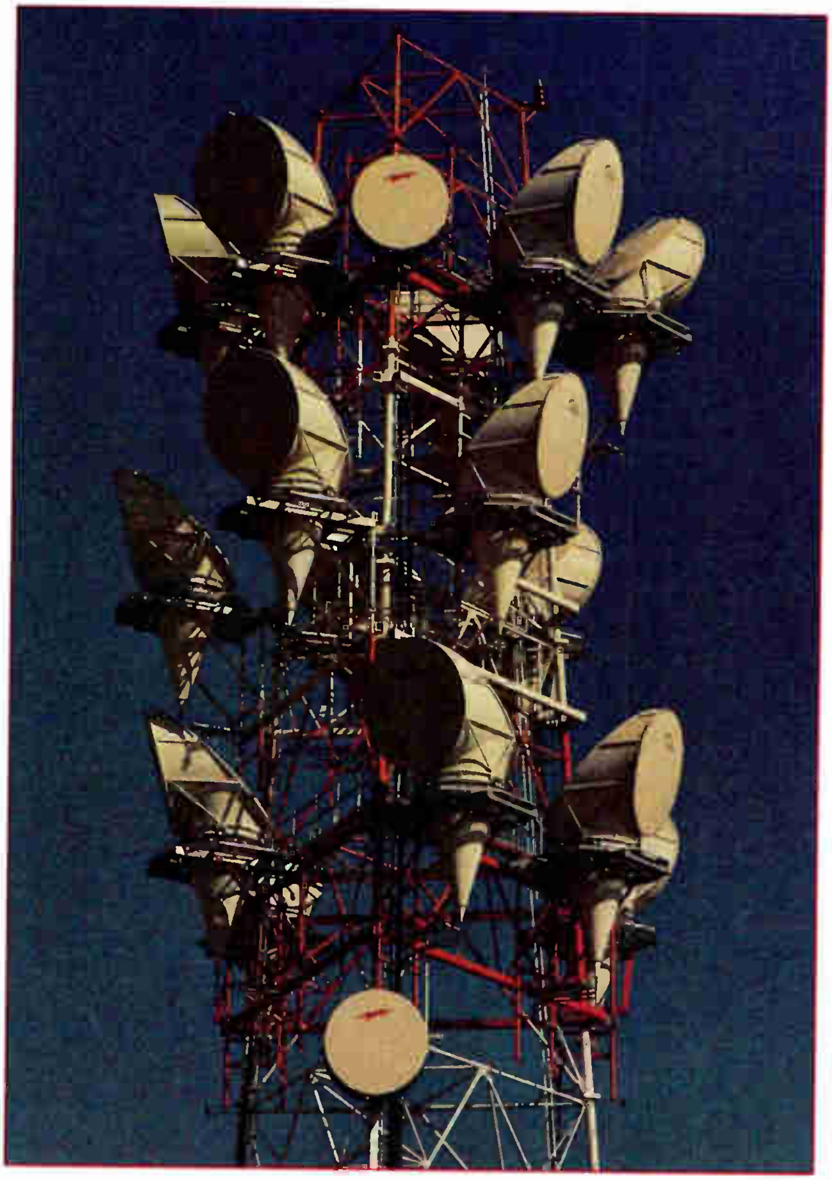
COMMUNICATIONS TECHNOLOGY

Official trade journal of the Society of Cable Television Engineers

Pull-out CARS band wall chart



Microwave maintenance, improvements and setup

Western Show wrap

January 1987

INNOVATION & INFORMATION

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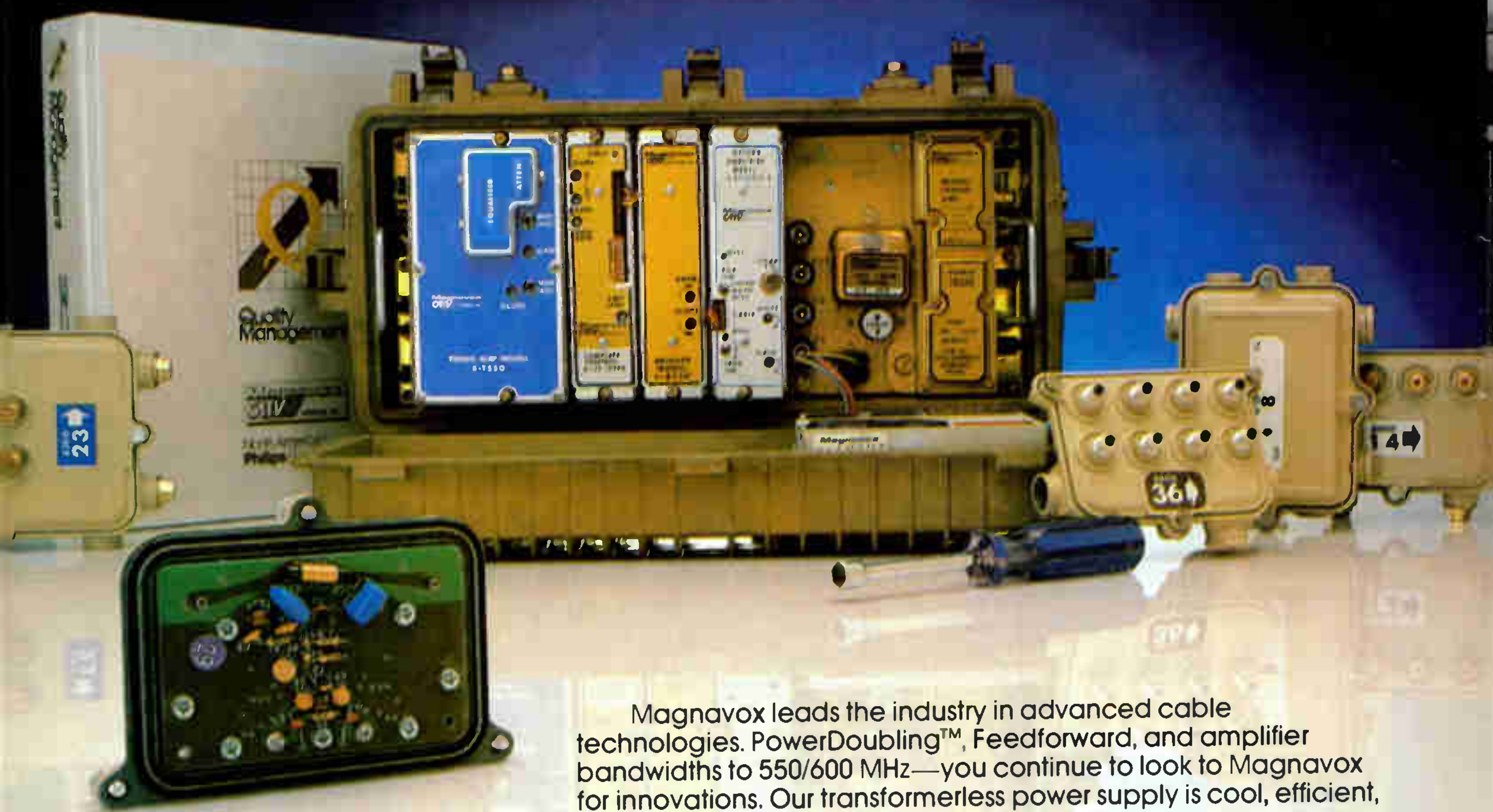

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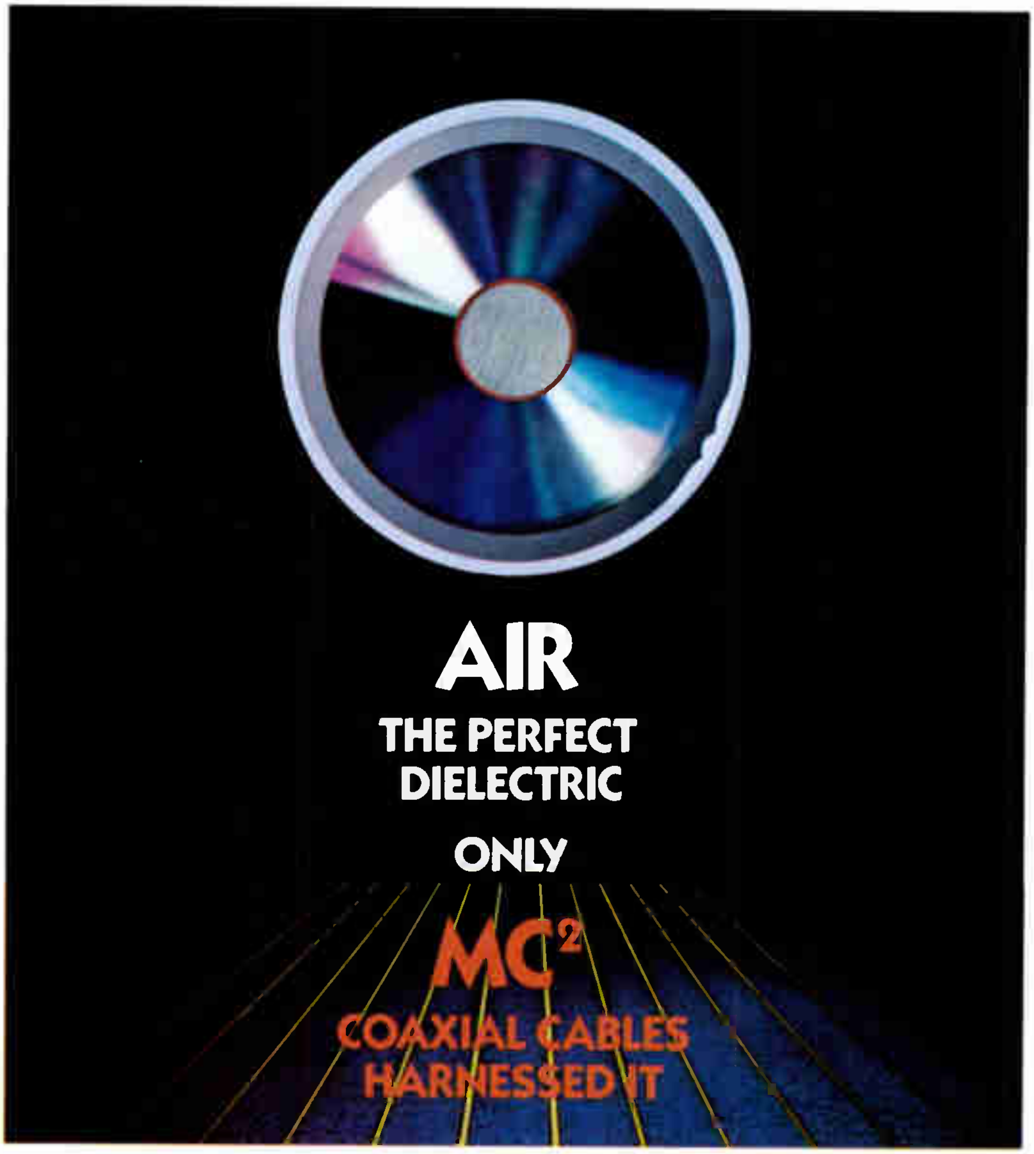

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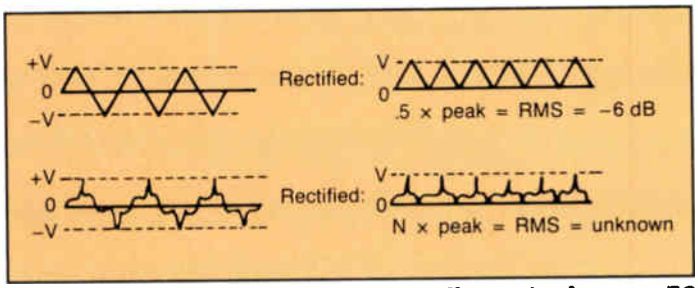

Features

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GENERAL INSTRUMENT

PUBLISHER'S LETTER

We're cooking with microwave

What a feast we have in store for you with this New Year's issue! Everything you've always wanted to know about microwave applications in cable. It starts with some well-prepared features and columns offering a smorgasbord of microwave topics, then moves on to a real treat: an expanded "Tech Book" by Ron Hranac, also about microwave. As I said, a feast.

But wait—the tempting finale, a pull-out chart compiled by Jones Intercable's Hranac and Paul Vadakin, displaying the frequencies for CARS band microwave. Suitable for posting on your office wall. Bon appetit!

Our philosophy

I think it's time we reiterated our philosophy at *CT*. To understand a topic (like microwave) fully, you've got to cover it thoroughly. That's what we've always done, from the very first issue in March 1984. We don't just "touch on" a subject, we go all out to give you the whole picture, from various points of view.

Besides the information contained in our "mini-handbook" on microwave, this month we also feature some excellent articles on tests and measurements.

And let's not forget our Western Show wrap-up. We've tried to present the major events: speakers, seminars, exhibits and products. This month we're highlighting some of the equipment that was introduced at the show, and we'll wrap it up in next month's product news.

Where else can you find all this? Right, nowhere else. So, those of you with a protective cover around your issue should take the time to fill out the qualification form and drop it in the mail post-haste. Go ahead, do it now. I'll be here when you're finished. This will keep you on our records and keep our records accurate. Thanks, you won't regret it.

Win a trip

On page 80 is something I think you'll find exciting—*CT*'s essay contest, our first ever. If you enter with a 250-word article on the topic "How does *Communications Technology* magazine best serve the cable TV engineering community and the SCTE" and are chosen by our panel of judges, you'll win an expenses-paid vacation for four to the 1987 Cable-Tec Expo in Orlando, Fla., April 2-5. And you'll get your essay printed in *CT*. But you don't have much time to enter: deadline is March 1.

The SCTE will open its new national headquarters in Exton, Pa., this month. This is indeed a move forward. Congratulations to Bill Riker and company. You'll read more about it next month.

I talked about this last month, but it deserves another mention. The SCTE national headquarters and its Chattahoochee Chapter are co-sponsoring an engineering and technical management development seminar at the Holiday Inn Airport/South in Atlanta on Jan. 21-22. Speakers and panel moderators include Bob Luff of Jones Intercable, Cliff Paul of RTK and Wendell Bailey of the NCTA. For more information, contact Mike Aloisi, president of the Chattahoochee Chapter, at (404) 396-1333; or Guy Lee, (404) 451-4788. You still have time to attend.

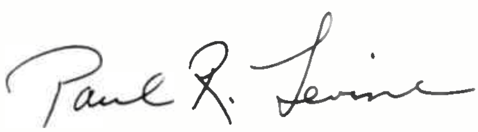
This issue contains the complete information package for the SCTE Cable-Tec Expo '87, including a registration form. If you pre-register before March 2, you'll get in at last year's prices. So don't delay; this year's going to be another blockbuster event. If you want more information, circle #1 on the reader service card.

Closed-circuit to SCTE national members: you already should have received your election packet for nominating new officers. Please mail them as soon as possible. If you haven't received yours, or if you have questions, call Bill Riker at the SCTE, (215) 363-6888.

Finally, coming up in next month's *CT* will be an update of the SCTE's Outstanding Achievement Awards.

Well, that does it for another month. Enjoy your microwave issue!

Congratulations to David Wilhelm and Ruben Gonzalez, the first two recipients of the SCTE Technical Tuition Assistance Awards. Read more about it in this month's *Interval*.



COMMUNICATIONS TECHNOLOGY

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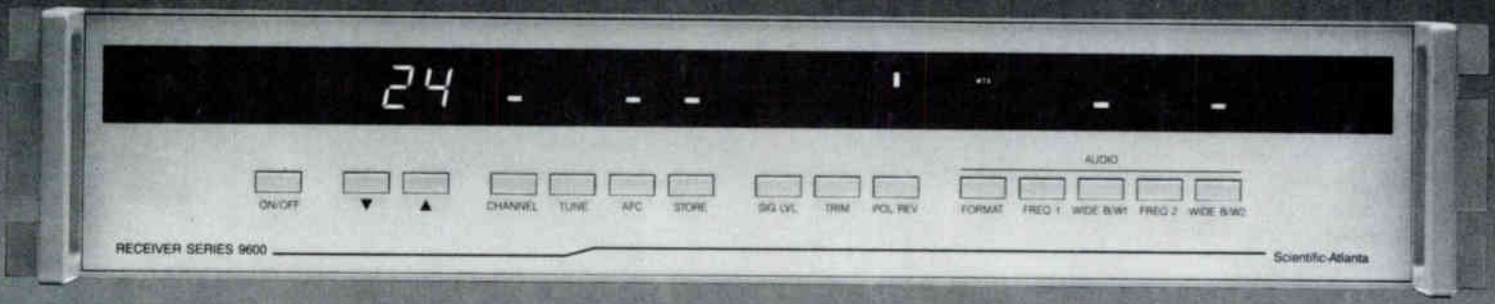

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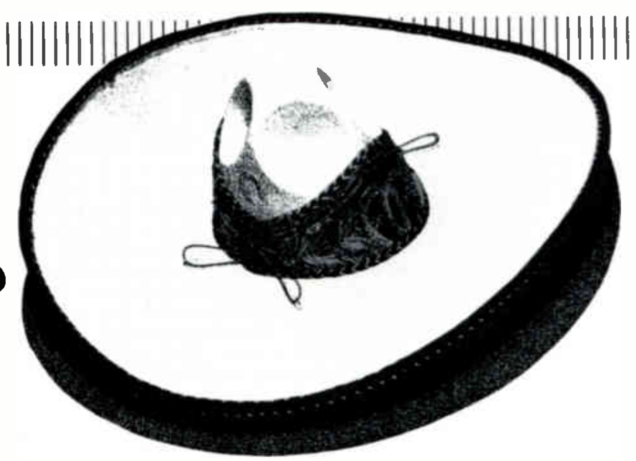
The Texas Show



SCTE to coordinate Texas Show sessions

SAN ANTONIO, Texas—The Society of Cable Television Engineers (SCTE) will coordinate the technical panels for the upcoming Texas Cable Show at the San Antonio Convention Center Feb. 18-20. Sponsored by the Texas Cable Television Association (TCTA), the show also will include Broadband Communications Technician/Engineer Certification exams on Wednesday, Feb. 18 between 10 a.m. and 2 p.m.

SCTE technical panels and moderators, slated for Thursday, Feb. 19, are as follows:

10:30-11:45 a.m.—"Future TV sets," with Bill Riker (SCTE).
1:45-3 p.m.—"Rebuild vs. retrofit," with Tom Polis (Communications Construction Group Inc.).
1:45-3 p.m.—"Addressability," with Dan Pike (Prime Cable).
3:15-4:30 p.m.—"FCC update on technical issues," with Cliff Paul, consultant.

For more information, contact Bill Arnold, TCTA executive secretary, (512) 474-2082.

FCC postpones must-carry rules

WASHINGTON—Late last month the Federal Communications Commission postponed the effective date of its new must-carry rules, including the obligation to install A/B switches, pending review of petitions for reconsideration. The National Cable Television Association (NCTA), joined by the National Association of Broadcasters (NAB) and the Community Antenna Television Association (CATA) and later supported by the Television Operators Caucus, had asked the FCC to stay the A/B switch obligations and the five-year sunset provision. Others had requested a stay of the rules in their entirety. The commission's decision specifically denies all the requests but grants the relief requested—namely a postponement.

A recent report by NCTA concluded that the A/B switch requirement would have cost the cable industry almost $1.4 billion over the next five years.

PTS Corp. announces acquisition of Katek

BLOOMINGTON, Ind.—PTS Corp., an electronics rebuilding firm, announced the acquisition of Katek from RT/Katek Inc. A new corporation has been formed under the name PTS/Katek. Terms of the acquisition were not released: all assets of Katek were bought for an undisclosed sum.

Jack Craig, former president of PTS Corp., will serve as president of the new company. Ron Katz, previously of RT/Katek, will serve as executive vice president and general manager of operations. PTS/Katek will operate 13 service centers nationwide, providing repair and sales of converters, amplifiers and distribution equipment.

Itel's acquisition of Anixter approved

SKOKIE, Ill.—The boards of directors of Itel Corp. and Anixter Bros. Inc. approved the acquisition of Anixter by Itel in a transaction valued at over $500 million. In its offer, Itel has agreed to pay $14 per share in cash for all Anixter common shares; Anixter currently has 36.4 million shares outstanding.

Anixter Bros. is a supply specialist for wire, cable and other products used in telecommunications, data and cable TV industries. Itel operates businesses in the cargo container, rail and marine dredging industries. Both companies are based in the Chicago area.

- The 1986 Industrial Research Institute's Achievement Award was presented to Dr. Robert Maurer of Corning Glass Works, Corning, N.Y. Maurer is credited with having developed the optical fiber that proved optical communications were possible. The institute is an association of 265 domestic and foreign companies established in 1938 to address problems confronting managers of industrial R&D.
- Sachs Communications Inc. is providing drop line installation training, aimed primarily at installers and technicians of companies using Sachs products. Consisting of slide and video presentations followed by a practical hands-on demonstration, training usually is done at the customer's office.
- Effective immediately, Eagle Cable Inc.'s new, enlarged facilities are located at 12135 "F" East 11th St., Tulsa, Okla. 74128, (918) 437-0666.
- Inwood Cable of Inwood, W.V., added two CARS band microwave relay paths to its existing 4.8-mile Channel Master Micro-Beam system. All three cable plants are linked to the service through microwave signals originating at the headend on Round Top Mountain, not by direct cable lines.
- Catel Telecommunications has moved to 4050 Technology Pl., Fremont, Calif. 94537-5122, (415) 659-8988. Its new toll-free number for calls outside California is (800) 225-4046.
- Comsearch Inc. has introduced testing and support services for compliance with FCC regulations on exposure to radio frequency (RF) radiation hazards. The company also is offering testing services for compliance with state and local laws and regulations and testing for use in connection with zoning and land use applications.
- CableTek Center Products Inc. has moved to 850 Taylor St., Elyria, Ohio 44035; its phone number, (216) 365-3889, remains the same. The move comes after an increase in the OEM's business and the addition of new products.
- Pioneer Communications of America Inc. has relocated its corporate headquarters to 600 E. Crescent Ave., Upper Saddle River, N.J. 07458, (800) 421-6450. This does not affect the company's repair facility, sales support or cable engineering staff, all of which will stay in Columbus, Ohio.
- Burnup & Sims Cable Products Group has moved its national sales and marketing headquarters to 8000 E. Prentice Ave., Suite C-5, Englewood, Colo. 80111, (303) 694-6446. The company's Lectro Division has been awarded the power supply portion of the Philadelphia build from Comcast, consisting of 650 plant miles. Also, Burnup & Sims' Capscan Division has been awarded the cable portion of the Queens, N.Y., build from ATC, consisting of 450 plant miles.
- Power Guard Inc. of Hull, Ga., and Merit Communications Supply of Decatur, Ga., have reached agreement for Merit to be a national distributor of Power Guard standby and non-standby supplies.
- Satellite Cable TV Corp. of Phoenix, Ariz., has changed its name to CableAmerica Corp. The MSO owns and operates over 35 cable franchises throughout the South, West and Midwest.
- Alpha Technologies Inc. has announced completion of its new facility, which will house the company's expansion in the telecommunications, computer and power supply markets, at 3767 Alpha Way, Bellingham, Wash. 98225, (206) 647-2360.

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Functional and scientific illiteracy

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

The extent of functional illiteracy, defined as the inability to read and write, is periodically discussed and researched with widely varying results. Estimates made by reputable sources range from 10 million to 60 million individuals who are performing below the eighth grade level. If illiteracy is restricted to the absolute inability to read or write at all, most studies point to 10 million souls whose only access to civilization is verbal. Expressed as a percentage of the U.S. adult community, 5.5 percent to 33 percent of your neighbors are destined for the underclass segment of our civilization.

In our wonderful land of opportunity and universal education, freedom from hunger, and social programs for every aspect of poverty, how does one arrive at adulthood without the necessary elementary three R's? The answers are legion and controversial, the remedial programs extensive, expensive and endless, but 10 million have confounded the authorities and they exist, a burden to themselves and society.

Thus, it seems as if most educational pundits, when they issue their profound papers on our educational ills, zero in on the illiterates as the major challenge to our well-being and the arena in which one must fight bravely with unlimited funds and vigor.

A very minor role

Well, I for one disagree with this popular belief. Frankly speaking, the functional illiterates play a very minor role in our social fabric. No matter how complex and intricate our world can become, there always will be tasks that only need a live body doing physical work guided by verbal instructions.

To achieve the highest level of prosperity and good living for all, we should concentrate our educational efforts on the *scientific* illiterates among us.

The designation "scientific illiterates" is rarely mentioned. Perhaps I may be guilty of coining yet one more term. My description of a scientific illiterate is "a person who possesses the ability to gain an education in reading and writing but deliberately bypasses the study of science because it is too difficult or too demanding of his time that he might otherwise spend in the pursuit of pleasure." (Do not mistake my use of the masculine gender; the feminine contingent is historically even more reluctant to pursue the study of science.)

Once upon a time, probably ending in the '30s, our schools demanded attendance in predetermined curricula, without options, to achieve the old-fashioned concept of a rounded education.

Taking a nosedive

Apparently, following World War II, the students were allowed to elect their own menu of simplistic studies, the school year got shorter, the teachers unmotivated, and correspondingly the study of science took a nosedive. What few science courses survived were non-mathematical, full of entertaining tricks to entice the student to enroll and devoid of any solid material.

The inevitable result: Our upper echelon of intellectuals are scientific illiterates. They are the cream of our country, to whom we must look for leadership and prosperity, and what do they have to offer us? Scientific ignorance. Admittedly, I haven't taken the time to research this subject in detail and, as I have previously stated, it is not recognized and documented as our major educational disease. But we can look at some of the more obvious problems arising from it.

We all can agree that science increasingly is the basis of our standard of living and survival in today's world. Gone are the plowshare and the sword; instead, the computer and the laboratory determine our future. One would believe that our leaders must be knowledgeable in science to understand the new technology and thereby able to competitively choose the path for the future.

Let us start with the judicial system. I have never seen a judge with a science education and, from my experience in the federal courts right through the Supreme Court, they all may be expert in law but are relatively as naked in scientific studies as the aforementioned functional illiterates who are unable to read and write.

How about Congress? It's full of lawyers, football players, basketball players and more lawyers. Can they decide on their own the wisdom of a legislative proposal on weapons, environment or the use of our scarce radiation spectrum? Not likely!

I believe there is one governor who is a scientist. He must feel lost in the company of his fellow governors, most of whom are scientifically illiterate lawyers.

Town fathers

If you still have the stomach for it, look at your town fathers, preponderantly lawyers in my own town, and I suspect the same is true in yours. I doubt if they voluntarily ever took a science course just to enjoy the thrill of learning how our universe is constituted. Yet our zoning laws, sewers, water and environment are dictated by these scientifically illiterate individuals.

Even our beloved Federal Communications Commission, which monitors one of the most difficult, demanding and technical tasks in Washington—the use of the radio frequencies—has not had an engineer as a commissioner since ancient times. Imagine the light that would glow in those hallowed halls, if by some miracle we had a new team composed of Bailey, Ciciora, Johnson, Taylor and Stern!

Thirty percent of college graduates go on to teaching. Judging by the flood of critical studies of teacher colleges appearing in our newspapers, standards are pitiful for graduation—and science courses are invisible. It seems that they are taught the technique of teaching without studying the subjects to be taught.

How can we persuade our students to forego the fleshpots of our decadent schools and study the 70 hours weekly that prevail in several work-oriented countries? I don't have the answer, but I can predict the result: The scientific illiterates will wind up with a living standard marginally superior to the functional illiterates.

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Reader Service Number 8.

