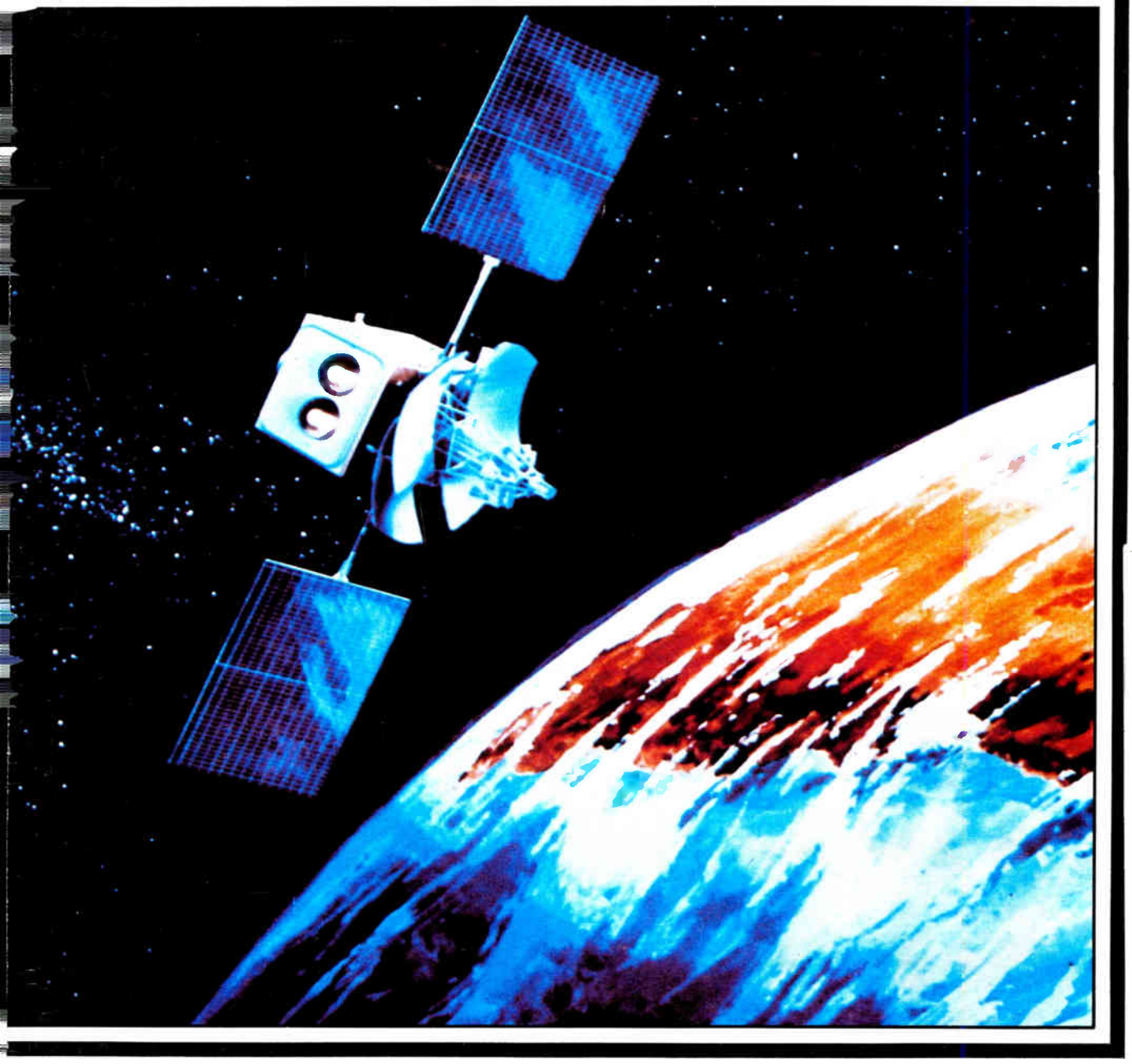
C-ED

Satellite Communications in CATV
Special Fiberoptics Section

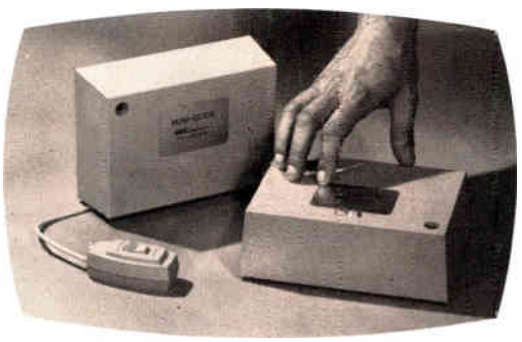


Communications-Engineering Digest
Reporting the Technologies of Broadband Engineering

September 1978
Volume 4, No. 9

OAK PRESENTS THE MINI-CODE NEWS

Oak CATV Division has announced the new Mini-Code—an effective and economical answer to CATV and MDS premium needs.



This technologically advanced decoder, offered in set-top or wall-mount format, works in your existing 12-channel or MDS system.

Use it in tandem with the Oak Mini-Scrambler, at a remote site, or with the Mark II Scrambler at the head-end.

The Oak sinewave sync suppression system is impossible to defeat.

SOURCE	CBS	PREMIUM	NBC	PBS
CHANNEL	2	3	4	5

Best of all, the Mini-Code uses only one channel to scramble and decode.

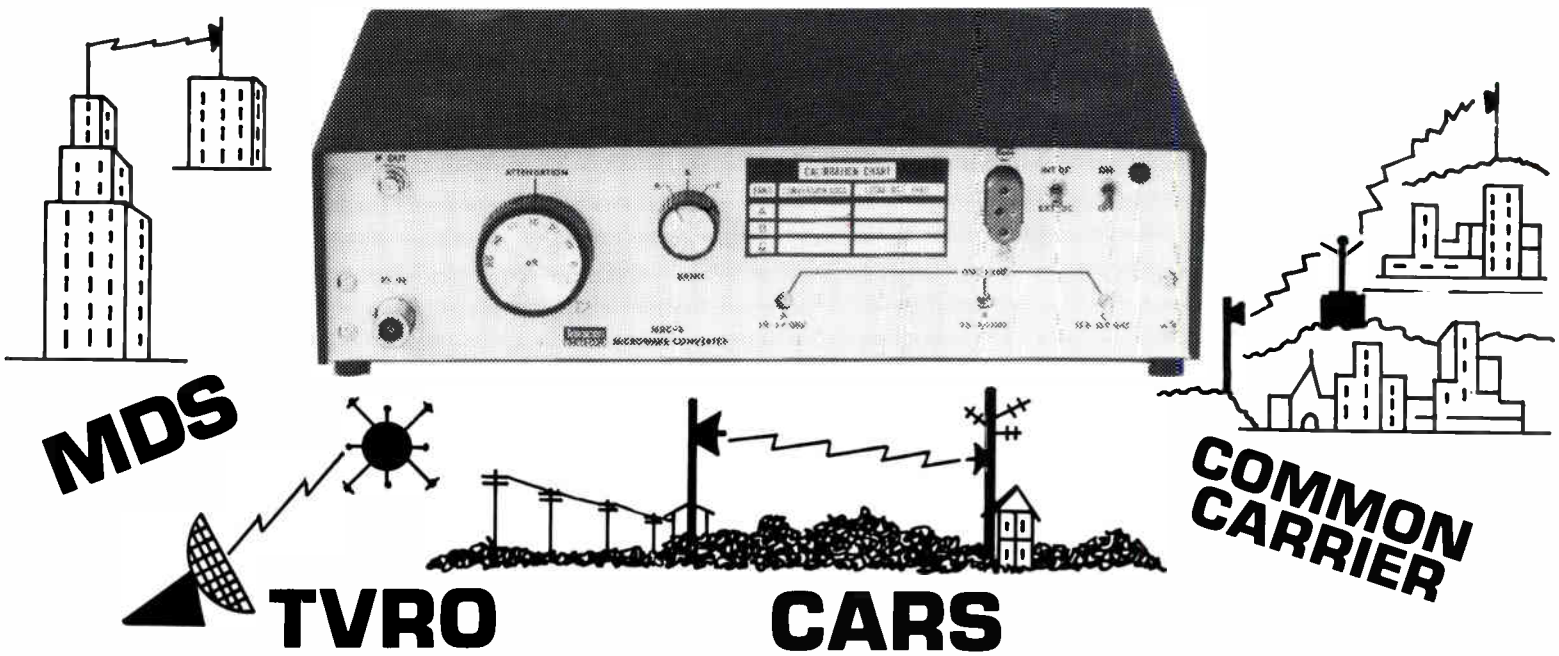
When you buy from Oak, you rest easy, because you know Oak products are manufactured in company-owned facilities. Oak backs up its products with effective field service, and offers all customers a one-year warranty.

FOR THE COMPLETE MINI-CODE STORY, CALL OR WRITE

OAK Industries Inc.
CATV DIVISION
CRYSTAL LAKE, ILLINOIS 60014
TELEPHONE 815-459-5000 TWX 910-934-3332

MICROWAVE

MEASUREMENTS MADE EASY!



Texscan's microwave down converter permits measurement in the MDS (2.1 GHZ) TVRO (3.7 GHZ) and CARS (12.7 GHZ) band with existing VHF test equipment. Spectrum analysis, signal strength and even microwave sweeping are possible with the MDC-3.

Available as an option are three bandpass filters which speed and simplify the measurement process. The filter kit is required for sweep operation. The MDC-3 has a calibrated insertion loss and adjustable local oscillator for each band. Other frequencies are available.

Texscan

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C-ED News at a Glance

SACRAMENTO, CALIFORNIA—On August 9, the **California Assembly Committee on Finance, Insurance and Commerce ended hearings on SB 1757—the Cable Television Bill of Rights. The bill passed in a 9-1 vote,** with eight amendments attached.

WASHINGTON, D.C.—In a recently filed petition, **NCTA urged the FCC to take immediate action on a backlog of over 1,500 certificate of compliance applications** pending in the FCC Cable Television Bureau.

"In apparent anticipation of the elimination of the entire certification process, the Certificate of Compliance Division staff has been cut from 25 attorneys to only seven," NCTA president Robert Schmidt said, "so cable systems which filed months or even years ago are still waiting for action."

NCTA recommended that the commission adopt interim procedures: • If an application is unopposed, a certificate should be granted automatically at the end of the 30-day public notice • If an application is opposed but is in compliance with FCC signal carriage rules, a certificate should be granted immediately • Where an application may be inconsistent with FCC rules, the certificate should be granted immediately except for authority to carry the broadcast signals in question.

WASHINGTON, D.C.—The **National Association of Broadcasters offered suggestions to the FCC for replacing the** present **CATV certificate of compliance process.** Noting that the FCC has proposed to eliminate the certification process, the **NAB urged that a cable system** instead **be required to register with the commission 30 days before commencing operation.** NAB also proposed that the system serve copies of its registration on all affected broadcast stations. The commission would then acknowledge the registration with a "postcard authorization."

Such advance registration, NAB said, would do much to insure compliance with FCC rules governing carriage of broadcast signals by cable systems. In addition, NAB added, the commission long ago determined that its statutory obligations require it (the FCC) to prevent even a significant risk that broadcast television service be destroyed or seriously degraded by competition from cable TV, and the advance registration requirement would provide an effective enforcement tool.

WASHINGTON, D.C.—**In response to the FCC's Notice of Proposed Rulemaking and Notice of Inquiry, NCTA and 13 parties of the cable industry filed** initial **comments that can be separated into two distinct groups — cable and broadcast.** The **cable interests overwhelmingly support the commission's basic proposals to expand the CARS frequency allocations and** most approve of the commission's concept to **improve spectrum efficiency but disagree with the specific commission scheme** and suggest other alternatives. Those parties associated with the broadcast industry oppose the commission's proposals at every turn on emotional basis.

NCTA urged that the commission adopt the instant proposed **expansion of the 12 GHz CARS band** and issue a Further Notice of Rulemaking considering CARS eligibility on a similar co-equal basis in the other broadcast auxilliary bands at 1900-2100, 2450-2500 MHz (Band A) and 6875-7125 MHz (Band B).

Communications-Engineering Digest is published monthly for the Society of Cable Television Engineers by Titsch Publishing, Inc., 1139 Delaware Plaza, P.O. Box 4305, Denver, CO 80204. © September 1978. Controlled circulation paid at Denver, Colorado.

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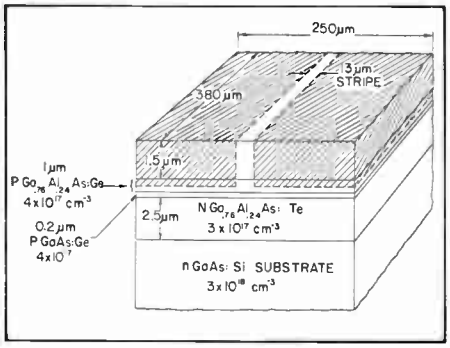

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FEATURES

DEPARTMENTS

OPINION

Cover: The emphasis of this issue of *C-ED* is satellite communications, as depicted by the photograph of the bird above the earth. Photograph supplied courtesy of RCA American Communications.

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Editor's Letter

Paul FitzPatrick, Robert Titsch and Paul Levine.

We're extremely pleased to announce that Paul Levine, formerly with Television Digest Inc., has joined Titsch Publishing as associate publisher of *C-ED* and *CableVision* magazines and our annual directory, *CableFile*. Paul comes to us after four and one-half years as assistant sales director at Television Digest, which publishes the weekly newsletter *Television Digest* and the highly regarded *Television Factbook*. A 1968 graduate of Emerson College in Boston, Massachusetts, Paul's responsibilities at TPI will include sales and circulation. His background at the Digest as well as Lewis Berlin Enterprises and Video Enterprises in New York will be invaluable to our ongoing efforts to provide our readers with news and feature information on the cable industry.

Kicking off our September issue of *C-ED* are articles featuring the latest state-of-the-art in cable TV—satellites and fiberoptics. On the satellite scene are two articles by Scientific-Atlanta and RCA American Communications. These features are on pages 11 and 25, respectively. As an added attraction we've included a feature called "From the Bird" on page 12.

We have also devoted a special section to fiberoptics and the upcoming FOC '78 exposition, beginning on page 31.

Paul A. FitzPatrick

Communicating in the Communications Industry

By Judith Scharf
SCTE Secretary
Tele-Communications, Inc.
Denver, Colorado

One of the most difficult endeavors of man, nonetheless essential, is the art of communication. Simply because we are in the business of disseminating information does not exempt us from the perfection of this task, in fact, this perfection becomes paramount. I would venture to say that the degree to which we are successful in the industry is proportionate to our success at communicating among ourselves.

This can be specifically related to all phases of our industry. Since we are composed of many diversified talents and abilities, all of which blend to produce a successful operation, our exchange of technical concepts and information becomes a primary concern.

For example, a cable system, from its inception to completion, is built upon this exchange. In the initial phase of franchise acquisition, a community's needs and desires are negotiated and balanced by feasibility, construction costs and return, on our part. It is in this very first step that some of the most important groundwork is laid. Our expertise in conveying our concern for their requirements will establish a solid foundation on which to build their future system.

The engineering of this build is perhaps most intricately involved in communicating. Its very nature is scope, proximity of the system and complexity of design require the utmost in the art of communication. Field personnel will be relied upon to provide accurate and up-to-date information for the strand mapping. The accuracy of these maps will be the basis for the designer to begin the work of providing a cable network, utilizing the equipment to the best electronic advantage, but bearing in mind cost and future maintenance as well. During the design phase there will be an ongoing exchange of information with the field; verifying crossings, possible routing changes or additional areas to be designated as underground construction. These open lines of communication will enable the designer to produce the best possible design. In the drafting itself lies another important means of conveying information. The designer's concepts must be interpreted for the final construction maps. Field personnel will make a final verification before "approved for construction" is stamped on the maps.

But as in all things that strive to endure, the lines of communication between this system and its creators must remain open if an ongoing constructive relationship is to exist. If this is achieved we will begin to realize some measure of success in communicating in the communications industry.

Mile-High City to Host 1979 Reliability Conference

DENVER, COLORADO—The site for the 1979 Conference on CATV Reliability will be Denver, Colorado. SCTE member Glenn Chambers of ATC will co-chair the meeting along with an IEEE representative. Dates for the conference will be scheduled for late February—early March and will be announced shortly.

SCTE Brings the Technical People to You

WASHINGTON, D.C.—The SCTE board of directors has approved a series of seven regional technical conferences for 1978-1979. Sites have been choosen that are easily accessible, inexpensive for accommodations and include two-day meetings so that participants may exhibit and also take part in the sessions.

Each of these meetings will center on one aspect of CATV operations. The Nashville conference will feature two days on CATV construction. Microwave will be the topic of the meeting in Phoenix; towers/antennas/power problems will be the program theme for the Melbourne meeting; new services will be the program emphasis in Madison, Wisconsin; TVROs go to Boston and personnel development and in-house training programs are the theme for Washington, D.C.

Location and dates: **Nashville, Tennessee,** Oct. 23-24, 1978; **Melbourne, Florida,** Jan. 8-9, 1979; **Phoenix, Arizona,** Mar. 5-6, 1979; **Portland, Oregon,** Apr. 23-24, 1979; **Madison, Wisconsin,** June 18-19, 1979; **Boston, Massachusetts,** Aug. 20-21, 1979; and **Washington, D.C./Arlington, Virginia,** Sept. 10-11, 1979.

For additional information, contact Judy Baer at (202) 659-2131.

