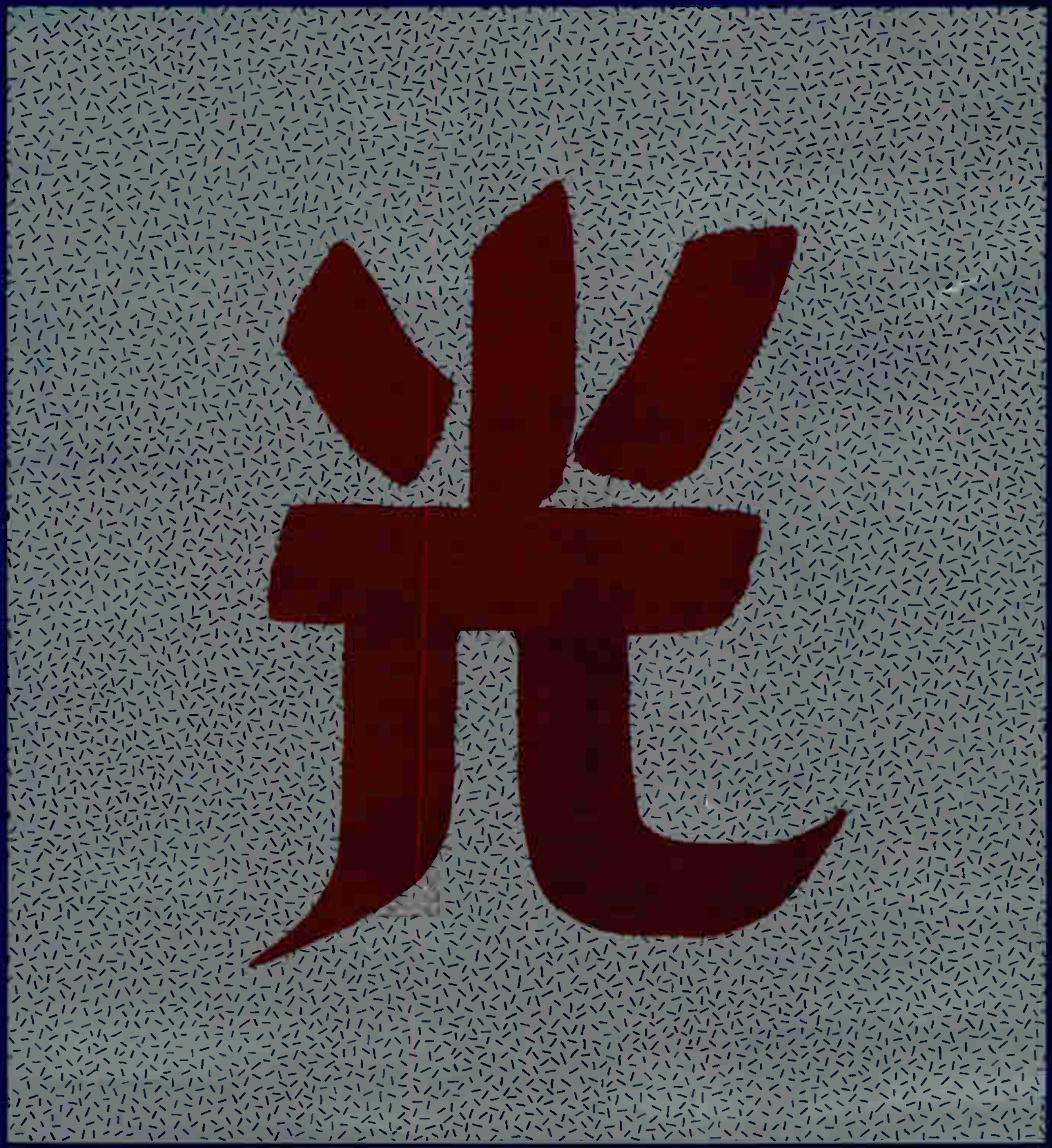
CATJ

OFFICIAL JOURNAL OF THE COMMUNITY ANTENNA TELEVISION ASSOCIATION
JULY 1983



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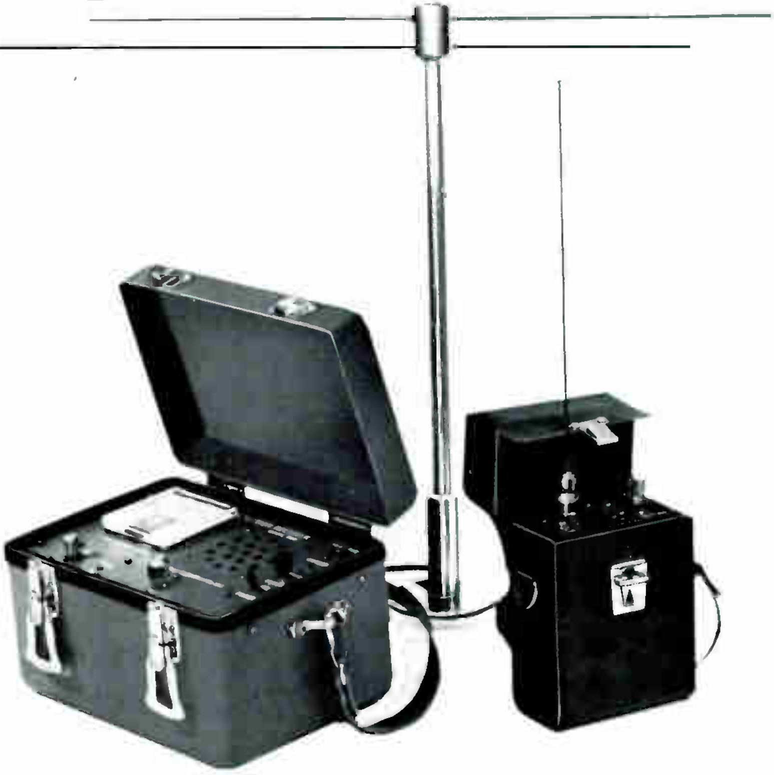

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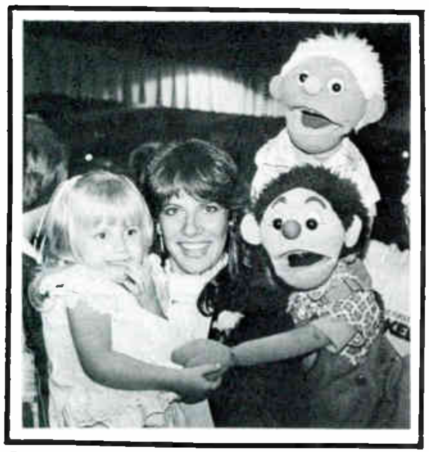

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Applying this to a receiving system with reference to the "receiver" input port (LNA flange), the antenna acting as noise source kTB, then if we had a "perfect" LNA, contributing no noise of its own, the noise power at its output would just be kTB multiplied by the LNA's gain factor G. (Remember here we are still considering numerical ratios, not dB — the standard 50 dB gain LNA has a numerical power gain of 100,000 times.)

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Here are some useful values:

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Fig. 1 is a plot of noise figure against equivalent noise temperature, over the range of greatest interest.

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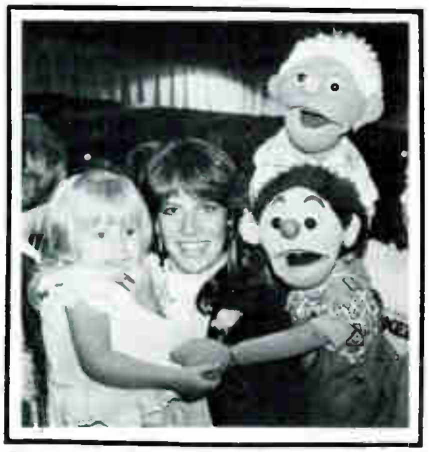

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DEADLINE FOR PRE-REGISTRATION FEE IS JULY 15th!! After that date, ALL registration is $150.

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catatorial

Peter Athanas
President of CATA

President's Note: The following letter was sent by CATA to Dan Ritchie CEO of Group W and the newly-named head of the "Consortium For Cable Information".

Mr. Daniel L. Ritchie
Chief Executive Officer
Group W Cable
888 7th Avenue
New York, N.Y. 10107

Dear Dan:

Congratulations on your assumption of the post of "first steward" of the new venture in cable television aimed at "improving cable's public image". There is no question that such an undertaking is needed. However, before plans get developed in stone, there are a few suggestions we would like to offer.

As I am sure you know, the Community Antenna Television Association has maintained for a long time that one of the most serious problems facing our membership is the rampant misperception of what the cable television business really is. CATA represents both large and small systems. Our membership spans the spectrum from very small "mom and pop" systems to the largest MSO in the United States. Our members run "traditional" "CATV" reception systems and are also involved in some of the most innovative experiments in broadband communications such as the efforts now going on in Boston. Our members provide cable television service to over 6 million subscribers, and that number is growing rapidly. The one unifying factor, however, is that CATA works with and represents the workers at the system level. We focus on the practical, day to day problems of the individual owner or manager and try to deal with those problems rather than focus on the board rooms of the large corporations as some other associations do. Both types of focus are important and they complement each other. That is why many major corporations are joining CATA — to assure that the input of the local owner or manager is attended to as well as the CEO. Having worked on that level for several years I can assure you that we are very sensitive to the "image" of cable television.

If the trade press reports are accurate, the NCTA and some of the major cable companies have decided to fund an effort to "improve" that image. But what image of cable television are you going to project? CATA believes that the problems we are all facing today regarding renewals and franchise promises stem in great part from unrealistic projections of cable's image in the past. This view, and its consequences, are apparently shared by many influential members of the cable community. I would recommend that you take a look at some of the recent comments of Tryg Mehren regarding recent franchise requests and promises for corroboration of that view.

The evidence is unfortunately all around us that the "popular" perception of what cable television is does not really comport with reality. Witness the ongoing struggle we face on Capitol Hill to get some reasonable stability in the regulatory process of cable. The debate has shifted to one that pictures cable as presenting such a threat to that Bell System's local telephone rates that, so the argument goes, our massive data transmission and "enhanced services" capabilities should be strictly regulated, or we should be put on an "equal" regulatory footing with the telephone industry! This is all happening at a time when less than one percent of all cable homes have the technical capacity for two-way interactive data transmission! The perception of what cable could be, or what it might be in the future, or what it has the technical capability for has far outstripped the reality of what cable is, and what services have been proved to be economically viable.

The popular perception of cable is that it is an extremely "rich" industry and the new "money machine" for big companies in the telecommunications business. The fact that the industry is over 5 billion dollars in debt is seldom mentioned. We are perceived as the technological solution to many urban ills — thus we see the demands for access, training, studios, mobile vans, etc. Very little is mentioned about the massive amount of equipment already purchased by cable systems around the country that has lain dormant after the initial thrill of the technology wore off. We are perceived as the purveyors of pornography but are seldom noted for the delivery of the unique, quality programming such as that provided by C-SPAN. But I'm sure you are aware of the litany of perceptual problems we face.

What are the solutions? One, to be sure, is the initiation of an effort such as the one you are now heading to "correct" some of our "image" problems. However, before you do so CATA would encourage you to engage in widespread dialogue with all segments of the industry to assure that the image which is ultimately projected is accurate. We have gotten into the problems mentioned above in no small part due to our own actions. The "bells and whistles" perception of the cable industry has served very well to promote the stock of some major companies. It served very little purpose in the middle of a franchise battle or an effort to impress Wall Street for some companies to focus on the economic realities of those technological wonders — the fact that they theoretically could be done was enough to create the desired excitement — the reality of whether the technology could be translated into services that consumers really wanted was left for later. The same is true of the major cable television trade show/media events. They are "sexy", they attract attention to the industry, but do they give an accurate picture of an industry that still has a majority of systems with 12 channel capacity or less? And speaking of "sex", is our problem with constantly getting "bad press" about "porn" a true picture of cable or is it really a reflection on the popular press — both television and newspapers, which find it useful for their purposes to stress such issues because it sells their products?

All of these issues must be analyzed and dealt with in a truthful and open manner in any effort to correct the misperception of the cable industry that is now so prevelant. We must all seek to portray what the cable industry as a whole really is — the good and the bad, the traditional and the experimental if we ever hope to be treated by the public, the financial community and the government in any sort of rational way. CATA stands ready to aid in any way we can in that effort.

We trust that you recognize that any effort to present the "image" of the cable television industry must be broad based. Consultation and cooperation with all segments of the industry will be necessary. A "PR" campaign designed and run by a few corporate giants will be recognized for what it is, and will dilute the effectiveness that could be attained. Of course the principal source of funding for any such campaign will have to come from companies such as yours — however we urge you to plan and execute your efforts in cooperation with the entire industry to assure that it succeeds, as it must, for the sake of the entire cable television industry.

I look forward to hearing from you regarding this innovative initiative, and again, congratulations and our deep appreciation for your willingness to take on what may be one of the most difficult and important assignments in the cable television business today. We are glad to see that "operation reality" is finally under way. ☐

S.J.BIRKILL on

EXPERIMENTAL TERMINALS

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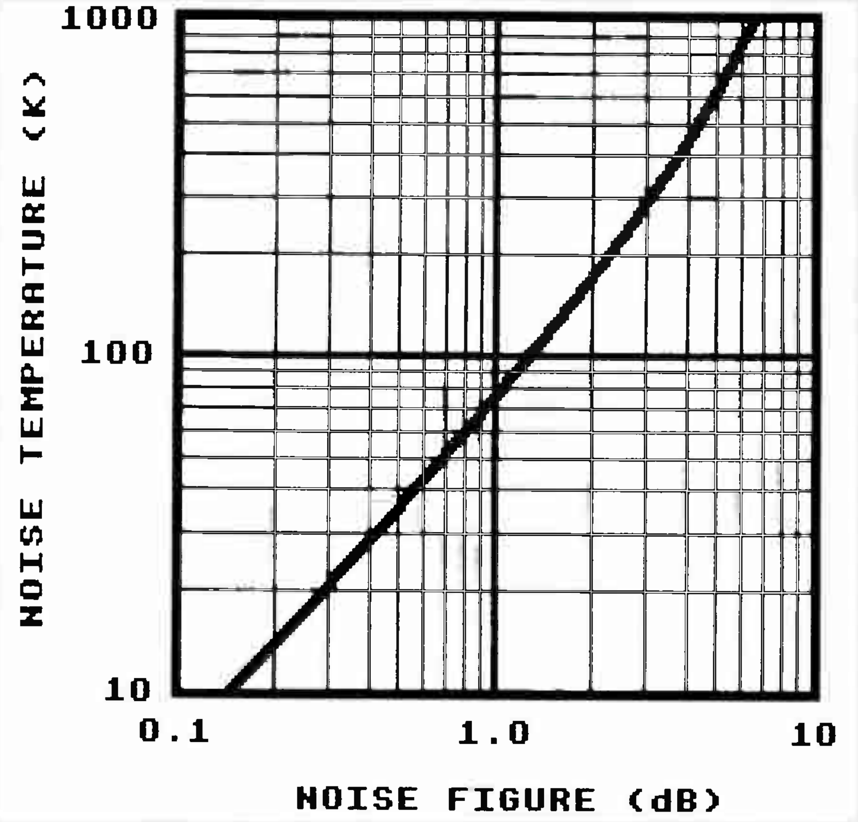

to know the way in which noise figures of subsequent stages modify the first stage noise figure to determine the overall receiver sensitivity. This applies both between stages (as in an LNA) and between blocks (say the interface between LNA and receiver).

Right at the front end there is additional thermal generated by any lossy component, for example the waveguide run between feed and LNA, or even (especially at 12 GHz) the downpath through the earth's atmosphere. This loss-related noise is given (as a noise temperature) by T_0 (1-α), where α is the transmission coefficient, the inverse of the loss factor as a numeric ratio. Alternatively if L is the antilog of 0.1 x (loss in dB), then noise temperature contribution T_L is given by:

$$T_L = T_0 (L-1)/L$$

As an example, consider a ferrite polarization rotator inserted between feed and LNA. These are becoming popular in home TVRO systems on account of their instant current-controlled selection of vertical or horitzontal, and their absence of moving parts. However, unlike the mechanical type (e.g. "Polarotor") the ferrite device can introduce significant loss. Good ones 0.15 dB or less, not-so-good ones as much as 0.5 dB.