Boosters for CARS band microwave systems

By Eric G. Pastell
And Dr. Thomas M. Straus
Hughes Aircraft Co., Microwave Products Division

Broadcasters for years have used two types of radio relay devices, active and passive repeaters, to circumvent obstacles in the transmission paths of studio-transmitter links (STLs) and intercity relay (ICR) stations. Passive repeaters require no power input and simply change the direction of the microwave signal in the same way a mirror reflects a beam of light. Active repeaters not only redirect the signal, but also amplify and retransmit it on a different frequency than the received signal.

In March 1984 the Federal Communications Commission authorized the use in the United States of nontranslating active repeaters, called *boosters*, for all broadcast auxiliary microwave services[1]. A booster is a class of unattended fixed relay station whose output frequency is the same as the input frequency. Microwave boosters possess characteristics of both active and passive repeaters in that they simply amplify the signal and use the same frequencies for both reception and retransmission. Boosters previously have been used in the VHF and UHF bands to retransmit the signals of a primary broadcast station to an area otherwise unable to receive it. By its action, the FCC sought to make boosters available as a low-cost and spectrum-efficient alternative to the problem of microwave path obstruction.

Steady improvements in gallium arsenide (GaAs) FET (field-effect transitor) technology over the past few years have led to the development of advanced low-noise Ku-band GaAs FET devices with the gain, bandwidth and power necessary for 13 GHz microwave applications. These devices are used to produce both low-noise amplifiers (LNAs) with noise figures in the order of 3 dB and linear broadband power amplifiers with 1 dB compression in excess of 1 watt.

Hardware description

In its simplest form, the booster is just a 2 watt GaAs FET amplifier with input and output isolators, harmonic and band-limiting filters, and power supply housed in an outdoor enclosure. Figure 1 shows the block diagram of this basic configuration. The power amplifier provides a nominal 28 dB of gain and a 3 IM intercept point of 41 dBm with an 11 dB noise figure. The input filter limits potential interference due to out-of-band signals that may leak into the booster input through a side lobe of the receive antenna. The 12 volt power supply is a DC-to-DC converter that accepts an unregulated 19 to 35 volt input from either a standard DC supply or from a solar power source when the booster is located in a remote environment. The booster is packaged in a modified CATV trunk amplifier housing.

The performance of the basic booster can be improved by adding a low-noise driver amplifier

Figure 1: Basic microwave booster

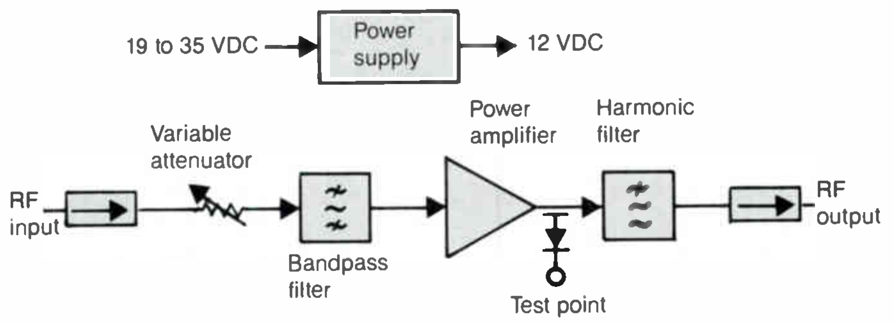


Figure 2: Microwave booster with LNA

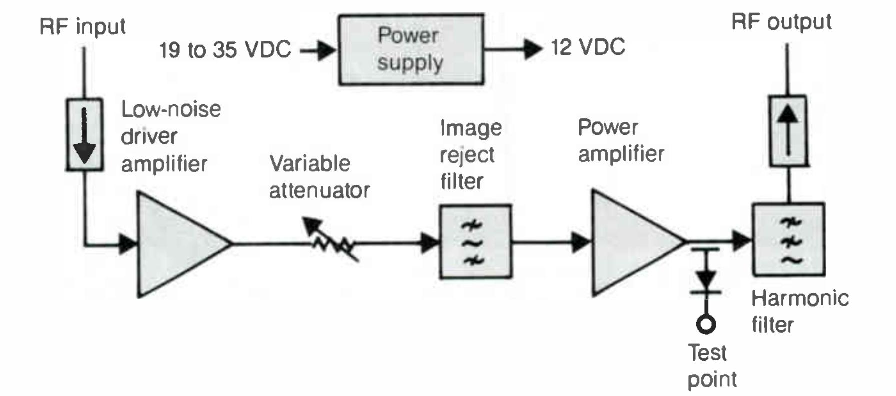
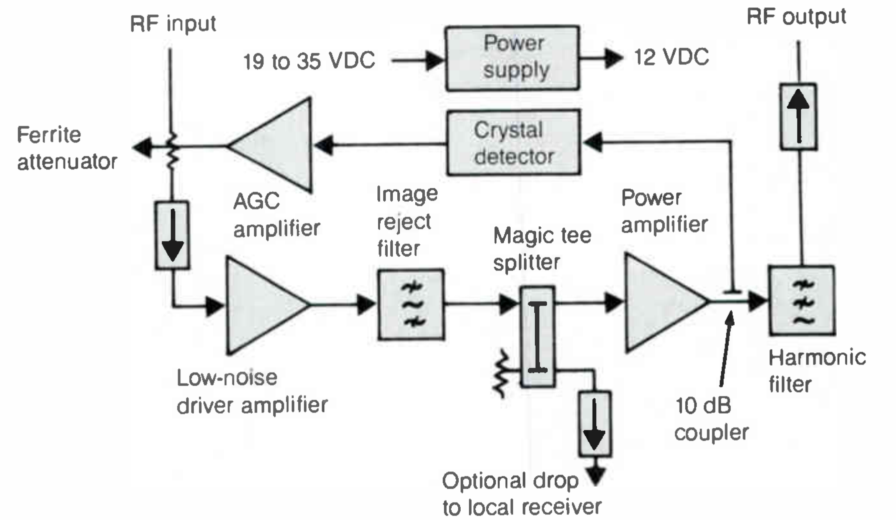


Figure 3: Microwave booster with AGC and local drop



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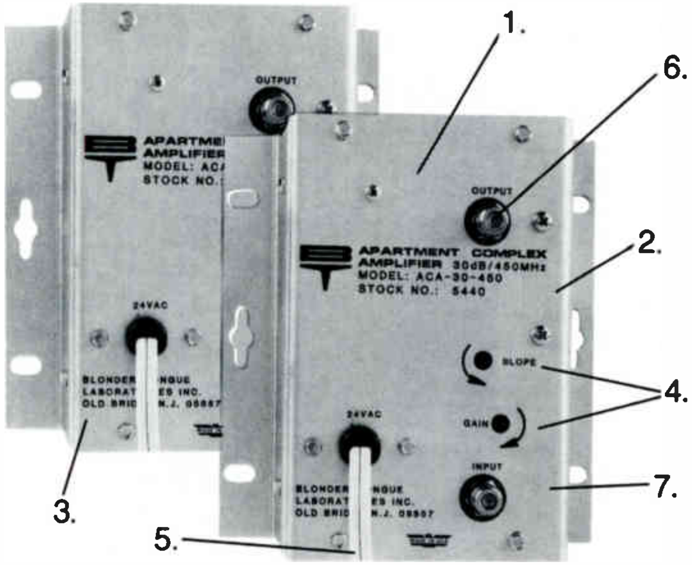

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Reader Service Number 9.

Table 1: Microwave booster parameters

	Basic booster	w/1-stage LNA	w/2-stage LNA, AGC	w/2-stage LNA, AGC, local drop
Nominal max. gain (dB)	26	33	40	37
Noise figure (dB)	12.5	7.6	5.7	6.3
3 IM intercept (dBm)	40	39	39.5	39
Max. input for 35 ch. 65 dB CW CTB (dBm)	−33	−41	−47.5*	−45*
C/N at max. input (dB)	62.5	59.4	54.8	56.7
Local drop:				
Max. gain (dB)				10
Noise figure (dB)				4.8
3 IM intercept (dBm)				20

*With AGC disabled

Table 2: Microwave booster typical output power for VSB-AM channel loading*

No. of channels	Power output (dBm/ch.)
6	0
12	−3
24	−6
35	−8
54	−10
60	−11

*For 65 dB CTB *measured with CW carriers*. Power output would be 4 to 6 dB greater if specification were given for modulated carriers.

ahead of the power amplifier to increase the overall gain of the unit and lower its noise figure. The driver amplifier is either a single- or dual-stage GaAs FET LNA with a nominal gain of 7 or 15 dB, respectively, and a noise figure less than 4 dB. Figure 2 shows this configuration.

Although the power amplifier's contribution is not entirely negligible, the noise figure of the driver amplifier and the subsequent overall booster gain primarily determine the output noise of the booster. On the other hand, the overall 3 IM intercept point of the booster is determined primarily by the output amplifier with only a small degradation introduced by the LNA. In applications where a local signal drop is desired at the booster location to feed a receiver, a magic-tee power splitter is inserted between the filter and output amplifier. In this case, the filter serves to reject the LNA image frequency noise[4], as well as to limit the frequency band of the otherwise wideband FET amplifiers. When the magic tee is added, the overall gain of the booster is decreased 3 dB, but the noise figure is degraded only slightly because the splitter loss follows the gain of the driver LNA.

An optional microwave AGC (automatic gain control) circuit further improves the overall performance of the booster and increases its utility. A simplified block diagram of the booster with optional two-stage LNAs and AGC is shown in Figure 3. The AGC is designed to maintain a constant output level for up to a 25 dB range of incoming microwave signal. In AGC, the booster C/N (carrier-to-noise) and third-order distortion are constant. The usual two-for-one tradeoff of these two parameters is obtained by adjustment of the AGC set point. The AGC adjustment sets the output C/N of the booster under unfaded conditions to a constant value that can be varied between about 50 to 60 dB.

The AGC circuit operates in the following manner: The output of the booster is sampled by a 10 dB coupler and fed to a temperature-compensated crystal detector, which supplies a control voltage to an AGC amplifier. The insertion loss of a ferrite attenuator at the input of the booster is controlled electronically by the AGC amplifier to maintain a constant input signal level to the LNA. In practice, the AGC range is determined by both the maximum signal level available at the input of the booster and the selected AGC set point. Although AGC is not provided in Figures 1 and 2, the selection of the clear-weather operating point can be fine-tuned by the attenuator setting. Table 1 summarizes key specifications including the nominal gain of the various booster configurations when the attenuator is set for minimum loss.

Booster applications

Boosters primarily are used for redirecting or "bending" microwave signals around obstructions such as buildings, trees and hills. In this application, they provide an efficient alternative to the construction of additional microwave repeater stations, with substantial savings in both cost and spectrum since they are non-translating amplifiers.[1]

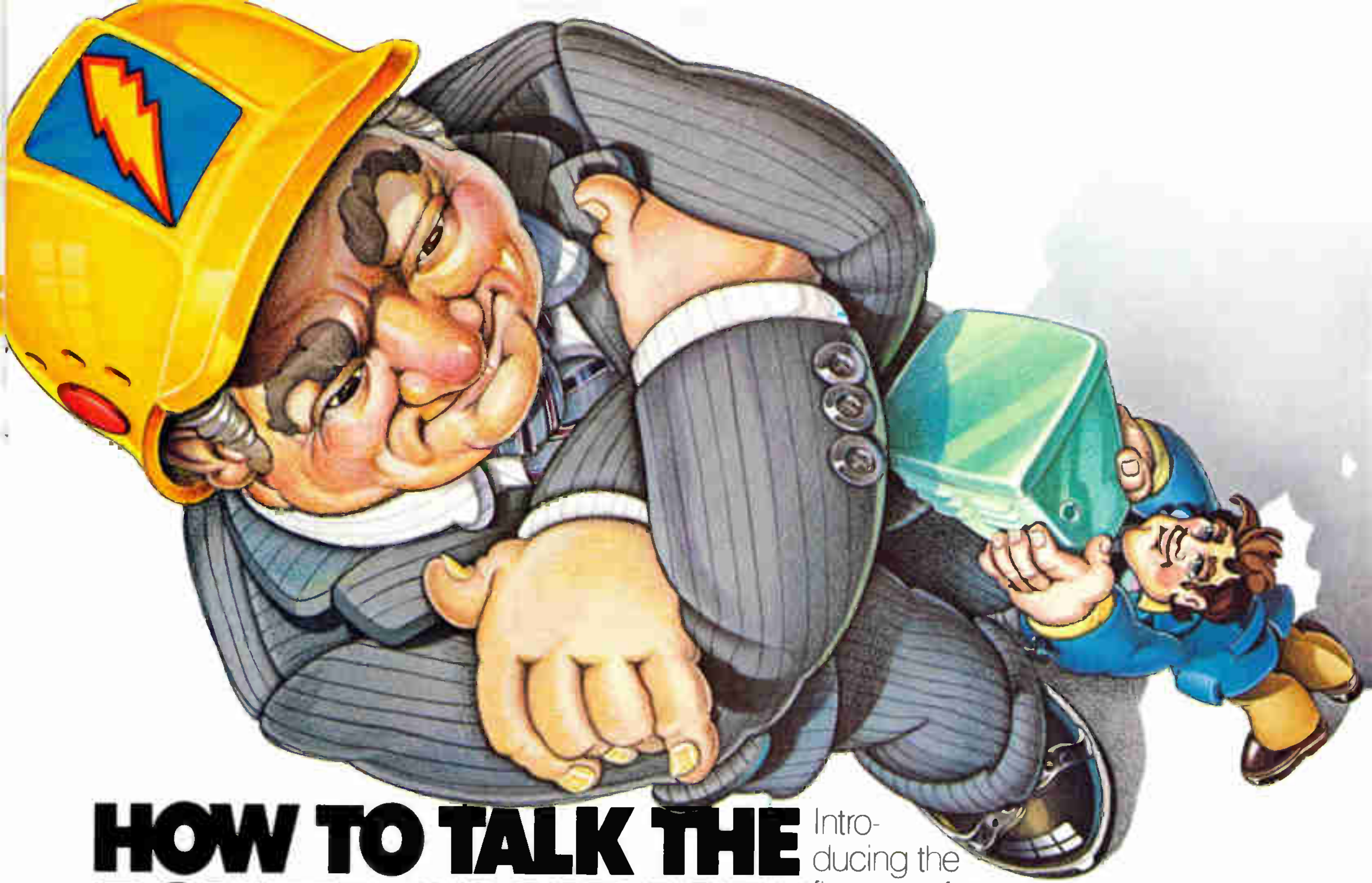
As active devices, boosters also can provide performance and cost advantages over passive reflectors. For the CARS band at 12.8 GHz, a booster with a nominal gain of 40 dB used with two 8-foot antennas has about 30 dB more overall system gain than a small passive reflector, and

Table 3: Example path calculation for basic booster

Transmitter output power	35 channels (dBm/ch.)	9.0
Transmit elliptical waveguide	25 feet	−0.9
Transmit circular waveguide	200 feet	−2.8
Transmit antenna	10 feet	48.8
Free space loss	10 miles	−138.8
Booster input antenna	10 feet	48.8
Booster elliptical waveguide	5 feet	−0.2
Field factor		−2.0
Booster input		−38.1
Booster noise figure	12.5 dB	
Booster gain		26.0
Booster output		−12.1
Booster elliptical waveguide	5 feet	−0.2
Booster output antenna	8 feet	47.6
Free space loss	2 miles	−124.8
Receive antenna	8 feet	47.6
Receive elliptical waveguide	5 feet	−0.2
Receive circular waveguide	0 feet	0.0
Receiver input AGC attenuation		−3.0
Field factor		−2.0
Receive carrier level		−47.0
Receiver noise figure	7 dB	

Transmitter C/N	80.0	Booster CTB	75.1
Booster C/N	57.4	Receiver CTB in AGC	76.1
Receiver C/N in AGC	54.0	*Overall CTB in AGC [+]	72.6
*Overall C/N in AGC [+]	52.3		

[+] Denotes power addition
*Microwave system C/N and CTB to be combined with values of headend (or other transmitter input).



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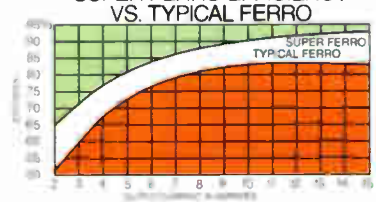

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Figure 4: Two-for-one tradeoff of CTB for output power in booster

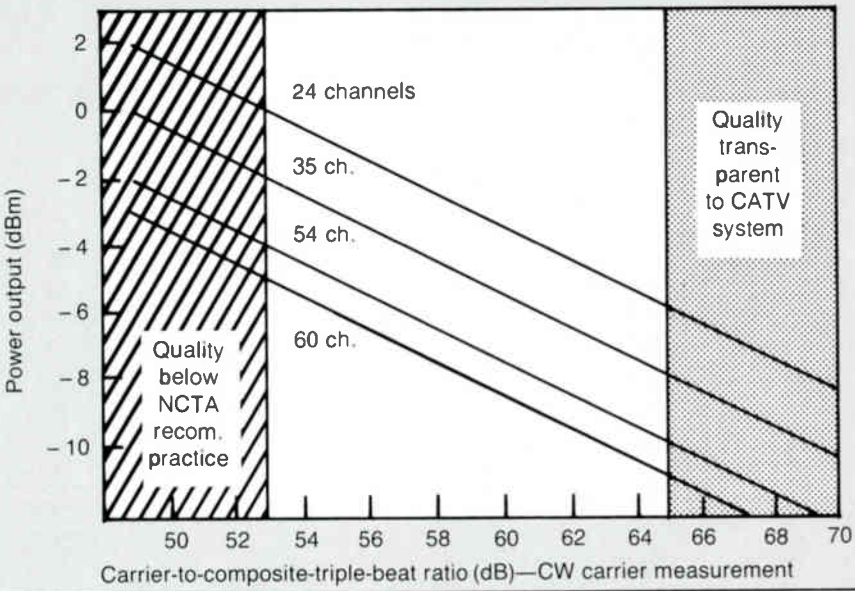

Table 4: Example path calculations for booster with two-stage LNA and AGC

Transmitter output power	35	channels (dBm/ch.)	18.0
Transmit elliptical waveguide	50	feet	-1.9
Transmit circular waveguide	200	feet	-2.8
Transmit antenna	10	feet	48.8
Free space loss	20	miles	-144.8
Booster input antenna	10	feet	48.8
Booster elliptical waveguide	5	feet	-0.2
Booster input AGC attenuation			-11.0
Field factor			-2.0
Booster input in AGC			-47.0
Booster noise figure	5.7	dB	
Booster gain			40.0
Booster output in AGC			-7.0
Booster elliptical waveguide	5	feet	-0.2
Booster output antenna	10	feet	48.8
Free space loss	10	miles	-138.8
Receive antenna	10	feet	48.8
Field factor			-2.0
LNA input			-50.4
LNA noise figure	3.7	dB	
LNA gain			15.0
Receive elliptical waveguide	100	feet	-3.7
Receive circular waveguide	0	feet	0.0
LNA image noise reject filter			-0.5
Receiver input AGC attenuation			-2.4
Receive carrier level			-42.0
Receiver noise figure	10	dB	

Transmitter C/N	63.0	Booster CTB in AGC	63.0
Booster C/N in AGC	55.3	LNA CTB	87.1
LNA C/N	53.9	(+)	62.5
Receiver C/N in AGC	56.0	Receiver CTB in AGC	79.4
*Overall C/N in AGC [+]	50.0	*Overall CTB in AGC [+]	62.4

[+] Denotes power addition
(+) Denotes voltage addition
*Microwave system C/N and CTB to be combined with values of headend (or other transmitter input)

about 10 dB more far-field system gain than the largest practical reflector size of 30 by 48 feet. Moreover, the gain of a reflector decreases as the included angle between the incident and reflected signal increases. At a 130° angle, the booster exhibits an additional 7.5 dB advantage over the passive reflector. For angles greater than 130°, double passive repeaters normally are required.

A secondary use for a booster is to extend the length of a microwave path to expand a system, especially from an established receiving station. In this application the optional splitter is used to provide a local microwave drop to feed the receiver, and the booster is equipped with a two-stage LNA. Thus, an existing receiver automatically benefits from the addition of the LNA in the booster (usually with AGC), which lowers the receiver's effective noise figure. A booster also may be used to implement two tandem links in some applications where a direct path proves slightly longer than practical, or where tower heights at the end stations are limited.

In planning two tandem paths using a booster, care must be taken to prevent the possibility of overreach interference.[5] This occurs when the signals from the transmitter on the first link reach the receiver on the second link, causing frequency-dependent constructive or destructive self-interference. In many cases, overreach is prevented by physical terrain blockage between the end stations. For site configurations where line-of-sight can exist, the system should be designed to provide at least a 40 dB carrier-to-interference ratio into the receiver. This design goal easily can be achieved by antenna discrimination if the two links are assigned opposite polarizations, and the transfer angle at the booster repeat station (i.e., change in azimuth) is kept greater than about 10° so that the two links are not almost directly in line.

In all booster applications, the input and output antennas must be isolated from each other to prevent uncontrolled feedback. To ensure that the amplitude ripple induced by self-interference is less than ±0.1 dB, this port-to-port isolation should be at least 40 dB greater than the nominal booster gain. Thus, if the booster gain is 40 dB, 80 dB of near-field antenna isolation is required. The near-field isolation between two parabolic antennas mounted on the same structure does not vary significantly with their sizes or polarizations, but depends on their azimuth difference and physical spacing. For all practical CARS band applications, antenna isolation of 80 dB is readily achievable, and usually the isolation will be about 100 dB.

When designing a microwave link with a booster, care must be taken to balance noise, CTB (composite triple beat) and operating power levels in order to maintain acceptable performance standards for the overall system. Power output levels usable for moderate path lengths can be obtained, provided waveguide losses are kept to a minimum. Table 2 summarizes booster output levels for a composite triple beat specification of 65 dB. The output power of the booster can be increased at the expense of CTB, as shown in Figure 4. Just as with CATV amplifiers, a normal two-for-one tradeoff exists. All CTB performances are specified with CW (continuous

wave) carriers just as for CATV amplifiers. If the specification were in terms of NTSC modulated carriers, either the CTB would appear to be an 8 to 12 dB better number, or the output power would be 4 to 6 dB higher[3,6], but the actual transmitter performance would, of course, not improve. Thus, up to 6 dB additional power output is obtainable if the Canadian Department of Communications BP-23 measurement is applied in place of the CW carrier technique[7].

The maximum allowable input level for boosters without AGC is just the maximum output level (based on allowable CTB) less the overall (adjustable) gain of the booster. This is also the *required* clear-weather input level for purposes of obtaining the desired output. For a booster with AGC, the normal two-for-one tradeoff between C/N and CTB can be made by adjustment of the AGC set point.

'In all booster applications, the input and output antennas must be isolated from each other to prevent uncontrolled feedback'

One example of a typical booster application is summarized by Table 3. In this instance, the basic microwave booster configuration of Figure 1 is utilized. The primary 10-mile path is fed by an MTX-132 transmitter with 35 channels. The booster "bends" this path and extends it by three miles to an AML (amplitude modulated link) receiver equipped with an internal single-stage LNA. Note that the net CTB is greater than 72 dB and C/N is almost 52 dB in clear weather. If either portion of the path fades, the C/N will degrade 1 dB for each dB of rain or multipath attenuation.

A second example utilizes the booster configuration of Figure 3, which includes a two-stage driver LNA and AGC. The results are summarized in Table 4. In this example, a two-stage LNA also is used at the receiver, outside of its AGC loop for the lowest possible noise figure. The CTB of the receiver and its external LNA will further degrade the CTB generated by the booster. Overall system CTB is calculated by first separately voltage-adding the VHF and microwave contributions, and then power-adding the resultant sums.

In this example, the AGC would hold the repeater output constant for 11 dB rain fade while maintaining the repeater C/N and CTB constant at the desired clear-weather values. Without the AGC option, the repeater input must be padded down (i.e., use smaller antennas) or the repeater gain reduced. In either case, the overall link has much more "outage" time for C/N less than 35 dB, and perhaps even more significantly much more time with C/N in the 35 to 43 dB region where overall cable system quality would be noticeably degraded. This example shows that a repeater with AGC is particularly useful when the first leg of the microwave path is much longer than the second, and when the received signal level at the repeater site can be much higher than −47 dBm.

Useful tools

CARS band microwave boosters are low-cost non-translating microwave amplifier stations that can be useful tools in overcoming problems of path obstructions. The booster characteristics including gain and noise figure should be matched to the application. Features such as microwave AGC and a local drop to feed a receiver can be provided. The design of a microwave link using a booster depends on a number of factors and involves tradeoffs in gain, output power, C/N and CTB performance. Careful engineering is required to optimize the overall system design.

This article was presented as a paper at the 1986 Canadian Cable Television Association convention and expo in Vancouver, B.C.

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[6] J.M. Hood, "Design Considerations for Composite Triple Beat," *IEEE Transactions on Cable Television*, Vol. CATV-2, No. 1, January 1977.
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CABLE-TEC EXPO 1987
AND ANNUAL ENGINEERING CONFERENCE
FACT SHEET

DATES: Annual Engineering Conference, April 2, 1987

Cable-Tec Expo, April 3-5, 1987

LOCATION: Hyatt Orlando Hotel - Orlando, Florida

HISTORY: Cable-Tec Expo '87 is the fifth annual convention/tradeshow sponsored by the Society of Cable Television Engineers, Inc., combining a wide variety of technical programs, hands-on training and breakout technical workshops with non-commercial hardware exhibits. The Annual Engineering Conference will be the SCTE's eleventh yearly conference dedicated to current engineering issues, FCC compliance and technical management. In addition, the Society has presented more than 60 technical programs in cities across the United States over the past fifteen years, attended by more than 11,000 engineering and technical personnel from the broadband communications industries.

ATTENDANCE: Attendance is open to individuals within the CATV industry as well as anyone involved in the broadband communications industries. Over 1,000 registered attendees are expected from all levels of the cable television and related businesses: persons engaged in engineering, construction, management, design, installation, technical direction or administration of cabled broadband, microwave, broadcasting, satellite, institutional, telephone, data or closed-circuit communications systems; persons employed by educational institutions, federal, state and local governments, regulatory agencies and related trade organizations are invited.

PROGRAMS: The Annual Engineering Conference will be packed with six hours of technical and management papers presented by many of the industry's engineering leaders. The annual membership meeting, scheduled during the conference luncheon, will afford attendees the opportunity to meet members of SCTE's Board of Directors. Awards also will be presented at the luncheon for "Member of the Year," as well as the "President's Award."

The 2½ day Cable-Tec Expo follows the Annual Engineering Conference and combines practical workshops with "hands-on" technical training and hardware displays. The format features many schoolroom style workshops to choose from. No other activities are scheduled during workshop sessions in order to guarantee maximum attendance and participation.

EXHIBITS: The exhibit floor has been designed to provide industry suppliers with the opportunity to present live technical demonstrations of their products in a relaxed and non-commercial atmosphere.

Over 100 hardware exhibitors are expected to participate in the 1987 Cable-Tec Expo. Exhibits will include all types of products, supplies, services and equipment used in the design, construction, installation, repair, maintenance and operation of cable television systems. The exhibit floor will also feature a Technical Training Center for further equipment demonstrations.

SPECIAL EVENTS: The Florida Cable Television Association and SCTE's Florida Chapter will sponsor a welcome reception on April 2. NASA space shuttle commander Paul Weitz will be guest speaker during the Engineering Conference. Friday night, April 3, features the main social event — the Expo Evening — at Medieval Times. Dress for the Expo Evening is casual. Scheduled for Sunday, April 5, is the administration of Broadband Communication Technician and Engineer (BCT/E) Professional Designation Certification Program examinations. In addition, a special "Behind the Scenes" tour of technologies employed by Walt Disney World and Epcot Center will be available to Expo attendees at an extra charge (see registration form).

