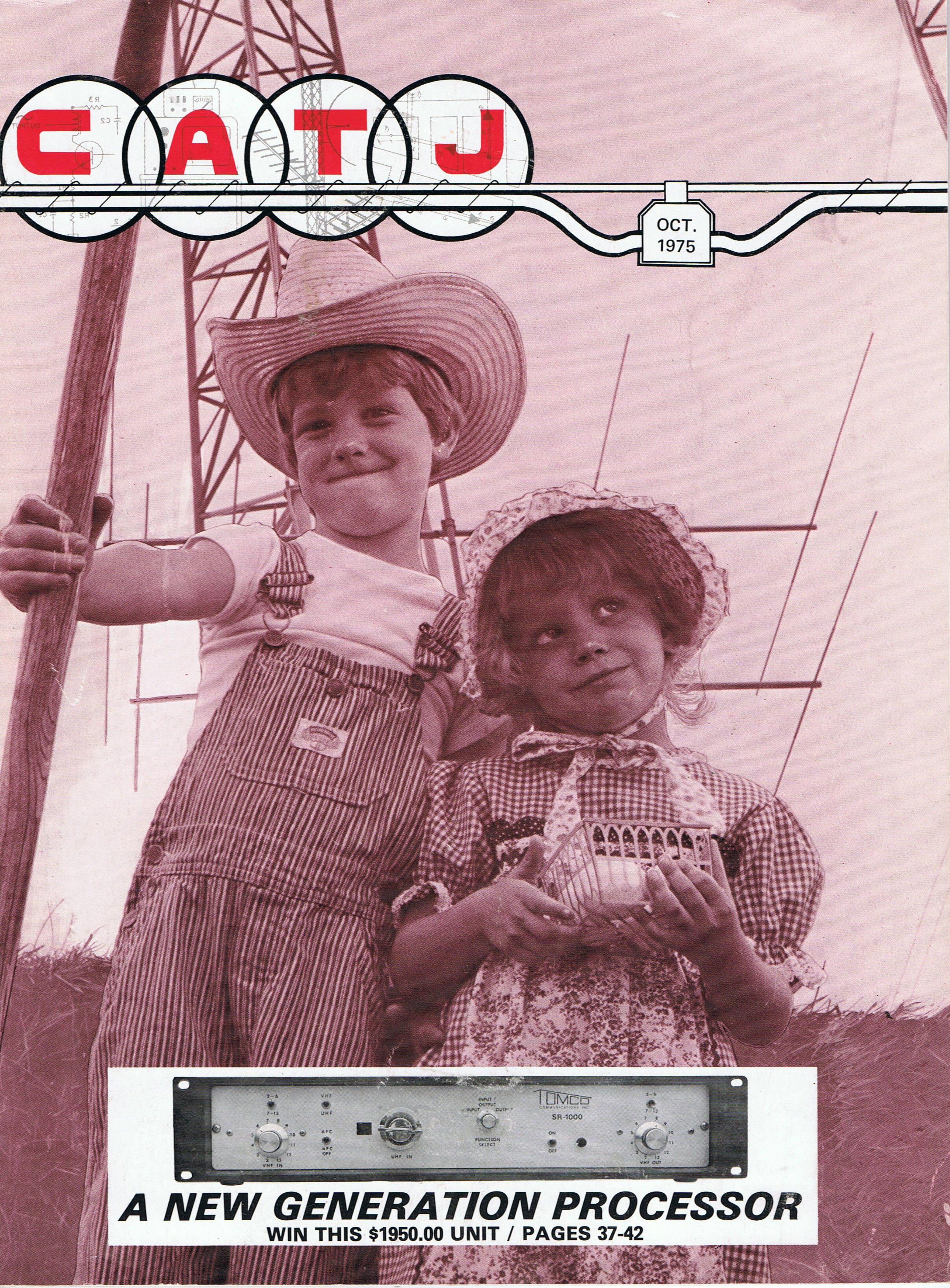
CATJ

OCT.
1975



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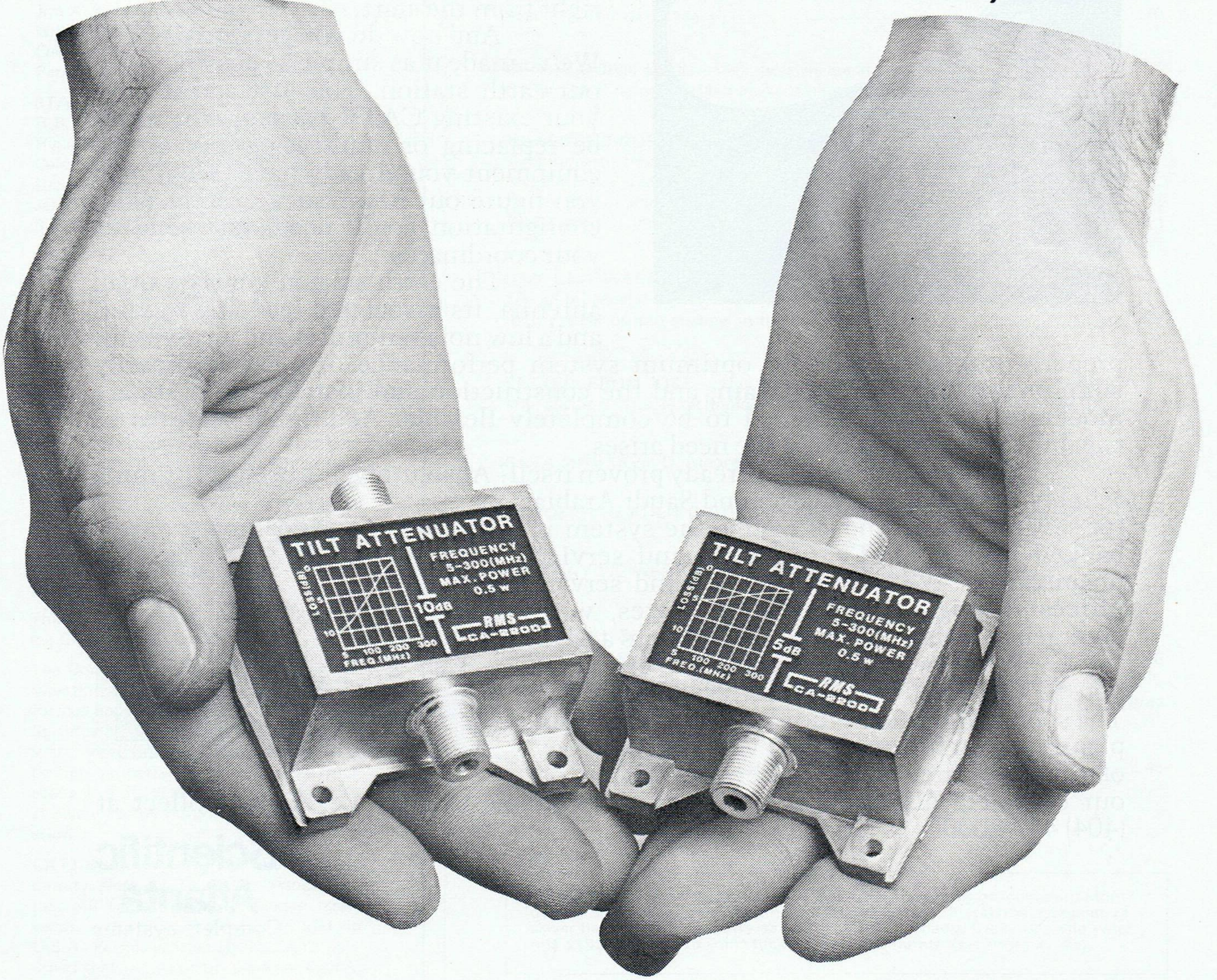

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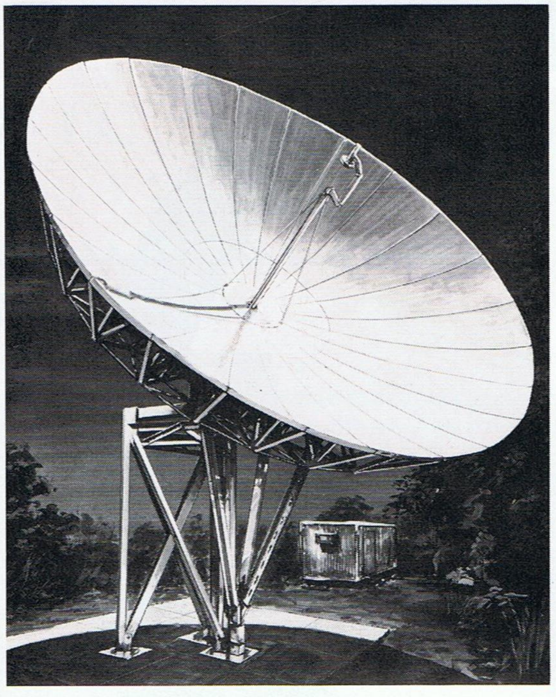

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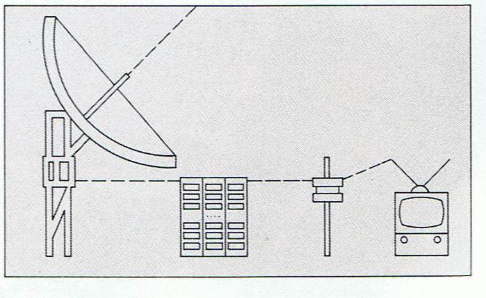

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CATJ

OCTOBER 1975

VOLUME 2 - NUMBER 10

PUBLISHED MONTHLY, AS ITS OFFICIAL JOURNAL, BY THE COMMUNITY ANTENNA TELEVISION ASSOCIATION, INC., OKLAHOMA CITY, OKLAHOMA AS A SERVICE TO ITS MEMBERS AND OTHERS PROVIDING CATV/MATV SERVICE TO THE TELEVISION VIEWING PUBLIC LOCATED THROUGHOUT THE WORLD.

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—CONTENTS—

OUR COVER

A New Era In Signal Processing — freed from the bonds of locked-up input/output channel choice, the new TOMCO SR-1000 standby headend receiver has a lot of flexibility going for it. Additionally, CATJ is giving away this $1950.00 unit to some lucky reader this month (see Pages 37-41).

Tip, Tipping, Tipped

America was borne out of individual initiative. American immigrants moved West in search of new frontiers to conquer, new land to tame, and of "room" they could call their own. They labored long and hard with their hands and their backs and, out of their sweat, a continent nearly 3000 miles wide was conquered and put into productivity.

During the first World War, Americans returned to the homelands of their ancestors to assist in waging a battle against despotism. During the second World War, Americans spread men, resources, and equipment both east and west because for the first time in this nation's history **our own land,** the land which our grandfathers and great grandfathers had tamed in the westward march, **was distinctly threatened** by the spread of two Axis dictatorships.

America has been called the great human experiment: the creation of a nation out of pure wilderness, a new nation, shaped by the visions of such men as Ben Franklin, John Hancock, George Washington and hundreds of others. America was borne with few preconceptions, no great legacy, and very few lasting traditions. America was not only a fresh start for its immigrants, it was a fresh start for human government.

