Decibel Rd., State College, Pa. 16801, (814) 238-2461.

LeCroy Corp. has announced **Larry Van Der Jagt** as product group manager for fiber-optic products. He will be responsible for directing the company's efforts toward the fiber-optic communications market. Van Der Jagt was previously with Computrol as communications product manager and with Taylor Instrument as customer support manager, Northeast region. Contact: 700 S. Main St., Spring Valley, N.Y. 10977, (914) 578-6084.

Currier

Earl Currier has joined **Tele-Wire Supply Corp.** as general manager of its Voice, Video and Data Division. He will be responsible for sales and marketing of LANs, satellite and microwave communications systems to Fortune 1,000 companies, as well as broadcasting equipment to radio and TV stations. He previously served as sales manager of Microdyne's satellite communications products. Contact: 7 Michael Ave., East Farmingdale, N.Y. 11735, (516) 293-7788.

Dave Massaglia has joined **Burnup & Sims Cable Products Group** as Western region sales manager; previously he was vice president of sales and marketing for Western CATV. **Mike Kearns** was named Eastern region sales manager; he was most recently national accounts manager with Times Fiber. **Dennis Geltmacher** was named account executive for the Southeastern territory; previously he was with General Instrument Corp. Finally, **Marty deAlminana** was promoted from sales engineer to manager, commercial markets. Contact: 8000 E. Prentice Ave., Suite C-5, Englewood, Colo. 80111, (303) 694-6446.

James Kearney has joined **Malarkey-Taylor Associates** as director of engineering. Prior to this, he was system engineer for Tele-Communications Inc.'s Chicago Cable TV. Contact: 1301 Pennsylvania Ave., N.W., Suite 200, Washington, D.C. 20004, (202) 737-2300.

Now MMDS Operators Don't Have To Go Through Channels To Double Their Channels.

The Comband® System.

Forget about red tape. Because now you can take channel expansion into your own hands.

All it takes is the Comband® system from General Electric.

The Comband system is a necessity for all Multichannel Multipoint Distribution Service operators and Instructional Television Fixed Service operators. Because its unique two-for-one technology lets you quickly double the channels within your allotted bandwidth.

The system also offers other features that will enable your operation to reap greater profits. It's flexible, stereo-ready and contains an unsurpassed one-way addressable baseband system. Plus the Comband bandwidth compression process makes signal theft virtually impossible. Unauthorized programs cannot be seen or heard.

The modular design of the Comband system allows you to control when, and to what extent, you upgrade your operation. So whether you're planning to enter a market or planning to capture a larger share of one, you can do so with minimum time and expense with a Comband system.

Before you make any further plans, see the Comband system in action. Call Ron Polomsky at 1-800-432-2253 to arrange a Comband demonstration.

Because when it comes to doubling the capabilities of your operation, we're the authority.

Don't forget your instruments!

> 'The test instrumentation available...today is more accurate and reliable than ever before'

By Ronald B. Adamson
Sales Manager, Texscan Instruments

Remember the time you had the outage on the east side? Remember the weather that day? It surely wasn't sunny and balmy. Remember muttering to yourself as you fumbled around in the back of the service van for your hard hat, belt and meter? Remember thinking the pole was much higher than any of the others you've climbed as you struggled toward the top? It really wasn't, but on days like this it seemed that way. Remember opening the amp housing, connecting your meter and turning the meter on? Remember what you said when the meter didn't work? (I can't repeat it here!)

Stories like this one are, unfortunately, too numerous. But in the continuing efforts to provide the subscribers with a top quality, uninterrupted product, we all too often overlook the fact that our instruments need preventive maintenance, too. Batteries discharge, connectors wear out, control knobs loosen; the instruments are shaken, banged and, unfortunately, dropped!

Improved instrumentation

The test instrumentation available to the cable engineer and technician today is more accurate and reliable than ever before. Instruments are smaller, lighter and provide for more portable operating time than in the past. In many cases, operation is simpler and measurement results more specific and easily interpreted. But for all the plus features, today's instruments share a common need with those of yesteryear — routine maintenance to assure top performance when in use.

