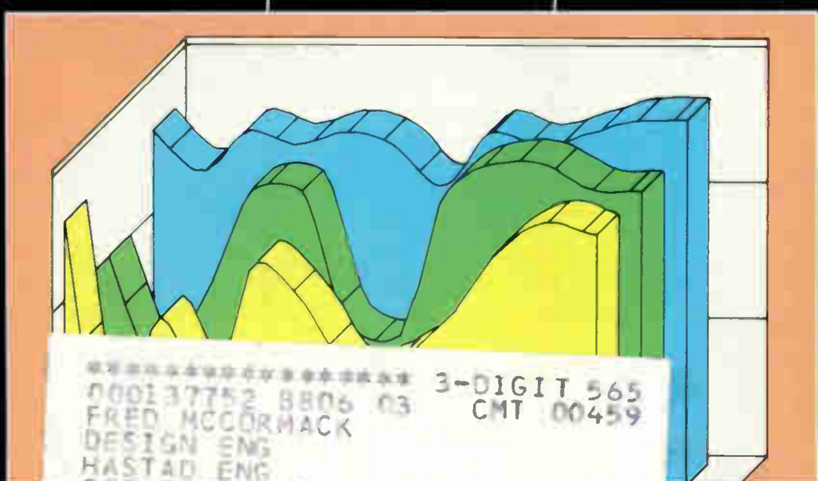
COMMUNICATIONS TECHNOLOGY

Official trade journal of the Society of Cable Television Engineers

Addressability: Delivering the service



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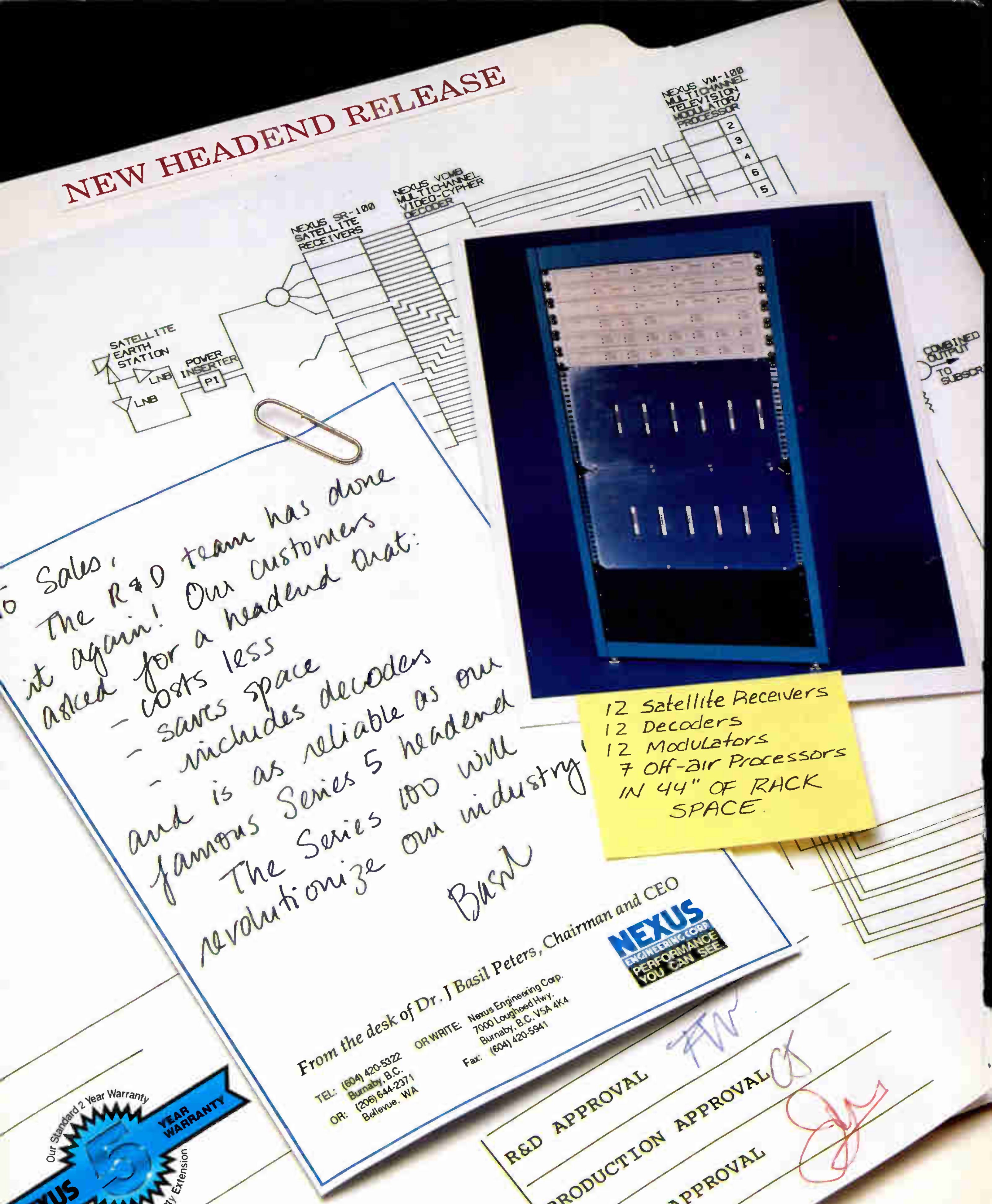

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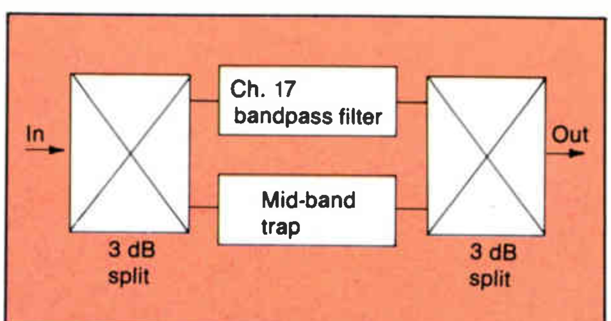
CONTENTS

Departments

News 13

Engineering conference 36



Tech Tips 82

Features

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EDITOR'S LETTER

Setting the standards

What would it be like if all of our F fittings and other cable interfaces were standardized throughout the CATV industry? An impossible task, perhaps, but one that is currently being tackled by the Interface Practices Committee of the Society of Cable Television Engineers. This new committee first met at the Cable-Tec Expo '88 in San Francisco last June; the second meeting was held last month at the Atlantic Show in Atlantic City, N.J.

So what is the committee attempting to accomplish? For the answer to that one, I'd like to quote from a report presented to me by committee member Barry Smith of Tele-Communications Inc.:

"We will try to standardize the basic requirements for drop cable and aluminum cable interfaces, as well as testing and evaluation procedures. We hope to optimize the electrical, mechanical and environmental performance of the CATV cable-to-equipment interface.

"This group is designed as an open forum to encourage communication between the various component manufacturers, between manufacturers and end-users, and to promote the use of quality products and procedures. This should in no way hinder or limit product development, but knowing what one end of the interface will look like makes it easier to design mating components that will yield a reliable interface.

"The majority of the components available are high quality as individual components but are typically evaluated only on their individual merits and occasionally are not compatible with the parts they are intended to be used with. The committee will be studying all components as they relate to the interface rather than individual parts.

"In attendance at the first meeting were cable, connector and equipment manufacturers, MSOs, consultants and engineers. At this meeting we identified the basic direction of the committee and elected officers. Tom Elliot of TCI was elected chairman; Joe Lemaire of Raychem Corp. was elected secretary.

"The second meeting initially formed three subcommittees: the Aluminum Cable Interface (5/8-inch and 1-inch ports), chaired by George Bollinger, General Instrument/CommScope; the Drop Cable Interface (3/8-inch port), chaired by Bill Down, Gilbert Engineering; and Interface Testing Procedures, chaired by Barry Smith, TCI.

"It was generally felt the group should focus on recommending minimum mechanical, electrical and environmental performance along with recommended test and measurement procedures and practices. Also discussed were ways to increase the purchase of compatible parts and tools to simplify the component purchasing process.

"The Aluminum Cable Interface Subcommittee will define and standardize cable prep dimensions and prep tool performance requirements, as well as minimum and maximum connector grip forces; standardize the effectiveness of the O-ring interface; and recommend electrical and environmental requirements. A timely issue will be the 1-inch interface definition.

"The Drop Cable Interface Subcommittee will define and standardize the cable and fitting interfaces, recommended dimensional tolerances and performance requirements, thread quality and shape of male and female sides of the interface, and minimum terminal contact gripping force. It also will recommend minimum environmental performance.

"The Interface Testing Procedures Subcommittee will define and standardize many of the currently used test procedures for electrical and mechanical performance, along with developing recommended procedures and performance requirements for examining drop system and trunk/distribution interfaces.

"Ultimately the Interface Practices Committee needs participation from MSOs, engineers, manufacturers and anyone interested in creating more reliability and less confusion for the CATV industry. Standardizing the basic components of the cable system and reducing the number of variables will allow us all to focus attention and effort on teaching proper techniques and optimizing the interface performance, rather than trying to figure out what connector goes on what cable."

I suggest you attend the next meeting of the committee, to be held at the Hilton Hotel in Anaheim, Calif., on Dec. 6 (the day before the Western Show). The subcommittees will meet at 1 p.m. and the committee will meet at 2:30 p.m. For more information or to participate, contact Tom Elliot, (303) 721-5349, or Joe Lemaire, (415) 361-5792.

Sorry about that

The seminar "HDTV and beyond," scheduled for last month, had to be cancelled. According to the SCTE and its Rocky Mountain Chapter, this decision was made because all but one exhibitor cancelled participation in the event. It would have been unfair to the attendees to hold the seminar as scheduled.

We'll be publishing our *CT Daily* at the Western Show next month. If you're exhibiting and have some information (new products, etc.) for the show, please send it to: CT Daily, P.O. Box 3208, Englewood, Colo. 80155. Deadline is Friday, Nov. 18. Don't wait; send it now!

And have a happy Thanksgiving!

Rikki T. Lee

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Shelley Bolin

Attendees at "Technology for technicians" in Dallas examine various signal level meters.

SCTE tech seminar attracts 20 to Dallas

DALLAS—The Harvey Hotel was the site for the Society of Cable Television Engineers' premiere "Technology for technicians" seminar Sept. 12-14. Director of Chapter Development and Training Ralph Haimowitz presented the seminar to 20 industry personnel, ranging from 20-year veterans to relative newcomers.

This course is designed for installer technicians and covers such topics as customer relations, safety, materials and cables and connectors. Other topics include standard house drop procedures, service connection, testing and troubleshooting, and customer education.

The lectures were enhanced by a manual (also developed by Haimowitz), several video presentations and hands-on laboratories. The labs allowed attendees to prepare cable using different tools, sample various signal level meters and test for signal leakage. Haimowitz also answered individual questions about specific system problems, from ghosting to dealing with management and budgeting.

In addition, attendees received solar-powered calculators and were treated to two cocktail parties sponsored by the Texas Cable Television Association. The next "Technology for technicians" seminar will be held Nov. 14-16 in Charlotte, N.C. For more information, contact (215) 363-6888.

CATV museum raises more than $2 million

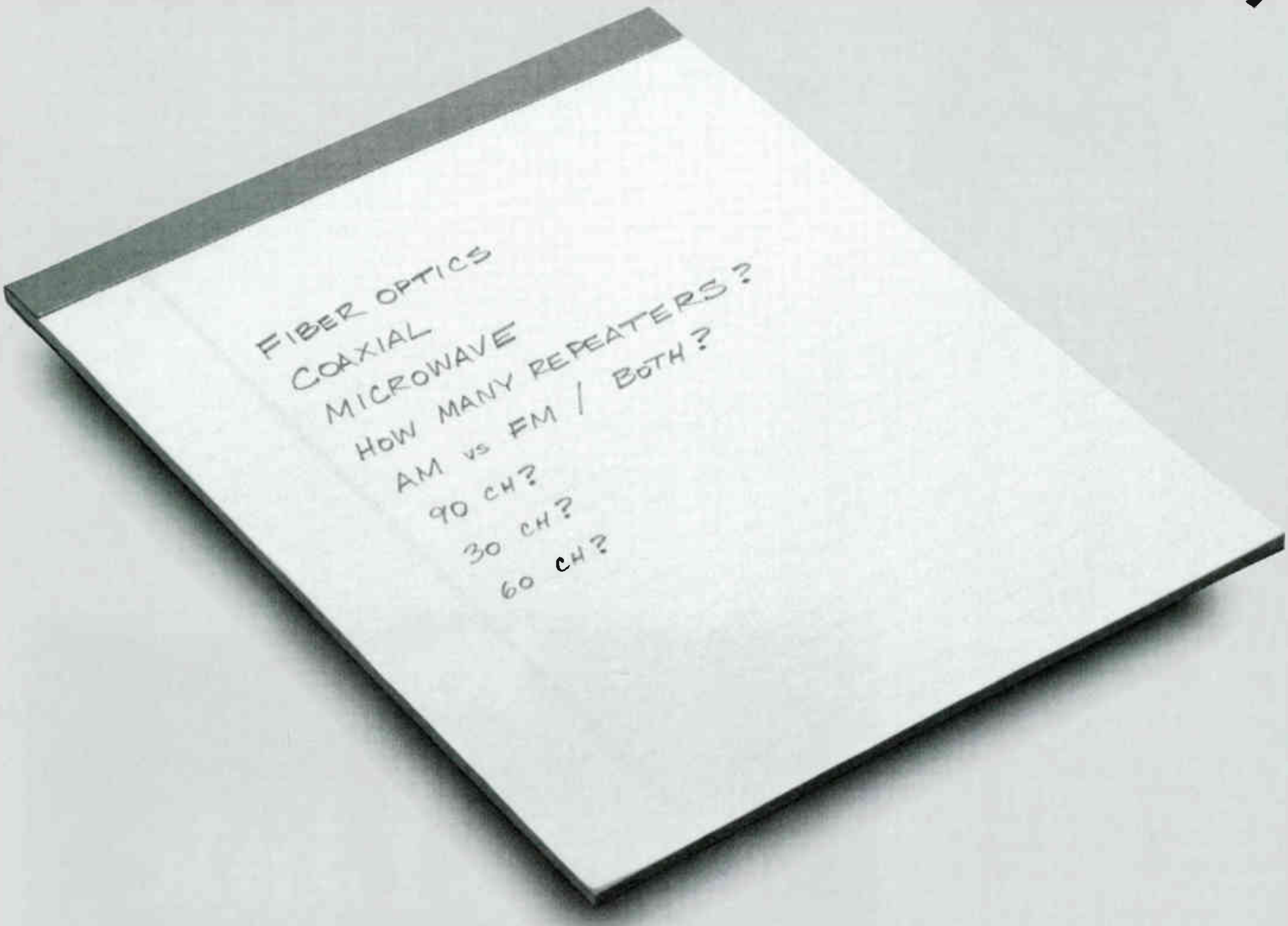
UNIVERSITY PARK, Pa.—More than $2 million was raised for the National Cable Television Center and Museum, which opened Oct. 4 in temporary quarters at Pennsylvania State University's campus here. In less than three years, more than 250 gifts and pledges were received from cable leaders, state and regional trade associations and other groups and individuals connected with the industry.

These funds will help support construction and operating costs of a permanent center and museum and will endow a faculty chair in telecommunications in Penn State's School of Communications.

The museum, which houses oral histories, documents, samples of technology and programming and other cable artifacts, is open to students who are preparing for careers in cable. It also will be used for training programs for the continuing education of industry personnel. The Cable TV Pioneers, in collaboration with the National Cable Television Association and the Community Antenna Television Association, began planning the museum in 1985. Their aim was to establish a single national archive for the history and continuing development of cable television.

- The Jerrold Division of General Instrument will co-sponsor the technical curriculum module of the CTAM General Manager Achievement Series, which is geared to training and education at the general manager level to improve skills needed to run a cable system.
- Midwest CATV announced that its Matrix System, a cable security box offering off-premise addressability, has been approved for production. It will be available in limited quantities after beta site testing.
- The Drop Shop Ltd. marked its 10-year anniversary with a move to a new facility in New Jersey and a quadruple in sales. It also now designs and manufactures specific products that exceed the stricter FCC requirements that take effect in 1990.
- Pioneer Communications of America transferred its CATV service center operations to Pioneer Electronics Service. The service center itself will move to a newly renovated facility at 2190 Dividend Dr., Columbus, Ohio 43228, (614) 771-1050.
- Japan's NEC Home Electronics acquired the rights to manufacture and market Payview Ltd.'s Payview III addressable video scrambling system.
- LeCroy Corp. opened a new sales office at 7500 E. Arapahoe Rd., Suite 335, Englewood, Colo. 80112, (303) 741-0537.
- Turner Broadcasting will implement the Wegener Network Controller system on its two news networks, CNN and Headline News, in addition to TNT.
- Cablenet BBS, a new computerized telecommunications service, has been established to promote the free exchange of ideas and information among persons involved or interested in the CATV industry or related fields. It is available to anyone with a personal computer and modem by calling (913) 842-5206.
- Donley International is changing its name to Donley Cablevision Supply to better describe its function as a stocking distributor for CATV operators.

KNOWING WHERE YOU WANT TO GO,



You know where you want to go.

You want to stay competitive. And in the cable television industry, that means using the best, most cost-efficient technology. Maybe a new build is in order. Perhaps a system upgrade. Either way, you face a perplexing situation.

You know where you want to go. But how do you get there?

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At Catel, we realize that finding the answer isn't easy. There's a lot of talk and a great deal of confusion regarding CATV technologies—fiber optics, microwave, and coaxial.

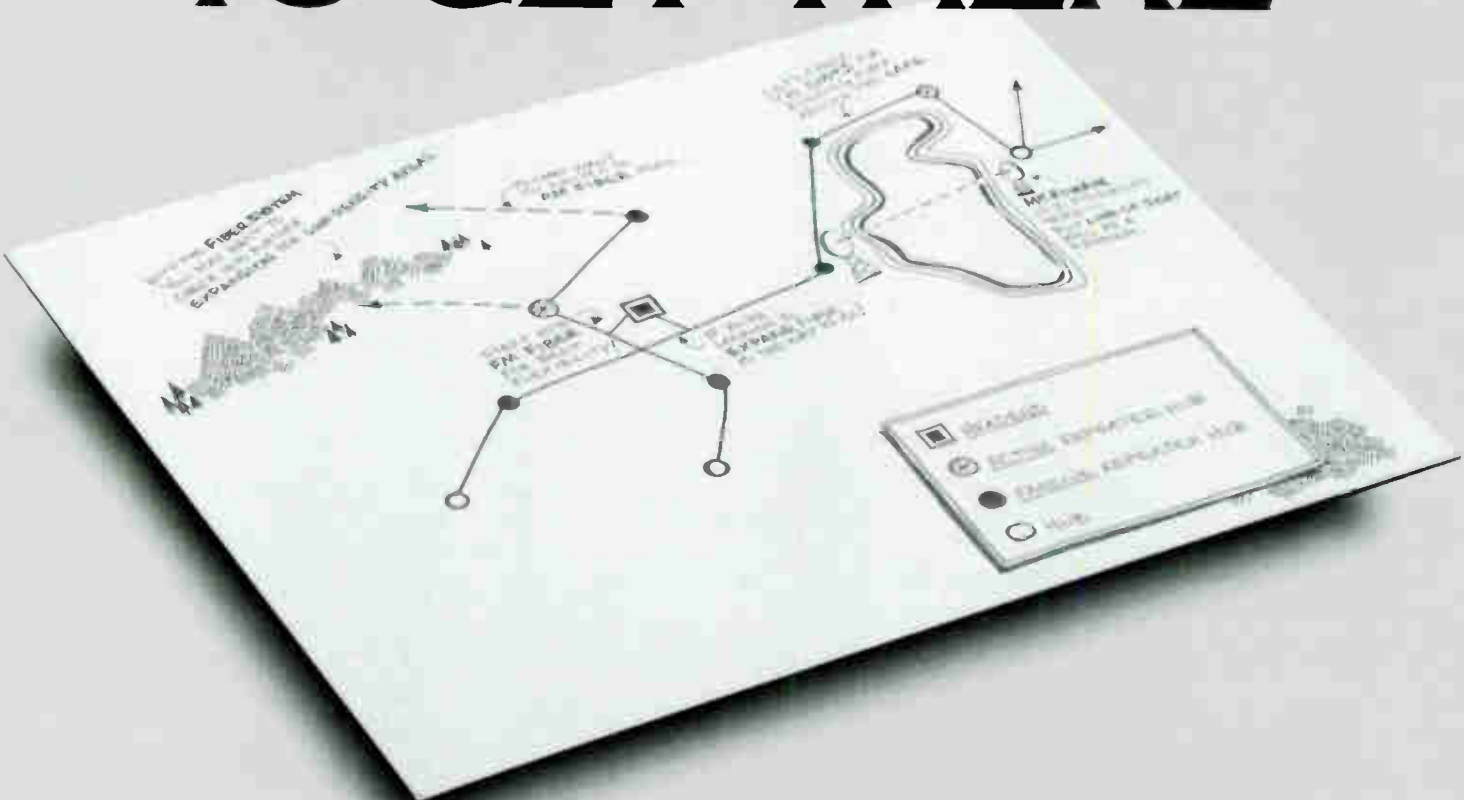
Catel can make the decision-making process easier by examining your specific network requirements. Together, we can determine your cost, network distribution, and overall system objectives.

Then—and only then—can a particular technology be considered.

The Best Route

Oftentimes, the best route may consist of more than one technology. Eventually you'll realize that Catel's fiber optic technology has several distinct advantages over the others—superior quality, future expandability, and maximum channel capacity, to name a few.

ISN'T THE SAME AS KNOWING HOW TO GET THERE



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Memories of yesterdays

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

Last June, the University of Connecticut's class of '38 held its 50th reunion at Storrs, Conn. One should probably never describe a reunion as a time of unremitting joy. We mourned for the deceased, marvelled at the survivors and were humbled by the immense growth and complexity of our once-modest institution.

Toward the end of our ceremonies, having renewed old friendships and put the names together with the faces, we relaxed at dinner where finally a natural good humor came to the fore. One of our classmates read a potpourri of wry comments from unnamed sources that expressed the sour/sweet mood of the occasion and our age. Here they are, along with some added astringencies of my own.

The name of the game

It is said that we live through three ages: youth, middle age and you haven't changed. But change is the name of the game. Consider: We were here before frozen food, penicillin, polio shots, radar, credit cards, antibodies and Frisbees. Before nylon, Dacron, polyester, ballpoint pens, fluorescent lights, Xerox and Alfred Kinsey. For us, "timesharing" meant togetherness, a "chip" was a piece of wood, "hardware" meant hardware, and "software" wasn't even a word.

We were before pantyhose and drip-dry clothes. Before ice makers and dishwashers, clothes driers, refrigerators and electric blankets. How many of you learned how to regulate the lifetime of a block of ice in your icebox by wrapping the ice in vanishing layers of newspapers until the next delivery by the iceman?

We got married first and *then* lived together; how quaint can you be? In our days boys and girls lived in separate dormitories. On weekdays, the doors to the girls' dorms were locked at 10 p.m., Saturdays at midnight. Any young lady arriving late had to have an ironclad excuse or was immediately sent home. Every sorority or fraternity had a house mother who rivaled the one at home in caring and discipline.

We were before disposable diapers, Ann Landers, plastics and hair dryers. Before pizzas, Cheerios, frozen orange juice and instant coffee. We thought fast food was something you ate during Lent. In our day smoking was considered fashionable for the men and daring for the ladies. Grass was mowed, Coke was something you drank and pot was something you cooked in. We were before day-care centers, househusbands and computer dating. The term "making out" referred to how you did on an exam. You could buy a new Chevy coupe for $659 in 1938, but who then could afford it? Nobody, unless you had a safe government job with a steady income so the bank would dare to give you a loan. A pity, too, because gas was 11 cents a gallon and oil was 10 cents a quart.

There were 5-and-10-cent stores where you could buy things for 5 to 10 cents. Indeed, Kresge boasted that nothing was higher than a quarter! For just one nickel you could ride the streetcar or the ferry, make a phone call or buy a Coke. Just look at what we got for a quarter on Saturday afternoons: First stop, after hitchhiking to town, was at the 5-and-10 for a nickel hot dog and a large nickel soda. Then, on to the heavenly candy counter where for 5 cents you could choose between a half-pound of tar babies, Christmas candies, salted peanuts or chunk chocolate. Then, on to the local cinema with the remaining 10 cents for a gargantuan program consisting of a newsreel, two cartoons, a short comedy, a Western, a detective story and Chapter 9 of *The Perils of Pauline*. Finally, when the advertising showed on the screen, you knew it was time to leave and on the way you picked up the free magic trick!

We were not here before the difference between the sexes was discovered, but we were before sex change. We just made good with what we had, and we were the last generation to be dumb enough to think a husband was needed to have a baby.

Now, consider what we *did* in those days: We had opening and closing prayers at every formal occasion, the Pledge of Allegiance and required courses in Latin, French, history and Shakespeare.

Women wore hats and white gloves, girdles with garters on them and petticoats and serge bloomers for gym. Men wore a coat when in the presence of a lady and always a suit and tie to work. We had fountain pens and bottles of real ink and blotters to dry the ink. Toscanini, Edward VIII, saddle shoes and cars with rumble seats. Bulbs were something you planted, valves controlled the flow of fluids, the finest glass was made from crystal. Tesla electricity relieved your aches and pains, the Morse code saved the lives at sea and phonographs were the only source of great artists in the home.

In the springtime of my senility I am a misfit. I don't go in for consciousness-raising or sensitivity training. I'm not into veggies, yoga or rock music. My idea of a good time is to walk and talk with a man or a woman, not jog with a Walkman. I seek silence when silence is as rare as a gold-backed dollar. The person I live with is my spouse; after 36 years she is still the same one. (How embarrassing!)


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In-band vs. out-of-band addressability

By Paul Harr
Applications Engineer, Scientific-Atlanta

Addressability in cable TV today suggests a modernization of delivering signals to the home. In addition to the many features available on converters —e.g., VCR timers, volume, etc.—and the ability to control these features with addressability, subscribers perceive a higher value of service. The ability to order new services and pay-per-view (PPV) by simply picking up the phone and calling the cable operator offers tremendous convenience to the subscriber.

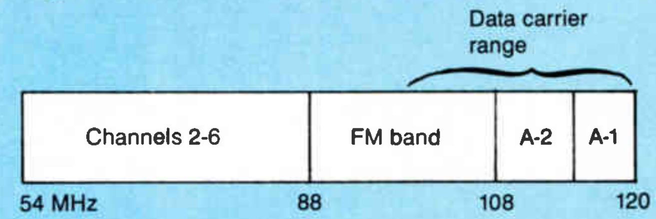
The operator also has found convenience with addressability. Having met its original objective, addressability has significantly reduced operational expenses incurred by supporting everyday churn of pay services. In markets where penetration is increasing and subscribers demand flexibility, the operator must be capable of responding quickly and the response must appear transparent to the subscriber.

Addressability also has given the operator new sources of revenue. At one time, the prime motivator to purchase addressability was to cut operational expense. Now, with PPV maturing, the motivator is a new source of revenue. In fact, addressability can hardly be justified if its sole purpose is to reduce operational expenses. Today, systems with addressability are not considered mature unless a profitable PPV business is achieved.

The technique of addressing converters has remained relatively unchanged since addressability came on the scene. Two methods of transmitting data to converter are in use today: out-of-band or in-band schemes. Both perform the same function of sending data to converters over the forward path of the distribution system. However, the method of transmitting address data differs completely between the two schemes.

Out-of-band transmission refers to data being transmitted on a separate RF carrier, usually in or near the FM broadcast band (Figure 1). Since the data carrier is not transmitted within a cable channel, the term *out-of-band* is used to describe data carrier transmission. In-band data transmission, on the other hand, refers to transmitting converter address data within a cable channel. Both techniques have advantages and disadvantages; however, each transmission scheme provides sufficient data communications to converters for complete addressable control. By analyzing both transmission techniques, it can be seen that, whether out-of-band or in-band, how data is transmitted should not be a major factor when considering addressability.

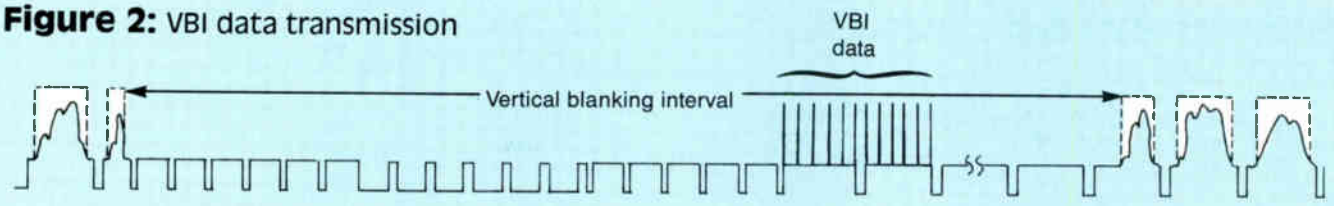
Figure 1: Out-of-band data transmission



Out-of-band transmission, as mentioned, refers to data being transmitted on a separate RF carrier. Data is modulated on the carrier by frequency shift key (FSK) modulation and is typically transmitted at a data rate of 19.2 kilobits per second (kbps). The RF carrier frequency is shifted in minute steps by modulating the carrier with data.