America was created, its founders said, as a "democracy", a land where individual rights were to be protected above all else. And through this idealistic desire to protect the individual's rights, individual Americans found the freedoms necessary to make a nation nearly 3,000 miles wide and 1500 miles tall turn from wilderness into habitable, productive, farm lands, towns and cities. It all happened in the short span of just over 100 years, or roughly three generations.

The allure of the American experiment attracted 19th century scholars from throughout the world in the 1800's. One of these, Alexis de Tocqueville, visited the (then) young American Republic in the early 1830's. When de Tocqueville returned to France he set upon the creation of a great written composition which he called "Democracy in America". De Tocqueville was both impressed with and concerned for the future of this "noble experiment in human relations", and by the end of his second volume he had set out the worries **he had** for the America's survival. Speaking in the language of the era, de Tocqueville spoke of the "despotisms which America has to fear". **"The type of depotism America will face"** he wrote **"will be different kind of despotism from that experienced in Europe or elsewhere in the world. It will be a milder despotism, but more extreme in its reach; it will degrade men** without **tormenting men."**

In the future of America, de Tocqueville saw a nation inhabited by a multitude all absorbed by their own affairs, "preoccupied with the petty and paltry pleasures with which they glut their own lives".

De Tocqueville envisioned "Above this race of man will stand an immense and tutelary power, which **takes upon itself alone** to secure man's gratifications and to watch over their fate. The power which this government shall exert shall be absolute, minute, regular, provident and mild. For the happiness of this race of man, such a government willingly labors. **But in return,** it elects to be their sole agent, and the only arbiter of their happiness. This government provides for this race's security, it foresees and supplies their necessities, facilitates their pleasures, manages their principal concerns, directs their industry, regulates the descent of their property, and subdivides their inheritances."

"What can remain for this race's government **but to spare them** of the care of thinking and the trouble of living?"

"Thus through its regulation it daily renders the exercise of the free agency of this race of man less useful and less frequent; it circumscribes the free exercise of will, and the creativity of the individual man, within an ever narrowing range and **this government gradually robs this race of man of all of the uses of the individual man.**

"This government has professed the doctrine of equality so often and so long that this race of man has gradually been prepared for these things. This government has predisposed this race of man to endure these **individually** small and petty erosions of individual liberty, and often to look upon them as benefits.

"After having thus successively taken each member of the community in its all powerful governmental grasp and fashioned each man at will, the supreme power of this government then extends its protective arm over all of the community. **It covers the whole surface of society with a network of small, complicated rules.** A network of individually minute and individually uniform rules through which the most original minds and the most energetic characters cannot penetrate to rise above the crowd.

"The will of man has not been shattered; it has been softened, bent, and guided. Men are seldom forced by this will to act; **but they are constantly prevented from acting.** Such a power does not destroy, but it prevents existence. Such a power does not tyrannize with a despotism of old. But it does compress, extinguish and stupefy the great body of man until the nation as a whole is reduced to nothing better than a flock of timid and industrious animals.

"And the government is the shepherd".

Were Alexis de Tocqueville to return to America 135 years after he penned the proceeding, he would find his prophecy dangerously close to reality. In every endeavor in life there is something called a balance or tipping point. A child learning to ride a two wheel bicycle for the first time knows all too well that there is a **tipping point** on the folcrum of balance. A man adjusting a CATV line extender knows full well that there is a point at which the amplifier **breaks** from linear operation into class C operation; **cross mod.** A businessman charging a price for his product or service knows well there **is a point** in his charges where customers refuse to buy. **Life is one big teeter totter.** Push just a little bit too far, and disaster. We usually arrive **at the tip point** gradually, but the tip point is abrupt and well defined. The Arabian fable about th straw which broke the camel's back is illustrative of the tipping point; one last straw, and the camel's back **tipped.**

When this nation was founded 199 plus years ago, we gradually **began** moving towards that tipping point. In a democracy such as ours, rules, laws and edicts are replaced by legislation enacted by the elected representatives of the people. But legislation, as perceived by de Tocqueville, **is its own form of evil.** The vice of legislation is that it follows its own inexhaustible course. Our founding fathers began with a Bill of Rights and Ten Amendments. That little trickle has now become a flood; a little legislation has been followed by a lot of legislation. Within our state legislatures, and our federal legislature, there develops what has been called **the legislative itch.** A rash is seen on the body politic and the rash **must** be scratched. A little scratching in the form of a little legislation leads to more scratching and more scratching.

Laws are created pell mell. Laws are created on top of laws. And then new laws are created on top of these.

Laws must be **enacted.** They then must be **administered.** The administration of these laws must be **monitored.** The monitoring of these laws must be **interpreted, construed,** disected, expanded, **and finally enforced.** And with the enforcement comes **the regulator.** The regulator is a decent sort of chap, more often than not, anxious to do **his job** well. But first, foremost and forever, **his job is to regulate.** He looks neither left nor right. He sees **only his regulation** and the enforcement of that singular objective.