The instrument instruction manual is always a good source of information that may be used in conjunction with a routine maintenance program. A checklist for each instrument type used can be compiled from the respective manual information pertaining to operating specifications, control functions and procedures. At a minimum, the checklist should reference the basic operating functions of the instrument, such as power control, battery level test, calibrate test, display test and any other functions associated with the essential operation of the unit. A routine check of the instrument on a regular basis (daily, if usage is such) against its checklist will assure you of performance when needed. For instruments used on an occasional basis, a routine check prior to use is a recommended practice. (Did you ever get ready to run a test and find out your analyzer battery is dead?)

Most of the portable test instrumentation we use is powered by nickel cadmium or gel-type batteries. Both types require 10 to 14 hours of charge time after discharge. Manufacturers include in their instruction manuals two important bits of information pertaining to the routine maintenance of batteries: the initial charge/discharge cycle procedure for new batteries and the recommended recharge time. Check this information out and follow it. You will find that your instrument batteries will give you good performance for a long time.

Calibration

Calibration means the instrument will provide measurement results within the tolerances specified under the operating specifications. Today's instruments have varied calibration requirements. Regardless of the specific instrument requirement, a good maintenance practice is to check all of your instruments against a single, standard calibration source on a regular basis. Meters used on a daily basis should be checked weekly. Other instruments used on an occasional basis should be checked prior to use and routinely every two weeks or so.

Manufacturers recommend periodic service and/or recalibration intervals for their test instruments. The period may be annually, bi-annually or otherwise. If you have an in-house service organization, cycle the instruments through it at intervals that conform with the manufacturer's recommendation. If you don't, then consider a good service organization or the manufacturer for this recommended service. The bottom line will be a lot of good service years from your instruments.

Remember the specification in the instruction manual regarding storage temperature? Exceeding the low or high limits specified for extended periods of time can cause damage to the instrument involved. Keep in mind that on a hot summer day the interior temperature in a parked service vehicle will elevate above the outside temperature. In turn, any instruments stored in the vehicle will be subjected to temperature build-up. Components such as liquid crystal displays and batteries can be irreversibly damaged by excessive temperature exposure for extended time periods.

The little problems

Last, but not least, take care of the little problems. Don't let loose control knobs, stripped input connectors, loose screws or any of those other little irritating problems persist. If you encounter these during your daily activity, either take corrective action or bring it to the attention of those responsible for keeping your instruments in top operating order.

When a problem occurs in the cable plant and results in the degradation or interruption of service to the subscribers, you rely on your instrumentation to analyze and assist in pinpointing the source of the problem. You use the instrumentation to perform preventive maintenance on the plant so that subscriber service problems are minimal. Be sure your PM program extends to the instrumentation, which is so important to the daily technical operations.

Next time an outage occurs on the east side you can feel pretty good about your instruments: When you reach the top of the pole and turn the meter on, it will tell you, just as you suspected, this is where the outage is!

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CALENDAR

October

Oct. 12-14: Iowa Cable Television Association fall convention, Airport Hilton, Des Moines, Iowa. Contact Jeff Barnes, (515) 842-7202.

Oct. 13-17: George Washington University course on operation and maintenance of TDMA terminals for satellite systems, School of Engineering and Applied Science, Washington, D.C. Contact (202) 676-6106 or (800) 424-9773.

Oct. 14-17: Center for Personal Development seminar on antenna analysis, design and measurements, Arizona State University, Tempe, Ariz. Contact (602) 965-1470.

Oct. 15: SCTE Delaware Valley Chapter meeting on transportation systems with BCT/E exam on distribution systems, Williamson Restaurant, Horsham, Pa. Contact Bev Zane, (215) 674-4800.

Oct. 15-17: Magnavox CATV training seminar, Richmond, Va. Contact Amy Costello, (800) 448-5171.

Oct. 19-22: Intelevent Inc. Fifth International Telecommunications Conference, Hotel Bayerischer Hof, Munich, West Germany. Contact Marianne Berrigan, (202) 857-4612.

Oct. 20-22: Magnavox CATV training seminar, Richmond, Va. Contact Amy Costello, (800) 448-5171.