PRELIMINARY PROGRAM

Engineering Conference

-Lightning and Grounding
Dr. Rodney Bent, Consultant for NASA

-Consumer Interface Issues
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-A Technical Evaluation of Competing Technologies
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-Developing a Corporate Training Program

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-Headend Antenna Theory and EMI Reduction

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-Baseband Video Test Equipment Measurements and Modulator Alignment

-A Technical Evaluation of Pay TV Security

-Q. and A. Session with FCC Engineers

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SCHEDULE OF EVENTS

Wednesday, April 1, 1987

5:00 P.M. - 8:00 P.M.	Annual Engineering Conference Registration

Thursday, April 2, 1987

8:00 A.M. - 9:00 A.M.	Conference Registration
9:00 A.M. - 5:00 P.M.	Engineering Conference and Annual Membership Meeting
4:00 P.M. - 6:00 P.M.	Cable-Tec Expo Registration
6:00 P.M. - 8:00 P.M.	Welcome Reception (sponsored by the Florida Cable Television Association and the SCTE Florida Chapter)

Friday, April 3, 1987

8:00 A.M. - 4:00 P.M.	Registration
8:30 A.M. - Noon	Hands-On Workshops
Noon - 5:00 P.M.	Exhibit Hall Open
7:00 P.M. - 11:00 P.M.	Expo Evening

Saturday, April 4, 1987

8:30 A.M. - Noon	Hands-On Workshops
Noon - 5:00 P.M.	Exhibit Hall Open
4:00 P.M. - 5:00 P.M.	Exhibitors' Reception

Sunday, April 5, 1987

8:30 A.M. - Noon	BCT/E Certification Program Examinations
9:00 A.M. - 12:30 P.M.	"Behind the Scenes" technical tour of Walt Disney World (optional at extra charge — 200 persons maximum)
1:30 P.M. - 5:00 P.M.	"Behind the Scenes" technical tour of Walt Disney World (optional at extra charge — 200 persons maximum)

CABLE-TEC EXPO '87 REGISTRATION FEES
UNCHANGED FROM 1986

	Until March 2, 1987		On-Site	
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EXPO only**	$145 00	$250.00	$165.00	$270.00
Engineering Conference only	$120.00	$200 00	$140.00	$220.00
Spouse Registration *		$ 95.00		$ 95.00

ADMISSIONS: Admission to all events will be color coded badges received at the registration desk upon arrival

* Includes tickets to the Membership Luncheon and Expo Evening

**Includes 1 ticket for the Expo Evening Additional tickets are available at $50.00 each.

Lunch Service at special prices will be available Friday and Saturday on the exhibit floor for your convenience.

TRANSPORTATION: SCTE has designated Eastern Airlines and United Airlines as the Expo's official air carriers. Discounted coach and "Supersaver" air fares have been arranged and National Rent-A-Car is offering special rates to attendees (see enclosed brochures) Transportation from Orlando Airport to the hotel can be economically gained through Airport Limousine Service (located near the baggage claim) for approximately $8 00

PLEASE NOTE — Although you may be able to locate equally priced air fares through your local travel agency, SCTE receives credit for all flights booked through the toll-free numbers listed in the enclosed brochures — even if your travel agent uses them to make your reservations. Your doing so will help us greatly by cutting costs in flying out engineers from the FCC and instructors for Expo workshops. Additionally, your local travel agent can receive an additional 5% OFF Supersaver fares on United by ordering your tickets using these toll-free telephone numbers.

LODGING: The Hyatt Orlando Hotel is offering special attendee room rates
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ENTERTAINMENT: The Orlando Visitors Bureau will provide attendees with guides to area dining, nightlife and sightseeing activities Spouse programs will also be available on April 2, 3 and 4.

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INSTRUCTIONS

1. **Deadline:** Cable-Tec Expo '87 Registration Forms must be received by SCTE National Headquarters on or before March 1, 1987. Forms received after that date cannot be processed and will be returned to sender. If you do not pre-register for the Cable-Tec Expo in advance, you must register on-site in Orlando
   *Use a separate form for each individual (forms may be copied).
   *Appropriate registration and activity fees must be enclosed for this form to be processed.
   *Hotel reservations must be sent directly to the Hyatt Orlando Hotel and must be received by March 1, 1987. (This is prime vacation season in Florida and no rooms will be held after this date unless registration cards are received.)

2. **Registration Cancellations:** All cancellations must be received in writing by SCTE National Headquarters on or before March 15, 1987 Substitutions will be accepted until March 25, 1987. A $50.00 cancellation charge is applicable to all registrations cancelled after March 1, 1987. **NO REFUNDS WILL BE GRANTED AFTER MARCH 15, 1987.**

3. Telephone requests for cancellations and substitutions will not be accepted by the SCTE National Headquarters. All requests for cancellations must be submitted in writing and received before March 15, 1987 and all requests for substitutions must be received before March 25, 1987.

4. Return the Cable-Tec Expo 1987 pre-registration form with the appropriate registration fees to:

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5. Please make flight reservations through Eastern Airlines at 800-468-7022 or United Airlines at 800-521-4041. Rental car reservations may be made through National at 800-328-7949.

6. All correspondence concerning hotel reservations should be made directly with the Hyatt Orlando Hotel at 305-396-1234

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Reader Service Number 1.

How to adjust FML microwave transmitter deviation

So often when maintaining FM microwave transmitters, it's all too easy to check output power and frequency, and make sure 1 volt of video is present at the transmitter's baseband input. But somewhere in the shuffle, deviation just doesn't get checked. This article addresses a method of setting FM deviation—one that is relatively easy and extremely accurate.

By Ron Hranac
Corporate Engineer, Jones Intercable Inc.

Frequency modulation (FM) is a communications technique developed some 50 years ago to overcome the problems of noise and static common to amplitude modulation (AM) communications. In FM, the modulating intelligence is conveyed by changing the frequency of an electromagnetic signal, as opposed to AM, where amplitude variations represent the transmitted intelligence.

The amount of carrier frequency change, or deviation in an FM signal, corresponds to the amplitude, or strength of the modulating signal. The rate of carrier deviation corresponds to the frequency of the modulating signal. For example, a strong modulating signal will cause the frequency deviation to be larger; the higher the frequency of the modulating signal, the more rapid the deviation will be.

AM signals contain a pair of sidebands for each modulating frequency, but an FM signal theoretically can contain an infinite number of sidebands, each spaced at integral multiples of the modulating frequency. Because of the deviation of FM carriers and their sideband content, FM signals generally occupy more bandwidth

'Insufficient deviation results in ineffective use of the RF spectrum'

than their AM counterparts. FM bandwidth can be estimated by Carson's rule, which states:

$$\text{Bandwidth} = 2(f + \Delta F)$$

where f is the maximum baseband modulating frequency and ΔF is peak FM deviation.

Bessel functions and FM deviation

The additional sidebands that occur in an FM signal are a function of the relationship between the modulating frequency and the amount of carrier deviation. This relationship, called the modulation index, is the ratio between deviation and the modulating frequency, expressed as

$$t = \Delta F/f$$

where: t = the modulation index
ΔF = carrier deviation, in Hz
f = modulating frequency, in Hz

Bessel functions mathematically describe the relationship of the amplitudes of an FM carrier and its sidebands to the modulation index. FM carrier and sideband amplitudes vary from maximum to minimum through zero with changes in the modulation index, but the RMS (root mean square) value of the amplitudes is always constant and equal to the unmodulated carrier amplitude. As deviation is increased from zero, the carrier and sidebands will go through successions of nulling to zero amplitude. The first time the carrier nulls to zero amplitude is known as the first carrier Bessel null, and occurs at a modulation index of 2.4048. Knowing this, and the modulation index relationship $t = \Delta F/f$, one can determine the required modulating frequency that will provide the first carrier Bessel null, which represents a certain FM deviation.

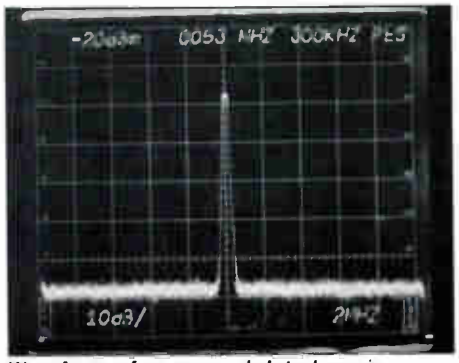
Example: What modulating frequency is required to produce the first carrier Bessel null on an FML microwave transmitter, assuming a desired 4 MHz FM deviation with 1 volt peak-to-peak baseband input level? *Solution:* Using the formula $t = \Delta F/f$, substitute the modulation index of 2.4048 for t, and 4,000,000 Hz (4 MHz) for ΔF:

$$2.4048 = 4{,}000{,}000/f$$
$$f = 4{,}000{,}000/2.4048$$
$$f = 1{,}663{,}340 \text{ Hz}$$

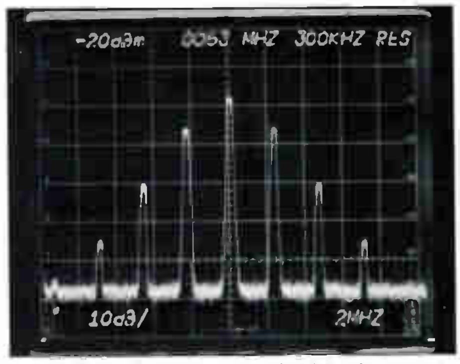
The required 1 volt peak-to-peak modulating frequency, then, is 1.66334 MHz. *(Note: If video pre-emphasis or other baseband processing is present in the transmitter, then this result will not be valid. The equipment manufacturer will have to recommend the proper frequency necessary to overcome the effects of these circuits.)*

Setting deviation

Proper deviation of an FM signal is important for several reasons. It establishes baseband unity

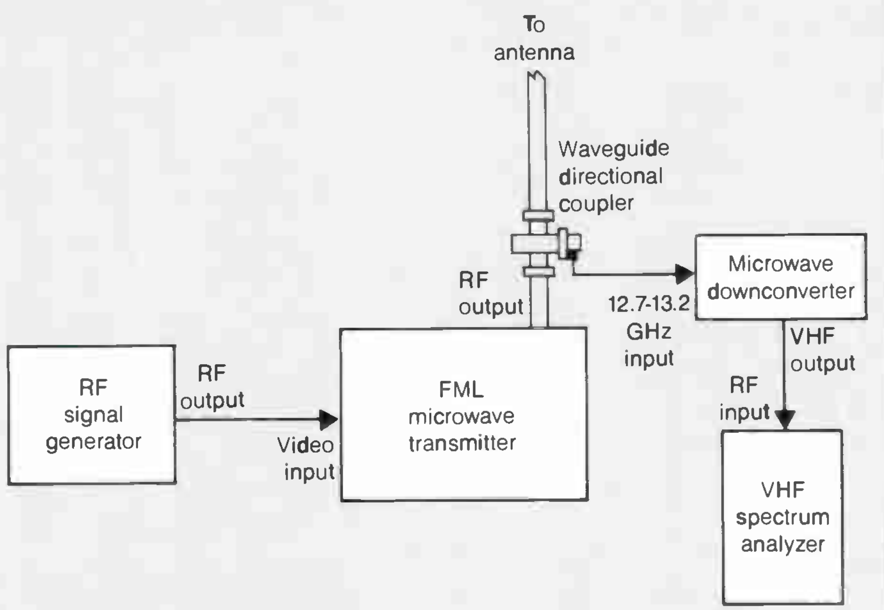


Waveform of an unmodulated carrier.



As deviation is turned up, sidebands appear, spaced at integral multiples of the modulating frequency (2.33 MHz).

Figure 1: Equipment configuration for transmitter deviation adjustment



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Until now BTSC stereo was considered by many to be too expensive. The other alternative was high churn from dissatisfied subscribers owning stereo TV sets.

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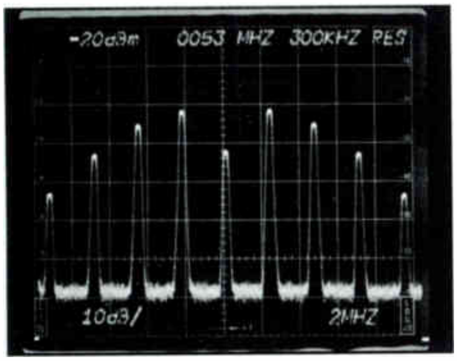
Reader Service Number 14.

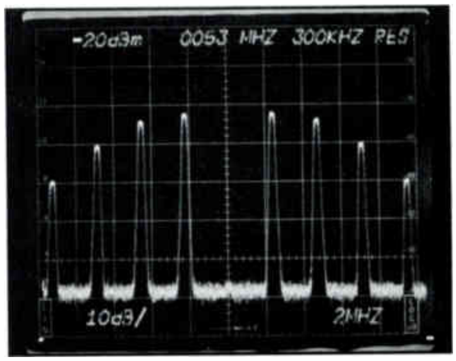


Carrier beginning to null.

gain, which will provide optimum S/N (signal-to-noise) and distortion performance. But perhaps more important, it avoids excessive deviation, which can cause signal splatter and interference. Insufficient deviation results in inefficient use of the RF spectrum. It also is wise to check new equipment, since deviation is not always adjusted correctly at the factory. Using the Bessel null technique to check and set FM deviation is among the most accurate methods available.

To set deviation on an FML microwave transmitter, the following equipment will be needed:

- Video waveform monitor or oscilloscope, terminated in 75 ohms;
- RF signal generator, 75 ohm impedance, that will generate stable CW (continuous wave) carriers in the 1 MHz to 10 MHz range;
- Frequency counter to measure the output of the RF signal generator;
- Microwave spectrum analyzer, or VHF spectrum analyzer with an external microwave downconverter that covers the 12.7 to 13.2 GHz band; and
- WR-75 crossguide directional coupler, 20 to 30 dB, to provide a transmitter test point (if the transmitter is not already equipped with one).



First carrier Bessel null indicates proper deviation.

Connect the RF signal generator to the frequency counter and set the signal generator to 1.66334 MHz (from previous example), or a frequency recommended by the manufacturer if pre-emphasis is installed in the transmitter (2.33 MHz for a M/A-COM MA-12G with video pre-emphasis). Adjust the amplitude of the RF signal generator to 1 volt peak-to-peak as measured on the terminated waveform monitor or oscilloscope (same as measuring video). Next, connect the RF signal generator to the transmitter video input, and the analyzer to the waveguide directional coupler test point (Figure 1). In some cases, it may be necessary to turn off the transmitter's automatic video sensing circuit.

Tune in the transmitter signal on the spectrum analyzer and set the analyzer controls to 10 dB/vertical division, 300 kHz resolution bandwidth and 2 MHz/horizontal division. While observing the analyzer display, turn the microwave transmitter deviation (video level) control all the way down; note the unmodulated carrier. Tune the carrier to the center of the analyzer's screen.

Slowly turn up the deviation control, noting the appearance of sidebands. As the deviation control is turned up more, the center carrier will begin to null out. When the carrier has been nulled to minimum amplitude (sidebands will remain), the transmitter deviation is 4 MHz relative to 1 volt peak-to-peak baseband input level.

Disconnect the equipment; ensure that the transmitter video input is 1 volt peak-to-peak, reconnect it to the transmitter and turn the automatic video sensing circuit back on. At the receive site, adjust the receiver video output to 1 volt peak-to-peak. The system is now at unity gain.

FM deviation adjustment can be part of the regular routine of microwave equipment maintenance. At least once a year, transmitter output power, frequency and deviation should be checked. Transmitter and receiver operating voltages, and video and subcarrier levels should be checked more often, and adjusted as necessary. Keeping tabs on all these parameters will ensure optimum CARS band operation.

Micro-Beam™ The Cable Expansion Problem Solver

Channel Master® MICRO-BEAM™ is a flexible, cost-effective CARS-band microwave relay system designed to solve the cable expansion problem facing today's cable operators.

That's why some of the top MSO's like, United Cable, Centel Cable, Cable Entertainment, Sonic Communications and Telescripts, use MICRO-BEAM™ as an alternative to the more expensive systems on the market today.

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MICRO-BEAM™ is available in two affordable systems that can be configured in many ways to meet your systems needs. A 36-channel 300 MHz system available in 1 and 5 watts, allows many more receive sites and offers cost savings in smaller systems for as low as $46,965! The 1-watt system can transmit your signal fully loaded over 9 miles in each of four directions or 15 miles in each direction with the 5-watt system.

The 60-channel 450 MHz system also comes in 1 and 5 watts and provides the range and channel capacity larger systems demand.

For example, the 1-watt system can cover a path distance fully loaded up to 7 miles in four directions or 14 miles in one direction. The 5-watt system can carry 60-channels up to 20 miles and allows up to 4 separate receivers fully loaded up to 12 miles in each direction.

In addition to extra power, the 5-watt system utilizes GaAs FET amplification, highly stable microwave oscillator and redundancy of key components to insure reliable operation and reduce maintenance. A Status Monitor Panel, included with the 5-watt transmitter, allows remote monitoring of all system functions by bringing all test points to the headend or tower base.

The rugged transmitter unit is housed in a heavy-duty weatherproof housing designed for pressurization. The transmitter is cable powered, and operates in temperatures ranging from -50°C to +60°C, with humidities up to 100%.

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With MICRO-BEAM™ you can expand your system cost-effectively because there are no "hidden costs" for optional equipment and services, so you get more for your money!

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- **450 MHz Transmitter**
- **Microwave Receiver**
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Because MICRO-BEAM™ is basically option free, the system you order is in stock, giving you the fastest lead time of any microwave product on the market.

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Channel Master® has added a new microwave repeater and microwave multiplier to its line of CATV equipment products, providing added versatility and cost-savings to CARS—band system expansion.

The new **Repeater** available in 1 and 5 watts, is a low noise amplifier designed to consolidate transmitter and receiver functions, allowing microwave links to be cascaded or hopped without downconverting and then up-converting the signal.

The new **Multiplier** allows the systematic addition of microwave paths to a single transmitter location without utilizing expensive and often excessive, high-powered tube type equipment. Designed with adequate gain to allow full output power over a wide range of input power, microwave paths can be added as needed, with the 1-watt delivering 60 channels up to 14 miles and the 5-watt, 60 channels up to 20 miles.

Contact us today and let our staff of qualified specialists show you how really flexible and cost-efficient your cable system expansion can be with MICRO-BEAM™.

CONTACT: Jim Crownover
Channel Master, Division of Avnet, Inc.
P.O. Box 1416, Smithfield, NC 27577
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Reader Service Number 16.

Baseband video performance testing

This is the first in a series on measuring performance levels of baseband video signals.

By Jim Schmeiser
Staff Engineer
And Terry Snyder
District Field Engineer Group W Cable Inc

As the cable TV industry continues to grow, a greater emphasis is being placed on obtaining the best quality picture available for delivery to the customer. Many technological developments in electronics have been finding an application in cable, either to increase the quantity of services or the quality of existing services. As the demand for better quality increases, so must a larger demand be placed on the technician responsible for the quality of that signal.

All TV signals begin as baseband video and are returned to baseband video at the customer's set. But what exactly is meant by the term *baseband video* and what are its components?

Definition through illustration

Let's begin with a few definitions and explanations of terms used with video. All illustrations presented and terms defined refer to NTSC (National Television Systems Committee) video. This industrywide engineering group developed the format and technical specifications for the color television signal used in the United States.

Through the accompanying illustrations, a realistic definition of terms easily can be understood. All waveforms presented are produced by a video signal generator for clarity.

Figure 1 represents two fields of composite video, which consists of blanking, field and line sync, color sync, chrominance, and luminance information. Two fields make up one frame of video and contain 525 lines of video; each field has 262½ lines. Figure 2 shows two fields of program video from a TV station after being demodulated.

Figure 3 shows two lines of video, referred to as a multiburst test signal, while Figure 4 is a display of two lines of program video from a television station after being demodulated. Figure 5 is a display of one line of video and Figure 6 is a single line of program video. Figures 7 and 8 illustrate an expanded view of horizontal blanking, showing various portions of the signal in Figure 5.

Figure 9 shows the colorburst content. The burst must have a minimum of eight cycles, the first cycle beginning where one half-cycle equals or exceeds 50 percent of the peak amplitude of the burst. Figure 10 is colorburst detail of program video.

Measuring video levels

As far as the frequency spectrum of composite video is concerned, the bandwidth is 0 to 4.2 MHz; the level of video is 1 volt peak-to-peak. To define this parameter, we use a waveform monitor with a scale marked in IRE (Institute of Radio Engineers). *Before making any level measurements, calibrate the waveform monitor according to the manufacturer's instructions.* One volt peak-to-peak of video is achieved when the peak white level is on the 100 IRE line and the bottom of the horizontal sync pulse is on the −40 IRE line.

As previously mentioned, all of the test signals are full-field test signals. Comparing this with pro-

Figure 5: One line of baseband video

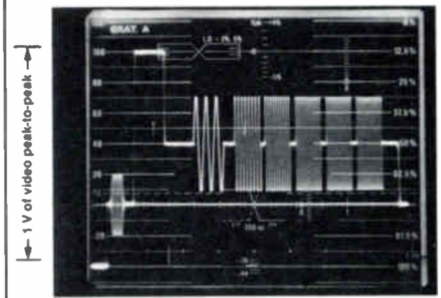


Figure 1: Composite fields of baseband video

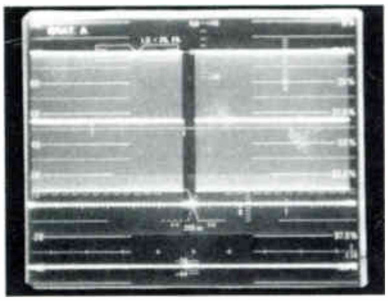


Figure 3: Multiburst test signal

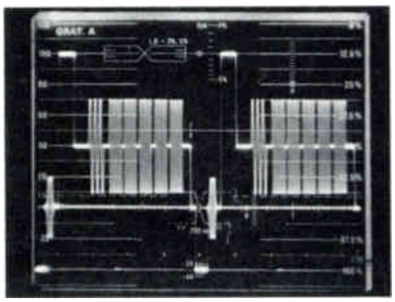


Figure 6: One line of program video

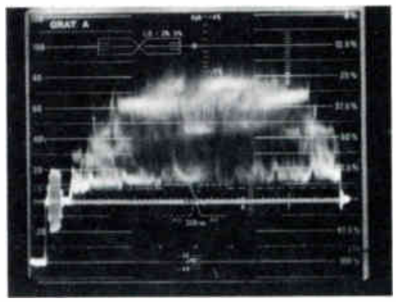


Figure 2: Demodulated program video fields

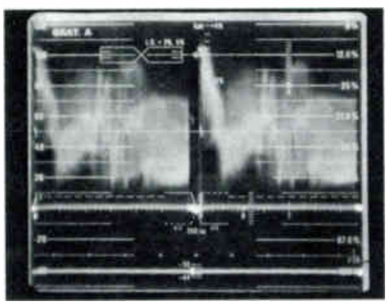


Figure 4: Lines of demodulated program video

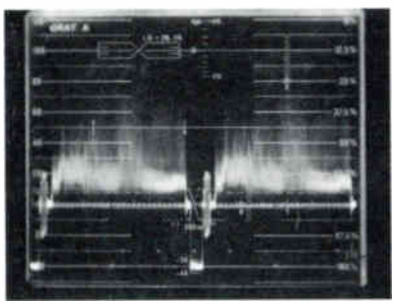
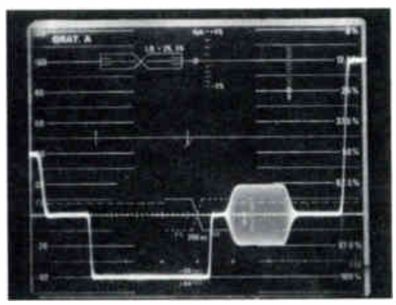
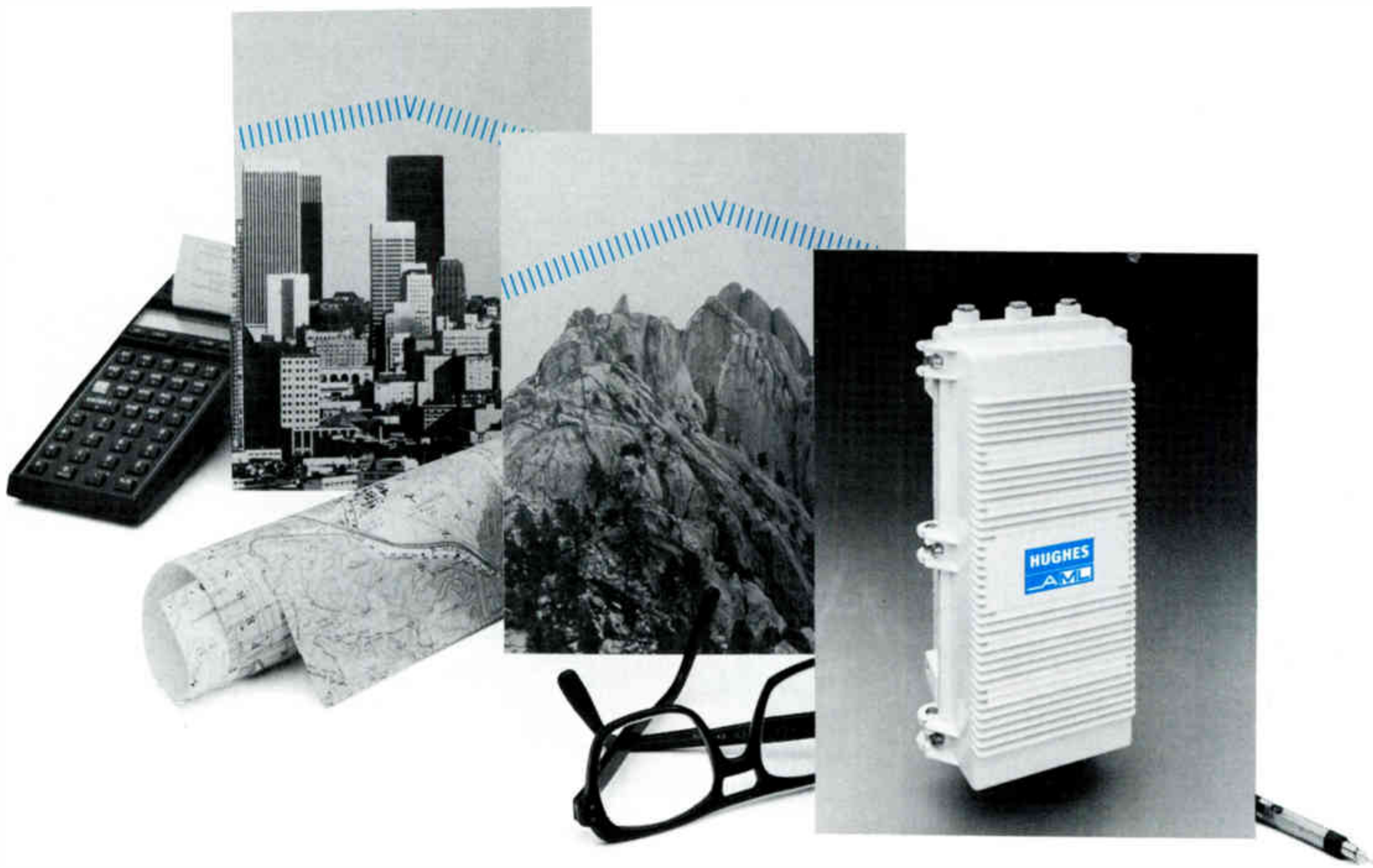
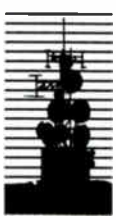


Figure 7: Horizontal blanking



FINALLY, A PRACTICAL SOLUTION TO OUT-OF-SIGHT MICROWAVE TRANSMISSIONS.