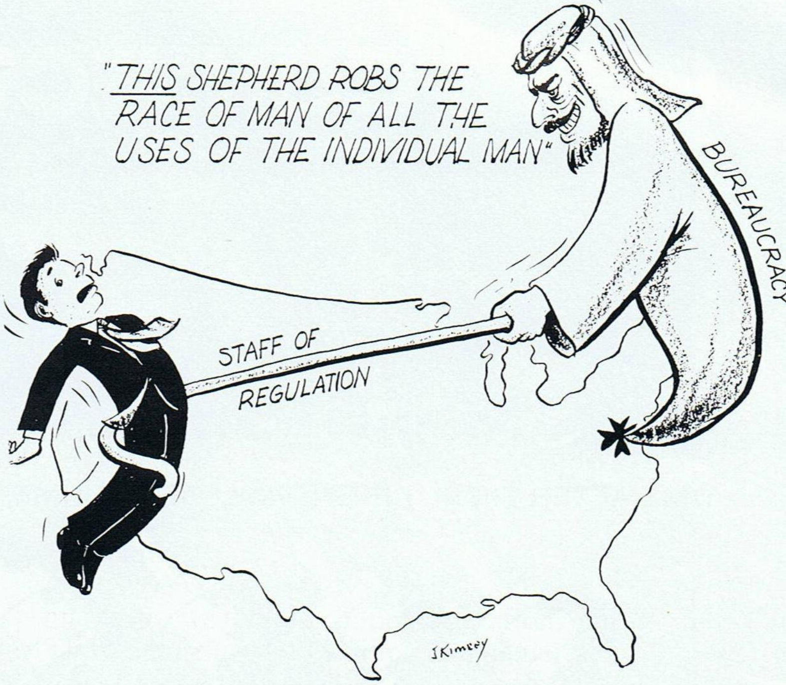
Each of Alexis de Tocqueville's singular men who make up this democracy sees only **that small sphere that immediately surrounds himself.** He exists in his **own** little room, and he views **his own** situation only through glasses tuned to his own "paltry pleasures which gluts his own life".

Each individual man functioning in his **own** world probably sees no great ominous cloud in the ever increasing expansion of regulation. After all, few would argue that freedom could exist unless there is order. And what are these laws and regulations **if they are not order?** So we erect a **false** premise; the more order we have in our lives, **the more freedom we shall all enjoy.**

So the dangers of expanding, **ever expanding** legislative itch are well perceived, but they are not **collectively** perceived. The farmer perceives new regulations and restrictions on the fertilizers he may use, the new safety standards for his grain elevator, and so on. The doctor perceives new regulations telling him which medicine he may prescribe, new doctor-patient relationships in Medicare programs, and new restrictions on his office hiring practices. School administrators perceive new approved text book lists which "qualify" for federal matching funds, new building codes and requirements that dictate ever increasing aspects of school room construction, and new federal legislation that will force changes in male/female physical education class techniques. The cable television system entrepreneur perceives new restrictions on signal carriage, new "fines" for failure to adopt uniform financial/accounting practices and new ladder requirements for his towers.

Each individual man inhabits his own small room and in each small room the air is slowly, gradually turning "rancid." Our very life blood, the freedom giving oxygen Alexis de Tocqueville perceived in America, is slowly, but surely being eaten up by "legislative itch." The change in our atmosphere has been slow, so slow that we may not even be aware of the change. Nor, living as we do in our own little sub-atmospheres each functions within, have we been aware that the "air" in the next room (where doctors, farmers et al must live) is also turning "sour". When we complain, we complain as a rule only to those who share **our room** with us. Little do we realize, in this gradual process, that **what we are losing is the very air of freedom itself.**

Yet it is happening to everyone, all over; even if our perception individually is limited to our immediate room and "family" of co-workers. Slowly, but surely, the government by edict, laws, regulations and mandate is imposing **its own sovereignty** in place of the sovereignty of the individual businessman, and consumer. **Government,** not the consumer, is determining **which** products go on sale, **where** they are sold, **how** they are sold, **who** buys them, and **how** they are used. Government regulations are raising the costs of products at **every** level. Regulations which individually are perceived only by the inhabitants of the respective levels of **rooms** are becoming or have become major cost factors in the mining or production of raw ingredients, in the molding and assembly of discrete parts and sub-parts, in the design and manufacture of full assemblies, in the transportation and distribution of finished assemblies, in the operation of the sales point for the finished product, and even in the employment and use of the final assemblies by the consumer himself. Yet **each** intrusion of regulation is seen **only** by the individual functioning at that singular level in one small room.



Thomas A. Murphy, chairman of General Motors, recently told a meeting of the National Association of Accountants **"What is of greatest concern is that each intrusion of government takes decision-making power away from the individual** (consumer) **and diminishes his own** (individual) **economic freedom."**

And the key word is **regulation.** Regulation is an era of stifling air, diminished individual freedoms and in the words of de Tocqueville "(a time where) government is the shepherd." It is the **Age of Regulation.** And living as we do in our individual rooms, tending to our own petty interests and concerns, we individually perceive but a tiny segment of the depth of this age. Many even welcome the changes we individually perceive because regulation has a basically friendly ring to it. We want to be regular fellows and many find no comfort in being an "irregular person." After all, **is not a regulated life a good life?**

If the legislators have become consumed with the legislative itch of passing ever increasing new laws upon new laws, pell mell, left and right, seemingly everywhere at once, **the creations of this legislation** are working at double speed to implement, expand upon, and enforce. Duplicating machines run day and night turning out new regulations, new edicts, new mandates. Regulatory agencies, like our own FCC, after nearly a decade (the 50's) of virtually **zero growth** are expanding at the rate of 10-40% per annum. All regulators have one overriding fetish; **they are to be obeyed.** The very smallest "offender" (i.e. the Gridley, Kansas type CATV operators) **must be sought out** and prosecuted, **lest** larger offenders be encouraged. The enforcement of these regulations by well meaning regulators knows no limits, no bounds. The helpless "offender" is at their mercy. His defense is severely constricted by his own individual funding. His opponents, the regulators, have **no** constrictions. Their funds are **unlimited,** and if they individually run shy of money, manpower, or legal expertise, they have **all of the people** to draw upon. These regulators merely request (and usually receive) an increased tax revenue allotment in the following fiscal year. And the real irony is that the offender through **his own** tax payments is contributing to **his own** prosecution!

