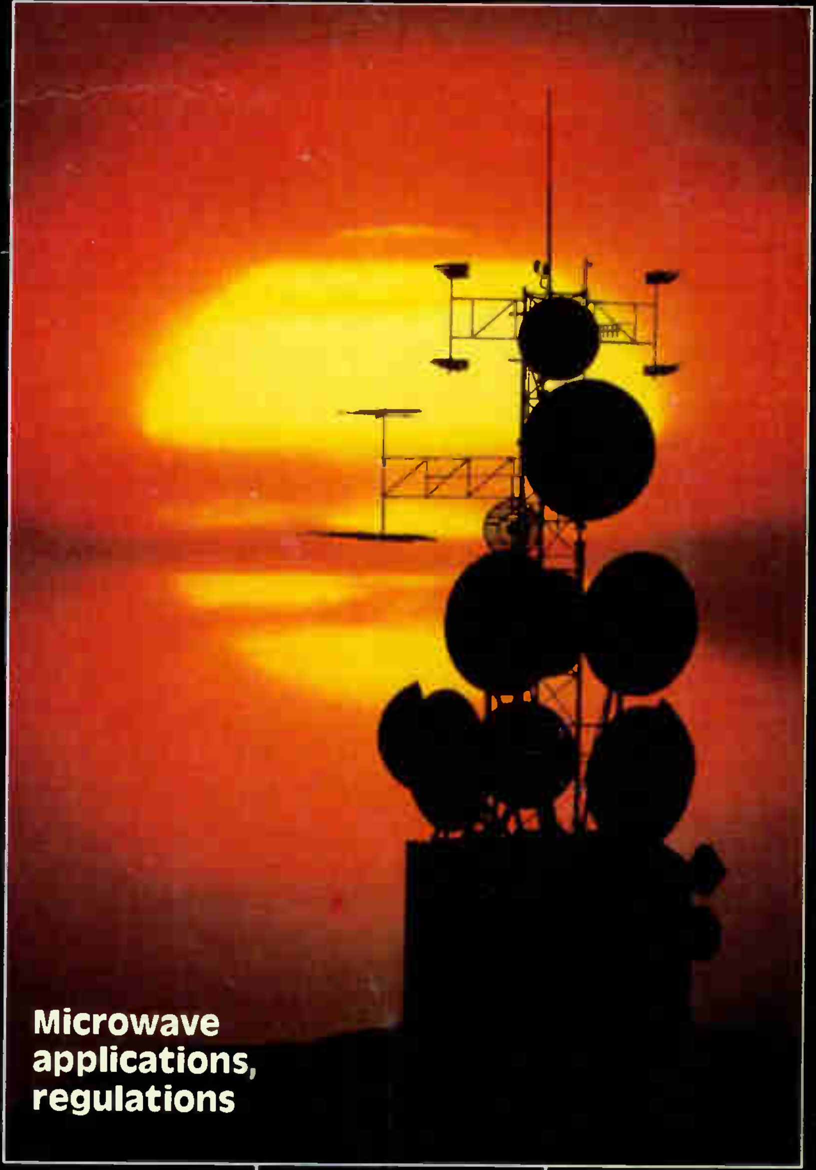
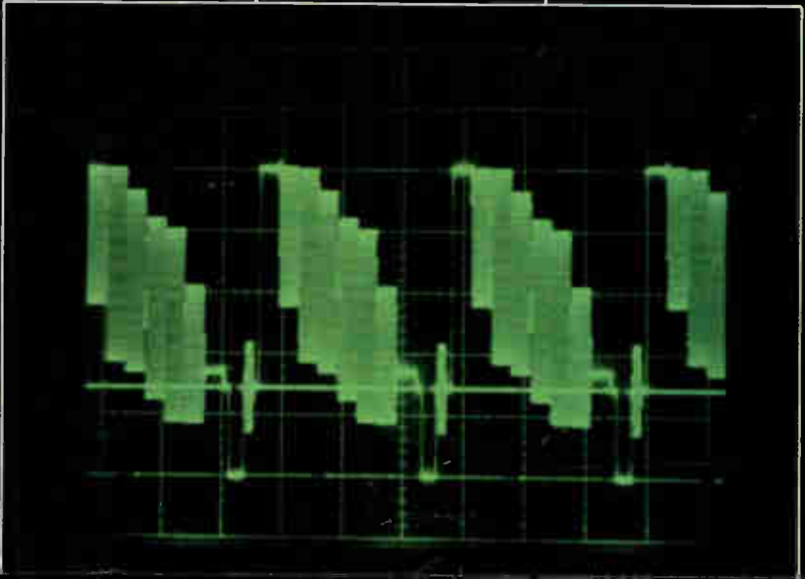
Pull-out
CARS band wall chart

COMMUNICATIONS TECHNOLOGY

Official trade journal of the Society of Cable Television Engineers



Microwave applications, regulations



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January 1988

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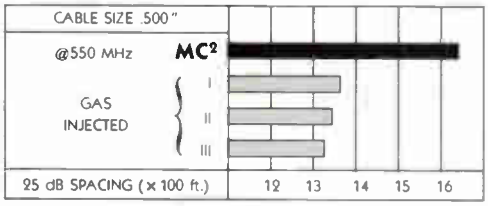

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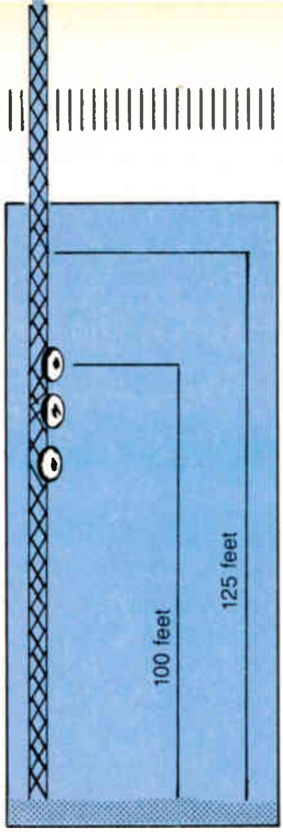

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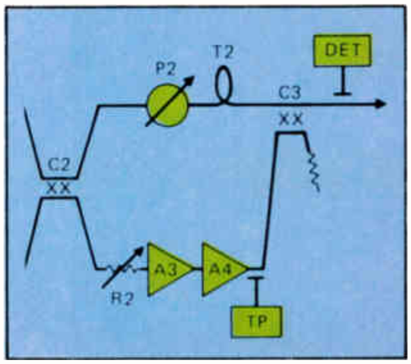

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Cover
Microwave photo courtesy Hughes Aircraft Co., Microwave Communications Products, P.O. Box 2940, Torrance, Calif. 90509-2940, (800) 227-7359 or (213) 517-6233.

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Way out Western

Last month's Western Show in Anaheim, Calif., might not be compared with such events as the parting of the Red Sea or even Apollo 11's moon landing, but it still held a few dazzling moments of its own. For example, just look at the numbers: Over 8,700 attended the 1987 show, compared to about 7,700 in 1986. Also, the number of exhibits increased to 214 (compared to 209 from 1986) and occupied 108,000 square feet of floor space.

Perhaps the most attention in the technical sessions was paid to two main topics: high-definition television (HDTV) and fiber optics. Each had several well-attended sessions devoted to it. However, HDTV was probably the more visible of the two, with a number of exhibitors employing HDTV in their booths. As well, there was a very impressive demonstration conducted by Home Box Office, comparing HDTV with NTSC—what a difference!

On the fiber side, a noteworthy announcement came from none other than Irving Kahn, chairman and president of Broadband Communications Inc. His company is planning to overbuild with fiber optics the Cherry Hill, N.J., cable system currently owned by NYT Cable. At the show, Kahn said he would build "a fiber cable system with a channel capacity of up to 100 channels at a cost equal to or less than the cost of a conventional 550 MHz cable system."

If you want to learn about some of the products unveiled and/or exhibited at the 1987 Western Show, turn to page 70 and our expanded "Product News" section.

Congratulations

Also at the Western Show, the National Cable Television Cooperative presented its Vendor of the Year Award to Bob Toner, president of Toner Cable Equipment Inc. Congratulations, Bob!

Mike Pandzik, executive director of the National Cable Television Cooperative, presents to Bob Toner, president of Toner Cable Equipment Inc., the Cooperative's Vendor of the Year Award.

Good news for the Society of Cable Television Engineers, as well. It recently announced the results of its fund drive to help defray the cost of the national headquarters building in Exton, Pa. To date, a total of $38,000 in contributions has been received, reducing the mortgage to $52,000 and enabling the reallocation of funding from interest payments to SCTE programs and services.

And let's not forget *Communications Technology.* The SCTE has just renewed its contract with CT Publications Corp. for the continued endorsement of *CT* magazine by the Society. The terms of the contract extend the endorsement for three more years. *CT* has been the Society's official journal since the magazine began in March 1984. We're proud to be affiliated with such an outstanding organization as the SCTE, definitely at the vanguard of the cable TV engineering community.

Words of wisdom

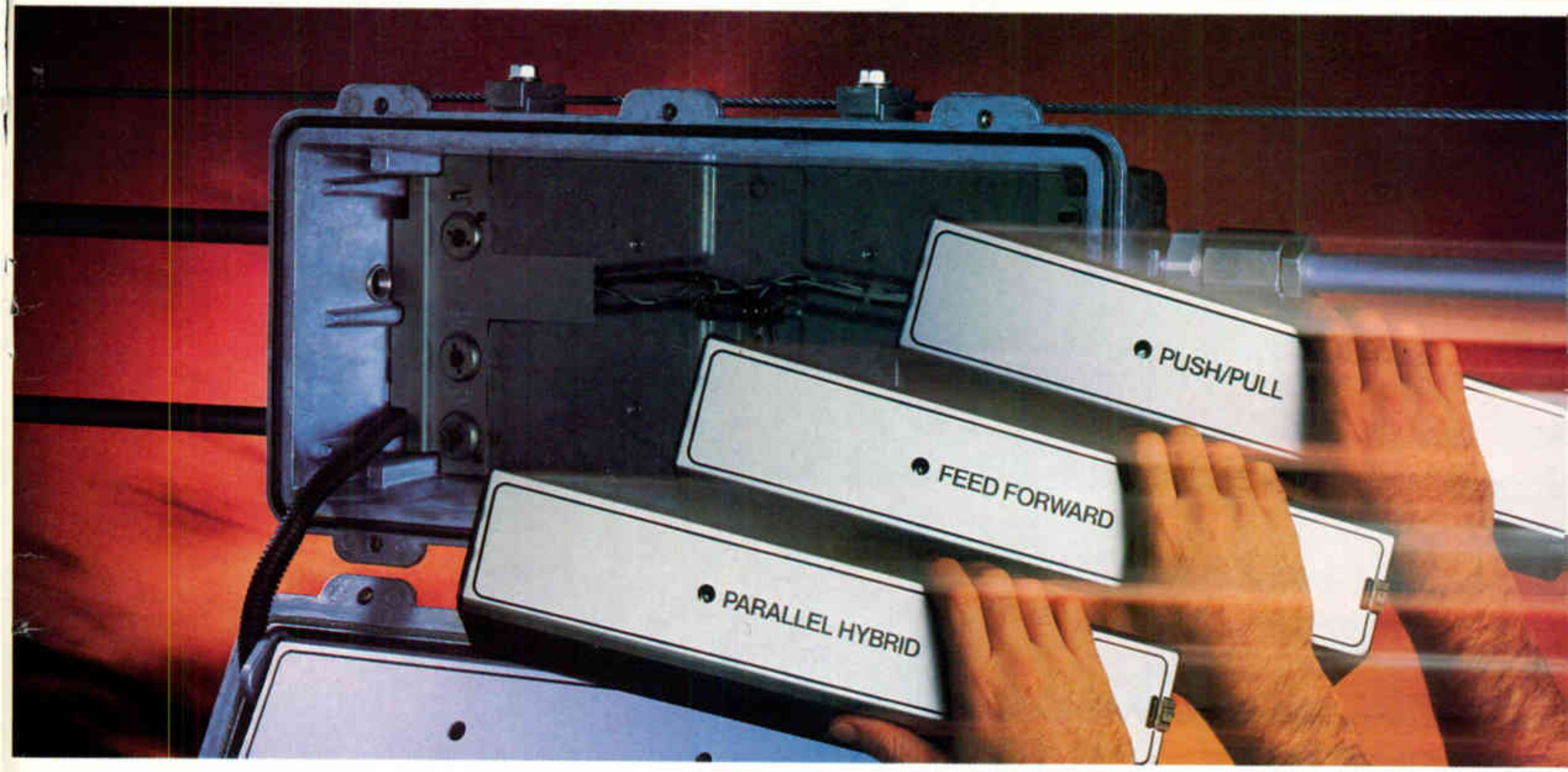
I'd like to leave you with a few words from an address given by Tony Acone, chair of the California Cable Television Association board of directors. I think it sums up quite well what the challenges are that face us this year and into the 1990s:

"Take a thorough look at cable in transition toward more and better service, better relationships with subscribers. See an accelerating cable TV industry as the agent changing the entire structure of the entertainment industry, and continue to explore the role you want to play in this dynamic process."

He continued, "Some say we have won virtually every battle and are due for a consciousness-raising slap in the face from some political or regulatory body...No, the political battles will probably never be over. But that is not the real danger. The real danger in my mind is that we have been so successful and are likely to remain so that soon we may be the institution, the major delivery system, the old guard. And then, just as sure as you are born, someone more adaptable, more flexible, someone hungrier, with a new idea will come along and want our piece of the pie."

Happy New Year!

Paul R. Levine



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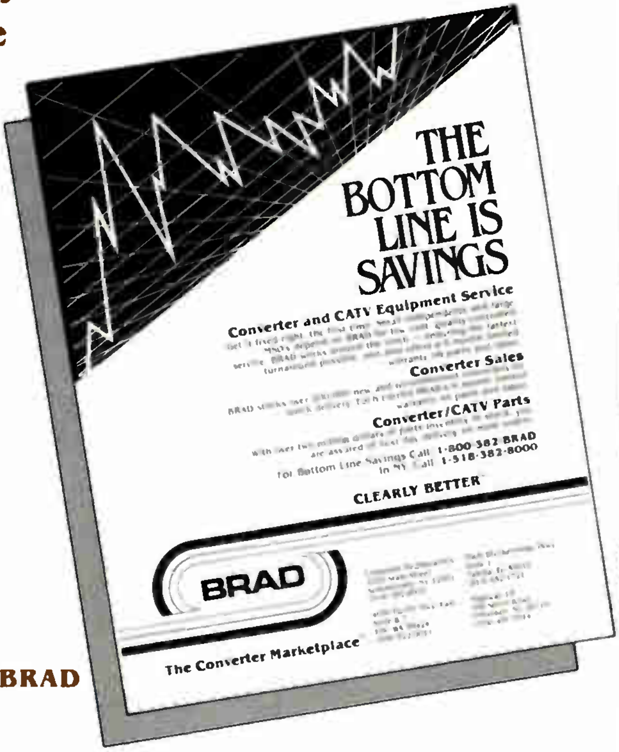

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SCTE announces building fund results

EXTON, Pa.—Nearly one year after the opening of the new national headquarters building for the Society of Cable Television Engineers, the results of a fund drive to help defray the cost of the building's purchase have been announced. To date, $38,000 in contributions has been received, reducing the mortgage to $52,000 and enabling the reallocation of funding from interest payments to SCTE programs and services.

The grand opening of the headquarters was held Jan. 14, 1987. A plaque listing the contributors will be placed in the lobby.

FCC adopts rules for A/B switches

WASHINGTON, D.C.—The Federal Communications Commission recently issued its decision establishing technical standards for A/B switches. It also agreed to extend the deadline for cable systems to offer the switches to subscribers. The rules adopted by the commission require that, in the frequency range 54-216 MHz, switches (both stand-alone devices and those built into TV receivers) must provide at least 80 dB of isolation between the antenna and cable inputs. In the frequency range 216-550 MHz, the switches must provide at least 60 dB of isolation. The commission concluded that these levels of isolation are necessary to prevent signal leakage.

Under the new rules, cable operators must supply subscribers with information on the potential for interference related to the use of the switch and suggest measures to avoid such problems. Further, operators are responsible for detecting and eliminating switch-related signal leakage that would cause interference outside the subscriber's premises or would cause the system to exceed its signal leakage limits. Operators will have until Feb. 29 to offer the switches and provide consumer-related information to all subscribers.

VideoCipher Plus introduced in Japan

SAN DIEGO—General Instrument's VideoCipher Division recently introduced the VideoCipher Plus scrambling system into Japan for secure transmission of entertainment and private network programming over satellites. This was made jointly with C. Itoh & Co. Ltd., a leading Japanese trading company and joint owner of Japan Communication Satellite Co. (JCSAT).

The system is designed to meet the needs for protecting video, audio and data signals on Japan's first communication satellites, which will be launched in 1989 by JCSAT and Space Communications Corp. This enhanced version of the VideoCipher II permits the export of the system to Japan and display of text information on TV sets using standard Japanese characters.

General Instrument and C. Itoh will conduct demonstrations and market development activities as they complete preparations for meeting Japanese private sector scrambling requirements.

Patent awarded for HDTV system

CHICAGO—Researchers here recently developed a new system for sending and receiving TV signals. Joseph LoCicero and Melih Pazarci from the Illinois Institute of Technology in Chicago, working with Theodore Rzeszewski of AT&T Bell Laboratories in Naperville, Ill., have been awarded a U.S. patent for their method of generating high-definition television (HDTV) signals that approach the quality found in 35mm motion pictures.

A feature of their method is that the HDTV signals can be received by conventional TV sets without auxiliary apparatus.

- United Cable Television Corp. has placed an order, valued at more than $1 million, with Hughes Aircraft Co.'s Microwave Products Division for a 60-channel AML microwave system for local signal distribution. The system will interconnect the East Bay, South Bay and Peninsula areas around San Francisco and will eliminate six smaller headends.
- Panduit Corp.'s Electrical Group will increase prices by 3 to 6 percent for wiring products, including cable ties and accessories, terminals and power connectors.
- Sammons Communications' current rebuilding project of its cable TV operation in Ocean City, N.J., is proceeding on schedule. When completed, it will offer 12,000 year-round subscribers new options and benefits, including addressable converters, a month's free service and reduced rates for the majority of subscribers in the community.
- Suburban Cablevision signed a contract to purchase approximately $5 million in distribution products from Scientific-Atlanta to rebuild over 1,600 miles of CATV plant in East Orange, N.J. The 550 MHz system will use S-A feed forward trunk stations, parallel hybrid bridgers and both parallel hybrid and push-pull line extenders.
- Microwave Filter Co. received an order of $116,000 for 400 high pass filters from Sammons Communications. Sammons will install the filters in a traffic control system for Fort Worth, Texas, to prevent signals from interfering with each other.

Correction

In the November 1987 issue's "Tech Tips," an error was made in describing CBN Cable's format and cue tones. CBN shows one non-scrambled program, *The 700 Club*; this program airs at 10 a.m., 9 p.m. and 2 a.m. (ET) Monday through Friday. The break occurring immediately after this program is audible, as the program audio and cue tones share the 6.8 MHz subcarrier during "clear" transmission until the end of the break.

Reader Service Number 9.

Beyond Judge Bork

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

All will agree, regardless of their political persuasions, that the recent Roman circus congressional inquisition into the qualifications of Judge Bork for a Supreme Court seat surpassed all previous spectacles of political pandering and posturing. There is no need to name the worst of the political scoundrels, whose mesmerized constituents re-elect them to high office again and again, but they certainly bared their guts to a record nationwide audience, apparently immune to political or legal condemnation for their hypocrisy. How dare these known liars and legal knaves, cloaked in congressional immunity, stand up in the full glare of television and demand that Judge Bork bow to their fanciful standards of judicial conduct, activism on the bench and disregard for the Constitution?

What, then, persuaded a majority of the senators to vote against Judge Bork? I suppose the simplest explanation may be the most accurate: How will their vote affect the next campaign for re-election to high office? Throughout the hearings, there must have been continuous polling of the hometown voter sentiment toward Judge Bork. Then there grew, like Topsy, the typical sensationalism impinged on every issue by the media. Negativism, rather than good news, sells papers. If some activist speaker for a special interest group condemned Judge Bork (in my opinion, usually on ill-informed and misinterpreted evidence), the space and position presented by the media of their diatribe far exceeded that of any favorable comments.

Finally and most ludicrous of all were the debates on extremely subtle and esoteric points of law—so obtuse and obscure that only scholars bent by years of study would presume to argue in the privacy of their domiciles. No, what we saw was one low-ranking lawmaker after another lecturing Judge Bork, an exemplary law professor, writer and judge, on subjects researched by their staff with material probably filched from the judge's own manuscripts. Quite often, it was obvious that they couldn't comprehend his learned replies to their inane questions.

The political rot

At this junction it might appear that I am unduly incensed at the political rot eating out the heart of our republic. Unfortunately, we are afflicted with a fungus that invades our political fabric more pervasively than the ceremonies surrounding the approval of a member of the Supreme Court. This rot is the legal stranglehold on every power point in the government juggernaut. No literate U.S. citizen need be told that lawyers fill the management positions in numbers far beyond their percentage of the population.

I will attempt to highlight the legal handcuffs on us by replaying the hearings with a difference—a mythical fairy godmother appears waving her star-studded wand, casting a spell on the participants, compelling all to tell the truth, the whole truth and nothing but the truth. So, onto the Senate hearing room...

Senator X: "Judge Average, what is your education in the subject of medicine and do you have the expertise to render a fair decision should a malpractice suit appear in your court?"

"Senator X, in my school career I went to great lengths to avoid any science courses and I confess I know nothing about the subject of medicine. It is up to the opposing lawyers to educate me in court on the malpractice aspects of medicine so that I can arrive at a fair decision."

Senator X: "How long will your cram course in medicine last?"

"Several weeks usually."

Senator X: "If you have neither interest, education nor skill in science, how could you make a knowledgable, intelligent decision based on such limited instruction?"

Judge Average: "I can't, but there are always appeals and maybe the next court will be more learned in medical malpractice. Please, Senator—if I may ask *you* a question—where do you get the knowledge from your education as a lawyer to vote intelligently on the hundreds of bills each year, some on such controversial technical subjects as SDI?"

Senator X: "I, too, avoided science courses like the plague in my schooling, but I have the funds to hire scientists to advise me."