Second Training Tape By SCTE

WASHINGTON, D.C.—Production for a second training tape, funded by SCTE, has been given the go-ahead via a letter from SCTE president Robert Bilodeau to SCTE member Ken Foster, chief of the New York State Commission on CATV. Sales of the first training tape, "Diagnosing Common CATV System Faults," have been excellent and sufficient funds are available to proceed immediately with this second project.

Titles under consideration include a tape on bonding and grounding, leakage detection, drop installation and construction techniques.

1978 SCTE/IEEE Conference Record Available

WASHINGTON, D.C.—Publications from the 1978 Third Annual Conference on CATV Reliability are finally available from SCTE. Due to papers from authors being late and the shipper losing the publications, this material has been unavailable until now. The publication contains 88 pages of useful information including the papers presented in St. Louis in March 1978.

The SCTE/IEEE Reliability Conference Record is available from SCTE, P.O. Box 2665, Arlington, Virginia 22202.

SCTE Tech Sessions At Southern Convention

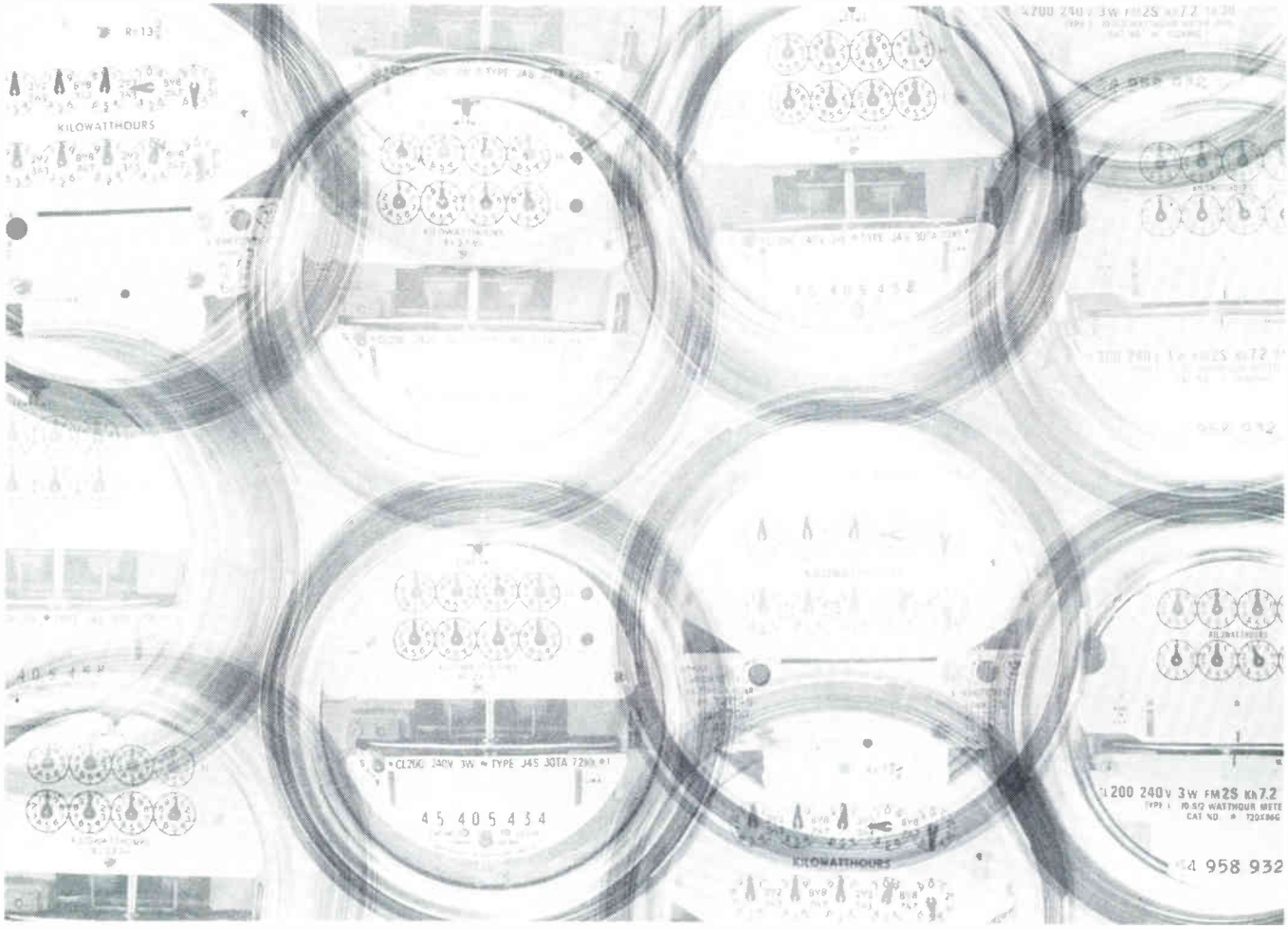
WASHINGTON, D.C.—For the third year in a row, the SCTE has been invited to participate in the Southern Cable Television Association annual convention, Sept. 24-26. Each year, as the number of engineers and technicians attending the meeting has grown, SCTE has tried to program topics of specific interest to engineers and technicians in the Southeast. The Southern Association was among the first state/regional associations to invite SCTE's partnership involvement in 1976. At the 1977 meeting in Atlanta nearly 100 technicians registered for SCTE's program and a similar response is anticipated for the September 25 meeting at the Atlanta Marriott Hotel.

Surge Protection and Standby Power is the topic of the first SCTE/SCTA technical session at 9 a.m. on Sept. 25.

The second session convenes at 10:30 a.m. and the program title is *CATV Grounding and Bonding*. James Stilwell, vice president of engineering at Communications Properties, Inc., will host this session. Stilwell is a past winner of the NCTA Outstanding Technical Achievement Award (1977), a member of SCTE and CATV industry representative to the National Electrical Code committees. He will host Richard Shimp, director of Research and Development at ComSonics, Inc., in Harrisonburg, Virginia and Harold R. Null, vice president of engineering at Storer Cable in Sarasota, Florida. Null, eastern vice president of SCTE, brings a specific familiarity with utility company requirements and soil conditions in the southeastern portion of the United States.

CATV technicians and engineers may register at a reduced $20 fee which will include the sessions, a reception on Sunday evening and access to the exhibit area which will feature nearly 100 table-top displays. These reduced registrations must be accompanied by at least one management program full-registration for the meeting.

"These programs have been developed specifically to appeal to CATV operators in the Southern's membership area and to involve experts who can share their experiences and provide solutions," says Robert Bilodeau, president of SCTE. The sessions will be staged in an interview format and encourage audience participation.



Your local electric utility can be your best customer.

If you manage a cable television business, Scientific-Atlanta has a new way for you to make profits, even with existing one way plant.

To avert energy shortages, many utilities are finding it necessary to implement what is commonly referred to as "Energy Management" measures. In short, they need the capability to turn off air conditioners and water heaters in various homes of a city without dimming lights or blacking everything else out.

Utilities cross country are already buying energy management products from us. Now they can lease a narrow bandwidth channel from you to transmit the home signal through your existing facility.

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Europe: 1-7 Sunbury Cross Centre, Staines Road West, Sunbury on Thames, Middlesex TW16 7BB, England,
Telephone Sunbury on Thames 89751, Telex 896015

In this issue of *C-ED* we are featuring three timely pieces concerning satellites and its role in the cable industry. The first article, "SatCom II to SatCom I Transition" by Larry Lawson of Scientific-Atlanta describes the procedures for computing geosynchronous satellite azimuth and elevation angles.

The second article entitled "From the Bird" lists the various programming from the birds and the transponders on which they're carried. "From the Bird" was first printed in the July 3rd issue of *CableVision*, *C-ED*'s sister publication, and has been updated for this issue.

The third article is from RCA American Communications. "Future Satellite Communications" by James Cuddihy discusses potential technological developments that may affect the services satellites provide to cable.

SatCom II To SatCom I Transition

By Larry C. Lawson
Cable Communications Division
Scientific-Atlanta, Inc.
Atlanta, Georgia

On June 1, the Big Switch occurred. The video traffic for CATV was moved from SatCom II to SatCom I. The move required three simple operations: adjust elevation, adjust azimuth, and adjust polarization.

A nulling carrier has been provided at 4,150 MHz, -10 MHz from the center band of transponder 23 modulated with 30 Hz energy dispersion frequency, set for 640 kHz peak-to-peak deviation per the following schedule:

Start Time (EST)	Finish Time (EST)
07:00	08:00
09:00	10:00
11:00	12:00
13:00	14:00

The nulling carrier provided may be used for polarization optimization. The antenna should first be optimized on the peaking carrier. The polarization adjustment will exhibit a broad peak, however the null will be very sharp.

The angular accuracy to which the feed must be adjusted to achieve the maximum null your antenna is capable of providing is less than ±1 degree; therefore care should be taken to accurately position the feed.

If you should choose to only peak the polarization, it may be necessary to readjust polarization when an adjacent cross-polarized transponder is activated at some time in the future. The cross-polarization rejection may be optimized and measured as follows:

1) optimize azimuth, elevation and polarization on the peaking carrier provided on 4,140 MHz. (Receiver in manual gain mode.)

2) Tune receiver to 4,150 MHz, rotate feed approximately 90 degrees until absolute peak is noted. If a wideband power meter such as the HP 435 is used, record the amplitude of this peak in dB.

3) Rotate the feed approximately 90 degrees again and monitor the 70 MHz IF for a null and optimize. If a power meter is used, record the amplitude in dB. The difference in peak amplitude and null amplitude, in dB, is the cross polar rejection for your site.

Locating Geosynchronous Satellites

The procedure for computing geosynchronous satellite azimuth and elevation angles is relatively simple due to the characteristics of a geosynchronous orbit and can be reduced to little more than the solution of a right spherical triangle. For our purposes we can make the following assumptions:

1) That the earth is perfectly round, and that its radius is 6,367 Km (3,957 miles);

2) that every synchronous satellite has a perfectly circular orbit, lying directly over the equator, at an altitude of 35,800 Km (22,245 miles) above the earths surface.

The first step in the computation is to compute the great-circle angle, c, between the earth station and the satellite subpoint.

The formula, then, is that for a right spherical triangle:

c = cos -1 (cosb × cosa)

Where:

c is the great circle angle between the earth station and the satellite subpoint

A is the latitude of the earth station (north is +, south is -)

b = g - f

g is the longitude of the earth station (east is +, west is -)

f is the satellite longitude.

When computing **b**, be sure to retain the proper algebraic sign. Also, **b** must remain within the range from -180 degrees to +180 degrees, and if it does not, add or subtract 360 degrees as necessary to put it back within that range. Note that **c** is an angular measure, just as **A** and **b** are angular measures in terms of latitude and longitude.

(Cont'd on page 14)

From the Bird

A wide array of programming services is now available to cable television viewers as a result of satellite technology. Satellite services have direct applications in both basic and pay-cable markets. Because of the diversity of programming services available via satellite, programming packages can be custom-tailored to the needs of specific cable markets.

RCA's Satcom I

Trans. Programming
(Horizontal Polarization)

2 **PTL Network (People That Love)**—Religious Programming featuring talk/variety/interview format shows 24 hours a day. Programming is available free to subscribers as a part of some basic cable packages. PTL purchases time from both broadcast and cable operations and has an audience potential of more than 83,300,000 viewers.

4 **Not in use**

6 **WTCG/Channel 17, Atlanta**—WTCG offers cable viewers a comprehensive programming package that includes a wide array of sports, country western groups, movies (40/week) and the gamut of syndicated programming. WTCG satellite feeds reach 229 cable systems with 1,233,978 cabled homes (WTCG programming — full- and part-time — reaches a total of 2,373,396 cable homes through off-air and microwave services). Rates are based on the number of subscribers in each system: 10¢/sub/month for full-time (24-hour) service, 2¢/sub/month for night programming only (12 midnight-6 a.m.) and 1¢/sub/month for wild card service (not to exceed 60 hours/month.)

UPI Newstime—Newstime is UPI's slo-scan news service launched in July. Features 15-minute news show format with national and international news, sports, business and finance. More than 150,000 subscribers will have access to the service by year-end according to figures to date. Available to operators at 5¢/sub/month as part of a basic package, 8¢/sub/month as part of a pay tier.

8 **Christian Broadcasting Network**—Christian entertainment and educational programming available free to cable 24 hours a day. More than 150 cable systems carry the religious broadcasting, representing an audience of more than 3-1/4 million cabled viewers.

10 **Showtime/Front Row West**—Premium programming service featuring 14 new events each month—first-run movies and made-for-pay specials. 131 systems with a potential of 983,000 subscribers have signed on to date. Rates to subscribers range from $8.00-11.00 for the full complement of Showtime programming and $3.00-5.00 for Front Row—Showtime's new mini-pay package featuring four or five G- and PG-rated attractions monthly. (Slated for mid-September start-up.)

12 **Showtime/Front Row East**—Same as above.

14 **Trinity Broadcasting Network**—24-hour-a-day religious programming provided free to cable systems. To date 25 systems have made formal commitments with the California-based operation; however, the program is carried on a number of additional systems.

16 **Fanfare Television**—Southwestern regional pay-programming package launched in June. Programming runs from 7:30 p.m.-12:30 a.m. and features sports, movies and special events from the Southwest. 30 systems representing some 400,000 subs have signed to date with a number of other agreements pending. Monthly rate of $4.75/subscriber in average-sized systems, but available for a rate as low as $4.50/sub/month to larger systems and MSOs.

18 **Home Theater Network**—A premium programming package scheduled for September 4 start-up in a number of new-build systems on an occasional use basis. Will be carried by satellite 5 nights a week from 8-11 p.m. EST (depending on whether 1 or 2 films are to be featured) and will premiere 4 to 6 G- and PG-rated movies each month. Contracts have been signed in systems representing 140,000 homes passed with a number of other agreements pending. Flat rate of $2/sub/month.

KTVU—Approval for KTVU, Channel 2, from Oakland/San Francisco is still pending at the FCC. Plans call for a full schedule of professional sports, movies, first-run specials and made-for-TV mini-series. KTVU programming will be wrapped around HTN movie package.

20 **UA-Columbia**—Over 100 systems representing 1.3 million cable subscribers are affiliated with UA-Columbia's Madison Square Garden programming package. These figures will grow in light of recent programming additions, which will include *Calliope*—a quality children's programming package featuring 90-minute programming, slated for a September start-up. MSG's sports package has expanded to 160 events each season. Rates determined on a per subscriber basis.

*Note: As of September 15, UA-Columbia's programming will be carried on RCA's transponder 9 (vertical polarization). HBO will use transponder 20 as a back-up.

22 **HBO West**—Combination sports, movie and pay-TV special premium programming package. Features 64 hours of programming/week, including 4 new properties every weekend (movies and specials) and at least one special sports event during the week. Over 500 systems have signed on to date for the service, which constitutes an audience of more than 1 million potential subscribers. Rates determined on a sliding scale as per published rate card. Rate to subscribers averages $8.00/month.

24 **HBO East**—Same as above.

(Vertical Polarization)

9 **UA-Columbia**—Programming from UA-Columbia will switch to transponder 9 beginning September 15 (see entry under transponder 20 above.)

3 **WGN/Chicago**—United Video, Inc. is awaiting FCC approval for satellite transmission of WGN/Chicago on transponder 3. Programming will run roughly 23 hours/day with a rate determined on a per subscriber basis. Plans call for an October start-up with a 20 percent discount for systems signing on for service before actual launch. Non-binding commitments have been indicated in 100 cable systems. SSS is also awaiting FCC approval for transmission of WGN/Chicago.

**While the Cable Satellite Public Affairs Network (C-SPAN) has not contracted for specific satellite time, the Washington-based non-profit organization is planning to carry gavel-to-gavel coverage of the House of Representatives starting as early as January 1979.*

Western Union's Westar II

Spanish International Network programming is now available to cable via Westar satellite. Cable plans call for programming from AmeriCom Satellite Network to include WGN/Chicago, KTTV/Los Angeles, WOR/New York and two pay packages.

Or...

How to sell much more by offering much more without paying much more!

It stands to reason that if you could offer Multi-Pay (a choice of two or more) services to each home passed, you'd have a much better chance of selling one or more of the services for a substantial increase in penetration of homes passed.

If you could do it without appreciably increasing your costs . . . would you? Of course you would . . . but *can* you? Of course you can!

VITEK's New Multi-Channel Traps are the answer for both new and existing systems. You already know VITEK's Cable Traps (the industry standard) are the best for Pay TV Security. They prevent theft of Pay TV Service *at the pole*. . . .

Now, with VITEK's Multi-Channel Traps, you have the recognized advantage of having cable-traps on the pole plus the added advantage of being able to offer Multi-Pay service.

Plan your installation with VITEK's Multi-Channel Traps and offer 2 or more levels of pay-service. If you're offering three levels of pay-service and you sell one of the three . . . replace the "Multi" with a "Dual-Channel Trap" and pass the selected service *only*. If you sell two out of three, replace with a Single-Channel Trap and pass the other two. If you can sell 'em all three, remove the Trap and that's all there is to it. *You'll smile all the way to the bank.*

Typically, the cost of installing VITEK Dual or Single Channel Traps are written off in a few months against income. And, remember . . . All VITEK Cable Traps look like regular drop cable, have superior environmental stability, durability and are maintenance-free.

For additional information on Multi-Level Service, or an analysis of costs for a system being planned, or to upgrade a present system, call or write: Paul Ellman

VITEK Electronics, Inc.
200 Wood Avenue, Middlesex, N.J. 08846
Tel: (201) 469-9400

VITEK

(Cont'd from page 11)

The effect on cross-polar rejection, in dB, for an ideal antenna is approximated by this expression:

$$C = 20 \log \sin O$$

Where:

C = is the loss in dB from the maximum null due to polarization offset.