Until now, all microwave systems shared this common problem: transmissions that weren't line-of-sight often drove costs out-of-sight. But with the new low-cost Active Repeater from Hughes Aircraft Company, you can now get around those obstacles and profit from areas previously too expensive to serve.

The easy to install Hughes 2-watt MWB-122 Active Repeater is directly compatible with all CARS band transmitters and receivers including Hughes AML® systems. It is outdoor mounted, totally self-contained, and its low power requirements are easily met by a small DC or solar power source. Whether your microwave path is blocked by man-made or natural obstacles—and whether your transmission is AM or FM—the MWB-122 stands alone as your most practical solution.

This Active Repeater is the latest development in the most comprehensive line of CARS band microwave equipment available. The Hughes AML Microwave Line includes an entire selection of low, medium, and high power transmitters and receivers suitable to every application. In addition, Hughes offers the product quality, experience, and support services that really can remove all obstacles from earning greater profits.

Find out more about the Hughes MWB-122 Active Repeater. Contact: Hughes Microwave Communications Products, Bldg. 245, P.O. Box 2940, Torrance, CA 90509-2940 or call toll free (800) 227-7359, Ext. 6233. In California (213) 517-6233. In Canada: COMLINK Systems Inc., 1420 Bayly Street, Unit 5, Pickering, Ontario L1W 3R4, (416) 831-8282.

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gram video, we see that program video constantly is changing levels, giving us nothing practical with which to measure 1 volt of video. Therefore, on most broadcast signals, there has been a test signal inserted on the vertical blanking interval, known as the vertical interval test signal (VITS). This usually is found on lines 18-21 and in one or both fields.

Future topics covered in this series will include types of video waveform monitors and waveform analysis.

Figure 8: Parts of horizontal blanking

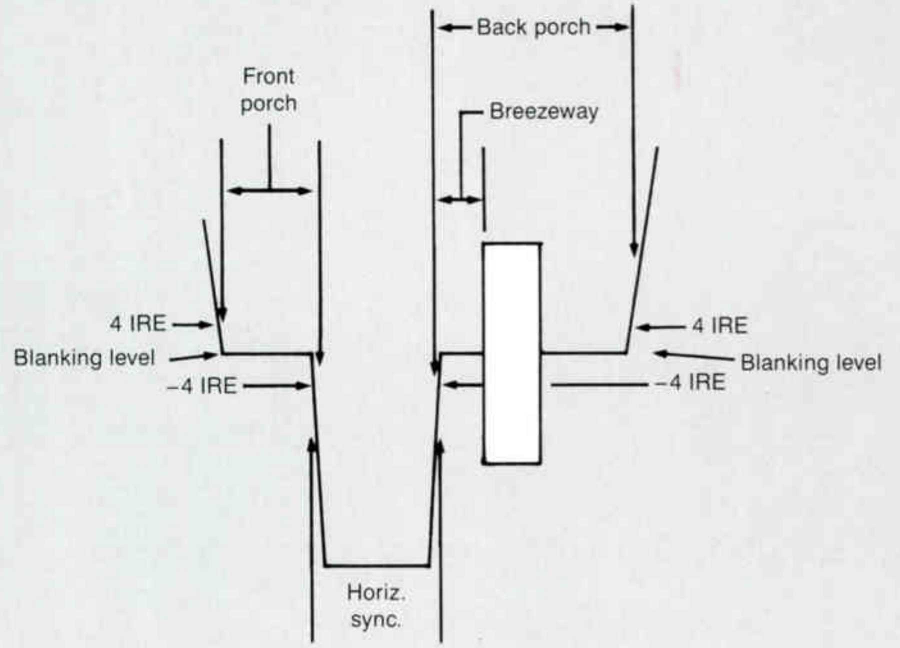


Figure 9: Colorburst content of baseband video

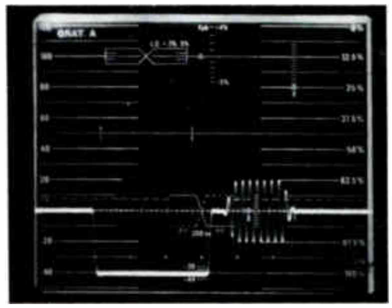
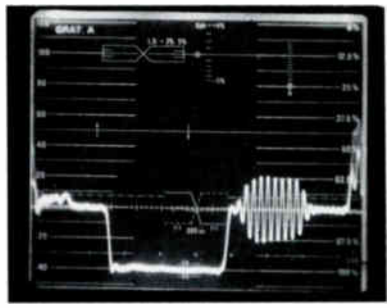


Figure 10: Colorburst content of program video



Making friends with the TDR

By Duff Campbell
Riser-Bond Instruments

The latter part of the 20th century could be called the "communications age." Not only are states and counties served to their remotest corners by telephone systems, they are becoming increasingly dependent upon other cable networks. Now we have cable TV, telex and facsimile networks, control systems for railways, plus innumerable other cable systems. There are public and private systems, large and small, using everything from twisted pairs to the latest in multicore cables. The wirescape is everywhere. Environmental pressure ensures that more and more cable is buried. With such a large investment in outside plant, major headaches can result when faults develop.

Locating a fault in a buried cable can be time-consuming and expensive if the exact location can be determined only by digging. One solution has been to utilize a time domain reflectometer (TDR) to help solve this problem. However, at the inception of time domain reflectometry, expensive and complicated high-speed oscilloscopes were used to make the time measurements. Today, microcomputer technology makes it possible to build a compact, battery-operated device that meets most of the needs of the technician at a fraction of the cost and complexity of the instruments it succeeds. Using TDRs, open and short circuits can be detected and their locations pinpointed. Other major impedance discontinuities also can be detected.

How it works

When a signal is transmitted down a properly terminated cable, the termination absorbs all of the signal. However, when a cable is not terminated in its characteristic impedance, some of the signal is reflected back through the cable to the signal source. The two extremes of improper termination are an open and a short circuit. In either case, all of the signal energy (minus the cable loss) is reflected. Conditions between these two extreme cases cause part of the signal to be reflected. TDRs send a pulse down the cable and measure the time required for reflections to return to the source. By knowing the cable's velocity of propagation (VOP), the operator can measure the actual distance from the source to the fault.

Referring to Figure 1, let us look at the building blocks that make up the TDR. A *pulse generator* transmits a narrow pulse of energy down the cable under test. A *timing circuit* measures the time between the transmitted pulse and the arrival of the reflected pulse, converts this measurement to distance—taking the VOP of the cable into consideration—and sends the information to the *digital display*. The VOP is adjustable by front panel control for the type of cable being tested.

Although the VOP probably is the most confusing and "asked about" feature of a TDR, it really is not that difficult to determine and use to your best advantage. Light travels in a vacuum at approximately 186,000 miles per second. A signal travels down a cable at a somewhat slower

Figure 1: Block diagram of time domain reflectometer

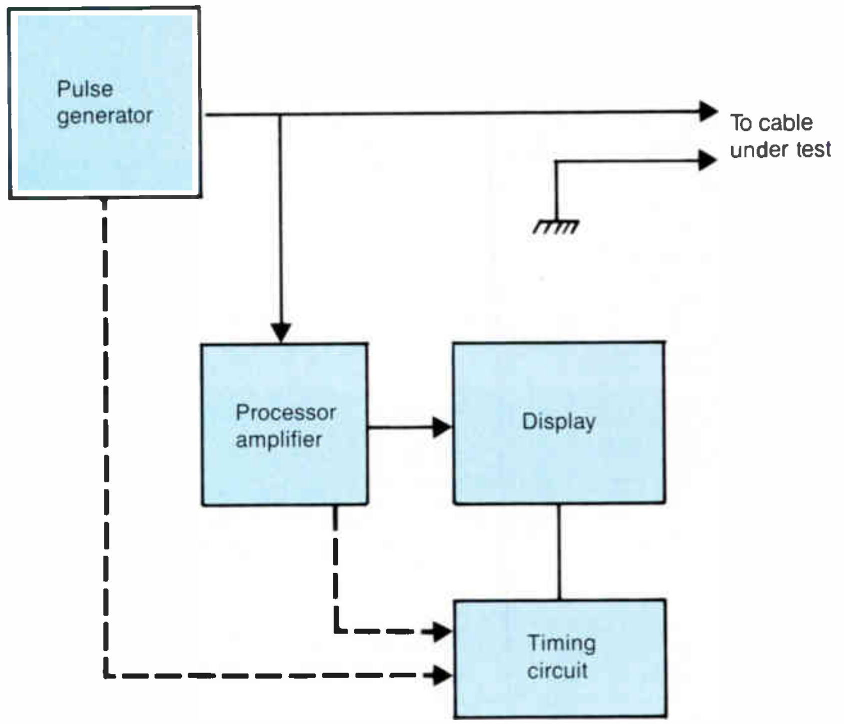


Table 1: Velocity of propagation by cable type

Manufacturer	Family	VOP
Coaxial cable		
Belden	Drop—Foam	78
	Solid	66
Capscan	Drop	82
	CC	88
Comm/Scope	Drop	82
	Para I	82
	Para II	87
	Q R	88
Trilogy	Drop	82
	MC^2	93
Scientific-Atlanta	Drop	81
	Cable Flex	87
Times Fiber	Drop	83
	T 4	88
	TR+	87
Twisted pair		
	PIC	67
	Jelly-filled	64
	Pulp	72
Power cable		
	2 conductor	68
Computer/instrumentation		
	Polyethylene	66
	Polyvinyl chloride	45
Belden	53 ohm	70
	73 ohm	70
	93 ohm	85
	Twin axial	71

rate. This slower rate is the VOP and is expressed as a percentage of the speed of light. The VOP of a signal in a cable is a function of the material that separates the center conductors from the sheath. This material is known as the dielectric.

Dielectric materials found in various types of cable include air, foam, pulp and plastic. Most cable manufacturers list the VOP for each type of cable made, usually as "VOP X%." A VOP of 0.84 thus would be 84 percent of the speed of light. Although "dielectric constant" and "VOP" sometimes have been used as interchangeable terms, the VOP is found by taking the inverse square root of the dielectric constant. If a manufacturer lists a number greater than 1.00, this would be the dielectric constant. If the number listed is 0.99 or less, it would be the VOP. Table 1 is a partial listing of cable types and their corresponding VOPs.

Sources of error

Three sources of error usually are encountered when troubleshooting with a TDR:

- *Temperature:* The VOP shown for a particular cable can vary approximately 1 percent for every 10°C of temperature change from room temperature. The lower the temperature, the higher the number usually becomes.
- *Cable:* The manufacturing run for a particular cable and the age of the cable can affect the VOP by as much as ±1 percent.
- *Instrument:* The accuracy of the TDR to make consistent and repeatable readings with very little deviation is critical.

All the factors that can affect the accuracy of faultfinding can be minimized by "normalizing out" the various errors. Because these factors contribute to fault location error, care should be taken to minimize their effect by use of the following techniques.

The first step is to locate the path of the cable using a cable locator. The length of the cable then is determined with a measuring wheel, with a length added for cable depth. Once the length is found, the VOP, as indicated by the cable manufacturer, is dialed into the TDR. The cable then is tested from both ends and the readings recorded. If the two readings added together equal the total length of the cable, you have accurately located the fault. However, if the two readings add up to a total greater or less than the known length, simply change the VOP setting and retest the cable from both ends.

Continue changing the setting until the two readings equal the known length of the cable under test. The fault location is then pinpointed. This technique assumes only one fault. If there are gross changes in the thumbwheel settings there probably are multiple faults or the cable route and length measurement may be wrong.

Another technique for determining the best VOP setting is to locate another cable identical to the one you wish to test. It is best if the cable is the same brand, same gauge, and same age and temperature as that of the cable you wish to test. The length of this cable is measured as closely as possible. The TDR is connected and the VOP setting adjusted while the display is

'Getting to know the instrument and the proper testing procedures result in greater accuracy and respect for its use'

watched. When the display shows the true length of the cable, the correct VOP for that particular cable at that particular moment has been determined. This VOP setting then is used for testing the faulty cable.

Although the VOP setting is important, it is not critical, since it can be determined as decribed previously. As with any other piece of test equipment, getting to know the instrument and the proper testing procedures result in greater accuracy and respect for its use.

Typical problems

There are many types of cable problems that can be solved by the TDR. For example, church services are shown Sunday on the local cable system. One Sunday, it was clear that the signal was not getting out. The technician first checked the transmitting equipment, finding that all was in order. The cable was next. The church is linked into the system by a 2,100-foot line. Checking from the church, the TDR indicated an open at 2,000 feet. From the other end, an open was indicated at 108 feet. With the aid of a cable locator and measuring wheel, the problem was found quickly. A new school-crossing sign erected the week before had gone right through the cable. The fault was found in just 15 minutes.

The TDR also has been found to be ideal for problem solving unrelated to cable faults. For instance, it can be used to measure cable length on reels, thus easing stock control. The TDR also is useful in identifying multiple cables into a pedestal on a new-build. By knowing where the cables should go and their approximate lengths, you can identify them by reading their lengths.

A helpful friend

As with any tool, the TDR is of little value sitting on the shelf; it must be used frequently so the technician can retain familiarity with its operation. Too often the TDR has been used only as a last resort, when it could have saved time and money when the problem first appeared. It should be kept close at hand in your service van, so that it will be readily available. When used by the technician on the job as a first resort, the TDR can become a helpful friend.

An audio metering system for CATV

By Bret Peters
Field Engineer, Tulsa Cable Television

As CATV engineers, most of us can measure video and RF parameters to the nth degree, have the equipment necessary to perform such measurements, and have stringent guidelines established by our corporations or the FCC to comply with. But aural measurements usually are confined to carrier frequency and amplitude. If each channel sounds about as loud as the local off-air stations, we call that acceptable.

There are only two instruments that are absolutely necessary to troubleshoot and monitor audio in the CATV headend: an oscilloscope and a modulation meter. The oscilloscope you already should have and you can build a modulation meter.

The oscilloscope can reveal a variety of defects in the audio channels. Some examples are clipping, noise, unbalanced lines and hum. The "o-scope" is as valuable to audio as the waveform monitor is to video. (By the way, if you use the waveform monitor at the frame rate and leave the input unterminated, you can observe audio waveforms simply by connecting a probe and looking in the appropriate locations. Try it.) If your headend is not brand new, you'll locate at least one problem the first time you look at all your sources. I wander around the headend about once a month, looking at receivers and subcarrier cards in search of just these types of problems.

The other invaluable instrument is a deviation meter. The metering found in most of the modulators that I've seen surely are meant to be just a rough guide in a pinch. Unit-to-unit tolerance is generally high.

Two kinds of meters

What is called for is a meter that allows you to change channels and observe deviation as easily as checking RF levels and video modulation depth. First, we'll examine the two main types

'Since the advent of digital audio, dynamic range has increased drastically'

Figure 1: RMS voltage vs. peak voltage

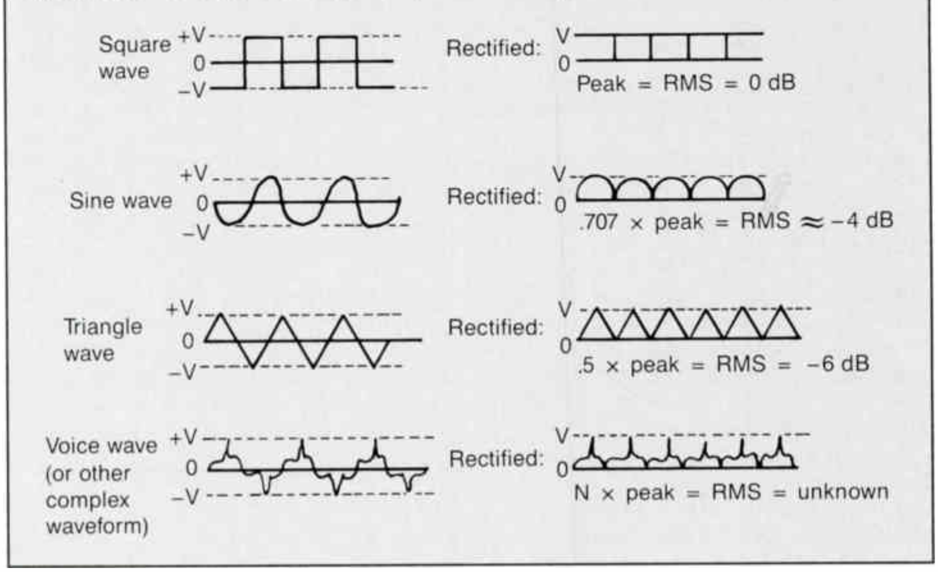


Figure 2: Integration time

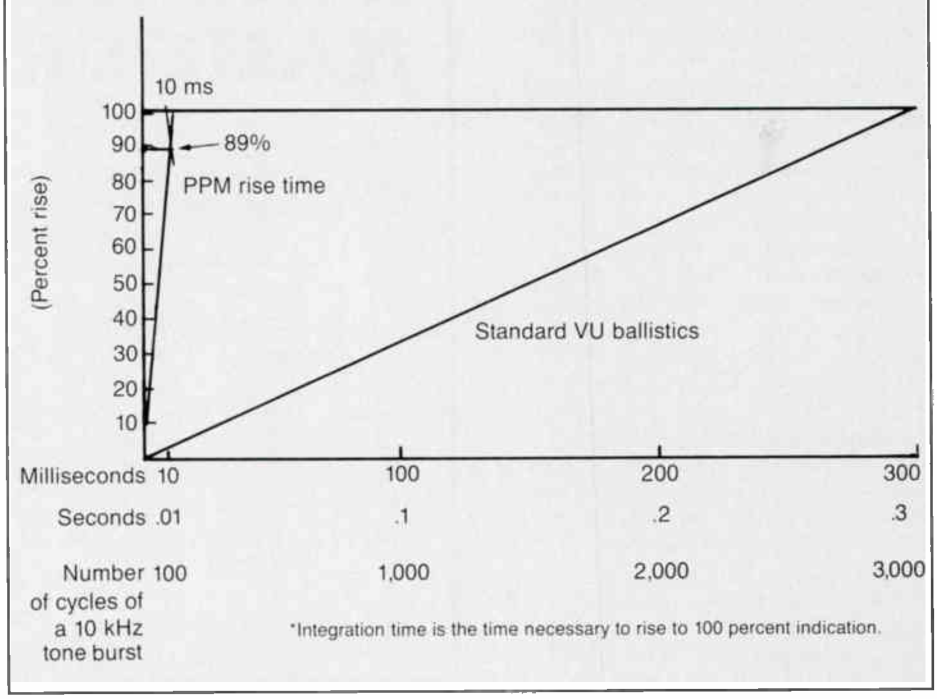
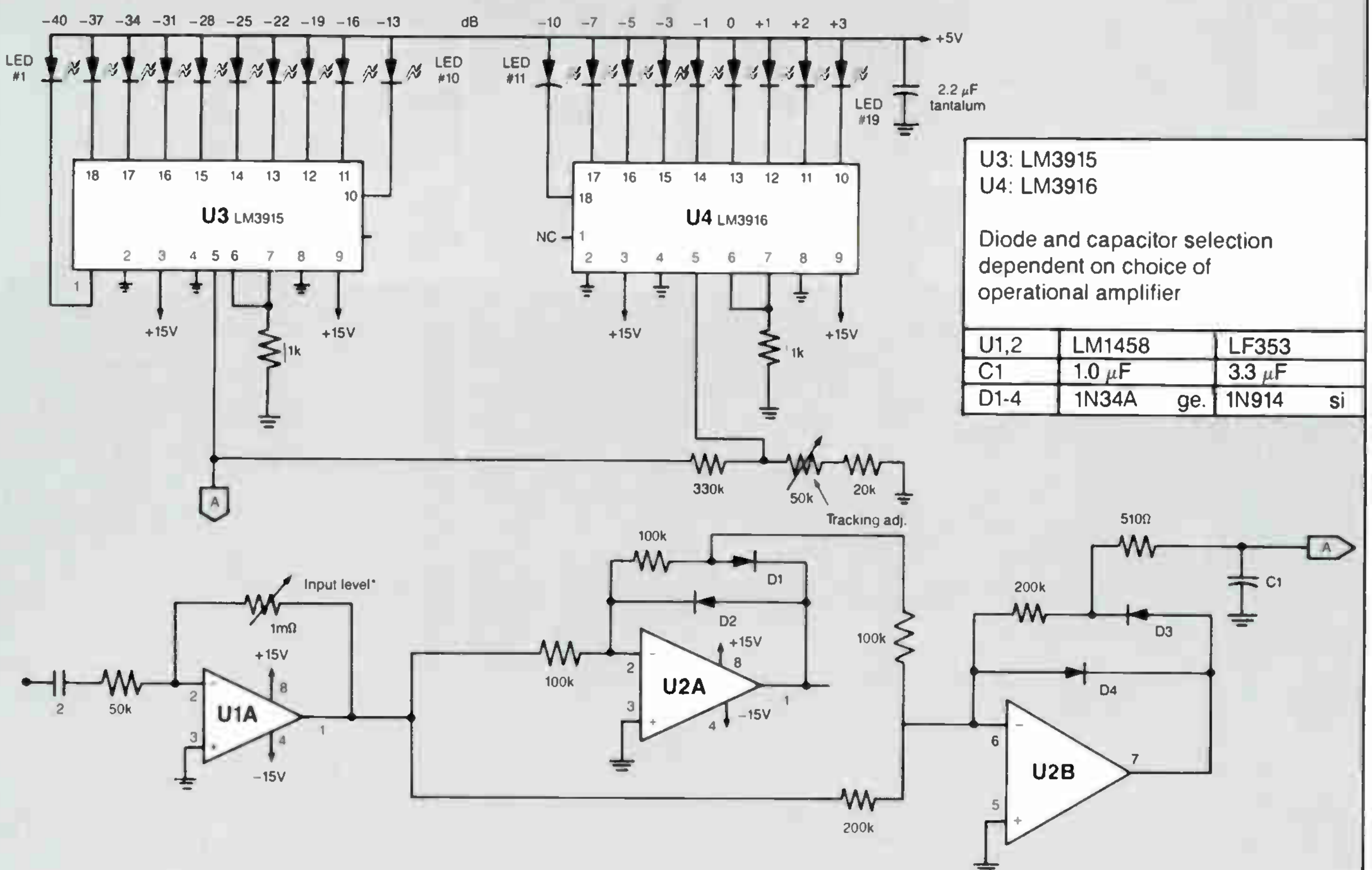


Figure 3: Circuit diagram of peak program meter



U3: LM3915		
U4: LM3916		
Diode and capacitor selection dependent on choice of operational amplifier		
U1,2	LM1458	LF353
C1	1.0 μF	3.3 μF
D1-4	1N34A ge.	1N914 si

*If demodulator has semi-fixed output, this can be a fixed 1 megaohm resistor. Adjust demodulator output for calibration.

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(Continued on page 52)

WE KEEP YO

A new National Electric Code is going into effect which will be adapted by many cities and states.

Comm/Scope manufactures several dropwires that already meet or exceed the new VW-1 Flame Test which doesn't even go into effect until July, 1988.

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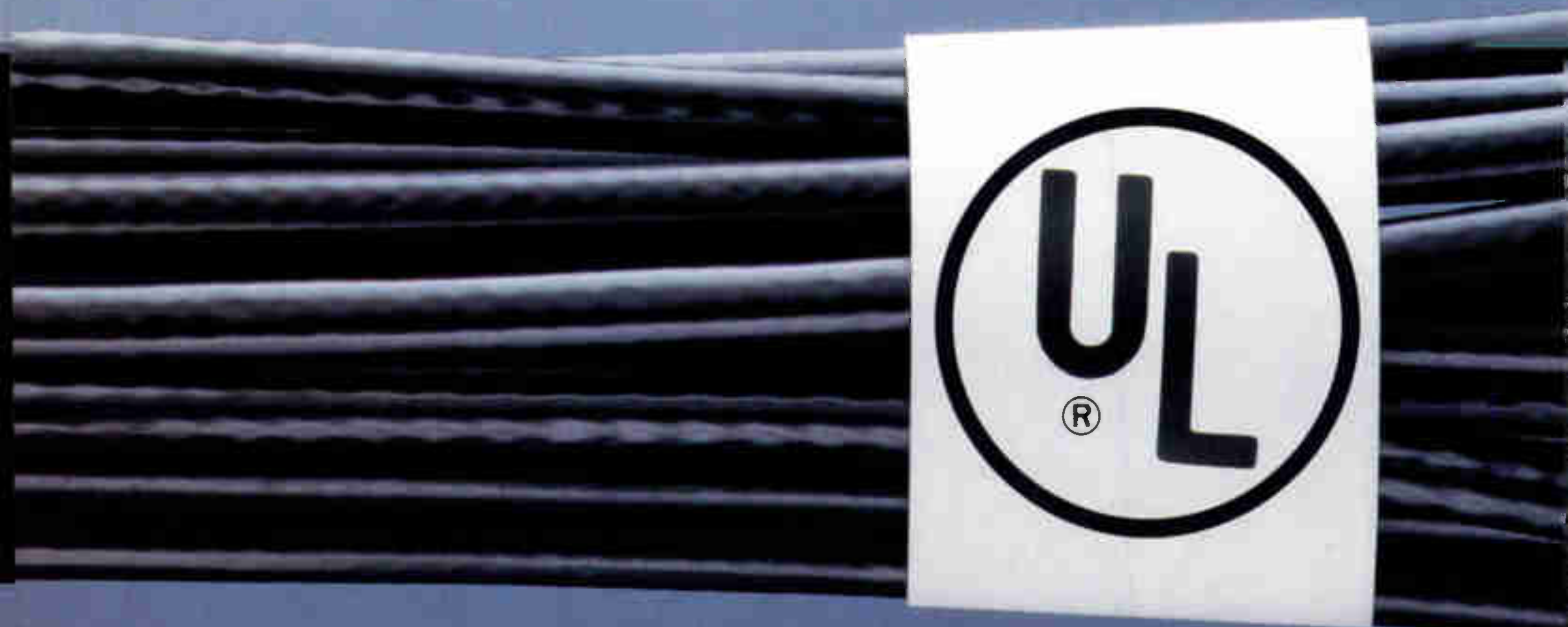

(Continued from page 37)

of metering that are currently popular, the VU (volume unit) meter and the PPM (peak program meter). After that, we'll move on to a construction project that uses the type best suited for modulation monitoring.

The VU meter is a holdover from the days when the telephone industry was in its infancy. It was designed in a time when meter movements were mechanical, slow and somewhat insensitive.

If we set up modulation with a sine wave and spectrum analyzer, and call ±25 kHz 0 dBVu, we can pronounce this correct and set our programming up with it. Right? Wrong. When program audio is applied and we modulate to 0 dBVu, we will be overdeviated, typically about ±70 kHz.

What happened? The VU reads root mean square (RMS) voltage, not peak. Voice and music have considerably less RMS voltage than a sine wave, about 6-10 dB less. Proof of this can be had by feeding a VU meter directly first with a square wave, then a sine wave and finally a triangle wave, while holding frequency and peak amplitude constant. The indicated level will change as the RMS value of the different wave shapes change (Figure 1).

Ignoring pre-emphasis, had this been modulation, our carrier swing would have remained the same for all three wave shapes. The meter, however, would not have indicated this. We could, I suppose, pad the meter about 10 dB, set up as before, then remove the pad for program audio. It's a "fudge" factor, but another problem begins to appear: VU meters are *slow*. Voices and music have another quality that separates them from sine waves: short-term peaks in the envelope of the signal. The current ANSI specification for a meter with VU ballistics calls for a 300 millisecond rise time. (See Figure 2.)