One disadvantage of using a data carrier is the potential for interfering with other frequencies. For example, if the data carrier is transmitted in the FM band, FM broadcast channels have to be eliminated from proximity of the data carrier. Moreover, if the data carrier is operated just above the FM band, Channels A-1 and/or A-2 cannot be used as a result of the data carrier falling within the channel.

Figure 2: VBI data transmission



However, out-of-band data transmission has operated for a long time. The facts that every converter has a data receiver and data is available at all times are distinct advantages over an in-band system. The converter can be off or tuned to any channel and still receive transactions from the addressable control system. This becomes particularly advantageous when loading conventional PPV (CSR, automated response unit, automatic number identification) orders. It is not necessary for the converter to be tuned to a particular channel to receive the PPV load in an out-of-band system.

The second method of transmitting data to converters is using in-band techniques. Transmitting data in-band refers to multiplexing data onto the cable TV channel; thus, the data is transmitted in-band. Several different techniques are in use for transmitting in-band data. These include transmitting in the vertical blanking interval (VBI) of a TV channel, changing the phase of the picture carrier for each horizontal line and transmitting amplitude-modulated pulses on the audio carrier. Each technique has advantages and disadvantages; however, all are effective in transmitting data to addressable converters.

The first in-band data transmission technique utilizes the VBI for location of addressable data. Typically, two lines of the vertical interval are used to transmit pulse amplitude-modulated data into the vertical interval (Figure 2).

VBI data transmission can provide data rates of approximately 24 kbps. However, effective data rates depend primarily on how efficient addressable transactions are formatted. The fewer number of bits for each transaction result in a higher average transaction rate. For example, a 64 bit transaction theoretically would equal approximately 375 transactions per second. A 128 bit transaction would produce half as many transactions per second. Note, however, these data rates do not include any provisions for bits that separate transactions nor bits for error checks; therefore actual transaction rates will be lower.

Even though VBI data transmission provides sufficient data performance, it is susceptible to other services using the VBI for data transmission. These include closed-caption data and teletext. Should a VBI addressable scheme transmit data on lines that use these services or any future services, delivery of those services may interfere with addressing converters and therefore could not be supported.

Another in-band data transmission technique uses phase modulation of the video RF carrier. This uses a unique switching of custom SAW (surface acoustical wave) filters that alternately delays the video-modulated RF by 180 degrees (Figure 3). By alternately switching filters, phase modulation of the video carrier is accomplished. The decoder regenerates data pulses by detecting the phase reversals and producing pulse widths that correspond to changes in phase. Data rates of one bit per horizontal line can theoretically be achieved with this type of in-band data transmission technique. Therefore, data rates of approximately 30 kbps are conceivable.

The last in-band data transmission technique uses amplitude-modulated pulses on the audio carrier. The pulses are modulated onto the audio car-

Figure 3: Phase modulation data transmission

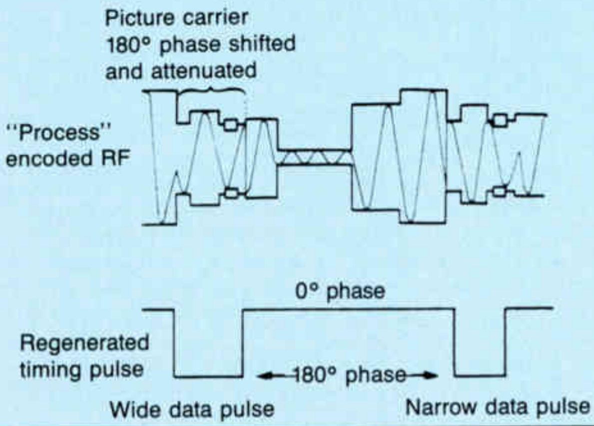
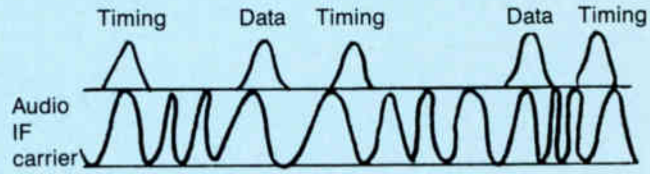


Figure 4: Amplitude-modulated data transmission



rier at IF (intermediate frequency) in a similar manner to timing pulses for synchronization of RF sync suppression descrambling (Figure 4). Data pulses are transmitted one per line, thus providing data rates approaching 30 kbps. With AM pulses multiplexed on the audio carrier along with timing pulses, critical timing is required to distinguish data pulses from timing pulses.

Having reviewed the different in-band data transmission techniques, commonality exists between each. For example, an encoder must be used to place data on a channel and also scramble the video as well as provide timing information for descrambling. Even though data is only on scrambled channels or a home channel, data is not required on every channel. Once a converter receives its service authorizations, it does not need to receive data again unless its services are changed.

Addressable transactions are typically transmitted in two ways. The first is "global" transactions where every converter responds to transactions such as the number of channels defined in a system and where to tune for the barker channel. The second is individual converter "address" transactions that configure each converter with its services. Global transactions are sent when a converter is first initialized and only periodically thereafter. Address transactions also are sent when the converter is first initialized and are re-sent only when a subscriber requests a change of service or the operator performs a headend refresh at the data base. Pay-per-view orders are considered address transactions and are transmitted to the converter when a subscriber has placed an order for a PPV event.

If we examine how each system transmits transactions, we can see that both systems can address converters sufficiently for service changes and PPV operation. We have said that an out-of-band converter receives out-of-band transactions regardless of which channel it is tuned to and that in-band converters must be tuned to a scrambled channel or a channel with data to receive in-band transactions. When a converter is initialized it must receive global and address transactions. The out-of-band converter will receive these transactions regardless of the channel tuned. This occurs because each converter has a data receiver tuned to the data carrier frequency. The in-band converter must be initialized by tuning to a channel with data. However, once initialized the in-band converter does not need continuous data to function. In fact, the in-band converter will get refresh data periodically when it is turned off and force tuned to the home channel.

When a subscriber requests a service change, the out-of-band system will send the transaction only once. The in-band system, however, will continually transmit the service change on channels with data. Should the subscribers attempt not to tune a channel with data, if they knew it, the converter would eventually time out and tune the home channel and receive its service change anyway, thus overcoming the need for data on every channel.

If the subscriber orders a PPV event, the out-of-band system will send the PPV load to the converter only once. The in-band system will continually transmit the PPV transaction before and during the event. Should the subscribers be tuned to a channel without data, they would need only tune the PPV channel when the event is to begin. The converter would tune the barker channel first and then authorize the event and tune back. This will occur only for last-minute PPV orders when the converter is not tuned to a data channel. PPV orders taken in advance will be continuously transmitted to converters on channels with data.

In summary, both out-of-band and in-band addressable data transmission systems provide complete addressable control of converters utilizing different techniques. While the out-of-band system provides a data carrier that every converter receives continuously, transactions are sent only once. Costs of out-of-band converters are generally higher than in-band converters and use of a data carrier takes up valuable spectrum. However, the out-of-band system will address converters more reliably.

On the other hand, the in-band system transmits data at faster rates, continually refreshing converter parameters while placing data on strategic channels. In addition to lower cost, the in-band system enhances security because converters are continually refreshed, minimizing attempts to filter out the data.

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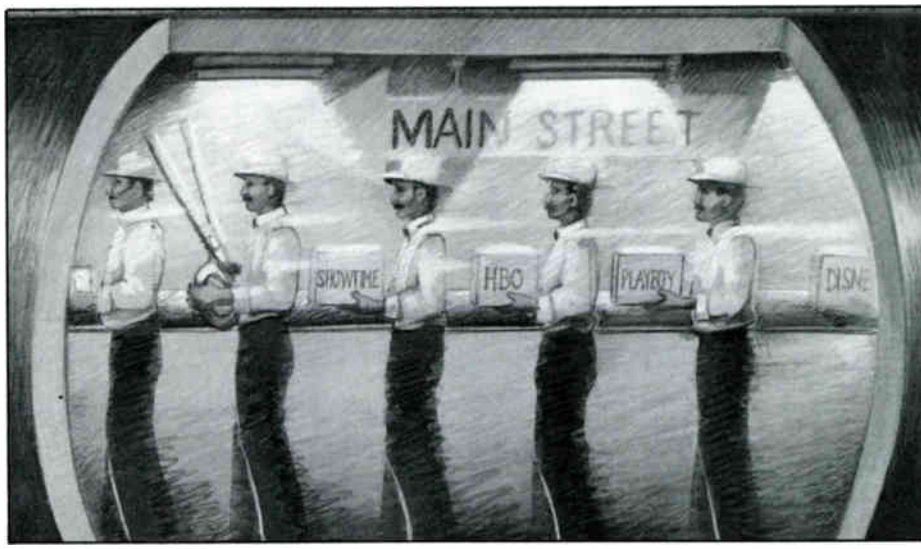
Friendly addressability

By Bill Dancy
Matrix Product Manager, Midwest CATV

And David Barany
Vice President of Engineering, Syrcuits International



Malcolm Farley

> *"An aesthetic objection is often raised by the subscribers concerning the presence of a cigarbox-shaped piece of equipment...perched atop their TV sets."*

"I paid $3,000 for my new big-screen TV set that has all the latest state-of-the-art gadgets. The salesman assured me that it was cable-ready. Now you tell me that I must use your converter if I am connected to your cable system. That means my fancy remote control with sound mute, volume control, favorite channels and a host of other things that I don't yet understand is useless. By the way, my remote also controls all the functions of my VCR. Why do I have to use your converter?"

If your cable system utilizes converter-based security you probably hear this complaint more than any other. As the population of cable-compatible sets increases day by day, subscriber distaste for the converter will grow at the same rate. Subscriber revolt to the use of converters can take several forms, and any or all of them will result in a negative effect on your bottom line:

a) disconnect (back to the old roof antenna),
b) basic only, no converter (loss of premium channels) or
c) moving to the new "overbuild" with a no-converter system.

Subs can and do switch in and out different premium services to meet their changing needs. It is possible that subs may change their premiums many times a year. This means that unless the electronics that control premium changes are remotely controlled, a service tech must go to the sub's residence to change the level of service.

The method of scrambling at the headend and then remotely controlling the descrambler using addressability is usually considered a cost-effective means, even with each converter/descrambler costing around $100. It allows for easy switching on or off premium service, turning off the total service in the case of late payments and enabling a pay-per-view event.

The trouble with VCRs/TVs

Scrambled channels interfere with the recording process of a VCR. The cabling interconnections at the back of a set can become a tech's worst nightmare. For example, if a scrambled channel is to be recorded, the converter/descrambler needs to be in circuit *before* the VCR so the VCR can record descrambled signals. If another non-scrambled signal is to be watched while recording the scrambled signal, a splitter is used prior to the converter with the new second output going directly to the TV set.

If a non-scrambled channel is to be recorded while watching a scrambled channel, the whole mess has to be taken apart and rewired. The VCR is now before the converter and the output of the converter goes directly to the set.

Probably the worst case is trying to watch a scrambled channel while recording another scrambled channel. The sub would need two converters to perform this task. A splitter needs to be used first, with one output going to one of the converters and then to a VCR. The other output of the splitter would go to the other converter, which would then connect to the TV set.

Some subscribers give up on the scrambled channels in disgust and trot on down to the neighborhood video store for their programming. This does not leave the cable operators or the programmers very happy with the technology of converter/descramblers.

Another recent blow has been the advent of sets that have the capability to tune the full spectrum of frequencies for cable. Most of the expanded features of these cable-compatible TVs become non-usable with a converter/descrambler, which is needed when the customer wishes to subscribe to a premium channel in a system with converter-based security. It also makes the TV set's remote useless for changing channels—the set is always tuned to the converter output (Ch. 2, 3 or 4) and never changes—and negates the remote's other advanced features as well. To confuse the issue further, the converter can be supplemented with a remote of its own; however, it usually just controls the converter's operation.

Furthermore, an aesthetic objection is often raised by the subscribers concerning the presence of a cigarbox-shaped piece of equipment from the cable company perched atop their TV sets. And households with VCRs *and* cable-compatible TVs have the previously mentioned problems connected with both.

A new approach

A method of inserting or removing traps without the necessity of sending a service tech to the subscriber's home would be a great improvement. A new approach in this direction is the Matrix system. In its basic form, it is an addressable off-premise device that provides for the control of four levels or tiers of switchable traps plus all-service disconnect. With the addition of a second plug-in module, the number of levels controlled is doubled. Also, this device can eliminate the problems of consumer-friendliness to subscriber-owned equipment, cable-compatible sets, VCRs, multiple outlets, etc.

The necessity for a scrambler at the headend for each channel is not required as in most converter-based systems. The two pieces of headend equipment needed are a "rejuvenator computer" and a "data generator." The former is an IBM-type personal computer, whereas the data generator encodes the address signals with the appropriate command codes onto Ch. 3. Hence, Ch. 3 (and whatever is on Ch. 3) becomes in part the data carrier for the address system. The available frequency spectrum is not reduced by the necessity for a data carrier channel; instead, the data is carried in the video of a low-band channel but is not visible to the subscriber.

If there were four negative traps installed in a Matrix unit, one for each RF path, you could use Ch. 16 for Cell 1, Ch. 17 for Cell 2, Ch. 18 for Cell 3 and Ch. 19 for Cell 4. Each cell can be independently switched to provide whatever mixture of the premium channels the subscriber orders. If the sub wanted the service on Ch. 18 and not the others, the unit could be addressed so that the RF path would go through the Chs. 16, 17 and 19 negative traps. The Ch. 18 negative trap would be switched out of circuit and be bypassed. Premium channels chosen by the subscriber are delivered unscrambled, allowing the use of the sub's own remotes for the cable-compatible set and VCR.

The complete unit is bolted to an outside wall of the dwelling; no equipment is needed atop the TV set. This allows for easier servicing and accessibility. Optional security protection in high theft-of-service areas can disconnect the signal at the pole or pedestal if an attempt is made to bypass the unit.

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Reader Service Number 18.

Addressability: The system approach

By Rich Schnur
Product Manager, Addressable Systems

Today's addressable system is as different from its predecessors as the microcomputer is from its dinosaur-sized, tube-filled ancestors. The computer-based addressable system was originally developed as a method for securing signals and reducing truck rolls through easy authorization of multiple cable services. For these purposes, the one-way, low-power addressable system with its relatively unsophisticated computer was revolutionary compared to the trapped and scrambled systems in operation at the time.

When considering an addressable system now, however, the operator must fit together all the pieces of a cable TV operation, from programming to subscriber satisfaction, and understand how those pieces interact. An addressable system is more than a disjointed group of hardware held together by a single purpose; it is an integrated method for delivering the best possible signal in a manner most convenient for both the operator and the subscriber.

Today's sophisticated addressable controller acts as the operational heart of the cable system. In a heartbeat the addressable controller updates a customer record; changes another customer's converter features; activates operator-determined options such as remote control, volume control or impulse ordering; resets a converter time-out counter; broadcasts the time of day; and transmits the system's unique site code. All this occurs repeatedly throughout the operational day, consuming only a fraction of a second per transaction.

Hubs receive control information through flexible and reliable communications paths, allowing them to control the converters within their geographic domain. The data communications components of the addressable system provide a means to control and synchronize scramblers and transmission equipment within the headend. In addition, the controller provides the operator with a series of reports that serve as tools to verify and correspond to the data base of its computerized customer service. The computer also initializes virgin converters both in the warehouse and subscriber homes.

An integrated series of help messages, combined with an easy-to-understand menu of selections, is necessary for proper and simple operation of the addressable system. Communication errors in transmission from the host customer service computer must be easy to understand and simple to recover. CRTs can be configured as communication traffic monitors to allow the computer operator to view each individual transaction. Support from suppliers should be available via competently staffed emergency hotlines and diagnostic phone modems, allowing secure access to troubleshoot system problems.

The addressable control system must be flexible enough to handle a variety of different business situations when offering pay-per-view (PPV). It must be able to load a large number of events prior to their actual start time to ease the data entry burden.

Another part of the overall system, the scrambler, helps to simplify PPV offerings by using event memory to store upcoming scramble mode changes and previews for each new event being shown. Scrambler routines are remotely controlled by the system PPV manager to provide automatic and unattended operation.

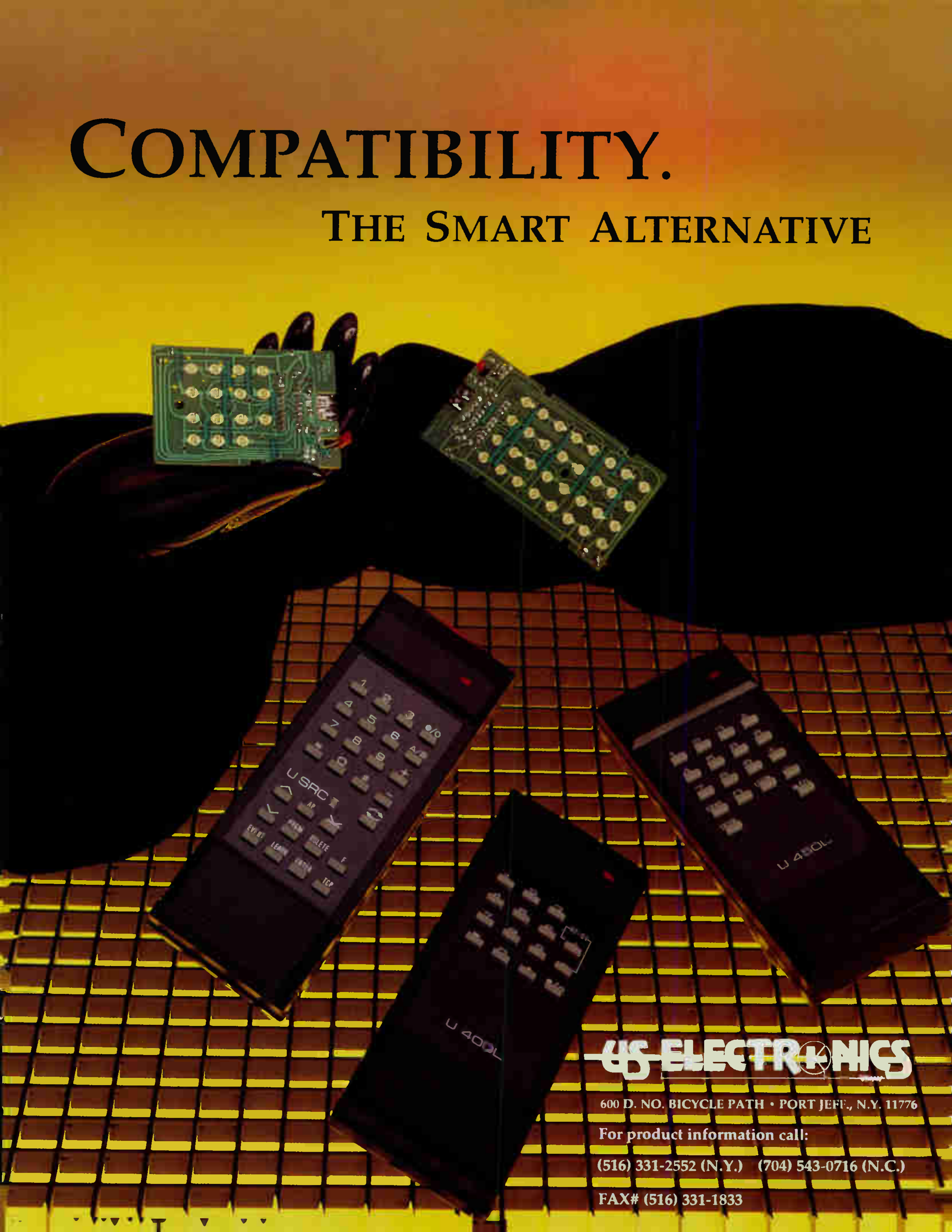
No overload problems

The controller must be able to process a large number of orders from one hour to 15 minutes prior to the start of the next big event if the ordering method calls for real-time authorization as close to the time of the event as possible. The addressable system must bear the traffic burden while keeping the rest of the system on-line. Multiple wire links and blocking of customer orders adds to the efficiency of offering PPV.

Since it has been mathematically proven that no real-time ordering method can keep up with the entire subscriber base ordering at the last minute, store-and-forward impulse ordering is used to give the subscriber the feeling of instantaneous ordering while allowing the system to poll the converters at a later time to uncover the ordering information for billing purposes. The addressable system provides for a combination of impulse ordering methods; impulse return paths can be via the telephone or through the return path on the cable system. Once the system polls the converters for purchases, the system will provide a batch billing file to be uploaded to the customer service system.

The system approach to addressability ensures that the whole is equal to the sum of the parts. The components of the addressable system include the addressable control computer, data path electronics, scramblers, converters and multiple links to the customer service computer. The components are married together to provide solutions for many applications.

In each instance, the system must be able to handle the demands of today's technology and to be upgraded to meet the needs of tomorrow's as the cable industry continues its metamorphosis.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Laser Link AM CATV System

The Anixter Fiber Optic Laser Link AM CATV System creates a fiber network architecture which meets the system needs of today while preparing the network for tomorrow. The system can transport AM-VSB (Vestigial Side Band) channels over one single mode optical fiber. This architecture, while providing improved performance, also allows for easy network upgrades to provide alternative and enhanced services such as PPV, IPPV, digital access, and HDTV.

Features/Benefits

- Accommodates up to 60 channels per fiber
- Fully compatible with existing CATV technology
- Provides improvement in signal quality, reliability, and performance
- Reduces amplifier cascades and hubsite locations
- Utilizes AM baseband modulation
- Accommodates all available scrambling techniques
- Cost effective compared to AML or other fiber optic systems
- Allows extension of existing CATV system
- Easy to install and maintain
- Allows for easy network upgrade to provide alternative and enhanced services

The system has been designed for various trunking applications. It provides point-to-point transmission of an AM-VSB spectrum from a headend location to outside plant locations. The entire spectrum is transmitted over one single mode optical fiber.

Transmission distance will vary depending on individual applications. System performance for 42 channels and a 5dB loss budget and performance curves which can be used as guidelines for network planning are shown in figures 1 and 2.

C/N	51	dB
PSO	60	dBc
CTB	65	dBc
XMOD	60	dBc
LOSS	5	dB

FIGURE 1

The system is comprised of two major elements: the Laser Link Transmitter, which is installed at the headend, and the Laser Link Receiver, which is available in either a headend or outside plant version.

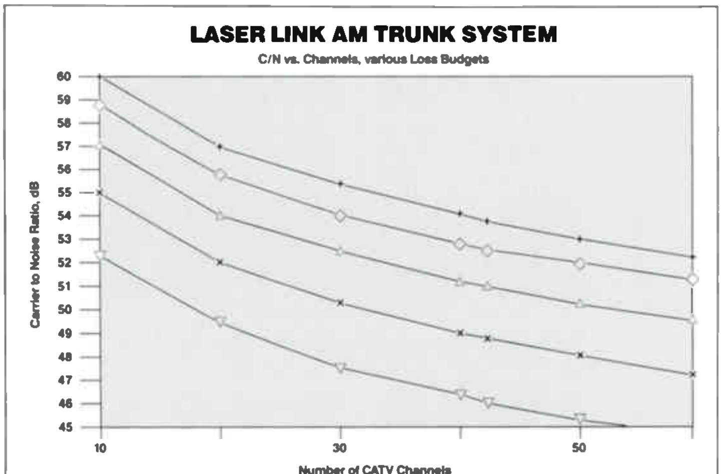

FIGURE 2

Laser Link Transmitter LLT-1300A (Headend)

The Laser Link Transmitter (LLT) incorporates a laser diode light source which has been specially developed to have high optical power output at 1310 nm wavelength in the infrared spectrum and to be highly linear so that second and third order harmonics and intermodulation products are very low.

Optical isolation techniques are used in the system to ensure quiet laser operation and high carrier to noise ratio.

Features/Benefits

- Adjustable modulation level
- Remote status monitoring
- Automatic Gain Control (AGC)
- AGC and laser status indicator lights

The LLT faceplate is conveniently equipped with the necessary adjustments and indicators to ensure proper operating status of the unit. An access protected ON/OFF power switch and an "F" connector test point are standard. Modulation level, which is preset at the factory at 5dB, can be manually adjusted from 0 to 10dB in 1dB increments.

A dual color indicator which monitors the status of the AGC is provided so the system can accept a wide range of input signal (10 dBmV ± 5dB) level and still maintain a standard operating output. The indicator will be red when the AGC is out of range (i.e., input signal is too strong or too weak) and green when the input levels are within the proper range. When the temperature is too high or when the laser bias current is out of range, the laser status indicator will turn red. When the indicator is green, the laser unit is running properly.

A 15-foot single mode pigtail is provided to terminate the laser output. The pigtail is terminated with an AT&T ST connector. The user has the option of terminating this ST connector in an ST bulkhead provided on the back of the unit, or running the fiber out a port provided in the back of the unit and then terminating the connection on a lightguide cross-connect shelf (LGX or equivalent interface to outside plant fiber).

Unit status can be continuously monitored at remote locations. A terminal strip is provided on the back of the unit for connection to the user alarm equipment. A relay closure indicates laser operation.

Specifications

Input Signal Level	10 ± 5 dBmV
Input Impedance	75 ohms unbalanced
Return Loss	16 dB
Modulation Bandwidth	30-550 MHz
Wavelength	1310 nm
Power Requirements	110 VAC, 60 Hz
Power Consumption	50 watts
Physical	19″ rack mounted
Dimensions	19″ x 3″ x 14″
Operating Temperature	+40° to 120°F
Relative Humidity	20 to 55% (non-condensing)

Laser Link Receiver LLR-1000R (Headend)

The Laser Link Receiver (LLR) is available in two versions: headend and outside plant.

The headend version (LLR-1000R) is 19″ rack mountable and comes completely equipped with the necessary electronics to terminate the fiber optic trunk in the headend environment. This unit cannot be used for distribution applications.

Features/Benefits

- Compatible with existing headend equipment
- Provides typical trunk AMP output level
- Optical power test point provided
- "F" connector test point provided for monitoring received signal power
- Equipped with AGC
- 15-foot single mode pigtail provided for option termination of fiber optical cable

Powering and cable termination arrangements for this unit are the same as for the LLT. A terminal strip is provided on the back of each unit. This should be connected to the user alarm equipment. A relay closure indicates if optic received power is below or above acceptable limits.

Specifications

Output Signal Level	30 ± 1 dBmV
Output Impedance	75 ohms unbalanced
Power Requirements	110 VAC, 60 Hz
Power Consumption	20 watts
Physical	19″ rack mounted
Dimensions	19″ x 3″ x 14″
Operating Temperature	+40° to 120°F
Relative Humidity	20 to 55% (non condensing)

Laser Link Receiver LLR-1000S (Outside Plant)

The outside plant LLR is housed in a standard CATV trunk amplifier housing and comes completely equipped with the necessary electronics. Distribution electronics can be ordered separately.

Features/Benefits

- Compatible with existing CATV technology
- Provides typical trunk AMP output level
- Provides received optical power test point
- Single mode jumper cable provided for pre-field testing of the unit
- Equipped with AGC
- Adjustable output level

A fiber input port allows the user to terminate fiber optic cable inside the housing. A Rotary Mechanical Splice (RMS), which terminates a PIN diode, is provided inside the case. It is suggested that the customer terminate his fiber here with a tuned RMS.