O = angular displacement of polarization of receiver antenna from the null point.

Again Assume O = 20 degrees
C = 20 log sin 20
C = -9.32 dB

If the antenna is capable of producing a cross-polar null of 28 dB, a 20 degree polarization offset would result in a null of only 18.68 dB.

Not only is **c** used in a subsequent calculation, but it gives us a quick check at the beginning as to whether the satellite is actually within view of the earth station (i.e., above the horizon). The absolute value of **c** must be less than 81.3 degrees to be useful. (This is the value of **c** when the elevation angle is zero). If it turns out to be greater than this value, then the satellite is below the horizon and there is no need to carry out further calculations. That is true only if we are not prepared to radically modify the surface of the earth! In the step prior to computing **c**, if **b** turns out to be greater than 81.3 degrees, we know even then that the satellite is not visible. That difference in longitude would put it below the horizon even if the earth station were located on the equator.

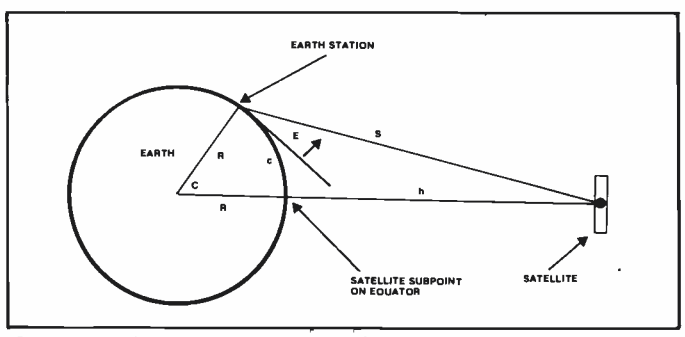
The azimuth angle, **A**, can now be computed directly. For a northern hemisphere earth station, use:

$$A = 180 \text{ degrees} + \tan \frac{-1 \tan b}{\sin A}$$

For a southern hemisphere earth station use:

$$A = \frac{-1 \tan b}{\sin A}$$

The purpose of having separate formulas for northern and southern hemisphere earth stations is simply as an aid in handling the algebraic signs of the computed angles and identifying the appropriate angular quadrant in the final result. This simplifies matters when solving the problem on certain types of calculators, but I do not mean to imply that this is the only way to get the solution. In either case, if you come up with a negative azimuth angle, add 360 degrees to it so that it will lie in the range from 0 degree to 360 degrees.



Cross-section representation of the earth showing the earth station/satellite relationship. The angle of great-circle arc, **c,** *is the same as that shown before, and is equal in degrees to included angle* **C.**

Now, looking at the earth in cross-section, see figure below. The great-circle Angle, **c**, is shown on the surface of the earth. The central angle, **c**, is the same angular measure and is equal to **c.**

The slant range, **S,** between the earth station and the satellite is found by the law of cosines:

$$S = R^2 + (R+h)^2 - 2R\,(R+h) \cos C$$

Where:

R is the radius of the earth (6,367 km or 3,957 miles)

h is the height of the satellite above the surface of the earth (35,800 km or 22,245 miles)

C is the central angle, equal to c.

The elevation angle, E, then, is given by

$$E = \cos^{-1} \frac{(S^2+R^2-(R+h)^2}{2RS} - 90 \text{ degrees}$$

We now have all the formulas needed to compute azimuth, elevation and slant range. For an example calculation assume an earth station latitude of 33.75 degrees north and longitude of 84.4 degrees west (Atlanta, Georgia) and satellite longitude of 119 degrees west (SatCom II).

$$c = \cos^{-1} (\cos b \times \cos a)$$

a = 33.75 degrees
b = -84.4 -(-119 degrees) = 34.6 degrees

$$c = 46.81 \text{ degrees}$$

Since **C** is less than 81.3 degrees we know that the satellite is visible.

Atlanta is in the northern hemisphere so we use the following to compute the azimuth angle:

$$A = 180 \text{ degrees} + \tan^{-1} \frac{\tan B}{\sin A}$$

$$A = 180 + \tan^{-1} \tan \frac{34.6 \text{ degrees}}{\sin 33.75 \text{ degrees}}$$

$$A = 231.15 \text{ degrees}$$

The slant range is computed as follows:

$$S = R^2+(R+h)^2 - 2R(R+h) \cos C$$

$$S = (3957)^2 + (3957 + 22{,}245)^2 - 7914\,(3957 + 22{,}245) \cos 46.81 \text{ degrees}$$

$$S = 23{,}670 \text{ miles}$$

The elevation angle can then be calculated as follows:

$$E = \cos^{-1} \frac{(S^2 + R^2 - (R+h)^2}{2RS}$$

$$E = \cos^{-1} \frac{[(23{,}670)^2+(3957)^2] - (3957+22{,}245)^2 - 90°}{2\,(3957 \times 23{,}670)}$$

$$E = \cos^{-1} -0.59 - 90 \text{ degrees}$$

$$E = 36.1^6 \text{ degrees}$$

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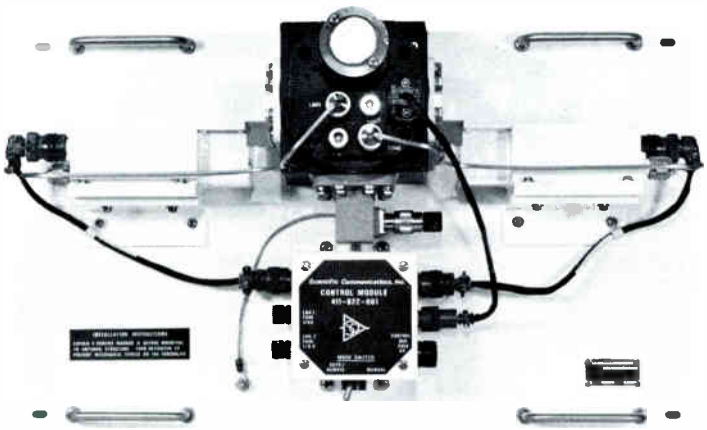
REDUNDANT FET AMPLIFIERS



The SCI Model SCF-306 Series Redundant GaAS FET Low Noise Amplifier Assembly provides amplification of RF signals in the 3.7 to 4.2 GHz frequency range. The assembly consists of two GaAs FET amplifiers, a low loss transfer switch, and a transfer switch control module. The entire system is mounted on a single plate designed for mounting near the antenna. Interface connector pins provide system status information for remote monitoring.

The two LNA's are in a redundant configuration. Either LNA may be "on line"; that is when the amplifier is connected between the RF IN and RF OUT ports of the transfer switch. The other LNA is "off line" and operating. The input and output RF ports of the off line LNA are terminated at the test ports of the transfer switch. The off line LNA may be tested or replaced without affecting the normal operation of the on line LNA.

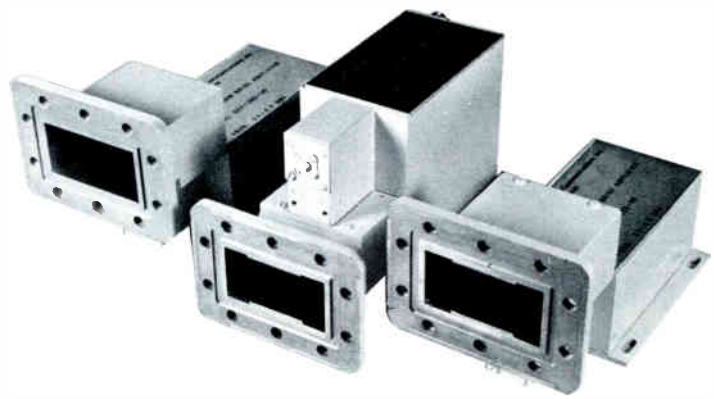
Scientific Communications offers standard 3.7 - 4.2 GHz FET amplifier models at guaranteed noise figures from 1.3 to 3.5 dB at 25°C. Waveguide input (CPR - 229G flange) and type "N" output are standard on all 50 dB gain units. Other options include 115 VAC or 15 - 28 VDC (positive or negative) operation, other gain values from 20 to 60 dB and fault monitor circuitry. All models employ specially designed bias networks for maximum power handling capability and optimum gain stability over wide ambient ranges.

SCI FET amplifiers are housed in weatherproof enclosures and utilize power connectors for installation convenience. An internal IC voltage regulator prevents gain changes due to input voltage variations, permits operation over an input voltage range of 15 - 28 VDC and rejects hum and noise on the DC input lines. The amplifiers also feature short circuit, overvoltage and reverse voltage protection. Waveguide inputs are pressurizable and all waveguide units are supportable by the input flange if desired.

MODEL	FREQUENCY RANGE (GHz)	GAIN (dB min.)	GAIN FLATNESS (+ dB max.)	NOISE (1) FIGURE (dB max.)	VSWR IN (max.)	VSWR OUT (max.)	POWER OUT AT 1.0 dB COMPRESSION (dBm Min.)
SCF-395-50	3.70-4.20	50	0.5	2.6	1.25:1	1.25:1	+10
SCF-395-50A	3.70-4.20	50	0.5	2.0	1.25:1	1.25:1	+10
SCF-395-50D	3.70-4.20	50	0.5	1.8	1.25:1	1.25:1	+10
SCF-395-505	3.70-4.20	50	0.5	1.5	1.25:1	1.25:1	+10
SCF-395-507	3.70-4.20	50	0.5	1.3	1.25:1	1.25:1	+10

(1) at 25°C

GaAs FET AMPLIFIERS



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The SR-4000 and SR-5000 Satellite Video Receivers provide quality picture and sound reception of satellite television transmissions. They have been specifically designed to cost/performance criteria for CATV earth stations.

The SR-4000 is a fully agile, synthesized 24 channel selectable model. The transponder number is selected by thumbwheel switches on the front panel with LED readout of the selected transponder number.

The SR-5000 is the fixed channel version with provision for transponder selection by a crystal change and retuning.

Both units are compact with module interchangeability between unit types except for synthesizer/L.O. source modules. They each have phase-locked loop demodulators to provide excellent FM threshold performance.

The compact design of these units allows two complete receivers to be mounted in a standard 19 inch rack only 3½ inches high. This feature minimizes the rack space required for multiple receivers when several satellite transponders are to be utilized.

A unique feature of these receivers is the availability of a second subcarrier demodulator. This feature is pre-wired on all units so that the addition of a printed circuit card can provide a second subcarrier for audio, slow scan TV or other software which may be offered by the programming originators.

The SCI receivers were specially engineered to provide simple methods for testing in an operational environment. A meter and selector switch on the front panel permit the monitoring of critical voltages and the IF monitor ouput is available at the front panel to facilitate C/N testing. An AGC/MGC switch and a manual gain adjustment are located on the front panel to further facilitate testing. The rear panel contains an auxiliary video output to allow monitoring of video performance without disrupting programming and an extra pair of audio outputs to facilitate audio monitoring.

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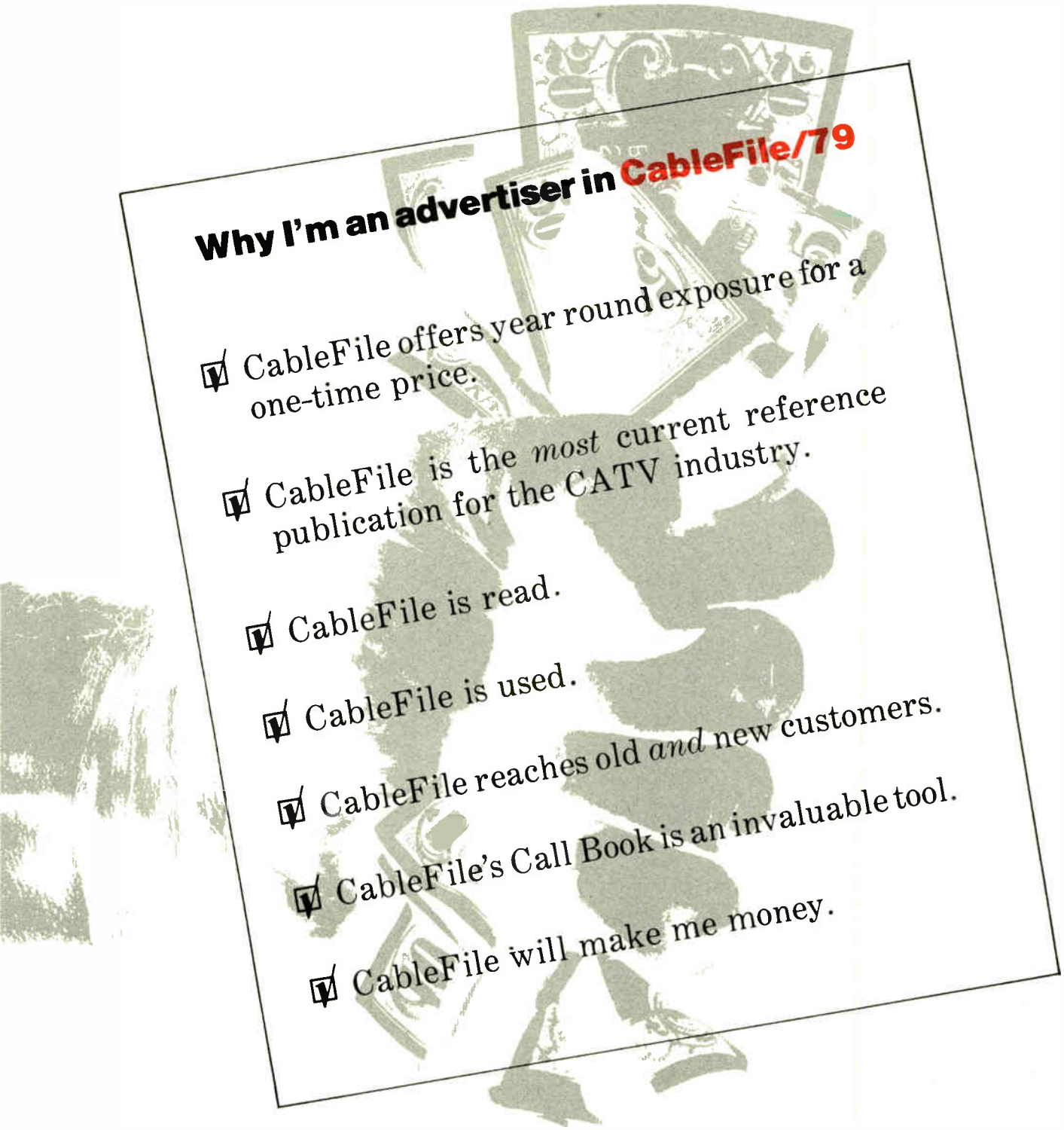

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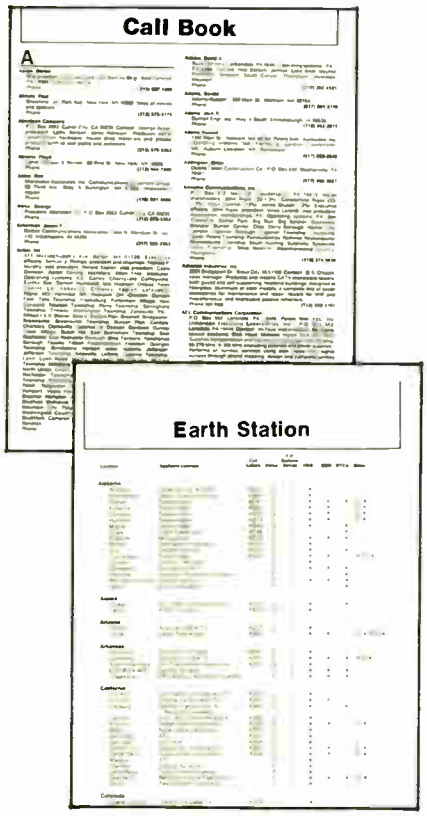

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- FCC Rules, Regulations and Forms
- Copyright
- FCC Organization Flow Chart
- Call Book
- Bell System Representatives
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- Catalog of Equipment and Services
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- CATV Off Air Interference Chart
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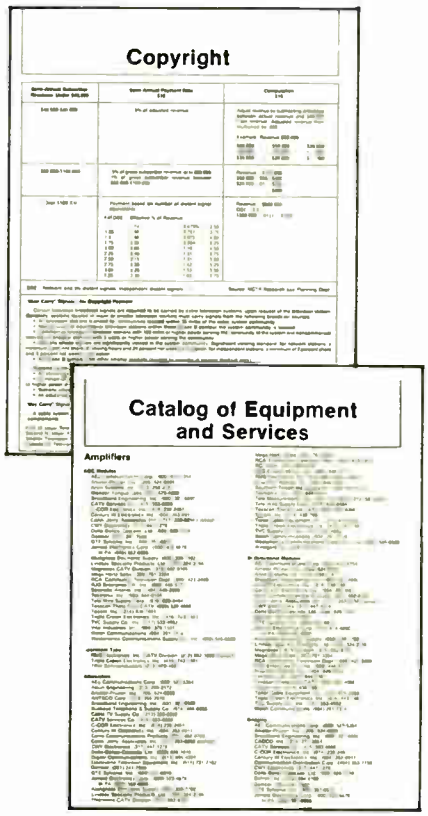

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ignal Carriage and Rewrite ighlight NCTA oard Meeting

ASHINGTON, D.C.—The importance distant signal carriage to cable TV xpansion in major markets and the dustry's position on the Commu- ications Act rewrite were central sues at a meeting of the National able Television Association Board of rectors at Sun Valley, Idaho, on ugust 14 and 15.