What do we need? A PPM meter, designed to follow the peak voltage envelope of the signal with faster attack times. Electronic meters also tend not to overshoot, as a mechanical meter does.

The German DIN specification 45406 calls for a 10 millisecond rise time to a level 1 dB down from that indicated by a steady-state signal. This corresponds to an integration time short enough to catch significant peaks in a signal, yet wide enough to ignore peaks that would not normally be called excessive overdeviation, by convention. This specification also calls for a decay time of 1.5 seconds to fall 20 dB. The slow release is designed to make the meter easier to read.

Questions arise

Now that we have defined a meter that will read true deviation and be consistent for music, voice and test tones, some questions arise. What about pre-emphasis? If you employ a spectrum analyzer and signal generator, then you must use a low distortion sine wave at about 400 Hz to keep out of the pre-/de-emphasis curve area. The curve was designed as a noise improvement system. In the case of normal program sources, the effect on total deviation is minimal, due to the low level at which high frequency energy is usually in such sources.

What do I attach this to? You can use any demodulator that has a fairly flat audio passband and fixed or semi-fixed—requiring an adjustment tool—output. The output should be independent of the audio monitor volume setting. The unit has a high-input impedance and represents negligible loading for most demodulator outputs.

Now that I've set deviation to 100 percent on loud peaks, some of my program sources sound "soft," overall. Since the advent of digital audio, dynamic range has increased drastically. (*Dynamic range* is generally defined as the difference between the lowest level that provides acceptable signal-to-noise and the highest level that produces acceptable distortion.) Some of the program suppliers think that 30-40 dB of dynamic range is really neat. Since their new digitized scrambling systems can deliver it, do so.

The problem is that television audio is nearly an afterthought to the picture. The narrow deviation lends itself to about 10-15 dB of dynamic range before noise starts to be serious. Add to that the listening environment of the normal subscriber, and you have a genuine problem. The only recourse is to compress the audio before it leaves the headend or contact the program suppliers, to see if they will do it.

I'm using BTSC; what good is a mono meter? It can warn of overdeviation or underdeviation in the sum channel. Further analysis might be called for.

Building a peak program meter

Now that we know what we need to accomplish, let's build a PPM that will do the job. (See Figure 3.) The heart of the project is a DIN-

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simplified system maintenance were brought about by Alpha's temperature compensating and performance monitoring circuit designs. In addition to these technological contributions, Alpha has

established the highest quality and safety standards. To date Alpha remains the only Standby Power manufacturer offering UL, CSA and SEV listed products to the CATV industry.

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Reader Service Number 25.

weighted, full-wave rectifier that has response times similar to that specified. This is formed by U2A and U2B, and the diodes D1 through D4. A small amount of filtering is provided by C2 to provide the integration. U1A is a buffer amplifier to separate the circuit from the outside world.

The display drivers U3 and U4 have an internal resistor string attached to 10 voltage comparators, one for each LED. The rectified signal is applied to the input and the LEDs light up according to level. There is 16 dB of pad between U3 and U4, to obtain the increased range.

The LF353 FET (field-effect transistor) input operational amplifier is the best to use, if you can locate it. The slew rate is higher (13 V/μs). Using the components listed in Figure 3 will give the desired attack times for each of the types of operational amplifiers. Use of the arrangement shown for the LM1458 will give good attack time, but release also is faster, making the display slightly harder to interpret. Do not use any type of Norton amplifier, such as the LM2900, since it does not behave properly. (The entire circuit is based on a compilation of designs in the *1982 Linear Databook* of National Semiconductor Corp., under the section for the LM3916. Note that U3 is an LM3915; U4 is an LM3916.)

You will need a power supply that can deliver three voltages with respect to ground: ±15 volts and 5 volts. This can be salvaged, or the LM series of voltage regulators make assembly easy. The 5-volt supply will be asked to deliver approximately .5 amperes. If you employ an LM7805, it will need to be heat sinked. Use a regulator for the LED supply to keep the constantly changing current demand from interfering with the brightness of the LEDs.

Construction is not particularly critical. There is no RF on board. I laid mine out on a perfboard that had a pin-out identical to the breadboard I worked up the circuit on. This saved the hassle of etching and drilling. I cut the power buss foils in the middle. The left side became 5 volt and ground, the right side ±15 volt.

I had a bunch of rectangular red LEDs and a couple of yellow ones. I used the yellow ones to mark the −10 dB and 0 dB points. A better way might be green from the bottom to −1 dB, yellow for 0 dB and red for the rest. Use what you can find—it's not critical. Just make it easy to read. You could put it in a box or rack mount it. If the meter is always on and in sight, you will pay attention to it.

Adjusting tracking and input level

There are only two adjustments to make. These are tracking and input level. The tracking level is adjusted so that there is a 3 dB step between the LM3915 and the LM3916. Feed a test tone to the input with an audio signal generator while observing the input waveform on an oscilloscope. Adjust the input level until only LED #10 lights. Double the peak-to-peak voltage, as read on the scope, by adjusting the output of the signal generator. Adjust tracking until only LED #12 lights. A doubling of voltage is a 6 dB increase. Tracking is now set.

There are several ways to calibrate input level. They vary in accuracy, but all are better than adjusting deviation "by ear." The first method, using a test tone on a carrier while observing a spectrum analyzer, may be the most accurate. This relies on the calibration of the spectrum analyzer and your interpretation of it.

The second way could be a test tone issued by a local station. My local PBS affiliate puts a tone and color bars up every morning before regular broadcast hours, calling it 0 dB. I do too, so at least I'm tracked to one station. If you demod/remod the local, you will need to calibrate off-air, not through the cable.

The third way, using the peak program levels of a local station in your area, may not be as accurate as the other two methods but would be consistent with your interpretation of the meter.

Don't touch that dial

Once calibrated, if the levels of your modulators seem out of whack, don't be in a hurry to adjust them. Commercials, cartoons and game shows usually are excellent to check levels with. Familiarity with the meter is essential, and so is an understanding that program suppliers occasionally don't watch as close as they should. Some services change program levels every shift. When different people are at the mix, they interpret the meters differently, so the levels may change. ■

Author's note: Many thanks to Frank McClatchie of FM Systems Inc., who pointed me in the right direction.

Reader Service Number 27.

THE 1986 WESTERN SHOW

Western Show wrap-up

By Toni Barnett

Dynamic, technical blockbusters, the greatest show on earth? Not exactly, but lively and healthy would be good adjectives to describe this year's Western Cable Show held in Anaheim, Calif., Dec. 3-5. The mood of the vendors, programmers and attendees was extremely upbeat.

The number of exhibitors increased to 209 from 186 in 1985. Advance attendance was up 4 percent over last year, and on-site registration was up 5 percent—7,700 this year compared to 7,500 last year. Unlike previous shows where floor traffic was heavy one particular day out of three, this year traffic was steady all three days. Not bad for a flat industry.

Admittedly, there were a few technical innovations to take note of, but most of the activity on the technical side involved around operators gearing up for rebuilds and upgrades.

A great deal of credit for this well-coordinated, smooth-flowing show belongs to the CCTA, NCTA and Rauscher & Associates. In fact, we have just learned that the NCTA has named Louise Rauscher as vice president for industry communications. Credit also is due to the Society of

Clockwise from far lower left: With attendance up slightly from last year (7,700 vs. 7,500), the '86 Western Show provided an upbeat atmosphere for the smooth-running event. Traffic was steady on the exhibit floor where 209 companies displayed their wares. The tech sessions, coordinated by the Society of Cable Television Engineers, were very well-attended. SCTE At-Large Director Tom Polis and Executive Vice President Bill Riker man the Society's booth, which included a cooperative demonstration of the decoder interface IS-15 by the NCTA. Bob Luff, SCTE president and an at-large director, and Polis. (All Western Show photographs by Bob Sullivan.)

Cable Television Engineers, who sponsored the technical sessions.

McKinney delivers bomb

We knew it was coming, and according to James McKinney, Mass Media Bureau Chief for the FCC, "The decision is firm and it is final."

McKinney delivered the FCC's first public explanation on the new must-carry decision to a standing-room-only crowd who gladly participated in a rousing booing session against the newly mandated A-B switches.

"The commission resolved its long-term concerns by adopting a two-part regulatory approach. The first prong ensures that cable subscribers will be given the choice to directly access broadcast signals," he explained. "The commission will require cable operators to inform the American public that they will need to retain the ability to obtain broadcast signals off-the-air.

"The second part of our long-term policy," he continued, "is to assist subscribers in re-establishing the technical capability to access off-the-air signals if they choose to do so. Providing both new and existing cable subscribers with input selector switches ensures that subscribers will have the opportunity to access off-the-air signals, should they decide to exercise that option."

Responding to an NCTA paper, McKinney declared, "I have read the technical critique of A-B switches released in such a timely matter for the benefit of the trade press. Speaking as an engineer—I was not and am not frightened by the NCTA document. Given the cost of initiating and serving your subscribers, I am also unimpressed by the dollar costs (even if I really believed them)." (Editor's note: How can we expect the public to correctly hook-up an A-B switch when they haven't been able to figure out how to use their VCR timers?)

On the floor

While most vendors displayed previously introduced equipment, there were a few exhibitors

who deserve the limelight. Scientific-Atlanta displayed a plethora of new equipment. Most notably, the company featured its new Series 4400 broadband delivery system, which TCI will be using in January 1987. This new system places the equipment outside the home. The unit mounts to an external wall in a mechanically secured, tamper-evident enclosure and delivers a composite broadband signal to wall outlets inside the home.

According to an S-A spokesman, "We have an order from TCI for a device that takes the electronics out of the home and replaces it with a device that denies unauthorized video from entering the home. We've developed a new positive trap technology that will make it more secure than the traditional positive trap."

Magnavox CATV Systems kicked off the show with a live demonstration of its latest innovations


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in status monitoring equipment. The company's Digital System Sentry with analog (DSSA) measurement products monitored a live cascade connected to a standby power supply. DSSA products shown operating included a forward field module with a microprocessor enabling it to perform functions beyond the scope of standard automatic gain/slope control modules, and an interface unit used to connect the controlling computer and the cable system. I also was quite impressed with a new line of software added to Magnavox's status monitoring package. This software package, the SOFT/DSS-IBM, using color graphic displays, helps monitor cable systems by providing feedback such as bar graphs of analog parameters, color-coded fault windows, and schematic maps showing signal paths through a cascade.

Several vendors had peripheral equipment they introduced. Please see the product section in this wrap-up and the next issue of *CT* for further details.

Getting technical

For the first time at a major show, the cooperative efforts of the SCTE and the NCTA were highly visible at SCTE's booth. A demonstration of the decoder interface standard (IS-15) equipment was set up in the booth. Also on hand to provide a briefing of this new standard was J.J. Gibson, fellow of the Technical Staff of Consumer Electronics Research for RCA.

Gibson explained that the Electronics Industries Association (EIA), a group of consumer electronics manufacturers, and the NCTA cooperatively developed this new standard. The purpose of the standard is to define a connector that would be included on new TV receivers and VCRs that would permit hook-up of a low-cost simple descrambler to the TV set. This would eliminate the need for a separate converter/descrambler.

Gill Cable's Dave Large, a pioneer of BTSC stereo, moderated the session on that topic.

The decoder interface standard is a technical specification that enables decoder manufacturers to produce set-back (versus set-top) descramblers, which plug into a socket behind TV receivers and VCRs made to specification.

According to Gibson, "Two manufacturers will have this product on the market in the first quarter of 1987. Panasonic's units will be available in July of '87, and in late '87-'88, VCRs will be manufactured also using this interface technology."

Off the floor

Kanematsu-Gosho held a press conference premiering its new Sprucer 310 two-way interactive cable television converter, which allows the viewer to order pay-per-view events and bill them to a major credit card. According to a KG spokesperson, "The system was designed for the hotel/motel/condominium/resort community areas that had previously, at best, been underserviced by the cable industry because we didn't know how to get services to them or how to bill those services. It is a system that utilizes proven field-tested technology and software. The added dimension, however, is that the bill will be generated and charged to your major credit card."

The VideoCipher Division of General Instrument also held a press conference regarding pirate activities. J. Lawrence Dunham, executive vice president and general manager of the division, stated that GI is speaking out to educate and warn consumers about fraudulent descrambler products, and cautioned consumers about claims regarding so-called pirate VideoCipher satellite TV descramblers.

"Consumers are being victimized right now by unscrupulous people and organizations selling purported 'fixes' to VideoCipher II descramblers, which are claimed to break the security of our VideoCipher II system," stated Dunham. "Our investigation of these products," he con-

An excellent overview on technical follow-up was presented in "After the Acquisition: A Technical Evaluation."

tinued, "shows many are outright frauds. In all other cases, attacks we have seen have been anticipated and can be controlled through multiple levels of security measures available to render these so-called pirate descramblers useless."

Technically speaking

The technical seminars, sponsored by the SCTE, were well-presented. Subjects ran the gamut from "Technology and Distribution Future of Satellite Communications" to "Current Technical Issues Facing the Cable Industry" to "Practical Considerations in Implementing BTSC Stereo Television." And, importantly, the SCTE administered several hours of BCT/E certification testing.

For most of the technical sessions, attendance was at a maximum, and several technical industry leaders were in the audience.

I found the most interesting technical session to be "Technology and Distribution Future of Satellite Communications" paneled by what the CATV industry calls "creamskimmers." The presentations by the distinguished panelists exceeded my expectations. The session was moderated by Charles Hewitt, formerly executive vice president of SPACE. (Prior to the Western Show, the Direct Broadcast Satellite Association and SPACE formally merged their organizations to form the Satellite Broadcast and Communications Association. Hewitt is the president of this new organization.)

Instead of a totally one-sided view for direct satellite transmission to the home, the panelists presented various scenarios in which cable and satellite could work together.

Taylor Howard, director of R&D for Chaparral Communications, made an analogy to direct satellite communications that many of us in cable can identify with. "There were a lot of people who, 30 years ago, fought cable. You changed the movie industry, the broadcast industry and the way people look at television. The same thing's going on again... Here comes a technology that hits everything at once... We are seeing the cable television industry putting in its budget, $350,000 next year, to go on a promotional campaign to

FCC Mass Media Bureau Chief James McKinney: "The decision is firm and it is final."

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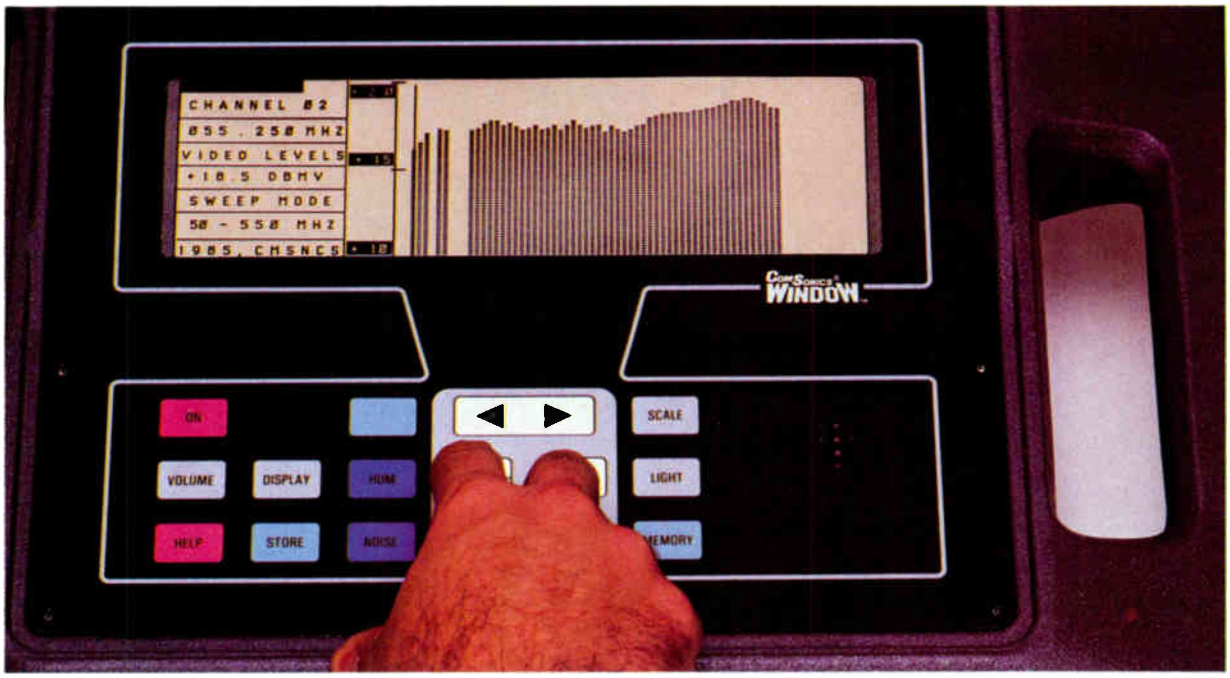

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The "Practical Considerations in Implementing BTSC Stereo Television" session provided good information on systems already using this technology.

woo back its customers... The probable truth to me...is I see a split market. I see homes like mine that have cable, satellite TV and broadcast TV. I don't want to miss anything... I feel that every television home will be served by satellite. Now, served by satellite doesn't necessary mean a dish... I think 50 million to 60 million homes will have outside antennas privately dedicated to their home at some time. I think an equal number of homes will have cable television. And a larger number of homes will have off-the-air television... The one thing that the cable system does very, very well is provide local content. That's the one thing a satellite system can never do... That's why I see a sharing in the marketplace."

Charles Ergen, president of Echosphere Corp., had quite a different view of satellite and cable technology. "In my vision of the future...in every single home in the United States that owns a TV set, I see a satellite dish... I think the reason I see this is economics. With the advent of scrambling, the economics have changed... The cost of owning a satellite system has gone up. So, it's very unlikely that as an industry, we're going to be a major factor at C-band in major franchised areas... There are still 15 million to 20 million homes out there that will never have cable, and for those people, we're still an economic alternative... The prices of decoders will come down and will become more economical. The trends will change... In 1990-1991...I think the economics will change drastically. The reasons they'll change drastically will be Ku-band... I think that what's going to happen as we get into the 1990s, it's suddenly going to be more economical just to give people dishes... Not only is it going to be cheaper, but in my opinion, the technology will be better. The video quality will be superior, high definition TV could become a reality, audio and stereo sound will be better. Dependability will be better and addressability will be much easier... My vision is I invite you to join this technology and embrace it and try to make the most out of it."

Andrew Hospidor, president of RCA American, offered a slightly different view. "The question of the programmer and cable operator has decide is which technology provides the most efficient way in getting my programming to my customers? We think K-band offers some unique opportunities. We think K-band will own SMATV in the near future. RCA is not out of the C-band business and is not intending to get out of the C-band business... Our C-band business will depend largely on our ability to find risk-sharing ventures in which programmers and operators come together with us in standing the risks for the launch and operation of satellites."

Tech Track 2 focused on "Current Technical Issues Facing the Cable Industry." Wendell Bailey, vice president of science and technology for the NCTA, provided a Washington update. He detailed several technical issues including one stemming from the "Captain Midnight" situation. "Anyone uplinking to satellites," said Bailey, "must identify themselves by code (possibly in the vertical blanking interval)."

John Wong, engineer for the Mass Media Bureau for the FCC, related several issues before the commission. Of note was that "there will be no changes in the 18 GHz area."

Bob Dickinson, president of Dovetail Systems, spoke on his favorite topic, signal leakage. Stated Dickinson, "Our only acceptable goal is leak-free cable systems." And, he asked the audience several important questions: "Is the kind of monitoring we do effective?; Is the monitoring of a single frequency sufficient?" He also expressed other concerns. "Flyovers are a great idea...but you can't see individual leaks..."

Walt Ciciora, vice president of new technology for ATC, gave a discourse on decoder interface (IS-15). "The consumer electronics interface issue is a complicated one. It's going to get more complicated."

The third tech track dealt with "Practical Considerations in Implementing BTSC Stereo Television." Moderating this panel was a veteran of BTSC, Dave Large, vice president of engineering for Gill Cable. Large declared: "BTSC is a fact, and it's available to 90 percent of today's households." This panel featured such notables as James Gibson, RCA Labs; W.J.J. Hoge, consultant to Leaming Industries; Al Johnson, director of marketing for Synchronous Communications; and Walter Reames, manager of special projects for Gill Cable. The upshot of this session was a lot of good information (problems and solutions) on systems already using BTSC.

The fourth technical session targeted on "Test Equipment Advances: Sweeping Without Interference to 550 MHz." Bill Riker, executive vice president for the SCTE, moderated this session, and took the opportunity to update the audience on the upcoming Cable-Tec Expo in April 1987.

The tech track on "Current Technical Issues Facing the Cable Industry," covered a variety of topics from uplinking safeguards to IS-15.

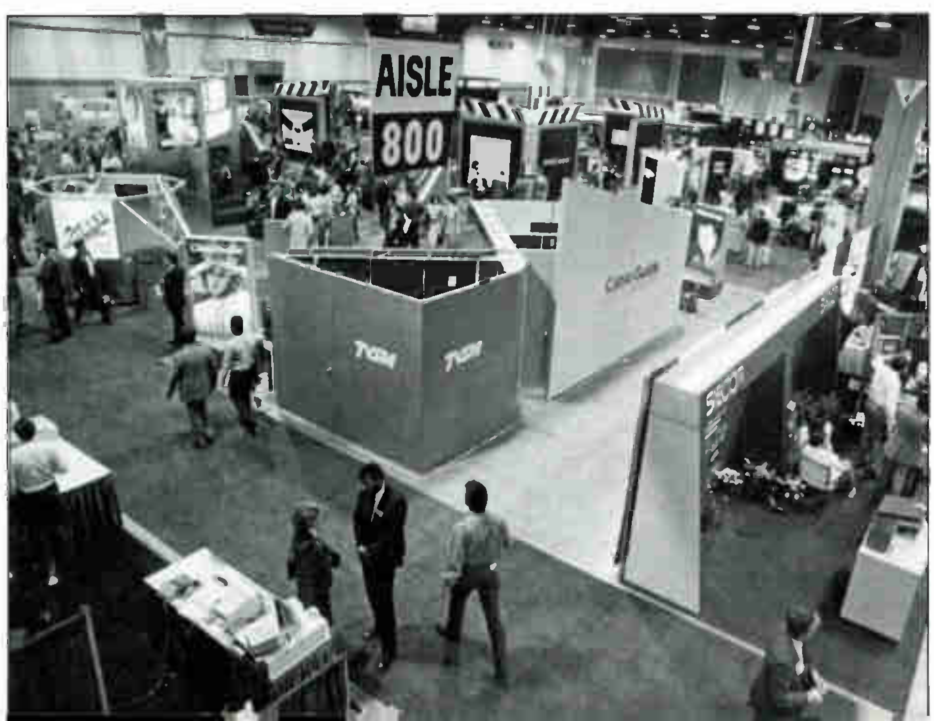
Ron Adamson, technical manager for Texscan Corp., talked about new advances. "One of the more current advances," he said, "is the surface-mount technology and the more powerful microprocessor pieces." Adamson also stated that there needs to be more focus on the part of manufacturers concerning operating temperatures. He also noted that because of the cumulative leakage index, there needs to be new methods of measurements and instrumentation.

Syd Fluck and Bill LeDoux of Calan Inc. spoke about continuous tracking and the problems with addressable converters. "Addressable converters," said LeDoux, "don't like rapid high levels going through them."

The last tech track, "After the Acquisition: A Technical Evaluation," provided an excellent overview on technical followup. Robert Luff, group vice president for Jones Intercable, gave his insight into the entire process. "The acquiring company," explained Luff, "should look for two ways to better performance: expand the system (upgrade it to make it more revenue efficient); or leave the revenues but reduce rebuild, personnel and vehicle maintenance."

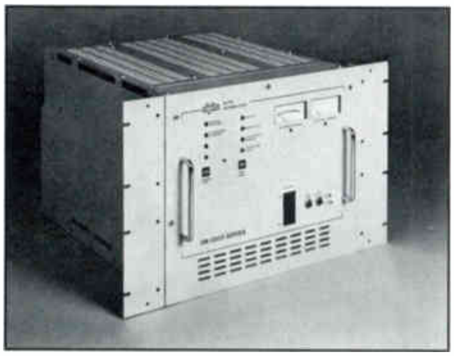
If you were unable to attend this year's Western Show, we hope this wrap-up will provide insight into what's currently happening. Even more, we hope that this information will encourage you to attend the trade shows. Now, sit back and enjoy some of the photos that we hope will bring the show closer to you.

THE 1986 WESTERN SHOW



THE 1986 WESTERN SHOW

From the Western Show...



Alpha Technologies' 3000 Series uninterruptible power supply.

Alpha Technologies introduced two new product series, the ALC Series of line power conditioners and the 3000 Series uninterruptible power supplies (UPS).

The high-power UPS products have application in the computer, CATV, LAN, telephone and industrial marketplaces. The ferroresonant UPS design, according to Alpha, offers uninterruptible power with the added benefits of higher efficiency, quieter operation and lower price. Offered in three formats (3 kVA, 2 kVA and 1.5 kVA), the units are supplied in rack-mounting or mobile-cabinet configurations. Various back-up times in the event of complete power blackouts are available through a choice of battery packages and battery extender options. The 3000 Series also protects equipment from the effects of spikes, surges and brownouts.

The ALC Series of line power conditioners handles power ratings from 150 VA to 1,000 VA. The units, which isolate power line variations from equipment, are designed to compensate for brownouts, to filter harmful spikes and electrical noise and to regulate varying line voltages at a constant, safe value.

For complete details, contact Alpha Technologies, 3767 Alpha Way, Bellingham, Wash. 98225, (206) 647-2360; or circle #100 on the reader service card.

Audiocom Inc. announced that it has begun distributing a new line of telecommunications equipment exclusively to the cable TV industry. The new product line includes interactive voice-response systems, automatic call sequencers and digital announcement systems.

Pay-per-view, hotlines, collection calls, appointment verifications and telemarketing are some of the applications that interactive voice-response systems can manage. The units work in both the inbound and outbound modes, use digital voice storage technology and, according to the company, can interface with virtually any billing service and host computer system.

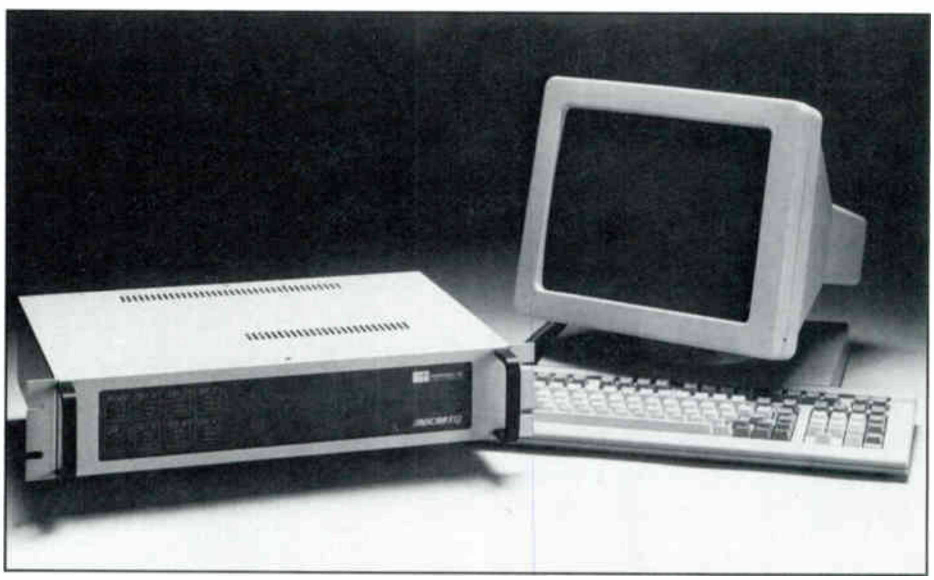
Audiocom's line of automatic call sequencers answer each incoming call with a recorded message, place the caller on hold and then process each call in the order it was received. As well, they can provide call management information to system managers.