"How can you select from the many contradictory views you receive the one most appropriate for the country?"

Senator X: "I never have enough knowledge to pick the right answer, but I can usually pick the one that will get me the most votes back home."

Senator Y: "Judge Average, your court has overseen the breakup of the nuclear power monopoly for the last five years. When will it end and what will you have accomplished?"

Judge Average: "There have been so many hearings and so much expert testimony that I am just now beginning to understand the technology and make some decisions on my own. However, the cost of electricity has risen more than the rate of inflation, and no new plants have been brought on line, so we may have done more harm than good."

Senator Y: "Suppose a nuclear physicist had been appointed in your place with all the powers of the court, and he had spent five years learning the law; what would have been the outcome?"

Judge Average: "Since law is an easier study than physics, I suppose he would be more qualified than I. But there is no legal precedence for appointing a layman, however qualified, to substitute for a man of law."

Senator Z: "Judge Average, your court declared that aspirin was an invention deserving a patent after emerging from a long, obscure and extremely litigated interference battle at the patent office. This decision was made, even though the product has been freely available for generations, present in many plants and known to native medicinemen throughout the world. Now the patentee is demanding exorbitant licensing fees and even threatens to remove aspirin from the marketplace if his demands are not met. How could your court uphold such a ridiculous judgment and cause such anguish to our feverish citizens?"

Judge Average: "It's incredulous even to an experienced jurist as myself; however, we must follow the letter of the law, and the judgment will hold."

So, dear reader, take your aspirins regularly, as we reflect upon the anguish of the senators over a mere candidate for the Supreme Court, whose learning in the law is only important to our legal masters, anxious to perpetuate their firm hold on our throats and pocketbooks. ■

FCC licensing procedures

By Paul Barth
FCC Coordinator, United Cable Television Corp

In the last few years, the two most noticeable changes in licensing procedure for CARS band microwave have been the elimination of the two-step license process and the charging of fees. On June 28, 1985, the rules eliminated the need to first obtain a construction permit before applying for a license. Under the new rules, an application for license or modification of license (FCC Form 327) is completed. When the application is granted, a license will be issued; however, the FCC allows one year for construction and notification to the commission that you are operational. Extensions will be granted but should be submitted 30 days prior to the end of the one-year construction period. Failure to notify the commission that your station is operational within that one-year period will automatically cause your license to be forfeited.

Notification is simple and can be either by postcard or letter. It should contain the following information:

1) company name
2) station call sign
3) transmitter location (city and state)
4) file number of relevant license authorization
5) grant date
6) statement indicating that the station is operating in accordance with the license

Although not required, a copy of the license can be sent with the letter. The license is issued for a total of five years, including the one-year construction period. If the license is for a modification, the license term will be the original five-year period. However, you still have only one year to complete the modification.

Getting back to the licensing procedure, path engineering and profiling and frequency coordination must be accomplished prior to submitting the application. The accompanying microwave worksheet is a handy way to gather pertinent information needed to accomplish the necessary tasks.

The first step normally taken is to obtain the coordinates of the microwave sites and profile the path. Simultaneously have the system engineers fill out this form as best they can. Of course, many of the items are path engineering functions so they should be instructed to fill out only the items they know. Items like the street address (or mileage and direction from a known point) of sites, as required on Schedule D, can be frustrating when you are trying to finalize the application and all the system technicians are out of the office.

Microwave worksheet

System
Path No.

Transmit site

Call sign (if applicable)
Site location (address)
(Including county)
Latitude: ° ′ ″ N
Longitude: ° ′ ″ W

Elevation AMSL: feet
Tower OHAGL: feet
Transmit azimuth:
Path distance: miles
Transmitter (make/model):
Output power:
Antenna size: feet
Antenna (make/model):
Antenna height AGL feet
Waveguide and powersplit loss:
Radome loss:
Antenna input power:

Receive site

Site location (address)
(Including county)
Latitude: ° ′ ″ N
Longitude: ° ′ ″ W

Elevation AMSL: feet
Receiver (make/model):
Tower OHAGL: feet
Antenna height AGL feet
Antenna size: feet
Antenna (make/model):
Waveguide loss:
Radome loss:

Frequency coordination is another necessity, but should only be accomplished after the certainty of the path is verified (via profiling and proper path engineering) as the cost of coordination runs about $350 per path. In order to properly complete Schedule C of Form 327, the system should fill out a form listing cable channel, microwave channel, programming and source. Remember, the FCC will not license any blank or spare channels.

There are several items that will cause the commission to return or at least hold your application; one is tower information. If Schedule D of Form 327 indicates a tower—of sufficient height to warrant Federal Aviation Administration (FAA) approval—is being used, then that FAA approval should accompany the application. If the approval letter is not available, the case number should be included. The regional FAA office may have this information. Any tower over 200 feet must be registered with the FAA and any tower within 20,000 feet of an airport must be investigated as the criteria involves a ratio between tower height and distance to the runway. For new tower registration, a FAA Form 7460-1 should be used.

For paths under seven miles (10 miles for A-band channels), justification of the necessity to use microwave should be included. The FCC is very protective of the frequency spectrum and generally operates under the premise of "use cable first and only as a last resort use microwave." This normally turns out to be a relatively simple justification as terrain features, amplifier cascades, franchise boundaries or major economic considerations are usually accepted by the commission. K-band channels, not adjacent, also need technical justification.

Remember the commission authorization procedure is step by step. Your application may be at the commission several weeks before an error or discrepancy is found. This could cause unnecessary delays especially if it must be resubmitted, thus starting the entire process all over. Prior planning and attention to detail when filling out the application can prevent many needless headaches.

Last, but not least, do not forget the check for $135 per station (transmitter) made out to the FCC. This fee also applies for renewals and modifications. The original plus two copies should be sent, unless there is a Schedule D involved; then, the original should be accompanied by four copies.

Mobile radio licenses

Licensing of mobile radios also has changed. As of April 1, 1987, land mobile licenses require a $30 fee. This fee is for modifications and renewals as well as for new stations. The fee is

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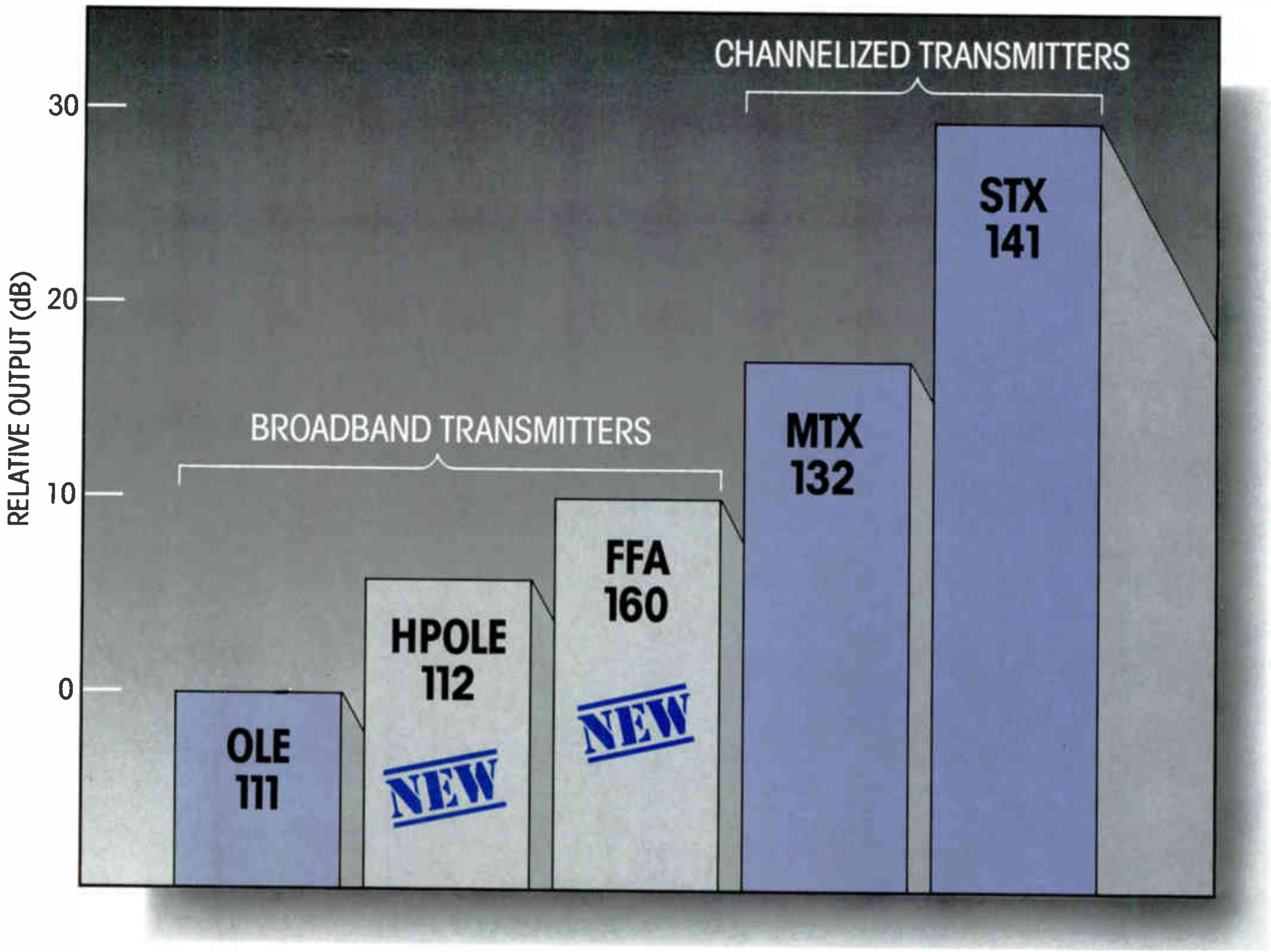
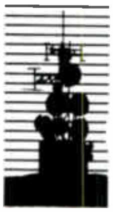


HUGHES FILLS THE POWER GAP WITH TWO NEW LOW-COST BROADBAND SOLID-STATE TRANSMITTERS



Now Hughes gives you two new economical ways of delivering high quality cable TV programming to subscriber pockets.

The HPOLE-112 broadband multichannel TV microwave transmitter delivers up to 60 channels of TV programming and provides 5dB more output power than the popular OLE-111 microwave line extender. This all solid-state transmitter accepts VHF inputs in the 54 to 450 MHz range and uses block upconversion techniques to reach the microwave transmitting frequencies of 12.7–13.2 GHz (CARS band).

Need more power? The new feedforward microwave power amplifier has it—and when used with the AML-OLE-111 line extender, provides up to 10dB additional output power. The FFA-160 provides the full benefits of feedforward distortion cancellation across the 12.7–13.2 GHz frequency band, and, like the HPOLE-112, is housed in a temperature-controlled outdoor enclosure.

For the facts on either of these new broadband transmitters, or on any other Hughes system, contact Hughes Aircraft Company today. 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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Reader Service Number 11.

not the only change in the license procedure. Any license application requiring frequency coordination must now be submitted by the frequency coordinator. Since you also must pay, two checks must be sent: one made out to the FCC and the other to the frequency coordinator. Of course, in cable TV situations the license most frequently applied for is in the business radio service. The designated coordinator for this service is the National Association of Business and Educational Radio (NABER) and the most common request is for a frequency pair. The coordination charge for this request is $105.

The suggested method is to send your completed FCC Form 574 and your NABER Form FC106-87 along with two checks to NABER (or the appropriate coordinator if applying for a different service). This process is not mandatory but is highly recommended by both the FCC and the coordinator. The alternative method involves sending a check directly to the FCC while the coordinator is sending in your application.

The address for NABER is as follows (although a phone call is all that's necessary to receive its forms and instructions): NABER, Attn.: Frequency Coordinator Dept., 1501 Duke St., Suite 200, Alexandria, Va. 22314, (703) 739-0303.

Renewals on the other hand need not be coordinated and the process is somewhat simplified. A $30 check made out to the FCC and your completed Form 574R should be sent to: Federal Communications Commission, 574R Land Mobile Renewal, P.O. Box 360559M, Pittsburgh, Pa. 15251-6599.

Multiple filings or renewals (same applicant and same service) can be incorporated into one check, but again it is highly recommended that a cover letter be attached explaining the disposition of the monies enclosed. If the application is extremely critical it is suggested that a certified check be sent, as any problems with your check, even if it's the bank's fault, will cause the license to be returned with no action taken.

Aeronautical frequency clearances

The entire aeronautical frequency spectrum is undergoing a sweeping change during the time frame from 1985 to 1990. The changes do, however, simplify the clearance procedure and end once and for all the confusion caused by individual clearing frequencies, requests for waivers and the dreaded "drop-ins." The upcoming cumulative leakage index (CLI) and the FCC's increased pressure leakage have attracted the attention of virtually all cable operators.

Table 1: Offset frequencies

Channel	Standard visual AM carrier (MHz)	HRC visual AM carrier (MHz)
A-2	109.2750	—
A-1	115.2750	—
14/A	121.2625	120.006
15/B	127.2625	126.0063
16/C	133.2625	132.0066
25/L	229.2625	228.0114
26/M	235.2625	234.0117
27/N	241.2625	240.012
28/O	247.2625	246.0123
29/P	253.2625	252.0126
30/Q	259.2625	258.0129
31/R	265.2625	264.0132
32/S	271.2625	270.0135
33/T	277.2625	276.0138
34/U	283.2625	282.0141
35/V	289.2625	288.0144
36/W	295.2625	294.0147
37/AA	301.2625	300.015
38/BB	307.2625	306.0153
39/CC	313.2625	312.0156
40/DD	319.2625	318.0159
41/EE	325.2625	324.0162
42/FF	331.2750	330.0165
43/GG	337.2625	336.0168
44/HH	343.2625	342.0171
45/II	349.2625	348.0174
46/JJ	355.2625	354.0177
47/KK	361.2625	360.018
48/LL	367.2625	366.0183
49/MM	373.2625	372.0186
50/NN	379.2625	378.0189
51/OO	385.2625	384.0192
52/PP	391.2625	390.0195
53/QQ	397.2625	396.0198

Note: Standard frequencies may be offset either up or down; however, the common practice has been up (as shown).

The new offset frequencies to be used in the aeronautical bands are listed in Table 1. It should be pointed out that in an HRC system Channels A-1 and A-2 are not allowed. The clearance procedures are relatively simple. The following frequency coordination items should be incorporated in a letter to the FCC:

1) Legal name and local address of cable operator.
2) Name and telephone number of local system official who is responsible for aeronautical frequency compliance.
3) Identity of cable TV community unit(s) served (include county, state and FCC identifier code numbers).
4) Geographic coordinates of a central point of the system.
5) Radius (in kilometers) from the central point that defines a circle enclosing the entire present and planned system.
6) Carrier frequencies to be registered.
7) Maximum power in dBmV.
8) Tolerance to be maintained (normally +5 kHz for standard and +1 Hz for HRC).

Also included should be a "description of routine monitoring" statement, as follows:

"The cable operator regularly monitors its system for signal leakage in accordance with FCC Rule 76.614 by substantially covering the plant every three months. Monitoring is done on (frequency) MHz using (make and model) equipment that is capable of detecting signal leakages that equal or exceed 20 microvolts per meter at a distance of three meters. Any such leakages detected will be noted and repaired within a reasonable period of time. As part of the system's preventive maintenance program, such leakages are logged and subsequently repaired. The cable operator will maintain a log of the date and location of each such leakage source, the date on which the leakage was eliminated and the probable cause of the leakage. This log will be kept on file for two years and will be made available to authorized FCC personnel upon request. Copies of any communications made in connections with this matter should be directed to: (your name and address)."

The letter should be sent to: William Tricarico, Federal Communications Commission, 1919 M St., N.W., Washington, D.C. 20554; Attn.: Mass Media Bureau, Video Services Division, Cable Television Branch. This is a notification only and unless there is a discrepancy, you will not receive a response from the FCC. Finally, it is suggested that all offset aeronautical frequencies be submitted at one time. You have until 1990 to offset these frequencies and may continue to use previously cleared frequencies during the changeover. You do lose your grandfathered status, in regard to monitoring, once you start using any one of the offset frequencies. Monitoring of your complete system is required once a year while exclusively using the old frequencies and four times a year under the new rules using the offset frequencies. ■

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21.200 - 23.600 GHz

Feature	Description	Advantages
FM Video/Voice Transmission	The Starpoint 23 HPV radio provides FM quality video and voice for short-haul communications.	Ideal for applications such as Studio-to-Transmitter Links (STL), video conferencing networks, security/surveillance systems, and many others.
Low Cost	The Starpoint 23 radio is economical and budget priced. Unlike cable and wirelines, a Starpoint 23 system is a one time investment not subject to future rate increases. Also, installation costs are low.	This system offers a cost effective alternative with typically faster payback than alternative transmission. Many systems have paid for themselves in less than a year.
Flexible	Transmit only/receive only, and full duplex systems are available. Models are compatible with broadcast standards. 2 or 4 foot antennas are also available.	Allows the system to be tailored to a customer's needs.
Weather-Resistant Outdoor Units	All outdoor modules are moisture, dust, and water resistant.	Increases the life of the system by protecting it against harsh environments.

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Reader Service Number 12.

Federal regulations and microwave

This is the first installment of a two-part series. Part II will discuss the state and local climate concerning development of microwave communications.

By John Rowe
President, Telecommunications Development Corp.

The greatest delays in route development of a microwave system are the regulatory constraints placed on it by government agencies. Such agencies are guided by regulatory law. For instance, the National Environmental Policy Act (NEPA) became law Jan. 1, 1970. Since this law was enacted, federal, state and local agencies have been compelled to consider environmental quality when making decisions concerning sociological, economic and technological project proposals. To properly evaluate the effect an action has on the environment, the law requires an environmental impact statement (EIS).

Federal Communications Commission

Much route development regulation of microwave is funneled through the Federal Communications Commission. Effectively, the FCC administers the regulatory concerns of other governmental agencies to microwave permits and investigates environmental issues.

Federal law requires that a governmental action must be necessary for a government agency to be responsible for filing an EIS under the NEPA. For microwave sites, licensing and permits are required under FCC Rules and Regulations. Because the FCC is authorized and responsible for the grants of radio station licenses and construction permits, it must administer the interpretation of the NEPA requirements with respect to communication projects.

Subpart I of the FCC Rules and Regulations specifies procedures to implement the NEPA and covers all major actions of the FCC that authorize the construction of communications facilities. A list of project types are included in law as major construction actions:

1) buried cable and waveguide routes;
2) aerial transmission lines;
3) antenna support structures and towers over 300 feet in height;
4) satellite earth stations having an antenna of more than 30 feet in diameter;
5) routes located in wilderness, wildlife, recreational, scenic and wetlands areas; and
6) facilities near areas that qualify for listing in the *National Register of Historic Places.*

The FCC rules make a distinction for incremental additions to pre-existing facilities; environmentally it is desirable to use existing routes, buildings and towers. To this end, the following actions are considered minor:

1) the installation of an antenna support structure or tower in an established "antenna farm" (though the Federal Aviation Administration has procedures for official designation of antenna farms, this need not be in effect),
2) a modification to a facility that does not require a site location change or tower height increase,
3) the replacement of an existing structure with a new one of the same kind on the same location or
4) actions not included as major.

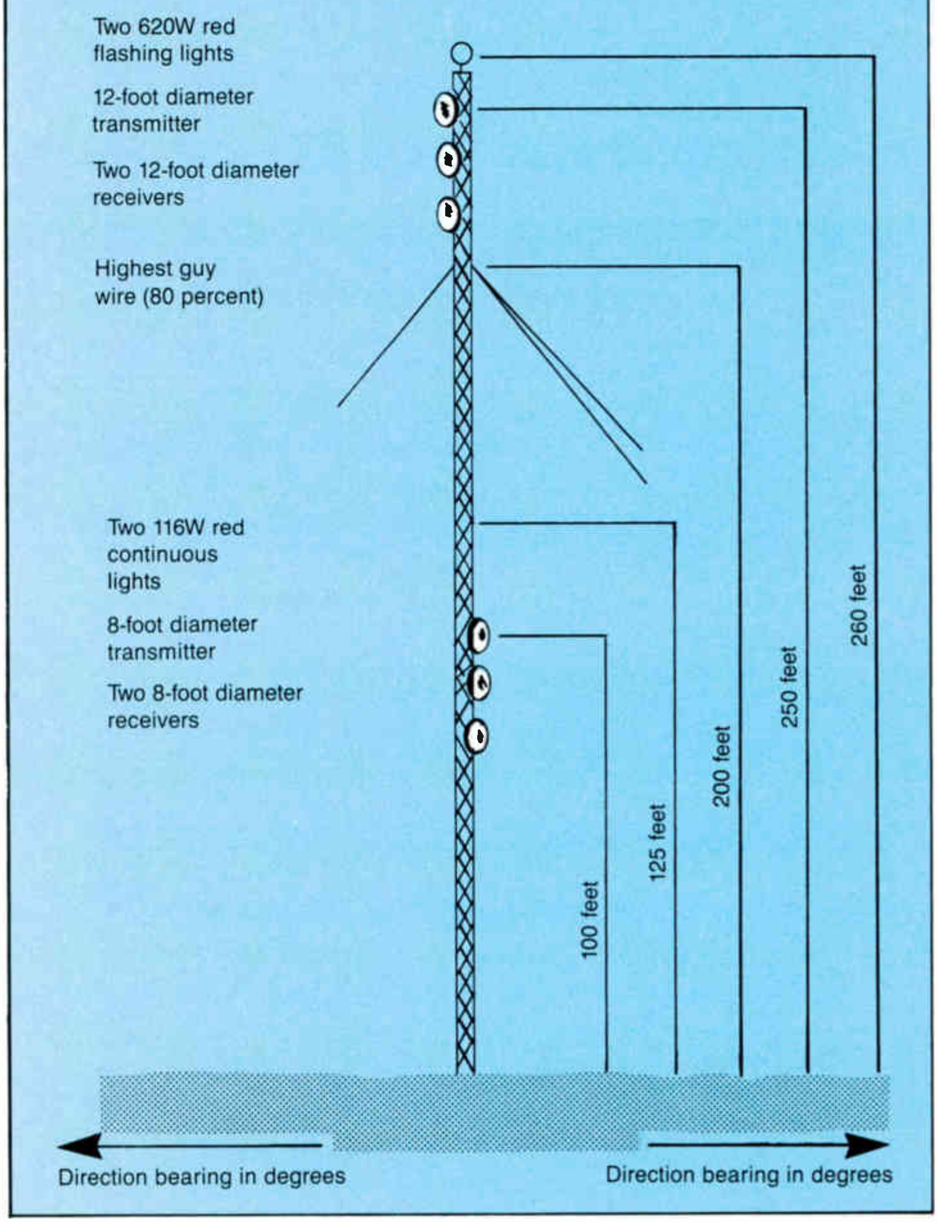
The rules go on to specify information that must be submitted to the FCC with applications for authority to construct major communications facilities and FCC consideration of this information. Requirements for draft, final environmental impact statements, hearings and final decision-making further define these rules.