In specific actions, the board voted lend financial support to United able Television Corporation in its urt appeal of a Federal Communica- ns Commission ruling denying a stant signal waiver for its Tulsa, klahoma system. The waiver was quested for carriage of Channel 17, lanta, Georgia.

In a related move, the board urged mediate FCC action in its rule- aking proceeding on satellite car- ge of independent television chan- ls 2 (KTVU, Oakland, California) and (WGN, Chicago, Illinois). "Cable levision systems under construction urban markets across the country e depending on importation of one or th of these signals via satellite," TA chairman Robert W. Hughes mmented. "Cable TV development urban areas will be delayed still ther unless the commission moves ickly to make KTVU and WGN ailable," he said.

After a status report on the first four eks of congressional hearings on e draft Communications Act of 1978, R. 13015, the board reaffirmed its pport for the rewrite effort, but commended two key revisions in the l. The board echoed recent industry stimony before the House commu- cations subcommittee calling for a early-stated national policy toward ble television and the exclusion of ephone monopolies from cable evision programming in their own ephone service areas.

NCTA president Robert L. Schmidt o reported to the board on prepara- ns for the first cable television pay- nts under the Copyright Act of 1976. hmidt released copies of a letter to e federal Copyright Office in which urged revision of several "rigid and gical" regulations imposed for the st payments, due August 29.

In other actions, the board:

- Approved new procedures proposed by the NCTA awards committee for the conferring of official association honors.
- Recognized the provision of communications services to rural areas as an important industry goal. A position consistent with that goal will be presented to the FCC in rulemaking comments due September 15.
- Approved a dues enforcement program covering both members and associate members.
- Voted to lend financial support to the Connecticut Cable Television Association in a generic rate hearing pending before the Connecticut Public Service Commission. (The commission has proposed rules limiting cable systems to a 16 percent rate of return on investment.)
- Unanimously approved a resolution of appreciation to Wally Briscoe, former NCTA senior vice president and now vice president of Gardiner Communications, Houston Texas, for 14 years of contributions to cable.

The FCC Tower Painting Rules Nobody Knows

WASHINGTON, D.C.—During the past several weeks the FCC took action on its "new" tower painting rules, apparently effective November 1977. Unfortunately, hardly anyone was aware these new rules existed. *C-ED* learned of this problem via a xeroxed letter from NCTA vice president of engineering Robert Luff to Phyll Horne, chief of the FCC's Field Operations Bureau. In that letter Luff stated, "I distributed this news to the CATV engineering population and was surprised to receive many industry responses, indicating that they knew nothing of the new rules and asking if I would please forward all pertinent information."

The new tower painting standards for antenna structures were adopted on October 14, 1970. The rules state that antenna structures up to 700 feet high be painted with seven alternate aviation orange and white bands. These new standards were effective November 1, 1970 for any new antenna structure or one which was changed in height or location. The new rules required existing and unaltered structures to be converted to the new standards when repainted, but by November 1, 1977, at the latest.

Extensions were awarded in a limited number of cases. These were principally those in which painting could not be completed due to climatic conditions or anticipated forthcoming approval of pending applications for move of transmitter site. In selected cases, the compliance date has been extended until October 31, 1978.

In his letter, Luff seems to have pinpointed the lack of communications between the FCC and the CATV industry. "The commission's daily output is, of course, voluminous, making it impractical for the various trades to read through all actions cover-to-cover... The cable industry and the in-town copying services are generally not geared to finding technical rule changes that affect the cable industry unless there is some mention of either Parts 76, 78 or the words 'Cable-TV' somewhere in the caption or summary news release . . . It would assist us

considerably if the commission could specifically spell out industries affected in the action summaries of similar technical rule changes."

FCC Issues Reduction of UHF Noise Interference

WASHINGTON, D.C.—The FCC recently released its order requiring improvement in UHF television (channels 14-83) reception in nearly all new television sets effective October 1, 1979, and a further improvement by October 1, 1982.

The action, announced May 19, orders a reduction in the maximum receiver noise interference figure from 18 to 14 decibels in all new set models submitted to the FCC for certification after October 1, 1979, and for all television sets manufactured after October 1, 1981.

The FCC also ordered a further reduction in the noise figure from 14 to 12 dB in all new set models submitted to it for certification after October 1, 1982, with all TV sets manufactured after October 1, 1984 satisfying this requirement. While it had no present reason to question the forecasts on which it based the required 1982 reduction to 12 dB, the FCC said that it might modify this timetable if warranted by further information it received. This reassessment will also consider the "more likely" possibility that it would conclude with further data that it could mandate an even further second stage reduction—to 10 dB instead of the 12 dB now ordered.

The commission said improved UHF reception and increased efficiency in use of the UHF spectrum would be the major focus of this effort. It said it would consider a wide range of issues including improved receivers, labeling of sets, ancillary service, grading of other receiving equipment such as antennas and lead-in wires, and transmitter operations.

"PCTA Comes of Age"

HARRISBURG, PENNSYLVANIA—"PCTA Comes of Age" will be the theme for this year's fall meeting of the Pennsylvania Cable Television Association. The meeting, which marks the twenty-first anniversary of the group, is scheduled for September 27 through 30 at Harrisburg's Host Inn.

According to PCTA president George F. Gardner, the convention will feature a wide array of outstanding management and technical seminars, highlighted by several sessions on CATV satellite service. Home Box Office and the Society of Cable Television Engineers are coordinating plans for a working earth station which will receive signals from the satellite right at the convention.

Other seminar subjects include national and state legislative activity, pole attachment and automated system operations.

PCTA's 21st birthday celebration will begin Wednesday, September 27, with the annual Associates' Reception and continue Thursday night with a champagne reception. Afterward, the association's "founding parents" are to be honored at a special banquet.

Election of officers is also set for the fall meeting, with the posts of president, vice president, secretary and treasurer on the ballot. Four seats on the board of directors will also be voted upon.

Approximately two-hundred cable television owners, operators and suppliers are expected to attend.

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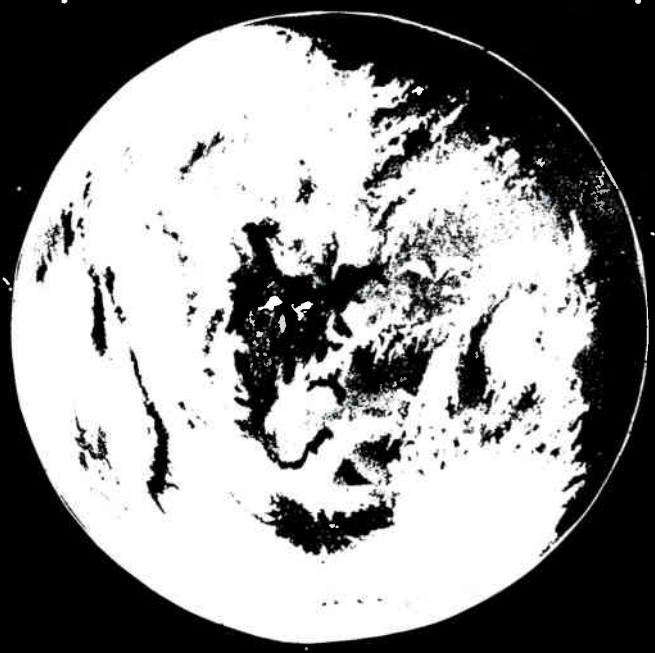

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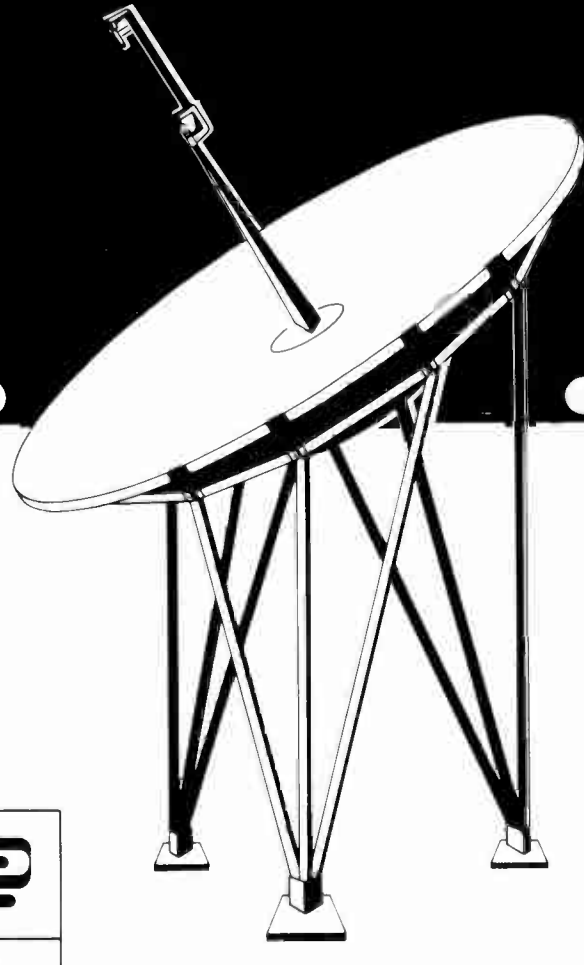

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Future Satellite Communications

By James Cuddihy
Manager of Technical Programs
RCA American Communications, Inc.
Piscataway, New Jersey

This article will discuss some of the potential technological developments that may affect the services that satellite communications systems deliver to cable television systems. These developments will affect the satellite itself, the earth station receive systems and modulation and signal processing techniques.

It is first appropriate to discuss the current operating satellites and the two authorized systems scheduled for launch within two to three years. These discussions will be limited to domestic U.S. systems. Several other domestic systems and the Intelsat system will have very little effect, if any, on cable television in the U.S.

Presently, there are three domestic satellite systems in orbit serving the United States: RCA Americom's RCA Satcom, Western Union's Westar and the AT&T - GTE utilized Comstar. Each of these systems was designed in the early 1970's based upon space-proven components and techniques that date back to the late 1960's.

The RCA Satcom and Comstar satellites both have twenty-four transponders each and the Westar satellites have twelve each. The greater capacity of the former spacecraft is obtained through the use of two orthogonal polarizations (vertical and horizontal relative to the spin axis of the earth) as opposed to the single polarization of the latter spacecraft.

All systems operate in the 4 and 6 GHz frequency bands (3700 - 4200 MHz downlink and 5929 - 6245 MHz uplink). The transponders on each satellite have a nominal bandwidth of 36 MHz. Each transponder is capable of handling one NTSC television channel.

Each of the three systems provides coverage of the contiguous 48 states, Alaska, Hawaii and Puerto Rico, however, the EIRP, flux density and G/T patterns and the number of transponders available in each area differ. It is not the purpose of this paper to discuss or evaluate those differences. Many other articles have been written on the attributes of each system and detailed information is on file with the FCC and available in several technical journals.

Two new systems have been approved by the FCC and are currently in the construction phase. Western Union plans an Advanced Westar (AW) which will contain twelve transponders at 4 and 6 GHz frequencies, similar to Westar and four transponders at 12 and 14 GHz (11.7 - 12.2 GHz downlink and 14.0 - 14.5 GHz uplink). Satellite Business Systems (SBS)—a partnership of IBM, Comsat General and Aetna Life and Casualty—plans a ten transponder satellite using the 12 and 14 GHz frequency bands.

Obviously, the primary differences between the present operating satellites and the systems scheduled for launch in the 1980's is the expansion to the higher frequency band. The primary reason for the change is that the 12 and 14 GHz frequency bands are allocated exclusively to satellite communications, whereas the 4 and 6 GHz bands are shared between satellite and terrestrial communications. This sharing necessitates the frequency coordination of new facilities in the 4 and 6 GHz bands with those facilities previously authorized. A large portion of common carrier microwave systems operate in the 4 and 6 GHz bands, which makes it difficult or impossible to establish earth stations at some locations. This is particularly true of clearing the 6 GHz uplink band. Use of the 12 and 14 GHz band would permit location of earth stations virtually at any location.

Both Advanced Westar and SBS systems plan to use digital time division multiple access techniques (TDMA) with very high density bit streams. Advanced Westar will have two 30 watt 225 MHz transponders on each polarization with spot beams to different areas of the contiguous states. Each of the four 12 - 14 GHz transponders will be capable of handling one 225 Mb/s (million bits/second). The SBS satellite will contain ten 20 watt transponders on one polarization with a bandwidth of 43 MHz. Each transponder can support a transmission in excess of 50 Mb/s. SBS also employs spot beam to concentrate energy in various parts of the contiguous states.

One of the principle detriments to the use of the 12 and 14 GHz bands has been the severe attenuation of rainfall at these frequencies, which will serve to decrease system availability. These transponders may support more than one television channel depending upon the digital encoding rate.

Future Developments

What technological developments will effect communications capacity for the next generation of satellite?

Satellite capacity is limited by the size and weight that launch vehicles can inject into a transfer orbit and the amount of power that can be accommodated within those constraints. The price of launch vehicles is also a major cost element in any system. The newest advance to stem the rising cost of expendable launch vehicles (usually three stage rockets of the Thor-Delta or Atlas Centaur class) is the development of the space shuttle. Formerly called the Space Transportation System (STS), the space shuttle will make larger and heavier payloads possible and reduce the cost per pound in orbit. This will tend to reduce the unit cost of services to the cable industry, as greater primary power will increase the communications capacity and additional stationkeeping fuel will extend the spacecraft life. Under development are improved solar cell efficiency and long life batteries that will improve lifetime.

Presently, the last stage of amplification is a traveling wave tube which usually has a saturated output power of approximately five watts at 4 GHz. Two significant developments are possible. One is the development of solid

state power amplifiers that would increase satellite life and reliability and the other is the development of higher power tubes and solid state devices that would increase output power. Both these potential developments tend to reduce the overall cost of programming to the cable industry. Also, the development of more powerful tubes at higher frequency bands is expected.

Improvements in antenna systems will be achieved by the use of mechanically or electronically steerable antennas which will permit the concentration of energy in a small area. These will be accomplished by the use of feeds composed of horns, arrays, or lenses. Such improvements should enhance EIRP availability for different services.

To materially improve the performance of present earth stations, it is necessary to improve the antenna gain by increasing efficiency or to reduce overall system noise temperature with lower noise receivers. Major improvements in efficiency do not appear feasible, but the development of gallium arsenide field effect transistors with lower noise figures and improved parametric amplifiers at the 12 GHz band appear promising.

The multiplicity of satellites may demand a toroidal reflector antenna with a movable feed structure allowing switching between satellites quickly and conveniently. This implies that one set of receive equipment would need to be designed to operate with several satellites in sequence.

Present satellites primarily use frequency modulated analog transmission for video and voice requirements. Only some special applications use digital techniques and generally those transmissions are on a frequency division basis (each bit stream occupies the same portion of a transponder continuously).

Future systems will employ both TDMA (time division multiple access) and CDMA (code division multiple access). Each of these systems employs complex electronics processing that is presently very expensive but is expected to decrease in cost with the advent of more complex LSI and VLSI circuitry.

For television transmission high quality, digital systems of as little as 22 Mb/s have been demonstrated, which represent 30 - 40 percent of a current 4 - 6 GHz transponder's capacity in a TDMA mode. However, present costs of modulation and demodulation and encoding and decoding equipment are too expensive for a large television distribution system.

Also under development are several noise reduction techniques. These systems tend to show significant improvements for poor quality video signals, raising the perceptible quality by 4 - 5 dB, but demonstrate little improvement to high picture quality signals.

For approximately one year now using transponders leased from the RCA Americom satellite system, RCA Alaska Communications, Inc., and the State of Alaska have been operating a system that derives two video channels on one transponder by dividing the bandwidth and power between the signal. The signals are received at two major earth stations in Alaska.

Another method of deriving two video channels from one transponder is an alternate field technique. The alternate field video transmission technique operates by selecting the odd fields of one NTSC video signal and the even fields of a second NTSC signal and interleaving them alternately into a single output line. At the receiving point, the interleaved odd and even fields are separated and fed to separate video outputs. Simultaneously, the missing fields for each of the

two output channels are replaced by new fields created in the decoding device by using the previous field of information appropriately time delayed, and interpolating between two consecutive transmitted scan lines to generate the missing interlaced scan lines. At present, this equipment is relatively expensive, but through volume, cost reductions may be practicable for cable television distribution in a few years.

These two methods have been combined to demonstrate reception of four video channels from one transponder in Alaska. These tests provided acceptable picture quality.

Other methods of deriving two television channels from one transponder have been suggested and generally employ digital storage and processing techniques. As the costs of digital storage and processing equipment decreases, it may be feasible to deliver two video channels on one transponder into present cable television earth stations with only the degradation from current signal quality due to the processing equipment.

Other Concepts

It was previously mentioned that one television channel only occupied 30 - 40 percent of a transponder's capacity depending on the encoding rate. Again, today's digital equipment costs make it economically unfeasible for the cable TV industry to operate in a TDMA system. Nevertheless, it is interesting to look at two concepts that may be only one or two generations of satellites away.

Some researchers have proposed a high density spot beam that would scan the U.S. at a rate of 600 Mb/s and collect and disseminate information from various locations in sequence. Such a system appears more applicable to a telephone system than to a television distribution system. However, if cable systems become involved with the collection or distribution of data in its various applications, it may be of some interest.

As described earlier, each current communications satellite has been launched on a separate vehicle. One new concept is the orbiting antenna farm, which would carry a large variety of payloads on one huge (relative to current size) platform, providing solar and battery power and other functions from a common source. It is expected that more efficient use of the frequency spectrum and orbit space can be realized. Also, some signal processing could be accomplished aboard such a spacecraft and relay of signals between the antenna farms is certainly practical.