Digital announcement systems are used to provide callers with pre-recorded messages of varying lengths, without involving personnel. Applications include programming information and service disruption hotlines. Messages can be changed routinely, and with some units, by remote access.

For further information, contact Audiocom Inc., 14645 N.W. 77th Ave., #203, Miami Lakes, Fla. 33014, (305) 825-4653, (800) 272-0555; or circle #99 on the reader service card.

Business Systems Inc. introduced CableTALK, a voice recognition system that can be integrated into its cable television management system. The system permits the telephone caller to speak interactively with the answering computer. This optional feature provides subscriber interaction with the cable office for pay-per-view, shop-at-home, technician tracking, and subscription orders and queries.

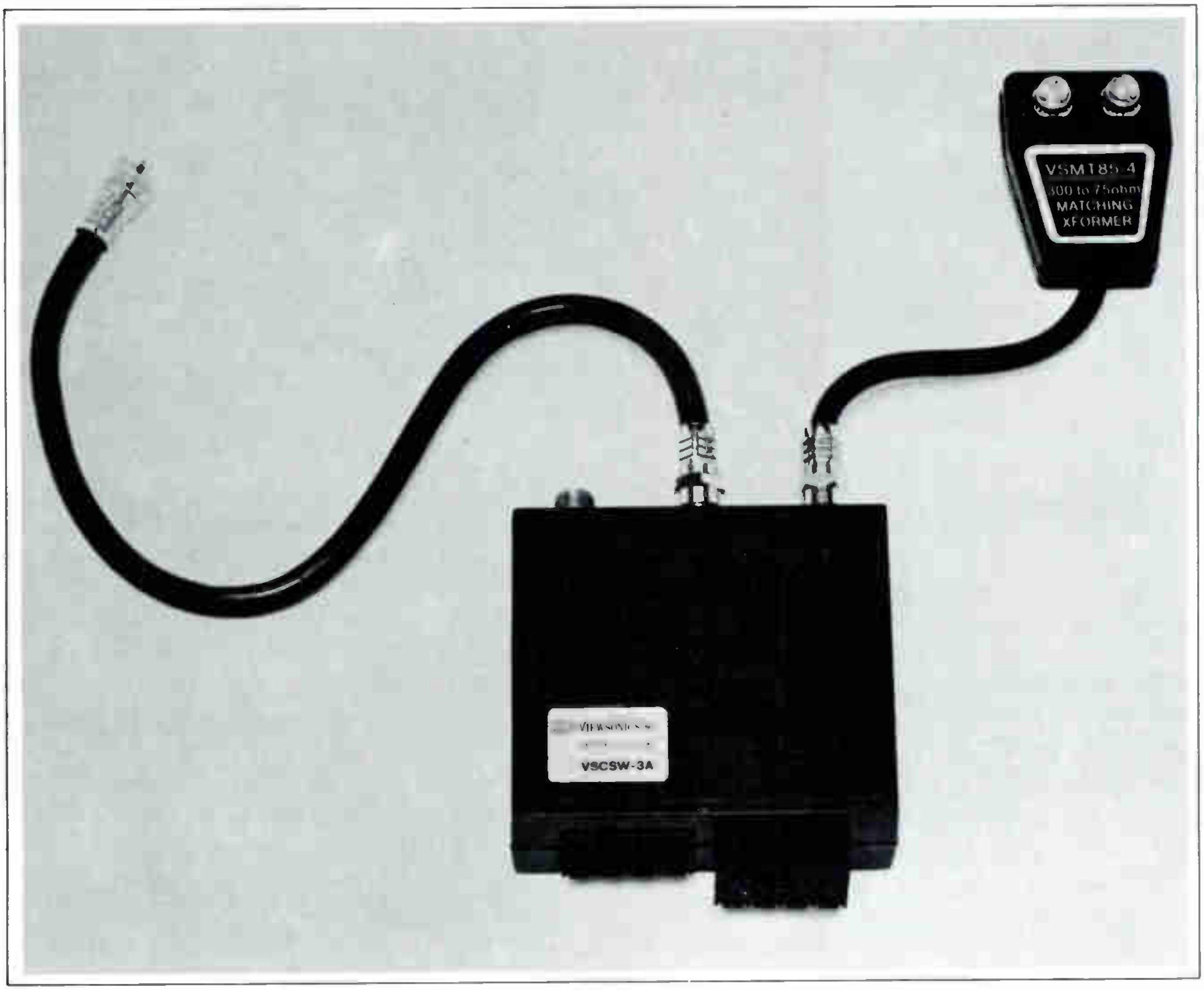
For more information, contact Business Systems Inc., 1 Marcus Dr., Greenville, S.C. 29615-9626, (803) 297-9290; or circle #98 on the reader service card.



The ADCART 2+2 system from Channelmatic.

The VIEWSONICS A/B SWITCH KIT

FCC MUST CARRY SOLUTION
FCC + A/B = VSABS



Composed of time-tested components: Model VSABS

......Model VSCSW-3A, 95dB isolation, −100dB RFI Integrity, 20dB return loss.
......Model MT85-4, 3 capacitor PC board, 35dB min. balance ratio, reverse matching transformer.
......3 ft. hi-shield cables with nickel plated F59 connectors.
......Easy-to-follow installation instructions printed on the header card. Sealed in one neat package.

The VSABS Kit is one of the many hook up kits VIEWSONICS produces, i.e. VCR, FM, etc. Special kits or components are readily supplied at little or no additional charge, depending on quantity and/or unique features. Call us with your particular requirements.

*Min. 100 pcs.

Reader Service Number 38.

Viewsonics inc.

"PROFIT FROM OUR EXPERIENCE"

P.O. Box 36 • Jericho, N.Y. 11753
Call Toll Free: 800-645-7600
In New York Call: 516-921-7080
FAX: 516-921-2084

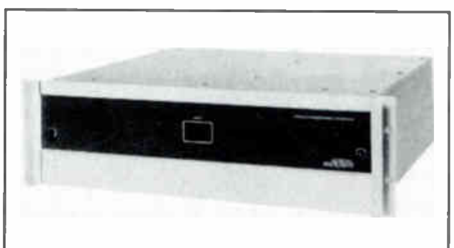
Channelmatic Inc. introduced two new products. The first is an automated random access ad insertion system called the ADCART 2+2, which is capable of fully automatic, two-channel stereo ad insertion. Using a new proprietary spot information encoding technique the system is able to free both audio tracks of conventional VCRs for two-channel stereo. As well, all audio switching, including satellite TVRO, VCR, auxiliary and preview, is full two-channel stereo.

The ADCART 2+2 employs advanced digital logic to regulate most important system functions. Instead of having to tweak audio trim pots to adjust audio levels, the system does it automatically; once the operator has set the levels with the CRT terminal keyboard. According to the company, the terminal's user-friendly interface features uncluttered screens, and commands are entered with single keystrokes from logically arranged, plain-language menus. A single screen displays summary system status information 12 channels at a time. System status also appears on the front panels of the Channel Control Units (CCU). As the heart of an ADCART 2+2 system, the CCU controls all ad insertion switching functions on two channels, and occupies only 3½ inches of vertical rack space. Expansion can be accomplished by adding one CCU for each two additional channels. Error reporting is an integral part of the ADCART 2+2 system. Any system error is immediately noted and displayed on the CRT screen. If a VCR error causes a spot to be lost, that fact is noted and becomes part of the verification log.

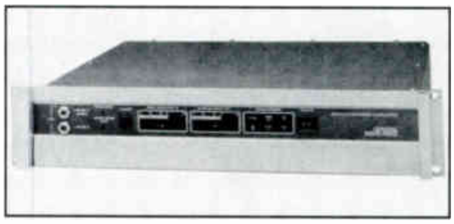
Channelmatic also introduced a new product in its line of ad insertion equipment designed to fill ad insertion requirements for small cable systems operating on limited budgets. The NSS-4A Network Share Switcher enables a cable system to insert advertising or program material into four CATV satellite networks from one source. It will interface with character generators, computer graphic generators, or low-cost sequential ad insertion equipment.

The switcher contains four dual-tone multifrequency (DTMF) decoders. When a decoder detects a valid cue tone, it disenables the other three decoders. After a predetermined delay, the unit switches the ad source into the designated network. When the ad has finished, the NSS-4A switches back to the network, and resets all the decoders to detect the next tone that occurs on one of the four networks. Ads are inserted on a first come, first served basis.

For further information, contact Channelmatic Inc., 821 Tavern Rd., Alpine, Calif. 92001, (800) 231-1618, (619) 445-2691; or circle #97 on the reader service card.



The Model AI-0 addressable interface unit from Jerrold.



Jerrold's Commander 5 frequency agile headend modulator.

Falcone International Inc. unveiled a 2X option for its ASI-SC insertion unit that allows the unit to control commercial insertion on two channels using only one VCR. The ASI-2X expander box accomplishes control by switching between networks after each insertion.

For further information, contact Falcone International, 1355 Marietta Pkwy., Suite 104, Marietta, Ga. 30067, (404) 427-9496; or circle #96 on the reader service card.

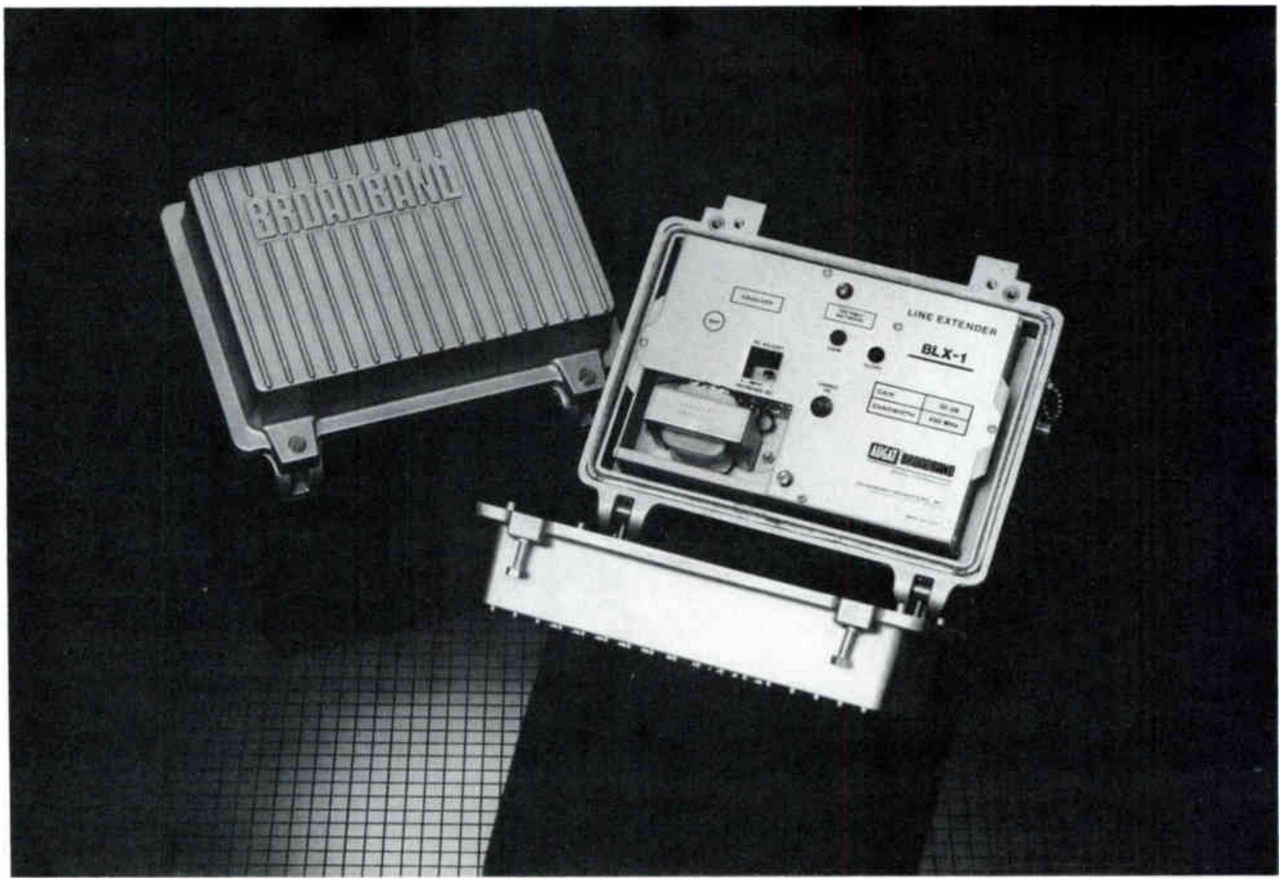
Two products were introduced by **Intercept Communication Products Inc.**, the Sandwich Groundblock Model SGB 500 and a 16-way splitter. The groundblock is designed to connect the outer sheath of a coaxial cable to a copper ground wire, which is then connected to a grounding rod. In applications where aluminum coaxial cable is used to feed cable TV signals to a building, the SGB 500 permits grounding of the cable system before entering the building as required by NESC codes. The "sandwich" configuration permits installation of the groundblock after the cable is already installed. Since cable is not cut, no interruption of service is experienced.

The unit consists of two aluminum plates with grooves for cable and messenger, a stainless steel clamp to secure copper ground wire and stainless steel spring leaf to secure coaxial cable to aluminum plates. The spring leaf is actuated by a screw. This feature eliminates the probability of denting the cable in the course of installation, according to the company. A stainless steel clamp mounted on the groundblock secures the copper wire, #6 AWG, from the ground rod. There is no physical contact between copper and aluminum assuring galvanic integrity. The groundblock is available to fit a variety of cable sizes.

The 16-way splitter, Model HS 16, operates from 5 to 600 MHz and features a zinc die-cast housing, nickel-plated F connectors (brass connectors optional) and an integral ground block. The port-to-port isolation is 27 dB (25 dB at 500-600 MHz) with an 18 dB return loss at all ports. The nominal impedance is 75 ohms and insertion loss is 14 dB (0 dB [active] and 10 dB [active] are optional).

For complete details, contact Intercept Communication Products, 85 Fifth Ave., Bldg. 16, Paterson, N.J. 07524, (201) 471-2212, (800) 526-0623; or circle #95 on the reader service card.

The **Jerrold Division** of General Instrument Corp. unveiled three new product offerings. The latest member of the Starcom VI family of addressable converters, baseband Model DPBB,


BROADBAND
LINE EXTENDER
BLX-1

The Starcom VI Model DPBB converter from Jerrold.

is a full-featured, 550 MHz addressable converter with impulse capability. The DPBB is compatible with all existing and new Jerrold systems and can be used in the same systems with all members of the Starcom VI family. In addition to impulse capability, the new baseband converter also has volume control, last channel recall, favorite channel programming, time-controlled programming for VCRs, parental control and remote control enable/disable.

The new headend-mounted addressable interface (Model AI-0), designed for use by smaller cable systems, is capable of servicing 8,000 subscribers in its basic mode, and 16,000 when optionally upgraded. It is controlled either through a billing system computer or by using a terminal and modem (Model AI-RTM) sold by Jerrold. The AI-0 was scheduled to be available for quantity shipments this month.

The Commander 5, a 550 MHz frequency agile headend modulator, is intended for use in all headend situations, and incorporates a user-friendly design that offers a full range of features, according to the firm. Features include front panel channel selection, video depth of modulation display, audio frequency deviation display and a front panel status indicator. As well, the Commander 5 is stereo-compatible, has automatic gain control, automatic signal switching, RF and baseband scrambling compatibility, and, in the phaselock version, is switchable for HRC or IRC operation. A complete set of options packaged on a single board will be available to provide video switching, audio and video AGC, second level IF switching and 4.5 MHz audio input. Both the phaselock version and option board are scheduled for production this spring. The modulator will be available for bulk shipments early this year.

For further information, contact Jerrold Division, General Instrument Corp., 2200 Byberry Rd., Hatboro, Pa. 19040, (215) 674-4800; or circle #94 on the reader service card.

Kanematsu-Gosho (USA) Inc. premiered its new 444 MHz Sprucer 310 two-way interactive cable television converter. The 310, which allows the viewer to order pay-per-view events and bill them to a major credit card, is designed especially for hotel/motel and resort applications. Viewers can order pay-per-view events using a keypad in the top of the converter. The order is then relayed to the cable system, where authorization and billing are handled.

The Sprucer 310 is fully compatible with the Sprucer 300 interactive converter, which is designed for residential use. Both units can be used within the same cable system. The 310 shares many of the most popular aspects of the 300, including the FAST (forced automatic select tuning) feature, which is designed to allow the cable operator to select the channel that the subscribers' TV sets will be tuned to when turned on.

For more details, contact Kanematsu-Gosho, 400 Cottontail Lane, Somerset, N.J. 08873, (201) 271-7300; or circle #93 on the reader service card.

Magnavox CATV Systems Inc. had several new products available: the Model 5-MLE-H/60 line extender and a status monitoring software package.

The 5-MLE-H/60 is a high-gain line extender designed to help overcome the increased cable and passive loss associated with higher bandwidth rebuilds. The line extender has diplex filters and operates in both the forward (50-450 MHz) and return (5-33 MHz) directions. It has a series regulated power supply for 60 VAC systems, with a typical operating gain of 33 dB.

The software package, designated SOFT/DSS-IBM, complements Magnavox's Digital System Sentry (DSS) line of status monitoring products. Using color graphic displays, the software helps monitor cable systems by providing feedback such as bar graphs of analog parameters, color-coded fault windows, and schematic maps showing signal paths through a cascade.

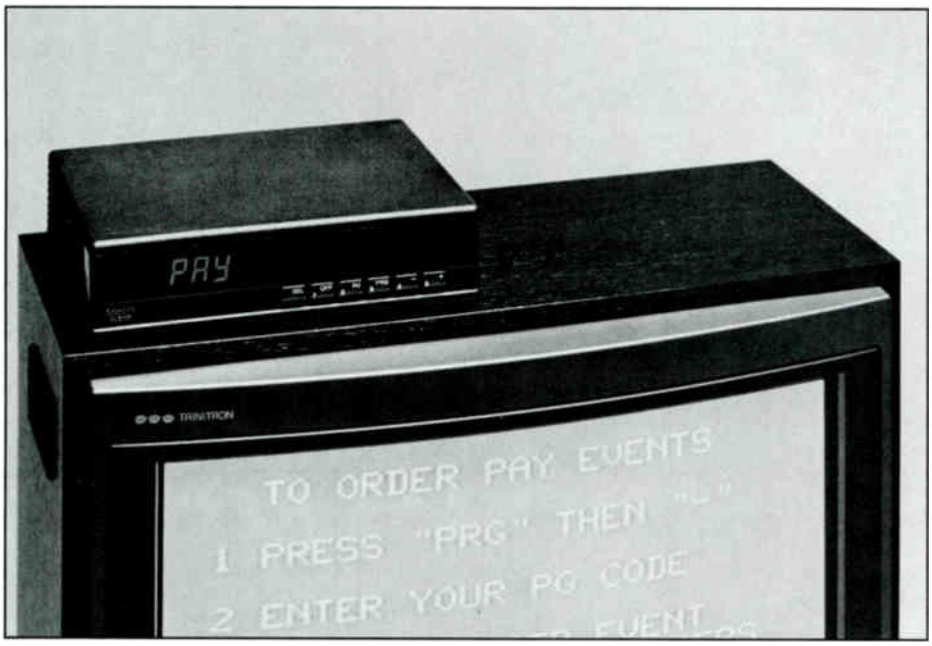
Color-coded bar graphs identify the parameters of a single mainstation as good, having a minor fault, or having a major fault. Analog parameters monitored include forward and return carrier levels, AGC/ASC gain and slope control voltages, power supply output voltage, and temperature inside the mainstation. Color-coded fault windows identify fault location as well as magnitude. Because of SOFT/DSS-IBM's schematic display showing connections between mainstations, problem sources can be quickly pinpointed and corrected, according to the company.

For more information, contact Magnavox CATV Systems, 100 Fairgrounds Dr., Manlius, N.Y. 13104, (315) 682-9105; or circle #92 on the reader service card.

Riser-Bond Instruments introduced the Model 2901B+ time domain reflectometer and cable fault locator. The scope output feature is said to enable the operator to connect an external oscilloscope to the front panel, allowing the operator to view the transmitted and reflected pulse and actual signature of the cable under test. The digital LCD simultaneously displays the

Kanematsu-Gosho's Sprucer 310 converter.

Reader Service Number 42.

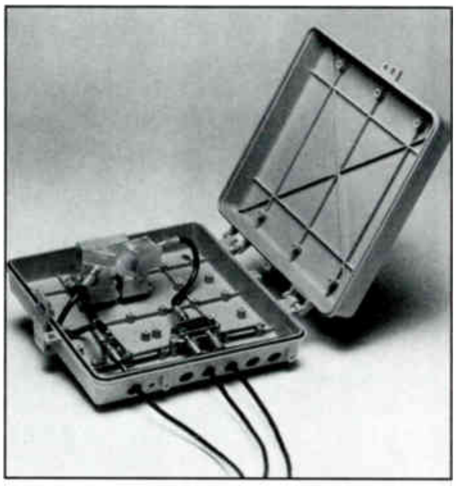


The Model 8580 IPPV-capable converter from Scientific-Atlanta.

distance to the cable fault in feet (or meters). The product can be used for cable fault location or for cable length measurement on any metallic paired cable.

For additional information, contact Riser-Bond Instruments, P.O. Box 188, Aurora, Neb. 68818, (402) 694-5201; or circle #91 on the reader service card.

Scientific-Atlanta Inc. (S-A) introduced two new basic service, set-top terminals, Models 8505 and 8510. Designed for operation in 330 MHz systems, the Model 8505 is the most basic; two buttons on the front allow subscribers to tune upward or downward and turn the unit on and off. The unit features two-speed channel increment/decrement, accessed by pressing either button for more than two seconds to increase channel changing speed. Model 8510 operates in systems up to 450 MHz and adds infrared remote control for direct channel entry and automatic fine tuning.



S-A's Series 4400 broadband delivery system.

S-A's Series 4400 broadband delivery system is designed to eliminate many of the problems associated with home entertainment center compatibility. The unit mounts to an external wall in a mechanically secured tamper-evident enclosure and delivers a composite broadband signal to wall outlets inside the home. The trap removes an interfering carrier placed extremely close to the video carrier by an interfering carrier generator device located at the headend.

According to S-A, the system features modular components that plug together to allow configuration according to various needs. Components include I/O modules that interface the F-connector on the drop cable to the system.

S-A also introduced the Series 6500 multiport distribution amplifier, designed to accept a wide variety of modules. This allows the product to be configured as a line extender, as a terminating bridger or, when configured with optional AGC, as an alternative to trunk station amplifiers. The product housing features four connection ports, said to make installations easier and quicker when the signal path must be split in two or more directions exiting the amplifier. Splitters and directional couplers used to divide the signal can be plugged inside the amplifier housing, eliminating the need for connecting external passive devices and reducing the chances for signal leakage problems, amplifier misalignment and cable separation.

Finally, S-A introduced its Masterworks impulse pay-per-view (IPPV) system that allows operators flexibility in establishing operating parameters. With this system, cable operators can determine subscriber credit lines, the value of credit units, the number of credits a program will cost, the amount of free preview permitted and the number of pay channels offered. The set-top's LED display presents the pertinent buying information, which can be entered either on the unit's keypad or via remote control. The LED display also flashes to warn the subscriber that a purchase is about to be made or that a purchased program is about to start.

For more information, contact Scientific-Atlanta, 1 Technology Pkwy., Box 105600, Atlanta, Ga. 30348, (404) 441-4000; or circle #90 on the reader service card.

Zenith Electronics introduced its new impulse pay-per-view system, the "PM-Pulse," built around the company's PM addressable decoders introduced earlier in 1986. Using the phase modulation scrambling technique, the PM system is said to be a secure, cost-effective RF system. PM-Pulse is a store-and-forward system; on impulse, even minutes before an IPPV event, subscribers enter a code on the decoder's remote control transmitter. The program is unscrambled immediately. The headend system polls the decoders in the system at a rate of 100,000 per hour, signaling each box to transmit the encrypted ordering data to the operator's billing system.

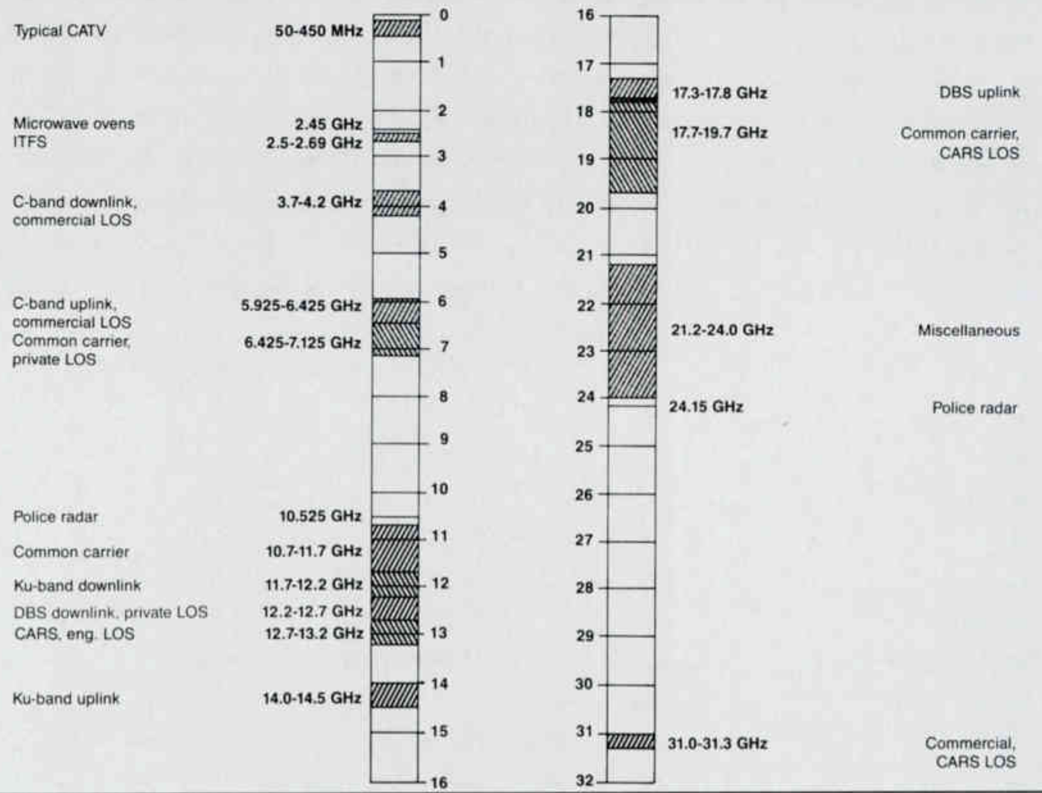
For more information, contact Zenith Electronics Corp., 1000 Milwaukee Ave., Glenview, Ill. 60025, (312) 391-8181; or circle #89 on the reader service card.

Scientific-Atlanta's 8505/10 set-top.

Microwave for CATV operators

By Ron Hranac
Jones Intercable Inc.