While the FCC regulates interstate communication, it is not concerned with intrastate communication activities, which are regulated under the authority of individual states through state utility commissions. Firms regulated by a state utility commission receive basically the same scrutiny on the state level that the FCC levies in its federal jurisdiction. The difference is that each state has its own interpretation of how to regulate utility-oriented organizations.

Federal Aviation Administration

The FAA regulates the height of towers that may impose a hazard to air traffic. Specifications attempt to provide the most effective indication of obstructions to air traffic pilots. Figure 1 indicates placement of lighting on a typical 260-foot tower. The FAA regulations affecting tower construction and location include a description of how and when notice of construction is to be filed on a project, standards for deter-

Figure 1: Visual description of a 260-foot tower



mining obstruction zones (areas) and discussion of the studies performed. A format for hearings is presented, along with rules for proposed construction in navigable airspace.

FAA policy encourages the use of antenna farms and the single structure/multiple antenna concept for communications towers. In accordance with this policy, the FAA considers aeronautical procedure and operation revision for proposals in order to establish antenna farm areas that fulfill technical broadcasting requirements.

Bureau of Land Management

Another federal agency to deal with is the Bureau of Land Management (BLM), a division of the Department of Interior. The BLM is active in land use regulation because of the land it controls (60 percent of all federal lands). Regulations have been established for processing land use applications for grants, permits, amendments, assignments and rights-of-way (including microwave sites). In reviewing and acting upon land use requests under its jurisdiction, the BLM observes the following objectives:

1) the protection of natural resources associated with public lands and adjacent property;
2) the prevention of unnecessary environmental damage to land and resources;
3) the promotion of joint use rights-of-way to achieve engineering and technological compatibility, national security and land use plans; and
4) the coordination of land use with state and local governments, interested individuals and appropriate quasi-public entities.

The BLM handles communication site applications submitted on a special form designed for electronic use. Approved dealings with the BLM include building permits as well as contracts between the BLM and a leasee.

U.S. Forest Service

The U.S. Forest Service is a division of the Department of Agriculture. It administers 24 percent of the total area in the United States controlled by the federal government. Like the BLM, the Forest Service receives electronic land use requests on a special form designed to include technical data. A more general special use application and report form also must be completed for site land use requests.

Where electronic use sites are present, local Forest Service authorities attempt to consolidate all electronic uses in the same general area. Because of this policy, Forest Service electronic use sites often become crowded.

Situations occur in which a microwave facility cannot locate with other electronic use sites because of RFI (radio frequency interference) parameters. Thomas Rodda, who has served with the BLM as a realty specialist and worked with the Forest Service in developing regulations under the NEPA, submitted the following strategy for designation of a new electronic use site on Forest Service property:

Situation: A microwave engineer finds an existing Forest Service communication site unusable and seeks a right-of-way at a new location. The new site is not approved for use, but is not encumbered by wilderness or other higher restrictive designations.

> ***"It is desirable to use existing routes, buildings and towers."***

Approach:

1) Determine why the existing site is unsuitable. Usually, the reasons are a combination of technological, economic, and legal or policy factors that can be organized into an acceptable proposition.
2) Determine the degree of conflict between the project's and the government agency's management objectives. The resource values present (e.g., scenic quality, wildlife habitat, cultural values, etc.) are the basis for the management objectives. Some resource values such as endangered species and archeological sites carry legal requirements, but all resource values must be considered when assessing conflict. After considering project design modifications and reasonable measures to reduce conflict, assess the extent and the rationale for a new site.
3) During these preliminary steps gather information on roles, responsibilities and attitudes of the Forest Service employees. Determine who the decision makers are. The actual design may be at the district ranger level. Contacts may be needed at the regional office as well, if for no other reason than to demonstrate knowledge of their organization and policies.
4) Decide on approach. Should initial contact be at district ranger or forest supervisor level, or a joint briefing? The objective is to obtain either support for the project or (at worst) a neutral attitude from decision makers.
5) Present the project. During the presentation, all aspects of public benefit should be made clear, such as lower consumer costs and antimonopoly aspects. These appeals are used to build support or to overcome initial objections. The necessity of the new site must be persuasively communicated. Identify the willingness to take all reasonable steps to avoid or mitigate conflicts with natural resource values. The company's ability to augment the agency's data base by hiring mutually acceptable consultants should be made clear. Early contacts should result in identification of the Forest Service project coordinator and the person responsible for preparing an environmental analysis report.
6) Work with key staff to determine the scope of the project. This formal or informal process is used to determine: the level of detail needed in the environmental analysis, the extent of public participation and at what organizational level the decision will be made. Participation results in finding opportunities to expedite the process by furnishing reliable inventories and analysis of data. It also affords opportunity for seeking higher level review if the project scope is unrealistic.
7) Develop a mutually agreeable schedule that identifies responsibilities for data inputs, key dates for completing analyses and a public involvement schedule, if necessary.
8) Continue active coordination. Maintain flexibility to respond to new situations while seeking ways to assist the agency people in doing their jobs.

Summary: This approach opens communications with key agency contacts to realistically seek changes based on mutual agreement, furnish data in order to meet deadlines and contribute scope determination and scheduling.

National Park Service

The National Park Service, an agency of the Department of Interior, administers the *National Register of Historic Places*. The Advisory Council on Historic Preservation has the opportunity to comment on projects affecting sites listed in the register, which lists historic properties recognized by the federal government as qualified for conservation due to their significance historically, architecturally, culturally and structurally. Such a listed property is given special consideration if it is to be impacted by a project under any sort of federal sanction. However, evaluation of impact upon historic properties is extended to properties that are only eligible for inclusion in the register.

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18GHz
12GHz
6GHz


18CC
M/A-COM

Broadband microwave for CATV

By Randy Karr
Applications Engineer, Channel Master

Single-channel microwave transmissions have been successfully delivering CATV signals for many years. The microwave transmitter is an upconverter that converts a 50-450 MHz CATV band signal to a 12.7-13.1 GHz CARS band signal. The single-channel approach provides an abundance of microwave power, a technique that has served CATV in the familiar AML (amplitude modulated link) systems.

However, existing AM and FM systems separately process each video channel at the transmitter at a cost of $9,000 to $14,000 per channel. With a typical 36-channel transmitter costing up to $324,000 to $504,000, few systems can justify that kind of expense. Today, a new technology has emerged that provides a more cost-effective approach to delivering microwave signals. The heart of this system is the 13 GHz GaAs FET (gallium arsenide field-effect transistor) amplifier that can transmit up to 60 channels with modest amounts of power at a fraction of the cost.

There are, though, application limitations in the broadband system that must be considered. In this case, appraisement of the amplifier performance will lead to a better understanding of its use. One such factor concerns the output capability of the GaAs FET amplifier. Since this one amplifier is used to amplify all the upconverted CATV signals, distortion or intermodulation results. In order to more accurately predict these intermod levels, it is important to examine standard formulas and basic theories utilized by both microwave and CATV engineers in their fields of endeavor. When necessary, conversions to and from dBm and dBmV will be shown. The use of a third-order intercept point to predict distortion ratios also may prove useful.

Output capability

The microwave GaAs amplifiers built today that exceed 60 watts saturated output power are responsible for the proposed DBS (direct broadcast satellite) service. Although these high-power amplifiers are expensive, they remain preferable to tube-type equipment, which, because of location accessibility, make tube replacement a routine maintenance procedure.

High-power GaAs FET amplifiers are costly, making them impractical for use in CATV. However, medium-power 1- to 10-watt units are cost-effective and have the advantage of low noise, broadband response and no maintenance. These medium-power devices represent the newest component to be introduced to CATV in years.

Table 1 shows the intercept point of different amplifiers. Normally, the intercept point is 10 dB above the saturated power output. (A standard CATV amplifier has an intercept point of approximately 43.5 dBm. Built of bipolar transistors, it has performance similar to the microwave GaAs FET.) Amplifiers may be optimized for either intercept point or saturated output power; in this AM application the higher intercept point is chosen.

Third-order intercept point is defined in theory as the point where intermod equals or intercepts desired output. In reality intermod never actually reaches that point. It is known that third-order intermod varies to desired output of an amplifier at a 2-to-1 ratio; that is, for a 1 dB decrease in output power (below saturation) intermod will fall by 2 dB.

Figure 1 shows the output of an amplifier. Two desired carriers D1 and D2 are being amplified. Also shown are unwanted intermods I1 and I2. The intermods are caused by the non-linearity of the GaAs device. I1 is caused by D1 − (D2−D1). I2 is caused by D2 + (D2−D1). Both are third-order intermods. Second-order intermods would be at D2 − D1 and D1 + D2, also 2 × D1 and 2 × D2. Second-order products are not the limiting factor in the GaAs FET amplifier since it uses the balanced out-of-phase technique to cancel even-order products. As seen in Figure 1, the level of the desired carriers is +15 dBm, the level of the intermods is −35 dBm. (Note: the intermods are 50 dB below desired. The intercept point is the level of the desired plus one-half the difference.)

Table 1: GaAs FET amplifier intercept points

Power	Saturated power output (dBm)	Intercept point* (dBm)
100 watt	50	60
10 watt	40	50
1 watt	30	40
.1 watt	20	30
.01 watt	10	20

*Approximate

Intercept = desired carriers + (difference/2) **(1)**
Intercept = 15 + (50/2)
Intercept = 40 dBm

From intercept point we can derive other useful formulas.

Desired carriers = intercept − (difference/2) **(2)**

Difference = 2(intercept − desired carriers) **(3)**

In working with CATV we are always using many carriers at once. The additive effect of multicarriers must be accounted for. We must add together the power in a number of carriers using $10\log_{10}$ (number of channels).

Calculating output power

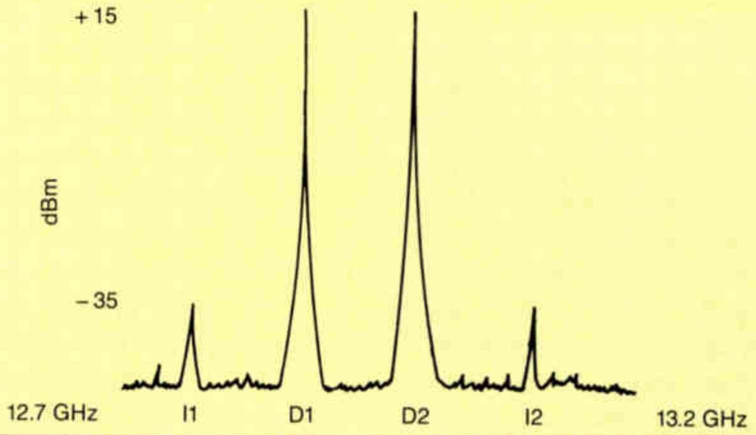
Let's assume that a particular application includes a 5-watt GaAs FET amplifier in a microwave transmitter with 36 channels transmitted at an intermod level 65 dB down. All calculations will be CW (continuous wave) to conform to CATV specifications. Desired carriers will be the total output power of the transmitter. Difference will be the composite triple beat (CTB) required, 65 dB. Intercept will be 47 dBm, a 5-watt amplifier.

Total power = intercept − (CTB/2) **(4)**
= 47 − (65/2)
= 14.5 dBm

Now that we know the total power present at the amplifier output, finding the power per carrier is accomplished by subtracting 10log(number of channels).

Power per carrier = 14.5 dBm − 10log(36) **(5)**
= −1.06 dBm

Figure 1: Output of a 1-watt amplifier



(as a point of reference −1 dBm = .79 mW or +47.8 dBmV)

Based on existing standards, −1 dBm is not enough power to answer every application that may exist, but does keep costs to a more reasonable level. In many applications a 60 dB CTB is acceptable, in which case output power would increase to +1.5 dBm. Also, by using tower-mounted equipment, waveguide loss is minimized. If an LNA (low noise amp) is placed before the receiver, noise figure is lowered by as much as 8 dB, provided that lower sideband noise is filtered off before detection. Therefore, by conserving waveguide loss and improving receiver noise contribution, the 5-watt amplifier has almost matched high-power tube type performance and eliminated maintenance as well.

LNA distortions

Not only is the intercept point useful in calculating power amp performance, it works on most any amplifier including low-noise amps. If you know an amplifier's intercept point, gain and input you can find its distortion ratios.

Assume an LNA with an intercept point of +23 dBm and a gain of 13 dB is used to amplify 36 carriers at a level of −50 dBm each. To find intermod or CTB you must first find the total power at the LNA input. To add together the power in each of the carriers, take the input signal plus 10log(number of channels). Next find the power at the LNA output by adding 13 dB to the input.

$$\text{Total input power} = -50\text{ dBm} + 10\log(36) \quad \textbf{(6)}$$
$$= -34.4\text{ dBm}$$

$$\text{Total output power} = 13 + (-34.4\text{ dBm})$$
$$= -21.4\text{ dBm}$$

Next find the CTB by using Formula 3:

$$\text{CTB} = 2(\text{intercept} - \text{desired carriers})$$
$$= 2(+23 + 21.4)$$
$$= 88.8\text{ dB}$$

Knowing the CTB for a given input power is required when designing a microwave path.

Combining distortion ratios:

Assume the LNA previously described is driven by the transmitter described. The distortion products will add together as voltage. So we must convert the dB ratios to voltage and add. The distortion ratios or CTB of two amplifiers or two complete systems can be combined in the same method:

$$\text{Total CTB} = 20\log[(\text{antilog LNA}-\text{CTB}/20) + (\text{Antilog trans}-\text{CTB}/20)] \quad \textbf{(7)}$$
$$= 20\log[(\text{antilog} - 65/20) + (\text{antilog} -88.8/20)]$$
$$= -64.4\text{ dB}$$

The system described requires an LNA to lower receiver noise contribution. However, beware of overdriving the LNA or total distortion will increase. In addition, the LNA added gain may overload circuits after it as well. First, let's check how much improvement is available.

$$\text{Total noise figure} = N1 + (N2/G1) \quad \textbf{(8)}$$

where:
N 1 = first noise figure
N 2 = second noise figure
G 1 = gain of first amplifier

As an example, consider an LNA with a noise figure of 3 dB and a gain of 13 dB preceding a receiver with a noise figure of 11 dB. This same formula could be used to find how much improvement a pre-amp provides. To use the formula we must convert from dB to power ratios.

$$\text{dB} = 10\log(P1/P2) \quad \textbf{(9)}$$

$$13\text{ dB} = 10\log(P1/1)$$
(assume P2 to be 1)

$$\text{Power gain 1} = \text{antilog}(13/10) \quad \textbf{(10)}$$
$$= 20$$

$$3\text{ dB} = 10\log(P1/1)$$
$$\text{Noise gain 1} = \text{antilog}(3/10)$$
$$= 2$$

$$11\text{ dB} = 10\log(P1/1)$$
$$\text{Noise gain 2} = \text{antilog}(11/10)$$
$$= 12.6$$

Now using the combining noise figure formula (Formula 8):

$$\text{Total NF} = N1 + (N2/G1)$$
$$= 2.00 + (12.6/20)$$
$$= 2.63$$

So, 2.63 is the total noise figure as a multiplier. To convert back to dB, take 10log(2.63/1), so

$$\text{Total NF} = 4.2\text{ dB}$$

If the LNA gain were increased from 13 to 20 dB, the total noise figure would decrease to 3.28; however the CTB caused by the added gain would increase by 14 dB.

Calculation of system noise

In CATV applications, all carrier-to-noise calculations are based on 4 MHz video bandwidth. Single-sideband upconversion does not increase occupied bandwidth. The CATV noise floor is normally taken to be −59 dBmV. In microwave applications using the same 4 MHz video bandwidth, the noise floor is also −59 dBmV; however, in microwave we work in dBm. To convert dBm to dBmV, subtract 48.8 dB. The microwave noise floor is −59 − 48.8 = −107.8 dBm.

Actually, as long as the bandwidth is 4 MHz the noise floor is always the same; different schools of thought make the conversion necessary. For those of you who don't like to be given a number like −107.8 here is the derivation:

$$\text{Noise floor in watts} = KTB \quad \textbf{(11)}$$

where:
K = 1.38 × 10E−23 (Boltzmann's constant)
T = 300 degrees Kelvin (room temperature)
B = 1 MHz (1×10E+6) for noise power per MHz

To convert to dBW, take 10log(KTB). Then, to convert dBW to dBm, add 30. Finally, for 4 MHz noise add 10log(4). So: 4 MHz noise in dBm is 10log(KTB) + 30 + 10log(4) = −107.8; 4 MHz noise in dBmV is −107.8 + 48.8 = −59.

If we know an amplifier's noise figure and input level we can find carrier-to-noise. For example, given a receiver with a noise figure of 4 dB, find its 4 MHz C/N with −50 dBm per carrier input.

$$\begin{aligned} C/N &= -107.8\ \text{dBm} + \text{noise figure} - \text{input} \quad \textbf{(12)}\\ &= -107.8 + 4 + 50\\ &= 53.8\ \text{dB} \end{aligned}$$

Given the output of an amplifier and its gain and noise figure, you can find its C/N. Assume the transmitter with an output of −1 dBm, a gain of 37 and a noise figure of 13 dB:

$$\begin{aligned} C/N &= -107.8\ \text{dBm} + \text{NF} + \text{gain} - \text{output} \quad \textbf{(13)}\\ &= -107.8 + 13 + 37 + 1\\ &= 56.8\ \text{dB} \end{aligned}$$

Note: C/N calculation does not depend on number of channels, only the noise vs. power in a 4 MHz bandwidth.

Combining carrier-to-noise ratios:

Assume the LNA previously described is driven by the transmitter described. The noise power in both will add together as power. So we must convert the dB ratios to power, then add. The C/N of two amplifiers or two complete systems can be combined by the same method.

$$\begin{aligned} \text{Total C/N} &= 10\log[(\text{antilog LNA}{-}\text{C/N}/10) + (\text{antilog trans}{-}\text{C/N}/10)] \quad \textbf{(14)}\\ &= 10\log[(\text{antilog } -53.8/10) + (\text{antilog } -56.8/10)]\\ &= -52.1\ \text{dB} \end{aligned}$$

Intercept point and CATV amplifiers

The third-order intercept point of a standard CATV amplifier is around 43.5 dBm. For power doubling, add 3 dB; for feedforward, add at least 6 dB. To find the exact intercept of the amplifier you're using, consult the manufacturer's specifications. Let's look at a Jerrold Starline 20 operating at 300 MHz. Jerrold's literature shows 35 channels at 32 dBmV each will provide a CTB of 92 dB. To find intercept use Formula 1:

$$\text{Intercept} = \text{desired} + (\text{difference}/2)$$

First, find the total power by adding 32 dBmV + 10log(35). Next, subtract 48.8 to convert to dBm.

$$\begin{aligned} \text{Total power} &= 32 + 10\log(35)\\ &= 47.44\ \text{dBmV}\\ \text{dBm} &= 47.44\ \text{dBmV} - 48.8\\ &= -1.4 \end{aligned}$$

$$\begin{aligned} \text{Intercept} &= -1.4 + (92/2)\\ &= 44.6\ \text{dBm} \end{aligned}$$

From the published specifications, Jerrold is 1.1 dB above the average trunk amplifier. With only two carriers in the middle of the CATV band, say F and G, you can measure the intercept. Intercept can differ at different points in the band, so you also might check at different points. You should measure intercept − (difference/2). Most spectrum analyzers will measure 50 dB down.

$$44.6 - 50/2 = 19.6\ \text{dBm}$$

in each carrier with intermod 50 dB down. Most CATV distribution is rated 1 dB higher than the same manufacturer's trunk amplifiers. This may be due to decreased loss on the motherboard or simply grading of hybrid chips.

If you want to calculate intercept on an amplifier that is rated on a tilted output, simply average: low-channel output + high-channel output divided by 2. (This is not to say that you should buy amplifiers that have the highest calculated intercept. But it does offer a simple way to compare spec sheets and measure performance with only two carriers.) When measuring intercept, you need an accurate means to measure power in each carrier. A power meter works best. Check one carrier at a time, setting both to the same level (normally CW carriers are used) and measure the difference.

Path calculations

The calculation of the microwave path is not the subject of this article but deserves some mention. Contact antenna manufacturers for further information.

Parabolic antenna system are used to focus the microwave energy toward its intended receive site. Parabolic antennas also are used at the receive site to gather as much signal as possible. In most respects the microwave signal travels as light energy. The path between transmit and receive must be clear line-of-sight. The amount of loss in a microwave path is very high; at 13 GHz, 119 dB of loss occurs in the first mile alone. After the first mile, the loss is 6 dB for every doubling of length. To calculate path loss, use the formula:

$$\text{Path loss} = 96.6 + 20\log(\text{frequency in GHz}) + 20\log(\text{miles}) \quad \textbf{(15)}$$

Fortunately, the gain of the parabolic antenna is high, which helps to offset the path loss. A 10-foot parabola at 13 GHz has 49 dB of gain. Using a 10-foot antenna at both transmit and receive sites yields 98 dB of gain.

$$\begin{aligned} \text{Receiver input} &= \text{transmitter output} + \text{transmitter antenna gain} - \text{path loss} + \text{receive antenna gain} - \text{miscellaneous loss} \quad \textbf{(16)} \end{aligned}$$

Utilizing the 5-watt amplifier described and a receiver with an LNA allows CATV signals to be transmitted about 25 miles. ■

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The author wishes to acknowledge Dr. Larry Burton, Dr. Marc Rafel, Dr. Kashiva Murthy, Robert Dennison and Kim Hughes.

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Reader Service Number 18.