Specifications

RF Output Level	30 dBmV ± 1
Output Impedance	75 ohms unbalanced
Power Requirements	60 VAC, 60 Hz
Power Consumption	20 watts
Physical	Strand mount
Dimensions	18¾″ x 5¼″ x 8⅞″
Operating Temperature	−40° to 140°F
Relative Humidity	5 to 100% (non condensing)
RFI Isolation	130 dB (5 MHz – 1 GHz)
Air Tight	15 psi

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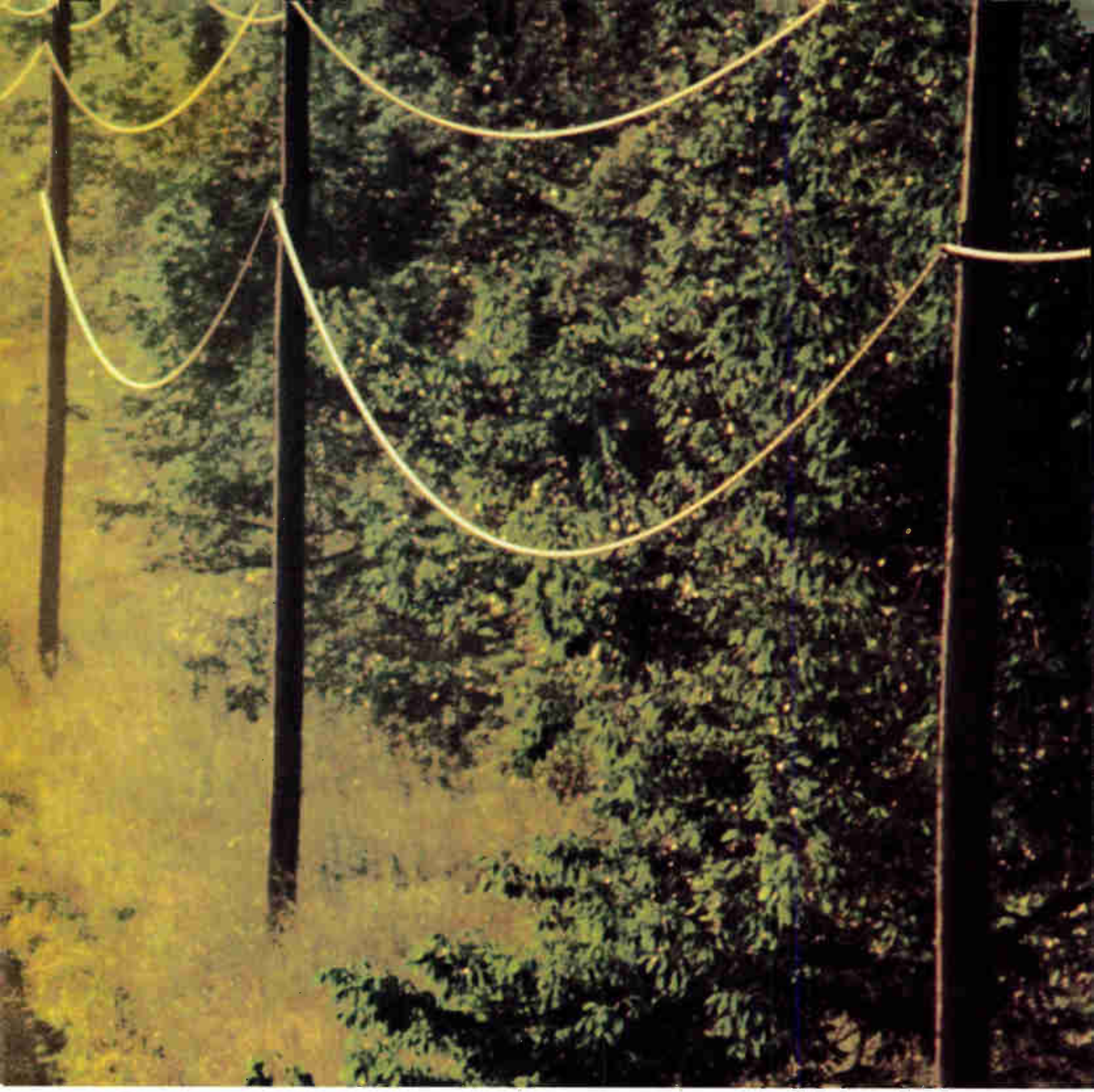

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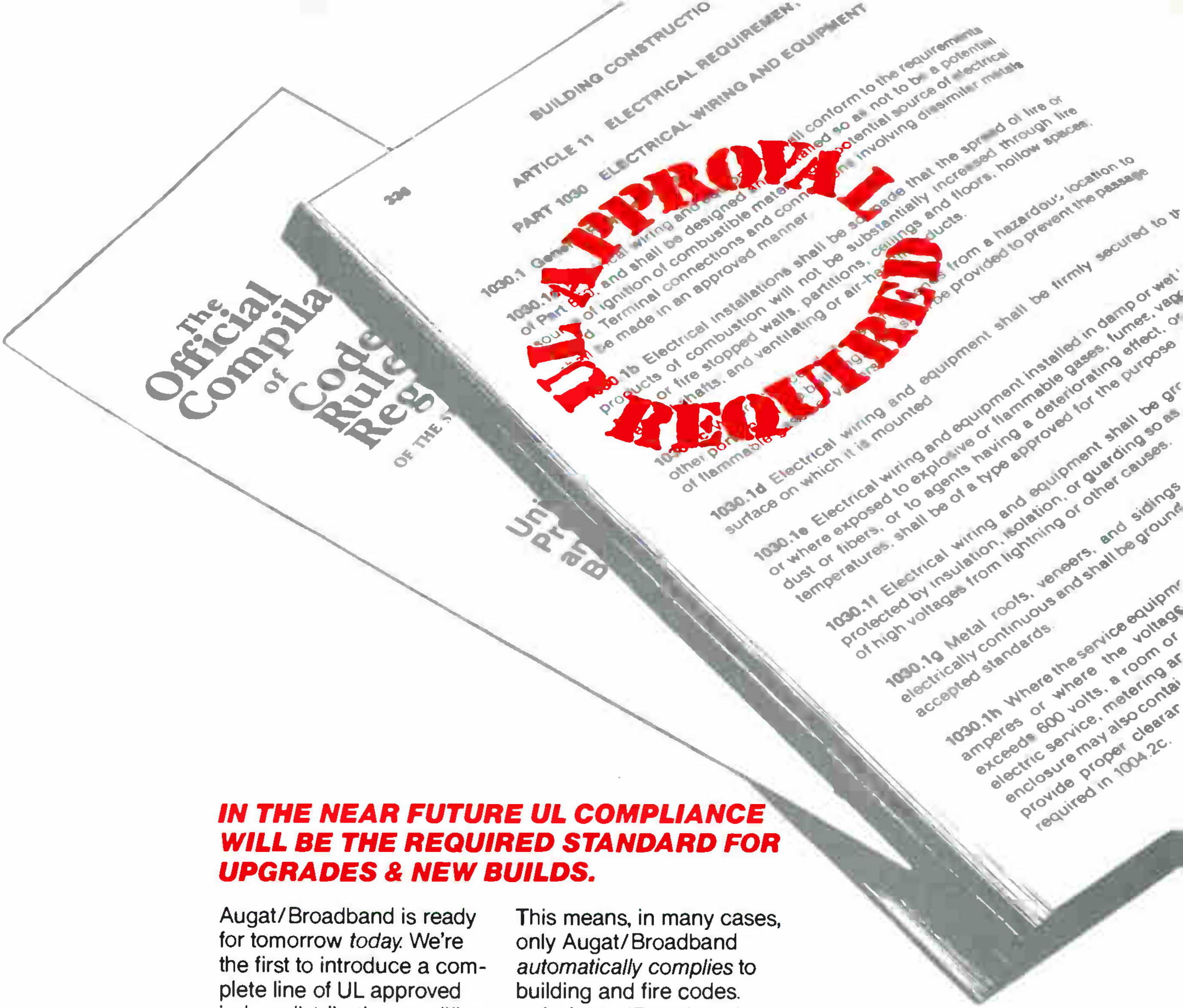

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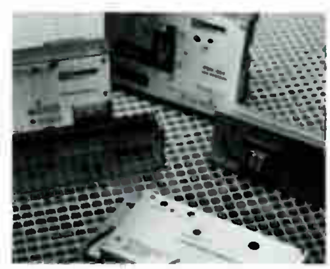

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Qube yesterday and today

By Michael T. Hayashi
Marketing Manager, Pioneer Communications of America Inc.

Eleven years ago, when cable TV penetration was barely over 15 percent and personal computers were being invented, a "new (communication) medium" was introduced to the world. Later named Qube, the new medium promised to revolutionize people's lives. For those unfamiliar with what it promised, here are excerpts from a press release dated April 26, 1977, describing Qube:

"...Two-way medium that allows people at home to participate extensively with programming brought to them via...30 channels of video entertainment, information and education....Five response buttons that allow the viewer to press a button and respond instantly to material that appears on his home TV screen....Nine channels of premium entertainment, sports and education. Customers will pay per program. ...Multiple channels (dedicated) to a variety of special interests....Security services, including fire and burglar detection, panic, medical alerts....Narrowcasting so that selected channels can be 'rented' and used to selectively telecast messages....TV ratings: On-line system will constantly provide aggregate numbers and percentages of homes viewing each channel....Advertiser can 'ask for the order' and the consumer can respond instantly."

Today, many of these features are making headlines and are being offered to our cable subscribers. Specifically, store-and-forward is credited with being the technology to make it all possible. But do technological changes alone make a difference? Many "Qubineers" (Qube engineers) do not think so and further believe Qube offered many additional innovations that are benefitting cable today.

Courtesy Pioneer Communications of America

Programming and security

Qube was well-known for its audience participatory interactive shows. Qube subscribers expressed opinions on President Carter's energy policies, called the next play on the Friday night local high school football game, won cars with their "Magic Touch," decided what the next affair should be on the soap opera, bought Ginsu knives and paid only for movies and events they chose to watch.

Qube was the first to offer 10 impulse pay-per-view (IPPV) channels, all of which were locally originated. Today, pay-per-view programming is available via satellite, eliminating all the programming origination hardware required to support 10 channels. Without any satellite delivery, some systems maintained over 100 ¾-inch machines alone, a considerable operational and financial impact.

The not-so-obvious implication of having 10 IPPV channels was the perceived value to a consumer. A $7 cable service suddenly was packaged with programming worth hundreds of dollars. The original Qube converter design invited subscribers to attempt to receive valuable programming for free. It failed to keep honest subscribers honest. Soon, high school bulletin boards were filled with notes outlining methods of cheating the converter, electronic stores sold paper clips, etc. However, Qube was real-time two-way and allowed operators to determine who was cheating the system and when.

From this costly experience, Qubineers learned scrambling was not the only issue but rather box security was just as vital. As a result, tamper-proof converters with access traps were designed to address the security issue.

With the number of blockbuster events on the rise along with the number of PPV movies, the value (or incentive) to cheat will increase. As human behavior is not expected to change, converters designed to offer PPV today, needless to say, must feature a tamper-proof design.

Data collection method and services

Qube terminal devices had a data rate of 256 kbps for both upstream and downstream, allowing for a polling to occur every 10 seconds. And, to accommodate a growing number of terminals, the system was segregated to allow for distributive processing. The technical requirement to accommodate this high speed demanded a highly reliable data communication path. As a result, bridger gate controllers were used to limit and control ingress and thermal noise accumulation on the reverse cable path. Consequently, supporting the high data rate was very costly.

Typical one-way addressable converters (upgraded to two-way) today communicate at a rate of less than one-tenth of the Qube terminals. Unlike high-speed polling where status information is returned immediately upon inquiry, a store-and-forward converter returns information previously accumulated in local memory. Thus, collection of IPPV data happens after a movie has been viewed instead of while it is being watched.

The direct implication of this difference is the content of the information that needs to be collected. With high-speed polling, information from the converter only has to be what channel it is tuned to and the rest can be computed by analyzing the information in the central computer. In store-and-forward, collection is not "real-time," and consequently more information must be retrieved. In addition to what channel the converter was tuned to, the information as to when and for how long the channel was tuned to is necessary. Memory requirement for the converter increases. However, the tradeoff of memory in lieu of high-speed processing is well worth it.

Another benefit of store-and-forward is the potential for "higher resolution" of viewer statistics. A polling system's information resolution is limited to the frequency at which information is gathered. Thus, if the polling interval is 20 seconds, determination cannot be made as to how many consumers are tuned in at a beginning of a 15 second commercial and how many abandoned at the end of it. Store-and-forward can resolve this because storage of information can be instantaneous, although collected later. Therefore, converters in the system can be commanded to store the information at the beginning of a commercial and at the end of the commercial. Later—even hours later—this information is collected for analysis.

Store-and-forward certainly seems to have fulfilled data collection requirement for IPPV and view statistics; however, there were other reasons why Qubineers preferred high-speed polling.

Monitored home security systems were another of the many ancillary services Qube offered. Cable-monitored home security, unlike traditional telephone-monitored security, provided the ability to continuously monitor the communication path. This feature is still not available over the telephone. Store-and-forward will compromise the future. (Why didn't cable home security work? Maybe because wireless sensors were not perfected 10 years ago.)

Interactive games on store-and-forward systems cannot provide immediate feedback to the viewers. Therefore, the games will never be interactive in a true sense.

As additional services resurface, communication needs from the consumer's home may increase. Store-and-forward data collection is certainly adequate for today's PPV needs. But as new requirements evolve, data communication needs may have to be revisited.

Consumer interface

The consumer interface issue is among the key problems facing our industry today. Developments are focused in on bringing a more "consumer-friendly" product to the marketplace. Broadband addressability and the IS-15 multiport are such examples. The newest addressable converters minimally feature wireless remote, volume control and multiple timers. Some advanced units even have VCR filters to allow for recording and watching different programming.

If we were to see a Qube converter today, we would get the impression that the Qubineers completely ignored consumer interface issues. Qube converters, to begin with, all offered wired remote, had no features related to VCRs, timers, volume control, etc. However, consumer interface did play a vital role in specifying the converter. Particular emphasis was placed on how a consumer could directly select a channel without remembering the channel number. Parental control was designed to give censorship to the parents—not to the operator. Pay-per-view event purchasing was made as straightforward as possible by eliminating complicated code entries. These are functions still pertinent in designing addressable converters today.

Qubineers will be quick to point out that 10 years ago there were no cable-compatible sets, VCR penetration was under 1 percent and VCRs sold for $1,500. A barking dog could change channels on ultrasonic wireless televisions. What we should remember is that technologies progress and new ideas evolve. Predicting consumer reaction to these changes is difficult. If any lessons were learned, Qubineers learned that a flexible product design is essential to adapting to the changing needs of our consumers.

The Qube system introduced numerous technical innovations to addressable converter design. Two-way addressable systems today probably could learn a few more tricks from Qube. Perhaps Qube even offers some foresight into the future of cable services, since it was designed to shape their future. With competition growing and promising many "old-new" services, maybe the future is now. Pay-per-view certainly is.

A new sync encoding method for scrambling

By Ted Johnson
President, The Serenics Co. Inc.

Most television security systems involve withholding from the user's receiver some critical part of the signal. In the descrambler the missing part is restored. Of course, this is possible only because the critical information has been provided, but in a form that the receiver cannot recognize. The information has been encoded by the scrambler at the transmitter and is decoded in the descrambler at the receiver.

One example of encoding, or scrambling, is to suppress horizontal sync by 6 dB so that it cannot be separated from the video signal in the TV set. Timing information for recovering the sync can be supplied on a separate carrier. At the receiving end the decoder is tuned to the separate carrier and the timing signal is recovered and applied to a circuit for selectively amplifying the original sync by 6 dB in order to restore it to its original level.

A similar arrangement involves applying the timing information to the sound carrier of the same channel, resulting in a combination FM (frequency modulation) for the sound and AM (amplitude modulation) for the sync. The advantage of this is that no extra bandwidth is required for the timing information.

One problem that occurs with the sound carrier timing signal transmission is the reduced power level. Normally the sound carrier is about 15 dB below the sync tip level of the picture carrier. Therefore, in this scrambling arrangement the timing information is 15 dB lower than the video.

On the unscrambled picture carrier the sync tip power is twice as great (3 dB) as the strongest video component. But when modulating the sound carrier (and assuming the same downward modulation) with timing information, the result is a 15 dB decrease in the margin of safety against interference from in-band or adjacent channel components.

Scrambler operation

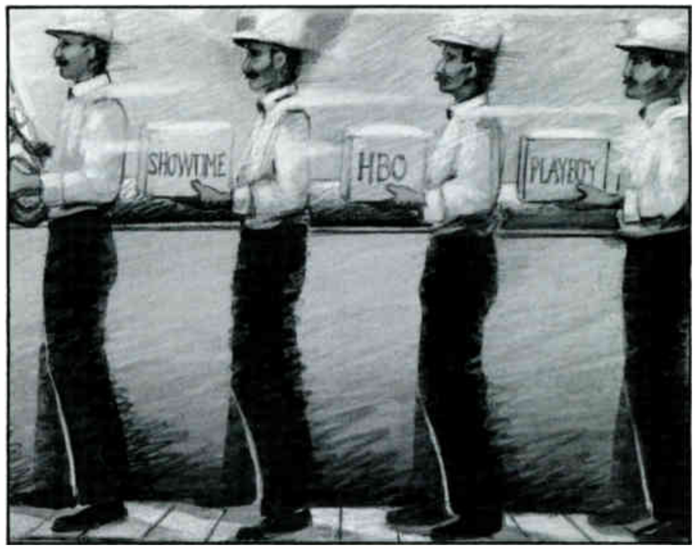
A variety of sync suppression alternatives are available to avoid problems just described. One possible method is to vary the time position of the sync pulses. Another is to remove all horizontal pulses except those in the vertical interval. Actually, as long as just two pulses remain, the original horizontal pulse train can be reconstructed.

From this point of view there are a great many choices of format for encoding the horizontal sync. Just pick any two pulses out of an integer multiple of 525 and suppress the others. Use the two unsuppressed pulses for decoding.

More formats result from retaining three or more pulses for descrambling. The purpose of this article is to describe a technique for retaining 25 pulses. The pulses are neither adjacent nor confined to a region such as the vertical interval. They are evenly spaced and are at a fixed position relative to the vertical interval. The method of retaining is basically the same regardless of the number and location. It is a matter of counting a certain number of suppressed pulses and then disabling the suppression for one pulse. In the case of 25 evenly spaced, the process is in effect the result of dividing by 21. The actual encoding circuit counts 20 and then, on 21, disables the suppression.

One may claim that the 25 remaining pulses are enough to keep a TV set synchronized. Not likely. But if so, then consider the effect on the receiver AGC (automatic gain control), which depends on sync peak amplitude. The AGC time constant becomes too small when 95 percent of the horizontal pulses are removed.

This same counting technique is used in other ways. Since everything about both encoding and addressing is a matter of timing, why not use the counting of clock pulses for both processes? Furthermore, if the clock generators in both scramblers and descramblers are accurate and stable,



Malcolm Farley

the combination becomes a more precision system. The actual clock rate is not the horizontal rate but rather 256 times that, or nominally 4.03 MHz. Therefore, the interval between any two horizontal sync pulses is divided into 256 pieces, and the result of counting up to any number between zero and 256 is a new sync pulse much narrower than the horizontal.

This sharp pulse is used to control the switchable attenuator that suppresses the horizontal sync. It also is used to operate a video switch that replaces normal video with digital address data on certain lines in the vertical interval. And it is used to control a shift register that feeds serial address data to that same video switch.

Counting is always done relative to something that is arbitrarily considered zero. In the scrambler the counting is relative to the leading edge of the horizontal sync pulse. For every horizontal pulse the counters are set to zero, and for any event occurring between the pulses there is a count somewhere between zero and 256.

For suppressing the horizontal sync pulse, two counts are required, one at the start of the suppress interval and one at the end. The start is triggered by the count of 246, which is the equivalent of 2.5 microseconds before the pulse being suppressed. Note that this count is relative to the previous sync pulse. The counting of clock pulses cannot be triggered by an event that has not yet occurred. The timing of an event relative to a horizontal pulse in the future requires a reference pulse that lies in the past, which in this case is the previous horizontal pulse.

The end of the suppress interval is marked by the count of 40, which corresponds to 10 μs after the pulse being suppressed.

Descrambler and address operation

In the descrambler a clock generator of the same rate is used. The accurate timing it provides is necessary for locating and processing the address data and for operating the reverse-sense attenuator that recovers the horizontal sync. A similar counting occurs, but it is referenced to only one out of every 21 horizontal pulses. When the counter reaches 256 it resets itself. This cycle is repeated 20 times. The 21st pulse is not suppressed, and it supplies an external reset, which removes any timing error that may have accumulated during the previous 20.

The address data also depends on accurate counting of clock pulses. The binary address information is spaced 43 counts after the leading edge of a sync pulse on one or more lines in the vertical interval. Depending on how many lines and how many addresses, the data may contain more than just binary customer-numbers and on/off control bits. Format changes can be made. Just one example is to switch from all frames scrambled to a series of 10 frames scrambled and one frame not scrambled. Address numbers could be either changed or simply disabled. The customer may be asked to punch in a new number or plug in a new device in order to reinstate service.

Assume, for example, that there are 200 clock pulse intervals available

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for data transmission. Also assume that each data bit is eight clock pulses long. Then there is room for 25 data bits. If 20 bits are used for address numbers, one has the capability of 32 control functions and more than 1 million customer locations.

The address and control data could be placed anywhere in the picture, but using the vertical interval allows transmission during viewing times. Suppose that 10 lines in the vertical interval are used. Then, with 60 vertical intervals per second, it is possible to control 600 locations per second. If there are actually 1 million subscribers, the total time required to completely update the system is about 28 minutes.

It is not likely that all customers will require turn-on at the same time. However, a widespread power failure could bring on comparable conditions. In the worst case, the 1 millionth customer would have to wait 28 minutes for restored service.

If all 525 lines are temporarily dedicated to addressing, the time required for complete system updating is reduced from 28 minutes to 64 seconds. The required change of format would be triggered by the control bits. If a single isolated turn-on request is received, that address could be activated immediately either by a computer command or by some manual technique. In effect, the data transmitter is switched from the normal address cycle to an immediate transmission of the address number in question. After that, the normal cycle is resumed either by continuing to count from the address in question or by starting from zero.

System weaknesses

A problem common to many sync suppression systems is that when video contains more than a certain level of noise, the scrambling performance degrades. This digital version is no exception. The timing functions used in both sync suppression and addressing depend vitally on sync, which is extracted from the composite video. If the sync is impaired by noise, the system fails.

A good example of troublesome video is that which sometimes comes from a satellite receiver. If noise is severe, the system may not function. Under these conditions the operator should turn off the scrambler and hope that the descrambler can differentiate sufficiently between noise and ordinary sync such that it will switch to the non-descrambling mode.

Another kind of signal impairment that will affect the digital system is sync timing jitter. This will obviously have a direct bearing on timing functions. Again, a certain impairment is tolerable, but beyond that there is no remedy. Consider, for example, the effect of timing jitter on the operation of the descrambler. The timing for it comes from the residual horizontal sync pulses, each of which precedes a group of 20 suppressed pulses. The timing for the recovery of those particular 20 is the result of counting from the residual pulse. Now, the counting will be accurate, since it is determined by a crystal-controlled clock. However, the spacing between pulses may vary, and even though the error is small, it is also cumulative.

Therefore, over the full set of 20 pulses the error could be greater than the timing margin between the scrambling and descrambling intervals. When this happens, descrambling begins to overlap into the region that was never scrambled. The result can be disruption of the picture as severe as with intentional scrambling.

The only significant source of video time jitter appears to be consumer-grade VCRs. Also, certain tapes have either altered timing or interfering pulses presumably for the prevention of copying. In all cases of time jitter so far, adequate measures have been found for compensation.

The digital sequencer technique for suppressing horizontal sync permits retaining a critical attribute of the TV signal—peak sync amplitude. Both encoded sync and address information are transmitted within a narrow band around the picture carrier. Therefore, the descrambling system is less susceptible to interference from other signal elements either in-band or out-of-band.

The sequencer technique permits a flexibility of format that can improve security. A variety of control functions, impulse pay-per-view and status monitoring are practical add-ons. Field testing to date shows that this digital approach is stable under widely varying conditions of signal environment. It is readily installed and is finding increasing field acceptance.

Acknowledgment: I am grateful to Gunther Diefes, president of D&P Manufacturing Inc. for his encouragement and advice during both the development of this product and the writing of this article.

Engineers in training

By Pam King
Technical Training Coordinator, Jones Intercable Inc.

Jones Intercable system chief engineers recently participated in the MSO's seventh annual Engineering Conference. The benefits of the training workshops are obvious: learning new skills and honing existing ones. But the benefits go beyond book learning. These associates have the opportunity to meet their counterparts in other systems and find how others have solved problems or where to look for answers. It is also an opportunity to share a little empathy for a job that is extremely demanding.

The engineering sessions began Friday, June 22 at the Radisson Hotel in Englewood, Colo., with review sessions for exams in the BCT/E Certification Program. Bob Luff spoke about professionalism, Ron Hranac discussed video and audio and I led a discussion on terminal devices. Richard Covell of Jerrold made an appearance to speak about distribution systems. On Saturday afternoon, the exams were administered by the Society of Cable Television Engineers' Rocky Mountain Chapter. Although this day was optional, about 90 percent of our engineers arrived early in order to take two or more of these exams.

After breakfast Sunday morning, for the attendees it was onto the bus and into the mountains to Breckenridge, Colo. The free time in the afternoon gave our engineers a chance to recover from jet lag and the mental strain of taking the exams, as well as to let those "flatlanders" get used to the 9,600-foot elevation at the Beaver Run Conference Center.

Wendell Bailey, vice president of science and technology for the National Cable Television Association, kicked off the conference with a discussion on customer service, new technologies and advanced TV systems—and how the CATV industry will meet these challenges.


Tom Sawyer

Glenn Jones awarded the Medallion of the Alliance award to Technical Training Coordinator Pam King, while previous years' winners Craig Chase, Wayne Davis and Howard Callentine look on.

Engineering manual

Then we jumped into our workshops, which were developed, written and presented by members of the corporate engineering staff, as well as by system engineers. This year we had a unique theme: We presented the newly revised *Jones Engineering Manual*. This manual, which consists of four volumes (1,342 pages total), outlines companywide technical operations policies and guidelines. (The manual is still under our systems' scrutiny; they have about four months to review and comment before it becomes "policy." By that time, our existing four volumes may be expanded even more.)


Pam King

Each Jones Intercable engineer received a copy of the four-volume "Jones Engineering Manual."

The four volumes consist of rules and bulletins, technical operations, technical administration and construction. Each engineer was presented with the four volumes. The workshops touched upon the more important topics in the manual, as well as introduced new topics and procedures.

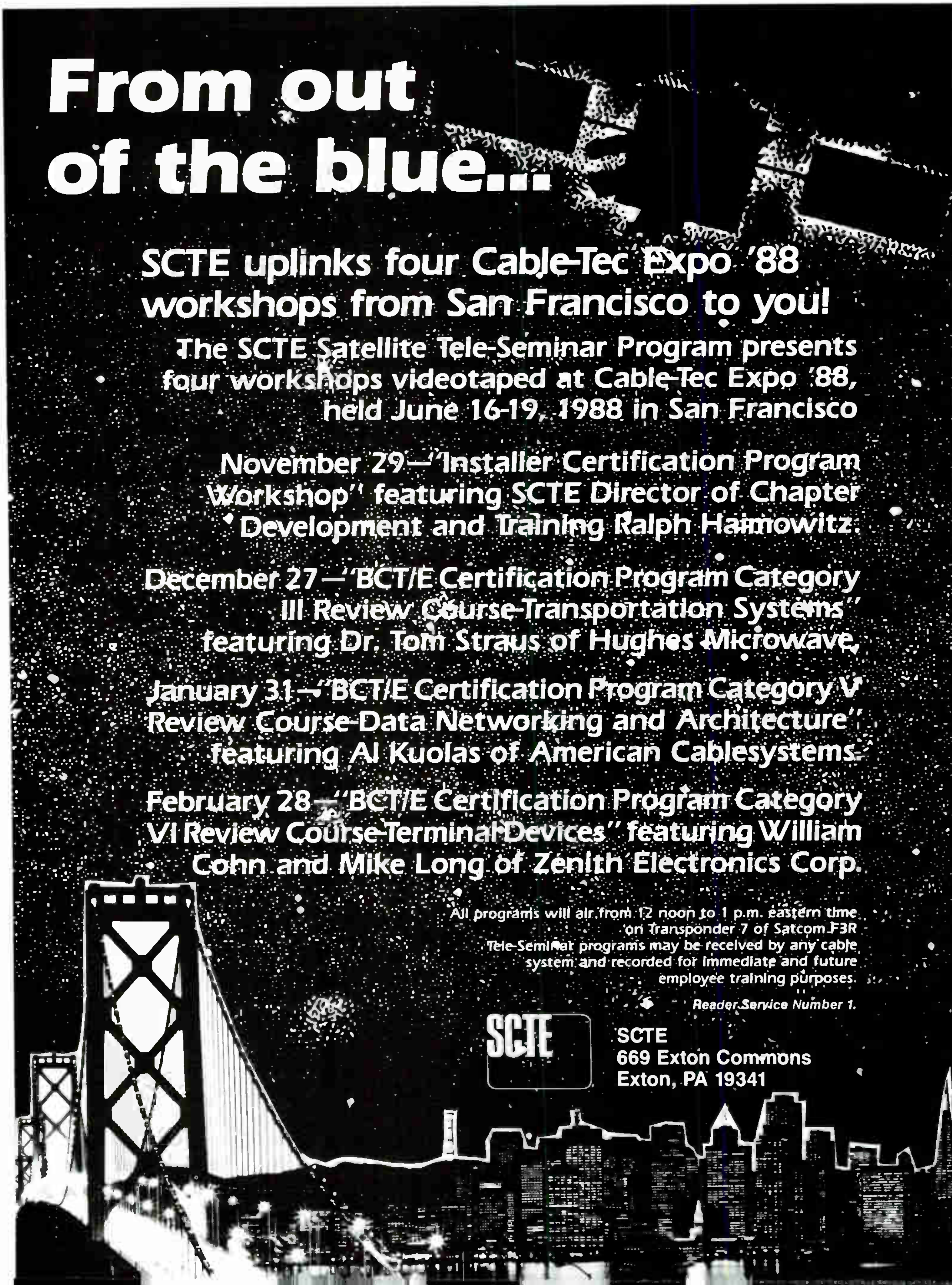
Over the next three days, the following workshops were presented: "Leakage control" (conducted by Roy Ehman), "Preventive maintenance" (Hugh Bramble), "Electronic mail" (Del Guynes), "Buyer's guide/materials management" (Steve Gines, Margaret Bryant, Deborah Lange, Bonnie Potter and Dave Demming), "Engineering curriculum/Qualified Installer Program" (Pam King), "Quality assurance" (Bob Luff and John Green), "CableData" (Steve Hubbard, Steve Blechschmidt and Wayne Davis), "Professionalism" (John Linebarger, Craig Chase and Ken Hisle), "Microwave" (Ron Hranac), "Outage control" (Roy Ehman), "Field bench production" (Doug Greene and Frank Eichenlaub), "Mapping and design" (Roger Seefeldt, Mike Manning, Brad Conine and Chris O'Neil), "Human resources decisions and the law" (Ron Christensen), "America is cable-ready" (Greg Liptak) and "Fiber optics" (Mike Sparkman of Anixter and Tim Gropp of AT&T). Typically, we don't have vendors present workshops; however, Hal Williams, who wrote the section in the manual on fiber, was called out on an emergency project.