On a warm day up near the antenna's prime focus the temperature of such a polarizer could easily reach 104° F, that's 40°C, or 313 Kelvin. Here's a case where we cannot assume T_0 to be 290K. With 0.5 dB insertion loss, the polarizer will not only attenuate the signals by that amount, but will also add its own noise contribution amounting to

$$T_L = 313 \text{ (antilog } (0.1 \times 0.5) - 1) \, / \, \text{antilog } (0.1 \times 0.5) = 34.04 \text{ K}$$

This noise temperature is referred to the polarizer's input port. It suffers its own attenuation in passing through the device, so the additional noise presented to the LNA flange is 0.5 dB less, at a noise temperature of 30.34 K. Given the G/T example quoted above, effective gain G is reduced by 0.5 dB, noise temperature T is increased by 30.34 K, so G/T becomes

44.25 - 0.5 - 10 log (104 + 30.34) = 22.47 dB(/K)

This represents a not insignificant reduction in sensitivity of 1.61 db, from the original value of 24.08 dB(/K). It should be noted that this simple analysis neglects the effect of the additional attenuation on the antenna noise temperature, a factor which offsets the damage by a small amount, typically no more than 3 K. ►

In considering cascaded networks, we can apply the same considerations of input and output noise power to each stage, as we did when defining figure. Without examining its derivation in detail, here is the general equation for system noise figure:

$$F_S = F_1 + \frac{(F_2 - 1)}{G_1} + \frac{(F_3 - 1)}{G_1G_2} + \ldots + \frac{(F_n - 1)}{G_1G_2\ldots G_{(n-1)}}$$

and likewise for effective noise temperature:

$$T_e = T_1 + \frac{T_2}{G_1} + \frac{T_3}{G_1G_2} + \ldots + \frac{T_n}{G_1G_2\ldots G_{(n-1)}}$$

Interstage (or feedline) loss may be allowed for by considering it to be a gain of less than 1. All gain terms here are numerical ratios, not dB.

A 4 GHz LNA design might include a first stage of 11 dB gain, 65 K noise temperature, and a second stage of 13 dB, 100 K. Input isolator loss is 0.15 dB, all figures worst case. Imagine the designer can choose between a third stage of 120 K (NF = 1.5 dB) at \$25, 290 K (NF = 3.0 dB) at \$10, or 438 K (NF = 4.0 dB) at \$5.

In each case the input isolator contributes 9.85 K to the LNA noise temperature (take T_0 = 290 K). For the first system,

$$\begin{aligned} T_{LNA} &= 9.85 + 65 + (100/12.59) \\ &\quad + (120/(12.59 \times 19.95)) \\ &= 9.85 + 65 + 7.94 + 0.48 \\ &= 83.27 \text{ K} \end{aligned}$$

For the second system,

$$\begin{aligned} T_{LNA} &= 9.85 + 65 + (100/12.59) \\ &\quad + (290/(12.59 \times 19.95)) \\ &= 9.85 + 65 + 7.94 + 1.15 \\ &= 83.94 \text{ K} \end{aligned}$$

And for the third system,

$$\begin{aligned} T_{LNA} &= 9.85 + 65 + (100/12.59) \\ &\quad + (438/(12.59 \times 19.95)) \\ &= 9.85 + 65 + 7.94 + 1.74 \\ &= 84.53 \text{ K} \end{aligned}$$

The designer would be well advised to go for the cheapest stage 3 option, as its noise contribution is effectively masked by the gain (24 dB or 251 times) of stages 1 and 2. In practice the LNA's noise temperature would also be modified by the effect of subsequent stages, but so long as stage 3 realised a useful amount of gain (8 dB or more) their noise contribution can be ignored. ☐

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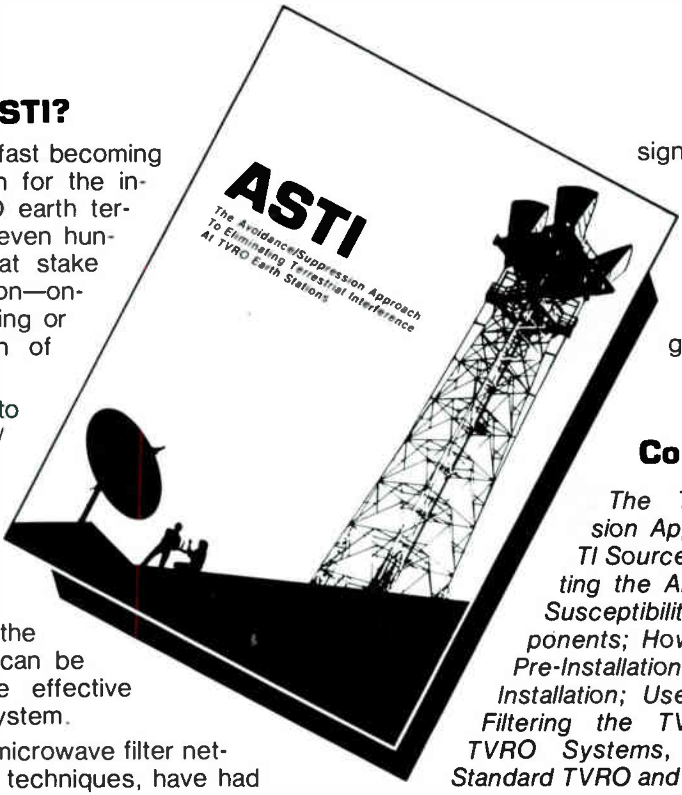

What Is ASTI?

Terrestrial interference (TI) is fast becoming a major economic consideration for the installers and operators of TVRO earth terminals. Thousands of dollars, even hundreds of thousands, may be at stake when the earth station is turned on—only to discover that TI is degrading or altogether preventing reception of desired satellite signals.

The purpose of this volume is to introduce ASTI — the avoidance/suppression approach to eliminating TI — to the 3.7-4.2 GHz TVRO industry. Conscientious application of ASTI will reduce the possibility that TI will be encountered at turn-on, increase the probability that unavoidable TI can be suppressed, and enhance the effective operating quality of the TVRO system.

The authors, as designers of microwave filter networks and other TI-suppression techniques, have had ample opportunity to test ASTI — it works! Measured over a period of time, the costs are substantially lower than any alternative, especially in terms of dollars saved when the initial or only site can be made operable. Furthermore, both cost and complexity of filtering to eliminate TI are lowered considerably when the essential aspects of ASTI are employed.

About the Authors:

Glyn Bostick is the founder, president and chief engineer of Microwave Filter Company, Inc. Mr. Bostick, who writes CATJ's monthly "Filtered Earth Station" articles, has been designing filters to suppress interference at CATV systems and TVRO earth stations since 1967.

John Fannetti is MFC's senior technical consultant and head of the company's Field Service Division. He has 30 years of engineering and earth station troubleshooting experience.

William Johnson, chief engineer of R&D, has designed many of MFC's CATV and TVRO products. Mr. Johnson earned his BSEE at Syracuse University and is currently engaged in graduate studies there.

Contents Include:

The TI Avoidance/Suppression Approach; Why Satellites; TI Sources; TI Symptoms; Selecting the Antenna for Least TI; TI Susceptibility of Other TVRO Components; How to Select a Site; The Pre-Installation Site Survey; Defensive Installation; Use of Artificial Shielding; Filtering the TVRO; Filtering Special TVRO Systems, SMATV Techniques; Standard TVRO and Satellite Data; Formulas and Derivations...

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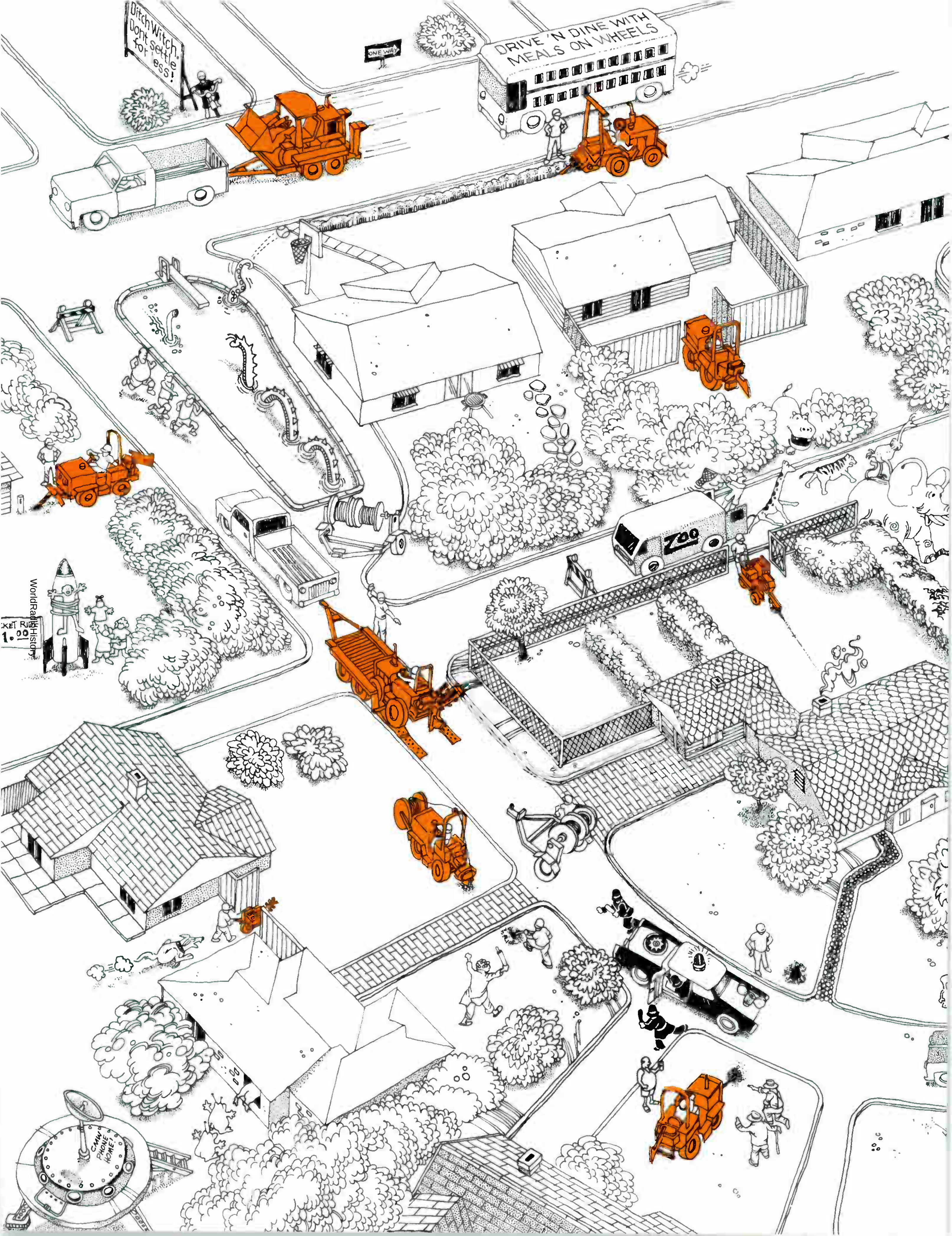
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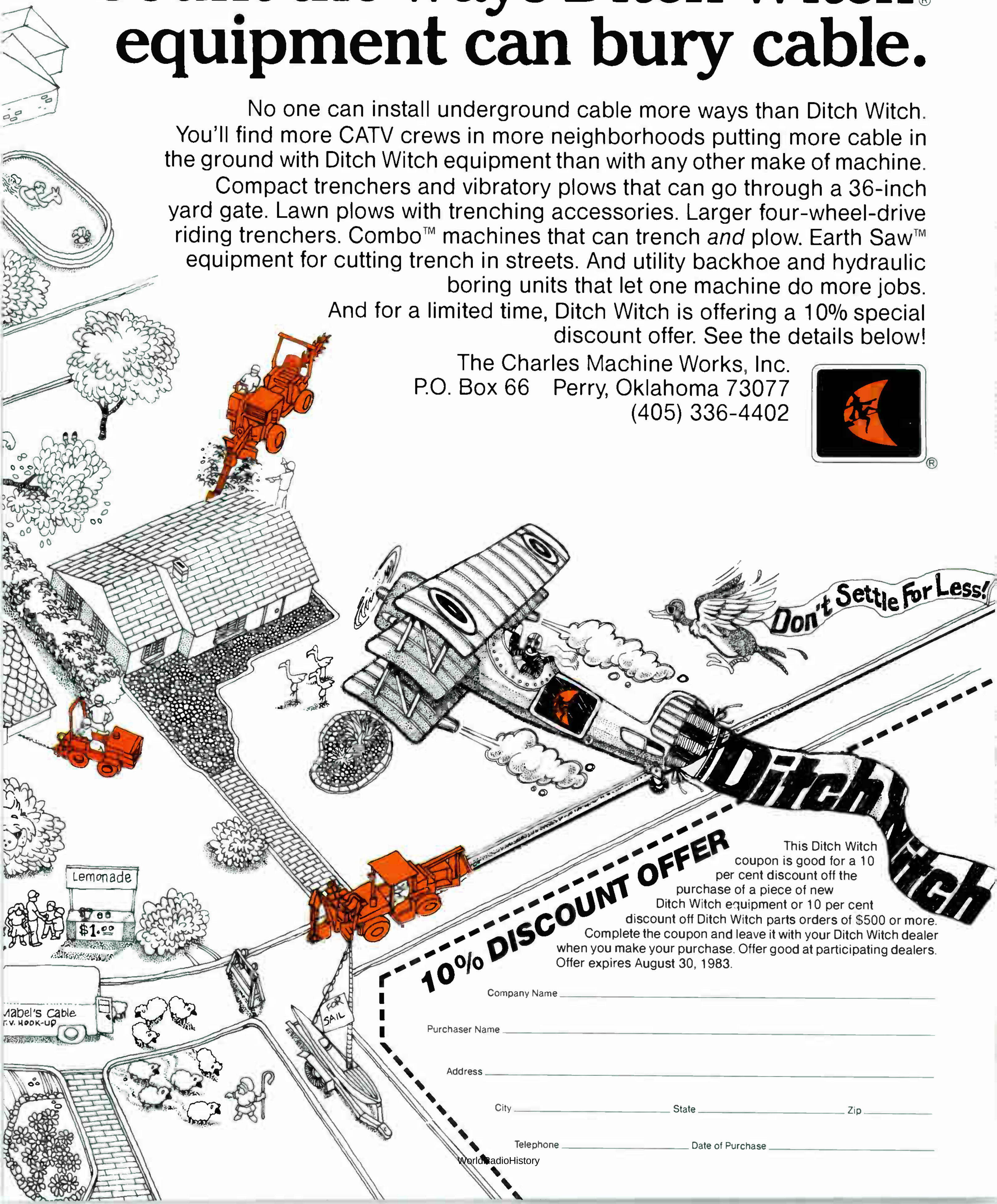

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マルチモード光ファイバを用いたVHFテレビジョン

Development of VHF Multichannel Television Transmission System Using Multimode Optical Fibers

Editor's Note:

This report, prepared by Kazuo Nemoto, Audio Visual Technician at Antelope Valley College, Lancaster, California and owner of Nemoto's Video and Computer Sales Co., was percipitated from several visits to Japan when Mr. Nemoto had occasion to visit the facilities. He found that the NHK (Japanese Broadcasting Corporation) working through Mr. Takizawa and his staff, had begun research on optical fiber seven years ago. As a result, laser diode development has made it possible to use optical fiberglass for multichannel TV transmission in VHF systems. The NHK has installed this system in Hakone, Japan, and has had successful results with the equipment. It was also reported by Mr. Nemoto that in visiting with Mr. Yamaura of the Hitachi Cable Company, who worked in conjunction with the NHK Technical Research Division, he observed additional material about optical fiberglass multichannel VHF TV transmission systems, which was in the production stage at the time of the article preparation.

Mr. Yamaura wrote Mr. Nemoto: "All equipment in Hakone has been checked out for testing performance after one year. The result of the test was excellent. They did not have any problems since they installed the Optical Fiber Transmission System."