Feedforward applied to microwave

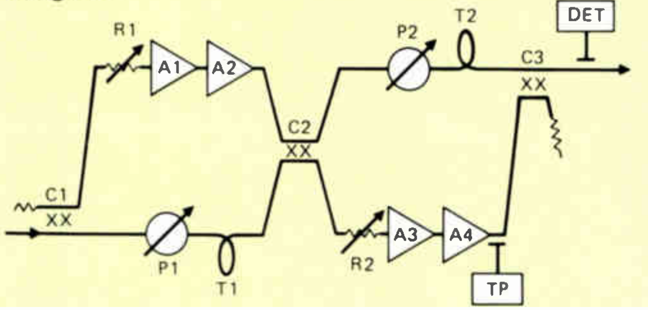
By T.M. Straus and R.T. Hsu
Hughes Aircraft Co., Microwave Products Division

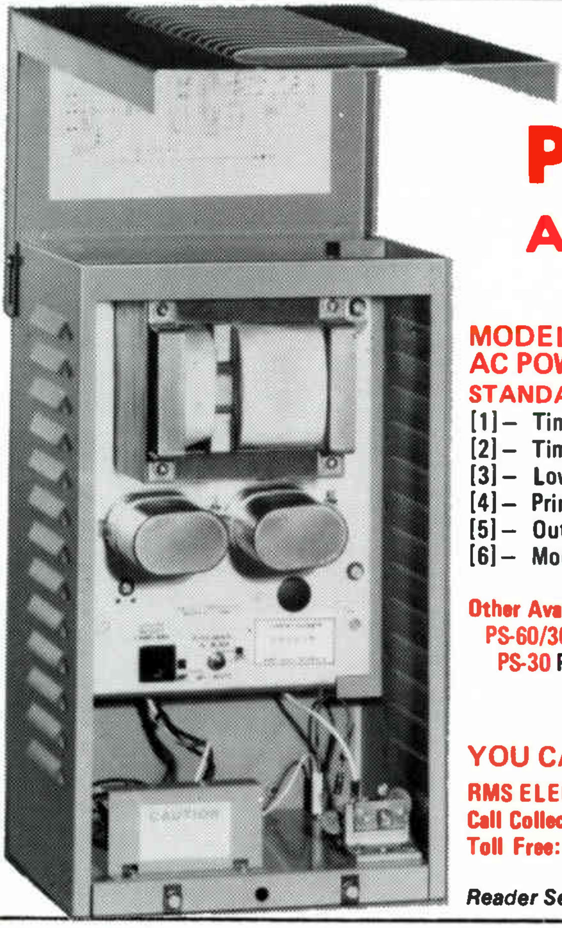
The feedforward principle has been employed for many years in various CATV trunk amplifiers to obtain the best possible distortion performance. As a result, feedforward is generally accepted, and both its advantages and limitations are well understood.[1,2] As with other CATV amplifiers, the feedforward circuits must operate over a multioctave frequency band, as well as a wide range of environmental temperatures. These requirements are generally met by careful circuit design, but they also contribute to the limitations observed in feedforward systems.

Feedforward techniques also have been applied to microwave circuits[3,4,5], although, to our knowledge, only as high as 4 GHz. These investigations demonstrated that feedforward could indeed dramatically improve linearity performance of microwave amplifiers. With the advent of low-cost, block-upconversion microwave transmitters utilized in 12 GHz CATV very high capacity microwave (VHCM)—local distribution service (LDS) in the United States—it was of considerable interest to see whether the multichannel output power capability of these transmitters could be improved through the incorporation of feedforward techniques. The typical block-conversion application services one or two small communities, where the tradeoff between microwave fade margin and distortion performance forms an acceptable compromise, given the economic and technical advantages of the microwave approach. Increasingly, one finds systems in which the microwave path is "stretched" to the very limit when the application cannot economically support a more standard channelized AML (amplitude-modulated link) transmitter solution. The development of feedforward at 12 GHz was therefore undertaken to substantially reduce the 18 dB performance gap between the channelized AML transmitter and the block-conversion microwave line extender.

Figure 1 shows a block diagram of the microwave feedforward amplifier. The input signal is split by a 6 dB directional coupler, C1, into two paths. The top path passes through the main amplifier modules A1 and A2. Amplifier A2 is identical to the output amplifier used in the block-conversion AML transmitter. Amplifier A1 is just a single-stage LNA (low-noise amp) that adds gain to the feedforward circuit. Part of the amplified signal, along with the distortion generated by A2, is sampled by the 25 dB directional coupler C2. By adjusting attenuator R1 and phase shifter P1 for minimum power at test point TP, leakage of signal into the distortion amplifiers A3 and A4 is suppressed by at least 20 dB. Therefore, amplifier A4 need not have the same output capability as A2 to perform its distortion amplification function without introducing any of its own distortion. Thus, A4 is only a 1-watt amplifier. A3 is a two-stage LNA that, together with the input losses, establishes the noise figure of the feedforward amplifier. This is because noise generated in A1 is to a large degree canceled out at the output of

Figure 1: Microwave feedforward block diagram





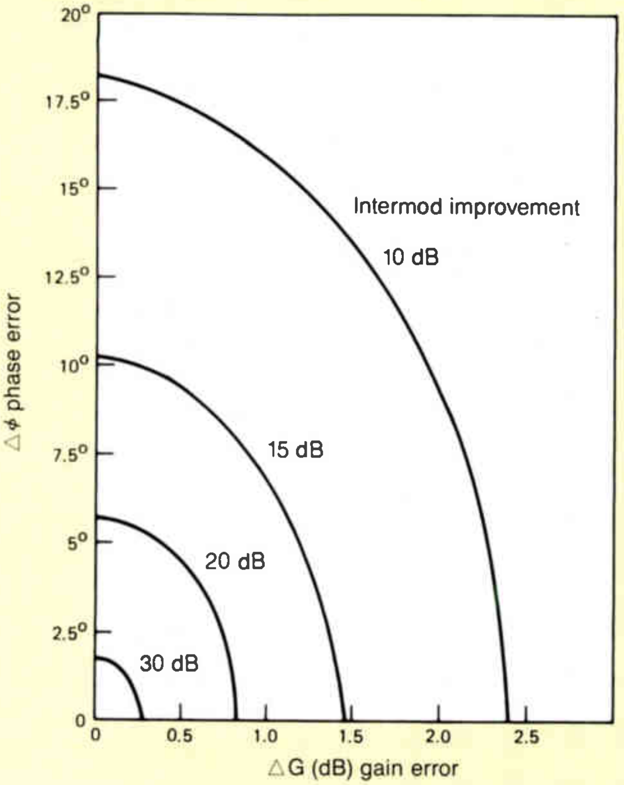

the feedforward circuit in the same way that distortion generated in A2 is canceled. To achieve this cancellation, attenuator R2 and phase shifter P2 are adjusted for optimum CTB (composite triple beat) at the output of the feedforward amplifier.

The feedforward circuit is constructed to match the absolute delays encountered in the main and distortion amplifiers, respectively, by the delays T1 and T2. These are implemented in waveguide to minimize loss that would otherwise be excessive at these high frequencies. Selection of the output coupler C3 value at 8 dB also is based on minimizing loss in the main signal path, without requiring unduly large gain in the distortion amplifiers. Although the resulting circuit is somewhat cumbersome, it was possible to package it within the temperature-controlled AML outdoor housing. This is vitally important, since at these high frequencies the feedforward circuit is particularly sensitive to changes in temperature. Indeed, the availability of this housing, with its passive gravity gradient freon temperature control loop[6], is the key element that makes this feedforward amplifier a practical part of a VHCM (LDS) microwave system.

The 12.7 to 13.2 GHz frequency range represents less than 5 percent bandwidth, while the housing maintains the feedforward circuit at essentially constant temperature over a wide range of environmental temperatures. In this sense, the microwave feedforward amplifier is easier to build than the CATV feedforward amplifiers. On the other hand, it must be recognized that at Ku-band frequencies, a length of only ¼ mm contributes three degrees of phase shift. Figure 2 shows that such an error in the distortion cancellation loop would limit intermodulation improvement to about 25 dB.

The actual distortion cancellation typically achieved is illustrated by Figure 3. The figure is a spectrum analyzer display from 12.7 to 13.2 GHz, with the vertical display showing 10 dB per division. The three tones were each set for 18 dBm output from the feedforward amplifier. With distortion amplifier A3 turned off, the third-order intermodulation products formed in A2 are very obviously displayed. Note that at this high an output level, equivalent to 20 dBm per tone at the output of A2, the amplifier is operating in a clearly non-linear region, as evidenced by the fifth-order products appearing just below 13.2 GHz. When A3 is turned on, the intermodula-

Figure 2: Allowable gain and phase error vs. intermodulation reduction



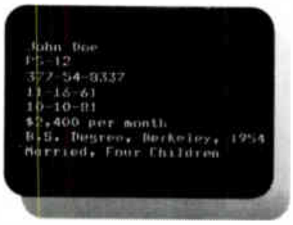
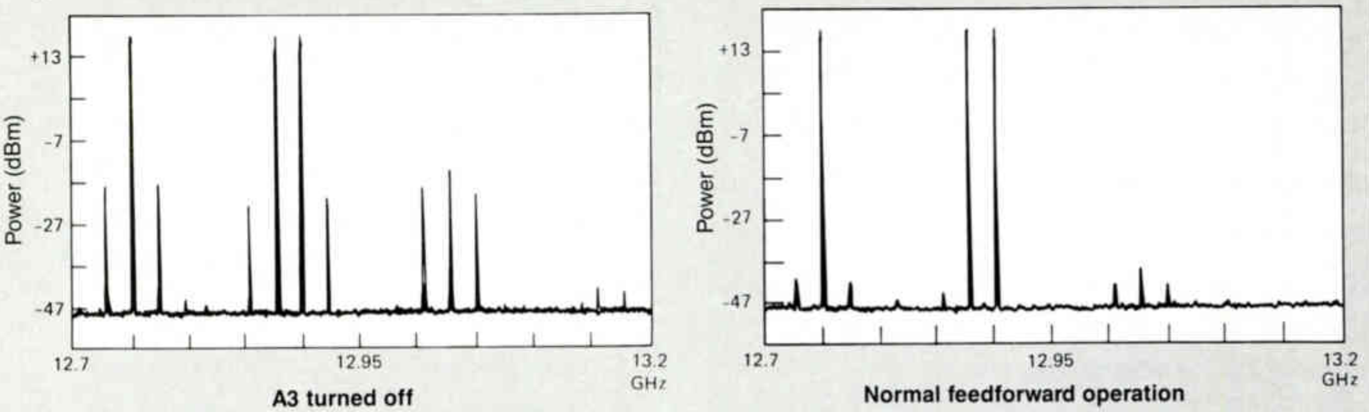


Figure 3: Three equal tone intermodulation cancellation



A3 turned off **Normal feedforward operation**

tion products are dramatically reduced. Some vanish altogether below the noise floor. The cancellation that is typically achieved is approximately 24 dB.

This result is further verified by the experimental results shown in Figure 4. Here, CTB is plotted vs. output power per channel for various channel loadings. All data except the high-power 30-channel loading were obtained without retuning the amplifier. Note that the slope of the curve is typically 3:1, but this is more an indication of the fact that A2 is itself operating at a high enough level that its behavior is no longer strictly 2:1 in CTB vs. P_O. Indeed, the several points associated with the much higher power 30-channel loading show that the feedforward operation does not suddenly "crash." It also should be pointed out that this data represents the worst-case channel at each power setting and channel loading. This channel is not necessarily at the center of the band where the greatest number of intermod products pile up, since even over this narrow 5 percent bandwidth, cancellation at the high-frequency end was not quite as good as at the lower frequency.

A further noteworthy feedforward phenomenon is illustrated by the single-tone power output vs. power input transfer function. As amplifier A2 starts to go into compression, cancellation in the first loop becomes less perfect and a larger signal is impressed onto A3. This signal is amplified and injected in phase with the main signal, so that the output of the feedforward amplifier continues to increase with drive power. Figure 5 illustrates that the transfer curve is very nearly that of an ideal limiter and that the maximum power output exceeds that of A2 by itself.

A final feedforward phenomenon is the possibility for improved amplifier frequency response, just as with negative feedback. One can again understand this in terms of imperfect signal cancellation in the first loop. If the combined gain of A1 and A2 drops, the "error signal" created at the input of A3 is amplified and injected back into the output in phase with the main signal to maintain a constant overall gain. The transfer function of Figure 5 illustrates just this point. However, if the gain of A2 should increase above its nominal value, there is again imperfect cancellation in loop 1, but this time, the error signal phase is reversed by 180°. Thus, overall gain is once again maintained at a nearly constant level. Figure 6 illustrates the improved frequency response of the feedforward amplifier. Again, turning off error amplifier A3 provides a reference for comparison purposes. In CATV VHF feedforward amplifiers, the same phenomenon occurs, but it is masked by other imperfections that, on the whole, can make the feedforward frequency response worse than that of the main amplifier. For in-

Figure 4: Feedforward amplifier CTB vs. power output

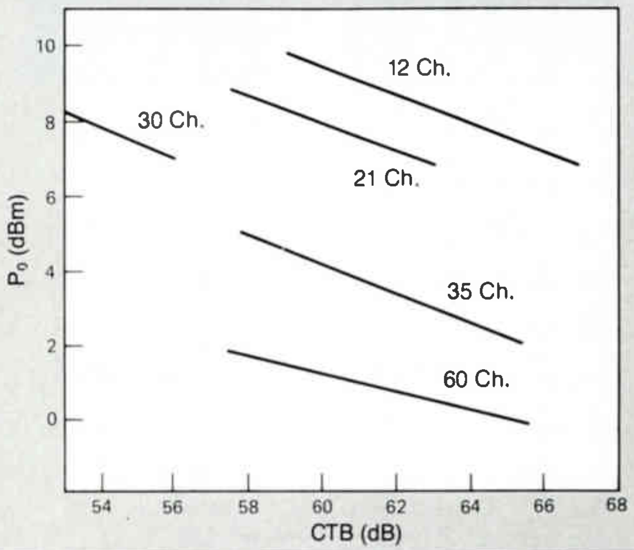


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Figure 5: Single-tone operation of feedforward amplifier

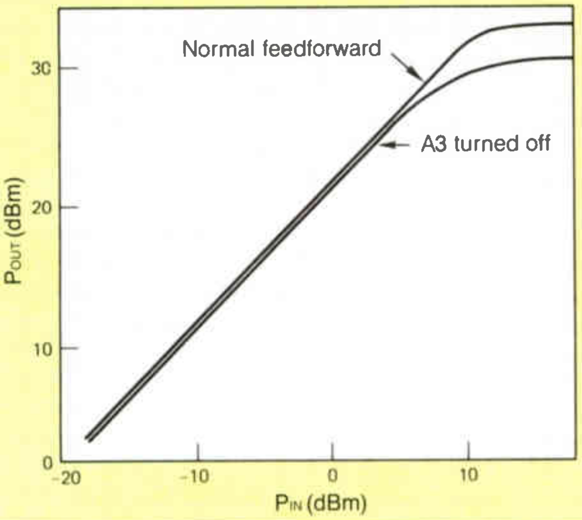
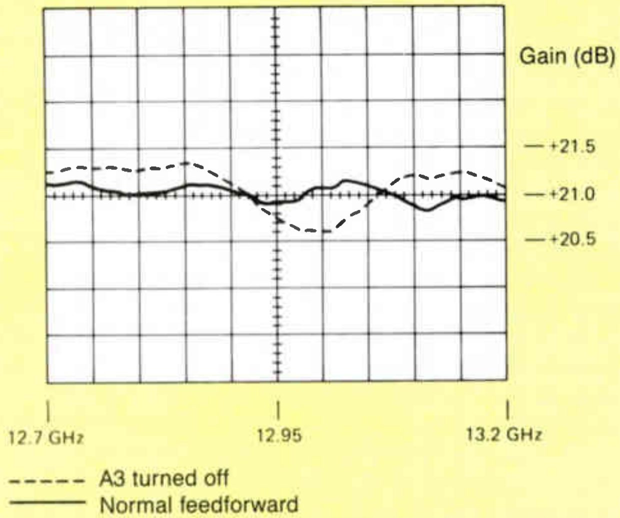


Figure 6: Feedforward amplifier frequency response



stance, variation in the C2 coupling value as a function of frequency will tend to deteriorate flatness, as would imperfect phase vs. frequency characteristics. In the wideband CATV feedforward amplifiers these factors predominate, but in the much narrower microwave version the opposite holds true.

Figure 7 shows how the AML feedforward amplifier is typically used in tandem with the microwave line extender. In establishing the desired operating levels, the first question to ask might be what level of CTB is acceptable, since block conversion transmitter output levels are generally limited by this parameter. If the microwave feedforward amplifier is to be the primary contributor to CTB, the microwave line extender must be backed off from its normal output level. The difference in level between the feedforward input and the line extender output represents the permissible loss, which might take the form of a long waveguide run if the feedforward amplifier is to be tower-mounted to achieve the greatest possible path length. With this allowance, the line extender might still be at the base of the tower, where maintenance should be much easier.

In any case, the next concern is to reduce the noise power output of the line extender, since its output level is quite low. By setting the interstage attenuator between the LNA and 2-watt amplifier to 14 dB, the primary source of noise is then the power amplifier. Finally, one must check to see whether third-order distortion generated by the LNA and upconversion

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Table 1: Feedforward amplifier performance summary

Power output/channel at 65 dB CTB (dBm)

Number of channels	P_0 (dBm)
12	+7
21	+5
35	+2
60	−1

Frequency range	12.7 to 13.2 GHz
Nominal gain	20 dB
Noise figure	15 dB

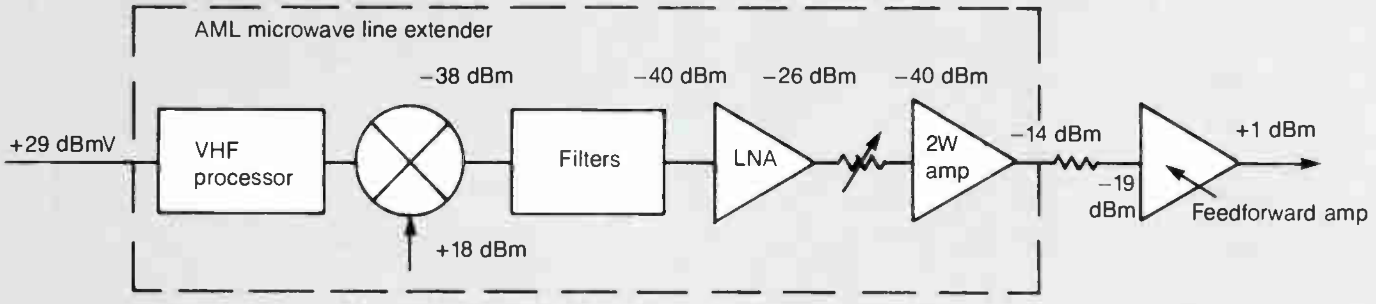
mixer, as well as second-order distortion of the mixer, are still acceptable. Since a high-power local oscillator is utilized in the line extender, mixer distortion is minimized. The LNA also is designed with distortion in mind, having a high two-tone third-order intercept point of +27 dBm. The noise and distortion contribution of each stage is shown in Figure 7 assuming 40-channel loading. The overall transmitter performance also is summarized. If the LNA is replaced with a piece of waveguide and the interstage attenuator is reset to 0 dB, a further 1 dB improvement in transmitter C/N (carrier-to-noise) is possible.

Note that power addition, rather than voltage addition, is applied to CTB. This is because each contributing stage is different from the others, resulting in a randomness of the relative phases of the intermodulation products. The necessity to back off the driver stage and the concomitant concern with C/N are features common to all postamplifier installations, not just when the postamplifier is of the microwave feedforward variety. However, if the postamplifier is a standard power amplifier, the intermodulation distortion from the intermediate power amplifier may more likely add in phase with those of the output amplifier, since their characteristics are very similar.

One of the fundamental differences between block-conversion transmitters and the more traditional, channelized AML transmitters is that the latter will typically provide a multiplicity of outputs, while the former only provides one output. Obviously, this output can be split with the use of external dividers, as shown by Figure 8. The levels utilized in this example are the same as those suggested in Figure 7. The problem with using splitters between the microwave line extender and the feedforward amplifier is that one requires a second postamplifier. On the other hand, if the splitter is used after the feedforward amplifier, the modest output power suffers further reduction. Nevertheless, the concept has the virtue of lower cost and flexibility, since the number of splits and coupling values may be selected to best match the transmitter configuration to the path requirements. However, one should recognize that, even with this highest power microwave feedforward amplifier, the capability falls well short of a standard channelized transmitter. For instance, a 40-channel AML transmitter would provide eight separate outputs, with each one at 9 dBm/channel. Further, the composite triple beat would be essentially nonexistent, since the active part of the transmitter is channelized.

An alternative to the diagram in Figure 8 is to use magic tee multiplex combining. This gets around another drawback of the block-conversion type transmitter; namely, that a single failure will take out all channels. It is true that a feedforward amplifier has a kind of fail-soft redundancy built into it, as illustrated by Figure 5. However, the failure is not really "soft" since a 24 dB change in CTB would occur. Figure 9 shows how a true fail-soft redundancy might be implemented. The configuration[7] is particularly important, as it might make maintenance of tower-mounted feedforward amplifiers more practical. The input channels are normally divided into two groups. For instance, one group may contain the even-numbered channels, while the other group contains only odd-numbered channels. In this way, the intermodulation products of one group do not fall on top of prod-

Figure 7: Typical feedforward application



C/N		63.5	58	74
CTB	75	75	75	65
Second-order	80			

Overall 40-channel transmitter performance
C/N = 56.8 dB*
CTB = 63.9 dB
Second-order = 80 dBc

*C/N would be 57.9 dB if LNA is removed and attenuator set for 0 dB.

ucts from the second group. Since only half the channels pass through each amplifier, the level can be raised 3 dB with the same CTB as in Figure 8. C/N is at first 3 dB higher, but after the magic tee combining, noise adds from both inputs, and the output C/N is also the same as for Figure 8.

In the event that a failure occurs in any of the equipment, the VHF input channels are combined at the VHF patch panel and all channels can be passed through the remaining fault-free branch, with only 3 dB of backoff in carrier level and transmitter C/N. Repair of the fault can be done at a time convenient to the system operator, since the fail-soft standby operation will not normally be noticeable by the subscriber.

A completely different application of the feedforward amplifier is to utilize it as a frequency agile backup to a large high-power AML transmitter array. A similar configuration has previously been suggested.[8] With feedforward, a single +29 dBm video signal can be provided essentially free of any distortion. This more nearly matches the +33 dBm output power provided by the high-power AML transmitter array.