On Wednesday, July 27, in keeping with the tradition started last year, four special achievement awards were presented. These awards are given to those associates who have gone beyond the call of duty in their service to the company. This year's recipients are Ken Hisle of the Tampa, Fla., system; Bruce Wasleske from the Wausau area of Wisconsin; and Jamie Lee and James Nolan, both of the Broomfield, Colo., system.

Wednesday night was the annual awards dinner, in which Glenn Jones updated the group on the direction of the company and presented the Medallion of the Alliance award, the highest award given within Jones Intercable. I will not expand upon the details but feel compelled to tell you that I was the recipient of this very important honor.

The remainder of the conference went past like a blur: more workshops, a closing session by Bob Luff and another opportunity to take the BCT/E exams. Then back down the mountain and, for most people, to the airport.

It's such a unique opportunity to have all of our engineers at the same place at the same time, so we sometimes try to jam more information than can fit in the time allocated. But our annual conference is the highlight of our year. As of this writing, about 70 percent of the attendees have returned their evaluations, complete with comments, to our office. Results indicate that this was the best conference to date.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System design in fiber-optic video

By Robert H. Walker
Vice President of Marketing, PCO Inc.

Many factors play a role in the design of a fiber-optic video/audio transmission system. Each factor varies in importance, depending on the user's needs and intentions. Careful attention to the relative impact of each system parameter and the choices available to the designer can direct users quickly to the most appropriate and cost-effective system.

Initially, the designer must address certain basic user functional requirements, which will ultimately influence the overall architecture of the system.

Quality of video transmission needed

A number of specifications govern video transmission quality. The most familiar and most widely used specification is EIA (Electronic Industries Association) RS250B. This overall specification refers to five different levels of transmission performance for some 25 video specifications and six audio specifications. The five levels, from highest to lowest, are short-haul, medium-haul, long-haul, satellite and end-to-end.

These five levels have no relation to the distance the signal traverses. Most broadcast studio transmissions as well as repeaters use short-haul specifications—the term "short-haul," used long before fiber optics entered the scene, signifies the highest quality transmissions. Fiber can provide short-haul specifications up to a distance of 100 kilometers without repeaters; the best coaxial cable can do is about 600 meters.

The most widely cited specifications that should guarantee a good picture are:

1) *Video frequency response to 4.2 MHz*—This term refers to the flatness of the amplitude of the video baseband signal over a range of frequencies up to 4.2 MHz, the highest video frequency.

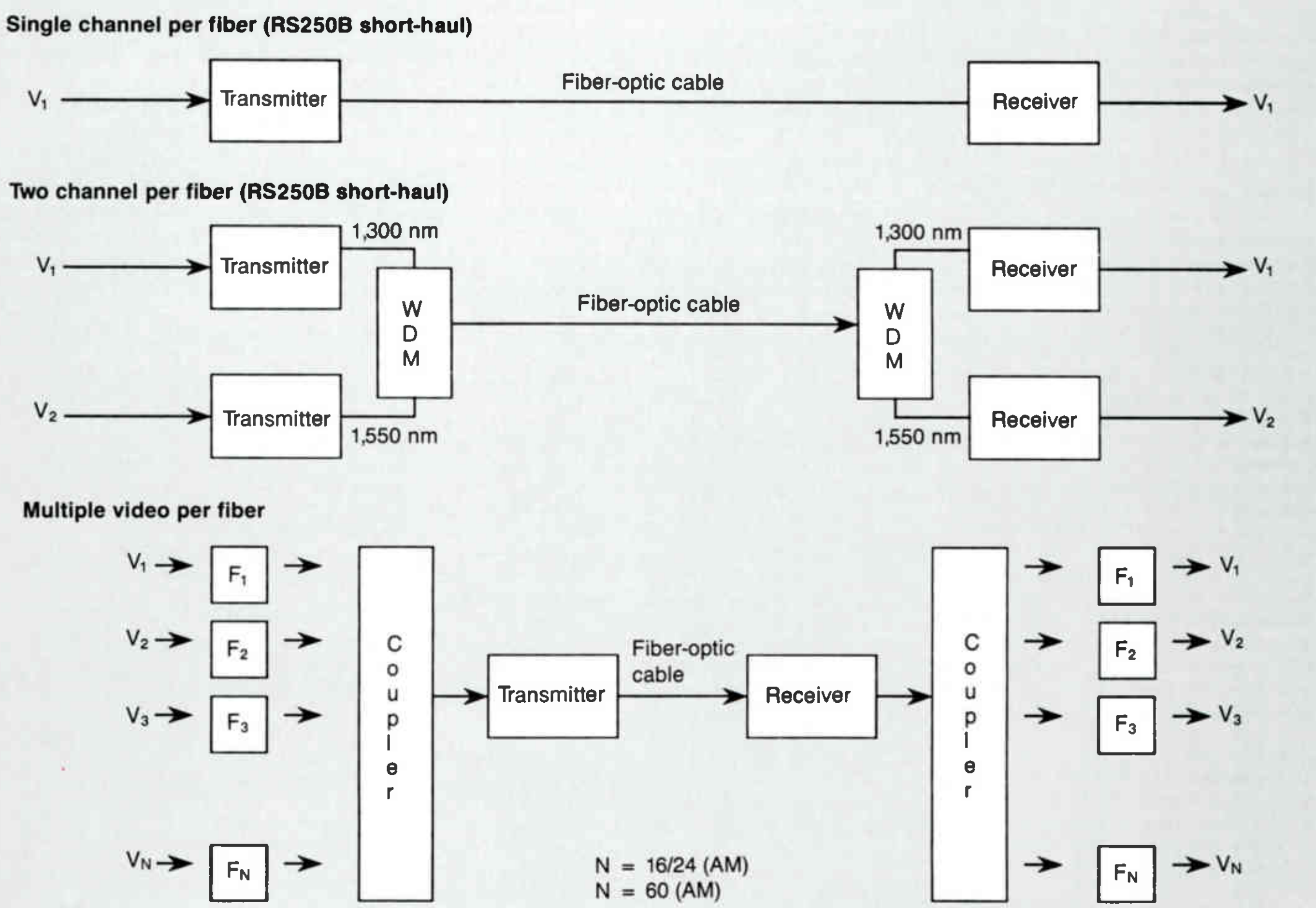
2) *Differential gain and differential phase*—Trueness of color should be independent of brightness and color saturation. These parameters gauge the distortion of color as a function of either the brightness of the picture or the relative color saturation.

3) *Weighted signal-to-noise (S/N) ratio*—This parameter deals with how "clean" the picture is. A noisy picture, one with a low S/N, appears grainy. This parameter is weighted so that the measurement more closely tracks the response of the human eye to noise in the picture. That is, certain frequencies are attenuated while others are accentuated in the weighting process. The highest possible S/N is desired for a clean picture; 67 dB is the short-haul specification for this parameter.

4) *Chrominance-to-luminance intermodulation, gain and delay inequality and non-linearity of luminance and chrominance gain and phase*—These parameters refer to how accurately the colors are reproduced in the system. The average brightness level of the scene at various points, the intensity of color (saturation) at those points, the size of the elements exhibiting the color and how fast the elements are moving—all these aspects impact the accuracy of color reproduction. Specific tests of these parameters show how well the system will render the colors. Both the luminance and chrominance are functions of the signal amplitude and how accurately the amplitude is reproduced.

Unfortunately, in addition to disagreement among engineers over specifications of "good" video pictures, some manufacturers cite those EIA specifications favorable to their product, while omitting those that are not. In general, a

Figure 1: Channel capacity



Common video transmission techniques

Service	Video transmission	Audio transmission	Multichannel audio	Security	EMI susceptibility	Access to and stability of right-of-way	Number of channels per system	Data capacity
Broadcast	VSB/AM	FM subcarrier	Multiplex on subcarrier	Scrambled video, offset audio subcarrier	High	Low	One	Low
CATV and broadband LAN	VSB/AM	FM subcarrier	Multiplex on subcarrier	Scramble video/deny channel access	Medium	High	Many	Low
Satellite	FM	FM subcarrier	Multiple subcarriers	Scramble video/format change	Moderate	Moderate	Two	High
Microwave (FML)	FM	FM subcarrier	Multiple subcarriers	No standard practice	Moderate	Moderate	One	High
Microwave (AML)	VSB/AM	FM subcarrier	Multiplex on subcarrier	Scramble video/deny channel access	Moderate	Moderate	Many	High
Fiber optic	FM	FM subcarrier	Multiple subcarriers	No standard practice	Low	High	Many	High
Fiber optic	AM	FM subcarrier	Multiplex on subcarrier	No standard practice	Low	High	Many	Moderate
Fiber optic	Digital	Digital	Digital multiplex	Full digital encryption	Low	High	One	High

system offering relatively flat video response and good S/N will provide good pictures. However, for these measurements to be of any real value to the designer, the manufacturer should guarantee without degradation the system specifications over the link distance that the signal must traverse—say, a distance of 10 km.

Quality of audio transmission needed

Although audio quality is perhaps as difficult for the user to quantify, it is much easier to convert into audio specifications. In general, audio frequency response, S/N and harmonic and intermodulation distortion are the key elements that govern audio system performance.

Other factors that can influence audio quality include the phase relationships between channels in multuichannel systems—e.g., in stereo systems, the integrity of the phase relationships between the left and right signals must be maintained. Another influential factor is the amount of peak signal headroom over the nominal (average) signal levels.

Most industrial audio systems are equipped with 600 ohm balanced input and output lines and are designed for nominal audio levels in the 0 to +8 dBm range. A good system will provide low distortion at levels up to +18 or +20 dBm on peaks. One more important note: The audio should be synchronized with the video to within 25 milliseconds to avoid obvious lip sync problems.

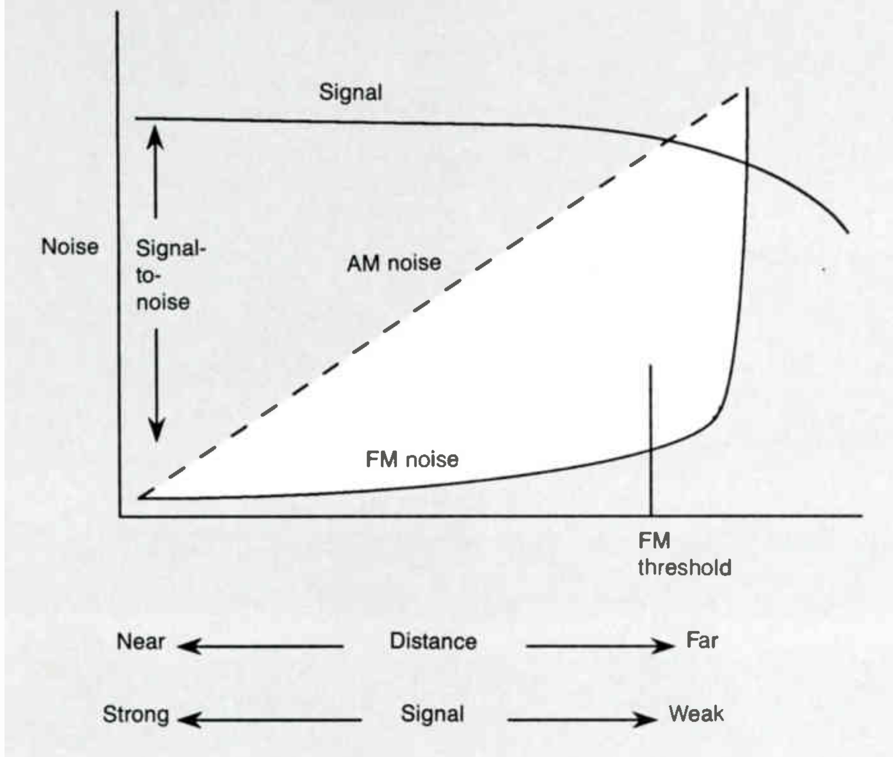
Distance signal must traverse

Link distance strongly influences the choice of the most appropriate system. For relatively short spans of several hundred feet, common coaxial cable is usually most appropriate. For longer distances, more options become available to the system designer, including microwave point-to-point, satellite, broadcast, cascaded coaxial cable networks and fiber-optic cable.

However, other factors besides distance also affect the choice between long distance transmission systems. Some of these factors are:

- *Signal interference environment*—Examples include lightning, man-made noise such as motor generators and radio frequency interference from communications signals in urban environments.
- *Access to and stability of right-of-way*—Satellites, for example, may only allow signal access for part of the time; optical fiber, on the other hand, provides dedicated access and therefore maximum stability for signals.
- *Level of signal security desired*—Scrambling and encrypting the signal are options if required.
- *Number of simultaneous channels needed*

Figure 2: FM threshold effect



—One or two channels per transponder for satellites and 16 to 24 for cable systems are examples.

For a perspective on how these factors interact in given system settings, the accompanying table summarizes the most common long distance transmission techniques and their key parameters. Fiber optics lends itself well to systems using FM (frequency modulation), AM (amplitude modulation) or digital transmission techniques for video. Of these three techniques, in general the highest quality will be obtained with uncompressed digital, followed by FM and then by AM systems.

Number of channels

The designer must look at the total number of channels required and the number of channels per link to determine the most appropriate design. For example, if a system uses a satellite link and needs two channels, a half-transponder per channel approach could be used, but at some expense to picture quality. On the other hand, if access is available to a multistrand fiber backbone cable, a single channel per fiber approach would be easier to implement and picture quality on each channel would be at the highest level.

As seen in Figure 1, single channel per fiber systems can be extended to two channels per fiber by using wave division multiplexing (WDM) —at no expense to picture quality on either channel.

Data transmission requirements

If the system also must accommodate data, the design must then consider certain additional basic elements, including number of data channels, data rate per channel, type of data and the interface needed (e.g., RS232, RS422, etc.).

There are a number of ways to transmit data over a video link. These include:

1) *Inserting the data in unused lines in the vertical interval*—Space exists for data to be transmitted over the same channel in some portions of the 22 vertical lines not used for the active picture. Teletext and closed captioning are transmitted in this manner.

2) *Placing the data on an unused audio channel*—This is another alternative for data transmission.

3) *Placing the data on a separate subcarrier*—This would be another supplemental frequency inserted into the overall signal in order to carry the data signals in addition to the basic video and audio signals. However, the number of subcarriers that can be inserted is limited since each subcarrier subtracts somewhat from the main signal power and can affect the video S/N.

Data on a subcarrier can generally be transmitted at higher rates, depending on the bandwidth available around the subcarrier. A higher data rate capability can then be offered the user. For example, a 256 kilobits per second data channel on a subcarrier can be used to transmit documents or drawings at the rate of one every two seconds. However, with RS232 links, transmission at this rate is not possible.

One of the unique aspects of fiber-optic transmission of video is that more variations are available to the system designer than other media provide. For example, either single-channel or multichannel configurations are available. In addition, the single-channel fiber configuration offers a level of transmission performance that far exceeds any other medium's single-channel video transmission.

Another unique characteristic is that, by using LED transmitters, fiber systems can be designed to minimize costs for shorter distance links. With most other media, the distance covered is not as closely related to cost and the cost is relatively fixed at some initial level. Fiber-optic systems offer FM, AM or digital modulation, enabling the designer to choose the exact configuration appropriate to the system requirements.

An FM fiber-optic system also takes maximum advantage of the available optical link budget due to the FM threshold effect. (The link budget is the loss of signal over the link, measured in dB.) The FM threshold effect essentially maintains a high S/N very near the limit of the optical link budget, meaning that as the signal drops off, the system does not change for a long time, but then rapidly falls off. An AM system, on the other hand, degrades linearly with reduction in signal level received; i.e., as distance is increased and the signal level lowered, the system impairment is almost linear (Figure 2).

An LED high quality FM system with good threshold performance will generally outperform an AM system, even when the AM system is using a laser. The designer should pay particular attention to the system performance attainable at a specified optical link budget.

On balance, fiber-optic systems are the wisest choice when distances are long, interference (both electromagnetic and electrical) is probable and cannot be tolerated, and when signal security is of concern. System designers' ability to choose from a wide variety of fiber-optic product offerings is also a great advantage since they can then carefully select a specific system architecture.

Yet another advantage of fiber-optic systems is their relative flexibility, even after initial installation. Additional considerations for fiber-optic video systems are:

- *Whether a switched or unswitched system is needed*—At present, no fiber-optic video quality switches are available, although, as research proceeds, optical switches will eventually appear.
- *Multiple cable fiber backbones*—Single- or multiple-fiber cables are available. Multiple-fiber cables are made with up to 144 fibers in a single cable.
- *Interface to other media*—Should the designer choose to use a telco-provided fiber-optic system, then standard Telco DS-3 lines must be used. The interface to a Telco DS-3 line, which provides a 45 Mbps digital service, necessitates a codec (coder-decoder) at both ends. The resultant reduction in vertical resolution due to the 2:1 bandwidth compression is a subjective issue.

Finally, the oncoming move toward HDTV (high-definition television) will necessitate systems with wider bandwidths than now commonly allocated for TV channels. Although satellite, microwave point-to-point and coaxial cable systems will be able to accommodate HDTV signals, fiber-optic transmission offers the greatest potential for HDTV in many of its proposed formats.

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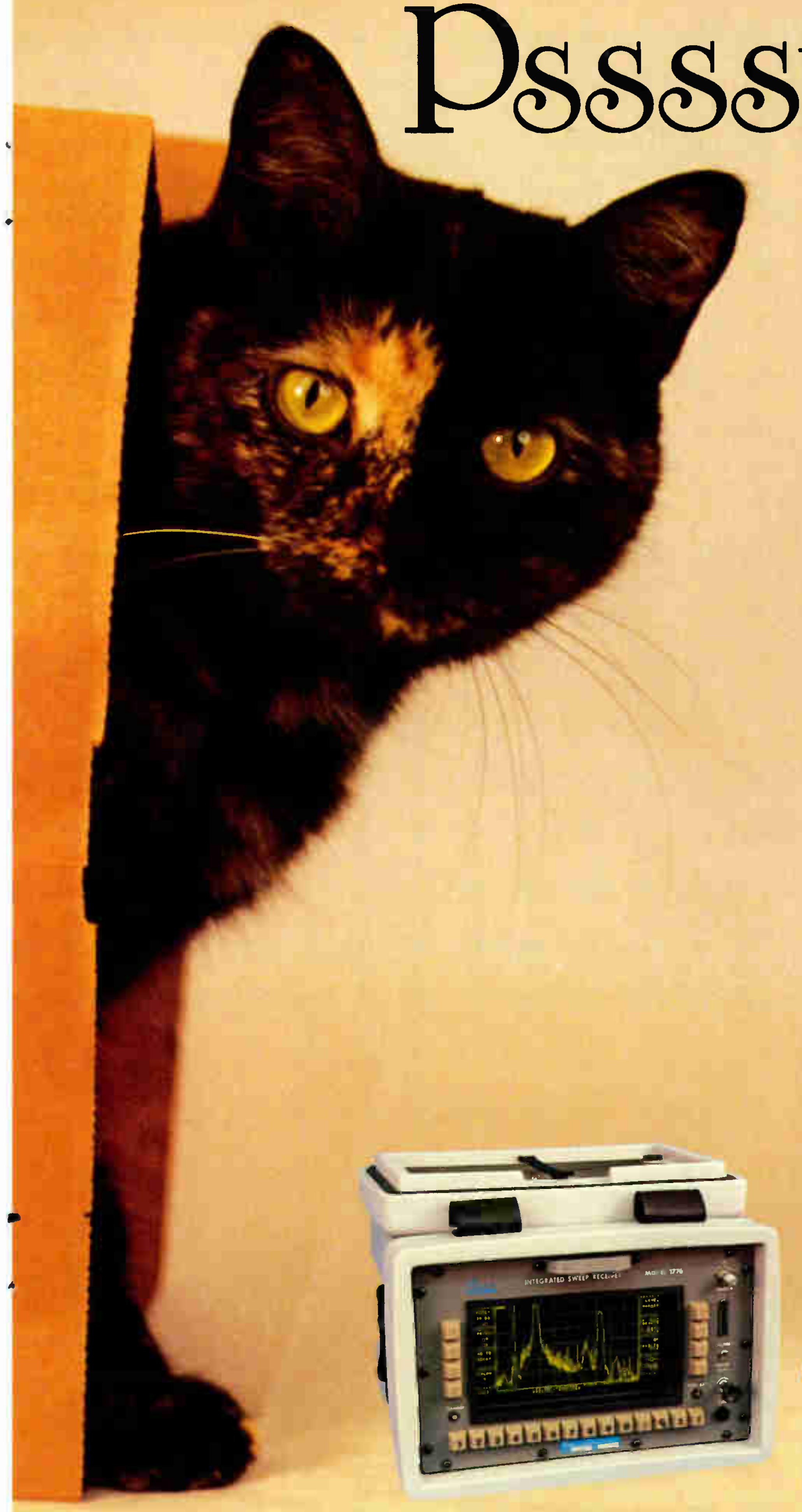

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CT's index of articles

The following is a listing of all feature articles and columns appearing in "Communications Technology" from November 1987 through October 1988. This index is cross-referenced by topic, with articles arranged in reverse chronological order (i.e., most recent article first).

Key

Topic (arranged alphabetically)

CLI

Signal leakage compliance, Robert Saunders, Sammons Communications, July 1988, 14.

Title of article — **Author** — **Company** — **Issue** — **Page**

Compiled by Shelley Bolin

Addressability

Signal security and subscriber terminals, Earl G. Langenberg, ATC, November 1987, 16.

Addressability and microwave, Steve Hubbard, Jones Intercable, November 1987, 18.

Considerations for integrating status monitoring and addressability, Patrick McDonough, United Cable Television Corp., November 1987, 24.

Amateur radio

Is amateur radio an asset to the cable industry?, Dave Pangrac, ATC, December 1987, 80.

Antennas and earth stations

Calculating TVRO expected performance, Jack Sanders, ATC, August 1988, 82.

Dipole antennas, Ron Hranac, Jones Intercable, July 1988, 83.

Log-periodic antennas for CATV, Steven Zahn, Consultant, April 1988, 63.

Anti-icing earth station antennas, Joe Lemaire, Raychem, February 1988, 32.

Back to basics

How to set video levels with an oscilloscope, Ron Hranac, Jones Intercable, January 1988, 52.

Blonder's view

The myth of free trade, Isaac S. Blonder, Blonder-Tongue Laboratories, October 1988, 14.

Triphonic sound for television, Isaac S. Blonder, Blonder-Tongue Laboratories, September 1988, 12.

Saluting a noble scientist, Isaac S. Blonder, Blonder-Tongue Laboratories, August 1988, 14.

Child labor — Can it work?, Isaac S. Blonder, Blonder-Tongue Laboratories, July 1988, 12.

The H Factor, Isaac S. Blonder, Blonder-Tongue Laboratories, June 1988, 16.

You and me and the IEC, Isaac S. Blonder, Blonder-Tongue Laboratories, May 1988, 20.

The eight degrees of charity, Isaac S. Blonder, Blonder-Tongue Laboratories, April 1988, 14.

HDTV — Who's on first?, Isaac S. Blonder, Blonder-Tongue Laboratories, March 1988, 12.

Science at Loch Ness, Isaac S. Blonder, Blonder-Tongue Laboratories, February 1988, 14.

Beyond Judge Bork, Isaac S. Blonder, Blonder-Tongue Laboratories, January 1988, 11.

China — April 1987, Isaac S. Blonder, Blonder-Tongue Laboratories, December 1987, 12.

Going, going, gone, Isaac S. Blonder, Blonder-Tongue Laboratories, November 1987, 12.

BTSC stereo

How BTSC brings stereo to the TV set, Frank McClatchie, FM Systems, March 1988, 49.

Mutual effects of RF scrambling and BTSC stereo in the headend, Steve Fox, Wegener Communications, December 1987, 16.

A guide to installing your BTSC encoders, Karl Poirier, Triple Crown Electronics, December 1987, 28.

Integrating BTSC into a cable system, Kim Litchfield, Learning Industries, December 1987, 40.

BTSC stereo in a digital audio system, Bob Reiner, Oak Communications, December 1987, 50.

Cable-Tec Expo

Cable-Tec Expo '88: San Francisco treat, Rikki T. Lee, August 1988, 62.

HDTV and fiber optics at Cable-Tec Expo '88, Lawrence W. Lockwood, TeleResources, August 1988, 83.

Career planning

Marketing your services, Chris Papas, The MITRE Corp., February 1988, 58.

Ciciora's forum

Cable technology S-curves, Walter S. Ciciora, Ph.D., ATC, October 1988, 114.

Innovation in a competitive environment, Walter S. Ciciora, Ph.D., ATC, September 1988, 106.

Windows on the future, Walter S. Ciciora, Ph.D., ATC, August 1988, 118.

The Paperback Movie, Walter S. Ciciora, Ph.D., ATC, July 1988, 86.

Video digital downloading, Walter S. Ciciora, Ph.D., ATC, June 1988, 118.

A trail guide to the FCC HDTV committees, Walter S. Ciciora, Ph.D., ATC, May 1988, 120.

HDTV report from Japan, Walter S. Ciciora, Ph.D., ATC, April 1988, 110.

An HDTV committee road map, Walter S. Ciciora, Ph.D., ATC, March 1988, 74.

Issues for HDTV, cable, Walter S. Ciciora, Ph.D., ATC, February 1988, 86.

High-definition television, Walter S. Ciciora, Ph.D., ATC, January 1988, 98.

B-ISDN and cable TV, Walter S. Ciciora, Ph.D., ATC, December 1987, 118.

What ISDN means for cable, Walter S. Ciciora, Ph.D., ATC, November 1987, 86.

CLI

Signal leakage compliance, Robert Saunders, Sammons Communications, July 1988, 14.

Leakage detection program, Jim Bishop, United Cable of Colorado, July 1988, 18.

Procedures for conducting a flyover, Robert V.C. Dickinson and Edwin L. Dickinson, Dovetail Systems Corp., July 1988, 24.

History of Docket 21006, Cliff Paul, RTK Corp., July 1988, 28.

CLI revisited, Pam King and John Green, Jones Intercable, July 1988, 34.

Dipole antennas, Ron Hranac, Jones Intercable, July 1988, 83.

Commercial insertion

StarNet in the headend, Engineering Staff, Wegener Communications, February 1988, 24.

A holistic approach to ad insertion, John Kienast, Grumman Electronics Systems Division, November 1987, 26.

Engineering the interconnect, John Fitzpatrick, Northwest Cable Interconnect, November 1987, 29.

Commercial insertion and cue tones, Allen M. Kirby, Falcone International, November 1987, 64.

Construction

Mapping a rebuild with computer-aided drafting, David W. Cervone, Viacom Cablevision of Long Island, April 1988, 16.

Handling and installing aluminum-sheathed cables, Rex Porter, April 1988, 28.

The alternatives of turnkey construction, Thomas J. Polis and William F. Earle, Communications Construction Group, April 1988, 34.

Project management for CATV engineers, Steve Hubbard, Jones Intercable, April 1988, 38.

Part II: Anchoring utility poles, David Chandler, Foresight Products, January 1988, 58.

Part I: Anchoring utility poles, David Chandler, Foresight Products, December 1987, 82.

Construction techniques

Part II: Anchoring utility poles, David Chandler, Foresight Products, January 1988, 58.

Part I: Anchoring utility poles, David Chandler, Foresight Products, December 1987, 82.

Consumer interfacing

Consumer interfaces, Earl Langenberg, ATC, May 1988, 22.

Interfacing in the year 2000, H. Mark Bowers, Centel Cable Television Co., May 1988, 26.

The VCR/CATV interface question, Michael Spratlin, Qintar, May 1988, 30.

Interfacing pay-per-view in the cable-compatible home environment, David E. Wachob and Joseph Vittorio, General Instrument/Jerrold Division, May 1988, 32.

The elements of consumer friendliness, Pam King, Jones Intercable, May 1988, 40.

The intelligent remote, Michael T. Hayashi and Dan Wiltshire, Pioneer Communications of America, May 1988, 50.

A case study of consumer friendliness, John W. Dawson Jr., Mile Hi Cablevision, May 1988, 70.

Converters

A converter for premium channels only, Archer S. Taylor, Malarkey-Taylor Associates, September 1988, 63.

Modeling the converter in the residential lightning environment, Dave Wachob, General Instrument/Jerrold Division, August 1988, 28.

Signal security and subscriber terminals, Earl G. Langenberg, ATC, November 1987, 16.

Correspondent's report

Part I: Light measurement, Lawrence W. Lockwood, TeleResources, October 1988, 92.

Telcos, television and fiber optics, Lawrence W. Lockwood, TeleResources, September 1988, 93.

Levels in fiber-optic networks, Lawrence W. Lockwood, TeleResources, June 1988, 94.

Ruminations on HDTV transmission, Lawrence W. Lockwood, TeleResources, May 1988, 96.

More HDTV activity, Lawrence W. Lockwood, TeleResources, December 1987, 88.

HDTV viewing distance, Lawrence W. Lockwood, TeleResources, November 1987, 70.

Data and local area networks

Design, installation and certification of a broadband LAN cabling system, Larry C. Brown, NaCom Corp., September 1988, 14.

Implementing a broadband LAN, Geoff Roman, General Instrument/Jerrold Division, September 1988, 19.