In accepting this material, CATJ felt that the information concerning Japanese fiber optics used in cable television would be of great benefit to its readers. The material is thus presented and reprinted in its entirety for the information of our readers.

チャネル多重伝送システムの開発

TV Signal Transmission System Using An Optical Fiber

BY: Kazuo Nemoto
43315 Edson Street
Lancaster, CA 93534

Instead of coaxial cables, optical fibers are now attracting public attention for an analog transmission system of VHF TV signals like a CATV.

For the transmission of TV signals in base band, optical fibers have been already utilized. But, for that of TV signals in VHF band, they have not been utilized yet.

We had been involved in studying an analog and multi-channel transmission system of VHF TV signals using optical fibers and laser diodes, and finally obtained the following system performances under the conditions: transmitting TV signals are on 7 channels arranged in the frequency range from 90 MHz to 222 MHz.

System performances
- Signal to noise ratio; 44 ~ 46 dB
- Intermodulation; – 50 ~ – 54 dB
- Crossmodulation; less than – 62 dB

Here, you can see the experimental arrangement of the system, and its details are as follows;

Optical fiber
- type; graded index
- diameter of crad; 195 μm
- diameter of core; 120 μm
- fiber length; 2 km
- transmission loss; 3 dB/km

Optical transmitter
- type; laser diode
- wave length; 0.83 μm
- average optical output; 5 mW

Optical receiver
- type; avalanche photo diode

In order to complete the transmission system, we had to solve two important problems.

One was the reduction of multi-path distortion generated in a fiber with a small diameter. At first, we thought of picking up a single mode fiber. But, its light coupling loss was so large that we had to adopt a multi-mode fiber. Although 'graded index curve' should be made ideal, in multi-mode transmission, it is difficult to realize it in manufacturing process. Accordingly, we adopted a large diameter fiber to reduce multi-path distortion.

The other was the reduction of noise generated in a laser diode. The noise occurs when the emission wave length skips discretely, depending on the temperature of the laser diode. This is not an avoidable phenomenon in its basic properties. Finally, we put the laser diode package on a Peltier Thermo-element to reduce the noise.

NHK has developed an optical transmission system of VHF multi-channel TV signals in cooperation with Hitachi Cable Ltd.

Hitherto, it has been considered that an analog wide-band transmission system using a multi-mode fiber, a laser diode and a photo diode was impractical because of the following problems:

1) the distortion generated in the laser diode with non-linearity,
2) the noise caused by the fluctuation of emission wave-length when the temperature of the laser diode drifts,
3) the noise caused by the interference in the laser diode between emission wave and reflection wave which reflects from optical connectors and other discontinuous points,
4) the modal noise and distortion generated in the fiber by the multi-mode propagation.

Then, theoretical and experimental studies were made to solve these problems.

For problem 1), we have developed a new type of laser diode which has a large optical output power and excellent linearity. (HITACHI Type 3000)

For problem 2), we put the laser diode on a Peltier thermo-element and controlled the temperature of it within ± 0.1 °C.

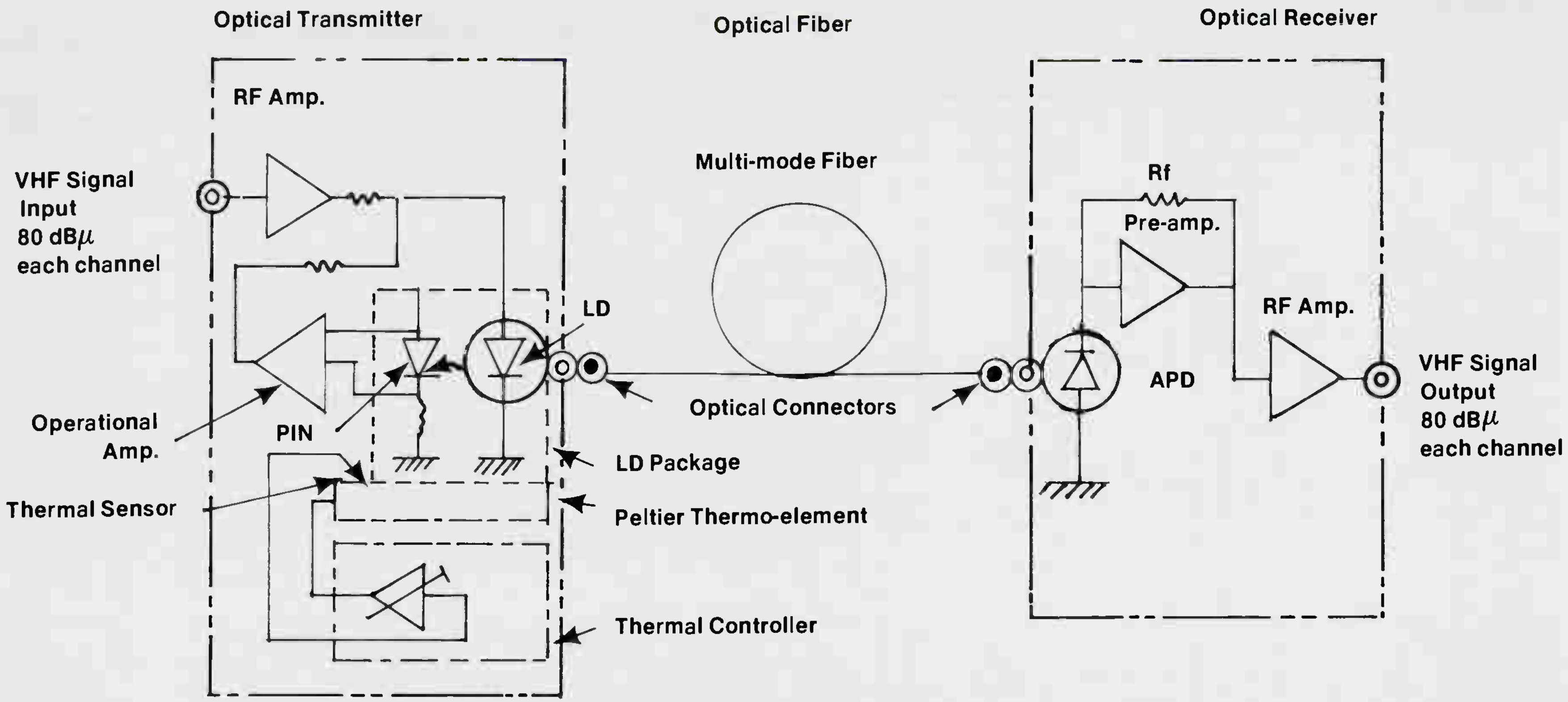
For problem 3), we cut the ends of the fiber with oblique angle at optical connectors and other discontinuous points.

For problem 4), we adopted an optical fiber with a large core diameter and a small numerical aperture.

As a result, the optical transmission system, which transmits seven channel TV signals in VHF band, have been realized through a multi-mode fiber in length of 2 km, as shown in Photo 1.

The system performances are as follows:
Signal to noise ratio; 43 dB
Intermodulation; – 50 dB
Crossmodulation; – 60 dB

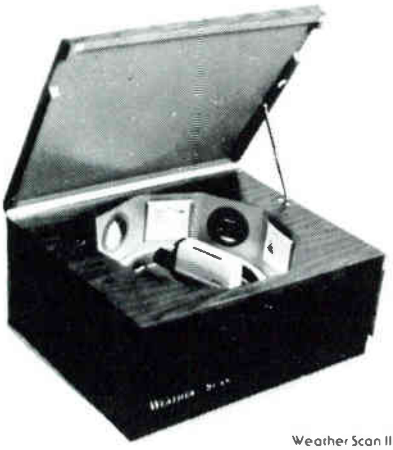
►



LD: Laser Diode, PIN: PIN Diode, APD: Avalanche Photo-diode

Experimental Arrangement

Figure 1



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VHS Multichannel TV Transmission using multimode fibers

ABSTRACT

In VHF multichannel TV transmission systems, the influence of a reflected wave from the fibers and multimode propagation are identified as the causes of the deterioration of the transmission properties. The use of optical isolation devices and larger core/small NA fibers is one of the solutions which enables short haul transmission.

1. Introduction

Improvement of laser diode linearity enables VHF multichannel TV transmission. [1] However, problems noise and distortion generated in light sources and transmission lines have occurred and many of them are unsolved. [2]-[4] This paper describes the measured noise and distortion characteristics of experimental systems using multimode GI fibers and also the measured results with regard to the dependence of fiber parameters on IM distortion, clarifying the causes of degradation.

2. Optical transmitter and receiver

The configurations of the transmitter and receiver are shown in Figure 2. As a light source, a HITACHI BH laser diode is used, which has excellent linearity. [5] The laser diode is packaged together with a pigtail fiber and a PIN photodiode, monitoring not only the average emitted power but also the RF signals. Average optical output is 5 mW and the modulation index is fixed at 10%/CH in all experiments of this paper. At the receiver an APD is used as the photodetector. Its output current is amplified through a low noise transimpedance amplifier. (equivalent input noise current = $10\,pA/\sqrt{Hz}$)

3. Experimental results

Measured C/N and second order IM distortion are shown in Figures 3 and 4 respectively, after transmission through 1 Km of a conventional GI fiber (core diameter = $60\mu m$, NA = 0.2), including two optical connectors at both ends and three splices. C/N shown in Figure 2 has fluctuations, which can be explained by the influence of the reflected optical signal from the transmission line. [6] However Figure 5 demonstrates that both the low frequency noise and the RF peak noise disappear by using isolation devices.

Figure 4 shows the IM as a function of the laser bias current at the TR MONITOR terminal and the REC OUT terminal. In Curve 2 (REC OUT), an increase of the distortion is observed, compared with Curve 1 (TR MONITOR). The slow variation in IM is also attributed to the interference of the reflected wave. ►

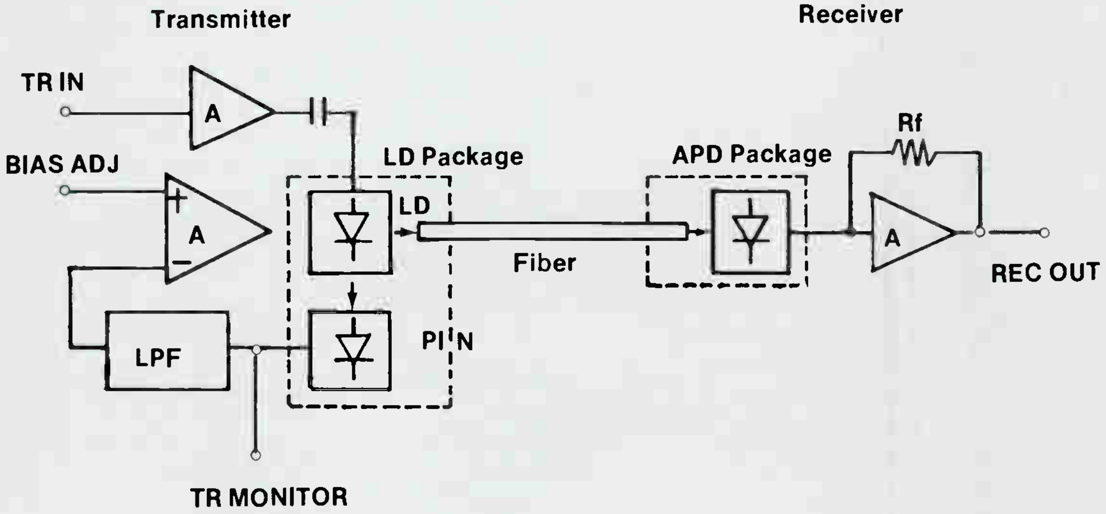
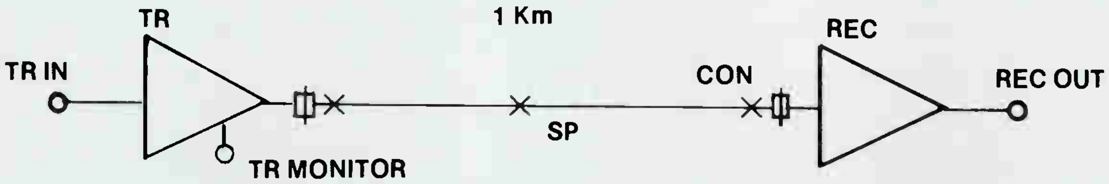


Figure 2
Configurations of optical transmitter and receiver

Figure 6 shows experimental results using 2 Km GI fiber (core diameter = 60 μm, NA = 0.2). Curve 1 shows the measured IM at TR MONITOR, and Curve 2 demonstrates the effect of isolation devices. Even in this case, serious degradation is observed at REC OUT terminal, as is shown by Curve 3. Therefore excess IM is generated when optical signals propogate through multimode fibers.

Based on this experimental result, several types of GI fiber were fabricated in order to investigate the dependence of fiber parameters on IM distortion characteristics. Figure 8 shows the relative IM as a function of fiber length for different fiber types. IM degradation decreases with increasing core diameter and decreasing NA. By optimizing the fiber parameters, the IM will not increase even after a transmission through 2-3 Km long fibers. It is known that the distortion characteristics depend considerably on such transmission parameters as the mode dispersion and the bandwidth etc. In addition to this, fibers of larger core diameter and smaller NA are favorable with regard to coupling with sources.



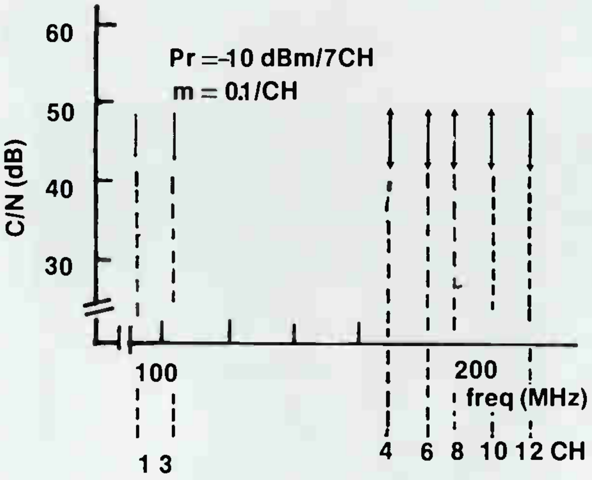


Figure 3
C/N for each
TV channel

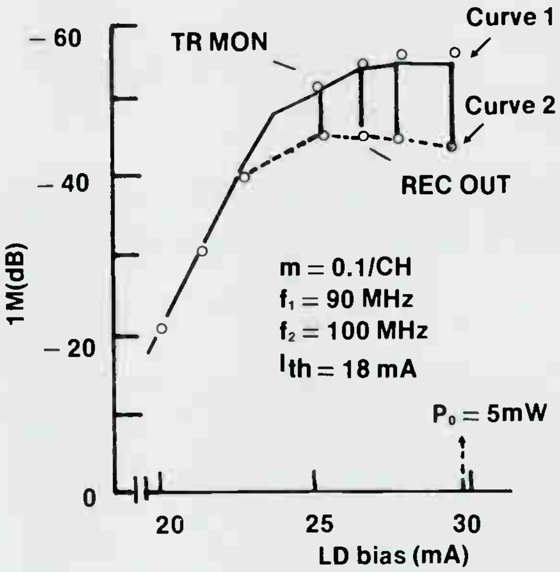
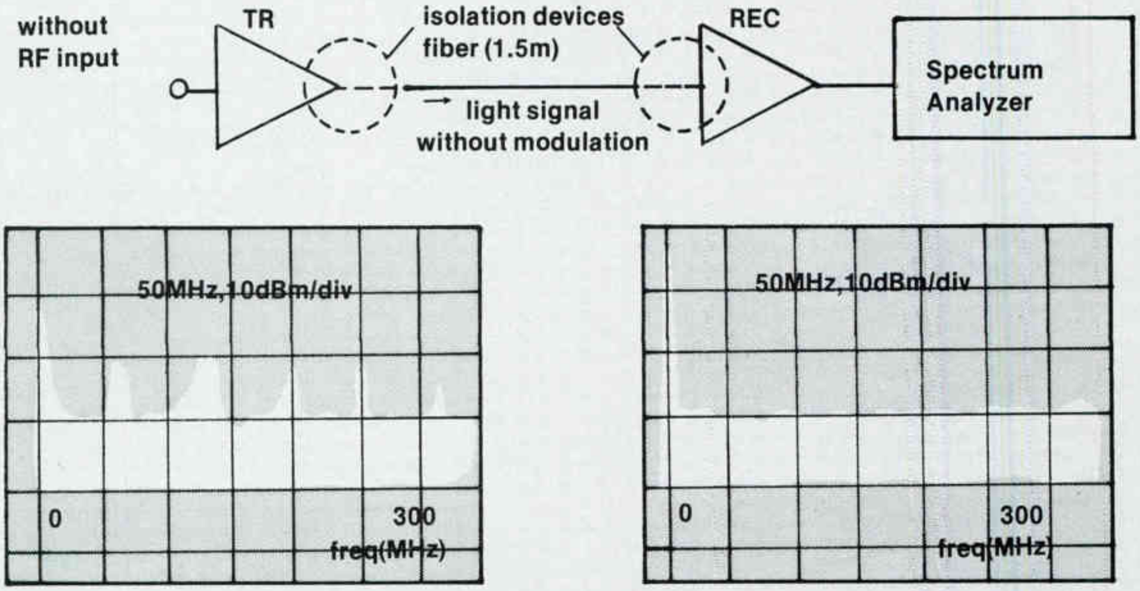