The very air of freedom is dangerously close to a tipping point. The teeter totter of America is dangerously close to the point where as de Tocqueville prophesied "...the nation is reduced to nothing better than a flock of timid and industrious animals and the government is the shepherd...."

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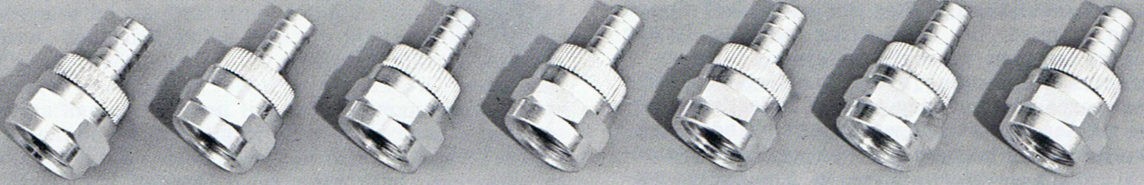

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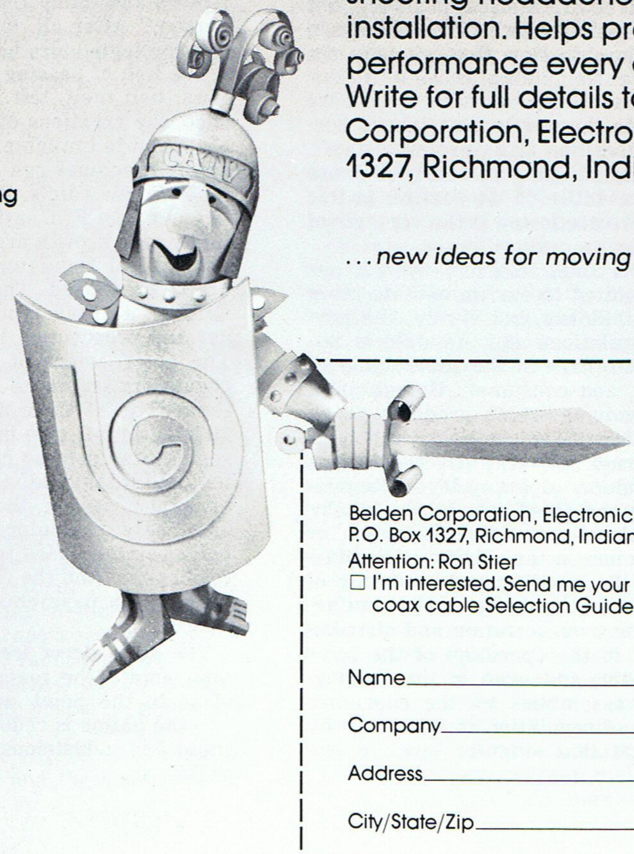

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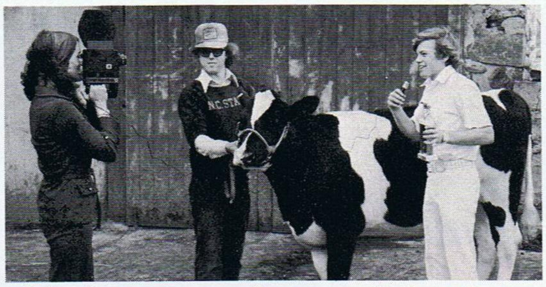

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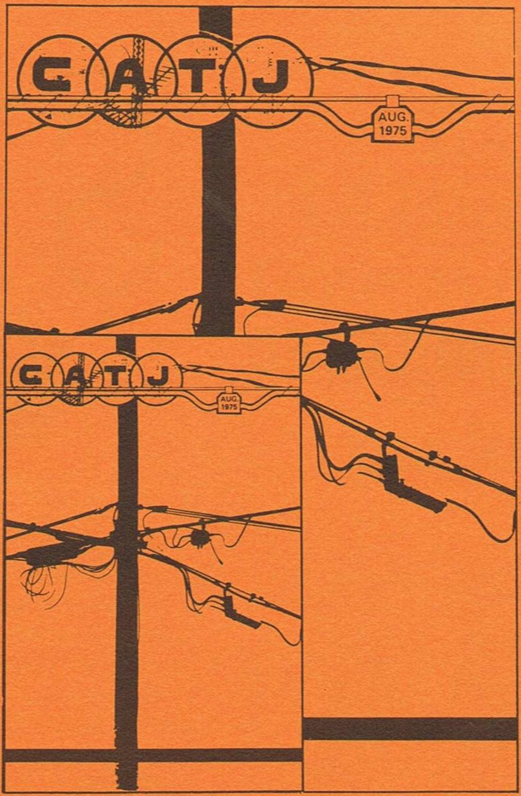

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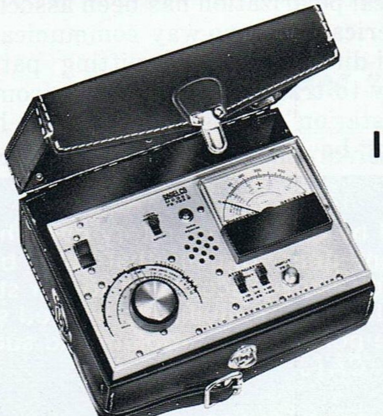
WEATHER SCAN



MULTI-MODE RECEIVING ANTENNA ARRAYS REDUCE SCATTER REGION SIGNAL FADING

Brave New Worlds

For as long as there has been a commercial-television transmitting-and-receiving industry, there has been horizontal polarization of television signals. The decision to radiate television signals horizontally, with respect to the earth (Diagram 1), resulted from a series of tests conducted by RCA (and others) in the 1930's.