Spectrum allocation in broadband systems, Tom Saylor, Columbia Telecommunications, September 1988, 24.

Part I: Fiber optics in local area networks, Robert Southard, AMP Inc., September 1988, 27.

LANs and electronic mail, Del R. Guynes, Jones Intercable, September 1988, 32.

Developing a community network, Karen Kalergis, Austin CableVision, September 1988, 36.

Cutting costs using your existing plant, Norm Canfield, Cooke Cablevision, December 1987, 87.

Design

Design, installation and certification of a broadband LAN cabling system, Larry C. Brown, NaCom Corp., September 1988, 14.

Part III: Fiber-optic system design, Robert K. Southard, AMP Inc., June 1988, 84.

Part II: Fiber-optic system design, Robert K. Southard, AMP Inc., May 1988, 74.

Mapping a rebuild with computer-aided drafting, David W. Cervone, Viacom Cablevision of Long Island, April 1988, 16.

Part I: Fiber-optic system design, Robert K. Southard, AMP Inc., April 1988, 24.

A tracking procedure for drafting and design, Pam King, Jones Intercable, February 1988, 62.

PC software for accurate design, Barbara Lukens, ATC, February 1988, 72.

Fiber optics

Single-mode fiber-optic technology, Douglas J. Eccleston, Corning Glass Works, October 1988, 16.

AM fiber-optic trunks, David Grubb III, General Instrument/Jerrold Division, October 1988, 24.

Multichannel AM on fiber: A status report, Vince R. Borelli and Hermann Gysel, Synchronous Communications, October 1988, 28.

Fiber-optic supertrunking, Britt McQuaide, Consultant, October 1988, 32.

Fiber backbone: A proposal for an evolutionary CATV architec-

Grounding

HDTV and advanced television

Headends

ISDN

Lightning

Management

Microwave

Multipath distortion

Multiple dwelling units
Securing MDU equipment, Malcolm S. White, Priority Television Consultants, June 1988, 90.
Planning cable installations for MDUs, Jerry Trautwein, Consultant, April 1988, 81.
Hooking up multiple dwelling units, Glyn Bostick, Microwave Filter Co., March 1988, 62.

National Electrical Code
Are you ready for 820-15?, Ron Hranac, Jones Intercable, June 1988, 79.
Testing the new NEC guidelines, Christopher D. Huffman, General Instrument/CommScope Division, June 1988, 81.
Article 820: Community Antenna TV and Radio Distribution Systems, National Fire Protection Association, June 1988, 81.

Pay-per-view
Satellite-delivered tag change system, Andrew Ferraro, Request Television, December 1987, 70.
ANI as a PPV ordering tool, Jeff Corbett, Business Systems Inc., December 1987, 72.
RF vs. telephone for an impulse system, Jeremy Rosenberg and Mei Yang, General Instrument/Jerrold Division, December 1987, 77.
Minding the store-and-forward, John Donahue, Comcast Philadelphia, December 1987, 78.

Powering
Part II: Outage management, Roy Ehman, Jones Intercable, October 1988, 100.
Part I: Outage management, Roy Ehman, Jones Intercable, September 1988, 80.
Power supply efficiency, Howard H. Bobry, Albar Inc., August 1988, 24.
Batteries in CATV standby power supplies, Neil Tinggaard, Daniels & Associates, August 1988, 32.
Energy consumption of power supplies, Paul Barth, United Cable Television Corp., August 1988, 104.
Standby power supplies, Gene Faulkner, Control Technology, March 1988, 56.

President's message
Technical training: Joint seminars, Ron Hranac, SCTE, October 1988, 98.
SCTE — A growing concern, Ron Hranac, SCTE, September 1988, 86.
BCT/E certification, Ron Hranac, SCTE, August 1988, 110.
SCTE's Tuition Assistance Program, Ron Hranac, SCTE, July 1988, 62.

Preventive maintenance
Four elements of success, Dan A. Neiman, Times Mirror Cable Television, September 1988, 78.
Eliminating paging transmitter interference, Glyn Bostick, Microwave Filter Co., June 1988, 88.
Vehicle and equipment maintenance, Arnold Cisneros, Heritage Cablevision, April 1988, 78.
Maintenance for the changing headend, Scott Cooper, Concord TV Cable, February 1988, 70.
The scientific method of headend maintenance, Thomas P. Saylor, Columbia Telecommunications, November 1987, 60.

Rebuilds
Mapping a rebuild with computer-aided drafting, David W. Cervone, Viacom Cablevision of Long Island, April 1988, 16.
So your system needs rebuilding, Jim Merriam, Palmer Cablevision, January 1988, 66.

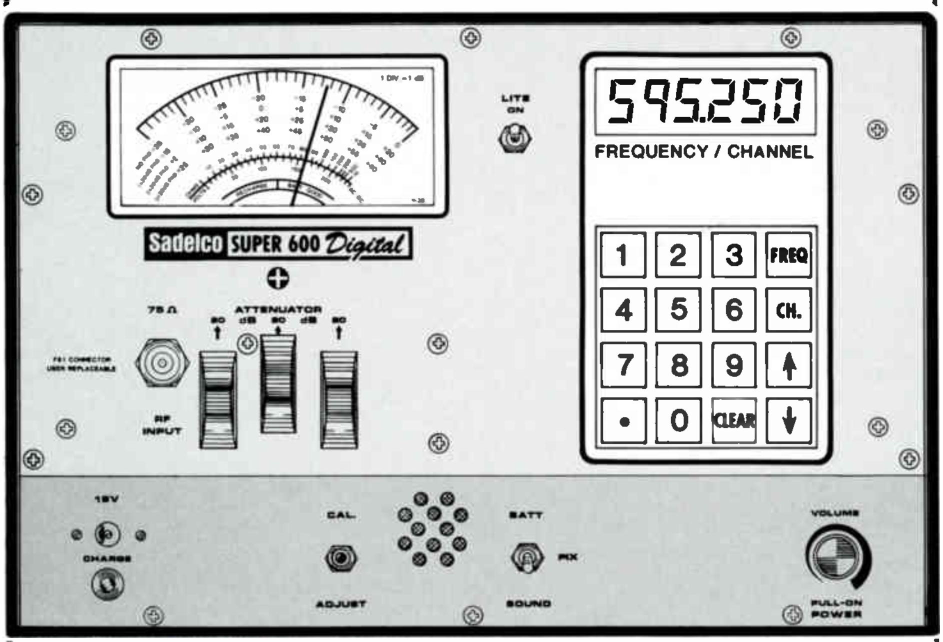
Satellites
Calculating TVRO expected performance, Jack Sanders, ATC, August 1988, 42.
Downlink frequencies for domestic satellites (wall chart), Ron Hranac, Jones Intercable, August 1988, 67.
Satellite-delivered tag change system, Andrew Ferraro, Request Television, December 1987, 70.

Signal leakage
Monitoring and locating signal leakage, Steven C. Johnson, ATC, August 1988, 96.
Signal leakage compliance, Robert Saunders, Sammons Communications, July 1988, 14.
Leakage detection program, Jim Bishop, United Cable of Colorado, July 88, 18.
Procedures for conducting a flyover, Robert V.C. Dickinson and Edwin L. Dickinson, Dovetail Systems Corp., July 1988, 24.
History of Docket 21006, Cliff Paul, RTK Corp., July 1988, 28.
CLI revisited, Pam King and John Green, Jones Intercable, July 1988, 34.
FCC leakage limits, Martin J. Walker, Simmons Communications, July 1988, 38.
Dipole antennas, Ron Hranac, Jones Intercable, July 1988, 83.

Signal security
Mutual effects of RF scrambling and BTSC stereo in the headend, Steve Fox, Wegener Communications, December 1987, 16.
Signal security and subscriber terminals, Earl G. Langenberg, ATC, November 1987, 16.

Status monitoring
Status monitoring: Hows and whys, Colleen McGuire, General Instrument/Jerrold Division, March 1988, 14.
Status monitoring — It can be done, Jerry Laufer, Bert Henscheid and Mark Harris, Texscan, March 1988, 19.
Remote headend monitoring, Eugene Fuller, Monroe Electronics, March 1988, 22.
Monitoring headend performance, William T. Homiller, General Instrument/Jerrold Division, February 1988, 20.
Considerations for integrating status monitoring and addressability, Patrick McDonough, United Cable Television Corp., November 1987, 24.

System economy
Part II: Outage management, Roy Ehman, Jones Intercable, October 1988, 100.
Part I: Outage management, Roy Ehman, Jones Intercable, September 1988, 80.
Energy consumption of power supplies, Paul Barth, United Cable Television Corp., August 1988, 104.
Securing MDU equipment, Malcolm S. White, Priority Television Consultants, June 1988, 90.
The use of automatic response units, Jeffrey Folkes, Cable TV Montgomery, May 1988, 90.
A case study of assets security, Sam Street, United Cable of Baltimore, March 1988, 61.
PC software for accurate design, Barbara Lukens, ATC, February 1988, 72.
So your system needs rebuilding, Jim Merriam, Palmer Cablevision, January 1988, 66.
Cutting costs using your existing plant, Norm Canfield, Cooke Cablevision, November 1987, 87.



Tech book

Part I: Fiber-optics glossary, Hal Williams, Jones Intercable, October 1988, 111.
Azimuth calculations, Ron Hranac, Jones Intercable, September 1988, 103.
Distance calculations, Ron Hranac, Jones Intercable, August 1988, 117.
Dipole antennas, Ron Hranac, Jones Intercable, July 1988, 83.
Fiber-optic loss budget, Hal Williams, Jones Intercable, June 1988, 109.
Amplitude modulation on an oscilloscope, Ron Hranac, Jones Intercable, May 1988, 115.
Amplitude modulation on a spectrum analyzer, Ron Hranac, Jones Intercable, April 1988, 105.
Noise, Ron Hranac and Frank Eichenlaub, Jones Intercable, March 1988, 69.
Voltage addition, Ron Hranac and Pam King, Jones Intercable, February 1988, 83.
Hughes AML reference data, Ron Hranac, Jones Intercable, January 1988, 93.
XMOD and CTB in a cable system, Ron Hranac and Pam King, Jones Intercable, December 1987, 113.
Power addition, Ron Hranac and Pam King, Jones Intercable, November 1987, 83.

Tech tips

Part II: Upgrading for increased capacity, Richard Covell, General Instrument/Jerrold Division, August 1988, 106.
Part I: Upgrading for increased capacity, Richard Covell, General Instrument/Jerrold Division, July 1988, 66.
XPress in the headend, Elizabeth D. Blick, XPress Information Services, May 1988, 92.
Planning cable installations for MDUs, Jerry Trautwein, Consultant, April 1988, 81.
Hooking up multiple dwelling units, Glyn Bostick, Microwave Filter Co., March 1988, 62.
Commercial insertion and cue tones, Allen M. Kirby, Falcone International, November 1987, 64.

Tests and measurements

Putting HDTV to the test, Willem A. Mostert, Magnavox CATV Systems, October 1988, 72.
Part IV: Fundamentals of spectrum analysis, Bill Benedict, Tektronix, September 1988, 70.
Part III: Fundamentals of spectrum analysis, Bill Benedict, Tektronix, July 1988, 53.
Part II: Fundamentals of spectrum analysis, Bill Benedict, Tektronix, May 1988, 82.
Amplitude modulation on an oscilloscope, Ron Hranac, Jones Intercable, May 1988, 115.
Part I: Fundamentals of spectrum analysis, Bill Benedict, Tektronix, April 1988, 46.
Amplitude modulation on a spectrum analyzer, Ron Hranac, Jones Intercable, April 1988, 105.
System sweep techniques on an FM transportation trunk, William LeDoux, CaLan, March 1988, 26.
How to see video levels on an oscilloscope, Ron Hranac, Jones Intercable, January 1988, 52.

Training

Training for the technical future, Kenneth T. Deschler, Cable Correspondence Courses, June 1988, 18.
Alternatives in training, Al Dawkins, Al Dawkins Enterprises, June 1988, 24.
Managing service call reduction, Robert A. Luff, Don Sutton and Pam King, Jones Intercable; and Dana Eggert, Performance Plus Training Programs, June 1988, 26.
Prerequisite to a training program, Pam King, Jones Intercable, June 1988, 32.
Providing needs-based training, Alan Babcock, ATC National Training Center, June 1988, 36.
Training in the use of fiber optics, Rebecca S. Frye, Siecor Corp., June 1988, 40.
The SCTE's role as a training resource, William Riker and Howard Whitman, Society of Cable Television Engineers, June 1988, 47.
Management training for engineers, Chris Papas, The MITRE Corp., June 1988, 50.
Improving efficiency of technical personnel, Jon Ridley, General Instrument/Jerrold Division, June 1988, 70.
Using videotapes in training, Russell Smith, Cardinal Communications, June 1988, 72.
Training with interactive video, Judy L. Geisman, InterComm International, and Dana Eggert, dB Associates, June 1988, 74.

Upgrades

Part II: Upgrading for increased capacity, Richard Covell, General Instrument/Jerrold Division, August 1988, 106.
Part I: Upgrading for increased capacity, Richard Covell, General Instrument/Jerrold Division, July 1988, 66.

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Scholarship grads: Where are they now?

By Rikki T. Lee

It's no secret that the Society of Cable Television Engineers has many opportunities for the continuing education of technical personnel in the CATV industry. Perhaps the most valuable and successful has been the SCTE's Tuition Assistance Program. Since November 1986, more than a dozen people in the industry have benefitted from the program. In all but one case, each chose a technical course from the many offered by the National Cable Television Institute (NCTI).

To qualify for the scholarship, the prospective student must be an active SCTE member and fill out a tuition assistance application (available from SCTE, 669 Exton Commons, Exton, PA 19341). After being chosen by the SCTE Scholarship Committee, the student must complete the selected course with a score of 70 percent or better within one year of the enrollment date. So far, five have successfully graduated their courses. Where were each of these students when they decided to apply for the scholarship and what are they doing now?

When he became the first recipient, David Wilhelm had been working for just over two years as a service technician at CableAmerica Corp. in Phoenix, Ariz. He had started in the industry at a Mesa, Ariz., company where, for over three years, he was a subcontractor performing pre- and post-wiring of MDUs, installation of aerial and underground cable, construction of headends, etc. So, with a great deal of hands-on experience, Wilhelm chose the NCTI's CATV Technician Course to supply him with theory and an overall knowledge of the industry. He completed the correspondence course in about seven months.

Today, Wilhelm works as a construction coordinator at CableAmerica, a higher position and a big change from his previous technician duties. What effect did finishing the course have on his career? "The NCTI course definitely helped me out in my job by giving me that overall picture of CATV I wanted. My suggestion is, if you want to excel in your job, apply for the scholarship. I highly recommend it to all," he said. Still an active SCTE member, his hopes are to some day move into a management position.

Ruben Gonzalez became the second scholarship winner in December 1986, when he had been working 2½ years at Group W Cable in Santa Cruz, Calif. He had started in the CATV industry as a customer service representative for the system with an interest in system design and engineering. While as a CSR for six months, Gonzalez took graphics classes at the local community college. He eventually became a design/field engineer, doing designing, drafting and field surveys. Like Wilhelm, he chose the NCTI CATV Technician Course for an overall understanding of operations and electronics theory. He passed that course and on his own went on to take the System Technician I course.

Nowadays, Gonzalez is a CAD (computer-aided design) drafting technician with the Office of the Assessor for the County of Santa Cruz. He's no longer in CATV and his design work consists of drafting property maps. Even though his membership in the SCTE has expired, his interest in CATV and electronics continues. Also, he is an avid amateur radio operator. His advice for those thinking of applying for tuition assistance: "I wholeheartedly recommend the SCTE Scholarship Program, as well as the BCT/E Certification Program."

When he became the third scholarship recipient in January 1987, Michael Pieson was a line/bench technician at Group W Cable in Prescott, Ariz., where he had worked for nearly four years. He had just finished night classes for an associate of applied science degree in electronics technology. His industry experience began in 1980 as an installer tech in a suburban Chicago system. He chose and completed the NCTI's CATV Chief Technician Course, which he says helped him understand and compare equipment specs cited by hardware vendors.

That was then, this is now: Pieson recently became a senior maintenance tech for Cablevision of Memphis—a major career advancement (and another relocation) for him. "As much as the industry is moving," he said, "you can never stop learning. And no matter what your experience is, it means nothing without credentials." Pieson continues to be involved in the SCTE and continuing his education. Case in point: I met him last month in Denver after he had completed the Tech I course at the ATC National Training Center. And there's no doubt of attaining his goal for more training.

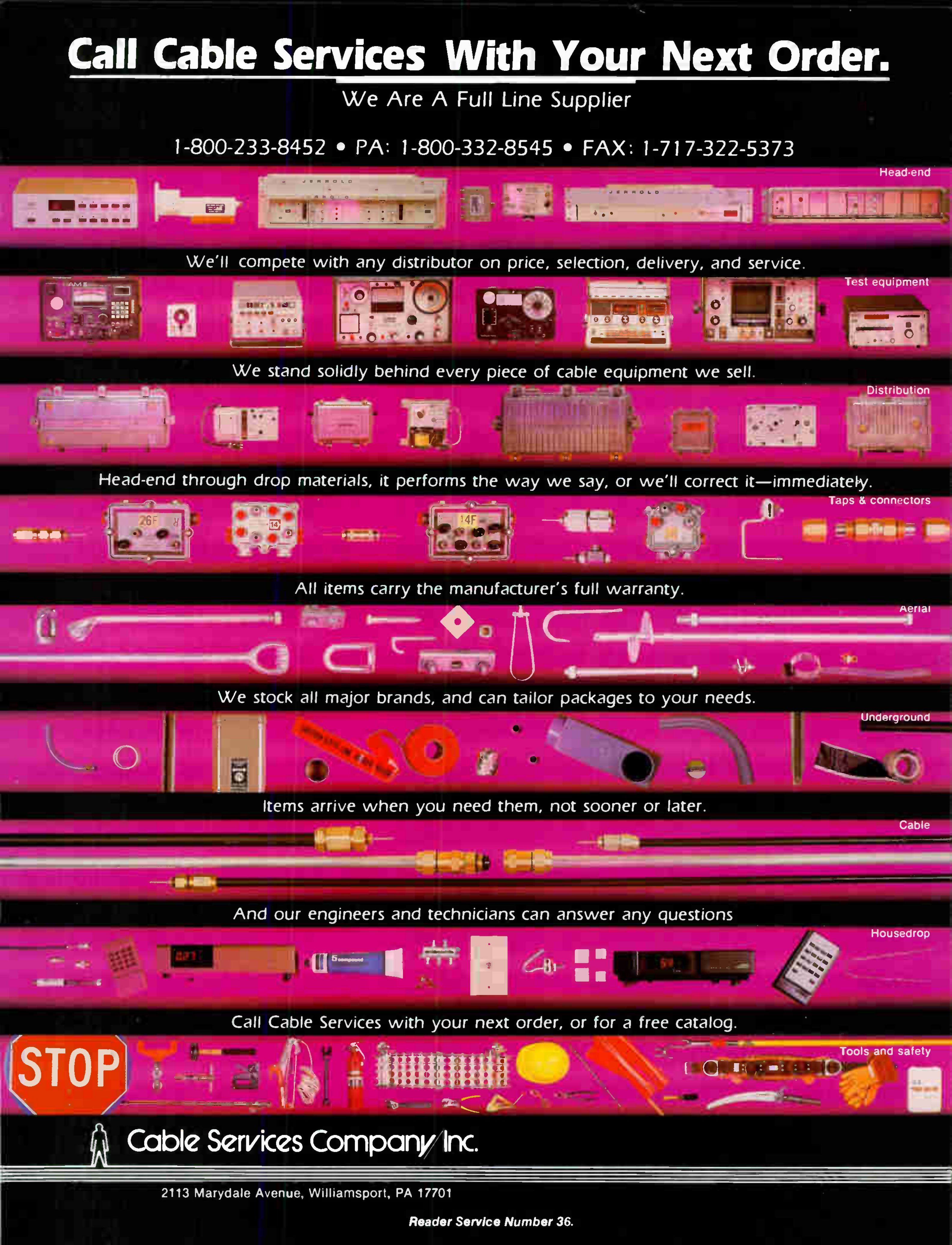
In April 1987, David Soldan became yet another scholarship recipient. At that time he was a lead technician for Lincoln Cablevision in Lincoln, Neb. Among his duties were installation, maintenance and repair of CATV headend and line equipment for several of Cablevision's systems in Nebraska. He began in the industry in 1980 as a field tech at the Lincoln system. After completing electronics training at the local community college, Soldan applied for tuition assistance and selected the NCTI's CATV Advanced Technician Course. He completed it in nine months.

Currently, Soldan is a bench technician at the same system he's been with for over eight years. "I picked up a few new things in the course, and the knowledge has definitely helped me in my job and in my future." he said. "Joining the SCTE has improved my outlook. I wasn't even aware of the Society until I read *CT*, joined and applied for the scholarship." Hence, Soldan advises his colleagues not to hesitate filling out the tuition assistance application. And what about the future? In five years Soldan plans to work on the engineering level.

Last summer, the SCTE Scholarship Committee awarded the first college course tuition assistance. The recipient was Jane Lode of Denver-based Daniels & Associates (now United Artists Entertainment), where she has worked in the engineering department for over four years. Her start in CATV began in 1980 as office manager and technical writer for Cotten & Associates Inc., a firm providing engineering and consulting services for the CATV industry. To continue her studies for an MBA, Lode chose and completed the graduate-level course "Management 6800: Consulting Skills" from the University of Colorado at Denver.

At this point you will probably agree that continuing your education, no matter where you are or what you may be doing, can make a difference in your future and that of the CATV industry. But don't take it from me; just ask any SCTE scholarship grad.

Acknowledgment: The author wishes to thank ATC's Austin Coryell of the SCTE Scholarship Committee for his help.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Zenith and compatible HDTV

By Lawrence W. Lockwood
President, TeleResources
East Coast Correspondent

In Washington, during the first two weeks of September, there was significant activity on the HDTV front. In the first week the Federal Communications Commission announced a tentative decision that outlines "fundamental policies and defines boundaries for development of Advanced Television." In the second week the House Subcommittee on Telecommunications, chaired by Rep. Edward Markey (D-Mass.), held more hearings on HDTV at which most of the major HDTV transmission system proponents presented equipment demonstrations. The two major statements by the FCC were 1) that it "will require the initial ATV/HDTV (advanced TV/high-definition TV) signals to either be compatible with existing TV (NTSC standard) receivers or that ATV broadcasters duplicate them on another channel" and 2) "if additional spectrum is needed for ATV, it can be found within the existing VHF and UHF TV bands—no additional spectrum be utilized." For HDTV/ATV transmission the new spectrum could be used to "augment" standard NTSC signals or used for "simulcasting"—i.e., one 6 MHz channel for standard NTSC TV "as is" and an additional 6 MHz (in the VHF or UHF bands only) used for simulcasting the HDTV by whatever transmission method is accepted as a standard—which most likely will be non-compatible with NTSC.

The Zenith proposal

The most notable addition to the HDTV activity at the FCC and the House subcommittee was the very interesting proposal by Zenith for an HDTV transmission system. It has significant advantages over any of the systems proposed to date.

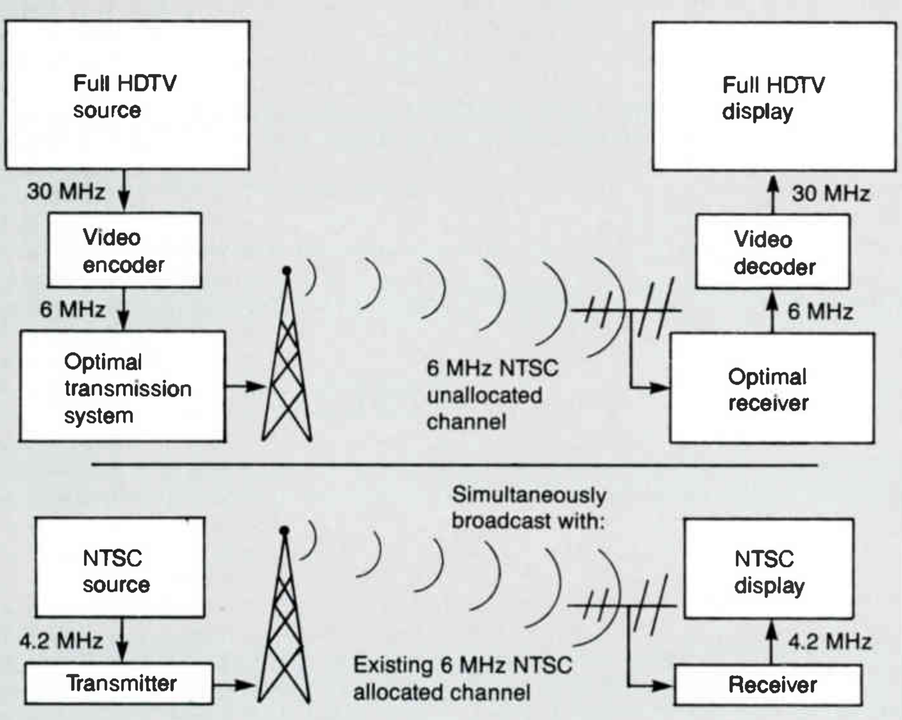
In a number of my columns in the past months, a brief outline of each of the major HDTV transmission proposals has been presented. In my May column I reviewed a scheme advanced by Professor Schreiber of MIT that, in many respects, is similar to the Zenith proposal. Zenith presented to the FCC a brief but thorough summary of its method; much of the following description of its system has been excerpted from the document.

HDTV simulcast: The Zenith system is a "simulcast" type. It would not obsolete the 160 million NTSC-standard TV sets in the public's hands today but would require an extra standard 6 MHz VHF or UHF channel to broadcast the unique method of transmission of HDTV (illustrated in Figure 1). Zenith terms its system "spectrum compatible." "The transmission system is the key," said one Zenith spokesman. "The medium—that we can utilize one additional TV channel for the additional HDTV information—is the message." The devilishly clever method of RF transmission can be accomplished with an enormous reduction of RF power—they claim less than 0.2 percent of that required by an NTSC transmitter with the same service area. This tremendous power reduction (aided by some other system features) permits *every existing NTSC broadcast station* to obtain a second 6 MHz channel over which a true HDTV program can be broadcast simultaneously with its existing NTSC program. Restrictions, or "taboos," were established by the FCC based on NTSC television receiver performance when subjected to signals on taboo channels. In most metropolitan areas, spectrum use is restricted to every other VHF channel and every sixth UHF channel. Thus, if further development and testing of the Zenith proposal confirms its engineering analyses, the required compatible spectrum (within the standard VHF and UHF frequency limits) will be available to every current TV broadcaster.

Video signal processing: The Zenith system will utilize signal processing/modulation techniques with many of the procedures outlined in May's column. Briefly, the video signal is separated into two bands—the frequencies below 200 kHz and those above 200 kHz. The video frequencies below 200 kHz are transmitted in a digital format while the video signal having frequencies above 200 kHz are transmitted in an analog format.

"The Zenith system... would not obsolete the 160 million NTSC-standard TV sets in the public's hands today."

Figure 1: Zenith HDTV system



Baseband video: For all live video the energy associated with the high-frequency components is less than 1 percent of the total energy. Virtually all of the power associated with a video signal is contained in the low-frequency information, the synchronization information (which is also low-frequency) and the average (or DC) value of the video. The spectral density of off-air NTSC video is shown in Figure 2. Except for chroma at 3.58 MHz and the sound at 4.5 MHz, the spectrum decreases exponentially with most of the energy concentrated within the first one-half MHz.

As noted, the video signal is separated into two frequency bands—illustrated in Figure 3. The high-frequency portion of the video signal is subjected to sophisticated digital signal processing and unique modulation techniques to compress the video base bandwidth of HDTV enough to permit its broadcast in a standard 6 MHz channel. The low-frequency band signal is digitized and then digitally encoded for transmission. A low bit rate is adequate to represent this signal because of its narrow bandwidth. The digital data, which includes the low-frequency video, synchronization information, two channels of CD quality audio, captioning and error correction is transmitted during the vertical blanking interval (VBI). The spectrum of the processed video signal, with the low-frequency band removed, is shown in Figure 4. This signal is then combined with the digitally represented low-frequency band, which results in a transmitter signal that has a flatter spectrum and *greatly* reduced power.

Quad mod: The information-carrying capacity of the 6 MHz channel is maximized by use of in-phase (I) and quadrature (Q) modulation of a suppressed carrier located in the center of the band in a manner quite similar to that used for color modulation in NTSC. It is illustrated in Figure 5. A sophisticated digital processing scheme is used to compress the approximately 30 MHz video into two signals (I and Q) for the suppressed-carrier balanced modulator.

The Zenith proposal can accommodate various scan rates but the video encoding scheme presented to the FCC would have the HDTV scan rate a multiple of NTSC; i.e., 525, 787.5, 1,050, etc. Such NTSC-related scan rates permit interleaving the HDTV signal to any existing co-channel NTSC and thereby minimizes interference with any existing TV transmission. Also, since the data in the vertical interval of the HDTV signal (low-frequency video, sync and audio) will be the most visible interference, frame locking will hide that interference in the vertical interval of the NTSC channel.