Figure 4
IM as a function
of LD bias

4. Conclusions

In VHF multichannel TV transmission systems, using laser diodes and multimode fibers, the deterioration of transmission characteristics is attributed to the feedback from the line and also to multimode propagation. Isolation devices are effective for the former, and the use of larger core/small NA fibers is one of the solutions to the latter. Hereby short haul transmission can be realized. Further studies with regard to fiber excitation must be made to obtain improved transmission characteristics. ►



(1) without isolation devices

(2) with isolation devices

FIGURE 5
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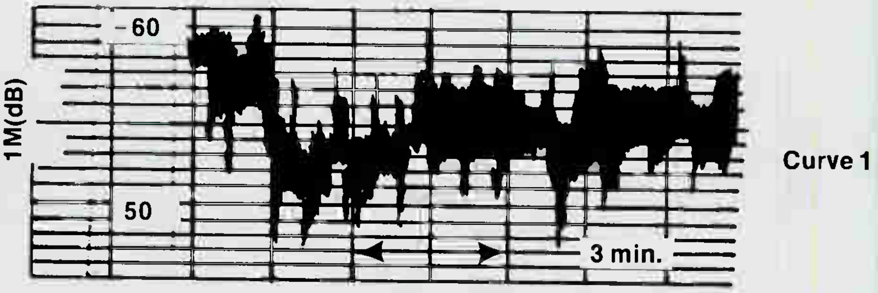
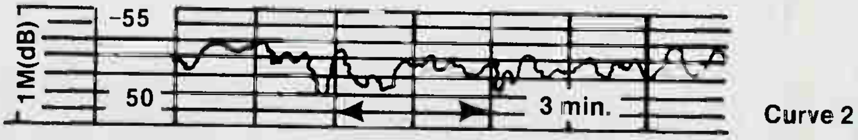
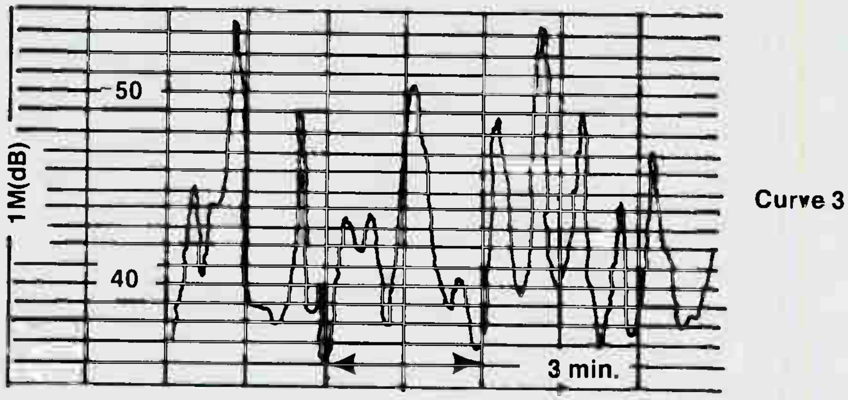


(1) IM at TR MONITOR, without isolation devices



(2) IM at TR MONITOR, with isolation devices



(3) IM at REC OUT, with isolation devices

Figure 6
IM degradation by multimode propagation
via 2 km GI fiber

Acknowledgement

The authors would like to express their thanks to the members of Central Research Laboratory, HITACHI Ltd., for valuable advice, and also to NHK (Japan Broadcasting Corp.) for their encouragement.

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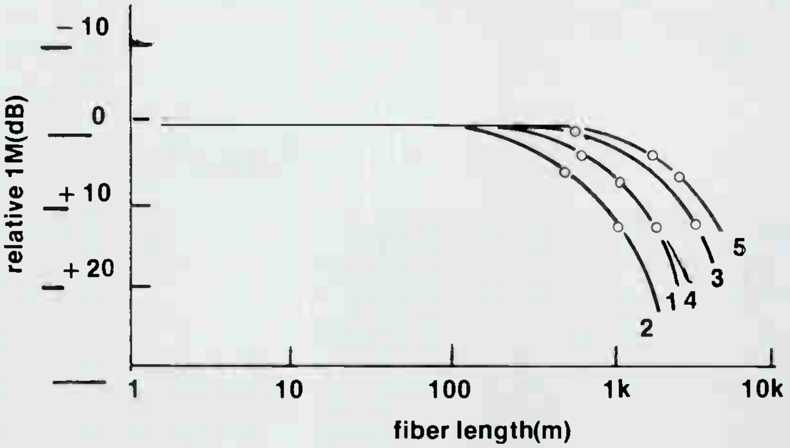
Mr. Ikeda - NHK Technical Consultant
Mr. M. Yamaura - Hitachi Cable, Head Engineer
Mr. F. Roberts - President, Mono County TV Inc., Dean of Technical Department at Antelope Valley College



	core dia.	NA	bandwidth
1	60μm	0.20	0.7 GHz. km
2	"	"	0.4
3	"	0.13	1.0
4	120	0.20	0.4
5	"	0.13	1.5

Figure 7
IM as a function of fiber length for different fiber types

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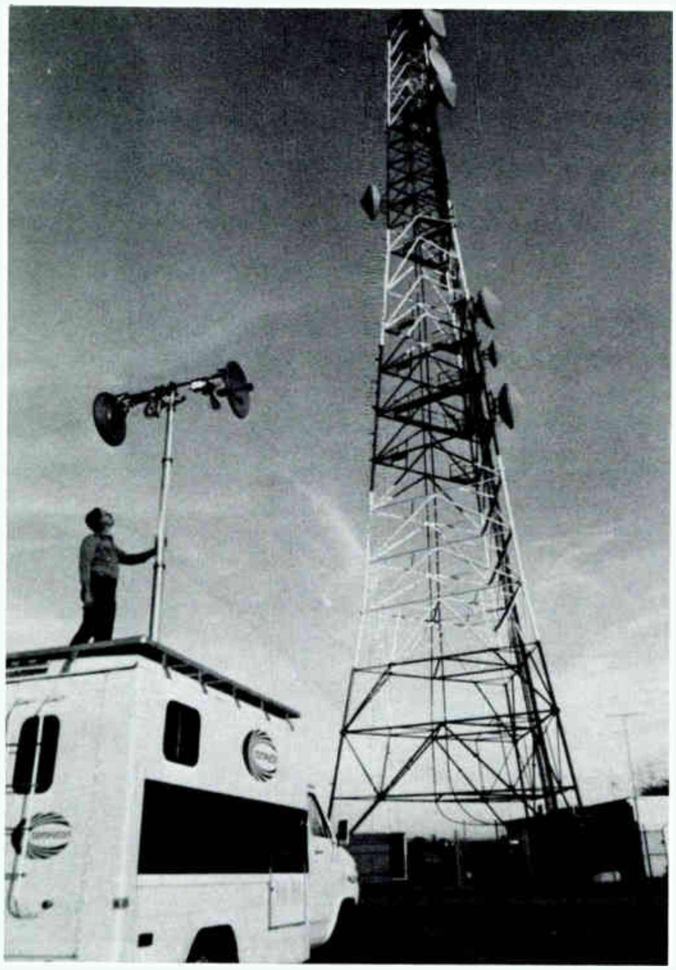
6. O. Hirota and Y. Suematsu, "Noise properties of injection lasers due to reflected waves", J. Quantum Electron. QE-15, 142 (1979) □

Return of
THE FILTERED EARTH STATION #14
Terrestrial Interference Avoidance
A Comprehensive Approach

The Purchased Professional Survey

By: Glyn Bostick
William P. Johnson
David Skevel
Microwave Filter Co.



Last Time

In part #13, it was shown how to compute the probable TI/Satellite signal ratio as seen at the downconverter, given the relative locations and beam pointings of the interference and TVRO antennas.

This Time

We discuss the result of visits with the leading frequency coordinating houses and illustrate and describe the services available from them to increase, by an order of magnitude, the accuracy of site analysis over do-it-yourself methods.

The Survey Defined

Strictly speaking, the survey is the intelligence gathering stage of the TVRO project. Applying gathered data to decide the exact location of the TVRO is properly called the **siting,** an operation to be discussed later on in this series.

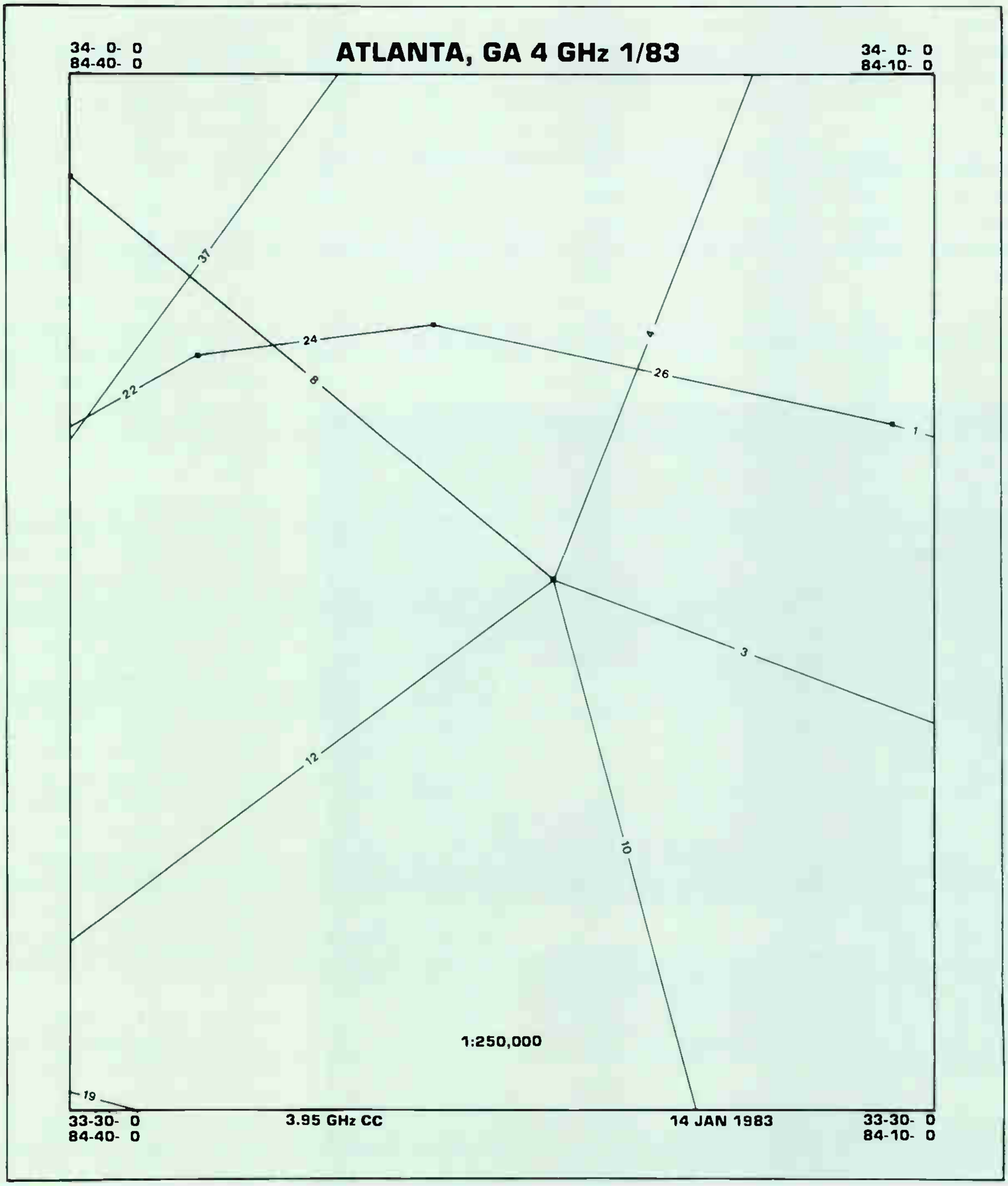
The objective of the survey is to identify every **potential** source of TI and determine its frequency, polarization, azimuth and intensity.

Properly equipped, TVRO owners and installers can identify **operational** microwave transmitters, but it is usually not feasible for them to investigate and discover the locations of new microwave facilities in the planning or building stage. The professional frequency coordinator can do both, and his services are recommended for commercial installations where quality operation into the indefinite future is essential.

While this series is mainly addressed to the CATV-TVRO engineer, residential earth station installers should seriously consider purchasing some of the services offered by frequency coordination firms. The rapid growth of the transcontinental microwave relay network will eventually make the present "install, then test" mode of TVRO installation unprofitable. Hence, every installer should learn how to test for TI **prior** to installation.

TVRO Frequency Coordination

Frequency coordination is the complete process of "clearing" a proposed TVRO site. It includes testing the site for acceptable TI levels, notifying current microwave users of the TVRO operator's plans, requesting that microwave users disclose any future plans which may impact on the proposed TVRO, and finally, consolidating this effort into legal protection by filing for license with the FCC.



This route map connects microwave towers, indicating microwave antenna beam pointing. Route segment distance is shown in miles. (Courtesy SPECTRUM PLANNING, INC.)

Why Do It?

If it is very important that the TVRO operate without trouble, the TVRO planner must test the site for TI and analyze the results. This is called the **interference analysis.** If it is economically important that quality TVRO operation continue into the future, then it is vital that the planner notify all present microwave users of his plans and request that they disclose new installations in the planning stage and facilities in the building stage. This is called a **coordination notice.**

These steps are the minimum acceptable for such revenue-generating TVROs as are used by CATV systems, for example. But what about future microwave facilities which are neither in the building or planning stage? After the TVRO is designed and constructed to include features to deal with **current** TI, what happens in the more distant future when a **new** microwave transmitter comes on?

If the TVRO system is unlicensed, the answer is simple: more TI might be expected and the only viable course of action is to perform more work on the installation. This may involve redesign of the TVRO or, in extreme cases, relocating it.

As implied, protection against such a contingency is afforded through licensing the TVRO with the FCC. Although not mandatory, FCC licensing gives legal protection against "surprise" microwave transmissions. Licensing places the installation on the public record and the planners of new microwave facilities must find and notify the TVRO owner of their plans — just as he had to notify all licensed microwave facilities of his plans. He is thus given a forum for formal objection, if necessary.

Where the investment is substantial and the TVRO operates as revenue-gathering capital equipment, serious thought must be given to obtaining maximum legal protection. Accordingly, the frequency coordination process should be mounted as a formal project — and this should include licensing. Considering what is at stake, the licensing process doest not represent a major inconvenience for a substantial TVRO facility.

Who Does It?

Doing the analysis work relating to the licensing of TVRO earth stations is the **exclusive** business of a number of professional frequency coordination firms. They routinely handle all phases of the work, including filing the license application. If desired, they will even notify the TVRO owner when a new microwave facility is proposed and advise him on its potential impact on the TVRO.

These firms operate from a large computer data base which includes the location, beam pointing, emitted power and many other factors pertaining to microwave transmitting stations. These data bases are continually updated to include FCC licensing and frequency coordinating notices.