Various literature has recently had articles concerning two-way interactive communications systems, such as ANTIOPE, View Data, and QUBE. These systems offer a new improved service that could be made available to the cable subscribers. Naturally, a satellite system can play a pivotal role in such a system. The satellite system would be capable of interrogating widely dispersed information centers, updating a large number of files simultaneously, and managing the overall system by connecting intelligent terminals in a cost effective and efficient manner.

This paper has presented the current posture of communication satellites and reviewed some of the work that may be incorporated in future systems. It appears that present satellite systems did not anticipate the synergistic effects that satellites would have on the distribution of cable television programs. By developing higher power spacecraft transmitters and higher EIRP, the tendency will be to reduce the costs of delivering a wide variety of programming to cable television systems. **C-ED**

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By John Dahlquist, CATV Marketing
Jerrold Electronics Corporation
Hatboro, Pennsylvania

At this year's NCTA convention in New Orleans, Jerrold offered the new "Super Switcher" power pack, the SJSW-60. This device is designed to be the most efficient and rugged power pack available to the cable operator.

All of those who witnessed any of the over 9,300 "shots" of 400 volt peak-to-peak surges (on top of a 150 volt sine wave input) . . . without failure, will attest to the rugged design of the SJSW-60. And how about the JSA-145 surge arrester? It certainly did the job—clipping those 400 volt peaks at 150 volts. For those who missed our "Super-Switcher" demonstration in New Orleans, the following is a run-down of that active exhibit.

A standard SJ-2A (manual trunk and bridger) station was used to provide the load (740 ma at -27 volts DC) for the SJSW-60. A 150 volt peak-to-peak sine wave supply was used to power the station, even though Jerrold recommends using a 60 volt square wave power source. Therefore, in the display's normal operation mode, the unit was already subject to a 25 percent overvoltage of 15 volts. An oscilloscope provided a visual display of the AC 75 volt sine wave input to the station. A digital counter recorded the number of 400 volt strikes to which the "Super Switcher" was subjected, and a digital voltmeter monitored the regulated -27 volt DC output.

Surge Demonstraion

With the unit operating as described, a 400 volt peak-to-peak high energy surge was applied to the AC input voltage and displayed on the oscilloscope. Over 9,300 strikes of this type were applied to the "Super Switcher" without failure, fuses blowing, destroying surge arresters and without short-circuiting circuit breakers. During this extreme duress, it maintained its specified regulated output, which in a real CATV system would provide uninterrupted service. (NOTE: The same power pack received another 3,500 shots at the Canadian CATV show without problems.)

We think that this demonstration proves the rugged, reliable design of the "Super Switcher" to our customers. This power pack can take all the punishment that the cable TV system environment can hand out and give unequaled efficiency of operation in return.

The reliability and dependability offered by the "Super Switcher" can be further improved by the addition of the JSA-145 surge arrester. This hefty, heavy duty surge arrester has a striking voltage of 145 volts and is capable of handling a continuous current of 80 amperes. The JSA-145 limits the amount of overvoltage abuse the "Super Switcher" components are subjected to.

For our demonstration, a momentary toggle switch was placed in series with the JSA-145. The momentary toggle switch was thrown after the surges were applied to the AC input. The oscilloscope showed that the 400 volt peak-to-peak surges were clipped at 150 volts and the discharging of the other 250 volts could be seen in the flashing discharge of the JSA-145.

The optional JSA-145 adds protection that will give you peace of mind for everything short of a direct lightning strike. This inexpensive surge arrester is specified to fire at 145 volts, has a 20,000 ampere surge discharge rating and an 80 ampere follow-on current. These surge arresters are unlike the typical gas surge arresters which are notorious for failures. Jerrold's intensive study of this subject has indicated that unless the heavy duty JSA-145 type is used, the surge protection is inadequate.

As further proof of the rugged design of the "Super Switcher," a 117 volt AC outlet was made available to power the unit. Even if a normal house voltage is used to power the SJSW-60, it maintains its regulated output. Normal house voltage is equivalent to approximately 330 volts peak-to-peak. That's a 275 percent overvoltage condition applied to the input while maintaining its regulated and uninterrupted output.

During a demonstration of the "Super Switcher", the surge arrester momentary toggle was accidentally switched, shorting the AC power to that section of the booth. This caused a main circuit breaker of the exhibit to trip. After the exhibit main breaker was reset the "Super Switcher" continued to operate normally, proving that it could withstand a 60 amp short circuit which is the ratio of the circuit breaker. C-ED

Jerrold demonstrated its "Super Switcher" power pack at the 1978 NCTA show.

Special Fiberoptics Section

This special section of *C-ED* is devoted to fiberoptics, the science by which light beams are guided in a glass wire. The rapid emergence of fiberoptics technology has been proven as one of the most effective means of information. transmission, whose extent has not yet been limited. The new technology was first employed during the 1960's for image transmission, light distribution and sensing applications. These uses are still expanding, but today communications is the most rapidly growing market for this technology.

In 1972, experts expected only very specialized applications for communications fiberoptics—the technique that transmits voice, video and data signals through hair-thin glass fibers. However, the development of ultra-pure glasses, semi-conductor solid-state lasers and LEDs have opened the doors to various other applications.

In this section are three feature articles involving this new technology: "8 kM, 12 Channel Fiberoptic Trunkline Serves Lompoc, California," by Times Fiber's Sol Yager; "Glass Fibers Solving Communications and Control Problems," by Valtec president James Godbey; and "Linear Lasers for CATV Applications" by General Optronics' Dr. C.J. Hwang. The Times article discusses how the Lompoc, California system works, and the Valtec story explains the advantages of fiberoptics vs. twisted pairs and that company's "ready-to-plug-in" Fiberoptic Data Transmission System. The article by Dr. Hwang describes the structure, fabrication, properties and performance of General Optronics' linear laser.

In addition to these three articles, we are previewing FOC '78—a fiberoptics and communications exposition sponsored by Information Gatekeepers, Inc. The exposition will be conducted September 6-8, 1978 at Chicago's Hyatt-Regency O'Hare and will unite a technical 21 session program with over 70 exhibits.

The main focus of FOC '78 will be "Present and Future Applications of Fiberoptics Communications." All aspects of applications will be examined including the availability of components, systems, design data, techniques and costs.

FOC '78 also boasts the largest exhibition in the fiberoptics and communications industry ever assembled. On-hand will be such exhibitors as Times Fiber Communications, Times Wire and Cable Co., General Optronics Corp., General Cable Corp., Corning Glass Works, Comm/Scope Co., ITT Telecommunications, Canstar Telecommunications, Belden, Siecor, Hewlett-Packard and Telemet—just to name a few.

Besides the technical program and exhibits, a two-day intensive course on "Optical Communications via Glass Fiber Waveguide," will be conducted by Dr. Robert L. Gallawa, Institute of Telecommunication Sciences, U.S. Dept. of Commerce. This course will familiarize the practicing engineer with the new technology of optical waveguide digital communications. Dr. Gallawa will present the course in four sessions.

For additional information on this exciting exposition, contact Information Gatekeepers, Inc., 167 Corey Road, Brookline, Massachusetts 02146, (617) 739-2022.

Linear Lasers for CATV Application

By Dr. C.J. Hwang, President
General Optronics Corporation
South Plainfield, New Jersey

In a conventional CATV system, the baseband signal is carried by carrier waves which propogate through the cable. At the receiving end, a TV receiver demodulates the carriers and displays the information from the baseband signal on the screen. In order to be competitive with this conventional system, a fiberoptic CATV system should be designed in such a way that minimum interfaces between the transmitter and receiver are introduced. This can be achieved by using the carriers to modulate the source light. The light is then sent through an optical fiber. A photo-detector at the receiving end is used to replace the conventional coaxial cable.

This analog system will be basically simple and cost effective if two requirements are met. The first is that the carriers are faithfully recovered at the receiver for distortion-free signal transmission. The second is that the light source must have a broad bandwidth 50 MHz to 250 MHz. The former requires a high degree of linearity in the light output vs. the current output of the light source. The latter requires a light source that is fast enough to respond to the modulation of the carrier frequencies.

A properly designed injection laser diode can meet the above two requirements. The following describes the structure, fabrication, properties and performance of such a laser, as produced by our company.

An injection laser is a semiconductor p-n junction device which emits coherent light upon application of a forward bias. Its use as a light source for fiberoptic communication is particularly suitable because of small size, high coupling efficiency, direct modulation capability and easy interface with conventional electronic circuitry. There are many different kinds of injection lasers. Among them, the stripe-geometry GaAs-GaAlAs double heterostructure lasers are the most developed and reliable devices which have been widely used since its introduction in the early 1970's. Most of the previous applications of the GaAs-GaAlAs lasers, however, were con-

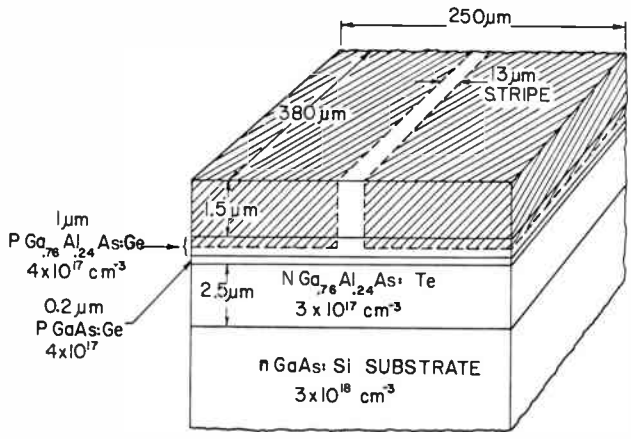

Figure 1. Layer Structure of the Stripe-Geometry Double Heterostructure Laser.

cerned only with using the laser as a light source; the problems associated with the linearity, and with the self-pulsing and relaxation oscillation which limit the bandwidth for modulation and are commonly observed in an injection laser, were never considered serious. It wasn't until a few years ago, when the lasers were used in the fiberoptic area for data transmission, that the problems of linearity and modulation rate started to attract wide attention. Many new structures have since been developed to improve the linearity and suppress self-pulsing and relaxation oscillation. We have developed a laser structure which possesses a high degree of linearity and does not show these other two characteristics.

The structure of the laser is shown in Figure 1. The size of the laser is typically 380 μm long, 250 μm wide and 100 μm thick. It consists of four epitaxial thin crystalline layers on a GaAs substrate. The epitaxial layers are grown by the liquid phase technique. Figure 1 shows a very thin p-type GaAs layer which is sandwiched between the two GaAlAs layers containing 24 percent Al. The interfaces between the GaAs layer and the two GaAlAs layers consist of two heterojunctions and hence the name double heterostructure. The two GaAlAs layers have a larger energy gap than the GaAs layer. The larger energy gap produces two potential barriers at the heterojunctions. When a forward bias is applied, the positive and negative change carriers are confined in the thin GaAs layer by the potential barriers and are forced to recombine. The emitted recombination radiation is further confined and guided in the GaAs layer because the layer has a higher refractive index than the two surrounding GaAlAs layers. Sufficient optical gain can be generated in this GaAs active layer by the interaction between the emitted protons and the charged carriers. As the forward bias increases to the point called the lasing threshhold, the optical losses caused by the absorption and scattering are overcome by the optical gain. The laser oscillation can occur if a pair of mirrors is provided. In the case of semiconductor lasers, the mirrors are usually formed by a set of crystallographic planes and therefore no external mirrors are needed.

At a typical threshold current density of 1KA/cm, it requires one ampere to operate a laser with the dimensions shown in Figure 1. Thus, even for such a small device, a very efficient heat sinking must be used in order to achieve CW operation. Furthermore, such a device generally exhibits multimodes as well as multi-lasing filaments in the plane parallel to the junction. The size of the filament is between 5 to 10 um. The concept of a stripe-geometry laser is based on the idea that by forming a stripe contact of the size of a filament, one should excite only one filament. In addition, the total current required to operate the laser is greatly reduced and thus is favorable for CW operation without using an elaborate heat sink. The waveguide dimensions in this case are thus defined by the two heterojunctions in the vertical direction and by the current spread in the active layer in the horizontal direction.

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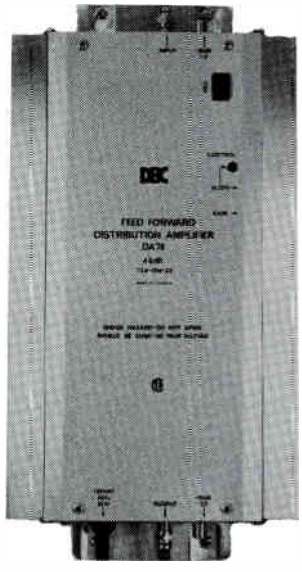

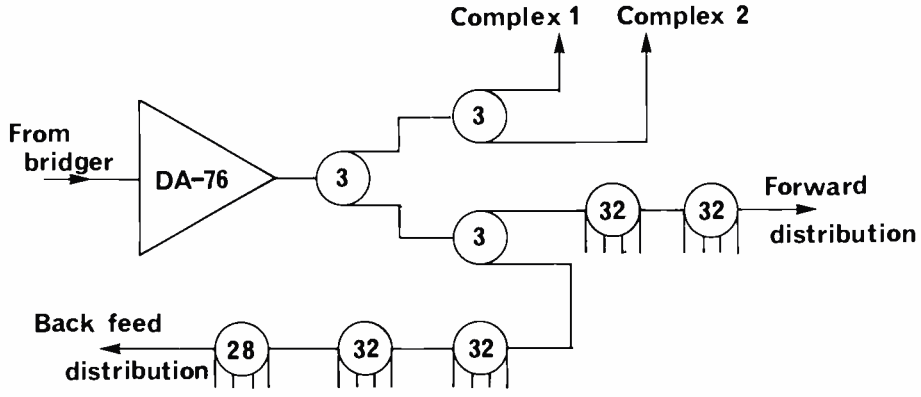

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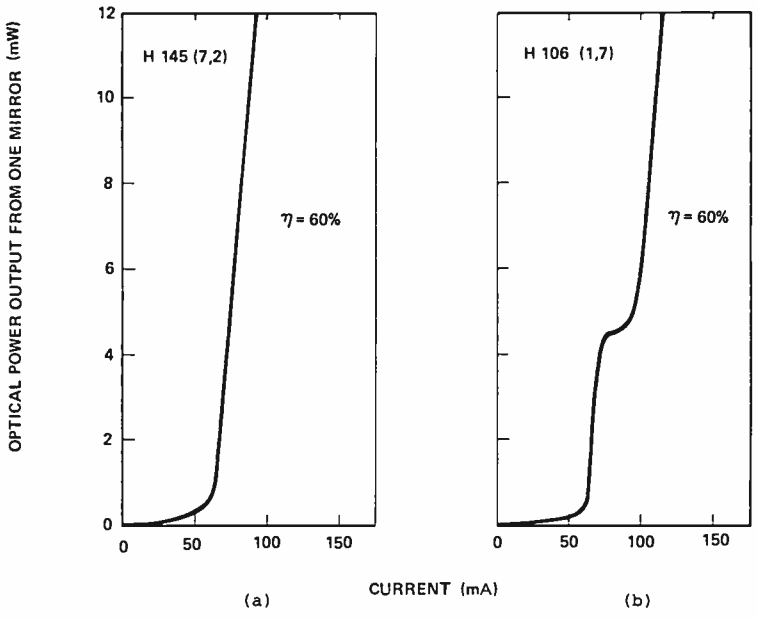

Fig. 2 Output Characteristics of Linear and "Kinked" Lasers.

Because of the dimensional asymmetry and difference in waveguiding mechanisms in both directions, the light pattern diverges 45 degrees vertically and 10 degrees horizontally.

Properties of a Highly Linear Laser

The light output vs. current input characteristic is shown in Figure 2(a). The light intensity increases very slowly initially. As the current increases beyond the threshold of the laser, the light intensity increases very rapidly. The degree of linearity of the laser is determined by the behavior of the light output with the input current in this range. If the waveguide dimensions are not stable with respect to the current variation, poor linearity results. In the extreme case, a kink in the output as shown in Figure 2(b) is observed. This nonlinearity is unacceptable in the CATV system.

In most of the commercially available lasers, the stripe contact is formed by cutting a stripe opening on an insulating layer deposited on the surface. Because of the finite distance of the active layer from the surface, the current spreads substantially by the time it reaches the active layer. Since the extent of the current spread depends on the current, the lateral waveguide dimension also changes with current. This type of laser, although it is simple to make, often shows poor linearity as well as poor transverse mode stability. On the other hand, the General Optronics laser uses proton implantation to define the stripe. The implanted region, as shown by the shaded region in Figure 1, turns into semi-insulating and hence only the stripe region can conduct current. Furthermore, the current spread can be controlled by the implantation depth. If the implantation depth is equal to the distance of the active layer from the surface, the current spread in the active layer is greatly minimized. Consequently, we have a much better defined waveguide with respect to the current variation and hence the superior linearity and more stable transverse mode structure.

For analog modulation, a constant current greater than the threshold value is used to bias the laser. The TV carrier signals are superimposed to produce the modulation. The bias current and modulation depth are then adjusted to obtain minimum distortion and maximum signal-to-noise ratio. It is important to point out, however, that distortion can still be introduced by operating the laser improperly even though the laser is perfectly linear. As is common to all light emitting devices, the laser properties are sensitive to the temperature variation. The temperature variation causes the threshold current to change which in turn shifts the curves in Figure 2 horizontally. The shape of the curves remains unchanged. Thus, for a constant bias current, the bias power can fluctuate in a fluctuating ambient. This can cause an apparent nonlinearity in the light output vs. current input characteristics.