Zenith has developed additional signal processing steps that further reduce interference. Some of these technologies are familiar in transmission engineering, e.g., pre-emphasis and companding. However, Zenith has borrowed a modulation technique from radar known as "chirping." Because of the low-frequency removal, peaks in the transmitted analog signal only occur as pulses. Chirping (also known as *time dispersion*) is a technique used to expand narrow pulses to wide pulses (while reducing their amplitude) for *transmission* and to compress the wide *received* pulses to the original narrow pulse width and wave shape (and restoring their amplitude). This improves the SNR (signal-to-noise ratio) without signal degradation, and the reduction in transmitted peak power produces a corresponding reduction in the interference that the HDTV signal can cause. The improvement in the received SNR is achieved (as in radar) because chirping spreads in time and reduces the magnitude of received noise components. The chirp filters used to compress and expand the signals are usually made of SAW (surface acoustic wave) materials that Zenith has had extensive successful experience using in its digital TV set manufacture.

As noted, Zenith recommends that the scan rate (lines/frame) be related to the NTSC rate and in its proposal Zenith presented a system with a rate of 1.5 times NTSC (787.5 lines/frame) using progressive scanning. Progressive scanning eliminates interlace; i.e., no alternate interlaced fields but a full 787.5 line frame scanned over one-sixtieth of a second. Progressive scanning will

Figure 2: Off-air NTSC video

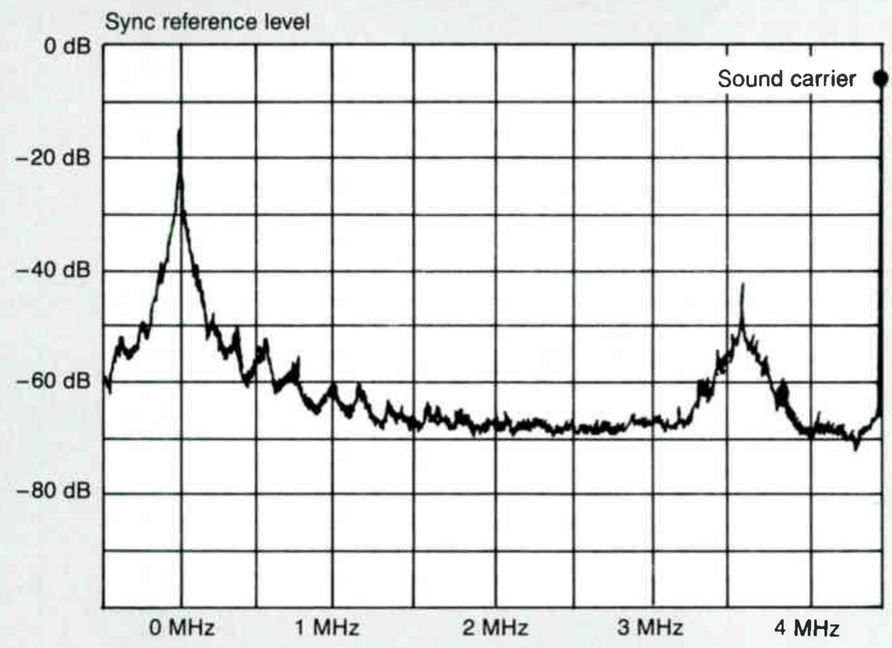


Figure 3: Separation of video into two frequency bands

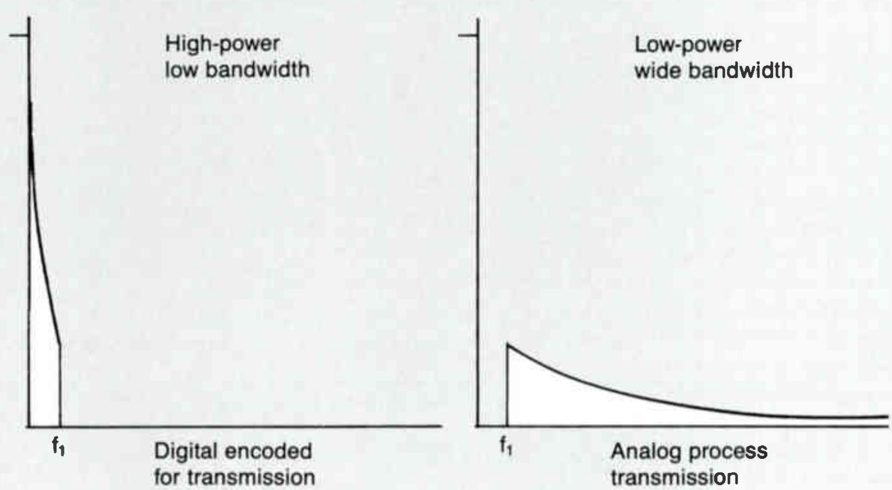
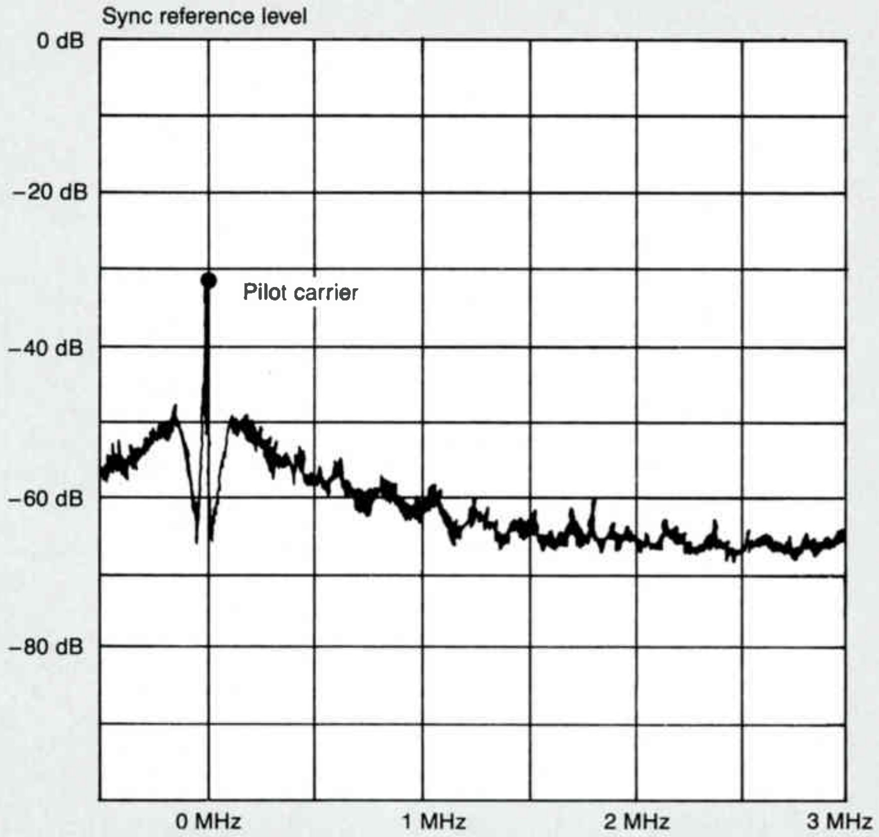


Figure 4: Video with low frequencies removed



increase vertical resolution over that of interlaced scanning. The sophisticated digital signal processing required to reduce the bandwidth contains a component multiplexer to produce the two signals that modulate the in-phase (I) and quadrature (Q) RF carriers. Since the HDTV scan rate is related to the NTSC rate, the video encoding produces two processed video component signals at a multiple of NTSC rates. A pictorial of the components that modulate the I and Q carriers is shown in Figure 6.

Each signal starts with two lines of synchronization (for digital clock) and 20 lines of four-level data. This is then followed by a group of 240 lines of analog components, two more synchronizing lines, 21 lines of four-level data and finally a second group of 240 lines of analog components.

Values and investments

Zenith presented values for a typical example of a TV transmission installation. The typical NTSC UHF high-power installation delivers 5 megawatts ERP (effective radiated power), using an antenna gain of 16 dB (40/1 power) and transmitter power of 125 kW. This requires 240 kW of AC power. The annual power bill for such a transmitter operating for 18 hours a day, seven days a week, 52 weeks a year at $0.12/kW-hour is $189,000.

The average power required for the HDTV proposal consists of three components, namely the VBI data, pilot carrier (for carrier regeneration in the receiver) and analog video high frequencies. Each of these components are approximately 32 dB less (1,600/1 power reduction) than an equivalent NTSC video signal sync peak. This results in a 533/1 (27 dB) power reduction. The HDTV transmitter average power requirements using the same antenna gain is 225 watts, or with a 10 dB antenna gain the power requirement is 1 kW. The annual power bill in this case is only $786.

In his testimony before the House subcommittee, Jerry Pearlman, chairman of Zenith, presented an unvarnished view of the economics of the future of HDTV and electronics in this country. He said, "There is still a lot of research and engineering work to be done to get true, second-stage broadcast HDTV. And this will take significant investments. We strongly urge the government to fund such an effort in domestic engineering labs for implementation in domestic factories—because, sadly, the domestic color television industry can no longer afford the investments."

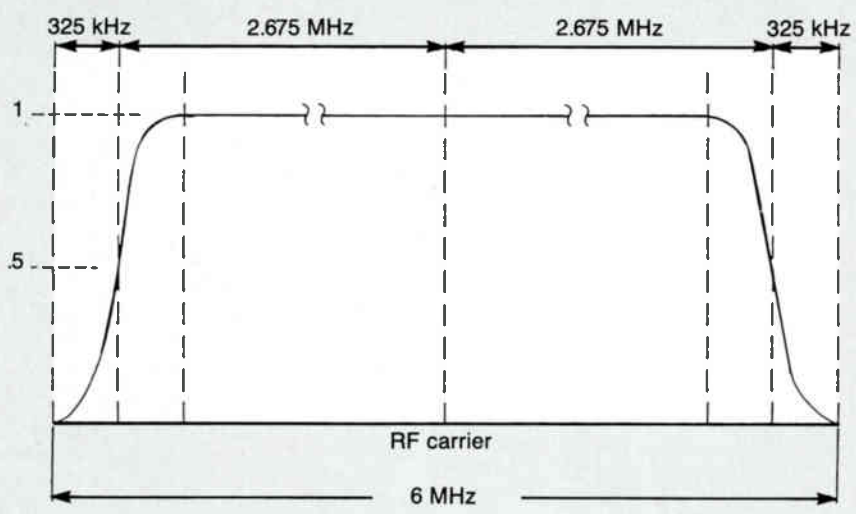
Betrayal in high places

In this column in the past months, I have deplored the betrayal of the U.S. television industry—a betrayal by the very industry management entrusted with its protection and advancement. This perfidy was achieved by financial management addicted to immediate bottom-line gratification. An example of the abandonment of national treasures is the action of General Electric headed by CEO John Welch. GE bought RCA and destroyed for the United States the TV portion of the business—the very company that led the engineering and business development of black-and-white TV and subsequently the same for color TV. GE sold off the TV manufacturing business—to a *foreign* company, at that—and then gave away the laboratories that were the birthplace for so much of the industry. GE is not the only company guilty of this national disgrace—all other U.S. TV manufacturers (with the exception of Zenith—who at the time of this writing is under attack in a hostile takeover attempt) also have abandoned their capabilities (most also to foreign companies).

Possible rescue of U.S. electronics

Rep. Markey suggested at the hearings that the real issue regarding HDTV's future in the United States may now be whether the new technology will simply result in America shipping "billions of dollars and thousands of jobs overseas—what is at stake? Perhaps the very future of the U.S. electronics industry." This sweeping statement is justified because each HDTV set will require lots and lots of semiconductor chips—

Figure 5: Overall channel shape

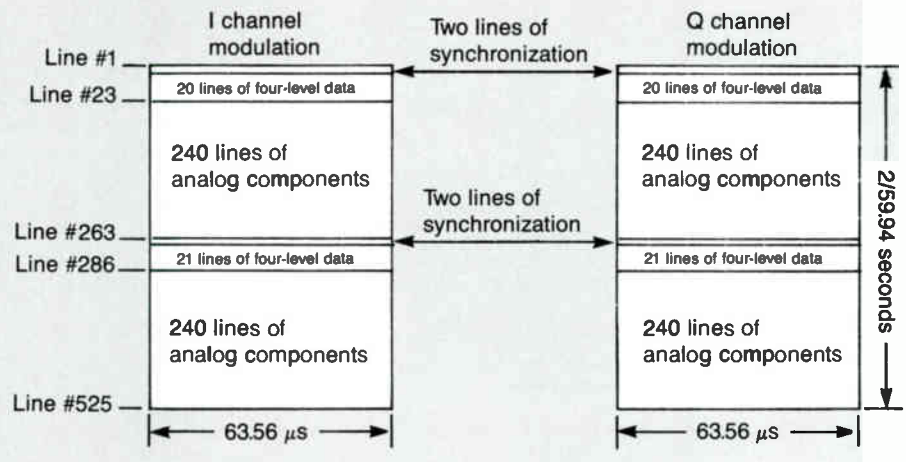


e.g., much memory, many microprocessors, etc. The total manufacturing volume for this solid-state material will be *enormous* because of the size of the consumer market. Thus, the ripple effect (more accurately a tidal wave) of the requirements of HDTV into the semiconductor market would have immense consequences—even endangering our national security since it would be calamitous to force our military to depend on foreign manufacturers.

Many foreign countries have not been as foolishly lavish in giving (or licensing) away developments made in their own countries as we have. As an example, American companies have done better in protecting the fiber business than the electronics business largely due to Corning's solid patent position. In October 1987 Corning's lawyers won a court decision that stopped Sumitomo, the Japanese fiber maker that has tried the hardest to penetrate the U.S. market.

Zenith's Pearlman has suggested that in this country "the vehicle for development may already exist at Sematech." Sematech is a government-approved manufacturing research consortium funded one-half by the federal government and one-half by the 14 member companies (most of which are competing U.S. semiconductor suppliers). Incidentally, that funding totals over 1 billion dollars for the next five years, or $200 million a year. Pearlman added that a string should be attached to any federally aided developments—"Royalities should be high for sets with high offshore content or made by companies that did not contribute major efforts from their laboratories." AEA (American Electronics Association) President Dick Iverson suggested that perhaps this consortium might be called "Consumertech," but it is likely that, as in Sematech, no developments produced by a federally aided consortium would be allowed to be used by any other than the active contributing members of the consortium. This sort of protection for U.S. funded advancements is a far sounder approach than prohibitive tariffs, such as those resulting from the disastrous 1930 Smoot-Hawley tariff act.

Figure 6: Modulation on I and Q channels



Conclusions

The Zenith proposal for HDTV transmission is so promising it demands further work. As Richard Wiley, a past chairman of the FCC and the current chairman of the FCC Advisory Committee on ATV, said recently, "The Zenith proposal must be tested to confirm their engineering analyses." Should these tests, and possible further developments, prove out as well as the engineering analyses indicate, the United States may well have found its HDTV transmission system.

Oscillator phase noise: A follow-up

This is an update to the article "Oscillator phase noise and its effects in a CATV system," which appeared in last month's issue.

By Dan Pike
Vice President of Engineering, Prime Cable
And Rezin Pidgeon
Principal Engineer, Scientific-Atlanta

First published in the *1988 NCTA Technical Papers*, last month's article described some of the work being done by Group 1 of the National Cable Television Association Engineering Committee's HDTV Subcommittee. The portion of the paper summarizing the conclusions reached by the committee is given here to help technical personnel determine if phase noise is visible in a particular circumstance. (Phase noise associated with FM links is described by Gerald Robinson in another 1988 NCTA paper, "The effects of phase noise in an FM video link.")

Summary of conclusions

Phase noise is another source of system noise in a CATV system that could result in a discernible amount of noise in the final TV display but should not be noticeable in systems with a signal-to-noise ratio (SNR) of 45 dB or worse. A general discussion of oscillator phase noise was presented and equations given for the case in which the noise spectrum decreases at a 6 dB/octave rate from the carrier. Simple equations enable one to calculate the video SNR from measurements of the phase noise spectrum. Actually, the RF carrier spectrum may vary to a large extent from the assumed 6 dB/octave rolloff, but an understanding of the principles discussed will help in evaluating and determining the effects of phase noise.

Phase noise is distinguished from thermal noise by its low-frequency character. Generally, demodulated phase noise decreases slowly to approximately 1 MHz and follows the rolloff in the RF spectrum above that. An examination of the video spectrum will show if the noise caused by phase modulation of the carrier is significant.

Phase noise, if excessive, appears in a TV display generally in low luminance and highly color saturated areas. Phase noise appears different from thermal noise due to its higher low-frequency content. Phase noise does not appear as granular as thermal noise and shows some low-frequency streaking.

A baseline for phase noise measurement is the sideband level of the unmodulated carrier at 20 kHz offset and in a 1 kHz bandwidth. For an RF carrier with sidebands that generally decrease 6 dB/octave, the weighted SNR due to phase noise sidebands is approximately equal to the sideband level thus measured. Also, if the phase noise spectrum intercepts the thermal noise floor (measured in the same IF bandwidth) below approximately 1.5 MHz, thermal noise is likely to predominate. If it intercepts above approximately 1.5 MHz, phase noise is likely to predominate. These are simple tests that should help the operator realize whether phase noise is likely a problem.

Perceptibility tests are reported in which a video carrier is noise modulated with modulation bandwidth approximately 250-500 kHz. In these tests, phase noise became perceptible at a level of about −52 to −56.5 dBc (measured 20 kHz from the carrier in a 1 kHz bandwidth). Video SNR without added phase noise was 54 dB or better. In a similar test with an oscillator with 4 MHz modulation bandwidth, phase noise became perceptible at −62 dBc. With thermal noise increased to make weighted SNR equal to 46 dB, phase noise became perceptible at a sideband level of −50 dBc.

Synchronous detectors respond the same as envelope detectors or quasi-synchronous detectors to low levels of phase noise. Above a threshold narrow band synchronous detectors are much more sensitive to phase modulation and are particularly sensitive to low-frequency noise. High-frequency phase noise (above 10 kHz) is not expected to be a problem for tracking bandwidths 10 kHz or greater, but low-frequency, high deviation noise can cause PM-to-AM conversion in the detector.

Using traps in the broadcast tier

By Renee Louise
Technical Consultant
And Glyn Bostick
President, Microwave Filter Co. Inc.

For strategic reasons having to do with copyright, some CATV systems need to provide subscribers with special trap networks for "cherry picking" programming corresponding to off-air channels. Typical service requirements call for enclosure in a locked box that is weatherproof and capable of being mounted on the house or on the pole. This is usually the highest cost component of such a network, since many channel cherry-picking menus can be managed with correct selection of pay TV and tiering filters. The accompanying photos reveal typical housed networks.

Figure 1: Filter network

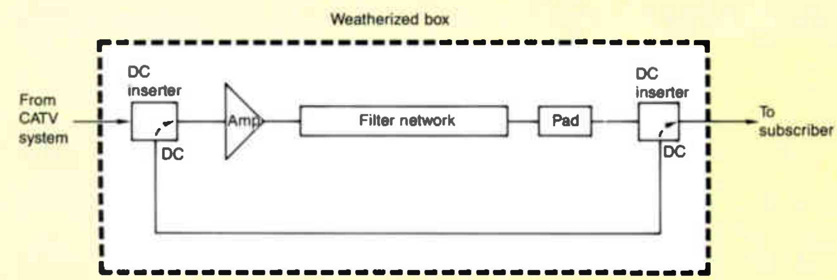
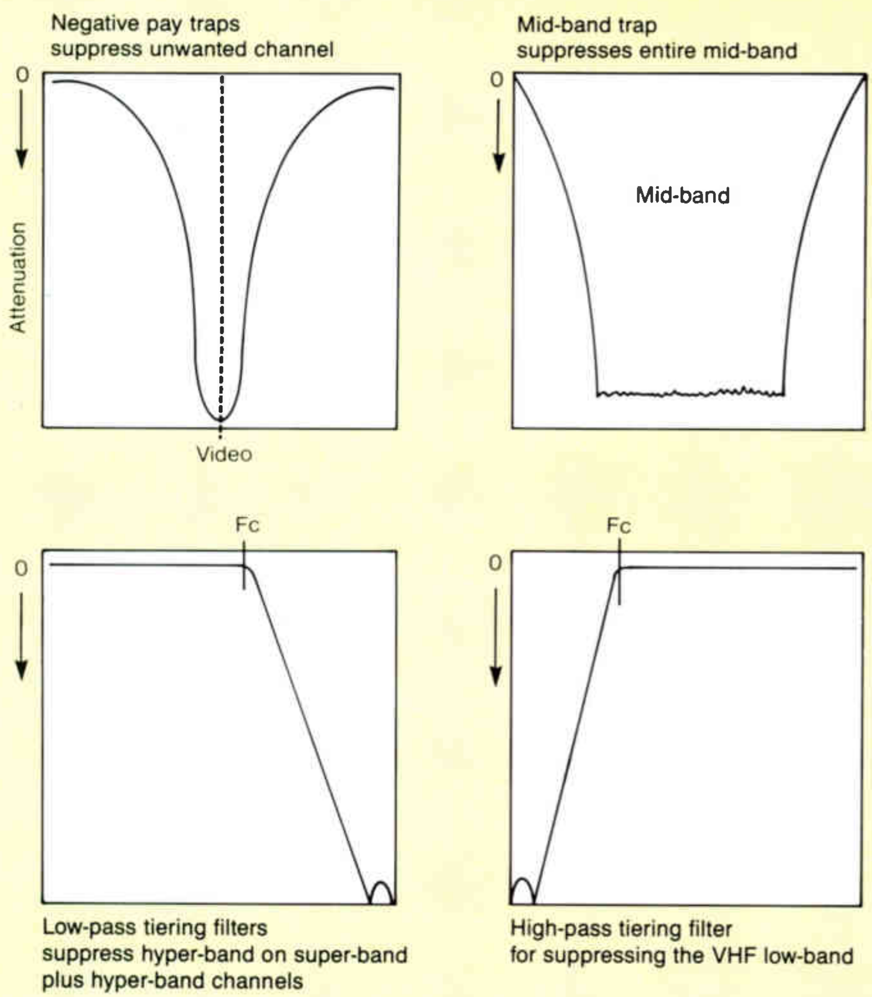
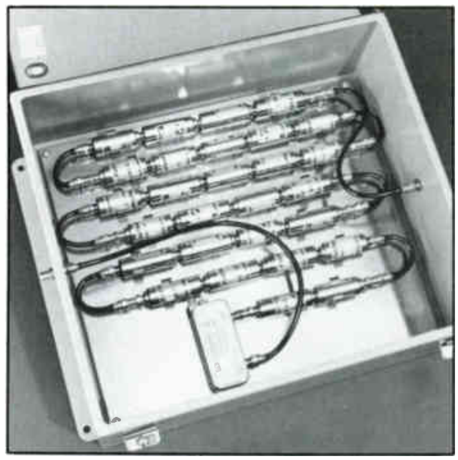


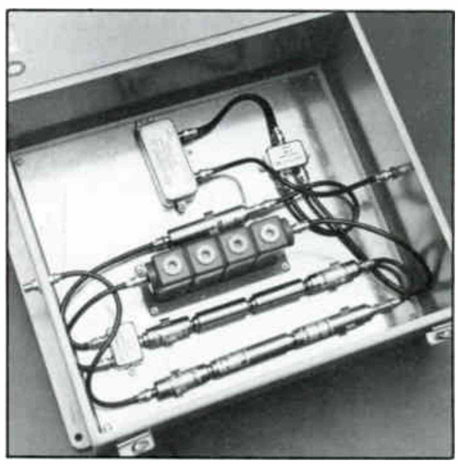
Figure 1 shows the basic filter network. Networks differ only in specific filters required to satisfy the off-air channel selection. An amplifier is placed ahead of the filters to counter their combined through-loss and to enhance the noise figure of the subscriber receiving system. The most suitable amplifiers are broadband models with provisions for powering through the coaxial cable. Power inserters can be used within the network and at the subscriber's set. A standard AC/DC inverter should be installed on a wall plug near the TV set. A pad may be necessary within or following the filter combination so that the sum

Figure 2: Trap responses





Typical multitrap assembly. The subscriber-powered amplifier counters cumulative trap loss.



This multichannel trap assembly uses a special bandpass filter to isolate a desired super-band channel.

"Networks differ only in specific filters needed to satisfy the off-air channel selection."

of losses equals the gain of the nearest standard amplifier.

A given network is usually specified in terms of "channels to be viewed"—corresponding to off-air acquired channels. Appropriate filters are then selected to suppress all other channels. In general, the more broadband the CATV system, the larger the number of individual filters in the network.

Network building blocks

Most filter networks can be assembled from pay TV traps and tiering filters available from a number of security hardware manufacturers. Temperature stability and moisture sealing are standard industry features. Figure 2 shows the response types most readily available.

Figures 3 and 4 illustrate special arrangements to minimize the number of individual channels traps when there is a single desired channel in the mid-band or super-band. Two 3 dB splitters surround a bandpass filter for the desired channel. The appropriate tiering filter is added to allow passage of the rest of the TV spectrum.

Figure 3: Channel isolation for super-band

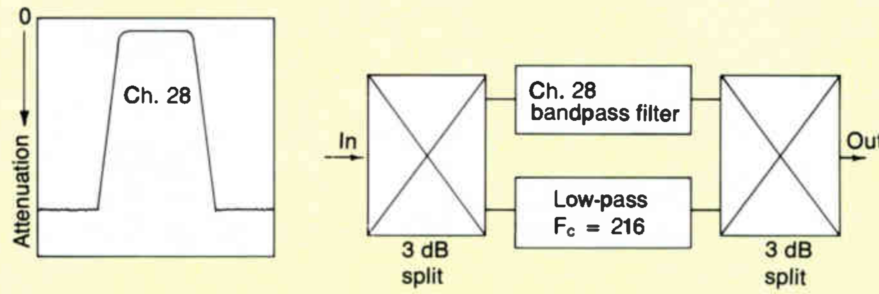
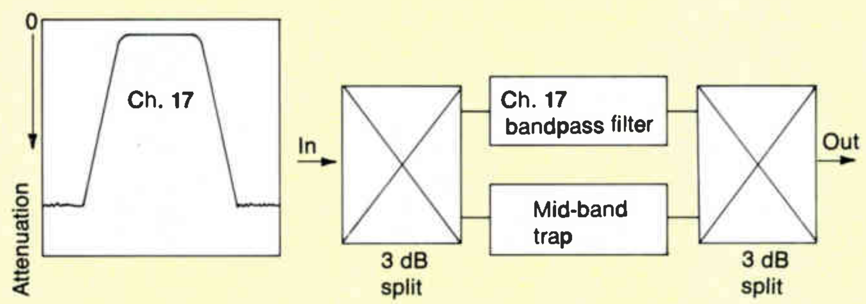


Figure 4: Channel isolation for mid-band



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Fiber-optics glossary

By Hal Williams
Jones Intercable Inc.

This is the second installment of a three-part series defining important terms in fiber optics, arranged in alphabetical order.

H

helium-neon laser (HeNe)—The most commonly used gas laser. It can be operated continuously in the red, infrared and far-infrared regions, emitting highly monochromatic radiation.
hertz (Hz)—A unit of frequency equivalent to one cycle per second.
heterojunction—A junction between semiconductors that differ in their doping level conductivities and also in their atomic or alloy compositions.
homojunction—A junction between semiconductors that differ in their doping level conductivities but not in their atomic or alloy compositions.

I

ILD—See *injection laser diode.*
incandescence—The emission of light by thermal radiation of temperature high enough to render the source of radiation visible.
incidence—Flux incident per unit area on a surface. Symbol: **E**.
incident ray—A ray of light that falls upon or strikes the surface of an object.
incoherent light—Light made up principally of non-parallel rays and lacking a fixed phase relationship.
index matching material—A material, often a liquid or cement, whose refractive index is nearly equal to the core index, used to reduce fresnel reflections from a fiber end-face.
index of refraction—1) the *relative* index of refraction is a fraction or ratio of the velocity of light in one medium compared to the velocity of light in another medium. 2) The *absolute* index of refraction is a fraction or ratio of the velocity of light in a given medium compared to the velocity of light in a vacuum. (Since air is so thin, it is convenient to consider the velocity of light in air the same as its velocity in a vacuum.)
infrared—Those wavelengths that extend beyond 770 nanometers. Infrared is used extensively in the transmission of light through optical wavelengths. These light wavelengths are invisible to the naked eye.
infrared detector—A device used to detect radiation in the infrared region. It may be a thermal detector, such as a bolometer or thermocouple, or a solid-state photon detector.
infrared-emitting diode (IRED)—A diode capable of emitting radiant energy in the infrared region of the spectrum, resulting from the recombination of electrons and holes.
injection laser diode—A solid-state semiconductor device consisting of at least one PN junction capable of emitting coherent or simulated radiation under specified conditions.
insertion loss—The total optical power loss caused by the insertion of an optical component such as a connector, splice or coupler.
integrated circuit—Multiple, interconnected circuit elements, contained on or in a common substrate, that function as a unit.
intensity—The square of the electric field amplitude of a light wave. Intensity is proportional to irradiance and may be used in place of the term "irradiance" when only relative values are important.
interference—In optics, the interaction of two or more beams of coherent or partially coherent light.
intrinsic joint loss—That loss, intrinsic to the fiber, caused by fiber parameter (e.g., core dimensions, profile parameter) mismatches when two non-identical fibers are joined.
inverse square law—The law stating that the incidence from a point source varies as the inverse square of the distance between the source and the receiver.
ion—An atom that has gained or lost one or more electrons and, as a result, carries a negative or positive charge.
IR—Abbreviation for *infrared.*
irradiance—Radiant power incident per unit area upon a surface, expressed in watts per square meter. "Power density" is colloquially used as a synonym.
isolator—Another name for *optoelectronic coupler.*

J

junction diode—A seminconductor diode that conducts current more easily in one direction than the other.