Microwave frequency bands



Frequency allocations

Frequency range	Description
3 kHz- 30 kHz	Very low frequency (VLF)
30 kHz-300 kHz	Low frequency (LF)
300 kHz- 3 MHz	Medium frequency (MF)
3 MHz- 30 MHz	High frequency (HF)
30 MHz-300 MHz	Very high frequency (VHF)
300 MHz- 3 GHz	Ultrahigh frequency (UHF)
3 GHz- 30 GHz	Superhigh frequency (SHF)
30 GHz-300 GHz	Extremely high frequency (EHF)

Microwave/radar bands (IEEE)	
L	1 GHz- 2 GHz
S	2 GHz- 4 GHz
C	4 GHz- 8 GHz
X	8 GHz- 12 GHz
Ku	12 GHz- 18 GHz
K	18 GHz- 27 GHz
Ka	27 GHz- 40 GHz
Millimeter	40 GHz-300 GHz

ECM bands (USAF)	
A	0 MHz-250 MHz
B	250 MHz-500 MHz
C	500 MHz- 1 GHz
D	1 GHz- 2 GHz
E	2 GHz- 3 GHz
F	3 GHz- 4 GHz
G	4 GHz- 6 GHz
H	6 GHz- 8 GHz
I	8 GHz- 10 GHz
J	10 GHz- 20 GHz
K	20 GHz- 40 GHz
L	40 GHz- 60 GHz
M	60 GHz-100 GHz

CARS band microwave frequency assignments

FML operation

Group A channels

FCC desig.	Boundaries	Center frequency
A01	12.7000-12.7250	12.7125
A02	12.7250-12.7500	12.7375
A03	12.7500-12.7750	12.7625
A04	12.7750-12.8000	12.7875
A05	12.8000-12.8250	12.8125
A06	12.8250-12.8500	12.8375
A07	12.8500-12.8750	12.8625
A08	12.8750-12.9000	12.8875
A09	12.9000-12.9250	12.9125
A10	12.9250-12.9500	12.9375
A11	12.9500-12.9750	12.9625
A12	12.9750-13.0000	12.9875
A13	13.0000-13.0250	13.0125
A14	13.0250-13.0500	13.0375
A15	13.0500-13.0750	13.0625
A16	13.0750-13.1000	13.0875
A17	13.1000-13.1250	13.1125
A18	13.1250-13.1500	13.1375
A19	13.1500-13.1750	13.1625
A20	13.1750-13.2000	13.1875

Group B channels

FCC desig.	Boundaries	Center frequency
B01	12.7125-12.7375	12.7250
B02	12.7375-12.7625	12.7500
B03	12.7625-12.7875	12.7750
B04	12.7875-12.8125	12.8000
B05	12.8125-12.8375	12.8250
B06	12.8375-12.8625	12.8500
B07	12.8625-12.8875	12.8750
B08	12.8875-12.9125	12.9000
B09	12.9125-12.9375	12.9250
B10	12.9375-12.9625	12.9500
B11	12.9625-12.9875	12.9750
B12	12.9875-13.0125	13.0000
B13	13.0125-12.0375	13.0250
B14	13.0375-13.0625	13.0500
B15	13.0625-13.0875	13.0750
B16	13.0875-13.1125	13.1000
B17	13.1125-13.1375	13.1250
B18	13.1375-13.1625	13.1500
B19	13.1625-13.1875	13.1750

Group K channels

FCC desig.	Boundaries	Center frequency
K01	12.7000-12.7125	12.70625
K02	12.7125-12.7250	12.71875
K03	12.7250-12.7375	12.73125
K04	12.7375-12.7500	12.74375
K05	12.7500-12.7625	12.75625
K06	12.7625-12.7750	12.76875
K07	12.7750-12.7875	12.78125
K08	12.7875-12.8000	12.79375
K09	12.8000-12.8125	12.80625
K10	12.8125-12.8250	12.81875
K11	12.8250-12.8375	12.83125
K12	12.8375-12.8500	12.84375
K13	12.8500-12.8625	12.85625
K14	12.8625-12.8750	12.86875
K15	12.8750-12.8875	12.88125
K16	12.8875-12.9000	12.89375
K17	12.9000-12.9125	12.90625
K18	12.9125-12.9250	12.91875
K19	12.9250-12.9375	12.93125
K20	12.9375-12.9500	12.94375
K21	12.9500-12.9625	12.95625
K22	12.9625-12.9750	12.96875
K23	12.9750-12.9875	12.98125
K24	12.9875-13.0000	12.99375
K25	13.0000-13.0125	13.00625
K26	13.0125-13.0250	13.01875
K27	13.0250-13.0375	13.03125
K28	13.0375-13.0500	13.04375
K29	13.0500-13.0625	13.05625
K30	13.0625-13.0750	13.06875
K31	13.0750-13.0875	13.08125
K32	13.0875-13.1000	13.09375
K33	13.1000-13.1125	13.10625
K34	13.1125-13.1250	13.11875
K35	13.1250-13.1375	13.13125
K36	13.1375-13.1500	13.14375
K37	13.1500-13.1625	13.15625
K38	13.1625-13.1750	13.16875
K39	13.1750-13.1875	13.18125
K40	13.1875-13.2000	13.19375

AML operation†

Group C channels

FCC desig.	Microwave boundaries	Microwave video carrier
C01	12.7005-12.7065	12.70175
C02	12.7065-12.7125	12.70775
C03	12.7125-12.7185	12.71375
C04	12.7185-12.7225	12.72046
C05	12.7225-12.7285	12.72375
C06	12.7285-12.7345	12.72975
C07	12.7345-12.7405	—
C08	12.7405-12.7465	—
C09	12.7465-12.7525	—
C10	12.7525-12.7545	—
—	12.7345-12.7545	—
C11	12.7545-12.7605	12.75575
C12	12.7605-12.7665	12.76175
C13	12.7665-12.7725	12.76775
C14	12.7725-12.7785	12.77375
C15	12.7785-12.7845	12.77975
C16	12.7845-12.7905	12.78575
C17	12.7905-12.7965	12.79175
C18	12.7965-12.8025	12.79775
C19	12.8025-12.8085	12.80375
C20	12.8085-12.8145	12.80975
C21	12.8145-12.8205	12.81575
C22	12.8205-12.8265	12.82175
C23	12.8265-12.8325	12.82775
C24	12.8325-12.8385	12.83375
C25	12.8385-12.8445	12.83975
C26	12.8445-12.8505	12.84575
C27	12.8505-12.8565	12.85175
C28	12.8565-12.8625	12.85775
C29	12.8625-12.8685	12.86375
C30	12.8685-12.8745	12.86975
C31	12.8745-12.8805	12.87575
C32	12.8805-12.8865	12.88175
C33	12.8865-12.8925	12.88775
C34	12.8925-12.8985	12.89375
C35	12.8985-12.9045	12.89975
C36	12.9045-12.9105	12.90575
C37	12.9105-12.9165	12.91175
C38	12.9165-12.9225	12.91775
C39	12.9225-12.9285	12.92375
C40	12.9285-12.9345	12.92975
C41	12.9345-12.9405	12.93575
C42	12.9405-12.9465	12.94175
*	12.9465-12.9525	12.94775
*	12.9525-12.9585	12.95375
*	12.9585-12.9645	12.95975
*	12.9645-12.9705	12.96575
*	12.9705-12.9765	12.97175
*	12.9765-12.9825	12.97775
*	12.9825-12.9885	12.98375
*	12.9885-12.9945	12.98975
*	12.9945-13.0005	12.99575
*	13.0005-13.0065	13.00175
*	13.0065-13.0125	13.00775
*	13.0125-13.0185	13.01375
*	13.0185-13.0245	13.01975
*	13.0245-13.0305	13.02575
*	13.0305-13.0365	13.03175
*	13.0365-13.0425	13.03775
*	13.0425-13.0485	13.04375
*	13.0485-13.0545	13.04975

*No FCC designation as of yet.

Group D channels

FCC desig.	Microwave boundaries	Microwave video carrier
D01	12.7597-12.7657	12.76095
D02	12.7657-12.7717	12.76695
D03	12.7717-12.7777	12.77295
D04	12.7777-12.7817	12.780012
D05	12.7817-12.7877	12.78295
D06	12.7877-12.7937	12.78895
D07	12.7937-12.7997	—
D08	12.7997-12.8057	—
D09	12.8057-12.8117	—
D10	12.8117-12.8137	—
—	12.7937-12.8137	—
D11	12.8137-12.8197	12.81495
D12	12.8197-12.8257	12.82095
D13	12.8257-12.8317	12.82695
D14	12.8317-12.8377	12.83295
D15	12.8377-12.8437	12.83895
D16	12.8437-12.8497	12.84495
D17	12.8497-12.8557	12.85095
D18	12.8557-12.8617	12.85695
D19	12.8617-12.8677	12.86295
D20	12.8677-12.8737	12.86895
D21	12.8737-12.8797	12.87495
D22	12.8797-12.8857	12.88095
D23	12.8857-12.8917	12.88695
D24	12.8917-12.8977	12.89295
D25	12.8977-12.9037	12.89895
D26	12.9037-12.9097	12.90495
D27	12.9097-12.9157	12.91095
D28	12.9157-12.9217	12.91695
D29	12.9217-12.9277	12.92295
D30	12.9277-12.9337	12.92895
D31	12.9337-12.9397	12.93295
D32	12.9397-12.9457	12.94095
D33	12.9457-12.9517	12.94695
D34	12.9517-12.9577	12.95295
D35	12.9577-12.9637	12.95895
D36	12.9637-12.9697	12.96495
D37	12.9697-12.9757	12.97095
D38	12.9757-12.9817	12.97695
D39	12.9817-12.9877	12.98295
D40	12.9877-12.9937	12.98895
D41	12.9937-12.9997	12.99495
D42	12.9997-13.0057	13.00095

Group E channels

FCC desig.	Microwave boundaries	Microwave video carrier
E01	12.9525-12.9585	12.95375
E02	12.9585-12.9645	12.95975
E03	12.9645-12.9705	12.96575
E04	12.9705-12.9745	12.97393
E05	12.9745-12.9805	12.97550
E06	12.9805-12.9865	12.98175
E07	12.9865-12.9925	—
E08	12.9925-12.9985	—
E09	12.9985-13.0045	—
E10	13.0045-13.0065	—
—	12.9865-13.0065	—
E11	13.0065-13.0125	13.00775
E12	13.0125-13.0185	13.01375
E13	13.0185-13.0245	13.01975
E14	13.0245-13.0305	13.02575
E15	13.0305-13.0365	13.03175
E16	13.0365-13.0425	13.03775
E17	13.0425-13.0485	13.04375
E18	13.0485-13.0545	13.04975
E19	13.0545-13.0605	13.05575
E20	13.0605-13.0665	13.06175
E21	13.0665-13.0725	13.06750
E22	13.0725-13.0785	13.07350
E23	13.0785-13.0845	13.07975
E24	13.0845-13.0905	13.08575
E25	13.0905-13.0965	13.09175
E26	13.0965-13.1025	13.09775
E27	13.1025-13.1085	13.10375
E28	13.1085-13.1145	13.10975
E29	13.1145-13.1205	13.11575
E30	13.1205-13.1265	13.12175
E31	13.1265-13.1325	13.12775
E32	13.1325-13.1385	13.13375
E33	13.1385-13.1445	13.13975
E34	13.1445-13.1505	13.14575
E35	13.1505-13.1565	13.15175
E36	13.1565-13.1625	13.15775
E37	13.1625-13.1685	13.16375
E38	13.1685-13.1745	13.16975
E39	13.1745-13.1805	13.17575
E40	13.1805-13.1865	13.18175
E41	13.1865-13.1925	13.18775
E42	13.1925-13.1985	13.19375

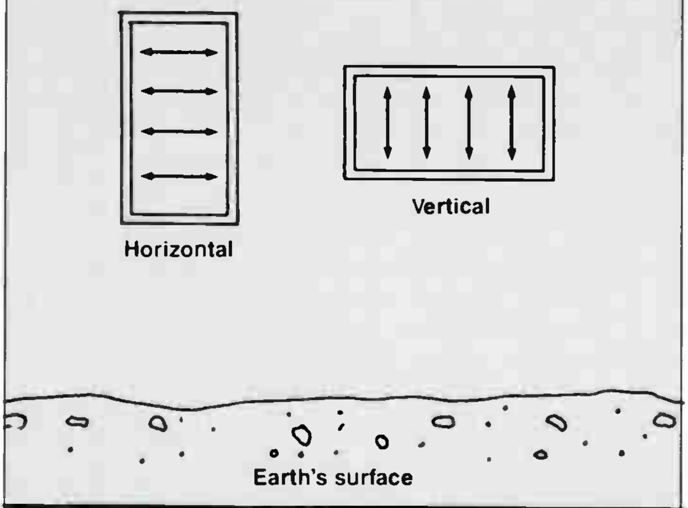
Group F channels

FCC desig.	Microwave boundaries	Microwave video carrier
F01	13.0125-13.0185	13.01375
F02	13.0185-13.0245	13.01975
F03	13.0245-13.0305	13.02575
F04	13.0305-13.0345	13.03428
F05	13.0345-13.0405	13.03575
F06	13.0405-13.0465	13.04175
F07	13.0465-13.0525	—
F08	13.0525-13.0585	—
F09	13.0585-13.0645	—
F10	13.0645-13.0665	—
—	13.0465-13.0665	—
F11	13.0665-13.0725	13.06775
F12	13.0725-13.0785	13.07375
F13	13.0785-13.0845	13.07975
F14	13.0845-13.0905	13.08575
F15	13.0905-13.0965	13.09175
F16	13.0965-13.1025	13.09775
F17	13.1025-13.1085	13.10375
F18	13.1085-13.1145	13.10975
F19	13.1145-13.1205	13.11575
F20	13.1205-13.1265	13.12175
F21	13.1265-13.1325	13.12775
F22	13.1325-13.1385	13.13375
F23	13.1385-13.1445	13.13975
F24	13.1445-13.1505	13.14575
F25	13.1505-13.1565	13.15175
F26	13.1565-13.1625	13.15775
F27	13.1625-13.1685	13.16375
F28	13.1685-13.1745	13.16975
F29	13.1745-13.1805	13.17575
F30	13.1805-13.1865	13.18175
F31	13.1865-13.1925	13.18775
F32	13.1925-13.1985	13.19375

†Courtesy of Hughes Aircraft Co./Microwave Products

Waveguide polarization

Waveguide and antenna polarization is determined by the direction of the microwave signal E-field vectors (arrows in diagram), either parallel (horizontal) or perpendicular (vertical) to the Earth's surface.



Waveguide attenuation
(12.7-13.2 GHz)

Waveguide type	dB/foot	dB/100 feet
Rectangular	0.0415	4.15
Elliptical (EW-122)	0.0410	4.10
Elliptical (EW-127)	0.0370	3.70
Circular*	0.0125	1.25
Flex	0.15	15.00

*Circular waveguide loss does not include top and bottom transition loss, which is typically 0.3 dB total.

Antennas and radomes
(12.7-13.2 GHz)

Size	Antenna gain	Radome loss
4′	41.5 dB	1.5 dB
6′	45.1 dB	1.7 dB
8′	47.6 dB	1.8 dB
10′	48.8 dB	2.1 dB
12′	50.9 dB	2.2 dB

Decibel conversions

50-ohm conversions

dBμV − 60 = dBmV
dBμV − 120 = dBV
dBμV − 107 = dBm
dBμV − 137 = dBW
dBmV + 60 = dBμV
dBmV − 60 = dBV
dBmV − 47 = dBm
dBmV − 77 = dBW
dBV + 120 = dBμV
dBV + 60 = dBmV
dBV + 13 = dBm
dBV − 17 = dBW
dBm + 107 = dBμV
dBm + 47 = dBmV
dBm − 13 = dBV
dBm − 30 = dBW
dBW + 137 = dBμV
dBW + 77 = dBmV
dBW + 17 = dBV
dBW + 30 = dBm

75-ohm conversions

dBμV − 138.75 = dBW
dBμV − 60 = dBmV
dBμV − 108.75 = dBm
dBμV − 120 = dBV
dBmV − 78.75 = dBW
dBmV + 60 = dBμV
dBmV − 48.75 = dBm
dBmV − 60 = dBV
dBV − 18.75 = dBW
dBV + 120 = dBμV
dBV + 60 = dBmV
dBV + 11.25 = dBm
dBm − 30 = dBW
dBm + 108.75 = dBμV
dBm + 48.75 = dBmV
dBm − 11.25 = dBV
dBW + 138.75 = dBμV
dBW + 78.75 = dBmV
dBW + 30 = dBm
dBW + 18.75 = dBV

0 dBμV = 1 microvolt across reference impedance
0 dBmV = 1 millivolt across reference impedance
0 dBV = 1 volt across reference impedance
0 dBm = 1 milliwatt across reference impedance
0 dBW = 1 watt across reference impedance

Microwave formulas

Path attenuation

Attenuation (dB) = $96.6 + 20\log_{10}F + 20\log_{10}D$

Fresnel zone clearance

1st Fresnel zone = $72.1\sqrt{\frac{d_1 d_2}{FD}}$

0.6 Fresnel zone = $43.26\sqrt{\frac{d_1 d_2}{FD}}$

Earth curvature

$h(@K=\infty) = 0$

$h(@K=4/3) = \frac{d_1 d_2}{2}$

$h(@K=2/3) = d_1 d_2$

$h(@K=1) = 0.67 d_1 d_2$

$h = \frac{d_1 d_2}{1.5K}$

For all these formulas:

- F = frequency in GHz
- D = total path length in statute miles
- h = height in feet
- d_1 = distance from one end of the microwave path to a given obstruction point
- d_2 = distance from obstruction point to the other end of the microwave path
- K = equivalent Earth radius factor

Relationship between system reliability and outage time

Percent reliability	Outage time each: Year	Month (avg.)	Day (avg.)
0%	8,760 hrs.	720 hrs.	24 hrs.
50%	4,380 hrs.	360 hrs.	12 hrs.
80%	1,752 hrs.	144 hrs.	4.8 hrs.
90%	876 hrs.	72 hrs.	2.4 hrs.
95%	438 hrs.	36 hrs.	1.2 hrs.
98%	175 hrs.	14 hrs.	29 min.
99%	88 hrs.	7 hrs.	14.4 min.
99.9%	8.8 hrs.	43 min.	1.44 min.
99.99%	53 min.	4.3 min.	8.6 sec.
99.999%	5.3 min.	26 sec.	0.86 sec.
99.9999%	32 sec.	2.6 sec.	0.086 sec.

Path reliability formulas

Fade probability (multipath outage hours) =

$$a \times b \times 2.5 \times 10^{-6} \times F \times D^3 \times 10^{\frac{-f}{10}}$$

Critical rain rate = $\left(0.465\,\frac{f}{D}\right)^{0.8}$

Slope of rain curve =

$$\log_{10}\left[\left(\frac{24\text{ hr. rain}/24}{1\text{ hr. rain}}\right)^{\frac{1}{1.38}}\right]$$

Rain outage hours = $\left(\frac{\text{Critical rain rate}}{1\text{ hr. rain}}\right)^{\frac{1}{\text{slope}}}$

Percent reliability = $\frac{8760 - (\text{hrs. multipath} + \text{hrs. rain})}{87.6}$

For all these formulas:

- F = frequency in GHz
- D = total path length in statute miles
- f = fade margin (to 35 dB C/N for AML, to FM improvement threshold for FML)
- 1 hr. rain = maximum rainfall, in inches, occurring in any one-hour period during the previous five years
- 24 hr. rain = maximum rainfall in inches, occurring in any 24-hour period during the previous five years
- a = terrain factor: Very smooth terrain, including over water, a = 4; average terrain with some roughness, a = 1; mountainous terrain, a = 0.25.
- b = temperature/humidity factor: Gulf coast or similar hot, humid areas, b = 0.5; normal interior or northern climate, b = 0.25; high altitude (mountainous) or very dry (desert), b = 0.125.

CARS Band Microwa
(12.7-13

Group A Channels (25 MHz Spacing)

13.2000	A20
13.1750	A19
13.1500	A18
13.1250	A17
13.1000	A16
13.0750	A15
13.0500	A14
13.0250	A13
13.0000	A12
12.9750	A11
12.9500	A10
12.9250	A09
12.9000	A08
12.8750	A07
12.8500	A06
12.8250	A05
12.8000	A04
12.7750	A03
12.7500	A02
12.7250	A01
12.7000	

Group B Channels (25 MHz Spacing)

13.1875	B19
13.1625	B18
13.1375	B17
13.1125	B16
13.0875	B15
13.0625	B14
13.0375	B13
13.0125	B12
12.9875	B11
12.9625	B10
12.9375	B09
12.9125	B08
12.8875	B07
12.8625	B06
12.8375	B05
12.8125	B04
12.7875	B03
12.7625	B02
12.7375	B01
12.7125	

Group E Ch

Frequencies: 13.1985, 13.1925, 13.1865, 13.1805, 13.1745, 13.1685, 13.1625, 13.1565, 13.1505, 13.1445, 13.1385, 13.1325, 13.1265, 13.1205, 13.1145, 13.1085, 13.1025, 13.0965, 13.0905, 13.0845, 13.0785, 13.0725, 13.0665, 13.0605, 13.0545, 13.0485, 13.0425, 13.0365, 13.0305, 13.0245, 13.0185, 13.0125, 13.0065, 13.0045, 12.9985, 12.9925, 12.9865, 12.9805, 12.9745, 12.9705, 12.9645, 12.9585, 12.9525

Channels: E42, E41, E40, E39, E38, E37, E36, E35, E34, E33, E32, E31, E30, E29, E28, E27, E26, E25, E24, E23, E22, E21, E20, E19, E18, E17, E16, E15, E14, E13, E12, E11, E09, E08, E07, E06, E05, E04, E03, E02, E01

Frequencies: 12.9465, 12.9405, 12.9345, 12.9285, 12.9225, 12.9165, 12.9105, 12.9045, 12.8985, 12.8925, 12.8865, 12.8805, 12.8745, 12.8685, 12.8625, 12.8565, 12.8505, 12.8445, 12.8385, 12.8325, 12.8265, 12.8205, 12.8145, 12.8085, 12.8025, 12.7965, 12.7905, 12.7845, 12.7785, 12.7725, 12.7665, 12.7605, 12.7545, 12.7525, 12.7465, 12.7405, 12.7345, 12.7285, 12.7225, 12.7185, 12.7125, 12.7065, 12.7005

Channels: C42, C41, C40, C39, C38, C37, C36, C35, C34, C33, C32, C31, C30, C29, C28, C27, C26, C25, C24, C23, C22, C21, C20, C19, C18, C17, C16, C15, C14, C13, C12, C11, C09, C08, C07, C06, C05, C04, C03, C02, C01

Group C C

Compiled by Ron Hranac and Paul Vadakin, Jones Intercable Inc.

NICATIONS
OLOGY'S

ve Frequency Guide
.2 GHz)

annels

W
V
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S
R
Q
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L
K
J
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8
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I
H
G
F
E
D
C
B
A
AUX
AUX
F10 (FM4)
FM3
FM2
FMI
6
5
PT
4
3
2

Group F Channels

13.1985		
13.1925	F32	M
13.1865	F31	L
13.1805	F30	K
13.1745	F29	J
13.1685	F28	13
13.1625	F27	12
13.1565	F26	11
13.1505	F25	10
13.1445	F24	9
13.1385	F23	8
13.1325	F22	7
13.1265	F21	I
13.1205	F20	H
13.1145	F19	G
13.1085	F18	F
13.1025	F17	E
13.0965	F16	D
13.0905	F15	C
13.0845	F14	B
13.0785	F13	A
13.0725	F12	AUX
13.0665	F11	AUX
13.0645	F10 (FM4)	
13.0585	F09	FM3
13.0525	F08	FM2
13.0465	F07	FMI
13.0405	F06	6
13.0345	F05	5
13.0305	F04	PT
13.0245	F03	4
13.0185	F02	3
13.0125	F01	2
13.0057		

Group K Channels (12.5 MHz Spacing)

13.2000	K40
13.1875	K39
13.1750	K38
13.1625	K37
13.1500	K36
13.1375	K35
13.1250	K34
13.1125	K33
13.1000	K32
13.0875	K31
13.0750	K30
13.0625	K29
13.0500	K28
13.0375	K27
13.0250	K26
13.0125	K25
13.0000	K24
12.9875	K23
12.9750	K22
12.9625	K21
12.9500	K20
12.9375	K19
12.9250	K18
12.9125	K17
12.9000	K16
12.8875	K15
12.8750	K14
12.8625	K13
12.8500	K12
12.8375	K11
12.8250	K10
12.8125	K09
12.8000	K08
12.7875	K07
12.7750	K06
12.7625	K05
12.7500	K04
12.7375	K03
12.7250	K02
12.7125	K01
12.7000	

W
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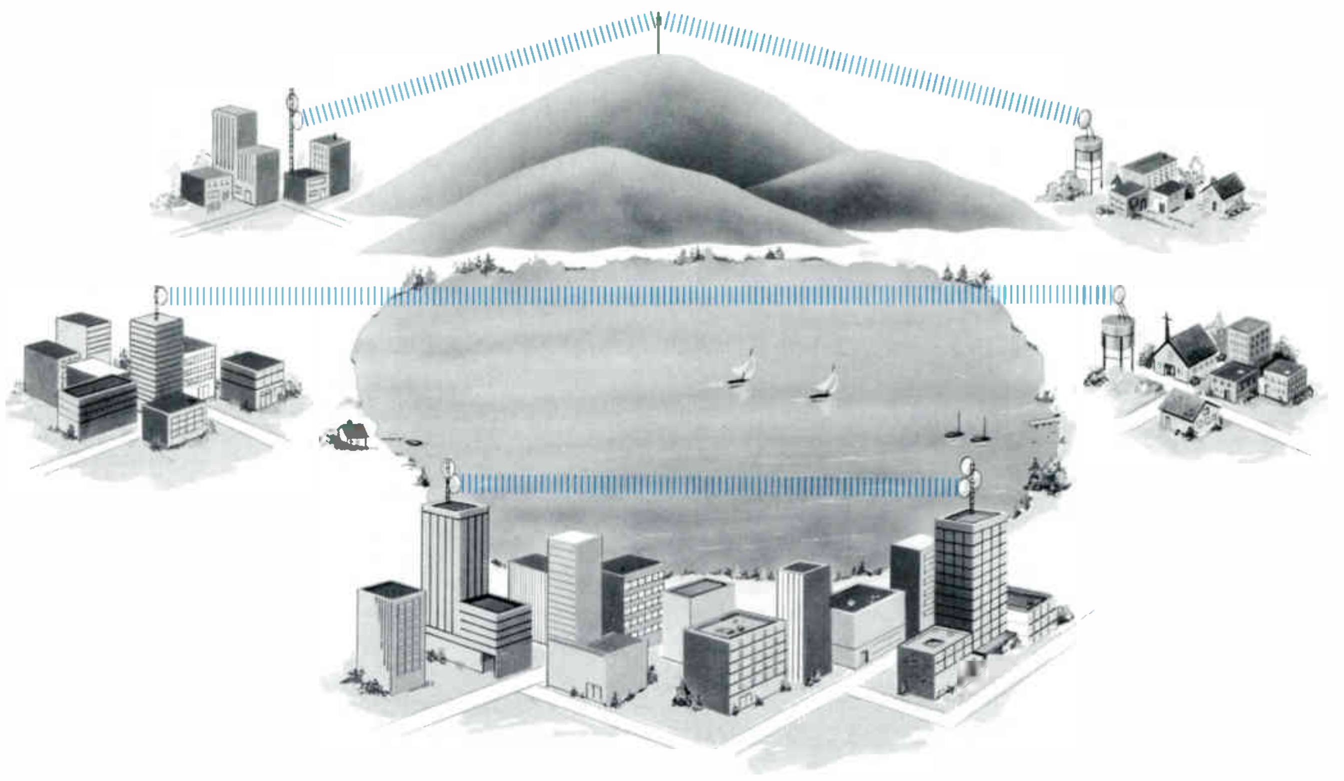
G
F
E
D
C
B
A
AUX
AUX
C10 (FM4)
FM3
FM2
FMI
6
5
PT
4
3
2

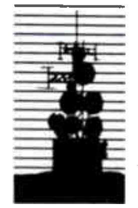
hannels

Group D Channels

12.9997	D42	W
12.9937	D41	V
12.9877	D40	U
12.9817	D39	T
12.9757	D38	S
12.9697	D37	R
12.9637	D36	Q
12.9577	D35	P
12.9517	D34	O
12.9457	D33	N
12.9397	D32	M
12.9337	D31	L
12.9277	D30	K
12.9217	D29	J
12.9157	D28	13
12.9097	D27	12
12.9037	D26	11
12.8977	D25	10
12.8917	D24	9
12.8857	D23	8
12.8797	D22	7
12.8737	D21	I
12.8677	D20	H
12.8617	D19	G
12.8557	D18	F
12.8497	D17	E
12.8437	D16	D
12.8377	D15	C
12.8317	D14	B
12.8257	D13	A
12.8197	D12	AUX
12.8137	D11	AUX
12.8117	D10 (FM4)	
12.8057	D09	FM3
12.7997	D08	FM2
12.7937	D07	FMI
12.7877	D06	6
12.7817	D05	5
12.7777	D04	PT
12.7717	D03	4
12.7657	D02	3
12.7597	D01	2

FROM SMALL TOWN TO DOWNTOWN–
HUGHES HAS THE RIGHT SYSTEM FOR YOUR APPLICATION





No one microwave system is intended to fit every application. And that's why Hughes Aircraft Company offers you a choice. Whether you're serving a rural community or a metropolitan area, you can now get a microwave video distribution system suited to your specific application…as well as your pocketbook.