While there are no legal structures preventing a TVRO owner or installer from performing any or all phases of the frequency coordinating process, it is hard to compete with professionals: because of their investment to complete computerized data bases, their work is swift and surprisingly modest in cost. The detailed services offered by the professional frequency coordinator are available individually, or as standard or custom packages.

Who Are The Coordinators?

Some leading professional frequency coordinators are listed at the end of this article. The list is not exhaustive as some coordinators carry on this activity as an adjunct to their principal business and do not use a business title indicative of this service.

The authors have investigated the specific services of three of the leading coordinators **(COMPUCON, COMSEARCH,** and **SPECTRUM PLANNING),** samples of whose work are illustrated. All three seem extremely customer-oriented, and they freely disclosed all details of their operations to permit their description here. Space restrictions would not allow complete descriptions of all three services, but the services illustrated here are thought to be representative of all three.

The Preliminary Computer Analysis

This is sometimes called the **free space interference analysis** because it is an analysis based on free space transmission, of the probable impact on the earth station of each microwave transmitter within a prescribed radius of the TVRO site.

This analysis does not take into account the attenuating effect of intervening terrain or other obstacles between pertinent microwave transmitters and the TVRO. It does take into account the gain of the transmit antenna **toward** the microwave transmitter. It is therefore a pessimistic analysis: almost invaribly, less TI will actually be measured at the site because of the above-mentioned attenuating factors. The usefulness of the preliminary computer analysis lies in the speed of delivery (overnight express, in many cases), and in the fact that the site can be cleared for licensing purposes, if the data indicates that TI will not prevent trouble-free operation of the proposed TVRO.

This type of analysis can be initiated by telephone simply by telling the frequency coordinator the latitude and longitude of the proposed earth station. The coordinator has instant access to detailed maps for any locality.

One of the outputs is an estimate of the TI/Satellite signal ratio seen at the downconverter. Interference is proportional to this ratio. The computer print out identifies microwave transmitters by many characteristics, including the frequency, polarization and level of **operating and planned** sources, their azimuth and distance to the proposed TVRO site.

The Detailed Computer Interference Analysis

This analysis is similar to the preliminary analysis but is more detailed: using computerized topographical maps of the TVRO location, it takes into account the attenuation of TI by intervening terrain. Almost invariably, the TI levels predicted by the detailed computer analysis will be lower than those predicted on the preliminary analysis. If the preliminary analysis will not clear the site for construction or licensing purposes, the detailed analysis will often do so. This service is also available on short notice, and although is somewhat more costly than the preliminary analysis, can be considered economical when weighed against the possibility of being surprised by TI at turn-on.

Ancillary Reports Derived From the Interference Analysis

The computers used by the coordinators are programmed to supply a number of different types of final readouts derived from the preliminary and detailed computer interference analyses. These readouts include a breakdown of operational and planned TI sources (as well as a differentiation between the two), an indication of which TVRO channel will be affected by each individual carrier, a polarization analysis, a polar plot with the TVRO at the center, indication of the aximuth, and strength of each carrier considered to be a threat to the TVRO. The latter is very useful

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                             ***** C O M P U C O N ,  I N C *****

                   MICROWAVE INTERFERENCE ANALYSIS FOR EARTH STATION PLACEMENT
                   -----------------------------------------------------------

     SITE NAME:  SYRACUSE N.Y.          COORDINATES:    43- 5-27 N LATITUDE     ELEVATION:      0 FEET AMSL
                                                        76- 4-46 W LONGITUDE    CENTERLINE:     0 FEET AGL

       COMPANY:  MICROWAVE FILTERS      DATE THIS RUN:  05/04/83   1538 HRS     INTERFERENCE CRITERIA:

                                        TOPOGRAPHIC                             -137.0 DBW/1 MHZ SHORT TERM
         AGENT:                              MAP(S):                              (0.01 PERCENT OF THE TIME)

      COMPUCON                           E.S. ANTENNA    F.C.C.                 -147.0 DBW/1 MHZ LONG TERM
      ENGINEER:  GARY W LOPEZ            PATTERN USED:   32-25 LOG(THETA)         (20.0 PERCENT OF THE TIME)


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```
C                                                       ⒶTRANSMIT ANTENNA                AZIMUTH    INTF
A       TRANSMITTER         LATITUDE      RECEIVER        AZIMUTH GAIN(TX)                FROM     LEVEL
S       -----------         ---------     --------      --------- ---------    INTF.     EARTH     INTO
E  COMPANY - CALL SIGN      LONGITUDE  COMPANY - CALL SIGN ⒷAZIMUTH ANTENNA    SOURCE   STATION    E.S.        E X C E E D S
     - FCC ANTENNA CODE     ----------  ------------------  TO E.S.  DISCRIM  DISTANCE   TO TX     ------      O B J E C T I V E
N  -------------------      ELEVATION-  PATH STATUS -CHANNELⒸDISCRIM TRANSMIT  --------  -------   SMOOTH
O     ANTENNA MODEL         CENTERLINE  LOADING - EQUIPMENT    ANGLE    GAIN     SPACE    HORIZON   EARTH    TERREST.   TIME  PCT
                                                                                  LOSS      GAIN     LOSS     TX POWER  SHORT  LONG
--- -------------------     ---------- -------------------  -------- --------  --------  -------  --------  --------  -----  ----
```

(Above Sea Level)

```
 1 NORTH SYRACUSE   , NY    43- 7-21   AMBOY CENTER    , NY    31.9    37.6DB    2.4MI    333.7   -127.6DBW   7.0DBW    9.4  19.4
   ATTNE -KEE85 -B53200     76- 6- 3   ATTNE  - KEE74         153.7    46.0DB    3.9KM
      KS-15640              420'- 79'     OP-12S-2PYY01       121.8    -8.4DB  116.3DB   -10.0DB     0.0DB    3.0DBW    5.4  15.4
      TRANSMIT FREQ: 3750.0V 3830.0V 3910.0U 3990.0U 4070.0U 4150.0U
```

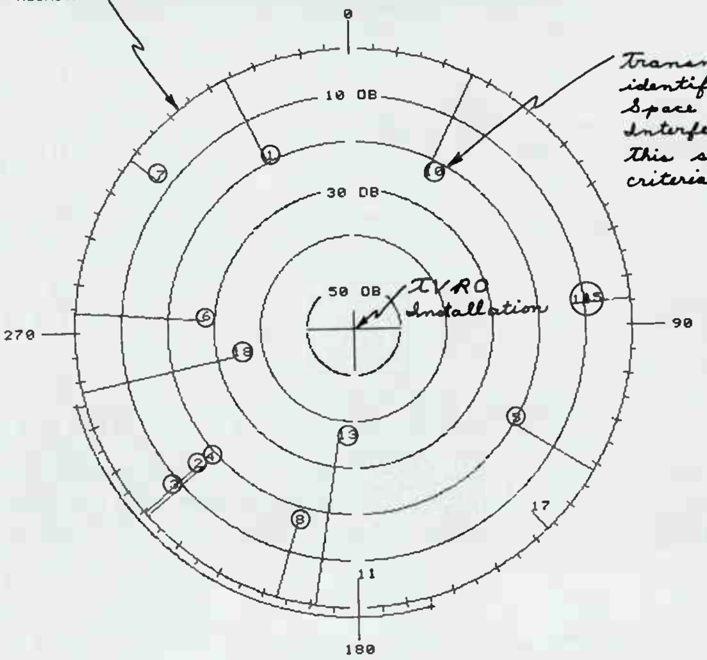
Frequency (MHz) — Vertical Polarization — (Future Carrier with Vertical Polarization)

```
 2 SYRACUSE         , NY    43- 2-55   PHOENIX         , NY   325.5    39.5DB    4.5MI    229.8   -132.5DBW   7.0DBW    4.5  14.5
   ATTNE -KEB31 -B42500     76- 8-51   ATTNE  - KEE75          49.7    55.9DB    7.3KM
      KS-15676B             400'-215'     OP-VS -2PYY01        84.2   -16.4DB  121.6DB    -1.5DB     0.0DB    3.0DBW    0.5  10.5
      TRANSMIT FREQ: 4010.0H
```

Type of transmission (VS = Stabilized Video)

```
 3 SYRACUSE         , NY    43- 2-55   SULLIVAN        , NY   101.4    39.5DB    4.5MI    229.8   -139.6DBW   7.0DBW    0.0   7.4
   ATTNE -KEB31 -B42800     76- 8-51   ATTNE  - KEA53          49.7    63.0DB    7.3KM
      KS-15676BC            400'-215'     PC-45D-2PY202       308.4   -23.5DB  121.6DB    -1.5DB     0.0DB    3.0DBW    0.0   3.4
      TRANSMIT FREQ: 3750.0H 3830.0G 3850.0U 3910.0G 3990.0G 4070.0G 4090.0U 4150.0G 4198.0G

 3 SYRACUSE         , NY    43- 2-55   SULLIVAN TOWNSHI, NY   101.4    39.5DB    4.5MI    229.8   -139.6DBW   7.QDBW    0.0   7.4
   ATTNE -KEB31 -B42800     76- 8-51   ATTNE  - KEA53          49.7    63.0DB    7.3KM
      KS-15676BC            400'-215'     OP-VS -2PYY01       308.4   -23.5DB  121.6DB    -1.5DB     0.0DB    3.0DBW    0.0   3.4
      TRANSMIT FREQ: 3770.0V 3930.0V

 3 SYRACUSE         , NY    43- 2-55   SULLIVAN        , NY   101.4    39.5DB    4.5MI    229.8   -139.6DBW   7.0DBW    0.0   7.4
   ATTNE -KEB31 -B42800     76- 8-51   ATTNE  - KEA53          49.7    63.0DB    7.3KM
      KS-15676BC            400'-215'     PC-45D-2PYY02       308.4   -23.5DB  121.6DB    -1.5DB     0.0DB    3.0DBW    0.0   3.4
      TRANSMIT FREQ: 3930.0V
```

```
                                                             05/04/83

                  POLAR PLOT OF TERRESTRIAL INTERFERENCE CASES
                       CRITICAL CASES, COMPUTER PREDICTED
                                     4 GHZ