K

kilo—A prefix in the SI system meaning 1,000 (1×10^3). Abbreviated k.
kinetic energy—Energy due to motion.

L

Lambert's cosine law—The statement that the radiance of certain idealized surfaces, known as lambertian radiators, lambertian sources or lambertian reflectors, is independent of the angle from which the surface is viewed. The radiant intensity of such a surface is maximum normal to the surface and decreases in proportion to the cosine of the angle from the normal. Synonym: *cosine emission law.*
laser (light amplification by stimulated emission of radiation)—A coherent light source capable of producing intense radiation in the form of a collimated beam.
laser cavity—An optical resonant structure in which lasing activity occurs when multiple reflections accumulate electromagnetic intensity.
laser diode—Synonym for *injection laser diode.*
laser pump—A term applied to a flash tube used to excite the atoms of a crystal or glass-rod laser.
lasing condition (or state)—The condition of a laser corresponding to the emission of predominantly coherent or stimulated radiation.
lasing medium—The material within a laser that emits coherent radiation as a result of stimulated electronic transitions to lower energy states.
lasing threshold—The lowest excitation level at which a laser's output is dominated by stimulated emission rather than spontaneous emission.
lateral offset loss—A power loss caused by transverse or lateral deviation from optimum alignment of source to optical waveguide, waveguide to waveguide or waveguide to detector. Synonym: *transverse offset loss.*
launch angle—The angle between the light input propagation vector and the optical axis of an optical fiber or fiber bundle.
LED—See *light-emitting diode.*
light—1) In a strict sense, the region of the electromagnetic spectrum that can be perceived by human vision, designated the visible spectrum and nominally covering the wavelength range of 0.4 μm to 0.7μm. 2) In the laser and optical communi-

cation fields, custom and practice have extended the use of the term to include the much broader portion of the electromagnetic spectrum that can be handled by the basic optical techniques used for the visible spectrum. This region has not been clearly defined but most workers in the field consider it to extend from 0.3 μm, through the visible region, and into the mid-infrared region to 30 μm.

light detector—An output device, such as a PIN photodiode, that detects light and then converts it into an electrical output that is a useful facsimile of the original information.

light-emitting diode (LED)—A PN junction semiconductor device that emits incoherent optical radiation when biased in the forward direction.

light guide—An assembly consisting of a number of optical fibers mounted in a component that is used solely to transmit light flux.

light leakage losses—Losses due to imperfections at the core/cladding boundary.

light pipe—See *light guide*.

light quantum—Another name for *photon*.

light ray—The path of a point on a wavefront. The direction of a light ray is generally normal to the wavefront. See also *geometric optics*.

light sensor—A generic term for light-to-electricity transducers, such as photocells, photodiodes, phototransistors and light-activated SCRs.

light source—A generic term including all sources of visible radiation from burning materials to ionized vapors and lasers.

longitudinal offset loss—See *gap loss*.

lumen—Abbreviated lm. Unit of luminous flux; a uniform point source of one international candle emits one lumen in a unit solid angle.

luminous energy—Radiant energy transmitted as visible light. The unit of measurement is the talbot. Symbol: Q_v.

luminous exitance—Luminous flux per unit area leaving a surface. Symbol: M_v.

luminous flux—Luminous energy per unit time. Unit of measurement is the lumen (lm). Symbol: Φ_v.

luminous incidence—Luminous flux per unit area on a surface. Unit of measurement is lux (lx). Symbol: E_v

luminous intensity—Luminous flux per unit solid angle. Unit of measurement is candelas (cd). Symbol: I_v.

luminous sterance—Luminous flux per unit solid angle and per unit area of emitting surface measured normal to the direction of flux propagation. Measured in candelas per square meter. Symbol: L_v.

lux—Abbreviated lx. SI unit of luminous incidence equal to one lumen per square meter.

M

macrobend loss—In an optical waveguide, that loss attributable to macrobending. Macrobending usually causes little or no radiative loss. Synonym: *curvature loss*.

macrobending—In an optical waveguide, all large, gradual deviations of the axis from a straight line; distinguished from *microbending*.

material dispersion—That dispersion attributable to the wavelength dependence of the refractive index of material used to form the waveguide. Material dispersion is characterized by the material dispersion parameter M.

material scattering—In an optical waveguide, that part of the total scattering attributable to the properties of the materials used for waveguide fabrication.

mechanical splice—A fiber splice accomplished by fixture or materials, rather than by thermal fusion. Index matching material may be applied between the two fiber ends.

mega—A prefix in the SI system meaning 1 million (1×10^6). Abbreviated M.

micro—A prefix in the SI system meaning one-millionth (1×10^{-6}). Abbreviated μ.

microbend loss—In an optical waveguide, that loss attributable to microbending.

microbending—In an optical waveguide, sharp curvatures involving local axial displacements of a few micrometers and spatial wavelengths of a few millimeters. Such bends may result from waveguide coating, cabling, packaging, installation, etc. Microbending can cause significant radiative losses.

micrometer—A unit of length in the SI system equal to 10 meters. Replaces the still widely used term *micron*. Abbreviated μm.

micron—Same as *micrometer*.

milli—A prefix in the SI system meaning one-thousandth (1×10^{-3}). Abbreviated m.

mode (or modal) distortion—Synonym for *multimode distortion*.

monochromatic—Consisting of a single wavelength or color. In practice, radiation is never perfectly monochromatic but at best displays a narrow band of wavelengths.

monomode optical waveguide—Synonym for *single-mode optical waveguide*.

multifiber cable—An optical cable that contains two or more fibers, each of which provides a separate information channel.

multifiber joint—An optical splice or connector designed to mate two multifiber cables, providing simultaneous optical alignment of all individual waveguides. Optical coupling between aligned waveguides may be achieved by various techniques including proximity butting (with or without index matching materials) and the use of lenses.

multimode distortion—In an optical waveguide, that distortion resulting from differential mode delay.

multimode effect—An effect that results from the time difference required in different rays to traverse the length of a multimode fiber. Axial rays will have the shortest path length and thus be transmitted in the least time. Rays entering the fiber at the maximum acceptance angle will require the maximum time.

multimode fiber—Optical fibers with relatively large core diameters compared to single-mode fibers. The core diameter of multimode fibers can range from 25 to 200 microns.

multimode optical waveguide—An optical waveguide that will allow more than one mode to propagate.

N

n—a symbol used to represent refractive index.

NA—Abbreviation for *numerical aperture*.

nano—A prefix in the SI system meaning 1×10^{-9}. Abbreviated n.

near-infrared—The shortest wavelengths of the infrared region, falling just below the visible spectrum.

near-ultraviolet—The longest wavelengths of the ultraviolet region, falling just above the visible spectrum.

normal—An imaginary line perpendicular to a surface used to determine incident, reflective and refractive angles.

numerical aperture—The numerical aperture (NA) of an optical fiber defines a characteristic of the fiber in terms of its acceptance of impinging light. The degree of openness, light-gathering ability and acceptance cone are all terms describing this characteristic. The light accepted by a fiber, in air, has a definitive relationship with the combinations of core and cladding construction of the fiber.

Outage management

This is the final installment of a three-part series on minimizing service interruptions. This month discusses real-time management of outages.

By Roy Ehman
Director of Engineering, Jones Intercable Inc.

As the title of this series states, outages have to be managed; this in turn means we have to have a plan. This plan must be written and explained very carefully and a copy left with the dispatcher(s) and CSR(s). (The term "dispatcher" will be used to include CSRs.) The role of dispatcher tends to be greatly underestimated by many systems. Dispatchers should be hired with a modicum of technical knowledge or given suitable training. Audio/visual buffs and amateur radio operators, for example, are potentially good material and frequently available. They also should be drawn from people who live on the system and are familiar with the topography and layout of the area.

After all, even a modest system of 5,000 subscribers at $2,000 a sub is worth $10 million and is very technical. Many of us lock the place up at 5 or 5:30 p.m. and walk away from our two biggest assets—our plant and our customers, leaving the latter to depend on a possibly indifferent if not unsatisfactory answering service that loses messages and never seems to understand the difference between an outage and a single-subscriber call.

Extended dispatch hours are greatly desired. The argument that there are little or no calls after the system's normal closing time and that there is therefore nothing for the dispatcher to do is simply not valid. First, such a system has probably trained its subscribers through long habit to accept the fact that there is little or no competent attention available after, say, 6 p.m. Apart from that there is plenty for the dispatcher to do. The dispatcher should be monitoring and TASO-logging all channels and signals carried by the system at hourly intervals, writing up or entering the day's leakage logs into the computer, organizing tomorrow's calls and handling customer PR callbacks in the early evening until 9 p.m.

We are talking here about peak viewing hours, which many of us walk away from. If customers know they can get real answers they would be more inclined to place inquiries leading to possible orders for more services during the early

Figure 1: Skeleton map

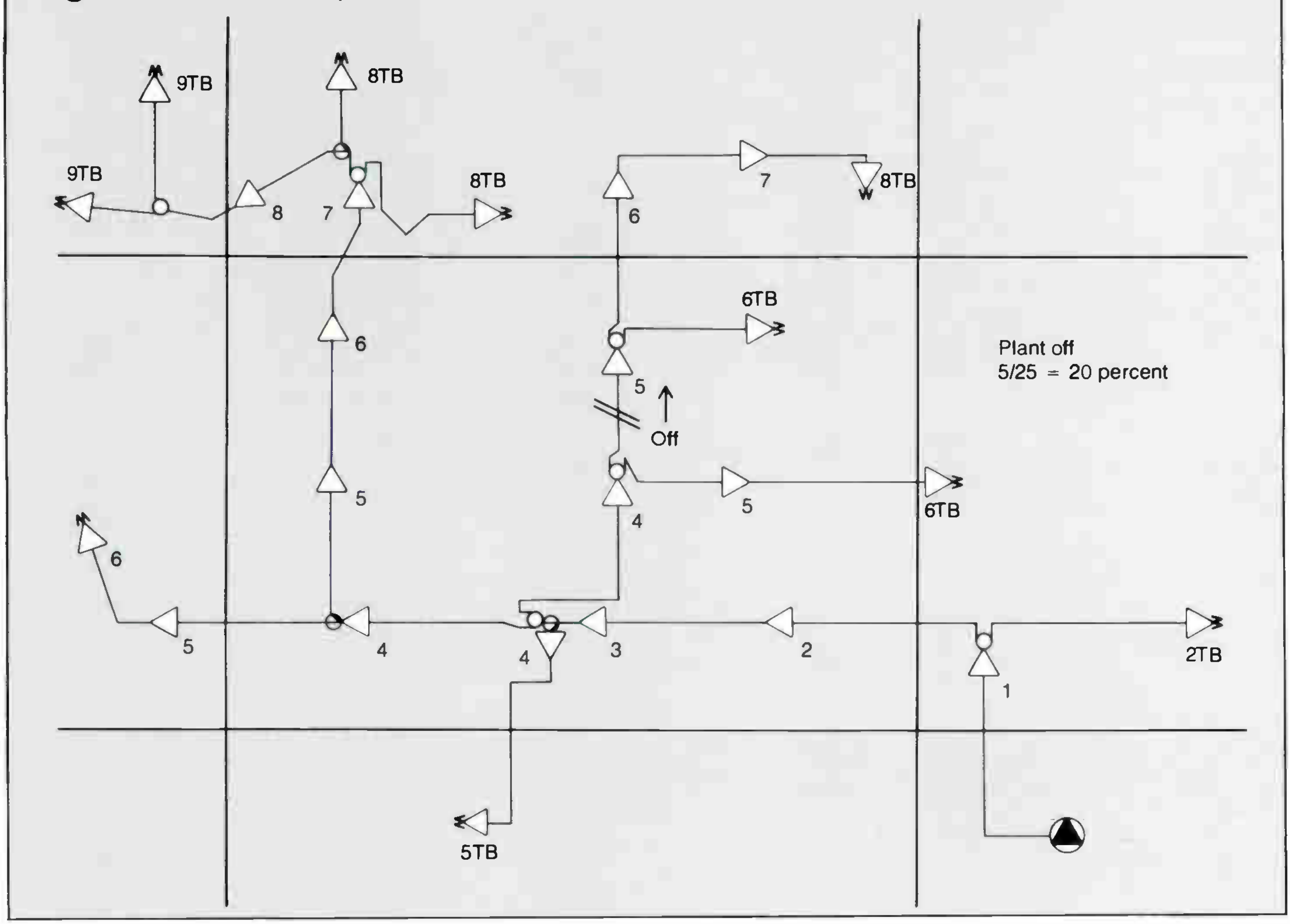


Figure 2: System operation log

Month ____________

Major/minor   Outage/impairment   No.: ____________

A) End time:	Date:
B) Start time:	
C) Duration: (minutes)	Duty dispatcher:
D) Number of amplifiers off:	
E) Total plant amplifiers:	Outage tech:

$\frac{C \times D}{E}$ = F (Outage time normalized to 100 percent plant equivalent = ____________ F) ____________ (minutes)

Notification times:	Chief technician notified:
Technician dispatched:	Additional manpower:
Time manager notified:	
Specify additional techs:	

Locations: ____________

Cause: ____________

Equipment documentation by serial number/location: ____________

If over one hour suggest possible ways to reduce future downtime: ____________

Signed ____________   Signed ____________
Date ____________   Date ____________
Manager

Major outage = trunk; minor outage = distribution
Major impairment = almost unwatchable   Minor impairment = noticeably degraded
Missing/wrong program, blank screen, white noise, no audio = major impairment

"Every service vehicle should be equipped...as though this was the only available outage team and it had to repair any kind of outage."

evening when they are at home and relaxed and interested in more and better entertainment. (I hope we have now justified the presence of a company dispatcher until at least after the late evening news.)

The point is that we now have someone who can immediately handle outages or any other company problem from a company perspective by taking the appropriate actions and/or calling the appropriate people based on an understanding of the outage management plan or any other instructions. The exact nature of the plan will depend on system size and condition and the owner's inclinations. There is no one exact plan. The important thing is to have a written procedure and refine it from time to time in the light of experience based on the outage post-mortems and balancing top-line service against cost. Just to get a feel for the type of things that need to be addressed to get the outage turnaround time minimized, the accompanying sidebar shows how this could possibly look in memo form. Remember, it is only an example.

This is by no means the ultimate plan but you will see that the necessary actions at the various time intervals are specified—lines of communication are opened and maintained—no time is wasted on side issues and everyone "keeps their eye on the ball" until 15 minutes after the outage is cleared. On major outages and any that last over the system "target" duration (in the previous case, one hour) it is desirable to analyze any of the time-consuming tasks, not for the purpose of finding a scapegoat but to see how future performance could be improved.

Did the tech take too long to get to the outage location? Maybe he had to drive across town in peak traffic, in which case, going with "zone techs" may help. Did the tech take too long to isolate the problem? Maybe more training on the plant simulator board is needed.

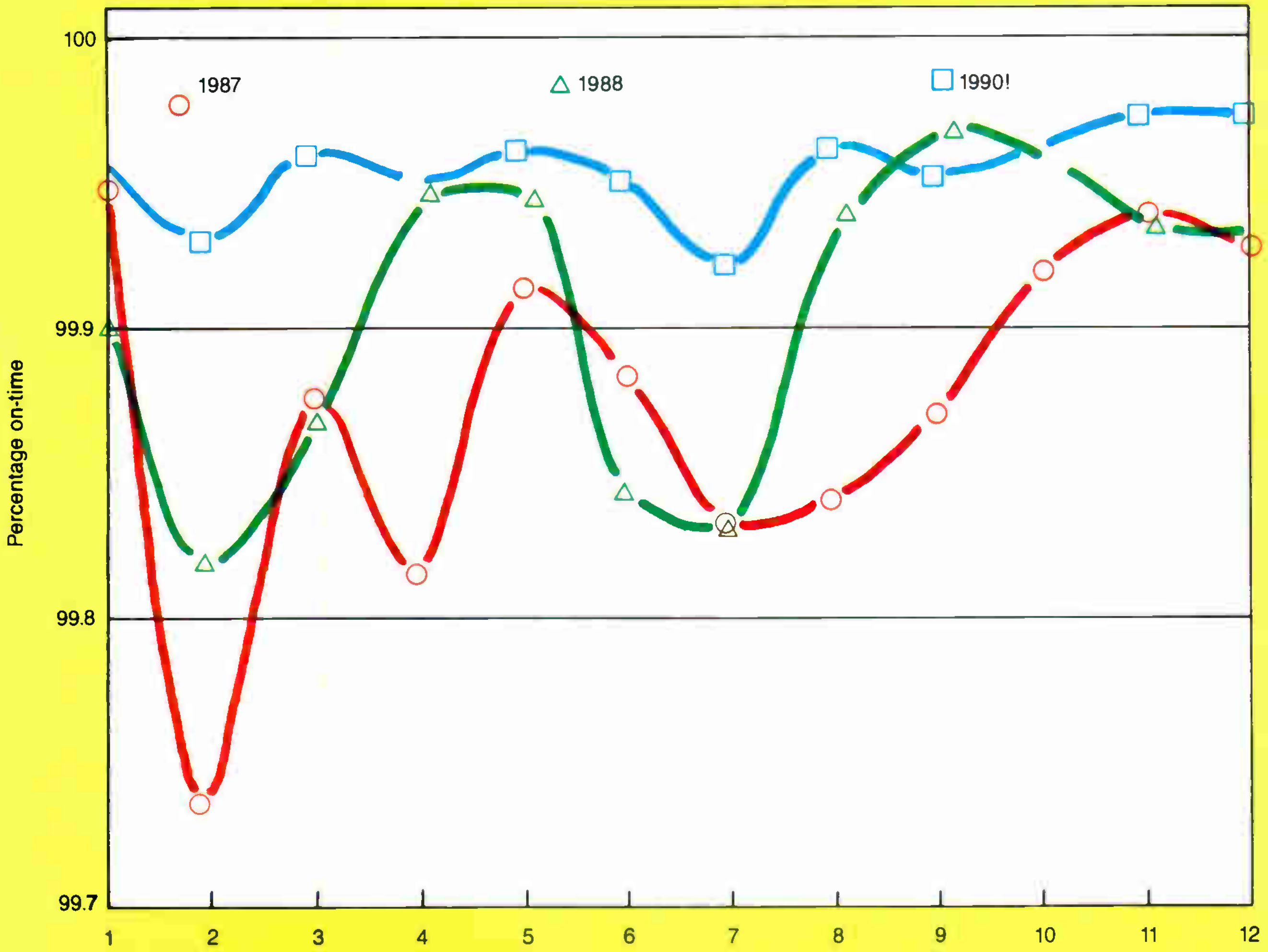
Other time-consuming problems might be not being able to contact a standby person immediately. Does he carry a pager? Was he where he was supposed to be? Did he have a fully equipped company vehicle immediately available or did he have to go home, drive to work in his own car and then pick up his van/truck and drive back to the outage? Did his vehicle start OK? In severe cold up north a block heater and a small battery charger built into the engine compartment will do wonders for quick starting. At −10 to −30° F, battery capacity is down over fourfold and the torque required to turn the engine could be up fourfold leaving you with about one-sixteenth of normal starting ability. Many factors such as these will emerge during the post-mortem and hopefully most can be improved upon.

Equipping for outage management

Every service vehicle should be equipped as far in advance as possible and its operator have sufficient training as though this was the only available outage team and it had to repair any kind of outage that came along. This means carrying a small quantity of every type of cable used in the system, a small quantity of the connectors that go with these and all necessary tools. A good idea is to mount a 4-inch rigid PVC tube to the top of the vehicle or ladder rack with one end closed and the other with a threaded cap so that 16-foot lengths of the various hard cables can be stored there in good condition. Adaptor connectors to go from hard cable to, say, RG-6 or RG-11 and back again are a must so that a temporary span, lying on the ground if need be, can be installed in a matter of moments after arrival on the scene of a torn-down section (police and other factors permitting, of course).

It is so sad to hear a tech at the scene of such a problem on the radio soliciting hardware from other techs who may be miles away—or worse yet, finding none and having to return to the warehouse. In order to ensure all the material that you consider necessary for any emergency is kept on the truck in good condition, a "truck-stock" checklist must be drawn up, approved, installed

Figure 3



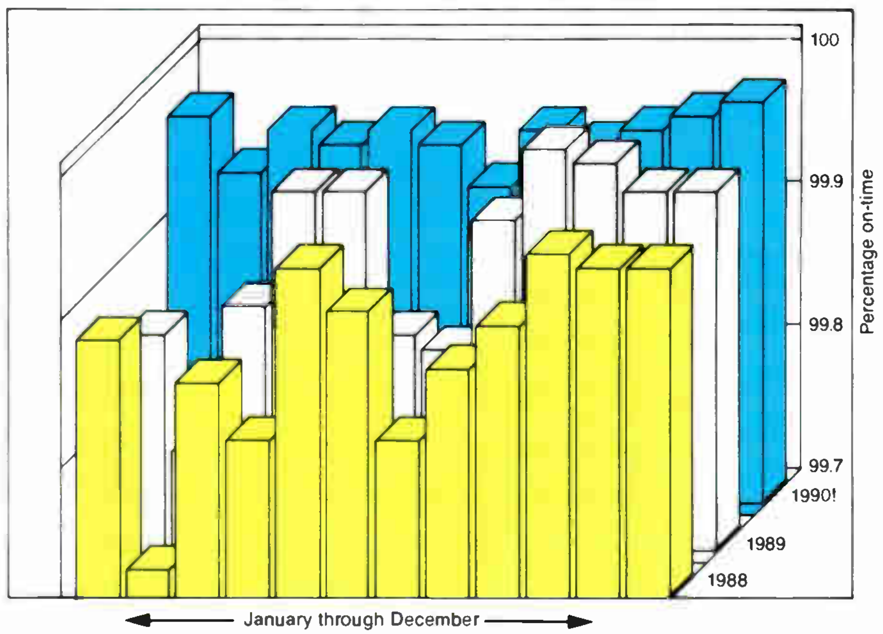
and checked by a supervisor from time to time. This could be part of a quarterly merit/award system. Regardless of outage management considerations, a truck-stock checklist is a must.

After all possible steps have been taken to prevent outages or to minimize the duration of those that cannot be prevented we need to be able to track how we are doing. Also, we need to perhaps be able to compare our performance with that of other systems or with other MSOs as we frequently do with service calls. Such a scheme was introduced as long ago as 1975[1] and is currently in use by several systems and companies. This is how it works.

System reliability index

"On-time" also could be called "system reliability index" and is a measure of the continuity of service provided, which in turn hinges on the vulnerability of the system to outages and the ability of the technical staff at all levels to reduce their number and duration by appropriate plant design and outage procedures. Example: Half the plant is off for 30 minutes. The outage is logged as 50 percent plant for 30 minutes. For statistical purposes, this can be considered as being the same as 100 percent of the plant being off for 15 minutes.

Figure 4



Example outage management plan

Memo to: Chief tech and dispatchers/CSRs
From: Chief engineer
Subject: Outage procedures

Outages may be classed as trunk outages (Trunks A through G) and distribution outages.

1) You'll be aware that you have an outage due to the volume of calls and their location. A trunk outage means that everything beyond a certain point in a direction away from the headends (i.e., downstream) will be off. Example: If you get calls from points A, B and C in a direction running away from the headend you will know that you have a trunk outage because everything at and beyond A will be off. (Use the trunk outline map of the system to start with, then pull out the 200:1 as-built map.)

2) Having determined that you have a trunk outage, activate the trunk outage tape recording on your main incoming telephone lines. If it's a feeder outage, go to item 3b.

3a) Now temporarily stop answering the incoming calls and *immediately* get your nearest two technicians started toward the part of the trouble nearest the headend. Call one or both out as necessary. No special authorization for overtime, etc., is required to do this.

3b) For a distribution outage, immediately get your nearest technician started to the troubled area. Do not send a "learner"; call out a technician if need be. No special authorization is needed to do this. Allow 30 minutes from time of arrival to the outage area for the technician to identify the problem and solution. If this does not happen, call out a second technician.

4) Obtain four telephone numbers and street names—two nearest the headend that is off and two further out. The first two are for localizing the problem and the second two for checking afterward to ensure that the outage is completely and totally cleared. There is no merit in answering hundreds of incoming calls. The manual answering of calls is a public relations function and here quality is more important than quantity. However, when you do answer customers, be brief, use the company script/formula and don't be drawn into a discussion.

5) Radio these street names to your technicians immediately. Do not waste time gathering addresses over and above those specified. You do not need to obtain the name of the people, just the telephone number and address. If you get a street that is exceptionally long—say, several miles long—then discard it and get another one that is shorter.

6) Log the outage start time in your daily dispatch log and outage log.

7) Call the chief technician no matter where he is or what time it may be. Advise him of the nature of the outage (that is, whether believed to be trunk or distribution), where you think the problem is and whom you have dispatched. He may respond with additional advice or, if the outage is sufficiently serious, he may wish to come down and take charge while you assist him. Another alterative might be for him to actually go directly to the scene and direct operations there.

8) If you cannot contact the chief technician, call the plant manager, technical manager, operations manager or system manager.

9a) When the outage is reported as cleared, call two customers to ensure full service has been restored. Then log clearance time in the dispatch log and outage log. In the case of a trunk outage, one of the techs must stay at the site for a further 15 minutes to make quite sure that the plant will stay back on.

9b) For trunk outages, notify the chief technician with the status every 30 minutes if he is not at the scene or at the dispatch position.

10) If at any time it becomes apparent that we have more than one outage—for example, one in the northeast and another in the northwest—then this is treated as two outages and all the procedures, including the manpower relating to the outage, is supplied to each of these according to its type. That is to say, trunk or distribution. No special authorization is required to incur this cost.

11) The dispatcher's function in an outage, especially in its early stages, is vital. Time is of the essence and this will be held to the utmost minimum if the dispatcher recognizes he has an outage early on and gets his technicians directed to the correct place without loss of time. He also greatly expedites the outage by actively participating while following on the 200:1 as-built map.

12) The chief technician will meet with the outage personnel and conduct a debriefing (post-mortem) session, the results of which he will report in the following format to the operations manager/system manager as soon as possible and not later than 9 a.m. of the business day following a night outage.

a) Times and duration of outages;
b) Location and extent of outages;
c) Personnel directly involved in outage;
d) Indirect personnel; i.e., dispatcher, chief tech, etc.
e) Cause of the outage;
f) Steps taken to restore system to normal;
g) An opinion as to whether the outage was preventable or reducible in time.
h) To suggest a maintenance or preventive procedure designed to eliminate or reduce future similar occurrences.

To properly respond to this question, you will need a skeleton map of the system, showing the amplifiers only. Figure 1 is a sample portion of a suitable type map. The amplifier numbers are not totally essential in this application, but they are invaluable when conducting an outage and for other maintenance considerations. Experience has shown that if systems over 100 miles do not count the extender amplifiers in an outage and also do not include them in the total amplifier count, the monthly figures are not affected because of the largeness of the system. This saves having an unduly large and detailed system skeleton map and much paperwork. Outages caused by extenders must, of course, still be reported on the outage sheet and handled just like any other outage. They just do not come into the monthly on-time calculation.

The basic problem with outage reporting has always been to equate large or small outages with varying downtimes so that they can be added and expressed in an industrywide, meaningful figure. Trying to evaluate the number of subscribers affected is too onerous and can be very wide of reality. The accurate, systematic way that we will do this is by factoring all off-times to what the equivalent would be if 100 percent of the plant was off. We call this "normalizing to 100 percent of plant equivalent."

Here is how to do it in step-by-step detail with an example at each step. It looks complicated, but actually it takes longer to show than to do!

1) Count the number of amplifiers that were "out." Let's suppose there were 87.
2) Verify the number of amplifiers in the system. This is usually a fairly constant number. Let's say it's 1,342 amplifiers.
3) Determine the duration of the outage in minutes. This is the time from first awareness of an outage until restoration verified by phone calls to two or more customers in the area. Let's use 75 minutes.
4) Normalize the outage for 100 percent plant equivalent as follows:

$$\frac{\text{Number of amplifiers out}}{\text{Number of amplifiers in system}} \times \text{off-time (minutes)}$$

and using our numbers:

$$\frac{87}{1{,}342} \times 75 = 4.9 \text{ minutes off-time (100 percent plant)}$$

A good idea is to do this little calculation on the back of the standard outage sheet (Figure 2) as soon as the sheet becomes available. (Do not leave it for the end of the month; it becomes too big a job then. This is a good task for the evening dispatcher!)

5) At cutoff time, add all the normalized off-times together. This gives the total off-time in minutes for the period. Let's assume it totalled 35 minutes.
6) Now get the number of minutes in the period to obtain the possible on-time; e.g., 31 days × 24 hours × 60 minutes = 44,640 minutes possible on-time.
7) Subtract the off-time from the possible on-time to get the actual on-time. Example: 44,640 minutes − 35 minutes = 44,605 minutes actual on-time.

8) Convert this actual on-time to a percentage on-time.

$$\frac{44{,}605}{44{,}640} \times 100 = 99.92 \text{ percent on-time}$$

This figure is the system reliability index—a very valuable tool in assessing system performance and a figure sought after by people such as MCI, Sprint, etc., in looking for systems for carrying services other than entertainment.

Evaluating your on-time figure

After you have obtained your monthly on-time percentage, it's a good idea to run it backwards to see what it means. Example #1: System on-time percentage was 99.55.