Key characteristics of the feedforward amplifier are summarized in Table 1. The power output capability is the highest presently available from block-conversion transmitters, but still falls well short of matching the performance of the channelized AML transmitter. Nevertheless, development of this first Ku-band microwave feedforward amplifier opens up new microwave application alternatives for the CATV system designer.

This article was presented as a paper at the 1987 Canadian Cable Television Association convention and expo in Montreal.

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Figure 8: Utilization of power dividers and feedforward amplifiers

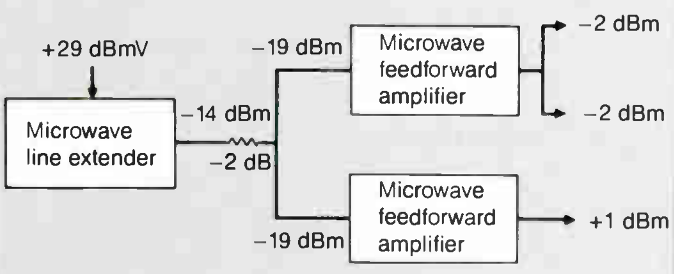
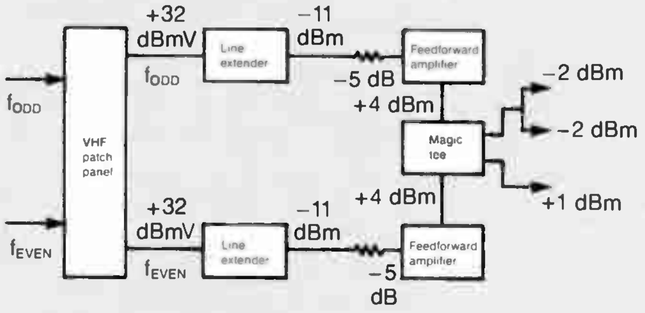


Figure 9: Feedforward amplifier utilization with fail-soft redundancy



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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

13.1985	E42
13.1925	E41
13.1865	E40
13.1805	E39
13.1745	E38
13.1685	E37
13.1625	E36
13.1565	E35
13.1505	E34
13.1445	E33
13.1385	E32
13.1325	E31
13.1265	E30
13.1205	E29
13.1145	E28
13.1085	E27
13.1025	E26
13.0965	E25
13.0905	E24
13.0845	E23
13.0785	E22
13.0725	E21
13.0665	E20
13.0605	E19
13.0545	E18
13.0485	E17
13.0425	E16
13.0365	E15
13.0305	E14
13.0245	E13
13.0185	E12
13.0125	E11
13.0065	
13.0045	E09
12.9985	E08
12.9925	E07
12.9865	E06
12.9805	E05
12.9745	E04
12.9705	E03
12.9645	E02
12.9585	E01
12.9525	

12.9465	C42
12.9405	C41
12.9345	C40
12.9285	C39
12.9225	C38
12.9165	C3
12.9105	C3
12.9045	C3
12.8985	C34
12.8925	C33
12.8865	C32
12.8805	C31
12.8745	C30
12.8685	C29
12.8625	C28
12.8565	C27
12.8505	C26
12.8445	C25
12.8385	C24
12.8325	C23
12.8265	C22
12.8205	C21
12.8145	C20
12.8085	C19
12.8025	C18
12.7965	C17
12.7905	C16
12.7845	C15
12.7785	C14
12.7725	C13
12.7665	C12
12.7605	C11
12.7545	
12.7525	C09
12.7465	C08
12.7405	C07
12.7345	C06
12.7285	C05
12.7225	C04
12.7185	C03
12.7125	C02
12.7065	C01
12.7005	

Group C

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

NICATIONS
DLOGY'S

ve Frequency Guide
.2 GHz)

hannels

W
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F
E
D
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AUX
AUX
E10 (FM4)
FM3
FM2
FM1
6
5
PT
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3
2

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A
AUX
AUX
C10 (FM4)
FM3
FM2
FM1
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5
PT
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hannels

Group F Channels

13.1985	F32	M
13.1925	F31	L
13.1865	F30	K
13.1805	F29	J
13.1745	F28	13
13.1685	F27	12
13.1625	F26	11
13.1565	F25	10
13.1505	F24	9
13.1445	F23	8
13.1385	F22	7
13.1325	F21	I
13.1265	F20	H
13.1205	F19	G
13.1145	F18	F
13.1085	F17	E
13.1025	F16	D
13.0965	F15	C
13.0905	F14	B
13.0845	F13	A
13.0785	F12	AUX
13.0725	F11	AUX
13.0665	F10 (FM4)	
13.0645	F09	FM3
13.0585	F08	FM2
13.0525	F07	FM1
13.0465	F06	6
13.0405	F05	5
13.0345	F04	PT
13.0305	F03	4
13.0245	F02	3
13.0185	F01	2
13.0125		

13.0057	D42	W
12.9997	D41	V
12.9937	D40	U
12.9877	D39	T
12.9817	D38	S
12.9757	D37	R
12.9697	D36	Q
12.9637	D35	P
12.9577	D34	O
12.9517	D33	N
12.9457	D32	M
12.9397	D31	L
12.9337	D30	K
12.9277	D29	J
12.9217	D28	13
12.9157	D27	12
12.9097	D26	11
12.9037	D25	10
12.8977	D24	9
12.8917	D23	8
12.8857	D22	7
12.8797	D21	I
12.8737	D20	H
12.8677	D19	G
12.8617	D18	F
12.8557	D17	E
12.8497	D16	D
12.8437	D15	C
12.8377	D14	B
12.8317	D13	A
12.8257	D12	AUX
12.8197	D11	AUX
12.8137	D10 (FM4)	
12.8117	D09	FM3
12.8057	D08	FM2
12.7997	D07	FM1
12.7937	D06	6
12.7877	D05	5
12.7817	D04	PT
12.7777	D03	4
12.7717	D02	3
12.7657	D01	2
12.7597		

Group D Channels

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
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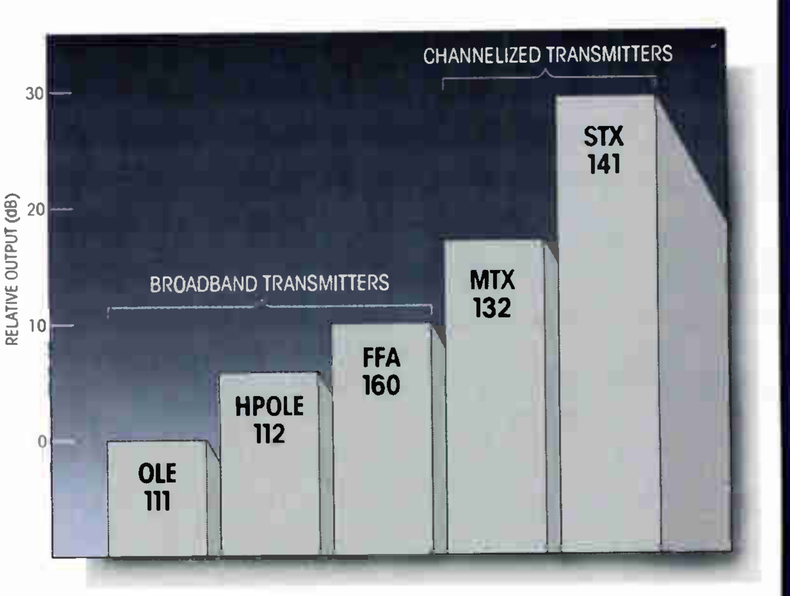
12.7000	



A case study in amplifier technology

By Roger Seefeldt
Fund Engineering Director, Jones Intercable Inc

Recently, Jones Intercable held its sixth annual engineering meeting in Denver and Breckenridge, Colo. Utilizing the theme "The Engineer as a Manager," the six-day conference consisted of two days of training in Denver on supervision and time management, and four days of classes and presentations in Breckenridge on problems facing today's engineers. The latter sessions included specific topics in which management techniques were used to solve problems.

More than 80 people attended. To facilitate communication, they were divided into four smaller groups, which took turns attending the different presentations.

One class on amplifiers consisted of three parts: a short review of amplifier technology and maintenance and a case study. The class was divided into smaller groups and given an identical case study of a situation chief engineers might encounter. They were asked to identify the problems that existed and develop a plan for solving. It was stressed that the point of the exercise was not the solution, but the process used to arrive at a solution; there was no one right answer.

Case study

The case study described a mythical system in an urban Southwest community:

"The system consists of 1,000 miles of plant, passing 100,000 homes with 30,000 basic subscribers. Channel capacity was recently upgraded to 40 utilizing feedforward trunk modules, and conventional bridgers and line extenders. The amplifier cascade of all five AML (amplitude-modulated link) paths was 23. Pay channels were either positively or negatively trapped. The service call percentage continued to run at about 8 percent per month, even though the upgrade was completed about 90 days ago. Outages had been reduced in quantity and duration.

"For some time, service technicians had complained that two of the microwave hubs seemed to have more problems than the other areas in the system. After reviewing service calls for the last 60 days, it was found that there were many complaints of snowy pictures during the day and beats and rolling pictures at night. Problems appeared to be worse during extreme temperature changes. The areas were balanced as part of the upgrade, and the headend technician believed the microwave was operating correctly.

"The manager has just informed the chief engineer that the system was on the city council's agenda for discussion about the problems they had heard on the south side of town."

Each group was asked to identify, evaluate and study the problem, plan a solution with approximate cost estimates, and determine the best procedures to follow to present the options and costs of the plan to management. They also were asked to develop a plan to implement the solution, and ideas on how to monitor and revise the plan as needed. Each group was instructed to appoint a spokesperson to take notes and to present the group's ideas to the rest of the class for discussion.

Once the first class understood the "game" rules, they jumped right in and came up with several excellent ideas. By the end of the class, they agreed that the best plan was to determine the most likely causes for the problem and then go out and prove or disprove the data, narrowing down the area and eventually identifying the problem. This group decided the problem was two defective AGC modules in two different cascades with a cost estimate of $750. It was decided the solution should be discussed with the manager and presented to the city council, with plans to monitor the area for a period of time to verify the problem was solved.

The second presentation was easier and went smoother. We deviated from our original plan by allowing the rest of the class to ask "difficult" questions after each spokesperson had presented the group's ideas. The full class then debated the methods each group used to arrive at their solutions. This technique demonstrated to the class that there could be several ways to approach the situation.

One problem and solution discussed at length was the possibility that during installation of the two microwave dishes on the transmit tower, one had been damaged and would have to be replaced—a major expense. The rest of the group picked up on the fact that this was a class on amplifiers and not microwave.

The third class was the least successful, perhaps because it was after a big lunch and everyone would have preferred to take a siesta. All the groups came up with quick answers and really didn't spend a lot of time researching alternatives.

The fourth and last class was probably the most fun. Not only did each group really get into the case study and ask difficult questions about the other groups' reasons for doing things, they also took it upon themselves to critique each other constructively on ways to improve their approach to solving the problem. They really worked as a team and shared many different ideas. (Isn't this what a good manager would do?)

While there were almost as many different plans and solutions as there were participating groups, the class was rated a huge success. This was an exercise in thinking out a situation logically, and working step-by-step to come up with a solution. A good manager will not assume the data is 100 percent accurate and will look for evidence on which to base a solution. Nor will a manager be afraid to admit mistakes and utilize the talent of all personnel.

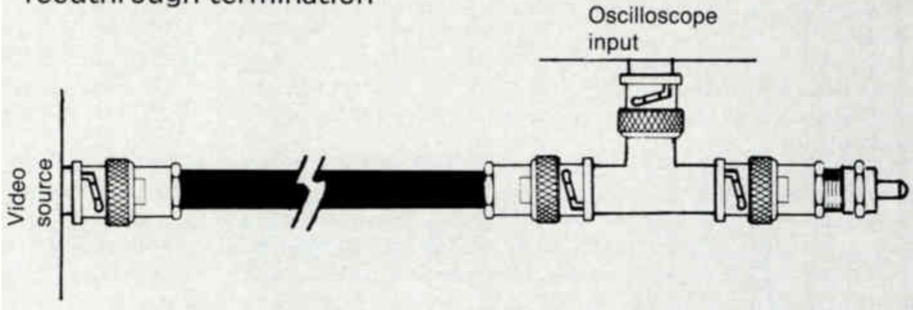
Each individual learned from the others within the group by listening and discussing the solutions presented by members of the other groups in the class. Communication skills were sharpened and ideas were shared, and the point made that there never really is only one sure way to solve a problem.

BACK TO BASICS

How to set video levels with an oscilloscope

By Ron Hranac
Senior Staff Engineer, Jones Intercable Inc.

Figure 1: Connection to oscilloscope with homemade 75-ohm feedthrough termination



The oscilloscope is a versatile piece of test equipment that has many uses in day-to-day cable system operations. One very important but relatively simple use is video level measurement.

A common misconception about video measurements is that a waveform monitor must always be used for accuracy. Waveform monitors, while certainly valuable in a studio environment, are nothing more than specialized oscilloscopes with features dedicated to video applications. On the other hand, the general purpose oscilloscope is capable of most waveform monitor duties in addition to a host of other tasks. Table 1 shows the relationship between waveform monitor IRE units and their equivalent oscilloscope peak-to-peak voltages.

For an oscilloscope to be used for video measurements, it should have at least 5 MHz bandwidth; greater bandwidth is even better. While not mandatory, video triggering—both field and horizontal line—is a useful oscilloscope feature. Delayed sweep can help with individual video line measurements. One extremely important thing to remember about using a general purpose oscilloscope for video measurements: The impedance of the oscilloscope is not the same as the video source being measured! An oscilloscope has a very high input impedance—typically around 1 million ohms. Most video sources have a 75-ohm impedance. Because of this, you must use a 75-ohm feedthrough termination at the input of the oscilloscope when measuring video signals.

Terminating the input of an oscilloscope can be accomplished two ways: You can use a commercially made 75-ohm feedthrough termination or you can make your own with a BNC "T," a BNC-to-F adapter and a conventional 75-ohm F terminator. Put the F terminator on the adapter, then install the adapter on one leg of the "T." Connect your video source to another leg of the "T,"

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Figure 2

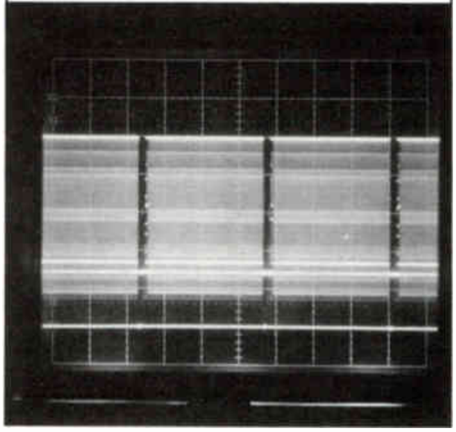


Figure 3

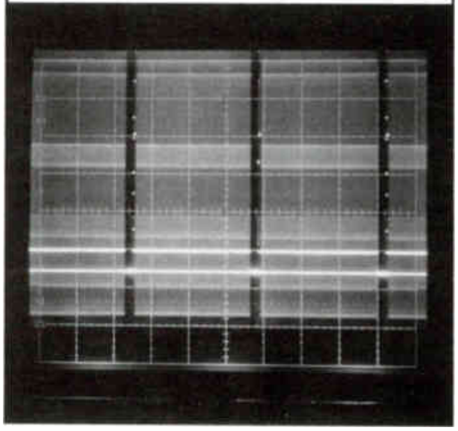
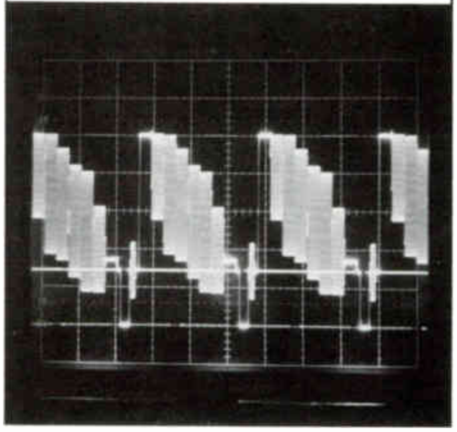


Figure 4



and the remaining leg of the "T" to the oscilloscope input (see Figure 1).

Making measurements

To make video measurements:

- Turn on the oscilloscope and let it warm up for 30 minutes. Check to make sure that all knobs are in the CAL position, and verify instrument calibration per the manufacturer's directions.
- Remove the oscilloscope probe from the in-

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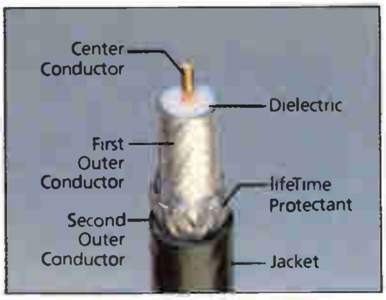

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Table 1: Waveform monitor IRE units and oscilloscope peak-to-peak voltages

Video parameter	Waveform monitor IRE units	Oscilloscope peak-to-peak voltage
Reference	1	0.00714 volt
Horizontal sync amplitude	40	0.286 volt
Color burst amplitude	40	0.286 volt
Setup	7.5	0.054 volt
Video (blanking to peak white)	100	0.714 volt
Total video signal amplitude	140	1 volt

> *"A common misconception about video measurements is that a waveform monitor must always be used for accuracy."*

put BNC connector (most probes are X10; the oscilloscope should be in a direct or X1 mode).

- Install your 75-ohm feedthrough termination on the oscilloscope's input BNC connector and connect the video source being measured to the termination.
- Adjust the oscilloscope's controls to the following settings:

Vertical sensitivity (volts/division)	0.2 V
Sweep rate (time/division)	5 ms
Trigger	TV field
Coupling	DC

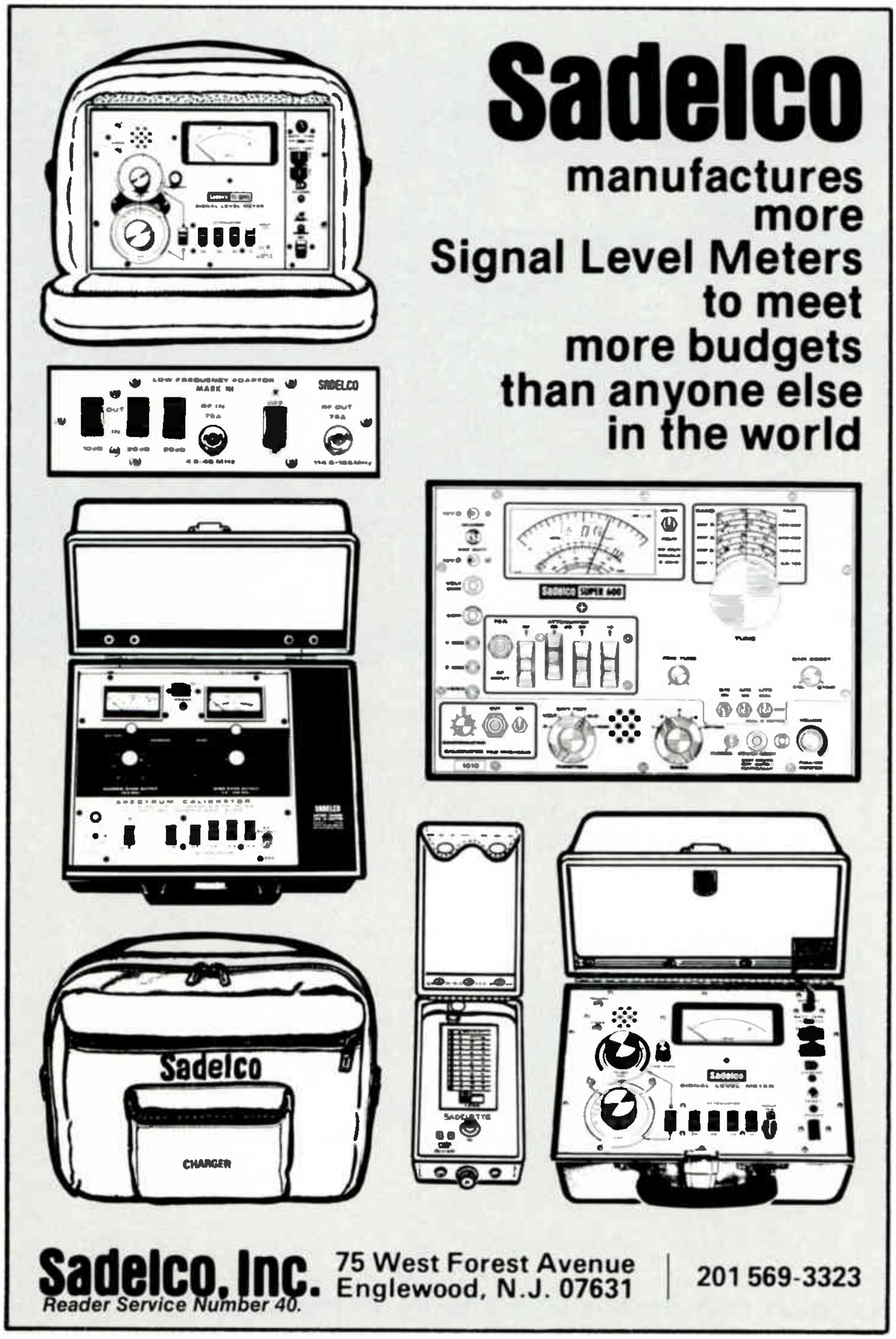
(If your oscilloscope does not have field or video triggering, use line triggering. This will lock the instrument to the 60 Hz AC power line.)

- Center the displayed video signal with the vertical and horizontal position controls. Then, using the vertical position control, adjust the position of the video signal on the oscilloscope CRT to align the sync tips of the video with a graticule near the bottom of the display.
- Adjust your video source until the oscilloscope indicates 1 volt peak-to-peak, or five vertical divisions from sync tips to peak white (Figure 2). If you don't use a 75-ohm feedthrough termination for this procedure, the oscilloscope will indicate a much higher video level than is actually present (Figure 3).

If you want to look at horizontal blanking to measure the color burst or horizontal sync, readjust the oscilloscope's horizontal sweep (time/division) control to 20 μs, and the triggering to TV horizontal or video line. It may be necessary to play with the oscilloscope's variable trigger control to stabilize the display, but you should get something that looks like Figure 4.