There were no set rules about wave polarization in the 30's when the first television experiments began in cities such as Milwaukee, Los Angeles, and New York. And a study of the literature of that era reveals that many years of industry-sponsored (in the main RCA) tests sought to learn whether the new "ultra-high frequency" transmissions (anything about 30 MHz was considered "ultra" in those days) propagated better when vertically or horizontally "sensed."

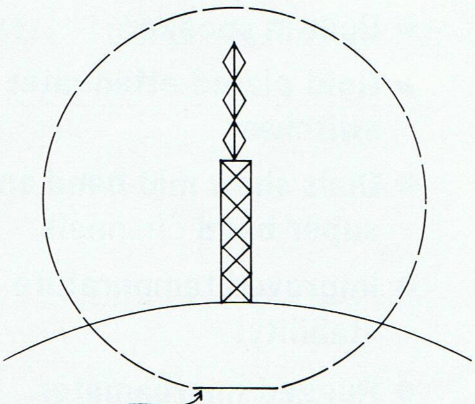


DIAGRAM 1

When the FCC adopted rules and regulations for the first commercial television service, and the first stations became operational in the early 1940's, the polarization chosen for the United States was horizontal. Slightly earlier, the British had adopted vertical polarization.

The "polarization argument" has never really been settled, simply because for all practical purposes *there is no argument.* Under certain conditions, each exhibits advantages over the other. Vertical polarization appears to fill in (i.e. more signals in dead spots) in regions in close to the transmitter (i.e. within our Grade A region); while horizontal polarization appears under most circumstances to exhibit better far-region coverage; i.e. in our far Grade B regions. But these are *not* hard-and-fast rules, and there is *no one clearly superior polarization mode* for the transmission of television signals to large geographic areas.

Most often vertical polarization has been associated in North America with two-way communications, where omni-directional transmitting patterns are necessary to transmit intelligence from one central "base station" to mobile units which may at any instant be located in virtually any

ABOUT MULTI-MODE. . It appears, from a series of extensive studies prepared by CATJ's laboratory over the past 18 months, that there may be yet one more breakthrough in CATV receiving antennas. Signals that travel beyond their Grade B (radio horizon) contours do not maintain their original polarization sense, according to our studies. Consequently, horizontally polarized receiving antennas capture only a small portion of the multi-re-polarized signals on such paths. This report, part one of a several part series, nvestigates the re-polarization problem and suggests some practical solutions worked out by CATJ's staff. Bob Cooper / Editor in Chief, CATJ.

direction from the base station.

We have not done badly with horizontally polarized waves; we would have done probably about as well if the choice had been vertical as in England. And the subject has therefore received little attention from researchers in the interim.

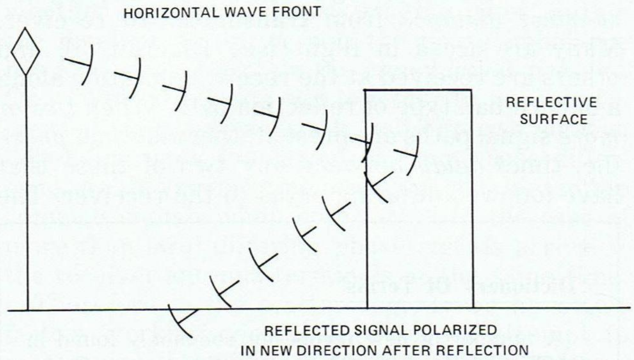


DIAGRAM 2

However, in the 1950's there was a small flurry of interest in both polarization modes when various IRE (later IEEE) study groups revealed that polarization of wave fronts at VHF (and UHF) are not sacred; *that under some circumstances* wave fronts which depart the transmitting antenna in one mode (i.e. either horizontal or vertical) may arrive at some distant point *skewed or twisted.* See Diagram 2. After suitable study of the phenomenon, it was determined that *obstacles encountered* by a wave front along the transmission path have the capacity to repolarize the wave front. Such obstacles, it was learned at the time, could be physical and obvious (a tall building or a range of mountains), or they could be "invisible" and not so obvious. But at that point the study was dropped, except in military applications where new types of transmitting-and-receiving antennas evolved to "take advantage" of the new information.

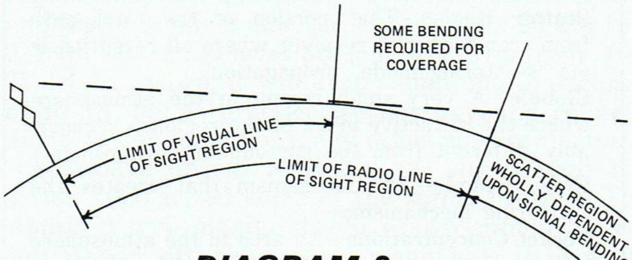


DIAGRAM 3

Of particular interest to us, in the television-receiving industry, are the "invisible" repolarization mechanisms. They are most apparent on relatively long paths (i.e. those that *begin at the visual horizon* and stretch outward into the radio horizon region—for whatever distance the radio horizon region can be stretched by the receiving-system designer). See Diagram 3.

It was apparent with IRE-sponsored studies in the 50's, and in subsequent studies, that repolarization of a wave front (horizontal in our case) takes place primarily in two regions of interest to us. In regions very close to the transmitter, where signal levels are very strong, repolarized wave fronts occur when the horizontal wave front encounters an obstacle such as a tall building, and in the reflection-from-the-building process the wave front "skews" or "twists" on its axis, ending up polarized other than horizontal. There is nothing magic about horizontal or vertical polarization; both are merely *way stations* around the point of the compass, and in one-degree increments there are 360 such increments or way stations. Which is another way of saying that if horizontal polarized wave fronts are assigned a mathematical number that corresponds to the plane of the wave front as that wave front "cuts through a circle," it would not be called horizontal; it would be called *90/270 polarization.* Or vertical polarization would be labeled 0-180 polarization. See Diagram 4. Many other variations are possible, for example 45/225.