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

Oct. 21-23: Microwave Communications Assoc.'s annual convention, Ramada Renaissance Hotel, Washington, D.C. Contact Elena Selin, (301) 464-8408.

Oct. 22-24: Hawaii Cable Television Association annual convention, Royal Sheraton Waikoloa, Hawaii. Contact Kit Beuret, (808) 834-4159.

Oct. 24-29: Society of Motion Picture and Television Engineers technical conference, Jacob Javits Convention Center, New York. Contact (914) 761-1100.

Oct. 28-30: Atlantic Show, Convention Hall, Atlantic City, N.J. Contact (609) 848-1000.

Oct. 27-29: Institute for Advanced Technology seminar on local area networks, Holiday Inn, Albuquerque, N.M. Contact (505) 884-2511.

Oct. 28: SCTE Satellite Teleseminar, part two of video and audio signals and systems, plus SCTE promotional tape. 1-2 p.m. (ET) over Transponder 7 of Satcom IIIR. Contact (215) 363-6888.

Planning ahead

Dec. 3-5: Western Show, Convention Center, Anaheim, Calif.
Feb. 18-20: Texas Show, Convention Center, San Antonio, Texas.
April 2-5: Cable-Tec Expo '87, Hyatt Hotel, Orlando, Fla.
May 17-20: NCTA annual convention, Convention Center, Las Vegas, Nev.
Aug. 30-Sept. 1: Eastern Show, Merchandise Mart, Atlanta.

November

Nov. 3-7: CADCON II satellite convention and trade show, Chicago. Contact (312) 882-0114.

Nov. 4-6: C-COR Electronics technical seminar, Dallas. Contact Debra Cree, (800) 233-2267.

Nov. 11-13: Jerrold technical seminar, Hatboro, Pa. Contact Joan Thielen, (215) 674-4800.

Nov. 12-14: Magnavox CATV training seminar, Orlando, Fla. Contact Amy Costello, (800) 448-5171.

Nov. 14: Wavetek system sweeping seminar, the Wavetek factory, Beech Grove, Ind. Contact Steve Windle, (317) 788-5980.

Nov. 17-19: Magnavox CATV training seminar, Orlando, Fla. Contact (800) 448-5171.

Nov. 18-20: MIRA Corp.'s product safety seminar, Cincinnati Radisson Inn, Cincinnati, Ohio. Contact (513) 434-7127.

Nov. 19: SCTE Rocky Mountain Chapter meeting on long-haul microwave and fiber optics, ATC National Training Center, Denver. Contact Joe Thomas, (303) 978-9770.

AD INDEX

Metric conversion and CATV

By Ron Hranac and Bruce Catter
Jones Intercable Inc.

The metric system is the international system of measuring. It includes units to make any kind of measurement, such as length, temperature, time or weight. Although the metric system is relatively easy to learn and use, its perceived difficulty occurs when converting to another measurement system — for example, the English system.

The following charts are intended to simplify some of the conversions applicable to cable television. Examples are provided on the next page.

Metric prefixes

Prefix	Symbol	Numeric equivalent
exa	E	10^{18} (one quintillion)
peta	P	10^{15} (one quadrillion)
tera	T	10^{12} (one trillion)
giga	G	10^{9} (one billion)
mega	M	10^{6} (one million)
kilo	k	10^{3} (one thousand)
hecto	h	10^{2} (one hundred)
deka	da	10^{1} (ten)
deci	d	10^{-1} (one-tenth)
centi	c	10^{-2} (one-hundredth)
milli	m	10^{-3} (one-thousandth)
micro	μ	10^{-6} (one-millionth)
nano	n	10^{-9} (one-billionth)
pico	p	10^{-12} (one-trillionth)
femto	f	10^{-15} (one-quadrillionth)
atto	a	10^{-18} (one-quintillionth)