A properly calibrated oscilloscope with a stable video trigger circuit will let you measure video parameters usually left to be handled by a waveform monitor. With a bit of practice, you'll soon find it's not too difficult to measure setup, sync timing, pulse width, burst amplitude and even some common video distortions.

Proper video levels are an important part of cable system operations, especially in microwave and headend applications. Using the right tools and techniques to set and maintain video levels will help to ensure that such things as FML transmitter deviation and RF modulator depth of modulation are within specification. The bottom line will be better pictures in your subscribers' homes.



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Reader Service Number 62.

Part II: Anchoring utility poles

Part I of this series discussed anchoring in various types of soils. This month will deal with drive anchors.

By David Chandler
President, Foresight Products

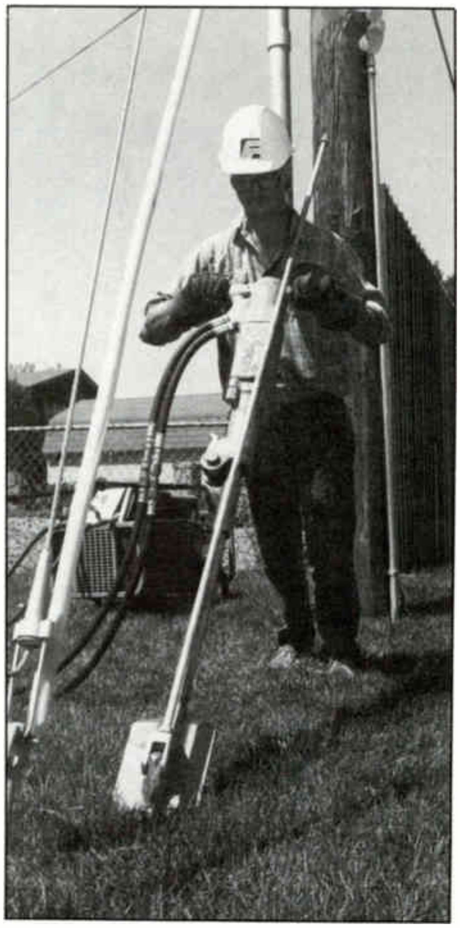
As described in the first part of this series, there are three types of devices used for anchoring utility poles and communications towers—auger, expandable and drive. Since the drive anchor is relatively new, a few words need to be said about its proper use in the field. Installed by one person at ground level, using only an ordinary jackhammer and drive gad, the drive anchor makes unnecessary the use of equipment costing from $50,000 to $150,000.

The first of its kind, the Manta Ray anchor (so named because of its devilfish shape) is manufactured of galvanized ductile iron, as is the shackle, which is fastened to the anchor by a galvanized steel pin. A standard screw anchor rod is screwed into the threaded shackle and driven into the ground with the anchor.

A drive gad is a steel rod; one end of it is inserted in the anchor, the other end is fitted into the jackhammer. The hammer then drives the gad and the anchor into the ground to the desired depth and at the desired angle. The drive gad consists of a chuck and three sections, which are rope-threaded and coupled together section after section as the anchor is driven into the ground. Made of carburized tool steel (mining steel), the gads fit the standard chuck sizes of $1^1/_8$ inches and $1^1/_4$ inches used by the vast majority of hydraulic and pneumatic hammers. The gad has a radiused drive tip to accommodate the radiused core bottom in the anchor.

Installation procedures

After the anchor has been driven into the ground, the installer pulls the drive gad out of the ground by hand, leaving the threaded end of the anchor rod at ground level; or in looser soils it may be countersunk up to 12 inches below the surface of the ground to obtain greater holding capacity. A tubular setting pipe is screwed onto the end of the anchor rod, and the load locker is put in place over the tubular setting pipe. The



Installer starts drive anchor into earth using standard jackhammer and drive gad.

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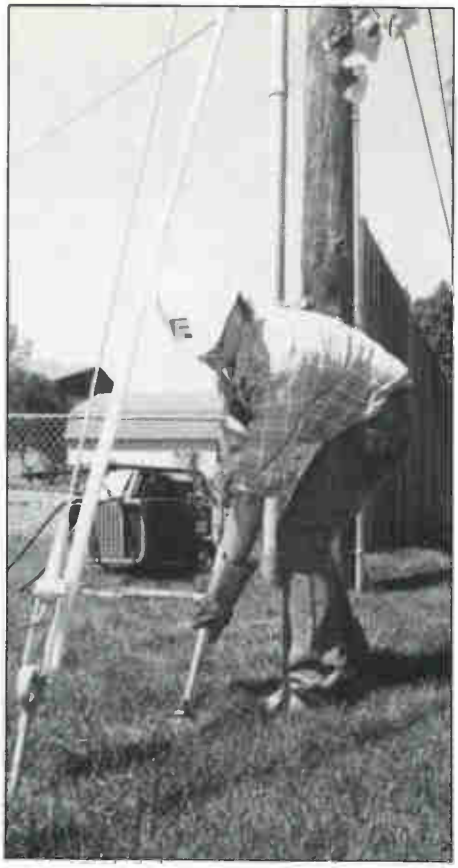


After the anchor is all the way in the ground to the desired depth and angle, the drive gad is pulled out of the ground.

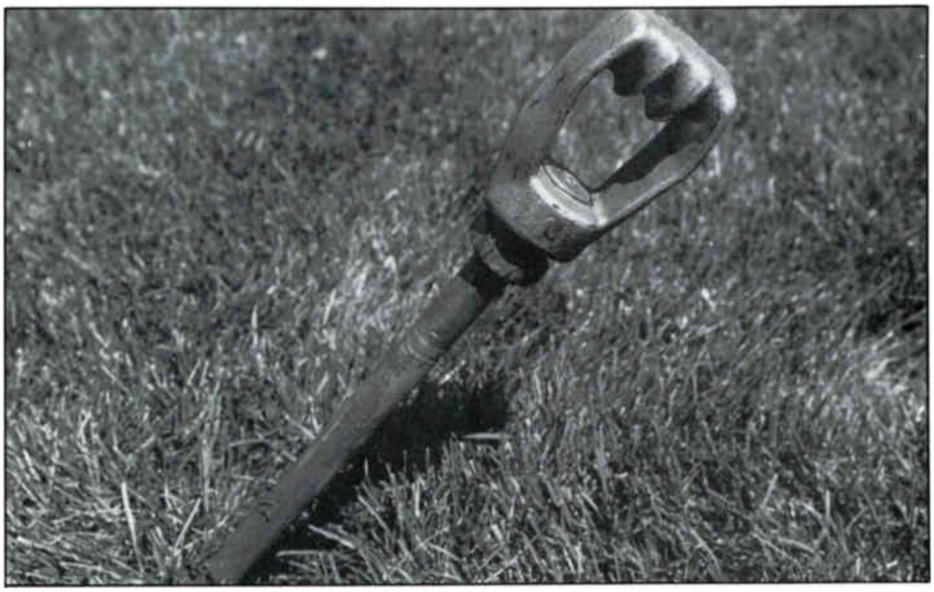
A tubular setting pipe is screwed onto the end of the anchor rod. The load locker base and hydraulic ram are then put in place over the pipe.

With a power source, the load locker pulls up on the anchor rod, rotating the anchor into load lock position to the desired holding capacity.

> *"In normal soils...the driving and setting of this anchor are usually accomplished in less than 20 minutes."*

installer operates a power pack that activates the load locker, which pulls up on the anchor rod, rotating the anchor into load lock position like a toggle bolt in undisturbed earth. A gauge on the load locker tells the installer how many pounds of holding capacity have been locked in. When the desired holding capacity has been reached, the installer stops pulling up on the anchor rod, removes the load locker and screws the thimble eye onto the end of the anchor rod. The thimble is then ready for guying.

In normal soils, classes 3 through 8, the driving and setting of this anchor are usually accomplished in less than 20 minutes. At this rate, as many as 12 drive anchors have been installed in one day by one person.



After the load locker is removed, the thimble is screwed onto the end of the anchor rod, ready for guying.

Ron Hranac was promoted to senior staff engineer at **Jones Intercable**. Prior to this, he was corporate engineer for the MSO. Contact: 9697 E. Mineral Ave., Englewood, Colo. 80112, (303) 792-3111.

Rollins

Patricia Rollins was named office manager for **Adams-Russell Cable** in Bangor, Maine. Most recently, she was senior customer service representative for the company. Contact: 278 Florida Ave., P.O. Box 1405, Bangor, Maine 04401, (207) 942-4661.

United Cable announced several promotions in its finance department. **Gary Howard**, formerly treasurer, was appointed vice president and treasurer. **Norman Stephens** was promoted to vice president of taxation; prior to this, he was assistant vice president of taxation. **Mark Schneider** was named vice president of corporate development; before joining United, he was director of federal government and regulatory affairs for Standard Oil.

Also promoted were **Kenneth Warner**, formerly controller, to assistant vice president; and **Bernard Dvorak**, previously assistant controller, to controller. Contact: 4700 S. Syracuse Pkwy., Denver, Colo. 80237, (303) 779-5999.

Centel Cable Television Co. promoted **Carol Sulkes** to vice president, general counsel and secretary. She was previously general attorney and assistant secretary with Centel Cable.

The company also named **Michael Small** vice president of finance and treasurer. Prior to this, he was assistant controller.

In addition, Centel Cable announced the election of four outside directors for the company. They are: **Robert Bottoms**, president of DePauw University, Greencastle, Ind.; **Jerry Bradshaw**, president of Gary-Wheaton Bank, Wheaton, Ill.; **Leo Henikoff**, president and CEO of Rush-Presbyterian-St. Luke's Medical Center, Chicago; and **John McCarter Jr.**, vice president of Booz, Allen & Hamilton, Chicago. Contact: 2001 Spring Rd., Suite 700, Oak Brook, Ill. 60521, (312) 954-4812.

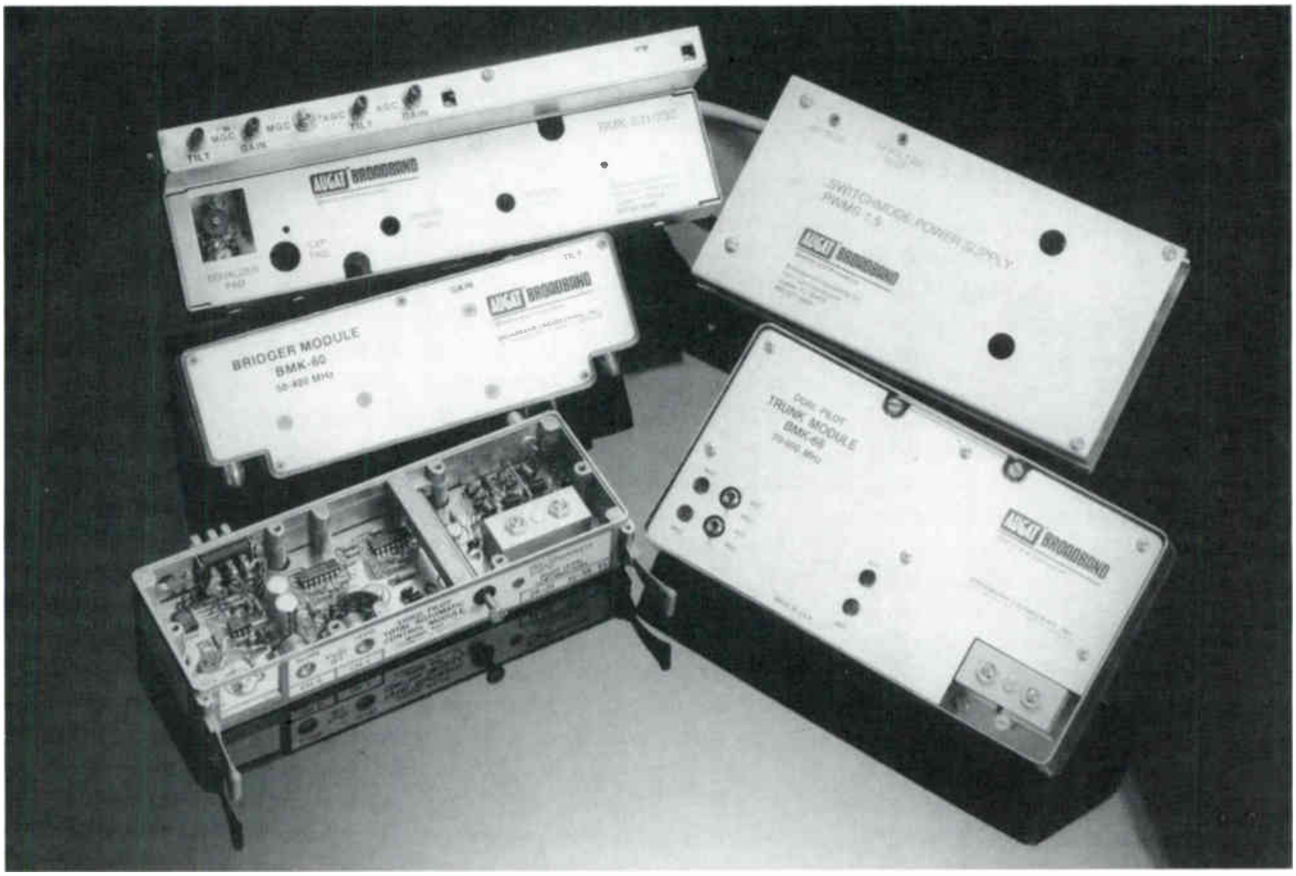
Dynair named **Lorrie Davis** marketing communications manager. She has had 20 years experience in computer-related marketing and advertising. Contact: 5275 Market St., San Diego, Calif. 92114, (619) 263-7711.

Midwest CATV selected **John Johnson** as purchasing manager. He was formerly corporate purchasing manager with Cox Cable Communications. Contact: P.O. Box 271, Charleston, W. Va. 25321, (304) 343-8874.

Paul Fisher joined **Warner Cable** as director of technical operations. Prior to this, he was with Harte Hanks Cable. Contact: 8400 W. Tidwell, Houston, Texas 77040, (713) 462-1900.

Riddle

Microdyne named **Leo Riddle** as sales engineer of satellite communications. Previously, he was national sales director for Radyx Satellite Systems. Contact: P.O. Box 7213, Ocala, Fla. 32672, (904) 687-4633.



Broadband:
The leader in upgrade electronics

Upgrading rather than rebuilding has been the cost effective way of extending the life of cable systems by many years thus adding profits to the bottom line.

Broadband originated the concept of upgrading almost 9 years ago and we have continued our leadership ever since.

You can feel confident with the technical superiority and reliability that we have always been known for.

We don't look for quick fixes, we engineer long term solutions to your upgrading problems.

The result is electronics better than the original equipment that you are upgrading.

We stand behind our product too. Our upgrades have a one-year warranty and we are always there to discuss any immediate problems by phone.

For more information call Broadband Engineering at 800-327-6690 (in Florida 305-747-5000) or write us at 1311 Commerce Ln., Jupiter, Florida 33458.

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Quality and Innovation

Reader Service Number 41.

So your system needs rebuilding

By Jim Merriam
Rebuild Manager, Palmer Cablevision

Many operators are facing a system rebuild, either because the plant is old, service is costly and quality is poor, or limited channel capacity is restricting profits from newly available services. Whatever the reason, the primary questions asked by management are how much is it going to cost and how can it be controlled. If you're facing a rebuild, some of these suggestions may prove helpful.

The first important move is hiring a good rebuild manager who is experienced with design and construction procedures. The manager's only responsibility should be controlling quality and costs. A small fortune can be lost or saved in the field and a salary can be made five times over.

The next step is to have a meeting with key management personnel and establish a rebuild policy. Several questions must be answered, such as: How many channels do we need? How many will we need five to 10 years from now? How much system shall we rebuild and in what areas? How much budget per year should we commit? Are our converters adequate or will we need to update? Should we consider a two-way system? Should we consider one-way addressability or addressability in just some areas? With expanded channels what will our maximum amplifier cascade be? Do we need hub sites? What equipment should we buy and what will our system specifications be?

System design

Once these questions are answered the next project is system design. Many cable operations have adequate design personnel who know the basics and can do a fair job, but a design professional can save up to 30 percent in equipment costs. By proper placement of amplifiers, you can utilize every spare dB. The cost savings on equipment can be much more than the charge for service. Large value taps at the ends of distribution lines are the most obvious indication of poor design.

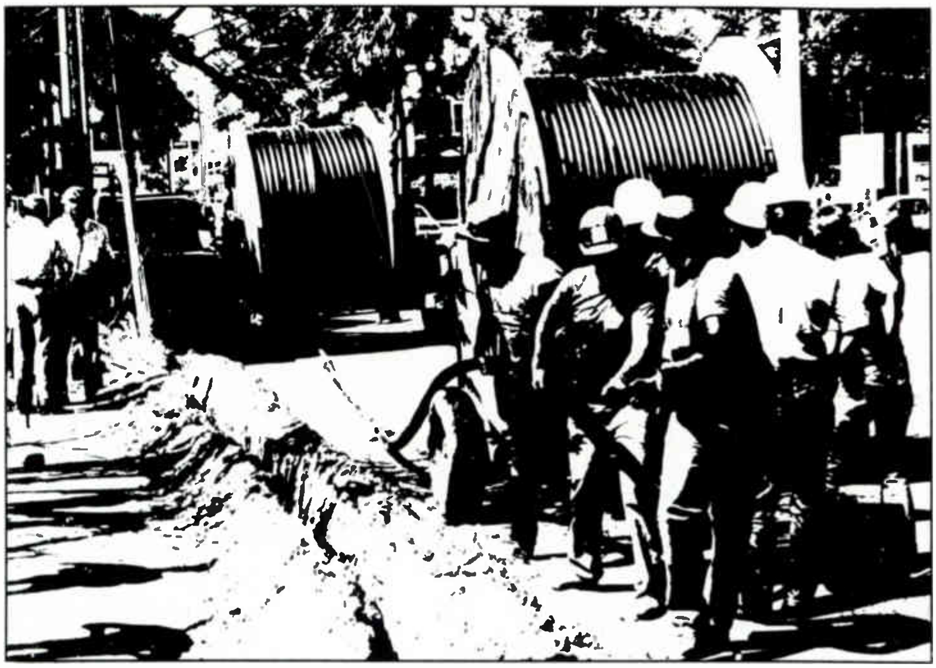
If you have a choice of going aerial or underground, most operators would agree the advantages of aerial plant far exceed underground. Foremost is cost. Aerial plant will run 40 percent to 60 percent less than underground. Underground construction is where your costs can vary significantly depending upon your control procedures.

One of the first concerns with going underground is customer relations. We certainly can't plow up people's lawns without giving them notice. Newspaper ads and 30-second spots on the cable system are excellent ways of informing customers of your plans. A week to 10 days before construction crews start an area, hang a door knocker at each residence to inform the occupant that crews will be coming across the easements with new cable and that restoration will follow. The notice should be positive, brief and describe the advantages of this rebuild.

Once the crews have installed cable, hang a second notice explaining what happened, with a phone number to report any missed damage and assure the occupants they are not being abandoned. The phone number we use is a line to a separate office set up and staffed by the contractor. Their people answer all trouble calls and complaints. Most systems do not need the extra burden of handling these calls. Of course, disruption of service is turned over to system dispatch for the service techs to follow up.

There are several methods of getting the cable into the ground. The fastest and probably the easiest, with less restoration, is to plow it in. In southwest Florida we are very particular about the condition of the cable once it is in the ground. Florida's soil has a lot of shell in it that can skin a jacket off a cable like a razor blade.

What we opted to do was order our cable already inside the conduit. The advantages of this option far outweigh the additional costs. First of all, the cable is protected when it is plowed. It is harder to kink when handling and the conduit provides adequate protection from a shovel or the prodding of the water or gas companies when they search for their lines. It is also handy when replacing a span. It can be pulled out of



the conduit and replaced with a new one with very little effort.

One word of caution: If you decided to use cable in conduit with this method of installation, a kellum grip must be used if pulling directly off the reel; otherwise, cut the proper cable length from the reel and attach it to the plow. The cable must float free within the conduit so it will not stretch.

During the installation procedures it is very important that your rebuild manager or inspector be in the field daily. This can mean the difference between a good job that is cost-efficient and a poor job that is expensive. The per foot rate of installing cable will jump four to six times when a contractor has to bore under concrete or cut and patch asphalt. Many times minor field changes can be made to areas where the plow can go, saving hundreds of dollars, which add up to thousands over a period of months. It is also important to check each span with a measuring wheel for plow footage and bore footage and record them for invoicing. Mistakes can be made that add up to a sizeable amount of money.

The expense of running new drops can be eliminated or postponed if the new pedestal locations are the same as the old design. Instruct the contractor to set the new pedestals right next to the old ones. When the time comes to switch drops they can easily be routed into the new can. Once the contractor has finished an area, sweep crews should sweep all trunk lines and spot check the distribution portion. Once this is accomplished it's time for taps.

We saved approximately 50 percent from a contractor's bid price by letting our own experienced people cut in taps and line extenders at a per piece rate on their own time. They were paid better than time and a half and we were happy with the result. We also dedicated two senior service techs to cutting in the trunk amps, power supplies and activating the new lines.

Switching over

When both systems are running side by side, a junior tech switches over the drops. When this is complete turn the old system off, allowing time for customers to report hookups that have not been switched. If all is well the junior tech goes back and wrecks out the old system, while inspecting for restoration, leaning pedestals, etc. It also is important to accurately track the rebuild progress on a set of maps. I find color coding the progress very helpful.

110%

That's the kind of effort we put out. Because that's what it takes to become the leading CATV standby power system manufacturer in North America. That's what it takes to design the technology that sets the standards in the industry. And that's what it takes to beat the competition.

Efficiency. Alpha has developed standby power supply transformers rated at 94% efficiency – the highest in the industry. And this without sacrificing quality, thanks to superior engineering.

Cost of Ownership. Alpha systems cost less because our efficiency, reliability and performance monitoring result in lower maintenance and operating costs.

Modularity. Alpha pioneered functional modularity. Just add simple plug-in components and your standby power system is updated with the latest innovations from Alpha's R&D labs.

Uninterrupted Power. Alpha's transfer time is so immediate that we offer standby power with the advantages of uninterruptible power. Uninterrupted power means uninterrupted service to your subscribers.

Innovation. We're never content. We're always looking for ways to improve. That's why the industry looks to Alpha for innovations in standby power. Single ferro-resonant design. Temperature compensation. "Smart" battery charging. Performance monitoring. Status monitoring. Major innovations resulting in real benefits – and all introduced by Alpha Technologies.