Now it happens that in addition to physical encounters that cause repolarization (see Diagram 2), there are "invisible encounters" that cause the same effect. These invisible encounters *can* take place at virtually *any point along the path* from the transmitter to the receiver, and in fact do. But their impact or noticeability is *most apparent* in those regions along the transmission path which are located beyond the visual line-of-sight range. See Diagram 3.

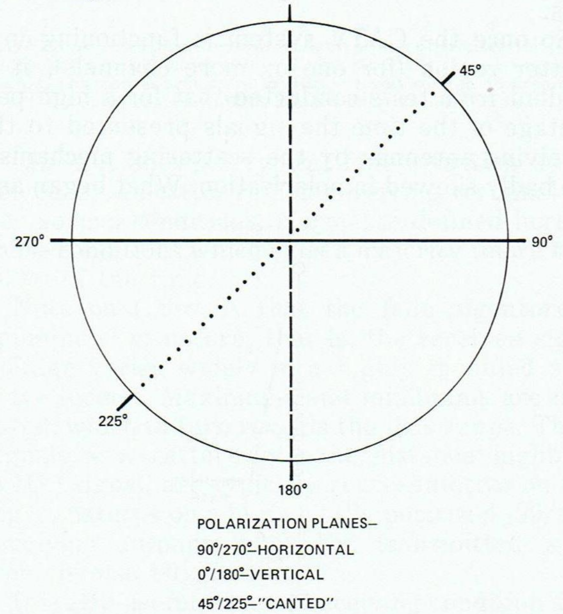


DIAGRAM 4

The propagation of signals in the VHF/UHF spectrum region *beyond the horizon* (i.e. *further out* from the transmitter than line-of-sight will reach) is due almost entirely to a propagation mechanism known as "scattering." Scattering of wave fronts is best explained by the thesis that wave fronts encounter, in the scatter region, small, localized areas of the lower atmosphere (i.e.

ground level up to a few thousand feet) which are concentrations of moisture or pockets of hotter than surrounding or colder than surrounding air. These small pockets or concentrations of moisture-different or temperature-different air are constantly in motion (i.e. they are not stationary in location). A wave-front path that has an encounter with one such concentration one instant will find no such concentration at the same point along the transmission path seconds thereafter.

And these pocket-concentrations have the ability, because of their localized concentration of signal-reflection (or refraction) components, to cause a wave front entering or passing through to bend and twist. In effect, a wave front passing through such a "globule" exits often slightly (considerably) repolarized. In an *extreme example*, a 90/270 wave-front signal would exit the globule concentration as a 0/180 wave-front signal.

This whole thesis depends upon the presence, along the transmission path from transmitter to receiver, of *pocket concentrations* of *moisture globules* or *temperature globules*. And it depends upon an *absence* at the receiving location of any *direct* path signals (i.e. line-of-sight signals), because line-of-sight signals tend to be considerably *stronger* than scatter-range signals, and the scatter-range signals propagated along the path by globules are masked (i.e. covered up in signal-strength level) by the stronger line-of-sight signals.

So once the CATV system is functioning in a scatter region (for one or more channels), it is evident from tests conducted that for a high percentage of the time the signals presented to the receiving antennas by the scattering mechanism are badly skewed in polarization. What began as a 90/270 wave-front signal may at any instant point in time be considerably different from 90/270.

To complicate the situation, scatter-region signals arrive at the distant receiving station along a multitude of *different* signal paths. Not all signals arrive at the receiving antenna by traveling the *shortest distance* from transmitter to receiver. Many are arced in flight (see Diagram 5), and others are received at the receiving location along a billiard-ball type of reflection path. When *two or more* signal paths are present, there is some *phase* (i.e. time) *delay* between any two of these that have followed differing paths to the receiver. The

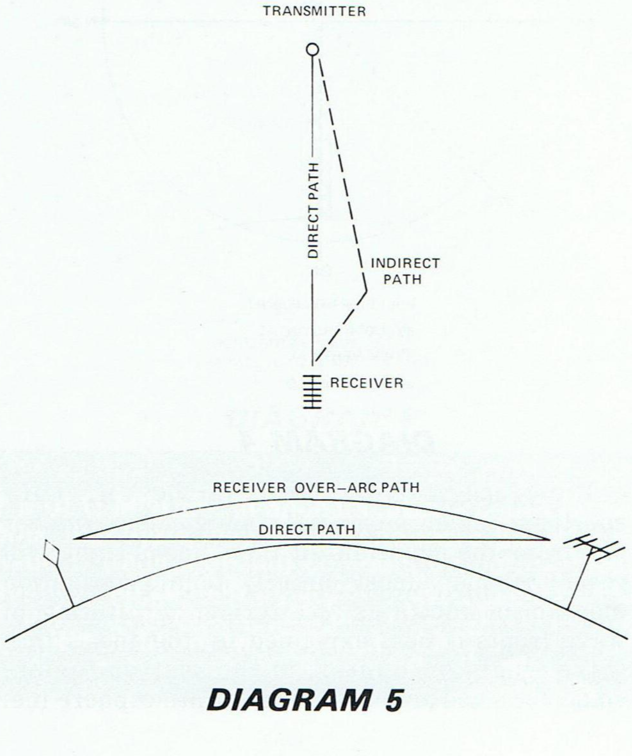


DIAGRAM 5

"Dictionary Of Terms"