It is, therefore, required to develop some means to stabilize the bias point for distortion-free transmission. We have designed a feedback circuit which is capable of keeping the laser operating at a constant output power. A photodetector placed near one of the mirrors is used to detect the laser light. The signal from the photodetector is amplified and fed into the base circuit of a transistor to control the collector current which passes through the laser. The RF modulation signal can be applied directly to the laser through some appropriate impedance match network. Because the slope of the light ouput vs. input current (Figure 2(a)) is quite steep, only a small input signal is required to obtain relatively deep modulation. For example, a 0.75 volt peak-to-peak RF signal can produce more than 70 percent modulation when the laser is in series with a 70 ohm resistor and is directly connected to a 75 ohm input source. An even smaller voltage can be used if an apropriate impedance match network is used. In the General Optronics optical transmitter designed for transmitting 12 channels of TV signals through a single fiber, a transformer is used to match the 75 ohm system to an 18 ohm input. It also incorporates a thermal electric cooler which ensures the operation of the laser at 25 degrees C even if the ambient temperature gets as high as 70 degrees C.

The frequency response of the package is essentially flat from 10 MHz to 280 MHz. In this frequency range, second and third harmonics are typically less than 55 dB and 65 dB respectively below the fundamental at 70 percent modulation when the laser is biased at 3 mW. For a 12-channel input, the bias point and modulation depth were adjusted to give maximum signal-to-noise ratio and minimum cross modulation. A signal-to-noise ratio of less than 65 dB with cross modulation of less than 60 dB was obtained. The transmitter was used to transmit 12 channels of TV signal directly from an antenna through one mile of optical fiber without any visible distortion.

Because of its large bandwidth, the injection laser is suitable as a light source for fiberoptic CATV application. The simplest and most economical CATV system, however, demands a high degree of linearity on the light output characteristics of the laser. We have been able to make such high quality lasers by properly controlling the waveguide structure. C-ED

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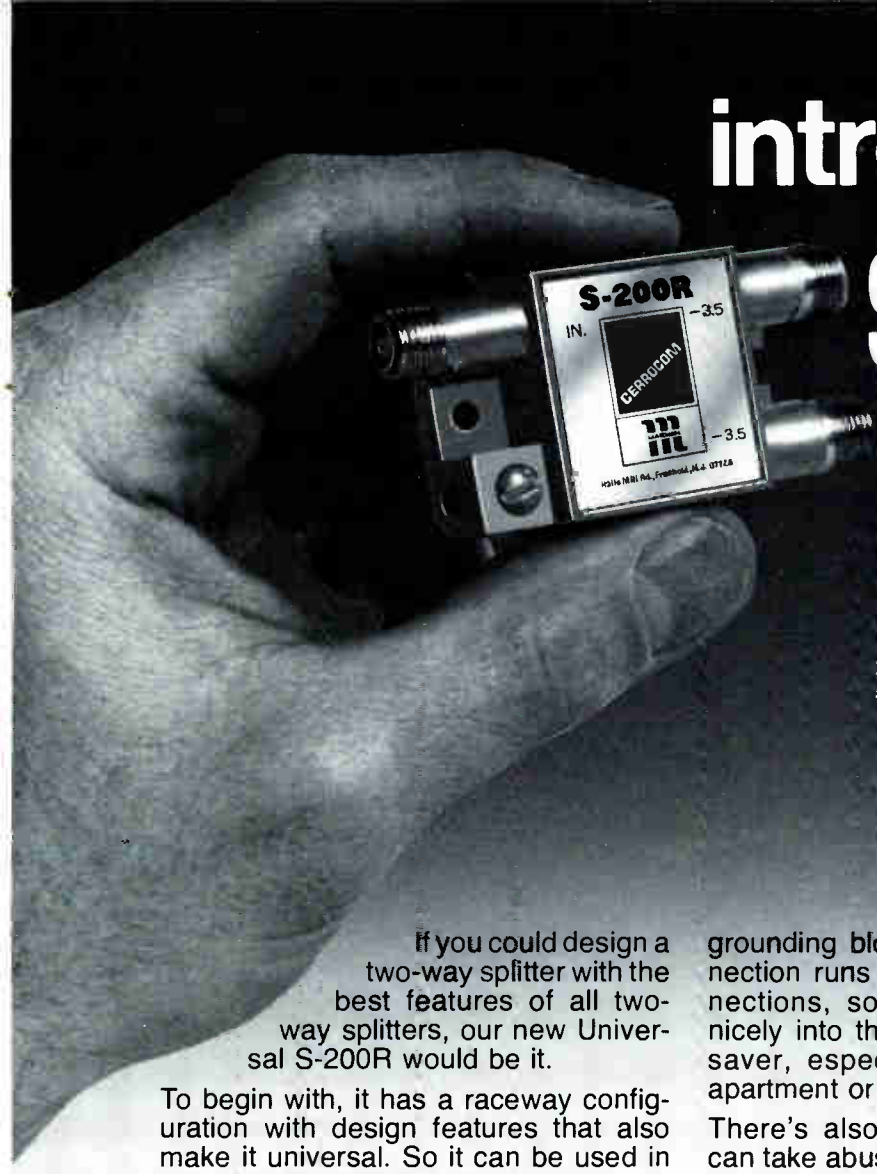

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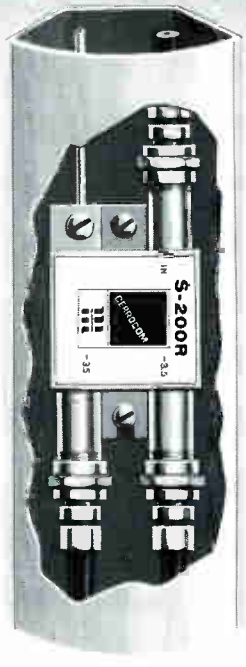

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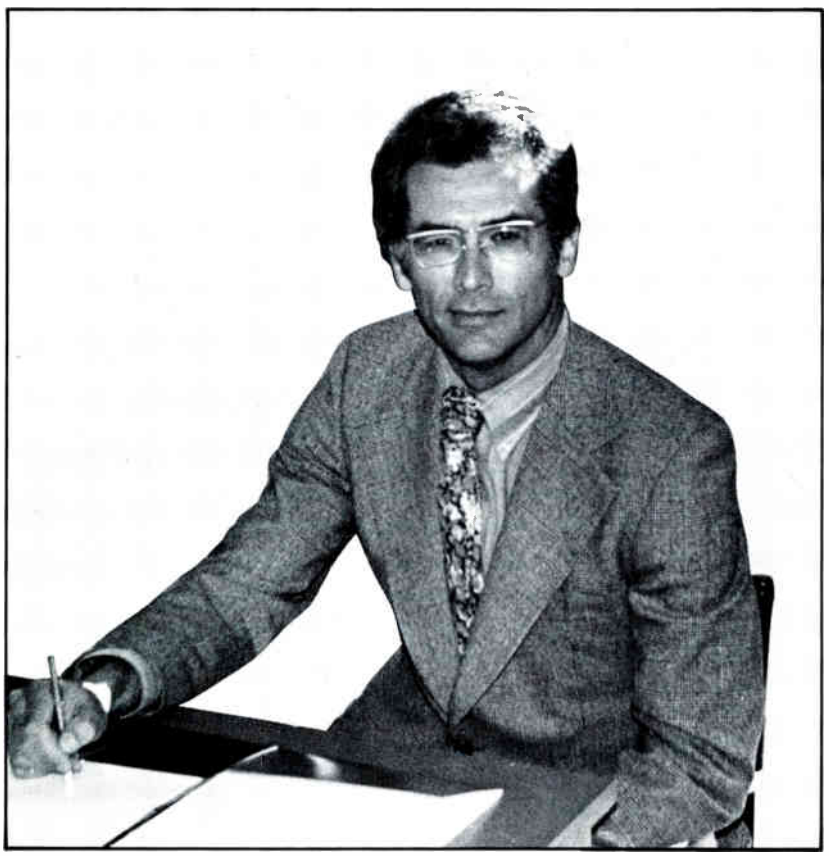

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Glass Fibers Solving Communication And Control Problems

By James A. Godbey, President
Valtec Corporation
West Boylston, Massachusetts

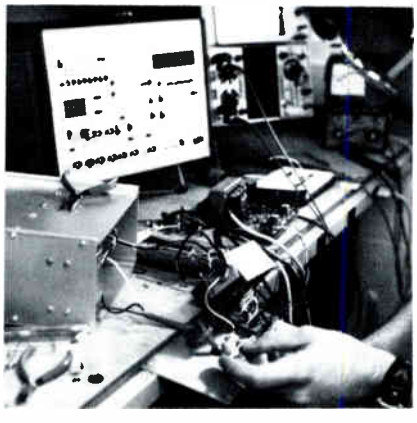
Until recently, business, industry, banks, insurance companies, military and government agencies were blocked from meeting their need for additional data communications and process controls by seemingly-insurmountable obstacles.

They were hampered by sheer lack of physical space for more wires or cables, interference from nearby high-voltage lines and other electrical systems, danger where explosive elements were present, environmental limitations, possible security leaks and high costs of upgrading present systems. It looked like the "Communications Explosion" had been smothered.

Then Valtec Corporation engineers turned the science of fiberoptics into a practical art. They designed, manufactured, and installed a fiberoptic voice/television phone system in Las Vegas and a color TV subway monitoring system for the San Francisco Bay Area Rapid Transit System (BART).

In both cases, Valtec proved that its optical fibers, wispy strands of very pure glass through which signals are sent by rapidly-pulsing lights, such as lasers, can be coupled with ruggedized cable to defeat the communications problems which plague conventional systems.

Because it's not practical to continually put engineers in manholes, subway tunnels and other places where fiberoptic systems will be used, Valtec designed products which can be installed by the end users' regular work crews (with some engineer or technician supervision at the spot where the



It was check and double-check in Valtec's stringent preparations before shipping the fiberoptics/cable communications system materials to Las Vegas. At top left, cable is color-coded so that each fiber can be identified to allow installers to choose the proper sets. At top right, fibers at cable end are prepared so each will be flat and flush to allow maximum light flow through splices, thus taking full advantage of the low loss characteristics. At bottom left, Dr. Marshall C. Hudson, New Technology Manager-Fiberoptic Communications, measures to insure that full information capacity will travel the entire distance. At bottom right, a Valtec technician assembles the receiver section which reconverts the light back into the original voice or video signal.

optical fibers interface with electronic receivers or transmitters).

Because the fibers can carry thousands of times the volume of data of similar-sized copper wires (six fibers have the capacity of 900 pairs of copper telephone wires), the glass "light pipes" defeat the space problems created because architects and industrial designers didn't allow for data communications system expansion.

No Interference Problem or Explosion Danger

The problem of interference with or from high-voltage electrical sources does not exist with fiberoptics because the glass fibers radiate no electricity and they are unaffected by other systems. In the BART installation, the fiberoptic link was tied on to a 34,000 volt power line with no disruption in communications. This advantage makes fiberoptics ideal for mass transit systems, mines, chemical refineries, nuclear power plants, factories and large office complexes.

The lack of radiation also allows fiberoptic installations to be employed in those explosive atmospheres where sparks from shorted electrical cables could be catastrophic. This is a constant danger in many refineries and chemical complexes, as well as some military installations. But now, cabled fiberoptic systems can be used as control lines from a central process controller or monitor to remote processors or equipment because there are no problems with electromagnetic noise or with "spikes" caused by motors, relays or power cables. In fact, fiberoptic cables actually protect communication systems from damage by lightning or atomic bursts as well as offering increased protection from nuclear radiation damage.

Protection Against the Environment

Properly prepared, such as in the Las Vegas and San Francisco installations, the fibers can be totally protected against the environment by the proper cabling system.

Valtec recently introduced its PC-10 FIBERdata™ general purpose communications fiberoptic cable which guards against temperature extremes as well as the other dangers to conventional systems which were previously listed. This cable was Valtec's first move in the development of completely-engineered "turnkey" data links which can easily be installed with no expertise in fiberoptics.

Security Leaks Halted

Since electrical signals do not radiate from optical fibers, information cannot be compromised by use of conventional external "listening devices." The military was the first to recognize this, but industry is fast becoming aware of this means of providing communications (internal telephone systems as well as data links) while protecting proprietary information.

Cost Competitive and Dropping More

Fiberoptic cables cost more than twisted pair copper wires, but ease of installation brings their price to a par. And expectations are that copper prices will continue to rise.

Besides the lower installation costs, PC-10 offers hardware savings over other types of single fiber cables per end termination pairs and in light source costs because of the general purpose cable's large light acceptance capability. These end costs are particularly significant in computer interfacing, where terminations represent a large part of the cabling cost. Currently, Valtec estimates savings of from $40 to $140 per end termination and light source cost savings of from $50 to $150 per channel.

The simplicity of PC-10 connectors and terminations means labor savings because a technician can install quickly with no need to align tiny rods, overlay V-grooves, jewels or miniature springs. PC-10 connectors, available from several major manufacturers, use familiar coaxial concepts such as coaxial pre-drilled ferrules, crimps and quick-set adhesives.

This standardized fiberoptic cable also offers inventory savings because it can be cut and terminated for applications from a few inches to a couple of kilometers.

Because the general purpose cable is upgradable, users will save in the future as well. It's expected that this will be the cable of the future for "data bus systems" because passive optical couplers ("stars" and "tees") will soon be available. Bi-directional transmission over a single fiber is expected to result in a 50 percent cable savings.

Next: The Fiberoptic Data Link

The successful development and marketing of PC-10 led Valtec to its next innovation: "The Ready-to-Plug-In" Fiberoptic Data Transmission System.

Valtec introduced four FIBERdata™ links, each fully duplex (two-way simultaneous transmissions) with a transmitter and receiver on each end. Power supplies were included as standard equipment so users could plug them directly into wall outlets. Each was fully-packaged and ready for hook-up to duplex fiberoptic cable. Terminated cable was also made available at about $1 per foot.

The new pre-engineered data link series includes: the RS 232-C, RSK D-1 model for long distance computer applications; the RS 232-C, RSH D-1 for moderate distances; the TTK D-1 for long-distance digital data transmissions, and the TTH D-1 for moderate distance digital applications.

The designation RS 232-C refers to links designed to accept the standard 25-pin connector and to convert directly to digital data transmissions. The RSK D-1 model transmits over distances up to 3,000 feet and RSH D-1 is a lower-priced version for short-to-moderate distance requirements.

The other links are engineered for electrical input through standard connectors with all optical conversions within the link. Fiberoptic connectors on the link mate with pre-terminated, duplex fiberoptic cable. The TTK D-1 operates at ten million pulses per second and is ideal for transmission of up to 3,000 feet while the lower-priced TTH D-1 at three million pulses per second, and designed for most applications within a single building, operates at distances up to 300 feet.

The pre-engineered data links broke new ground. The market was there, but before fiberoptics became a practical engineering art, there were no products capable of filling the needs. To be successful, Valtec engineers agreed that standardized products were necessary to keep costs low. Thus, the four standard data links, which could solve the vast majority of data transmissions problems, were developed and manufactured.

Process Control Interest Rising

"Computer applications were an obvious market," said James A. Godbey, Valtec president, "but we're talking with more and more industrial designers these days. They're interested in communications and data processing, but there's a rising interest in fiberoptic systems for process control.

"The designers are taking advantage of the safety features inherent in optical fibers," Godbey emphasized. "We expect an expanding market in applications such as chemical plants, mines and installations with high explosives. We proved

fiberoptics in the Navy A-7 fighter plane ALOFT program when Valtec demonstrated both safety and lower costs by running fiberoptic cable through the liquid oxygen and weapons storage areas where electrical cables were prohibited. The pilots then went through full combat maneuvers with the fiberoptic systems abroad. And, because of the weight savings, planes can carry more armor and weapons than before."

Installation Costs Also Low

The small size and low weight keep down manpower costs of installation. But other installation costs are also more economical. The Army uses 1¼-ton trailers to transport fiberoptic cable that replaces three 2½-ton truckloads of conventional electrical cable.

Where installation space is limited, a fiber cable can be combined with, or laid adjacent to, a power cable because the line currents won't disturb a fiberoptic signal. With the use of the smaller fiberoptic cable, the need for computer room raised floors probably will be eliminated.

Electrical codes often require that electrical cable be confined in conduits. There are no codes—and no need for them—with intrinsically safe fiberoptic cables. Therefore, the cost of laying conduits is saved. Cable routing through hazardous areas, as demonstrated in the A-7 ALOFT program, makes it possible to save on line length—an important consideration in safety-related applications.

Technical Support Available

"Interfacing fiberoptic and communications technologies to produce functional results represents our greatest strength," explained Godbey. "We offer this capability to guide design staffs in meeting project goals. When a system requires that special measurements be made on fiberoptic components or operating assemblies, our measurement laboratory performs these services quickly and economically. And we provide full documentation.

The six Valtec optical fibers in a reinforced cable, at right, are compared to the 900 pairs of conventional copper telephone wires at left

Frederic Wilkenloh, Valtec vice president of Optical Communications, and Richard Cerny, Communications Fiberoptic marketing manager, inspect the connectors on a reel of fiberoptic cable.