Length/distance

Mile	Yard	Foot	Inch	Millimeter	Centimeter	Meter	Kilometer
1	1,760	5,280	63,360	1,609,300	160,930	1,609.3	1.6093
0.00056818	1	3	36	914.4	91.44	0.9144	0.0009144
0.00018939	0.33333	1	12	304.8	30.48	0.3048	0.0003048
0.000015783	0.0277778	0.0833333	1	25.4	2.54	0.0254	0.0000254
0.0000006213	0.0010936	0.0032808	0.03937	1	0.1	0.001	0.000001
0.0000062138	0.0109381	0.0328083	0.3937007	10	1	0.01	0.00001
0.0006213881	1.0936132	3.2808398	39.370078	1,000	100	1	0.001
0.6213881	1,093.6132	3,280.8398	39,370.078	1,000,000	100,000	1,000	1

The meter

1 kilometer	=	1,000 meters
1 hectometer	=	100 meters
1 dekameter	=	10 meters
1 meter	=	1 meter
1 decimeter	=	0.1 meter
1 centimeter	=	0.01 meter
1 millimeter	=	0.001 meter

Temperature

Temp. in Celsius = (temp. in Fahrenheit − 32) × $^5/_9$

Temp. in Fahrenheit = (temp. in Celsius × $^9/_5$) + 32

Using the metric system

Problem
You are filling out a microwave license application. It asks for the height of your towers in feet and meters; it also asks for the path length in miles and kilometers. Assuming 150-foot towers and a 15-mile path, what are the metric equivalents of each?

Solution
Tower height: Find 1 foot on the length/distance chart, then move horizontally to the meter column (0.3048). Multiply the tower height, 150 feet, by 0.3048. The answer is 45.72 meters.

Path length: Find 1 mile on the length/distance chart, then move horizontally to the kilometer column (1.6093). Multiply the path length, 15 miles, by 1.6093. The path is 24.14 kilometers long.

Problem
An equipment manufacturer warrants the performance of a product to a maximum temperature of 41° Celsius. What is that temperature in Fahrenheit?

Solution
Use the formula:

$$\begin{aligned}\text{Temp. in Fahrenheit} &= (\text{temp. in Celsius} \times 9/5) + 32\\ &= (41 \times 9/5) + 32\\ &= (41 \times 1.8) + 32\\ &= (73.8) + 32\\ \text{Temp. in Fahrenheit} &= 105.8^\circ\end{aligned}$$

Problem
While checking for video distortions in a headend modulator, you measure 45 nanoseconds of chrominance-luminance delay. What fraction of a second is 45 nanoseconds?

Solution
From the metric prefixes chart, nano is 10^{-9} (one-billionth), so 45 nanoseconds equals 45×10^{-9} seconds, or 45-billionths of a second (0.000000045 sec.).

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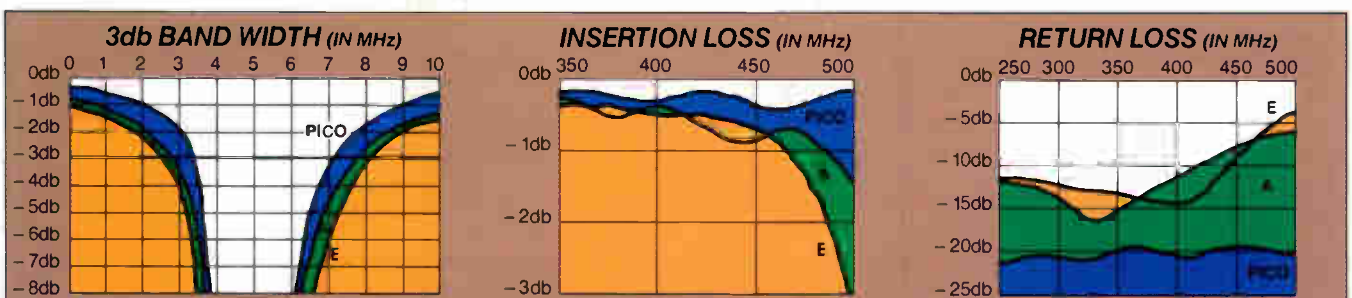

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Anixter, America's No. 1 supply specialist for the Cable-TV industry, provides everything from head-end equipment to subscriber products for operating, maintaining, upgrading and constructing CATV systems. Anixter serves the industry from computerized distribution centers throughout the United States, Canada and the United Kingdom.

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