Low Power. This low-cost, solid state OLE-111 transmitter is pole mountable, will handle 1-60 TV channels, and allows you to rapidly and inexpensively extend your cable plant from the end of a cascade to new subscriber pockets.

Medium Power. The most widely used Hughes AML® transmitter, the MTX-132, is easily expandable to accommodate cable systems up to 550 MHz, and is ideal for providing local distribution of a large number of television signals from headend to hubs.

High Power. The STX-141 offers the ultimate in high power microwave video distribution. It is intended for use where large numbers of hubs are served, or where long microwave paths may be encountered.

Beam Bender. This low-cost, on-frequency, active repeater is solid state, requires little power, and is designed for outdoor mounting. The MWB-122 is used to redirect a microwave signal when the path is blocked by a man-made or natural obstacle.

These transmitters deliver AM or FM signals, and, like all Hughes AML products, are backed by a comprehensive support program. So contact Hughes today and let us help you select the right system for your microwave application. Hughes Microwave Communications Products, Bldg. 245, P. O. Box 2940, Torrance, CA 90509-2940, or call toll free (800) 227-7359, Ext. 6233. In California: (213) 517-6233. In Canada: COMLINK Systems Inc., 1420 Bayly Street, Unit 5, Pickering, Ontario L1W 3R4, (416) 831-8282.

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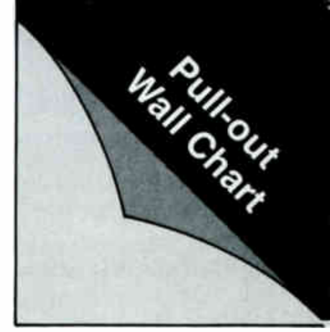

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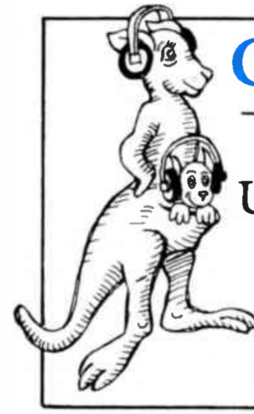
CARS Band Microwave Frequency Guide (12.7-13.2 GHz)



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AML microwaves

By Jeff Kaczor
Engineer, Complete Channel TV Inc

AML (amplitude modulated link) microwave preventive maintenance should accomplish three things: ensure system reliability, ensure system quality and provide an insight when problems do occur. When planning a maintenance program, you should start with the transmitter input and encompass the entire system to the receive interface unit (IFU) or IFU output.

The transmitter site requires daily preventive maintenance; transmitter output levels should be checked daily. If the transmitter is in a remote location, it should be checked at least two or three times per week. Of course, your transmitter is going to run only as well as your headend. At least half the time when problems do happen in our system, they usually are in the headend. We do not use a headend combiner but a transmitter, a transmitter monitor and an IFU to feed trunk out of the building; the advantages of this far outweigh having a headend combiner. The two main reasons we decided to do it this way were transmitter isolation and ease of headend setup.

If you use a combiner, you must first check trunk out then check your transmitter out. When you read your IFU out, you are looking at the transmitter. The idea behind this is that it is much easier to maintain one mix instead of two. This setup also will force you to have at least one hot-running spare receiver to back up the transmit monitor in your system; we have three. A majority of preventive maintenance is done on a monthly basis.

Recording measurements

In our system, to check transmitter input and transmitter frequency we usually keep the counter on the transmitter oscillator hooked up and running. Klystron currents are logged in a separate book so that we can look at a particular klystron during six months to a year without having to wade through a lot of paper. The redundant oscillator also is switched in and allowed to run for a day; its frequency and output levels are checked. If it is a MTX transmitter, we pull it off the shelf and test it quarterly.

Air-conditioning for the transmitter/headend room is checked for belt tension and condition. Filters and heat exchanging coils should be examined for dirt and obstructions. Without a reliable air-conditioning system it is hard to run an STX high-power array.

A complete check of all receive sites should be done monthly. Receiver operating parameters should be established and not change much. In a composite system, check the receiver frequency. IFU input and output should be measured and logged along with receiver parameters.

Waveguide pressure, both primary and secondary, also should be logged on the same sheet. If you have a good, tight site, your waveguide pressure won't change either. If it does leak, get the soapy water out and find the leaks. I strongly recommend using dry nitrogen rather than air dehydrators, because the heater that should keep the desiccant dry might fail and eventually lead to a problem known as "moisture in the waveguide." Sites where you can hook up a nitrogen tank to run 2 to 5 pounds per square inch and not have to change the tank but once or twice per year decreases your probability of taking on water. We have sites where we change the tank every four to five years and we also have others where after five years no appreciable pressure has been lost. Of course, some of this

'Another thing to check while on your monthly receive site run is a general visual inspection of the site'

Remote headend operating log

DATE:	TIME:	METER:	TECH:
OUTSIDE TEMP:	INSIDE TEMP:	MULTIMETER:	HUB NUMBER:

TELEVISION CHANNEL SIGNAL LEVEL MEASUREMENTS

CHANNEL	AML RX VIDEO	AML RX AUDIO	IFU OUT VIDEO	IFU OUT AUDIO	CHANNEL	AML RX VIDEO	AML RX AUDIO	IFU OUT VIDEO	IFU OUT AUDIO
2					10				
3					11				
4					12				
73.96 mhz					13				
5					J				
6					K				
118.25 mhz					L				
A					M				
B					N				
C					O				
D					P				
E					Q				
F					R				
G					S				
H					T				
I					U				
7					V				
8					W				
9									

PARAMETER (IDEAL)	PRIMARY RECEIVER	STAND-BY RECEIVER
SERIAL NUMBER/TYPE		
TEMPERATURE (2878 Ω)		
AGC (0 TO -15 VDC)		
SOURCE ALARM (0 VDC)		
SRCE. PHSE. LCK. (-2 TO -16 VDC)		
HI ALARM (0 VDC)		
LO ALARM (0 VDC)		
ERROR (-2 TO -16 VDC)		
-20 VDC (-20 VDC)		
+24 VDC (+24 VDC)		
VAC (6 VDC)		
WAVEGUIDE PRESSURE		

depends on who built the site.

I cannot place enough emphasis on the mechanical integrity of the system. Another thing to check while out on your monthly receive site run is a general visual inspection of the site, including building condition, security, etc. If you have a phase-lock system, you can perform what we call the "phase-lock shock test": While observing the error voltage, slap the front of the receiver with the palm of your hand. If you don't have any bad connections in your receiver, then it won't move. If it does move, you have a bad connection; find it.

Transmitter power should be set; we do it bi-yearly. All towers should be checked for grounding, guy tension, plumb, visual inspection for corrosion and anchor inspection.

Once all system parameters are established, a preventive maintenance routine will keep an AML system just purring along. If the equipment is properly installed and set up according to manufacturer specifications, long-standing reliability can be expected.

Summary of preventive maintenance

Daily

1. Check trunk out levels.
2. Check TX monitor for proper levels.
3. Check TX waveguide pressure.

Weekly

1. Check source lock voltage; log klystron voltage and current and power supply voltages.

Monthly

1. Check TX frequency.
2. Check all receive sites for the following:
   a. levels out of RX
   b. levels out for trunk
   c. RX frequency, source lock voltage, AGC voltage, power supply voltages
   d. waveguide pressure and tank pressure
   e. general visual inspection of site
   f. fade margin (watch for fluctuations on windy days)

Yearly

1. Tower inspection:
   a. grounding
   b. guy tension
   c. plumb
   d. visual inspection for corrosion
   e. anchor inspection
2. Set TX power (I do it bi-yearly)

Reference

Hughes AML Seminar Manual

With our CAT System you can monitor your headend without leaving your office.

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January

Jan. 5-6: University of Central Florida course on low-noise electronic circuits for electro-optics systems, Americana Dutch Resort Hotel, Walt Disney Village, Lake Buena Vista, Fla. Contact Vince Amico, (305) 275-2123.

Jan. 7: SCTE Rocky Mountain Chapter seminar on engineering management and professionalism. Contact Joe Thomas, (303) 978-9770.

Jan. 7-9: Magnavox CATV training seminar, Torrance, Calif. Contact Amy Costello, (800) 448-5171.

Jan. 7-9: University of Central Florida fiber-optics workshop, Americana Dutch Resort Hotel, Walt Disney Village, Lake Buena Vista, Fla. Contact Vince Amico, (305) 275-2123.

Jan. 12-14: Magnavox CATV training seminar, Torrance, Calif. Contact Amy Costello, (800) 448-5171.

Jan. 13-15: Jerrold technical seminar, Clarion Hotel/Airport, San Francisco. Contact Seminar Administrator, (215) 674-4800.

Jan. 14: SCTE Shenandoah Valley Meeting Group seminar on fiber optics, Blue Ridge Community College, Verona, Va. Contact David Lisco, (703) 248-3400.

Jan. 19-20: Washington State Cable Communications Association annual convention, Sheraton Tacoma Hotel, Tacoma, Wash. Contact Kari Spencer, (206) 851-6290.

Jan. 20-22: Magnavox CATV training seminar, San Jose, Calif. Contact Amy Costello, (800) 448-5171.

Jan. 21: Colorado Cable Television Association's annual winter meeting, Governor's Court Hotel, Denver. Contact (303) 863-0084.

Jan. 21-22: SCTE National Headquarters and **Chattahoochee Chapter** engineering and technical management development seminar, Holiday Inn Airport/South, Atlanta. Contact Mike Aloisi, (404) 396-1333; or Guy Lee, (404) 451-4788.

Jan. 26-30: George Washington University course on optical fiber communications, Seapoint Hotel, San Diego. Contact (202) 676-6106 or (800) 424-9773.

Jan. 27: SCTE Satellite Tele-Seminar Program, "Basic Fundamentals in Cable System Powering" (from Cable-Tec Expo '86), 1-2 p.m. EST on Transponder 7 of Satcom IIIR. Contact (215) 363-6888.

Jan. 27-29: Magnavox CATV training seminar, Portland, Ore. Contact Amy Costello, (800) 448-5171.

Jan. 28-30: Institute for Advanced Technology seminar on local area networks, Loews Summit, New York. Contact (212) 752-7000.

February

Feb. 2-3: South Carolina Cable Television Association annual meeting, Radisson Hotel, Columbia, S.C. Contact Patti Nichols or Jay Bender, (803) 799-9091.

Feb. 3-4: Arizona Cable Television Association annual meeting, Phoenix Hilton Hotel, Phoenix, Ariz. Contact (602) 257-9338.

Feb. 3-5: Magnavox CATV training seminar, Denver. Contact Amy Costello, (800) 448-5171.

Feb. 6-7: Society of Motion Picture and Television Engineers conference, St. Francis Hotel, San Francisco. Contact (914) 761-1100.

Planning ahead

Feb. 18-20: Texas Show, Convention Center, San Antonio, Texas.

April 2-5: SCTE Cable-Tec Expo '87, Hyatt Hotel, Orlando, Fla.

May 17-20: NCTA annual convention, Convention Center, Las Vegas, Nev.

Aug. 30-Sept. 1: Eastern Show, Merchandise Mart, Atlanta.

Sept. 21-23: Great Lakes Expo, Indianapolis Convention Center/ Hoosier Dome, Indianapolis.

Oct. 6-8: Atlantic Show, Convention Center, Atlantic City, N.J.

Oct. 18-22: Mid-America CATV Show, Hyatt Regency at Crown Center, Kansas City, Mo.

AD INDEX

Benefitting from microwaves

By Robert Schumacher
Telecommunications Engineer
American Television and Communications Corp.

Economy is defined as "care and frugality in the use of money, time, resources, etc." All cable system operators are well aware of the necessity of complying with that definition if they are to survive. It is a well-known fact that a cable TV system today consists of much more than just a headend and a cable distribution system. For many years microwave has been a favored, and often the only, means of transporting TV programming from one point to another. With the advent of the "clustering" concept and ad insertion, microwave became even more important to the CATV operator.

Often, building trunk lines to deliver the desired programming to distant points is not economically feasible. Such obstructions as interstate highways, railroad switch yards, airports, large rivers, etc., can make cable construction costs prohibitive.

Worth considering

Whether the problem is to interconnect suburban areas of a metropolis or to serve several smaller communities from one central hub, microwave is certainly worth considering. If a minimum number of channels is required, single-channel FML (frequency modulated link) equipment may be desirable. Greater channel capacity dictates that the AML (amplitude modulated link) equipment be considered. Both systems require towers, antennas and feedlines at both ends, so the deciding factor is the cost of transmitting and receiving equipment. Obviously, engineering considerations will vary from location to location. Rain zones require reduced path lengths, so what might be acceptable in Arizona probably would not work in Florida.

For those not familiar with microwave systems, FML equipment consists of a single transmitter and receiver for each channel to be transmitted. CARS (community antenna relay service) microwave is limited to the 12 GHz frequency band (12.7 to 13.2 GHz). For shorter length paths, the FCC requires that the Group K channel frequency plan be used, which assigns a 12.5 MHz bandwidth to each channel. For longer paths, a 25 MHz bandwidth per channel is allowed (Group A channels). The audio information generally is transported on a 4.5 MHz subcarrier along with the video signal. Since the programming is transported at baseband, to use the signal on a cable system a demodulator (or a video source) is required at the transmit end and a modulator is required at the receive end.

AML uses a totally different concept. Again, a transmitter is required for each channel that is to be transmitted but only a single broadband receiver (54-300 MHz or 54-440 MHz) is needed at each receive site. VHF signals from the cable system headend equipment (6 MHz bandwidth per channel) are fed to the AML transmitter drivers where they are amplified and then block-converted up to the CARS band microwave frequencies and transmitted to the various receive sites. At the receive end, they are blockconverted back down to the television frequencies. In effect, the AML receiver can be considered as the first trunk amplifier for the cable system fed by the CARS receive site.

Combining losses

Unfortunately, as the number of channels to be transmitted increases, the antenna input power decreases due to combining losses. With today's channel requirements, this can be significant and requires careful engineering for a workable system.

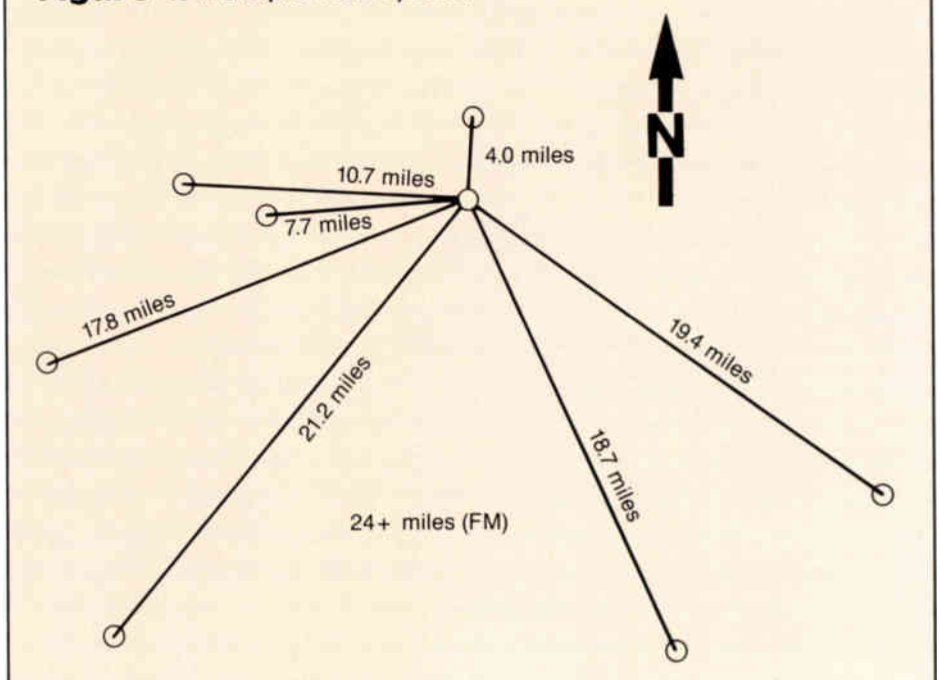
Figure 1 illustrates a typical multiple hub system. In this particular instance, path lengths vary from four to 21 miles. The main transmit site consists of 25 high-power AML transmitters furnishing identical programming to all receive sites. In addition, there are FML return paths from some of the receive sites back to the main hub.

If only one or two signals need to be transmitted over relatively short distances, another alternative is the 23 GHz private operational-fixed microwave service. Equipment prices are approximately the same as the CARS equipment we have been discussing. Transmit/receive equipment is available for either video or digital service. Both types are currently in use and provide satisfactory service. Naturally, rain is more of a problem with the 23 GHz frequencies than with the 12 GHz services, but with careful engineering, the 23 GHz equipment provides reliable communications.

'Often, building trunk lines to deliver the desired programming to distant points is not economically feasible'

There are other sound reasons for considering microwave as a means of signal transmission. Whether considering a rebuild, a new-build or an expansion, including a microwave system may prove to be much less expensive than investing only in cable equipment. Often, excessively long amplifier cascades can be avoided and construction time reduced considerably. The net result well could be better pictures for the customer at less expense for the operator. After all, that's what economy is all about.

Figure 1: Multiple hub system



Communication tower installation

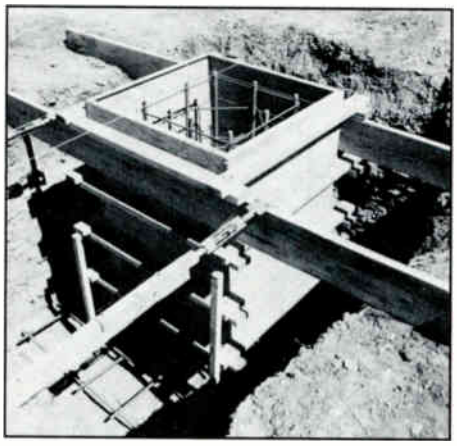
By Ted Glatz
UNR-Rohn Inc

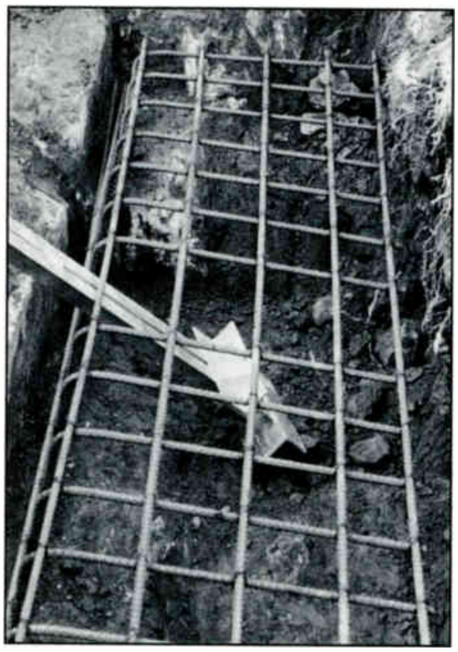
There are many uses for communications towers in our fast-moving, modern society. Towers may be used for cable and broadcast TV, microwave, AM and FM broadcast, and cellular radio, just to name a few. As there are only two basic types of towers—guyed or self-supporting—the amount of land available and the cost usually are the deciding factors in the type chosen. Making sure that the tower is designed and constructed/installed properly requires planning and experience.

Before the tower parameters can be determined certain information is required, such as wind- and ice-loading, antenna-loading, plot plan or site area, and any other specifications unique to the particular application. In addition, an accurate, detailed soil analysis should be performed so that the foundations can be engineered for the existing conditions.

Once the specific requirements are known, we utilize a computer-aided design system to ensure that the tower and its components will meet the provided criteria. At the appropriate time in the construction schedule and after the necessary permits have been obtained, the installation is ready to begin.

Clockwise from above: self-supporting tower being erected using a crane; pier-and-pad foundation for guyed tower base under construction; foundation reinforcements for "dead-man" anchor block for guyed tower.





The installation

Most tower installations are broken down into three phases: foundation installation, tower erection, and antenna and line installation.

Depending upon the circumstances, a different subcontractor may be selected for each of these phases or just one chosen to install the entire job. Over the years towers have gotten much larger; foundations, likewise, must be much larger in order to support the added loads. In many cases, because of the larger foundations required for self-supporting towers, a specialized foundation subcontractor should be employed. Special foundations could consist of large mat-types, pier and pad, drill and bell, or large diameter vertical shafts. Guyed tower foundations usually consist of a pier and pad base for the tower and three or more "dead-man" buried anchor blocks.

Tower foundations should be installed following the design parameters as well as industry-mandated codes. These codes define minimum requirements for cement, aggregate, admixture, reinforcements, mixing, transporting of the ready-mix material and placement of concrete. They also define minimum requirements for compaction of the back-fill against the installed concrete. We require our foundation subcontractors take concrete cylinder tests and have the results certified by the testing laboratory as added insurance that the concrete did in fact reach the specified strength. In some cases, slump tests also are taken at the time concrete is poured.

Erecting the tower

After the tower foundation has cured for the appropriate amount of time, the tower material is shipped and arrangements made for the tower erector to be present upon arrival. The tower material usually is hauled to the site by 40-foot flatbed trucks. During the unloading procedure the erector lays out the material, with whatever is to be used first nearest the tower base. As well, the erector should take an accurate inventory against the packing list to make sure that all material needed for the erection of the tower is on hand.

Depending on the size of the tower, it may be assembled and erected with a crane or using a winch and gin pole to stack the tower. Because of the size and weight of the tower elements, many erectors now use mobile cranes or cherry-pickers to speed up the work. At times, depending on location, helicopters are used. In any case the tower, as assembled, should be kept true and plumb as it is being stacked.

Painting and lighting

If the towers are required to be painted in accordance with FAA regulations, this may be done at the manufacturer's facilities, on the ground at the site or in the air after erection. If lighting is required, this is done during erection. However, prior to the permanent lights being installed, temporary lighting must be used as set forth by the FAA.

The tower grounding system usually is attached to the tower base section at the commencement of the stacking procedure. During erection, certain attachments such as ladders and safety climbing devices, antenna mounts, ice shields, etc., are installed on the tower. After erection, the communication devices (antennas, horns, etc.) are installed along with the appropriate feed lines.

Upon completion of the erection work, minor adjustments may be necessary to make sure that the tower is true and plumb in accordance with specifications and recognized standards. ■

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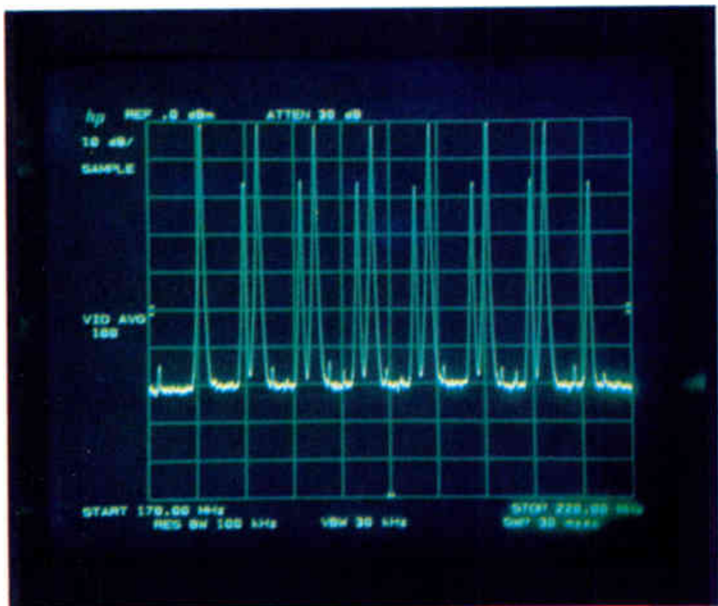
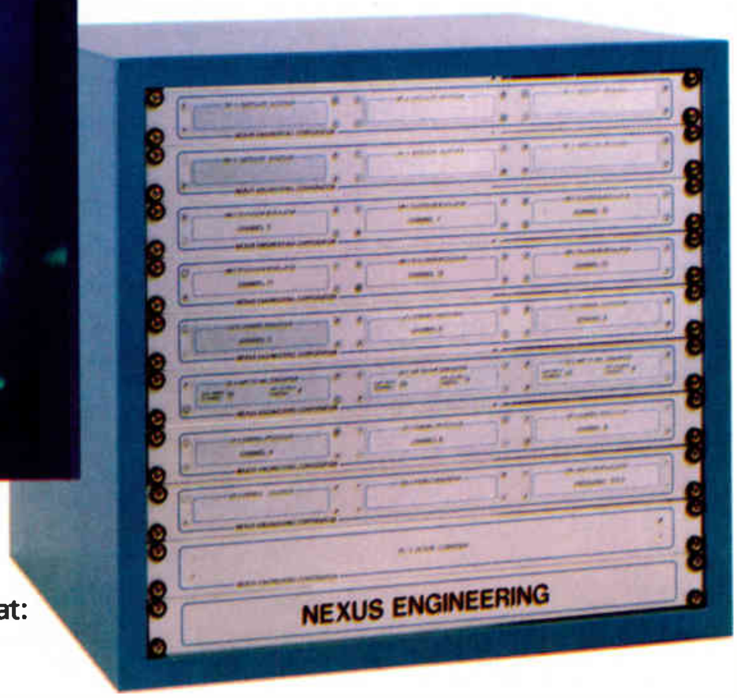


. . . and look like this.



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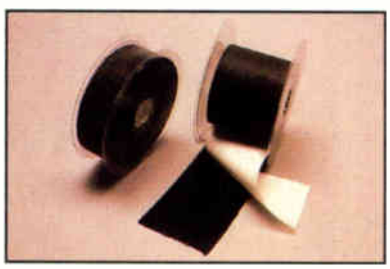

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