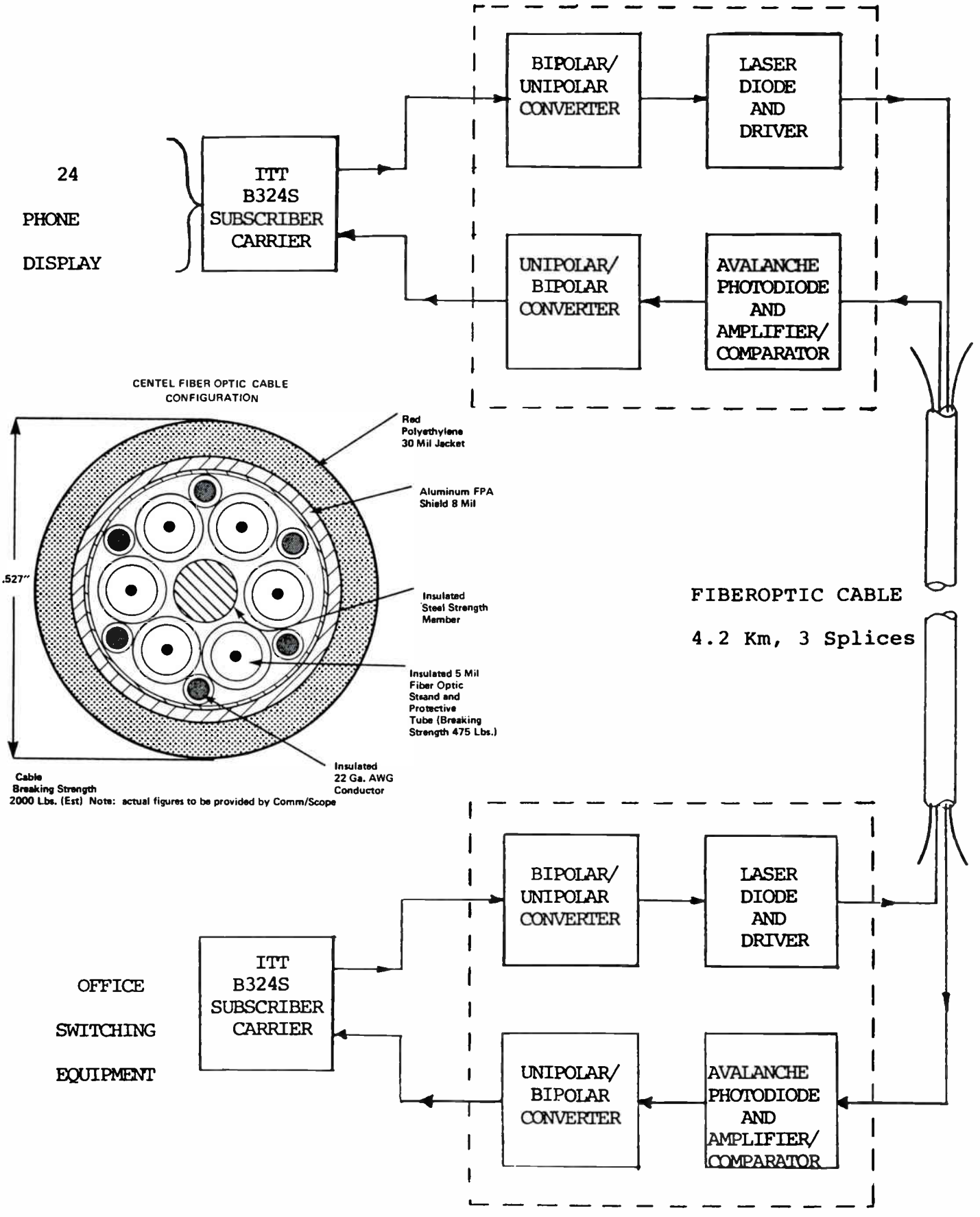
"Integrating new technologies, such as communication fiberoptics, into existing systems can be a challenge," Godbey stated. "Because of our experience in solving literally hundreds of specific application problems, we can often show our customers simple, inexpensive methods for improving performance. And, increasingly, we are using our standardized products to do this, thereby adding to the cost savings and cutting shipping and installation time."

How the CENTEL System Works

The Valtec-Comm/Scope fiberoptics/cable system works with interfaces between the carrier (already standard equipment with wire systems) and the fiberoptic cable. The carrier combines the many phones into the signal which would normally be transmitted over copper cable. Then the bi-polar signal is converted into a uni-polar signal and sent into the laser diode and driver which emits light into the fibers. The light is transmitted to the other end and received by the avalanche photodiode and amplifier/comparator which extracts the voice signal. The signal is then reconverted with a uni-polar converter which is then sent anywhere by conventional equipment. The optical system is fully compatible with existing telephone equipment.

Optical Cable Cutaway

The center of each fiberoptic cable is insulated with 3/32-inch steel strength member (also used to pull cable through duct) fitted with polyethylene jacket for smoothness. Surrounding the steel are six fibers, each covered with polypropylene tubing and then by a flame-resistant strength member. Copper wires surround the six sub-cables to provide an electrical supply in event of future installation of higher bandwidth or video systems which cannot transmit the full distance without repeaters. The wires are covered by mylar tape for a thermal barrier and for binding the cable together. Then aluminum sheeting serves as a strength member and a moisture-rodent barrier. This is covered by a water-resistant polyethylene shield. The cables are finished in red polyethelene so workers will recognize them as being optical cables.



CENTEL system and cutaway of optical cable.

Special to C-ED

Eight kM, 12 Channel Fiberoptic Truckline Serves Lompoc, CA

By Sol Yager
Director of Systems Engineering
Times Fiber Communications, Inc.

The dream of fiberoptics systems for CATV has become a reality far more rapidly than most industry experts believed possible. Full scale, cost-effective CATV optic trunklines are here now. And they work.

Surprisingly, the CATV industry's first full size fiberoptic link was demonstrated at a trade show. Those who attended this year's NCTA show in New Orleans saw a complete five kM fiberoptic trunk in the Times Fiber Communications booth. Only the small size of fiber optical cable made this demonstration possible.

Now, however, these same principles are being applied for the first time in the field. Times is currently installing an 8 kM, 12 channel fiberoptic link to serve some 12,000 Teleprompter subscribers in Lompoc, California. This system will replace microwave link.

By now, the advantages of fiberoptics are well known. Fiber optical cables are relatively small and light. Their signal handling capability is enormous. Since optical fibers neither pick up nor emit electromagnetic radiation, they are completely free from such coaxial cable problems as RFI and direct pickup. Ground loops and transient power surges don't exist in fiberoptic cables either.

Three recent developments have made fiberoptics practical for CATV today. First, the attenuation of optical fibers has been decreased dramatically, while bandwidth has increased. Older fibers had attenuation in excess of 15 dB/kM, with bandwidths of only 50 MHz. Today's fibers are much better. Times G6-600, for example, has a bandwidth of 600 MHz and attenuation of only 6 dB/kM.

Second, long-life injection laser diodes have been developed as a light source for optical transmitters. Until recently, these lasers were capable of only very short life at low power output. Times uses lasers capable of 100,000 hours of continuous use (more than ten years). Manufactured for Times by General Optronics, these lasers provide useful power output.

Finally, until now designers of fiberoptic systems have concentrated on digital transmission. Times makes equipment for digital optic links also, but for many CATV applications, analog transmission is preferrable. It is the use of analog equipment that has made the Lompoc system cost-effective.

How the Lompoc System Works

Figure 1 is a block diagram of the Lompoc system. This is what is called an FDM-FM-IM analog system. Analog is preferrable to digital in systems of this type because it is less expensive and conserves bandwidth. For example, each channel in a digital system takes up 94 MHz. Therefore, to get 12 channels onto a single fiber, you would need a fiber with a bandwidth of over 1,100 MHz. This type of fiber is not presently available in cables suitable for CATV. Further, digital systems

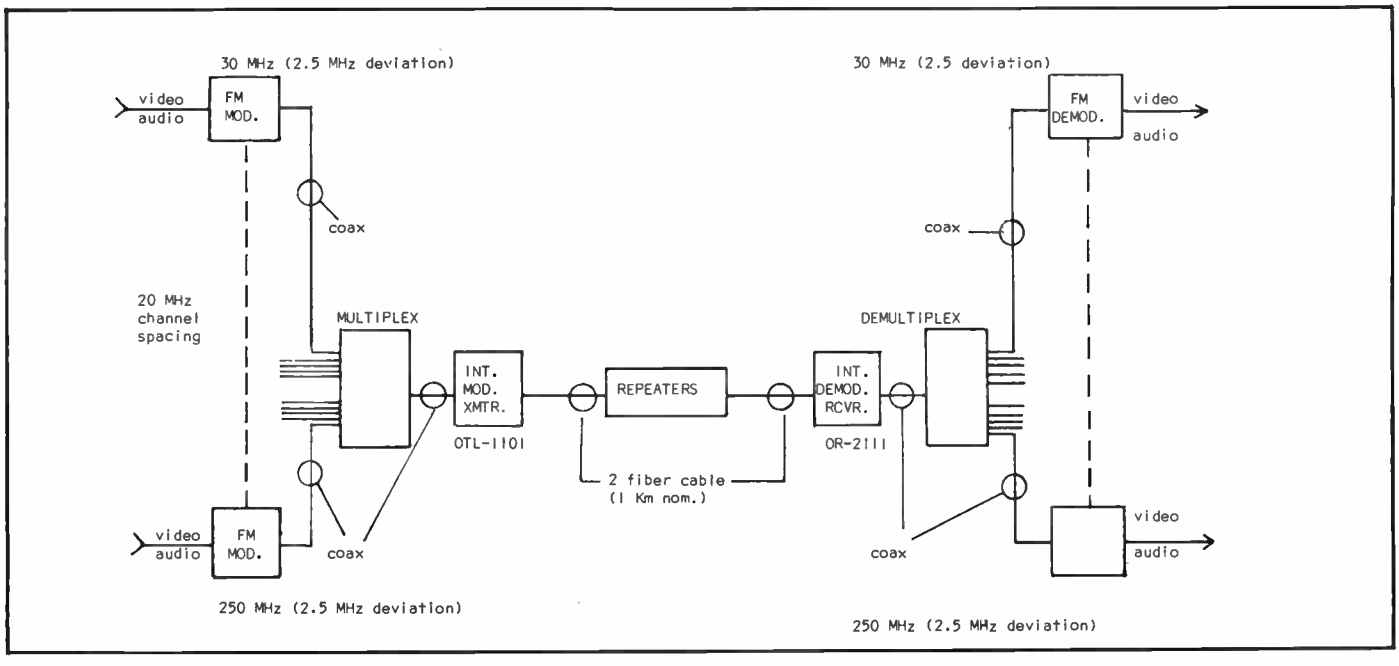


Figure 2

require very complex terminal equipment.

FDM stands for Frequency Division Multiplexing. It is the method by which a number of different channels are combined for carriage over a single optical fiber (or coaxial cable).

FM stands for Frequency Modulation. TV signals are broadcast commercially in AM, but we are converting here to FM for enhanced picture quality. FM provides a higher signal-to-noise ratio than AM, as well as greater distortion tolerance. Times also makes analog FDM-AM-IM systems, which are suitable for other applications. When improved lasers are available, AM will provide pictures as good as those currently being delivered by FM, in systems of this length.

IM represents Intensity Modulation. All of today's fiberoptic communication systems (digital as well as analog) use IM. In an Intensity Modulation system, electronic signals are used to modulate the light output of the laser (or LED). The modulation portion of the electronic signal is used to vary the brightness of the light source. At the receiver, these variations in light intensity are converted back into their original form.

In Lompoc, each of the 12 TV channels is processed by the headend equipment and applied to the Times fiberoptic link as 12 separate audio/video baseband signals. Each baseband signal is fed into a 30 MHz FM modulator. The modulator outputs are then combined (FDM) into a single coaxial cable and applied to the input of a Times model OTL-1101 IM optical transmitter. Seven repeaters are used to cover the eight kilometers. A fiberoptic repeater is something like a CATV trunkline amplifier, but it operates in a different way. The first stage in an optical repeater is an optical receiver. This receiver uses an avalanche photo detector. The variations of light intensity are converted into an electronic signal. The electronic signal is then amplified by conventional means in the second stage of the repeater. The third stage of the repeater is an optical IM transmitter, using the same type of laser used in the transmitter.

At the other end of the eight kilometer link is a receiver, followed by a demultiplexer and 12 FM demodulators, each of which delivers the original baseband signal.

Figure 2 shows the model OTL-1101 transmitter used in this system. The operating wavelength is 830 nanometers and spectral bandwidth is five nanometers. A standard 75 ohm F connector is used at the RF input. An optical connector is used at the output.

Figure 3 shows the model OR-2111A fiberoptic receiver used. Bandwidth is 300 MHz. A standard 75 ohm F connector is used at the RF output, and an optical connector is used at the input. All of the system components operate from 110V AC. Subscribers in Lompoc will be enjoying the benefits of fiberoptics this fall. The system is being installed for Teleprompter on a turnkey basis by Times. **C-ED**

Figure 3

Ad Index

If we didn't solve so many drop cable problems, someone else might be number one.

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Fiberoptics

Siecor Interconnecting Hardware Complements Optical Cables

In addition to a multi- and single-channel line of optical cables, Siecor Optical Cables, Inc. offers interconnecting hardware.

Cable terminations, in-line connectors and source/detector receptacles are included. Each element is interchangeable and intermateable, and all hardware is compatible with Siecor optical cables.

Performance of Siecor cable terminations and in-line connectors depends upon exact positioning of an optical fiber to permit light to enter or leave an adjacent source, detector or other optical fiber.

Further information is available from Siecor Optical Cables, Inc., 631 Miracle Mile, Horseheads, New York 14845, (607) 739-3562.

Test Equipment

Wave-Maker from KeyTek

The first high-speed, high-energy commercial test equipment capable of producing precisely-simulated electromagnetic pulses (EMP) has been introduced by KeyTek Instrument Corporation.

The new EMP Wave-Maker (model PN 284) is a plug-in pulse generator that is used in conjunction with the firm's model 424 Surge Generator/Monitor. The resulting system generates 1 MHz damped cosine pulses with leading edges as fast as 1 to 2 MV/uSec.

The new model 424/PN 284 system produces and monitors well-characterized test waves that can be directly injected through system interconnects to inputs of critical subassemblies. Measured responses to the simulated EMP transients can provide solid, quantitative information on both malfunction and failure modes.

For more on this equipment, contact KeyTek Instrument Corporation, 220 Grove Street, Waltham, Massachusetts 02154, (617) 899-6200.

Wavetek Announces Low Radiation Leakage Option

Wavetek Indiana Inc., has announced Option 07 that improves the standard RF leakage of its 3000 series signal generators by a factor of ten.

The RF leakage of the 3000 series signal generators with Option 07 is less than 0.1uV into a two-turn, one-inch diameter loop held one inch from any surface.

The improved shielding and power line filter allows measurments of ultra-sensitive receivers and transceivers in non-shielded environments.

For further information, contact Wavetek Indiana Inc., 66 N. First Avenue, Beech Grove, Indiana 46107, (317) 783-3221.

Microprocessor-Controlled Microwave Counter Now Measures to 24 GHz

A new option for Hewlett-Packard's model 5342A microwave frequency counter extends its measurement range to 24 GHz. The new option H10 guarantees a -15 dBm sensitivity from 18 to 24 GHz, giving radar and microwave communications equipment users and designers a low-cost, accurate measurement instrument.

The basic model 5342A was introduced in November 1977 and offers simple keyboard control and versatility. It comes in a field-portable package and measures frequency from 10 Hz to 18GHz with a resolution of 1 Hz on an 11-digit LED display.

For more information, contact Hewlett-Packard Company, 1501 Page Mill Road, Palo Alto, California 94304, (415) 856-1501.

Miscellaneous

Theater-Style Home TV Can Be Viewed in Normal Light

A six-foot projection TV that can be viewed in normal room light is at the home threshold. The new development by Henry Kloss, founder of Acoustic Research, KLH, and Advent Corporation, promises to reduce manufacturing costs of high performance projection television by 50 percent, while eliminating the need to darken surroundings theater-style for picture visibility. The invention can make possible a $2,000 system of higher brightness and clarity than present systems costing $3,000 or more.

Tooling of tubes and optics is complete, and prototype quantities have been manufactured by Kloss Video Corporation.

For more data, contact Arthur D. Little, Inc., 25 Acorn Park, Cambridge, Massachusetts 02140, (617) 864-5770.

Inductive Coupler Locates Buried Cable in Crowded Areas

The new IC-56 inductive coupler from Aqua-Tronics locates a selected pipe or cable buried in crowded joint trenches or with other lines under concrete floors, even when they are grounded to a common junction. The IC-56 singles out the target line by inducing its own transmitter's identifiable tone on the line with no physical connection. The hinged induction coil is applied to any accessible section up to 5 5/8-inches in diameter (5-inch conduit). Since no ground plates or rods are needed, confusing ground currents are eliminated.

For more information, contact Aqua-Tronics, Inc., Dept. 44, 17040 S.W. Shaw Street, Beaverton, Oregon 97005.

***Cox Cable Communications**, parent company of **Mission Cable TV, Inc.**, has announced the election of **Gerald L. Bahr** as a vice president of Mission. Bahr was previously chief engineer of Mission Cable.

***Scientific-Atlanta** has announced two major engineering changes. **Donald Pisarcik** has been named director of sales and services for the **Instrumentation Group** of S-A. He will be responsible for field sales and service operations for the domestic and international markets. Pisarcik was previously with Monsanto. **Soloman H. (Skip) Webb** has joined S-A as manager of distribution products for the company's **Cable Communications Division.** He will be responsible for all activities concerned with sales and service of S-A's line of electronic distribution products for the CATV industry.