And have we finished yet? Don't bet on it.

Reader Service Number 45.

ALPHA TECHNOLOGIES

We're Here to Back You Up.

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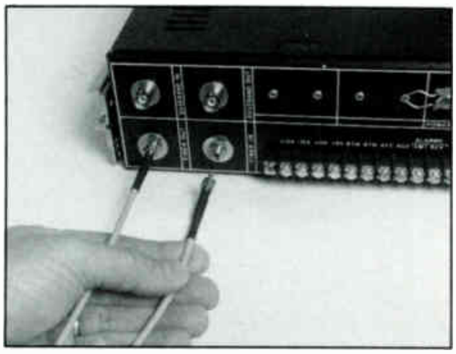
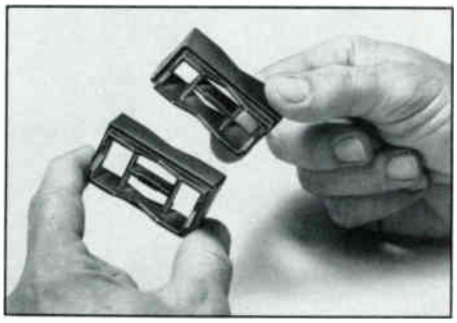
206-647-2360 FAX: 206-671-4936
133 Antrim Ave. Burnaby, B.C. V5J 4M



23 GHz link

The MIcroNET 23 fiber extension link from Microwave Networks is a 23 GHz microwave radio link for extension of fiber-optic data networks when a fiber connection is not possible. The product features up to 10 Mbps data rate operation with basic Manchester encoding, protocol independence, field tunable frequencies and transient surge protection.

For further details, contact Microwave Networks, 10795 Rockley Rd., Houston, Texas 77099, (713) 495-7123; or circle #131 on the reader service card.



Cable spacers

Panduit introduced its stackable cable spacers with large openings for four-way entry of cable ties. The spacers are used to separate cable from a support strand or another cable in underground or aerial support applications. One spacer snaps into another to increase height by ½-inch increments with each additional spacer.

For further details, contact Panduit Corp., 17301 Ridgeland Ave., Tinley Park, Ill. 60477-0981, (312) 532-1800; or circle #138 on the reader service card.

Compactor/driver

The Model 4700 Ho-Pac from Allied can be utilized in narrow trenches, in slope and excavation compaction and as a driver for beams, piling and sheeting. It is specially designed for mini-excavators, small skid-steer loaders, rubber-tired backhoes and trenchers with bucket. The product features a rotating eccentric for vibratory and impulse force, 7 gpm oil flow and 12-inch wide baseplate.

For additional information, contact Allied, 5800 Harper Rd., Solon, Ohio 44139, (216) 248-2600; or circle #137 on the reader service card.

BTSC encoders

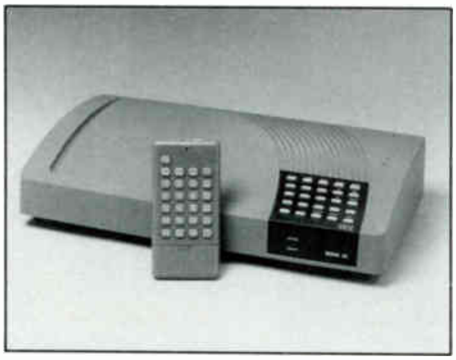
Wegener Communications has added two BTSC encoder configurations to its product line, the Model 1601-56 BTSC encoder system and the Model 1602-95 BTSC encoder. The 1601-56 incorporates up to four stereo encoders in a single mainframe, while the 1602-95 BTSC encoder is a low-profile single unit configuration. Both feature the addition of selectable high/low impedance and balanced/unbalanced audio interfaces, selectable stereo/monaural local commercial insertion and barrier strip interconnections.

For further information, contact Wegener Communications, 11350 Technology Circle, Duluth, Ga. 30136, (404) 623-0096; or circle #113 on the reader service card.

Microwave products

Channel Master unveiled several new Micro-Beam CARS band relay products designed specifically for CATV applications. The products utilize broadband, tower-mountable microwave system equipment to distribute signals to multiple receive sites without supertrunks, additional remote headends or special equipment environments.

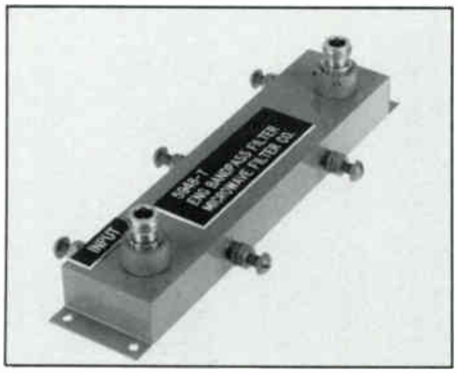
For additional details, contact Channel Master, P.O. Box 1416, Industrial Park Dr., Smithfield, N.C. 27577, (919) 934-9711; or circle #134 on the reader service card.



IPPV system

Oak Communications introduced its Sigma ASAP (automatic self-authorized purchasing) impulse pay-per-view (IPPV) system integrated within its Sigma line of set-top terminals. For the subscriber, ordering of PPV programming is accomplished with two key strokes (MODE BUY). Sigma's on-screen messages prompt for all input from the simplest to the most complex transactions. For the cable operator, the system permits immediate PPV authorization to an unlimited number of subscribers on multiple PPV events, purchasing tailored for on-channel or off-channel ordering or both, advanced ordering of upcoming PPV events, subscriber home shopping services, ratings research and system error function recall.

For more information, contact Oak Communications, 16935 W. Bernardo Dr., Rancho Bernardo, Calif. 92127, (619) 451-1500; or circle #130 on the reader service card.



ENG bandpass filter

The Model 5948 ENG channel bandpass filter is available from Microwave Filter for any channel within the 1,990-2,110 MHz ENG band. Center frequency insertion loss is less than 0.5 dB and return loss is greater than 17 dB over the 0.5 dB roll-up band of ±8 MHz. Selectivity is greater than 30 dB at ±16 MHz from center frequency.

For more information, contact Microwave Filter, 6743 Kinne St., East Syracuse, N.Y. 13057, (315) 437-3953; or circle #135 on the reader service card.

Pedestals

Pyramid Industries introduced its VTP series of vault-top pedestals. The series is designed to protect active and passive equipment and is available in three sizes: VTP 1419, VTP 1324 and VTP 1730. The pedestals come complete with bracketry and hardware necessary for installation in the field.

For more details, contact Pyramid Industries, P.O. Box 23169, Phoenix, Ariz. 85063, (602) 269-6431; or circle #129 on the reader service card.

Self-fusing tape

Polychem has developed Polyflex SFT-150 self-fusing tape for use in housing to housing connections, drop connections and all aerial or underground connections where the use of an open flame is prohibited or undesirable. According to Polychem, this product features excellent weatherability, −55° C low temp flexibility and clean stripping.

For more information, contact Polychem Electronics, 420 Boulevard, Suite 101, Mountain Lakes, N.J. 07046, (201) 316-5775; or circle #132 on the reader service card.

The right way for installers to figure out what's wrong.

The best time to discover a subscriber installation problem is at hook-up. *Before* you have to make an expensive service call.

That's why Wavetek developed MicroSAM, a new hand-held installer's meter that gives digital readouts of channel signal levels.

For instant trouble-shooting.

If an installer discovers a problem, he can track it down simply by retracing his steps. Testing every point from the TV to the tap. Until he finds it.

An LCD display gives the *exact* signal level (without dummy lights or needles to read.) At *three* frequencies, not just two. Frequencies *you* set, not the factory.

MicroSAM has programmable band ranges up to 550 MHz. At ± 1 dB accuracy, with 0.1 dB resolution.

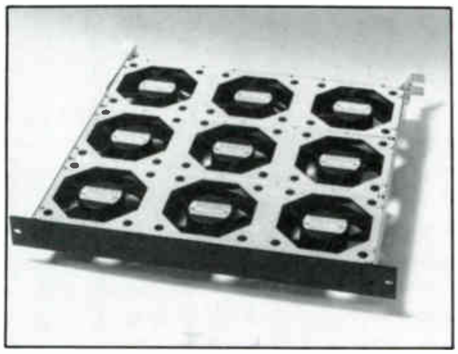
And a suggested list price of only $369.

MicroSAM gets rid of the guesswork. So you get it right the first time.

Call Wavetek at 1-800-622-5515 (in Indiana call 317-788-5965) for more information and the name of the nearest MicroSAM distributor.

WAVETEK®

Reader Service Number 46.



Cooling module

According to General Devices, its Model D-4118 cooling module provides adequate circulation of cool air for the efficient and safe operation of instruments, printed circuit boards and power supplies. The module requires no assembly, with all mounting hardware and adjustable rear brackets included. The user may specify up to nine fans in one module.

For additional information, contact General Devices, P.O. Box 39100, Indianapolis, Ind. 46239, (317) 897-7000; or circle #141 on the reader service card.

Stereo generator

Leaming Industries is offering the MTS-2B BTSC stereo generator with LED bar graph metering and frequency response flat out to 15 kHz. The product encodes satellite or local programming into the BTSC format using dbx companding. True AGC is built in to reduce the audio level adjustment routine from the technician's schedule. There are two pairs of left and right inputs (adjustable from the front panel), which may be selected by local or remote control. The built-in stereo synthesizer may be used with mono services, backup audio or local ad insertion.

A Bessel-null test tone generator is included to precisely set the deviation and both 4.5 MHz and composite baseband outputs are provided.

For additional details, contact Leaming Industries, 180 McCormick Ave., Costa Mesa, Calif. 92626, (714) 979-4511; or circle #128 on the reader service card.

Interface hub

The multichannel TransHub FM to VSB-AM from Catel Telecommunications is designed for the ultimate in fiber-to-coax trunk transition, according to the company. Features include 40-channel per fiber capability, 25-kilometer bidirectional fiber links without repeaters and broadband output of 550 MHz into coax trunks. It also is transparent to scrambling, BTSC and headend frequency plans.

The product is intended to provide solutions to problems such as the carrying of scrambled channels or future HDTV signals on supertrunks and pay-per-view return links on trunks.

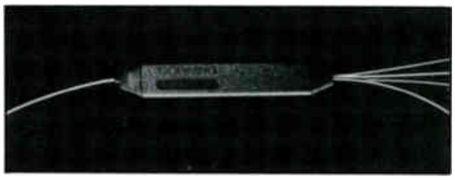
For further information, contact Catel, 4050 Technology Pl., Fremont, Calif. 94537-5122, (415) 659-8988; or circle #126 on the reader service card.

Line extender

The E-539 parallel hybrid device (PHD) line extender from C-COR Electronics is said to incorporate advanced double darlington hybrid circuitry for forward amplification. The parallel hybrid circuitry provides for increased output without additional distortion. A conventional hybrid circuit is utilized for amplification in the reverse pass band.

The product is available with one or two output ports and features a weatherproof, corrosion-resistant aluminum housing designed for either pedestal or aerial mounting.

For more details, contact C-COR, 60 Decibel Rd., State College, Pa. 16801, (814) 238-2461; or circle #127 on the reader service card.



Optical coupler

Photocor is a multiport bidirectional optical coupler made using Corning's integrated-optics technology. According to the company, the coupler is useful in applications requiring low loss and uniform splitting of optical signals. The technology makes feasible smaller components with more consistent performance than those currently available.

For further information, contact Corning Glass Works, Corning, N.Y. 14831, (607) 974-9000; or circle #133 on the reader service card.

Signal processor

Pico Macom introduced its Model SP60-U, a heterodyne signal processor with UHF-to-VHF conversion capability. The product features SAW filtering for 60 dB out-of-band signal rejection, spurious outputs down 60 dB, high adjacent channel rejection of 60 dB, low input signal capability, sync tip AGC, stereo signal compatibility, 45 MHz IF loop-thru and 100 percent burn-in.

For further details, contact Pico Macom Inc., 12500 Foothill Blvd., Lakeview Terrace, Calif. 91342, (818) 897-0028; or circle #140 on the reader service card.

Ad creation

The Adams-Russell Video Information Systems Division introduced the ARVIS 2000, also known as the AdView system. This product is a broadcast-quality ad creation machine that allows cable operators to create their own commercials by digitizing photo images to put onto videotape or transmit via modem for broadcast. With AdView, cable operators can offer advertisers that traditionally use print media, such as car dealerships, real estate companies, retailers, restaurants, etc., the opportunity to do broadcast advertising.

For further information, contact Adams-Russell Video Information Systems Division, 300 Second Ave., Waltham, Mass. 02154, (617) 890-5850; or circle #124 on the reader service card.

Reporting system

CableTek announced the availability of its CableMax system, designed to offer on-line update and inquiry capabilities to cable systems of fewer than 15,000 subscribers. The system offers users the full advantage of CableTek's mailing and inserting services and on-site inquiry, data base updates and reporting. CableMax features a report writer that complements CableTek's industry standard reporting package by providing users with information on-site and demand. Inventory for both addressable and non-addressable converters is supported, as well as addressable interfaces for popular converters.

For additional details, contact CableTek, P.O. Box 11908, Lexington, Ky. 40578-1908, (606) 259-1366; or circle #115 on the reader service card.

CATV enclosures

Moore announced two CATV security enclosures, the Moore Econo-Box and the Moore Hinged-Lid Box. The Econo-Box is an MDU enclosure said to deliver security and durability. The open-side design facilitates access and allows the use of a smaller, more economical unit.

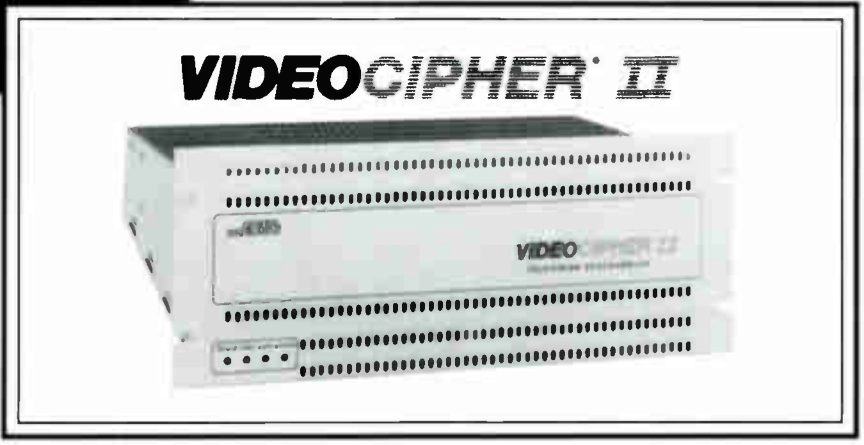
With the Hinged-Lid Box, the lid slides below the interlocks and swings out. Both the lid and the hingepins can be removed and replaced if necessary. If the box is not locked, the lid will not stay in the closed position. Security features include top and bottom interlocks running the full length of the lid, heavy gauge steel, fillet weld construction and tight manufacturing tolerances.

For more information, contact Moore Diversified Products, 1441 Sunshine Lane, Lexington, Ky. 40505, (606) 299-6288; or circle #122 on the reader service card.

Channel elimination

Qintar announced the availability of its channel elimination filter Model CEF that eliminates a full 6 MHz-wide channel, enabling insertion of another channel in its place. The overall on-channel suppression is −55 dB minimum at the video carrier with adjacent channel loss of −4 dB maximum. The Model CEF-* is available in Channels 2-6 and the Model CEF-R-* is available in Channels A-I and 7-13.

For further details, contact Qintar, P.O. Box 6579, Westlake Village, Calif. 91359-6579, (800) 252-7889; or circle #117 on the reader service card.


VIDEOCIPHER* II

Pre-amplifier

Pico Macom's Model MPA-25 mast-mounted pre-amplifier is said to enhance antenna performance, broadcast signal strength and television picture quality. The product features high input capability, low noise figure and out-of-band interference filtering to prevent picture degradation caused by reception of other RF transmissions. Switchable FM traps within the pre-amplifier prevent interference by FM frequencies.

The product also includes selection between input terminals for 75- or 300-ohm cable, lightning protection, all-weather performance and indoor power supply.

For additional information, contact Pico Macom, 12500 Foothill Blvd., Lakeview Terrace, Calif. 91342, (818) 897-0028; or circle #121 on the reader service card.

Antenna

DH Satellite has designed a deep .25 F/D ratio dish to reduce terrestrial interference. This 12-foot all-aluminum antenna is made by the spinning process on an all-steel mandral and transported in one piece. Although it is primarily used with C-band, it has a very high efficiency at K-band, according to the company.

For more information, contact DH Satellite TV, P.O. Box 239, Prairie Du Chien, Wis. 53821-9990, (608) 326-8406; or circle #139 on the reader service card.

Multiport decoder

Pioneer Communications of America is developing a multiport descrambler compatible with the Electronic Industries Association's IS-15 multiport standard, already being implemented on some television models. It allows the subscriber to utilize all the features of the television, without a converter box and two remotes. According to the company, costs will be reduced as manufacturing will be simpler with this product, which consists primarily of data communications and descrambling circuitry.

For further details, contact Pioneer Communications of America, 600 E. Crescent Ave., Upper Saddle River, N.J. 07458-1827, (201) 327-6400; or circle #123 on the reader service card.

Agile modulator

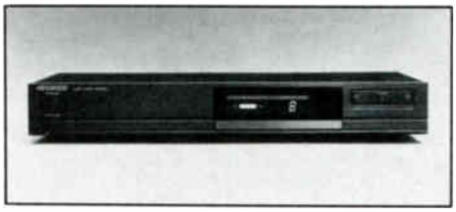
According to Jerrold, its S300M modulator is ideal for smaller cable systems. The product incorporates SAW-filtered frequency agility over the 54-300 MHz band and is only 1¾ inches high, fitting most headend racks. It features front panel control switches, 60 dBmV output capability and is BTSC stereo-compatible.

For additional details, contact Jerrold Division, General Instrument Corp., 2200 Byberry Rd., Hatboro, Pa. 19040, (215) 674-4800; or circle #120 on the reader service card.

Generators

Viewsonics has announced the availability of two models of comb generators (CW oscillators) that are NiCad-battery operated. Model VS-OSC-7 produces 50 dB of signal at 7, 14, 21 and 28 MHz, while Model VS-OSC-50-600 produces 34 dB of signal every 50 MHz from 50-600 MHz. Both operate four to eight hours when batteries are fully charged.

For more information, contact Viewsonics, 170 Eileen Way, Syosset, N.Y. 11791, (516) 921-7080; or circle #114 on the reader service card.



Sound system

Kenwood announced its digital CATV sound system that elevates cable audio transmissions to digital quality similar to the compact disc with no loss in signal quality, according to the company. The system consists of a transmitter terminal and a nearly unlimited number of subscriber receiving terminals. It features a high signal-to-noise ratio and a wide dynamic range even in weak field areas.

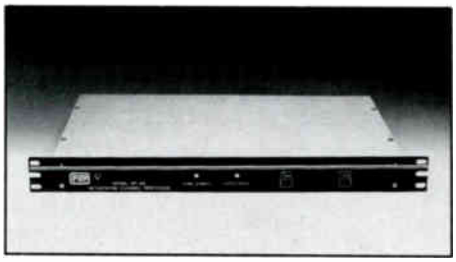
The system is said to be highly economical because eight stereo channels are transmitted on a single TV channel's bandwidth. Employing pulse code modulation ensures low noise levels as the digital signals are consolidated into one channel for transmission.

For more details, contact Kenwood, P.O. Box 22745, 2201 E. Dominguez St., Long Beach, Calif. 90801-5745, (213) 639-9000; or circle #125 on the reader service card.

Commercial inserter

Texscan MSI has produced the ComSerter-192 (CSR-192) with full stereo capabilities, CMOS non-volatile memory and simplified tape marking. This product provides auxiliary source input and preview of spots before air. The CSR-192 is also capable of dubbing without degradation of data and the use of time base correctors is possible through an external processor loop. According to MSI, installation and serviceability is simplified with the new design while maintaining compatibility with all other MSI ComSerter models and associated software packages.

For more information, contact Texscan MSI Corp., 124 Charles Lindbergh Dr., Salt Lake City, Utah 84116, (800) 367-6011; or circle #116 on the reader service card.



Clock controller

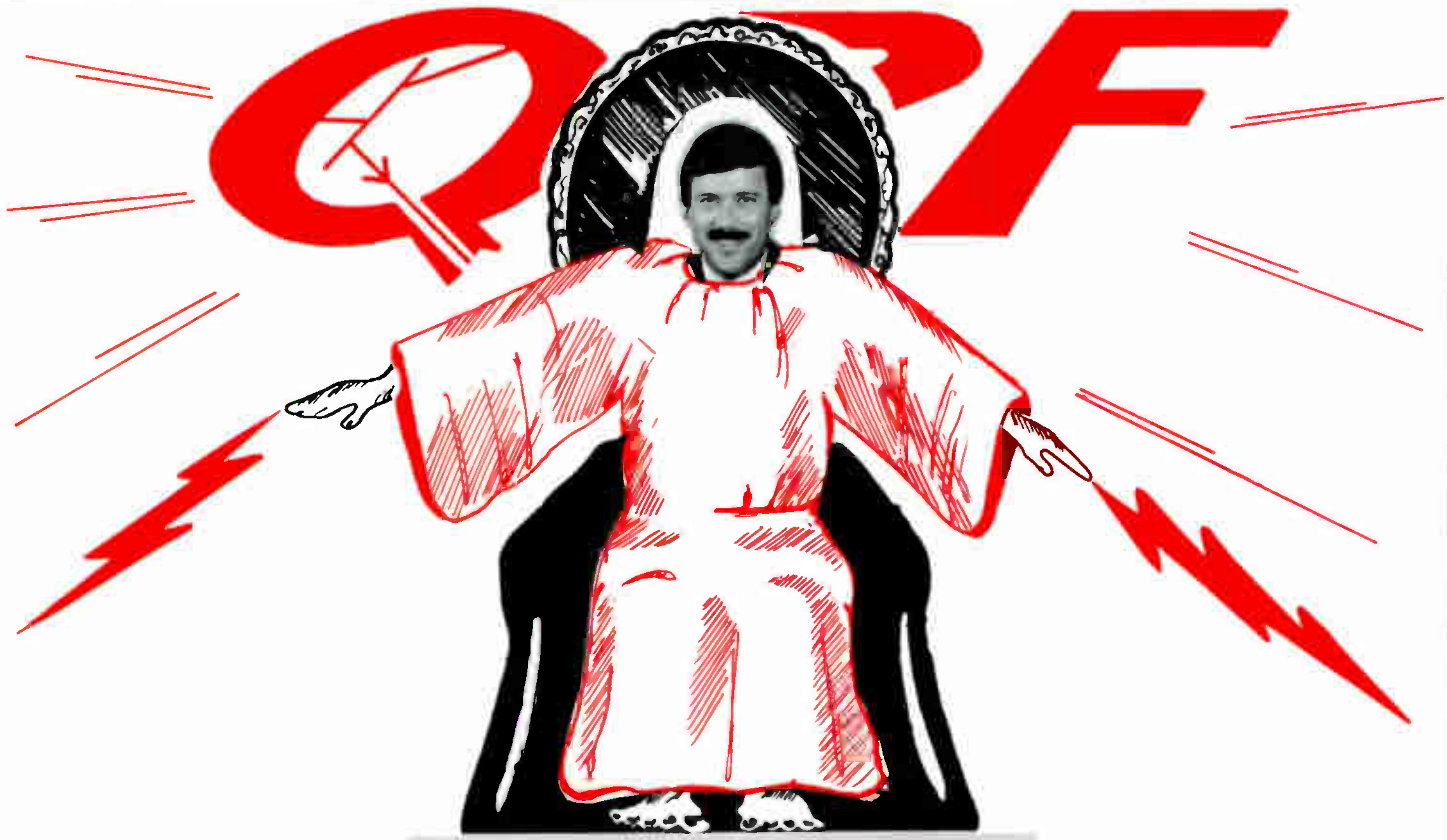
Channelmatic introduced the Li'l Ben clock controller, a seven-day programmable controller especially suited for applications in headends to automate switching between several services sharing a single channel slot. The basic unit has eight outputs that can be individually programmed to turn on or off up to 100 times. Output events are controlled to within one-second resolution. A simple four-key pad is the programming interface, and LED indicators show program and operating status.