CLIENT    : MICROWAVE FILTERS                          LATITUDE  :  43- 5-27
SITE      : SYRACUSE N.Y.                              LONGITUDE :  76- 4-46
CRITERIA  : -147.0 DBW / 1 MHZ FOR 20.0 PERCENT (LONG TERM)
ANTENNA   : F.C.C.            32-25 LOG(THETA)   (F40022)
AZIMUTH   : 165.5 - 255.2 FOR GEOSTATIONARY SATELLITE ARC OF 66.  - 145.
```



Transmitter #10 identified on "Free Space Microwave Interference Analysis" this signal exceeds criteria by about 21 db

Preliminary computer interference analysis. Calculations are made on free-space basis with no allowance for attenuation of intervening terrain. The ***detailed*** *computer interference analysis takes terrain attenuation into account by use of the applicable computerized propagation path model. (Courtesy of COMPUCON, INC.)*

The Polar Plot is one of the many ancillary print-outs available with the computerized interference analysis. Here all interference carriers which exceed the agreed criteria are plotted in azimuth and intensity as a guide to augmenting and/or taking advantage of natural shielding. (Courtesy of COMPUCON, INC.)

to the operator — it gives him a guide to spotting local obstructions which might aid in placing the TVRO in a "quiet zone" .

The Route Map

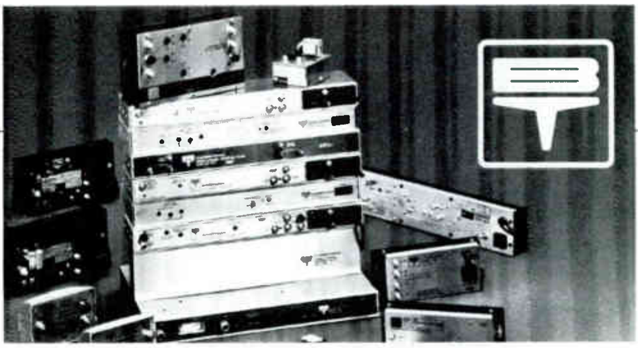
This is a map of the TVRO's designated area showing the location of microwave transmit stations. Lines connect these stations indicate their beam pointing. This is an extremely useful device for the regional professional TVRO installer or operator as it permits swift identification of microwave facilities most likely to product TI.

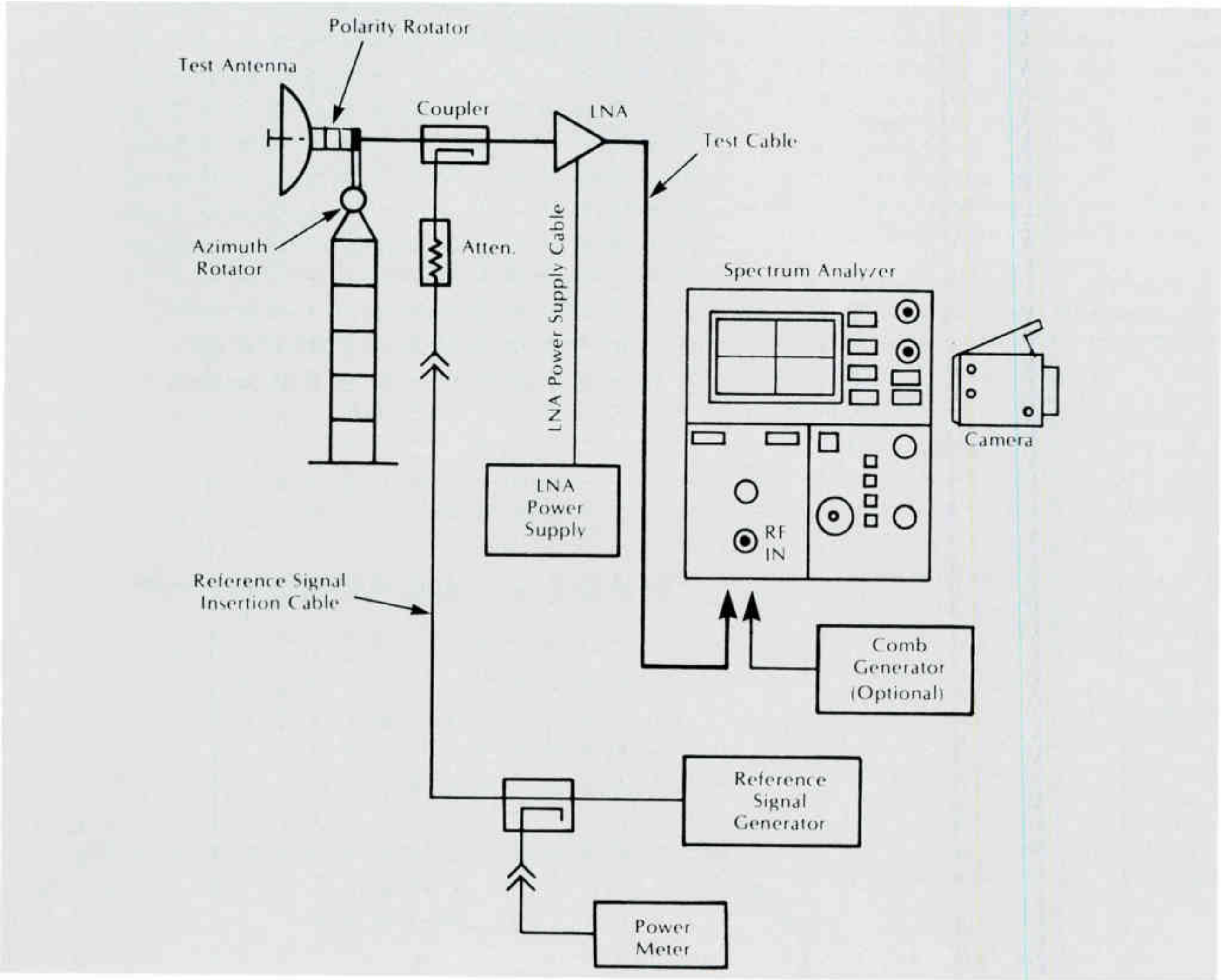
The Intensity Overlay

This is another specialized map of the TVRO's designated region showing approximate intensities of interference at various locations in that region. This computer generated map takes into account applicable microwave transmitters and the specific regional terrain. This map is especially useful to the regional installer as it indicates "good" and "bad" areas, and alerts him to the advisability of making a thorough pre-installation survey in the troubled areas.

The Professional Site Survey

This service consists of a personal visit to the proposed site by a frequency coordination field team. The field team measures actual TI levels, especially those signals indicated as unacceptably high by either the preliminary or detailed computer





Typical Field Survey Equipment of the Frequency Coordinator. The basic equipment is the calibrated test antenna and wide-band, microwave spectrum analyzer. Other equipment shown is necessary to calibrate the basic equipment to high accuracy. (Courtesy of SPECTRUM PLANNING, INC.)

analysis. The team is equipped as shown in the illustrative block diagram. Essentially, the equipment consists of a spectrum analyzer and a calibrated test antenna-amplifier. The remainder of the tools are used to field calibrate the team's equipment to a high degree of accuracy. The team measures and charts each TI signal, and computes its degradation effect on the satellite signal as received by the proposed TVRO.

This team usually includes an experienced microwave engineer familiar with available electronic interference filters, the construction of microwave barriers, and signal reflection analysis. The team will make detailed recommendations as to the best location for the TVRO and suggest means to reduce unacceptable levels of TI.

The Coordination Notice

The frequency coordinator will act as the agent for the TVRO planners in locating (by computer) and notifying all owners of operational microwave facilities of the proposed TVRO installation, and requesting that they notify you (through him) of any planned (not-yet-operational) facilities.

License Applications

The frequency coordinator will prepare and file the application for licensing the TVRO. To support the application he will use the results of the preliminary or detailed computer interference analysis, and if necessary, the results of the on-site analysis as evidence that the proposed site is acceptably clear of TI. Also necessary in the licensing process are the results of the coordination notice.

Future Protection Service

For an annual fee, the frequency coordinator will automatically notify the TVRO owner when a new microwave facility is proposed, evaluate the potential threat, and take steps on his behalf to reduce the conflict.

Minimum Survey Strategy Using Professional Services

The wide range of services available from the typical frequency coordination firm makes affordable TVRO planning strategies possible. This is true whether the TVRO being planned is a costly commercial installation or a less expensive residential system.

At the very least, those involved in planning and installing commercial systems should obtain a preliminary interference analysis before quoting the customer a total cost. The ancillary polar plot should be obtained at the same time. In case unacceptable levels of TI are predicted by the analysis, the polar plot can aid in eliminating the threats which are obviously blocked by intervening structions or terrain. If a study of these two documents induces doubt, it is recommended that a detailed analysis should be obtained. If a study of this third document does not resolve all doubt, then an on-site survey should be done, either by a professional frequency coordination firm or by the contractor himself, using the appropriate equipment. Prior to this costly last step, the customer's agreement should be obtained. Consistently applied, this strategy will preserve estimated profit in the average case.

Installers of residential TVROs can benefit from the same strategy, when it is affordable under their specific circumstances. As the typical installer operates within a relatively small regional area, his minimum investment for a typical site should include a preliminary analysis and a microwave route map. A simple survey kit (described in the next installment) is also preferable to the "demo" style of survey.

Next Time

Part #15 will show how to do your own TI measurement survey, using readily available and affordable equipment.

Acknowledgements

The authors wish to thank Bernadette Andaloro for reducing a great mass of material into a reasonable manuscript and David Bostick for the expert document stat work which

Continued on Page 40

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WorldRadioHistory

CCOS '83

MORE INFORMATION ABOUT THE SESSION . . .

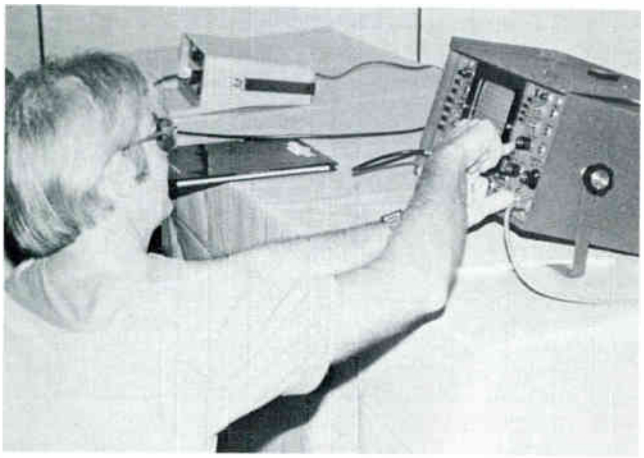
Management

CREATING AN EFFECTIVE AND PROFITABLE LOCAL AD SALES FORCE —

This session will demonstrate the ways and means to enter into the field of local advertising . . . how to prepare your office personnel to sell local advertising on your local origination channel . . . how to use satellite program ad sports as additional source of income (even for small cable system).

TO KNOW CABLE IS TO LOVE CABLE —

This session will illustrate the value of effective training . . . a program that gets into the specifics of various training programs and methods of training cable personnel to achieve the greatest potential and effectiveness from your cable system.



ADULT ENTERTAINMENT — HOW IT AFFECTS CABLE TELEVISION

The panel presenting this session will represent programming representatives from several adult programming sources . . . what is the future of adult entertainment on cable systems . . . what are the benefits and what are the problems? Sure to be a hot topic at CCOS '83.

WASHINGTON UPDATE

A presentation in the very latest information on what's going on in Washington . . . how is legislation going to affect cable television . . . what legislation is in the Senate and House of Representatives . . . what's going on at the FCC. All cable operators need this one!!

TIERING AND PACKAGING CABLE SERVICES

A presentation on the various methods of tiering and packaging satellite programming . . . how to use this to increase subscriber base for more profits.

GET YOUR DAILY PAPER ON CABLE

Leasing cable channels to the local newspaper — lots of discussion about this one — a new way to provide the daily newspaper electronically.

MAKING A CLEAN SWEEP OF IT

The Engineering Team from Wavetek will explain all the methods of cable television sweep generator tests, from system sweeping and balancing to bench testing of cable and components. Theory includes sweeping amplifiers, measuring return loss, measuring port-to-port isolation, and much, much more. This session will include a hands-on laboratory position to allow more cable technicians and engineers to perform the tests and measurements. Seating will be limited to 30 people each session (three are scheduled) and we would encourage you to reserve your space with the CATA office as soon as possible to insure your spot.

CABLE ANTENNA FOR LE$$

Wayne Sheldon, Chairman of CATA's Engineering Committee, will give a "back to basics" session on how to adapt inexpensive rooftop type television antennas for use in cable systems. Included will be hints on how to "build your own" antennas. Another opportunity for a Sheldon presentation you won't want to miss.

EVERYTHING YOU WANTED TO KNOW ABOUT THE FCC, BUT WERE AFRAID TO ASK

Chris Pappas, FCC Field Specialist **(see CATJ, January 1983, for his article on Signal Leakage and FCC Technical Standards)** will have the FCC Field Test Van at the site of the Arlington Hotel for cable operators to tour. In the seminar presentation, procedures used when the FCC Field Test Van appears at a cable television system will be discussed, demonstrating the tests and measurements taken to determine if the cable system meets FCC technical standards. Ample time will be allowed for a full question and answer session, and the cable operators will be definitely invited to tour the van. Should be an interesting on-site tour.

NEW TECHNOLOGY ON FIBER OPTICS

How are fiber optics being used today? What is the new fiber optic hub technology being used for rural cable systems? What's coming tomorrow in fiber optics?

CONVERTERS

A session all about converters . . . problems . . . proper use . . . All of It!!

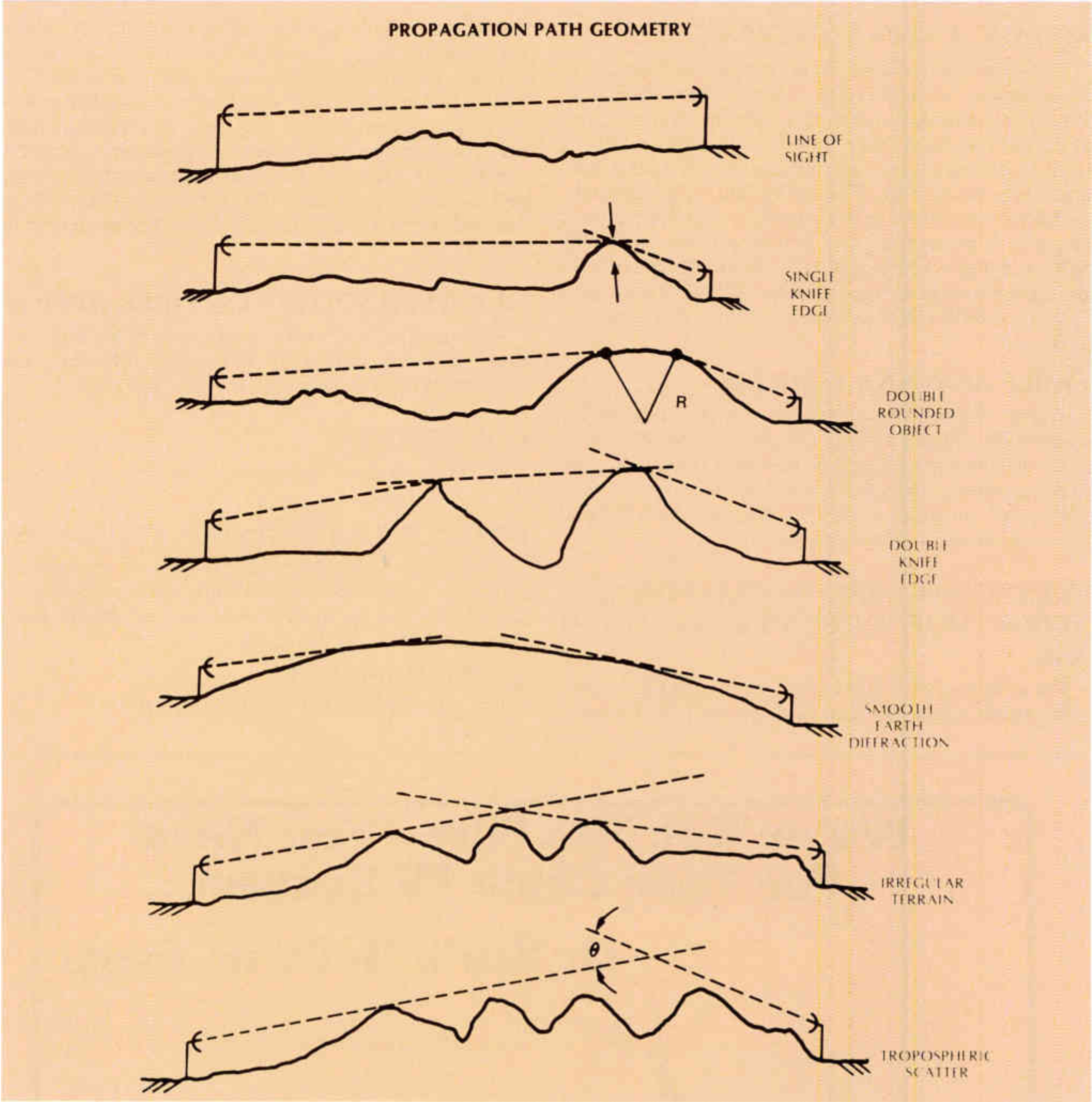
COMMON CABLE SYSTEM PROBLEMS

Common cable system problems plague operators consistently . . . this will help to identify cable problems and faults . . . such as co-channel, cross-modulation, intermodulation, hum, ghosting, etc.

TEST EQUIPMENT

What do you need? When do you need it? □

Continued From Page 35



Propagation models defined in National Bureau of Standards Technical Bulletin #101. These models are among those which have been computerized by some frequency coordinators for use in detailed computer interference analyses. (Courtesy of SPECTRUM PLANNING, INC.)

made clear illustration of professional survey services possible. Our thanks, also, to Donna Kaiser who carefully reconstructed our dog-eared "dead sea scrolls" into neatly annoted exhibits. Special thanks go to the personnel of the frequency coordinators listed below. Their characteristic southern hospitality and their enthusiastic and frank discussion of their operation made this a very pleasant and fruitful learning experience, both for the authors and, we hope, the readers.

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AFTER JULY 15th, ALL REGISTRATION WILL BE $150.

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HOTEL INFORMATION

A block of hotel accommodations has been set aside for each seminar at the hotels indicated. Please make your own reservations directly with the hotel by completing and mailing in the hotel reservation form below to the appropriate hotel. For telephone reservations, be sure to include the information that you are attending the CATA CATV Technical Training Seminar to receive the special room rates as indicated.

BASIC

LAKE WORTH, FLORIDA
AUGUST 1-3

COUNTRY SQUIRE INN
7859 LAKE WORTH ROAD
LAKE WORTH, FLORIDA 33463
PHONE: (305) 968-5000
Take exit 36 off the Florida Turnpike.
S - $33.00
D - $35.00
Sponsored by the SCTA

ATLANTA, GEORGIA
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MASTER HOST INN MIDTOWN
1152 SPRING ST. N.W.
ATLANTA, GEORGIA 30309
PHONE: (404) 875-3511
Located at I-75/85 at 14th Street in Atlanta.
S - $28.00
D - $32.00
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RICHMOND, VIRGINIA
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CUT HERE

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Please reserve the following room requirements in the name of the company or individual shown:

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NUMBER OF ROOMS: ____________ OCCUPANCY: SINGLE DOUBLE

ARRIVAL: ____________ (Date) (Time) DEPARTURE ____________ (Date)

SEND DIRECTLY TO HOTEL CATA CATV TECHNICAL TRAINING SEMINAR

BULLETIN

SENATE ADOPTS S.66 -

Now The Real Fight Begins!

Washington Update

by Stephen R. Effros
CATAs Executive Director