Off-time = 100 percent − 99.55 = 0.45 percent

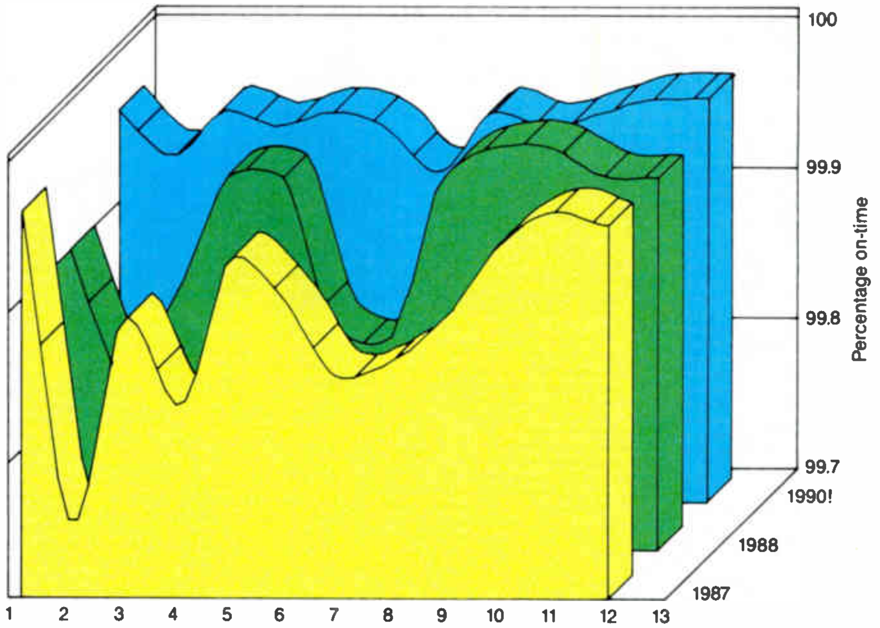
$$\frac{0.45}{100} \times 44{,}640 = 200.9 \text{ minutes} = 3 \text{ hours } 20 \text{ minutes}$$

Does that look good? No, it doesn't. Either the numbers are wrong or that month was an absolute disaster.

Example #2: System on-time percentage was 99.95. That's simply a way of saying that the 100 percent plant equivalent was off for 100 − 99.95 = 0.05 percent of the time. The time in a month (from Example 1) is 44,640 minutes. So, total time-off must have been:

$$\frac{0.05}{100} \times 44{,}640 = 22.3 \text{ minutes of 100 percent plant off}$$

Figure 5



Does that look good? Yes, it's a "good" number. In fact, anything over 99.90 percent would be good. Figures 3, 4 and 5 are graphics of how a system would look in 1987 if not managing its outages properly and how it could improve in subsequent years with proper organization and attention to detail.

References

[1] Roy Ehman, "System Performance Statistics," 1975 Canadian Cable Television Association paper.

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Building bridges

By Ron Hranac
President, Society of Cable Television Engineers

In 1987, the Rocky Mountain Chapter of the Society of Cable Television Engineers held a meeting called "Interfacing with Local Broadcasters." The meeting featured a panel of engineers from Denver-based MSOs and several local television stations. Coincidentally, the cable engineers represented the local SCTE chapter and the television engineers represented the local SBE (Society of Broadcast Engineers) chapter. This very successful and well-attended panel discussion forged new relationships between the local cable operators and the local broadcasters. After the meeting, personal invitations were offered by members of each group to tour the others' facilities—and thus began the rapport that now exists between the SBE and the SCTE at the national level.

At this year's Cable-Tec Expo in San Francisco, the SBE and the SCTE further strengthened the relationship when consulting engineer and SBE board member Dane Ericksen and I teamed up with Steve Fox of Wegener Communications to teach six workshops on BTSC stereo. And, at the SBE's annual convention held in Denver a few weeks ago, the SCTE had a booth in the exhibit hall, courtesy of the SBE's board of directors. Continuing this trend, the SCTE's board of director plans to offer the SBE booth space at next year's expo in Orlando, Fla.

Much in common

Why build such relationships in the first place? Over the years there has existed an attitude of "us and them" between cable operators and broadcasters. Must-carry, channel realignments and other issues have not been particularly beneficial to our mutual relationships. As well, neither party has gone to great lengths to establish good communications. In reality, though, the cable and broadcast industries have many things in common, among them the delivery of programming to the television viewer.

What better place to establish good relationships than the technical arena? Here the similarities of two of our technical trade organizations—the SBE and the SCTE—lend themselves well to building strong bridges. Both organizations are involved with the technical sides of our industries, each has technical certification programs in place and each is closely involved with providing the TV viewer quality and reliable service.

"The cable and broadcast industries have many things in common, among them the delivery of programming to the television viewer."

Establishing such relationships shouldn't stop here, either. We can build bridges with the Society of Motion Picture and Television Engineers (SMPTE), the Institute of Electrical and Electronic Engineers (IEEE), the Electronic Industries Association (EIA) and others—all of which will enhance our position and professionalism in telecommunications.

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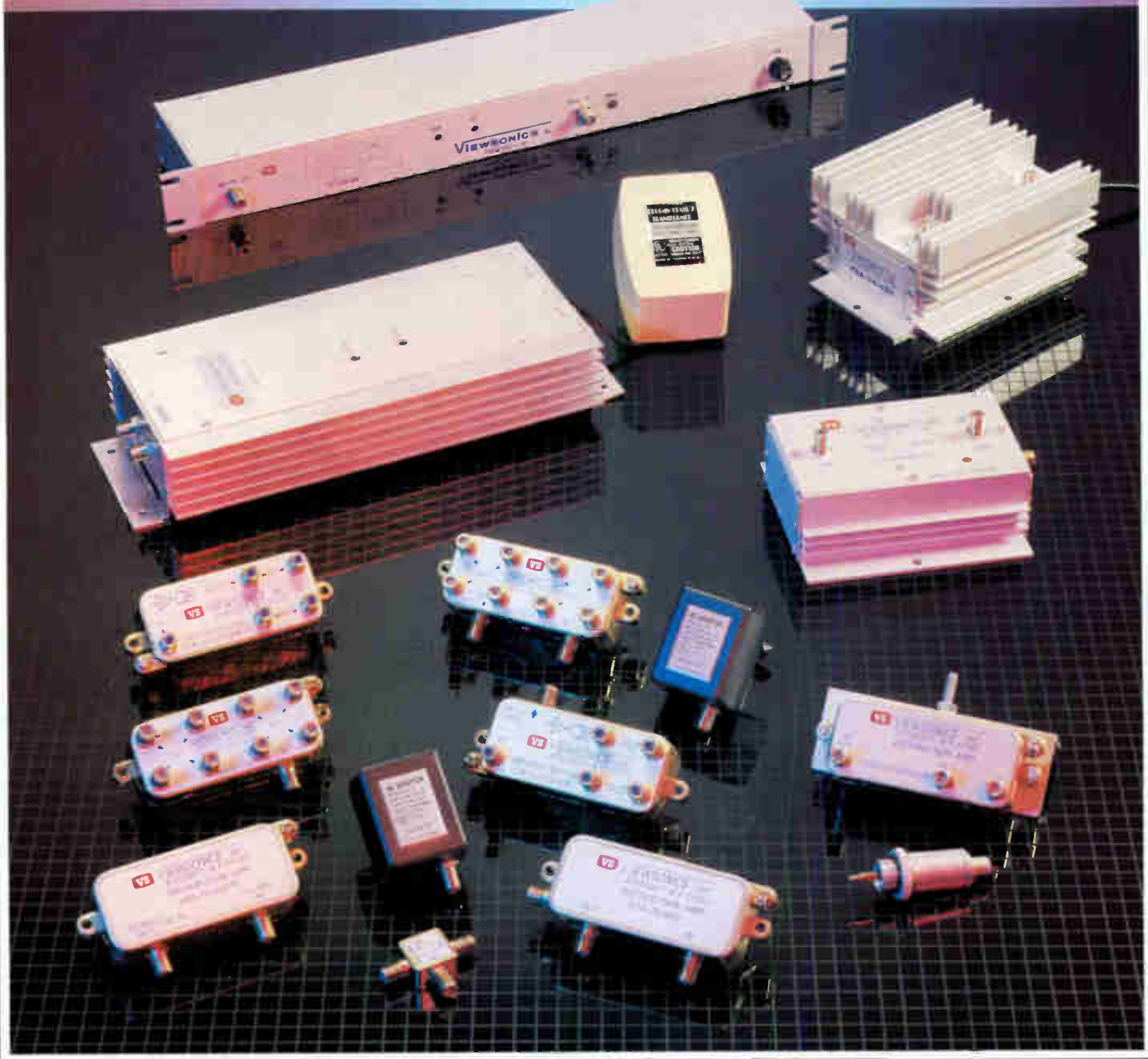

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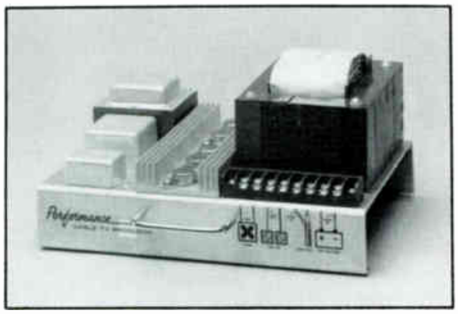


Standby power

Performance Cable TV Products' Model SB840A standby power supply was designed to provide the necessary backup for advanced CATV systems using feedforward and power doubling amplifiers. It is compatible with most existing 60 volt ferroresonant power supplies and is powered by a pair of batteries with a combined voltage of 24 VDC. Output is 60 volts RMS with a current rating of 14 amperes.

For more details, contact Performance Cable TV Products, 1770 Macland Rd., Hwy. 360, Dallas, Ga., 30132, (404) 443-2788; or circle #132 on the reader service card.

Return loss bridge

Viewsonics introduced its new line of test equipment, including a return loss bridge. It has a frequency of 5 to 600 MHz, impedance of 75 ohms, a direct reading, directivity of 40 dB, bridge loss of 12.5 dB and short-open error of 1 dB maximum. It also comes with an RF termination, which has a frequency of DC-600 MHz, 75 ohm impedance and return loss of 40 dB minimum.

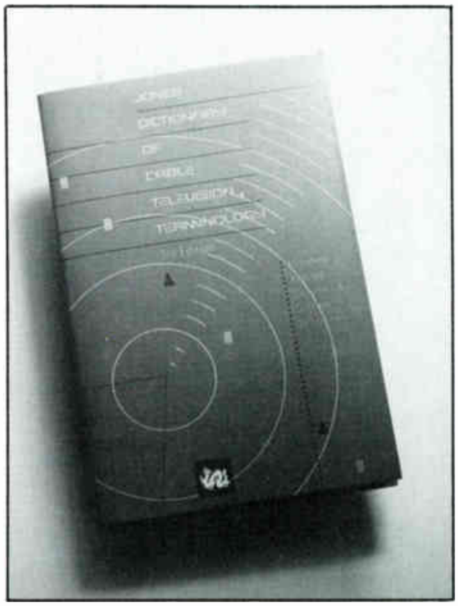
For additional information, contact Viewsonics, 170 Eileen Way, Syosset, N.Y. 11791, (800) 645-7600; or circle #139 on the reader service card.

Distortion analyzer

Available from ComNet Engineering, the RF Distortion Analyzer is a computer-aided engineering software package that calculates the sum of RF broadband cable distortions for both the LAN and CATV industries. It calculates carrier-to-noise, second order, composite triple beat, cross modulation and hum in a given cascade of up to five different amplifiers on that cascade.

This software is menu driven, requiring Y or N responses, equipment quantities and their published technical characteristics and provides "what if" changes and recalculates the modification. It is compatible with MAP, IEEE 802.7 and NCTA recommended standards.

For more details, contact ComNet Engineering, 3310 Western Dr., Austin, Texas 78745, (512) 892-2085; or circle #126 on the reader service card.



Dictionary

Jones 21st Century published the *Jones Dictionary of Cable Television Terminology, Third Edition*, which defines more than 1,600 cable-related terms, phrases and acronyms from the industry's engineering, operations, marketing, programming, management, manufacturing, finance, legal, international and regulatory arenas.

A major portion of the definitions, which run from one sentence to a brief paragraph in length, are devoted to technical and operations terms and are geared toward a basic technical level. The dictionary identifies more than 50 industry-related organizations, agencies and services, both national and international. Related computer and satellite terms also are included and all acronyms are cross-referenced.

For further information, contact Jones 21st Century, 9697 E. Mineral Ave., Englewood, Colo. 80112, (303) 792-3111; or circle #125 on the reader service card.

Cable testers

Tektronix's Communication Network Analyzers Division introduced its 1502B and 1503B time domain reflectometer cable testers. The 1502B delivers a 0.9-inch resolution between two faults and static suppression to protect the instrument against static blowouts. It also features a continuous display on-screen impedance readout at the cursor.

The 1503B delivers a two nanosecond pulse and resolution to less than one foot. It can find faults up to a 50,000-foot range for any general metallic cable application. Both models feature HyperTwist LCD display, optional internal printer, two operating levels, built-in memory and digital averaging.

For more information, contact Tektronix Inc., P.O. Box 500, Beaverton, Ore. 97077, (503) 923-4415; or circle #141 on the reader service card.

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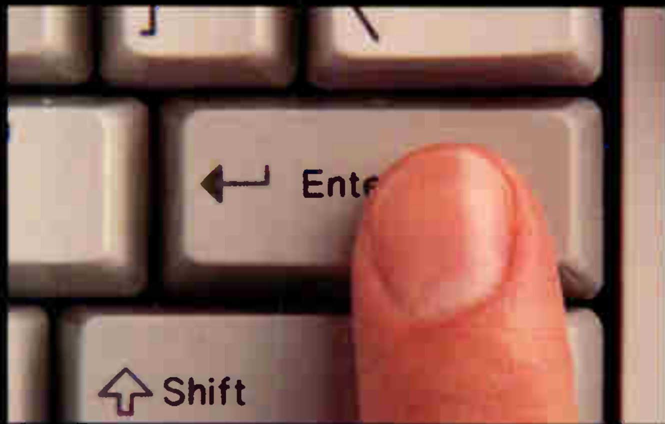

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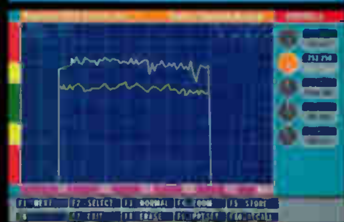
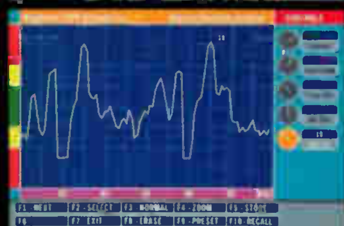
MLM has some features you'd find in more expensive digital spectrum analyzers. Like colorful and informative graphics that tell you at a glance how your system is performing. And storage and retrieval that gives you a complete record of system performance. MLM gives you all these features in an attractively-priced package, so you can install as many line monitors as you need to cover your whole system.

MLM is from Magnavox, a company you've come to know for quality, reliability and service. For application information and an MLM demonstration, call your Magnavox representative.

Compact MLM module is enclosed in a rugged housing that withstands the extreme environments of a cable system.



MLM display showing sweep response. White is actual response; yellow is stored response.



MLM display showing the video, color and sound carriers of Channel 3 with upper adjacent channel picture carrier and lower adjacent sound and color carrier also shown.

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Signal processor

Pico Macom introduced the Model SSP-10 satellite signal processor that amplifies incoming satellite signals (in the 950-1,450 MHz range) then directs them to five vertical and five horizontal outputs. It features a primary power supply that powers horizontal and vertical LNBs and a second standby power supply that automatically switches on if the primary one fails. It also has a voltage boost switch allowing LNB voltage to be increased 2 volts for long distance LNB applications.

For more information, contact Pico Macom, 12500 Foothill Blvd., Lakeview Terrace, Calif. 91342, (818) 897-0028; or circle #128 on the reader service card.

Impact breakers

Allied's Models 715 and 725 Hy-Rams mount on skid steers, mini-excavators and rubber tire backhoes for various breaking applications. Both hammers feature Allied's patented hydraulic design and a nitrogen gas charge that allows them to operate using a minimum of oil fed by the carrier pump.

The Model 715 is rated in the 550 foot-pounds impact energy class, while the Model 725 is rated at 750 foot-pounds. While the hammers are in action, dampened mounting pin bushings reduce vibration and automatic shut-off protects them from heat build-up and blank firing. Both models come with a chisel-style tool for breaking reinforced and non-reinforced concrete and rock.

For further details, contact Allied, 5800 Harper Rd., Solon, Ohio 44139, (216) 248-2600; or circle #136 on the reader service card.

Broadband amplifiers

Blonder-Tongue Laboratories added the BIDA 300-30 and BIDA 450-30 to its line of broadband indoor distribution amplifiers for CATV and SMATV signal distribution systems that use a cable drop as a signal source. They also can be used as post-amplifiers for headends using passive combiners.

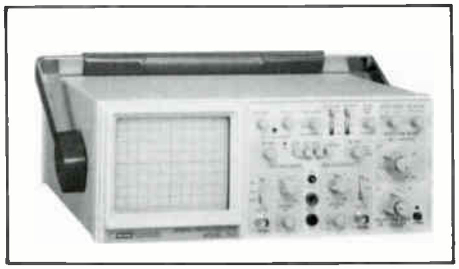
Both the 300-30 (with 50 to 300 MHz bandpass) and the 450-30 (with 50 to 450 MHz bandpass) are configured for one-way operation, with optional field-installable modules for two-way capability. They have a flat operation gain of 32 dB that can be adjusted down to 22 dB with a variable attenuator.

For additional information, contact Blonder-Tongue Laboratories, 1 Jake Brown Rd., Old Bridge, N.J. 08857, (201) 679-4000; or circle #137 on the reader service card.

Warning tags

Panduit designed a new line of ground warning tags for use with ground wires for CATV, electrical or telephone installations. The 2.75-inch by 1.375-inch semi-rigid polyethylene tags feature UV resistant black legends on a bright yellow background on both sides. They are available in packages of 100 and can be installed with Panduit cable ties.

For more information, contact Panduit, 17301 Ridgeland Ave., Tinley Park, Ill. 60477-0981, (312) 532-1800; or circle #135 on the reader service card.

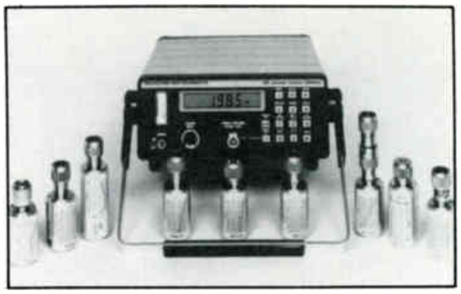


Oscilloscope

B&K-Precision's Model 2125 20 MHz dual-trace oscilloscope features 1 mV per division sensitivity and a built-in component tester for capacitors, inductors, diodes, transistors and zener diodes. Delayed sweep operation covers from 0.1 microsecond per division to 50 milliseconds per division in 18 steps.

In addition, holdoff is continuously variable for main sweep up to 10 times normal. Other features include ALT, CHOP or ADD modes of dual-trace operation, selectable auto/normal triggered sweep operation, with input coupling for AC, TVH, TVV and line operation.

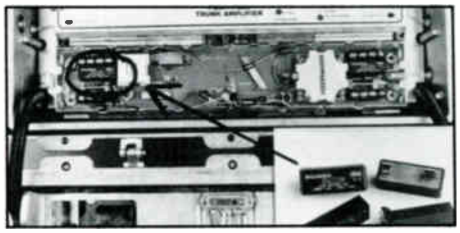
For further details, contact B&K-Precision, Maxtec International Corp., 6470 W. Cortland St., Chicago, Ill. 60635, (312) 889-1448; or circle #134 on the reader service card.



Power meter

The 6960A power meter from Marconi Instruments features a frequency range of 30 kHz to 26.5 GHz and a power range of +20 dBm (100 mW) to −70 dBm (0.1 nW), extendable to +37 dBm. Dynamic range is 0.1 nW to 100 mW at frequencies from DC to millimeter waves. It also offers a 3-W sensor, automatic signal averaging facilities, a high-power annunciator and a maximum-hold facility.

For additional information, contact Marconi Instruments, 3 Pearl Ct., Allendale, N.J. 07401, (201) 934-9050; or circle #133 on the reader service card.



Protector

GTE has developed a combination bimetallic and solid-state protector designed to improve the quality and reliability of cable TV networks. The Smart Breaker addresses common network problems associated with transient spikes and blown fuses.

If a temporary current surge develops in the system, the unit will open and protect the circuit from damage. Once the surge has passed, it will reset itself and restore service automatically. If the overload persists, it will switch from an automatic cycling mode to a hold open mode; the breaker can be reset after the problem stops.

For additional details, contact GTE Electrical Products, 100 Endicott St., Danvers, Mass. 01923, (508) 750-2439; or circle #129 on the reader service card.

Connector protector

The End Cap Protector from Insulation Systems is an air-shrinkable, waterproof device that prevents moisture from getting into connectors when disconnecting cable service. They are made of PVC material, pre-expanded and sealed in a foil package. Once installed on the connector, sealing occurs automatically and provides 100 percent uniform covering and environmental seal, according to the company.

For further details, contact Insulation Systems, 461 Nelo St., Santa Clara, Calif. 95050, (408) 986-8444; or circle #140 on the reader service card.

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The Agile 40 C/K is also the receiver to have when you're expanding your headend. Because our internal 950-1450 MHz active loop-thru design eliminates signal splitters, so you can add up to 16 additional receivers on the same polarity—with no signal loss.

And because it draws only 32 watts maximum, the 40 C/K runs cooler, lasts longer, and saves money year after year. So you'll probably never need our five-year replacement/warranty program.

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November

Nov. 9-11: Magnavox CATV training seminar, Boston. Contact Amy Costello, (800) 448-5171.

Nov. 13-14: SCTE Old Dominion Chapter technical seminar, Holiday Inn, Richmond, Va. Contact Margaret Harvey, (703) 248-3400.

Nov. 14-16: SCTE Technology for Technicians seminar, Luxbury Hotel, Charlotte, N.C. Contact (215) 363-6888.

Nov. 14-17: Siecor Corp. technical seminar on fiber-optic installation and splicing for LANs, building and campus applications, Hickory, N.C. Contact (704) 327-5539.

Nov. 14-18: Hughes Microwave technical training seminar on channelized transmitters, Torrance, Calif. Contact (213) 517-6244.

Nov. 15: SCTE Chesapeake Meeting Group technical seminar and BCT/E testing on Categories I, II, III and IV, Holiday Inn, Columbia, Md. Contact Thomas Gorman, (301) 252-1012.

Nov. 15-16: Probe Research conference on HDTV for telco, cable and broadcast, Mark Hopkins Inter-Continental, San Francisco. Contact Laurel Lewis, (201) 285-1500.

Nov. 15-16: Trellis Communications fiber-optics seminar, Key Bridge Marriott, Arlington, Va. Contact Richard Cerny, (603) 898-3434.

Nov. 15-17: Magnavox CATV training seminar, Boston. Contact Amy Costello, (800) 448-5171.

Nov. 15-17: C-COR Electronics technical seminar, New Orleans. Contact Shelley Parker, (800) 233-2267.

Nov. 16: SCTE North Central Texas Chapter technical seminar on fiber optics. Contact Vern Kahler, (817) 265-7766.

Nov. 16: SCTE Mt. Rainier Meeting Group technical seminar and BCT/E testing, Martha Lake Community Center, Seattle. Contact Russ Eldore, (206) 251-6760.

Nov. 16: SCTE Piedmont Chapter technical seminar. Contact James Kuhns, (704) 873-3280.

Nov. 16: SCTE Razorback Chapter technical seminar on CLI, Days Inn, Little Rock, Ark. Contact Jim Dickerson, (501) 777-4684.

Nov. 16-18: National Satellite Programming Network's Private Cable Show, Sheraton Denver Tech Center, Denver. Contact Nancy Toman, (713) 342-9655.

Nov. 21-23: Magnavox CATV training seminar, Syracuse, N.Y. Contact Amy Costello, (800) 448-5171.

Nov. 28-30: Siecor Corp. technical seminar on fiber-optic overview for management and supervisory personnel in LANs, building and campus applications, Hickory, N.C. Contact (704) 327-5539.

Nov. 29: SCTE Satellite Tele-Seminar Program, "SCTE Installer Certification Program workshop," 12-1 p.m. ET on Transponder 7 of Satcom F3R. Contact (215) 363-6888.

Nov. 29-30: Trellis Communications fiber-optics seminar, Holiday Inn, Las Vegas, Nev. Contact Richard Cerny, (603) 898-3434.

Planning ahead

Dec. 7-9: Western Show, Convention Center, Anaheim, Calif.

Feb. 22-24: Texas Show, Convention Center, San Antonio, Texas.

May 21-24: NCTA Show, Convention Center, Dallas.

June 15-18: Cable-Tec Expo '89, Orange County Convention Center, Orlando, Fla.

December

Dec. 1-2: British Academy of Film and Television Arts' European Satellite Communications Conference, London. Contact 01-868-4466.

Dec. 6: SCTE Interface Practices Committee meeting, Hilton Hotel, Anaheim, Calif. Contact Tom Elliot, (303) 721-5349; or Joe Lemaire, (415) 361-5792.

Dec. 7: SCTE Greater Chicago Chapter technical seminar on CLI. Contact William Gutknecht, (312) 690-3500.

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Zenith as an HDTV S-curve example

By Walter S. Ciciora, Ph.D.
Vice President of Technology
American Television and Communications Corp.

The last two columns have discussed concepts and examples from the book titled *Innovation, the Attacker's Advantage* by Richard Foster, published by Summit Books. Zenith Electronics Corp. recently provided us with a wonderful example of how innovation can be applied to leap from old S-curves to new ones with great potential. Zenith's example is its newly proposed HDTV system for North America.

The Zenith HDTV proposal can be divided into two parts. The first part is a signal transmission scheme that dramatically reduces the power in the signal without loss of performance. This is important because high energy levels are the cause of distortions when they encounter practical circuits that have slight imperfections. The second part of the proposal takes a 30 MHz HDTV signal and compresses the bandwidth. The result is that when it is modulated using the signal transmission scheme, it will fit into a standard 6 MHz TV channel. We will use the first part as our source of S-curve examples.

Encoding is the process of preparing a signal for modulation onto an RF carrier. Early in the history of broadcasting, no encoding was used at all; the audio and video signals were directly applied to their separate RF carriers. The first example of encoding TV signals came when color was added to the NTSC system. The video signals from three separate television pickup tubes were filtered and mixed to provide one luminance signal and two chrominance signals of different bandwidths. These chroma signals were then modulated onto a 3.58 MHz carrier before being added to the luminance signal. This tailored the chroma signal characteristic so it could be compatibly squeezed into the same spectrum space as the luminance signal. This was a brilliant technical achievement allowing the TV industry to leave the black-and-white S-curve, which had reached its point of diminishing returns. The new S-curve made color television possible.

The second example of TV signal-encoding S-curves involves the audio part of the signal. For decades consumers have enjoyed stereo sound from FM radio but missed it on television. The old monaural audio S-curve had reached its point of diminishing returns. The Broadcast Television Systems Committee had created a new S-curve for encoding left and right audio channels into a new aural signal for television. This S-curve went beyond the older S-curve for FM radio stereo. It incorporated new innovations that both improved performance and added a second audio program (SAP).

Zenith has taken the video signal-encoding process to yet a newer, more advanced S-curve. Zenith recognized that nearly all the average energy in a television signal is located in the frequencies below 200 kHz. By removing this part of the signal and digitizing it, the high energy components were converted to low energy versions. These digital signals were placed in the vertical blanking interval (VBI) of the signal. The VBI is that time when the TV picture tube's electron gun is turned off (blanked) because it is making its way back to the top of the screen from the bottom. The result of this encoding is a signal with only 0.2 percent of the energy of an ordinary NTSC signal.

The existing NTSC television signal is called a vestigial sideband/amplitude-modulated (VSB/AM) signal because a portion of one-half of it is chopped off, leaving only a vestige of that side. This rather clever approach allows us to have more channels in the available spectrum space.

The negative consequences of this technique include some unpleasant picture distortions. While they are acceptable for NTSC purposes, they would be a problem for true HDTV. In other words, this S-curve has been almost fully exploited, so Zenith jumped to a new S-curve. Two signals are modulated onto the same carrier in a manner that avoids the difficulties of VSB/AM while minimizing the energy required. The technique is called double-sideband, suppressed-carrier quadrature amplitude modulation. This technique itself is not new but the innovation that makes it practical is a relatively new circuit for use in the TV receiver. A composite S-curve is created out of the S-curves for the components of the system.

In the very strictest sense of the word, there were only a few inventions in the Zenith system. Most of the technologies existed for other applications in other industries. But there was a tremendous amount of innovation in bringing them together and exploiting their potential.

How does this happen? There are several ingredients to the recipe. First is talent: Without exceptional intelligence, the process is stillborn. Talent is a necessary but not sufficient condition. Broad experience and interest in how things are done in other fields of endeavor provide a warehouse of concepts to draw from. The last element is an open mind that is free to experiment with hooking together strange and diverse ideas to form new wholes.

This new combination of S-curves yields a composite S-curve that could serve us well for many years before reaching the point of diminishing returns. Of course, when that happens, we'll just have to find a new S-curve.

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