For further information, contact Channelmatic, 821 Tavern Rd., Alpine, Calif. 92001, (800) 231-1618; or circle #119 on the reader service card.

Addressable system

AM Communications unveiled its new DROPguard product line, designed for use in high churn areas. The device turns subscribers on and off from a computer terminal at a central location, eliminating the need for service calls.

For more details, contact AM Communications, P.O. Box 505, Quakertown, Pa. 18951, (215) 536-1354; or circle #118 on the reader service card.



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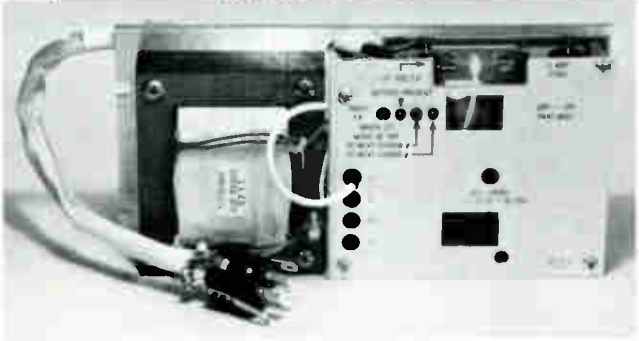

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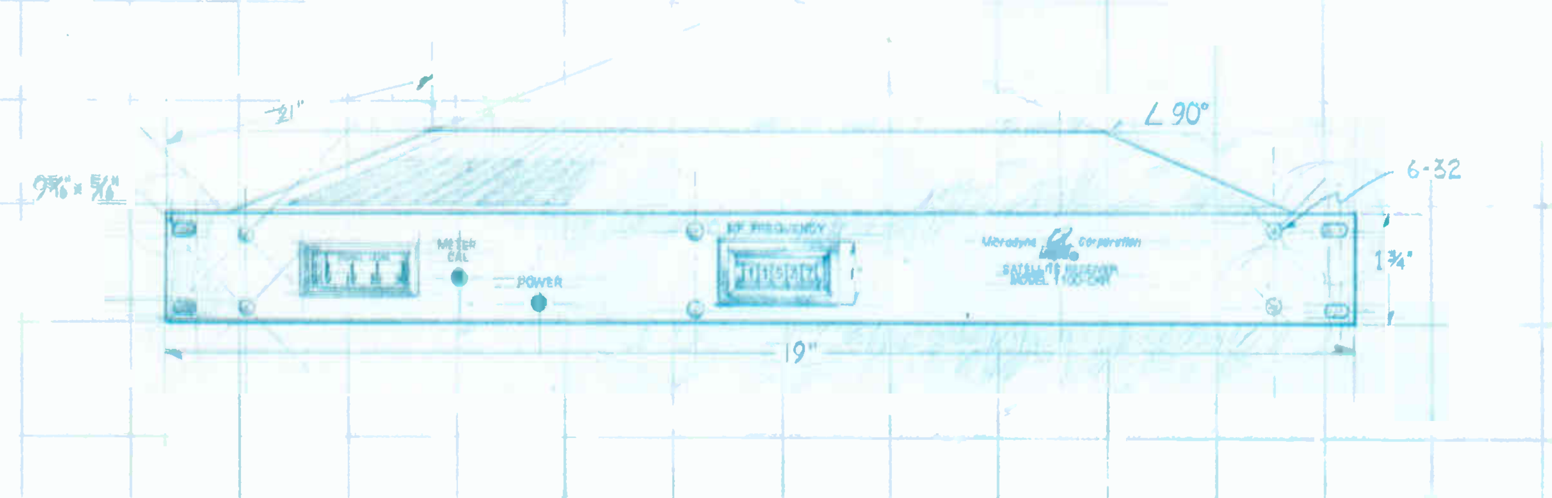
DMV

Reader Service Number 48.

Inch For Inch



Microdyne's new C/Ku-band receiver delivers more performance and reliability than any other.

Exceptional video quality

The 1100-CKR satellite video receiver delivers consistent superior video quality through the use of Microdyne's patented optimal threshold extension demodulator.

Maximum flexibility

Front panel control of the tuner in one megahertz steps assures you of simple fast tuning of any C or Ku-band transponder and the 950-1450 MHz input frequency makes it a perfect match for use with low cost LNCs.

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The 1100-CKR is cost competitive with imported satellite video receivers, but it's manufactured in the USA to military quality assurance specifications MIL-I-45208A.

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Reader Service Number 49.

Hughes AML reference data

By Ron Hranac
Jones Intercable Inc.

MTX-132 multichannel microwave transmitter power output vs. channel/bay configuration

(+40 dBmV input)

Number of bays	Number of channels	Number of output ports	Power output (dBm)
1	1-8	2	+16
1	1-8	4	+13
2	9-16	4	+13
3	17-24	4	+12
3	17-24	8	+10
4	25-32	8	+10
5	33-40	8	+9
6	41-48	8	+9
7	49-56	16	+7
8	57-64	16	+7
9	65-72	16	+6
10	73-80	16	+6

STX-141 and STX-141A high-power microwave transmitter power output vs. channel/bay configuration

(+40 dBmV input; 4 channels per 8-foot rack)

Number of bays	Number of channels	Number of output ports	STX-141 power output (dBm)	STX-141A power output (dBm)
1	1-4	1	+30	+33
2	5-8	2	+27	+30
3	9-12	4	+24	+27
4	13-16	4	+24	+27
5	17-20	8	+21	+24
6	21-24	8	+21	+24
7	25-28	8	+21	+24
8	29-32	8	+21	+24
9	33-36	16	+17	+20
10	37-40	16	+17	+20
11	41-44	16	+17	+20
12	45-48	16	+17	+20
13	49-52	16	+17	+20
14	53-56	16	+17	+20
15	57-60	16	+17	+20
16	61-64	16	+17	+20
17	65-68	16	+17*	+17
18	69-72	16	+17*	+17
19	73-76	16	+17*	+17
20	77-80	16	+17*	+17

*STX-141A transmitters must be used in bays 17-20 to obtain +17 dBm output.

OLE-111 microwave line extender output power

(for −65 dB CTB output distortion)

Number of channels	Output power (dBm)
1	+20
12	−2
24	−6
35	−8
60	−11
80	−12.5

HPOLE-112 high-power microwave line extender output power

(for −65 dB CTB output distortion)

Number of channels	Output power (dBm)
1	+24
12	+3
24	−1
35	−3
60	−6
80	−7.5

AML microwave repeater output power

(for −65 dB CTB output distortion)

Number of channels	MWB 122-4 repeater output (dBm)	FFR-123 feed-forward repeater output (dBm)
12	−1.5	+7
24	−5.5	+4
35	−7.5	+2
60	−10.5	−1
80	−12	−2.5

OLE-111 microwave line extender with FFA-160 microwave feedforward power amplifier output power

(for −65 dB CTB output distortion)

Number of channels	Output power (dBm)
1	+29
12	+7
24	+4
35	+2
60	−1
80	−2.5

Pilot tone and crystal oscillator frequencies

Frequency (MHz)	Group
73.956140	C
73.963450	C-HRC
74.302339	D
74.309649	D-HRC
75.429824	E
75.437134	E-HRC
75.780701	F
75.788011	F-HRC
72.959065	BBH
72.725146	BBL
72.833333	Austrian
74.852339	Finnish

LNA specifications

LNA	Noise figure	Gain
Single-stage	3.5 dB	7.5 dB
Dual-stage	3.7 dB	15 dB

AML 300 MHz and 450 MHz receiver distortion specifications

	Without LNA		With single-stage LNA	
	35 Ch.	60 Ch.	35 Ch.	60 Ch.
C/N	53 dB	53 dB	53 dB	53 dB
CTB	–86 dB	–80 dB	–78 dB	–72 dB
XMOD	–85 dB	–79 dB	–77 dB	–71 dB

AML 550 MHz receiver distortion specifications
(with single-stage LNA)

	35 Ch.	60 Ch.	80 Ch.
C/N	53 dB	53 dB	53 dB
CTB	–87.5 dB	–82.5 dB	–80 dB
XMOD	–87.5 dB	–82.5 dB	–80 dB

RM-2A receiver monitor test box readings

Switch position	Acceptable readings
VAC	1.8 to 3 VDC (for 18 to 30 VAC powering) 3.6 to 6 VDC (for 36 to 60 VAC powering)
–20V	19.5 to 20.5 VDC
+24V	22.8 to 25.2 VDC
Source alarm	0.5 VDC
High alarm	0.5 VDC
Low alarm	0.5 VDC
AGC voltage	Refer to AGC curve chart supplied with receiver
Calibrate	2,870 ohms (±30 ohms)
Temperature	3,340 to 3,890 ohms
Source phase lock	–6 to –14 VDC
Error voltage	–4 to –14 VDC

Data courtesy of Hughes Microwave Communications Products, Torrance, Calif.

You know how important your job is...

Do you know how important job safety is?

Poles and extension ladders are crucial elements of the careers of installer technicians and field personnel. Learning how to work with them properly is more than a matter of doing a job right—it's a matter of safety.

The Society of Cable Television Engineers, Inc. (SCTE), in association with the Atlee Cullison Training School, Inc. (ACTS), is now offering two videotapes detailing the safest and best ways to climb poles and use extension ladders.

T-1042 Pole Climbing—A comprehensive course which develops climbing skills and safety habits. Includes valuable information on climbing apparel and equipment, safe methods of ascending and descending poles, and testing poles to ensure safe climbability.

Running time: 60 minutes
Format: VHS or Beta
SCTE member cost: $250.00
Non-member cost: $290.00

T-1043 Extension Ladders—A course designed to provide thorough and comprehensive instruction on the safe use of extension ladders. Includes segments on ladder positioning, transporting and carrying, securing, climbing, and safety.

Running time: 35 minutes
Format: VHS or Beta
SCTE member cost: $175.00
Non-member cost: $200.00

To Order: All orders must be prepaid. Shipping and handling costs are included. All prices are in U.S. dollars. SCTE accepts MasterCard and Visa. In order to qualify for SCTE member prices, a valid SCTE Identification Number is required, or a completed membership application with dues payment must be included with this order.
Note: Videotapes are not returnable.

Send orders to:

SCTE
669 Exton Commons
Exton, PA 19341

Reader Service Number 53.

CALENDAR

January

Jan. 10-12: Caribbean Cable TV Association annual meeting, Frenchman's Reef Beach Resort, St. Thomas, U.S. Virgin Islands. Contact Andrea Martin, (809) 774-2080.

Jan. 12-14: Jerrold technical seminar on applying problem-solving technology, Quality Hotel, Los Angeles. Contact Jerry McGlinchey, (215) 674-4800.

Jan. 18-20: SCTE Florida Chapter seminar on fiber optics, Hyatt Orlando Hotel, Orlando, Fla. Contact Dick Kirn, (813) 924-8541; or Pat Luckett, (305) 660-5524.

Jan. 20: Colorado Cable TV Association winter meeting, Denver. Contact Steve Durham, (303) 863-0084.

Jan. 26: SCTE Satellite Tele-Seminar Program on digital TDRs and Part II of "Signal processing centers," 12-1 p.m. ET on Transponder 7 of Satcom F3R. Contact (215) 363-6888.

Jan. 26-28: C-COR Electronics technical seminar, San Francisco. Contact Shelley Parker, (814) 238-2461.

Jan. 29-30: Society of Motion Pictures and Television Engineers annual television conference, Opryland Hotel, Nashville. Contact John Varrasi, (914) 761-1100.

February

Feb. 2-3: Arizona Cable Television Association annual meeting, Hyatt Regency, Phoenix, Ariz. Contact (602) 257-9338.

Feb. 9-11: Jerrold technical seminar on problem-solving technology, Sheraton Hotel, Orlando, Fla. Contact Jerry McGlinchey, (215) 674-4800.

Feb. 16-17: Jerrold technical seminar on LAN system technology, Ramada Hotel, Culver City, Calif. Contact Chris Tancredi, (215) 674-4800.

Feb. 17-19: Texas Cable Television Association's Texas Show, Convention Center, San Antonio, Texas. Contact (512) 474-2082.

Feb. 23: SCTE Satellite Tele-Seminar Program on "Balance and alignment equipment for Scientific-Atlanta Series 6500 and 6800 distribution equipment," 12-1 p.m. ET on Transponder 7 of Satcom F3R. Contact (215) 363-6888.

Feb. 24-25: General Instrument's "Cable insights: Taking the mystery out of cable television," Marina del Rey Hotel, Marina del Rey, Calif. Contact Jim Barthold, (215) 674-4800.

Feb. 29-March 2: School of Lightning Protection Technology seminar on lightning protection, Orlando, Fla. Contact (815) 943-4005.

March

March 7-9: Center for Professional Development course on fiber-optic communications, Arizona State University, Tempe, Ariz. Contact (602) 965-1740.

March 7-10: Information Gatekeepers' Military and Government Fiber-Optics and Communications Exposition (MFOC '88), Hyatt Crystal City, Washington, D.C. Contact (617) 232-3111.

March 22-23: COMBEC '88, Montreal Convention Center, Montreal, Quebec. Contact (416) 536-4621.

March 22-24: C-COR Electronics technical seminar, Indianapolis. Contact Shelley Parker, (800) 233-2267.

March 29: SCTE Satellite Tele-Seminar Program on signal leakage detection, 12-1 p.m. ET on Transponder 7 of Satcom F3R. Contact (215) 363-6888.

Planning ahead

Feb. 17-19: Texas Show, Convention Center, San Antonio, Texas.

April 30-May 2: NCTA Show, Convention Center, Los Angeles.

June 16-19: SCTE Cable-Tec Expo, Hilton Hotel, San Francisco.

Sept. 7-9: Eastern Show, Atlanta Merchandise Mart, Atlanta.

Sept. 27-29: Great Lakes Expo, Detroit.

Oct. 4-6: Atlantic Show, Convention Center, Atlantic City, N.J.

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Microwave Chart
Channel Master
Hughes Microwave
Motorola

High-definition television

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

Interest in high-definition television (HDTV) has been building at an accelerating pace over the last year. Numerous demonstrations of the technology in the United States have served to stimulate interest. HBO has been a leader in raising cable awareness of the potential of HDTV by circulating a "white paper" on the subject and by providing demonstrations. As mentioned in last month's column, Bellcore has invested heavily in research on digital delivery of HDTV to the home over fiber. It is time to carefully think through the issues facing cable as HDTV standards evolve in the United States.

Advanced television systems

"HDTV" is a badly misused term. It is loosely applied to a variety of efforts that are under way to improve television pictures. The generic term, "advanced television" (ATV), which covers them all, is much more appropriate. HDTV is a subset of ATV. A committee called the Advanced Television Systems Committee (ATSC) was formed several years ago to propose technical standards. It is patterned after the National Television Systems Committee (NTSC), which created the black and white TV standard still in use today. The committee later reconvened to "shoehorn" color information into the unused corners of that signal. The ATSC divided ATV into three categories: improved NTSC, enhanced NTSC and HDTV.

Improved NTSC is roughly defined as techniques (applied to the TV receiver) that do not require any significant changes in the transmission signal. It is fully compatible with existing TV receivers. "Compatible" is a rubber word, often stretched to meet the needs of the moment. A careful definition can avoid misunderstandings. "Compatible with NTSC" should mean that essentially all existing NTSC receivers should receive a pleasing, but not necessarily perfect, picture without any modification of the receiver or any external adapter boxes. Improved NTSC is of interest because, as NTSC receivers get better, the performance gap between them and HDTV narrows. If the gap narrows too much, perhaps the consumer may not consider HDTV a worthwhile investment.

Enhanced NTSC falls into two major categories, those approaches that retain some of the aspects of NTSC but do not remain compatible and those that are fully compatible with existing NTSC receivers. The first category would require an adapter box if it is to be viewed on existing NTSC receivers. The second category is much more interesting because all existing receivers would receive a pleasing picture while new, advanced receivers would provide an enhanced picture. The picture on existing NTSC receivers suffers some minor degradations such as slightly increased background noise or signal artifacts. But such compromises were found acceptable when color was added to the black and white standard. Existing black and white receivers suffered a minor image quality loss in order to make possible a new viewing experience for the purchasers of color receivers.

A further splitting of enhanced NTSC proposals separates them into those that retain the familiar NTSC aspect ratio (four units of width for three units of height) and those that provide a wide-screen display (16 × 9 or 5 × 3). The parts of the picture providing the additional width of the wide-screen display have been called "side panels" or "wings."

There is a body of opinion that states that the wide screen is more important than the higher definition. According to that theory, ordinary NTSC definition with wings would be all that the average viewer would appreciate. It is certainly true that the wide-screen display is a difference from NTSC that can be noticed even when the TV set is off! NBC and the Sarnoff Labs recently announced an NTSC-compatible enhanced NTSC system with wide aspect ratio. The delivery signal for this system is completely contained in the current 6 MHz channel bandwidth. This work deserves close attention since cable may want to deliver it to subscribers.

High-definition television

The last ATV category is HDTV. While there are formal definitions for minimum HDTV parameters, a good working definition is that the display provides a 16 × 9 aspect ratio with at least 800 lines of resolution in the horizontal direction.

My June column discussed the meaning of "horizontal lines of resolution." Briefly reviewing it, TV resolution is measured by the number of alternating black and white lines resolved on the TV screen. Vertically, the maximum number is determined by the scan line structure. There are practical considerations that reduce the actual vertical resolution. Horizontally, the maximum resolution is determined by the video bandwidth and the amount of signal processing required by the system. Because the NTSC picture is three units high and four units wide, the number of black and white lines resolved in the horizontal direction is reduced by three-fourths to make it easily comparable with the vertical number. The NTSC system incorporates no signal processing to obtain its maximum horizontal resolution. Thus, the maximum horizontal resolution can be easily calculated.

The NTSC baseband bandwidth is 4.2 MHz. A total of 525 horizontal scan lines are delivered every one-thirtieth of a second. This calculates out to 1/30 divided by 525, or 63.5 µs per line. Of this, about 11.5 µs are used to retrace the electron beam from the end of one line back to the beginning of the next. Thus, there is a video active scan time of 52 µs. A 4.2 MHz sine wave would put 4.2 × 52, or 437 alternating black and white lines on the screen in the horizontal direction. Reducing this by three-fourths for easy comparison with vertical resolution yields a maximum of 328 lines of resolution in the horizontal direction. (This is rarely achieved in practice.) Other video sources of interest include VHS videotape with resolution of 230 to 240 lines, Super VHS with 400 to 450 lines and laser videodisc with 400 lines.

"It is time to carefully think through the issues facing cable as HDTV standards evolve in the United States."

Let's do this sort of arithmetic on an HDTV system with 800 lines of horizontal resolution, 1,125 scan lines every one-thirtieth of a second and a 16 × 9 aspect ratio. The time per scan line calculates out to 1/30 divided by 1,125, or 30µs. If we allow five µs for retrace, we have 25 µs of active video scan time. Upconverting the 800 lines of horizontal resolution by the inverse of the aspect ratio (16/9) yields 1,422 alternating black and white lines on the face of the tube. These lines can be created by a sine wave of 1,422 half-cycles in 25 µs. And 711 cycles of sine wave in 25 µs is 28.4 MHz; this is commonly quoted as 30 MHz. Clearly, this is more bandwidth than most media can afford.

The fundamental departure between NTSC and HDTV is that NTSC requires no signal processing while all HDTV transmission systems try to find ways to compress the bandwidth by using extensive signal processing at the transmitter and at the receiver. Nearly all techniques involve building up resolution over several of the discrete pictures. This works very well for still pictures; motion resolution suffers under this strategy. The real difference between the various proposals for HDTV is in the method of handling motion. The HDTV system with the most development investment behind it is the Japanese MUSE system. It manages to get the 30 MHz unprocessed bandwidth down to 8.1 MHz.

Signal robustness

When HDTV is demonstrated side by side with an NTSC picture, the NTSC picture usually comes off a high-quality tape machine and is delivered at baseband to an RGB monitor. No transmission system is involved. The NTSC picture is usually excellent. A commonly heard comment is something like, "Boy, if I could only deliver pictures like that to my subscribers!" It is important to realize that NTSC is a relatively robust signal with a high degree of tolerance to the imperfections of real-world cable systems. HDTV bandwidth compression techniques necessarily reduce the robustness of the signal. At the same time the subscriber will expect more because it's being sold as better. Thus, cable system technical quality will have severe demands placed on it.

Next month I'll deal with more detailed HDTV issues for cable. ■

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