By now you have already read the news. The United States Senate has adopted S.66. The cable television industry was successful in its lobbying efforts to keep the bill relatively free from incapacitating amendments, including the primary one, offered by Senator Abdnor, which would have resulted in cable being regulated at the State level under common carrier status. To our knowledge, this is the first time that an amendment or bill fully backed by AT&T and the local telephone companies has been defeated in a roll-call vote in the Senate. We have a lot to be proud of. It took a lot of work. A big "thank you" should be spread around the industry to all of you who helped us in this fight. The letters, telegrams, telephone calls and quick fights to Washington paid off. It could not have been done without the entire cable industry working together. We proved once again that having several different groups, looking at the issues from different viewpoints, but agreeing on the end result, created a synergistic force. A great deal of credit must be given to Jim Mooney of the NCTA who coordinated the effort of, not only the NCTA, but all the other players, including CATA. We all worked together, and we won. Now the question is — what did we win? The answer is that we won the opportunity to work even harder on the House side in an effort to get favorable deregulation of the cable industry.

We are not going to spend the time and space in this issue to go over the details of the bill as ultimately passed. Suffice it to say that the main outlines of the bill regarding rate deregulation and franchise renewal remain. The details, in many cases, are different. Throughout the consideration of the bill on the Senate floor, amendments were suggested in order to satisfy individual Senators. Some of those amendments were accepted, and some were rejected. The final package, from CATA and NCTA's perspective, still accomplishes the goal of substantial deregulation. However, it is not worthwhile to go into all the details here because a different bill will be written in the House of Representatives. Should we be successful in getting that bill passed, then a "conference committee" will have to clear up the differences between the two bills. Only then will it really be worth your learning all the legalistic details since, until then, you won't have to worry about complying with those details and neither will the cities.

Where do we go from here? Well, the negotiations have already begun with Rep. Wirth and his Communications Subcommittee staff regarding the drafting of companion legislation. A first round of hearings, at which CATA President Peter Athanas testified, has already taken place. And hopefully, in the not too distant future, in a month or two, we will see the first draft of a bill introduced in the House of Representatives that will become the focus of all of our attention for the remainder of this political year! Well, not exactly. We also have two, and soon to be three, copyright bills floating around Capitol Hill as well. Of course we will be working on those as well.

In any event, there is no question that when the "cable bill" does finally appear on the House side it will be a tough, bitter fight to get it through! Why? For starters, AT&T has already let it be known that it intends to fight passage of the bill. The telcos lost a major battle in the Senate — a battle that they put a lot of money and effort into. They lost it because they simply did not have the facts on their side. The "Big Lie", didn't work. Try as they might, they could not convince the Senate that the reason local telephone rates will be going up is because of competition caused by the cable television industry. Also, they did not get the response that they had hoped for from the argument that all providers of a similar service must be regulated in a similar manner. There are numerous examples of large companies being regulated in a different manner from their small "rivals". Independent oil producers pop to mind, and the Senate knew that if ever there was a "dominant" industry participant, it would have to be telcos with regard to data services. The telcos also know that they do not have much of a chance of convincing Tim Wirth's very knowledgeable subcommittee members that they are not dominant! So efforts to get their "amendments" added in the House are going to be very difficult. Thus, since they don't want this bill to ever get into a conference committee with the Senate, they will now focus their efforts on killing the bill outright. How? First, they will continue to spread the "Big Lie". There is no question that increased local telephone rates are a potent political club — even if that club is aimed at an industry, cable, that has nothing to do with the increases. Another likely move on the part of the telcos is to assist the dissident cities who have been fighting against the NCTA/National League of Cities compromise which was the basis for S.66. The reason this cable bill will be so much harder to win in the House is that House members are much more subject to the political pressures of local mayors. And in this case, the local mayors still don't understand the issues involved in this debate. They are being swayed by the rhetoric of some dissident cities, and they are being given incorrect information as well. As an example, a list was circulated of alleged "concerned cities" with regard to S.66. Yet when we checked with some of the city cable administrators on that list, they did not indicate that they were opposing S.66!

This is where you come in. If you thought the going was tough in the Senate, you have a big surprise coming! What we are going to have to do in very short order is make sure that our Congressmen really know what the issues are in cable television regulation. We are going to have to make sure they know the fact, the reality of cable television. This is something that CATA has been focusing on for some time now, and our first job on Capitol Hill will be to make sure that the members of the House Commerce Committee understand cable reality. You can help by being sure your Congressman or woman knows. You **MUST** start contacting their offices now as part of an overall educational campaign about cable. We must not lose the momentum! Again, thanks for the great work you have done already, and be prepared to do a lot more! You did it to build your system in the first place. Now it's up to you to protect your investment. If anyone has any questions about what they should do, or can do, or needs help explaining cable issues to either your local authorities or your Representatives, give Steve Effros or Ellen Adams in the CATA Washington Office a call — they'll help you out (703/691-8875). □

NEW PRODUCT REVIEW

Ben Hughes Communication

By: Diane Hughes, President
Ben Hughes Communications,
Products Co.

CABLE-PREP©ARATION

Following the introduction of Cable Television service over thirty years ago, the need for proper coupling of cable and connector eventually became more apparent. We all became aware that only through the proper preparation of the cable end, and the assembly of the connector, could we insure a sound connection to an appropriate signal device, as well as eliminate future costly service calls. As technology has increased in the cable industry, so has the development of hand tools.

The products manufactured by Ben Hughes Communication Products Company, Inc. revolve around the preparation of coaxial cable. Our product line consists of a Stripping/Coring Tool, and a Coring Tool for solid sheath aluminum cable, and Hex Crimp Tools for CATV, MATV, and STV applications. We also produce custom-designed crimp tools for special industry applications. Accessory tools, such as conductor cleaners, carpet cutters and drill guides, and cable forming tools are available too.

Ben Hughes Communication Products Company, Inc. is located in Old Saybrook, Connecticut. The company was founded in 1979 by Benjamin W. Hughes, Jr., who had worked in many facets of the industry since 1953. The products manufactured are promoted under the trademark of **CABLE-PREP®** and are distributed in the United States, Canada, and across Europe. The company's continuous concern is to provide effective, high quality hand tools which are used to prepare the appropriate cable and connector.

PREPARATION OF SOLID SHEATH ALUMINUM CABLES

With the development of the two-piece sleeve and integral mandrel connector, it became necessary to manufacture a tool which would remove the dielectric foam from the cable.

The **CABLE-PREP®** Stripping/Coring Tool (SCT) combines both the stripping of the aluminum sheath, and the coring of dielectric from the cable. This combined operation results in a fast, cost-effective cable preparation which eliminates the need for two separate tools. Sliding the Guide Sleeve of the SCT over a pre-cut cable and rotating the tool in a clockwise direction results in removal of the cable dielectric. By positioning a Stop Clamp on the cable, the distance from the end of

Cable Prep®

CATV, MATV & STV APPLICATIONS

MODEL NO.	CONNECTOR SERIES	RG-/U CABLE TYPES	MAJOR HEX	MINOR HEX
		Standard Single Braid and Single Tape Cables		
HCT-659	"F"*	RG-59 RG-6	.324	.262
HCT-911	"F"*	RG-11 RG-59	.410	.262
HCT-611	"F"	RG-11 RG-6 RG-59	.410	.324
		Double Braid and Double Tape Cables†		
HCT-6QS	"F" (LRC Connectors)	RG-6 Double Braid & Double Tape RG-59 Double Braid & Double Tape (also RG-6, 59 Single Braid, Single Tape)	.359	.324
HCT-660	"F" (Gilbert Connectors)	RG-6 Double Braid & Double Tape RG-59 Double Braid & Double Tape (also RG-6, 59 Single Braid, Single Tape)	.384	.324
HCT-211	"F"	RG-11 Double Braid & Double Tape 32-375CX (Scientific-Atlanta)	.475	.100

*Connectors for RG-59/U with separate crimp rings use .262 hex. Attached crimp rings for RG-59/U use .324 hex. RG-6/U connectors with separate or attached crimp rings use .324 hex.

†HCT-6QS and HCT-660 may be used on standard cable when attached crimp rings are used on F-59 connectors.

Table 1

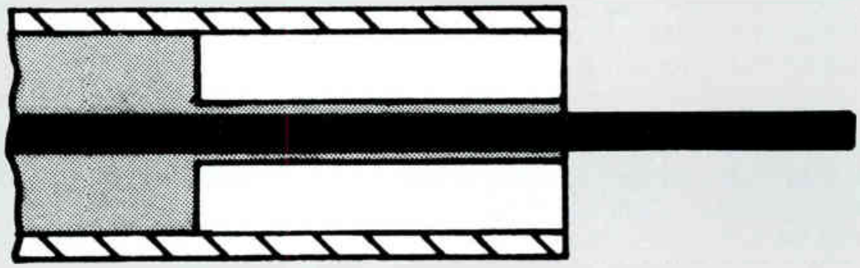

Figure 1

►

the Guide Sleeve to the Stop Clamp will determine the length of the exposed center conductor, and continuing to rotate the tool will strip back the aluminum sheath until the tool turns freely against the Stop Clamp. Excess dielectric material must now be removed from the exposed center conductor. By using our Part #4010 Center Conductor Cleaner, designed out of high strength plastic, the conductor is scraped clean without marring the copper cladding. The aluminum sheath now has a squared and slightly flared end with a clean, exposed center conductor, ready for easy sleeve and connector body insertion. (See Figure #1).

The SCT has a high alloy tool steel blade. This insures longer blade sharpness, as well as the ability of re-sharpening the cutting edges. This virtually eliminates the need for any future blade replacement. All SCT's are color-coded for easy identification to appropriate cable size. The SCT's are constructed of a high strength polymer, which offers impact resistance and added strength, as well as being insulated for use on activated system splices. The SCT is also readily adaptable for use with a 3/8" power drill if so required.

Although the Stripping/Coring Tool is relatively new, we have tested our product through field testing, under adverse conditions, to insure trouble-free operation. Our testing results show installation time is reduced by more than 50 percent due to our dual operation characteristics. In addition, with proper usage, repair/replacement of the SCT is almost nonexistent, which is why we back the tool with a One Year Full Warranty.

APPLICATION OF HEX CRIMP TOOLS FOR RG-/U CABLE

The most advanced design of "F" connectors requires a hex compression crimp. Once the connector has been compressed by a hex crimp tool, it exhibits both mechanical and RF improvement over the conventional 1/8" wide ring type "F" connector application. This crimping process of connector installation calls for a high compressive force, and a light-weight and easy-to-operate tool for the installer to use.

The **CABLE-PREP®** Hex Crimp Tool (HCT) manufactured by Ben Hughes Communication Products Company, Inc. stresses the simplicity of design while also offering a 14-to-1 mechanical advantage from the tool's toggle action, and the ability to compensate for wear of these toggle joints by using an adjustable eccentric pin.

Presently the concept of the 1/2" long ring and/or one-piece sleeve connector is the most effective "F" connector in use today, with respect to holding power (connector pull-out resistance) and RF integrity. In order to implement these two design requirements, one must select the proper connector for its intended cable design and finally select the proper hex crimp tool for that connector. The result of the proper connector and cable grouping will be an easy, efficient assembly with maximum RF integrity and holding power. Table 1 describes our HCT tools and which models are to be used with various RG Cable configurations along with the hex sizes of each particular model.

The operation of the **CABLE-PREP®** Hex Crimp Tool is quite simple; the hand force required to compress the connector sleeve is multiplied via a toggle clamping design. This particular design is eventually subject to wear at its critical toggle pin points, if not properly maintained by periodic cleaning and oiling. This wearing condition and high compressive force necessitated the design and implementation of a toggle adjusting feature. This adjusting feature clearly assures increased longevity, while also increasing the overall quality and utilization of the tool. The compression (toggle) adjustment allows for the reinstatement of the Positive Homing Action (PHA), which slowly deteriorates through normal usage. When normal usage tends to wear (loosen) the factory pre-set toggle action, an adjustment can easily be made to duplicate its original feel. In order to do so, one must remove the "clip ring", which retains the starred adjustment wheel, and rotate this adjusting wheel one or two positions in a counter clockwise direction until the correct toggle action is achieved. Reassemble the clip ring back onto its adjusting "D" pin, and the HCT is now ready for use again. For even longer life of the HCT, a field Maintenance Kit (MK-1050) is available. This kit consists of replacement pins, retaining rings, links, clip rings, and adjustment wheel. With these parts, you can easily rebuild the specific stress points designed in the HCT. Once the MK-1050 kit has been installed, the HCT is brought back to its original condition.