***United Press International** has named **Richard Boggs** as the first manager of Newstime, UPI's around-the-clock audio-video news service.

Boggs will direct operation of Newstime's news and production center at Smyrna, Georgia, and will be responsible for introduction of UPI's brief, broadcast writing style to the Newstime service.

Richard Boggs

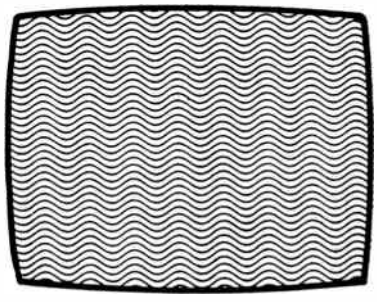
***Michael J. Mackin** has been promoted to manager of marketing services at **Philips Broadcast Equipment Corp.**, a wholly-owned subsidiary of **North American Phillips Corp.** He was previously field engineering supervisor. Mackin has been with PBEC since 1965 in various technical responsibilities.

*Three **Storer Cable TV** executives have been elected vice president of the company's CATV Division. They are **Jim Faircloth**, director of operations, based in Sarasota, Florida; **Ross Wileman**, director of operations, based in Thousand Oaks, California; and **Harold Null**, director of engineering, also based in Sarasota, Florida.

Faircloth has been a director of operations since 1976. He was formerly manager of Storer's Sarasota, Venice and Englewood, Florida CATV systems.

Wileman has also been a director of operations since 1976. He was previously manager of that company's Westlake and Thousand Oaks Cable TV systems in California.

Null has been a director of engineering for Storer Cable TV since 1970. He was also recently elected eastern vice president of the Society of Cable Television Engineers.



Q I have a Channel Commander 1 headend and have had problems with beats in the picture. The beat appears on channel 8 when channel 9 is on and disappears when I turn channel 9 off. I have seen this kind of problem at other headends that I've worked on and have usually been able to cure it by one means or another. This one is stubborn though. Thanks for any help you can give.

A One of the common problems found in many headends is a beat or interference being introduced into a channel by one of the adjacent channels. As an example, say you are tuned to channel 8 with a television receiver and see a beat in the picture. When channel 9 is turned off, the beat in channel 8 disappears. Exclusive of poor alignment of the TV set this interference, or beat, is generally caused by the third order intermodulation product from the adjacent channel processor or modulator. In this case channel 9 is interfering with channel 8. These beats are generated at a frequency 4.5 MHz below the video carrier and 4.5 MHz above the sound carrier of the offending channel. In the frequency domain they appear as follows:

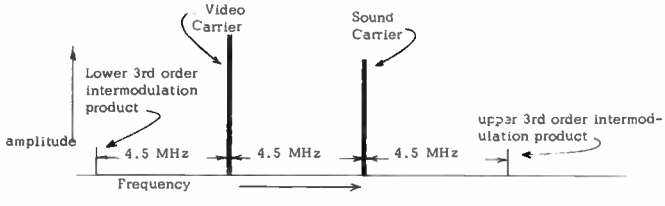


Figure 1

As you can see, these intermodulation products will indeed interfere with the adjacent channels. In the case of channel 9 interfering with channel 8, the frequency domain display (as seen on a spectrum analyzer), would appear as shown below:

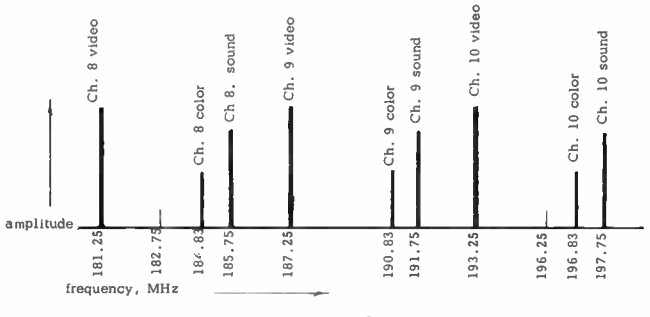


Figure 2

These beats at 182.75 MHz and 196.25 MHz are actually being generated in the channel 9 processor, but are showing up in channel 8 and channel 10 pictures as an interference. The 182.75 MHz beat would be the most visible because of its proximity to the channel 8 video carrier.

This problem can be handled in one of two ways. First of all, a pass band filter of sufficient skirt selectivity can be installed on the output of the channel 9 (offending channel) processor. A 3 to 6 dB pad may be required between the filter and the output of the processor to improve match and reduce loading effects between the processor output circuitry and the pass band filter. These loading effects can cause poor frequency response through the combination of the processor and filter, where a sweep response test may show the individual components to have good frequency response when checked separately.

The second method is to reduce the output level of the processor or modulator. The intermodulation products are a third order distortion and therefore obey a two for one ratio law, as does cross-modulation. (Cross-modulation is also a third order distortion.) An example of this 2:1 law is as follows: Assume that at an output level of +60 dBmV, the intermodulation products of our channel 9 processor are 50 dB below the video carrier (or at a level of +10 dBmV). If you turn the output level of the processor down by 1 dB to +59 dBmV, the intermodulation products will be reduced by 2 dB relative to the video carrier. In this case they would be 52 dB below the video carrier, or at a level of +7 dBmV. Using this bit of information, if the above processor were wired into an existing headend and followed by a pad, as is often times found in CATV headends, (in this example, assume a 10 dB pad), the actual output level of the processor, after the pad, would be +50 dBmV, and the intermodulator products would be 50 dB below that level, or a 0 dBmV. These intermodulation products would cause interference in adjacent channels 8 and 10 by adding the interfering signals at 182.75 MHz and 196.25 MHz as shown in Figure 2. At a level of 50 dB below the adjacent channels video carriers, these beats could be visible.

If, however, the processor's (or modulator's) output level is lowered by 10 dB to +50 dBmV and the 10 dB pad is removed, the actual output level will remain unchanged, but the intermodulation level will have been reduced by an additional 20 dB and will now be 70 dB down relative to the video carrier. The beat will still be present in the adjacent channel but instead of being 50 dB down and visible, it is now 70 dB down and invisible.

Q I'm measuring cross modulation with a spectrum analyzer and it doesn't correlate with the measurements made by an envelope detector and a waveform analyzer. Why is this?

A The cross modulation components on a given channel are not necessarily in-phase with each other. Because of this, there is a difference in the number received by the two methods. The spectrum analyzer will show a worse measurement than the envelope detector and waveform analyzer. The best method is determined by that method which most simulates what the TV set sees. In this case, the TV set sees the envelop detector and wave-form analyzer. Errors in the magnitude of 20 dB can be realized if you use a spectrum analyzer to measure cross modulation.

The Canadian Fiberoptic Project

By Kenneth Hancock, director of engineering, CCTA

Last November this column discussed the world's first fiber-optic super trunk system being developed for installation in London, Ontario by BCN Fibre Optics Limited.

At that time a field test on the fiberoptic cable was underway and Harris Corporation had begun to develop the electronic hardware. The fibers have been accepted and are currently being made into cable by Canada Wire and Cable Limited at their Winnipeg plant. The complete system will come together for further tests in Toronto in August. It is hoped that complete installation will commence early this fall, so the complete system will be operational by winter.

As was stated in the November issue of *C-ED*, the super trunk will consist of an eight-fiber cable with portions lashed to normal pole line strand and some buried underground along a 7.8 kilometer route in London, Ontario. This route parallels a one-inch coaxial super trunk currently in place so that comparison tests can be carried out. The super trunk will transmit 15 TV channels, 12 FM stereo channels, a test and maintenance link and digital channels. Only six of the eight fibers will be used, the remaining two being used as spares. There will be two repeaters along the 7.8 kilometer link.

The equipment developed at Harris Corporation, and accepted after very comprehensive tests, consists of a headend equipment rack, two repeaters with associated power supplies, miscellaneous spares and a hubend equipment rack. The system is designed so that the transmit equipment, repeater boards and receive equipment feeding one particular fiber are self-contained. An outage on one piece of equipment would, therefore, only effect the signals carried by a single fiber. Each fiber carries either three interleaved digital video channels with two FM stereo channels, and an additional one megabit of asymmetrical digital information or two channels of vestigial sideband video with two channels of FM stereo, and one megabit asymmetrical digital information. All the information is in digital PCM form and gives a 322 Mb/s bit stream. The final fiber is used as an upstream fiber carrying three channels of video information.

Both the headend racks and the hubend racks are configured in panels consisting (in the headend case) of all the modules required to process the signals and transmit them onto a single fiber, with the sole exception of the upstream panel which consists of all the modules required to receive the optical signal, decode it and demodulate it. The panels are divided into those for baseband video, vestigial sideband video and FM. The hubend rack configuration is the opposite of this, consisting of the reception decoding and demodulating equipment with the exception of the upstream channel.

As mentioned before, the two repeaters have individual cards for each fiber. The repeaters are mounted in typical trunk amplifier casings and regenerate only the bit stream and not the timing and synchronization signals. The repeaters have been subjected to full environmental cycling to plus and minus 50 degrees C. The repeater power supplies are comparatively standard 0.1 percent regulated power supplies with current limiting on the transients. The power supplies produce plus and minus five volts, plus and minus 15 volts and finally a plus 250 volts for the avalanche photodiodes. They have standard modular construction.

All of the equipment had a six week burn-in period and underwent several tests to overcome infant mortality. The injection laser diodes are held to plus 25 degrees C or less to achieve an injection laser diode lifetime objective of 100,000 hours. This is understood to be the highest lifetime figure achieved so far in North America in operational, as distinct from laboratory, equipment. Thermo-electric cooling is used to maintain the laser block at plus 25 degrees C or below. The injection laser diode is gain stabilized by a photodiode at the rear of the laser which provides an AGC voltage.

Three basic fault alarms are provided with individual read-outs for each of these three fault conditions. The fault conditions are receiver voltage, which is the bias voltage on the avalanche photodiode and therefore indicates a receiver fault; transmitter voltage which measures the current in the laser, and bit error rate (BER). The BER is the overall measure of the performance of each channel. The read-out of this parameter is normally kept on at all times as it provides an error trend for each channel, a very powerful tool in evaluating the performance of the system with time. It also allows replacements to be made prior to the system falling below its specified performance.

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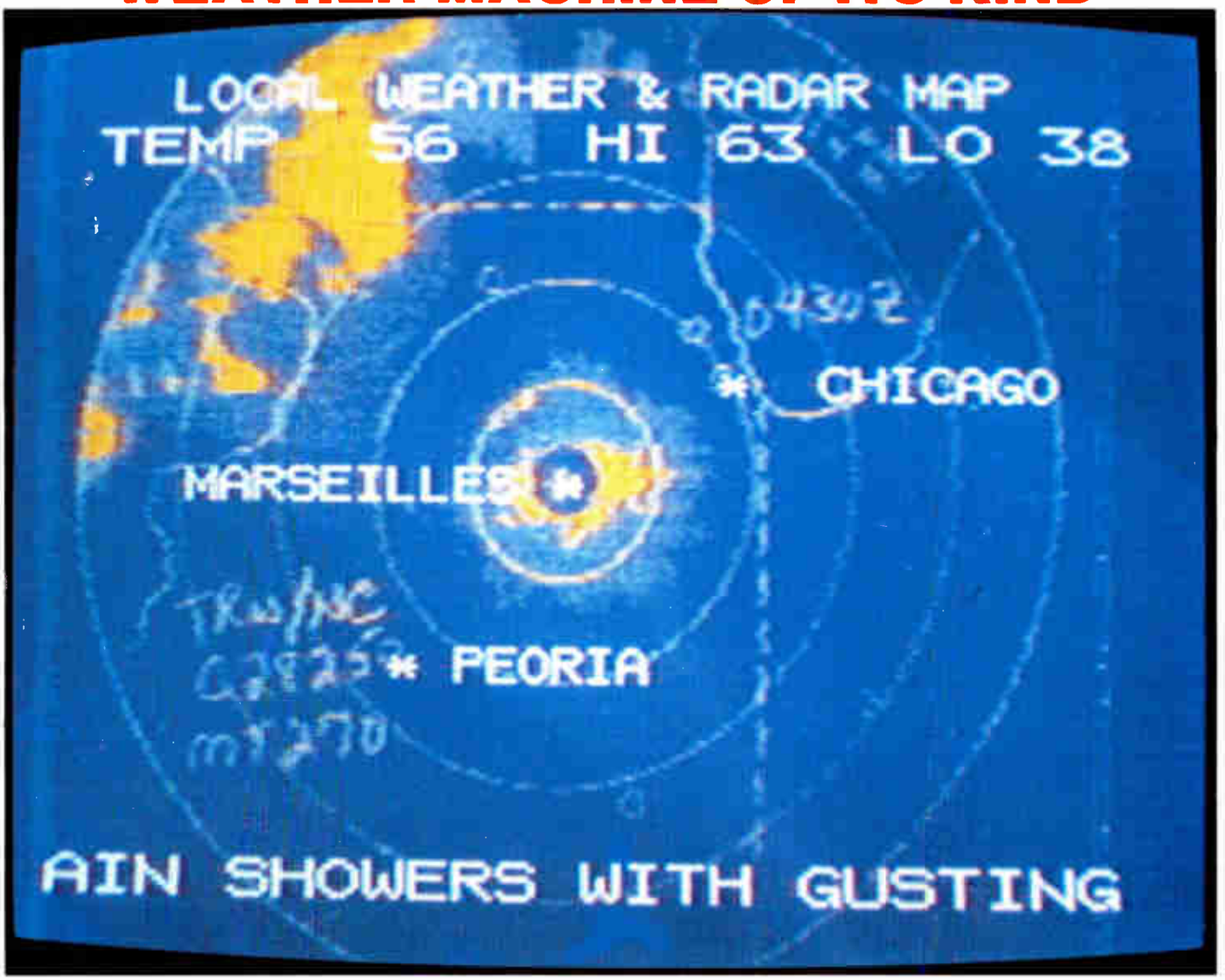

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Help Wanted

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Minimum 10 years CATV construction as a working supervisor. Must be able to do poll surveys, CATV engineering and design. Must be able to deal with Bell and PECO and know all their standards. Willing to work away from home. Please send resume to:

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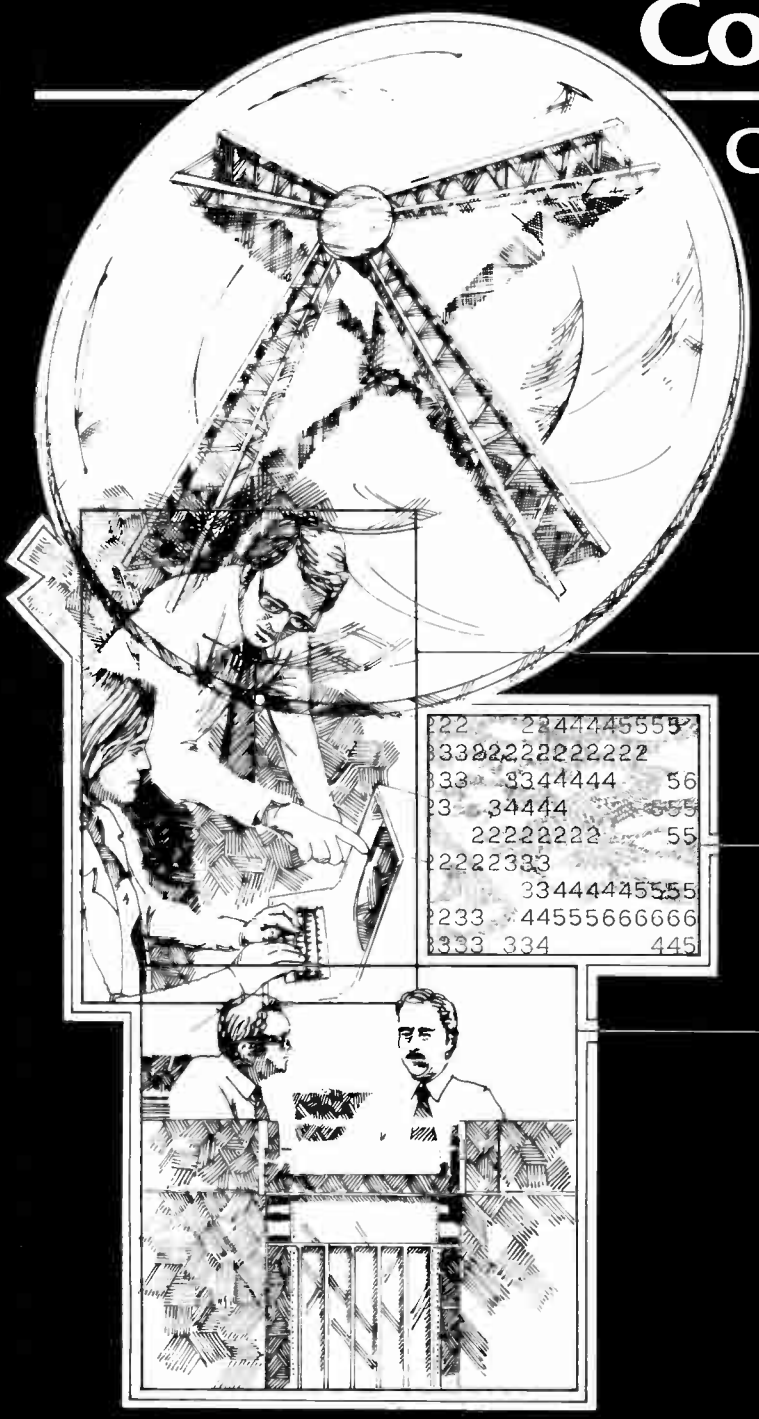

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