Each HCT model is specifically sized for two RG-/U size cables. **Table 1** can be used for easy reference when determining which Hex Crimp Tool to use with which RG-/U cable size and construction type. Over the last few years, with an influx of new cable designs and connector recommendations, the most recent application being used on Double Braid and Double Tape cables, some confusion has occurred. When ordering, please specify the HCT with the hex dimensions recommended by your connector supplier. A proper crimp is achieved with mechanical strength and prevention of R.F.I. only when the cable connector and crimp tool's hex size are in accord with each other.

CABLES, CONNECTORS, ET AL.

In the last thirty years, equipment employed during the installation of cable has evolved to where precision tools are now available to facilitate quality construction. Our hand tools are also designed to be as cost-effective as possible. Cable, connector and tool manufacturers, and those directly involved in the installation, are realizing the importance of working together to determine the job requirements without having to deal with avoidable problems and down-the-line non-profitability. Ben Hughes Communication Products Company, Inc. continues to research the development of new tool ideas and concepts, which will result in effective, high quality hand tools necessary in the industry. □

Distributors	Manufacturers	Service Firms
D1—Full CATV equipment line	M1—Full CATV equipment line	S1—CATV contracting
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D3—CATV cable	M3—CATV cable	S3—CATV financing
D4—CATV amplifiers	M4—CATV amplifiers	S4—CATV software
D5—CATV passives,	M5—CATV passives	S5—CATV billing services
D6—CATV hardware	M6—CATV hardware	S6—CATV publishing
D7—CATV connectors	M7—CATV connectors	S7—CATV drop installation
D8—CATV test equipment	M8—CATV test equipment	S8—CATV engineering
D9—Other	M9—Other	S9—Other

Associate Roster

Note: Associates listed with * are Charter Members.

ADT Security Systems,
One World Trade Center,
92nd Fl.,
New York, NY 10048
212—558-1444
(M9 Security Equipment)

Alpha Technologies,
1305 Fraser St. D-G,
Bellingham, WA 98225
206—671-7703
(M9, Standby Power
Supplies)

AMCOM, Inc.,
Bldg. E, Suite 200,
5775 Peachtree-
Dunwoody Rd., N.E.,
Atlanta, GA 30342
404—256-0228
(S9, Brokering &
Consulting)

Amplica, Inc.,
950 Lawrence Dr.,
Newbury Park, CA 91320
805—498-9671
(M4)

* **Anixter Communications**
4711 Golf Road,
Skokie, IL 60076
312—677-2600
(D1)

Apple/Store
Rte. #1, Box 156,
Beaver Dam, WI 53916
414—885-6249

The Associated Press,
50 Rockfeller Plaza,
New York, NY 10020
212—621-1513
(S9 Automated News
SVC)

Automation Techniques,
1846 N. 106th E. Ave.
Tulsa, OK 74116
918—836-2584
(M9)

Avantek, Inc.,
481 Cottonwood Dr.,
Milpitas, CA 95035
408—946-3080
(M8, 9 TVRO
Components)

Av-Tek, Inc.,
Box 188,
Aurora, NE 68818
402—694-5201
(M8)

BEI
P.O. Box 937,
Olathe, KS 66061
800—255-6226
(M9 Character
Generators)

**Ben Hughes
Communications**
P.O. Box AS,
Old Saybrook, CT 06475
203—388-3559
(M6, 9)

Blonder-Tongue Labs, Inc.,
1 Jake Brown Rd.,
Old Bridge, NJ 08857
201—679-4000
(M1, 2, 4, 5)

**Broadband Engineering,
Inc.,**
P.O. Box 1247,
Jupiter, FL 33458
1-800—327-6690
(D9, M4, S9)

Budco, Inc.,
4910 East Admiral Place,
Tulsa, OK 74115
1-800—331-2246
(D9, Security &
Identification Devices)

CATEL,
4800 Patrick Henry Dr.,
Santa Clara, CA 95054
408—988-7722

* **C-COR Electronics, Inc.,**
60 Decibel Rd.,
State College, PA 16801
814—238-2461
(M1, 4, 5, S1, 2, 8)

CCS Cable
P.O. Box 14710,
Phoenix, AZ 85063
602—272-6855
(M3)

CWY Electronics,
405 N. Earl Ave.,
Lafayette, IN 74904
1-800—428-7596
(M9, D1)

CableBus Systems,
7869 S.W.
Nimbus Avenue,
Beaverton, OR 97005
503—543-3329
(M1)

Cable Graphic Sciences,
7095 N. Clovis Ave.,
Clovis, CA 93612
209—297-0508
(M9 Character
Generators)

Cable Health Network,
2840 Mt. Wilkinson Pkwy.
Atlanta, GA 30339
404—436-0886
(S4)

Cable-Text Instruments,
Div. of Telpar, Inc.
P.O. Box 796
Addison, TX 75001
214—233-6631
(M9 Generators)

Century III Electronics, Inc.
610 Neptune Ave.,
Brea, CA 92621
714—671-2800
(M1, 3, 4, 5, 7, 8,
S1, 2, 8)

Capscan, Inc.
P.O. Box 36,
Adelphia, NJ 07710
1-800—CABLETV or
222-5388
(M1, 3, 4, 5)

Channel Master,
Ellenville, NY 12428
914—647-5000
(M2, 3, 4, 5, 6, 7)

Comm/Scope Company,
Rt. 1, Box 199A,
Catawba, NC 28609
1-800—438-3331
(M3)

**Communications Equity
Associates,**
851 Lincoln Center,
5401 W. Kennedy Blvd.,
Tampa, FL 33609
813—877-8844
(S3)

**Comprehensive Cable
Enterprises**
206 Westminster Ct.
Madison, WI 53714
608—249-3442
(S1, 2, 4, 5, 7, 8, 9)

**Computer Video
Systems, Inc.,**
3678 W. 2105 S. Unit 2,
Salt Lake City, UT 84120
1-800—453-8822
(M9)

COMSEARCH INC.,
11503 Sunrise Valley
Drive,
Reston, VA 22091
703—620-6300
(S8, S9, Earth station
placement frequency
coordination)

ComSonics, Inc.,
P.O. Box 1106,
Harrisonburg, VA 22801
1-800—336-9681
(M8, 9, S8, 9)

DF Countryman Co.,
1821 University Ave.,
St. Paul, MN 55104
612—645-9153
(D1, S1, 8)

The Disney Channel
500 S. Buena Vista,
Burbank, CA 91521
213—840-5080
(S4)

Ditch Witch,
P.O. Box 66,
Perry, OK 73077
1-800—654-6481
(M9)

The Drop Shop Ltd., Inc.
Box 284,
Roselle, NJ 07203
1-800—526-4100 or
1-800—227-0700 (West)
(D3, 4, 5, 6, 7, 8, 9,
M5, 6, 7, 8, 9 Plastics)

Durnell Engineering Inc.,
Hwy 4 So.
Emmetsburg, IA 50536
712—852-2611
(M9)

Eagle Com-Tronics, Inc.,
4562 Waterhouse Rd.,
Clay, NY 13041
1-800—448-7474
(M9 Pay TV Delivery
Systems & Products)

**Eales Comm. &
Antenna Serv.**
2904 N.W. 23rd
Oklahoma City, OK 73107
405—946-3788
(D1, 2, 3, 4, 5, 6, 7,
S1, 2, 7, 8)

Eastern Microwave, Inc.,
3 Northern Concourse,
P.O. Box 4872,
Syracuse, NY 13221
315—455-5955
(S4)

**Electroline TV
Equipment, Inc.,**
8750-8th Ave.,
St. Michel,
Montreal, Canada
H1Z 2W4
514—725-2471
(M4, 5, 7, 9, D7, 9)

Associate Roster

Electron Consulting Associates,
Box 2029,
Grove, OK 74344
918—786-5349
(M2, D1, S1, 8)

Elephant Industries,
P.O. Box 3626
N. Ft. Myers, FL 33903
813—995-7383
(M9)

ESPN,
ESPN Plaza,
Bristol, CT 06010
203—584-8477
(S9)

Franey & Parr of Texas, Inc., (Formerly Doherty & Co.),
One Turtle Creek Village,
Suite 524,
Dallas, TX
214—528-4820
(S9, Insurance)

GTE Products Corp., Sylvania CATV Div.
1790 Lee Trevino Drive,
Suite 600
El Paso, TX 79936
1-800—351-2345
(D7, M1, 4, 5, 9, Converters, S4, 8)

Gardiner Communications Corp.,
3506 Security St.,
Garland, TX 75042
214—348-4747
(M9 TVRO Packages, S1, 2, 8)

General Cable Corp.,
1 Woodbridge Center,
P.O. Box 700
Woodbridge, NJ 07095
1-800—526-4385
(M3)

Gilbert Engineering Co.,
P.O. Box 23189,
Phoenix, AZ 85063
1-800—528-5567 or
602—245-1050

Group W Satellite Communications,
41 Harbor Plaza Dr.,
P.O. Box 10210,
Stamford, CT 06904
203—965-6219
(S4)

H & R Communications,
Rt. 3, Box 102G,
Pocahontas, AR 72455
1-800—643-0102
(M2, D1, S2, 3, 8)

Harris Corporation,
P.O. Box 1700,
Melbourne, FL 32901
305—724-3401
(M2, 9, S2)

Heller-Oak Communications,
105 W. Adams St.,
Chicago, IL 60603
1-800—621-2139 * 7600
(S3)

Home Box Office, Inc.,
12750 Merit Dr.
Dallas, TX 75251
214—387-8557
(S4)

* **Hughes Microwave Communications Products,**
3060 W. Lomita Blvd.
Torrance, CA 90505
213—517-6233
(M9)

Ind. Co. Cable TV, Inc.,
P.O. Box 3799
Hwy. 167 N,
Batesville, AR 72501
501—793-4174
(D1)

* **Jerry Conn Associates, Inc.,**
P.O. Box 444,
Chambersburg, PA 17201
1-800—233-7600
1-800—692-7370 (PA)
(D3, 4, 5, 6, 7, 8)

KMP Computer Services, Inc.,
703 Central Ave.,
Los Alamos, NM 87544
505—662-5545
(S4, 5)

Karnath Corporation,
2001 Westridge,
Plano, TX 75075
214—422-7981 or 7055
(S1, 2, 8, 9)

Katek, Inc.,
215 Wood Ave.,
Middlesex, NJ 08846
201—356-8940

Klungness Electronic Supply,
P.O. Box 547,
107 Kent Street,
Iron Mountain, MI 49801
1-800—338-9292
1-800—682-7140 (Mich)
(D1, 8, S2, 8)

LRC Electronics, Inc.,
901 South Ave.,
Horseheads, NY 14845
607—739-3844
(M7)

Lash-Ade Company,
P.O. Box 147,
Guntersville, AL 35976
205—582-6333
(M9 Cable Protector,
S9 Equipment Repair)

Larson Electronics,
311 S. Locust St.,
Denton, TX 76201
817—387-0002
(M9 Standby Power)

Lemco Tool Corporation,
Box 330A,
Cogan Station, PA 17728
1-800—233-8713
(M8, 9 Tools)

Lindsay Specialty Products, Ltd.,
50 Mary Street West,
Lindsay,
Ontario, Canada K9V 4S7
705—324-2196
(M1, 2, 4, 5, 7, 9)

Magnavox CATV Division,
100 Fairgrounds Drive,
Manlius, NY 13104
1-800—448-5171 or
1-800—522-7464 (N.Y.)
(D4, 5, 7, M4, 5, 6, 7, S3, 8)

McCullough Satellite Equipment,
Route 5, Box 97,
Salem, AR 72576
501—895-3167
(M2, 9, D3, 4, 6, 7)

Microdyne Corporation,
471 Oak Road,
Ocala, FL 32672
904—687-4633
(M9 Satellite TV Receivers)

* **Microwave Filter Co.,**
6743 Kinne St., Box 103,
E. Syracuse, NY 10357
1-800—448-1666
(M9 Bandpass Filter)

Midwest Corp.,
P.O. Box 226,
Clarksburg, WV 26301
1-800—624-3845
(D1, 2, 3, 4, 5, 6, 7, 8)

Modern Cable Programs,
5000 Park St. N.,
St. Petersburg, FL 33709
(S4)

Mullen Communications Construction Co., Inc.,
P.O. Box 1387A,
Green Bay, WI 54305
414—468-4649
(S2)

National Farmers Union Property & Casualty Co.,
12025 E. 45th Ave.,
Denver, CO 80251
303—371-1760
(D9, Insurance Service)

North Supply Company,
600 Industrial Pkwy.,
Industrial Airport, KS 66031
913—791-7000
(D1, 2, 3, 4, 5, 6, 7, 8)

Oak Industries, Inc.,
Crystal Lake, IL 60014
815—459-5000
(M1, 9 Converters, S3)

Octagon Scientific, Inc.,
476 E. Brighton Ave.,
Syracuse, NY 13210
315—476-0660
(M9)

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D9—Other	M9—Other	S9—Other

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Phasecom Corp.,
6365 Arizona Circle,
Los Angeles, CA 90045
213—641-3501
(M1)

Power and Telephone
Supply Company, Inc.,
530 Interchange Drive
N.W.,
Atlanta, GA 30336
1-800—241-9996
(D1)

M/A Com Prodelin, Inc.,
P.O. Box 100
Claremont, NC 28610
704—459-9762
(M2, 3, 7, S2)

Pyramid Industries, Inc.,
P.O. Box 23169,
Phoenix, AZ 85063
1-800—528-4529
(M7, 8)

Quality RF Services, Inc.,
825 Park Way, Suite 3,
Jupiter, FL 33458
305—747-4998
(M4, S9)

RMS Electronics,
50 Antin Place,
Bronx, NY 10462
1-800—223-8312
1-800—221-8857 (Poleline)
(M4, 5, 6, 7, 9)

Reuters,
1212 Avenue of the
Americas, 16th Floor,
New York, NY 10036
212—730-2715
(D9)

Rockwell International,
M.S. 402-101,
Dallas, TX 75207
214—996-5954
(M9, Microwave/Satellite)

S.A.L. Communications,
Inc.,
P.O. Box 794,
Melville, NY 11747
1-800—645-9062
(D1)

Sadelco, Inc.,
75 West Forest Ave.,
Englewood, NJ 07631
201—569-3323
(M8)

Scientific Atlanta, Inc.,
3845 Pleasantdale Rd.,
Atlanta, GA 30340
404—449-2000
(M1, 2, 4, 8, S1, 2,
3, 8)

Showtime Entertainment,
Inc.,
1633 Broadway,
New York, NY 10019
212—708-1600
(S4)

Southern Satellite
Systems, Inc.,
P.O. Box 45684,
Tulsa, OK 74145
918—481-0881
(S9)

Superior Electronics
Center,
2010 Pine Terr.,
Sarasota, FL 33581
813—922-1551
(M4, S9)

TVC Supply Co., Inc.,
1746 E. Chocolate Ave.,
Hershey, PA 17033
717—533-4982
(D1, 2, 3, 4, 5, 6, 7, 8)

Teledac, Inc.,
1575 Taschereau Blvd.,
Longuevil,
Quebec, Canada J4K 2X8
514—651-3716
(M9 Character
Generators)

Tele-Wire Supply Corp.,
7 Michael Ave.,
East Farmingdale,
NY 11735
516—293-7788
(D1, 2, 3, 5, 6, 7, 8, 9)

* **Texscan Corp.,**
2446 N. Shadeland Ave.,
Indianapolis, IN 46219
1-800—528-4066
(M9 Bandpass Filters)

* **Theta-Com CATV,**
2960 Grand Avenue,
Phoenix, AZ 85061
602—252-5021
(M1, 4, 5, 7, 8)

* **Times Fiber**
Communications,
358 Hall Avenue,
Wallingford, CT 06492
1-800—243-6904
(M3)

Tocom, Inc.,
P.O. Box 47066,
Dallas, TX 75247
214—438-7691
(M1, 4, 9 Converters)

* **Toner Cable**
Equipment, Inc.,
969 Horsham Rd.,
Horsham, PA 19044
1-800—523-5947
In PA. 1-800—492-2512
also 1-800—523-5947 (PA)
(D2, 3, 4, 5, 6, 7)

Triple Crown
Electronics, Inc.,
4560 Fieldgate Dr.,
Mississauga, Ontario,
Canada L4W 3W6
416—629-1111
Telex 06-960-456
(M4, 8)

Turner Broadcasting
System,
1050 Techwood Dr.,
Atlanta, GA 30318
404—898-8500

Tyton Corp.,
P.O. Box 23055,
Milwaukee, WI 53223
414—355-1130
(M6, 7)

United Press International,
220 East 42nd St.,
New York, NY 10017
212—682-0400
(S9 Automated News
SVC.)

United Video, Inc.,
3801 South Sheridan Rd.,
Tulsa, OK 74145
1-800—331-4806
(S9)

Video Data Systems,
205 Oser Ave.,
Hauppauge, NY 11787
516—231-4400
(M9)

Viewstar, Inc.,
705 Progress Ave.,
Unit 53,
Scarborough,
Ontario, Canada M1H 2X1
416—439-3170
(M9 Cable Converter)

Vitek Electronics, Inc.,
4 Gladys Court,
Edison, NJ 08817
201—287-3200

Warner Amex Satellite
Entertainment Corporation,
1211 Avenue of the
Americas,
New York, NY 10036
212—944-4250
(S4)

* **Wavetek Indiana,**
5808 Churchman,
Beech Grove, IN 46107
1-800—428-4424
TWIX 810—341-3226
(M8)

Weatherscan,
Loop 132,
Throckmorton Hwy.,
Olney, TX 76374
817—564-5688
(D9, Sony Equip. Dist.,
M9 Weather Channel
Displays)

Western Towers
Box 347,
San Angelo, TX 76901
915—655-6262/653-3363
(M2, 9 Towers)

Winegard Company,
3000 Kirkwood Street,
Burlington, IA 52601
1-800—523-2529
(M1, 2, 3, 4, 5, 7)

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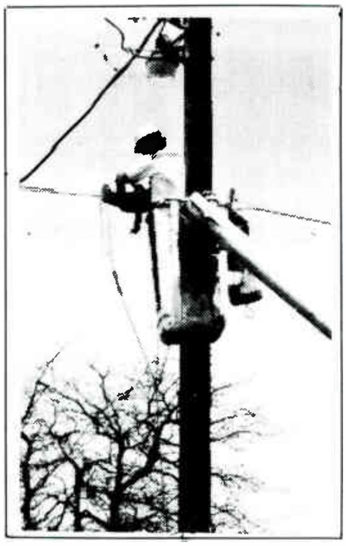

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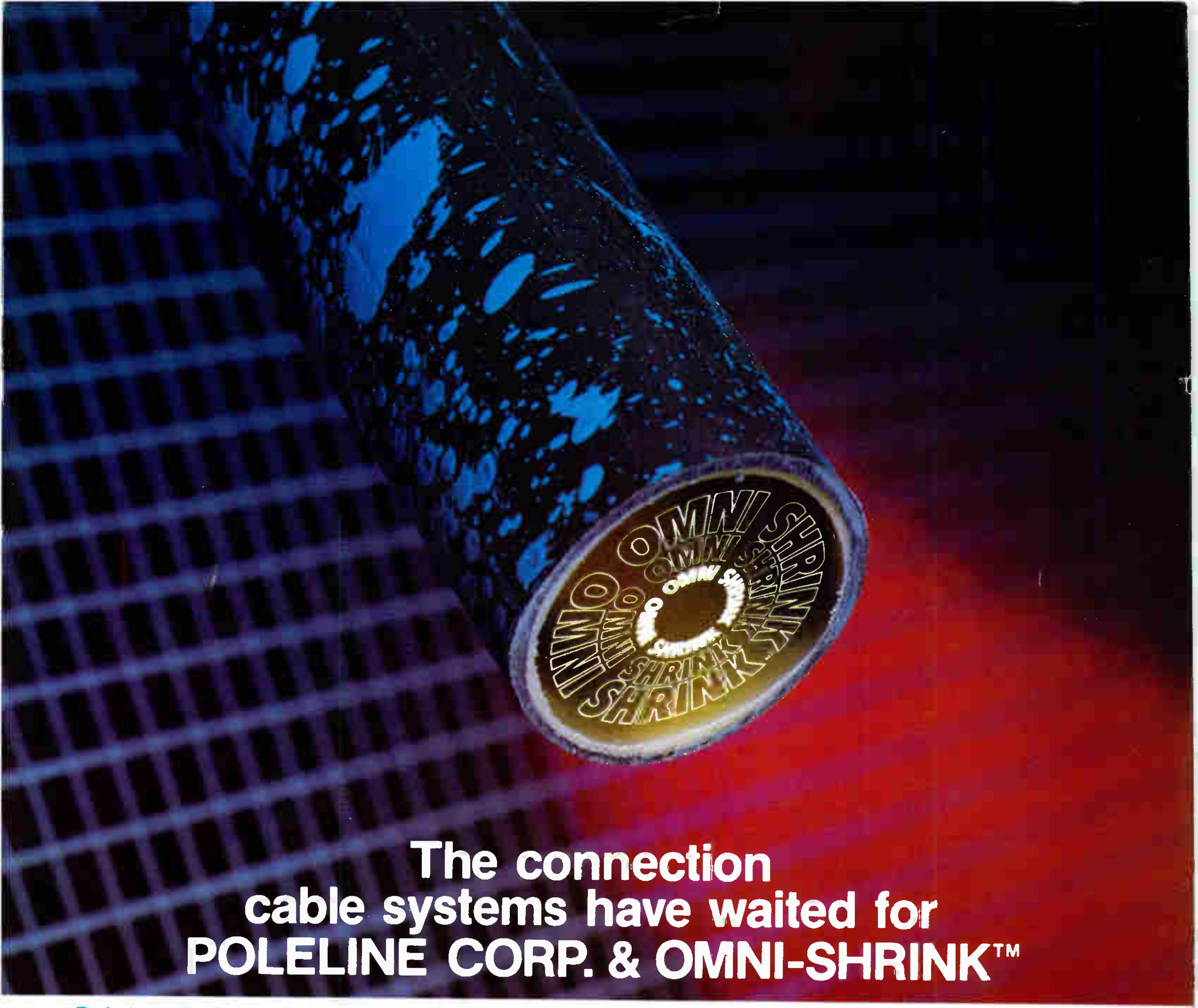

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