A number of **new terms** not commonly found in CATV (or other) print appear in this report. To insure that you have minimal difficulties following the "new language," we provide the following definitions:

Horizontal (polarization)—A plane that is parallel with respect to the earth's (assume flat) surface;
Vertical (polarization)—A plane that is perpendicular with respect to the earth's (assume flat) surface;
Wave Front—The graphic portrayal of the transmitted wave form, embodying its respective polarization form;
Skewed—A twisting of the wave-front polarization, meaning that the original polarization of the transmitter is no longer present;
Repolarized—Skewing of the original wave-front polarization to a new, known or measurable polarization;
90/270—Mathematical designation for horizontal polarization;
0/180—Mathematical designation for vertical polarization;
Scattering—The propagation mechanism whereby signals travel beyond radio horizon to some distant point where no direct-wave reception exists;
Scatter Region—That portion of the total path from transmitter to receiver where all reception is via "scattering mode" propagation;
Globule—A very small region in the atmosphere where the refractive index of the region is measurably different from the surrounding atmosphere;
Globule Mode—The mechanism that creates the scattering mechanism;
Pocket Concentrations—An area in the atmosphere where a high number of globules exist, creating a concentration of scattering mechanisms;
Fade Range—The decibel range through which a received signal fades;
Helix—A special form of antenna exhibiting circular polarization;
Multi-Mode Polarization—An antenna polarization "system" that combines two or more polarization formats (i.e. vertical and horizontal) or all formats (i.e. circular) into a single transmitting or receiving antenna.

phase or time delay is seldom so *extreme* as to cause visible receiver-screen ringing (i.e. ghosts), or if there are ghosts on a rapidly fading signal, they are transitory in nature, appearing only for brief instances (example of extreme ghosting due to multiple paths . . . airplane reflections). But whether the signals display ringing (ghosting) on the receiver screen or not, the phase imbalance has a dramatic effect on the *signal levels* present. Only in-phase signals *add together* to produce increased signal voltages. Or, out-of-phase signals, depending upon the extent of their phase difference, create varying amounts of attenuation in the summed signals when both (or all in the case of more than two) differing phase signals arrive at the receiver-antenna terminals at the same time.

Therefore in the scatter regions we have two factors working *against us* when we attempt to create viewable pictures for our system subscribers. (There are actually many more than two factors, but for now they will suffice.) The signals are being repolarized by globules; signals are arriving at the receiving antenna over multiple "scattering paths," with some degree of phase imbalance between them so that at any given instant they may sum in phase or attenuate out of phase.

Vertical vs. Horizontal

If the 90/270 wave front maintains the *majority* of its integrity in flight out to the scatter region (beginning at the point the line-of-sight point leaves off) and loses its 90/270 polarization only *some* of the time in the scatter region, what would happen to the receiving signal *level* present at the CATV headend if *two sets of antennas* were installed, one horizontal (90/270) and one vertical (0/180)?

Back in the line-of-sight region, and especially in close to the transmitter (such as in the Grade A region), if you merely take a horizontal antenna and flip it up on its side (i.e. turn it from 90-270 to 0/180), the signal level present will drop from 20-35 dB. In *theory*, it will drop something in excess of 30 dB, but in practice we have ground reflections, tower reflections, and other physical factors which have (in our local antenna site region) already repolarized some of the signal present. To obtain a true maximum *cross-polarization* differential (30+ dB), the antenna would have to be well elevated above ground in virtually free space where no localized ground reflections or repolarizations cause any skewing.

The same is *not* altogether true in the scatter region, primarily because a fairly large portion of the scatter-region signal is skewed in *as-received polarization* by the globule propagation mode along the path. Therefore, under conditions of high fade rates (i.e. many fades per minute), it is logical to *assume* that for *brief instances* the vertically polarized (0/180) antenna *would exhibit* substantial amounts of signal at its antenna terminals—perhaps even exceeding those present on the horizontal (90/270) antenna, *for that instant.*

Fade Signatures

To better understand the nature of the "disease," it is helpful to look at our symptoms. With the aid of a chart recorder attached to an SLM, this can be done quickly and conveniently.

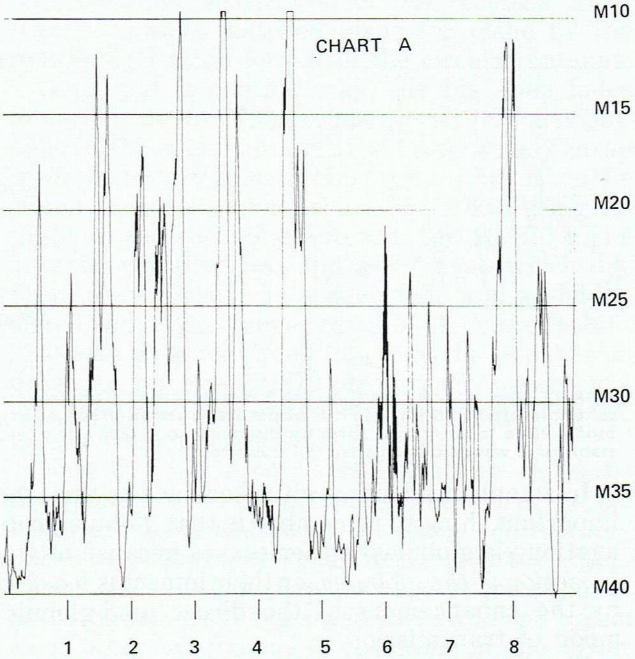


CHART A — Typical beyond-horizon tropospheric scatter signal (high band in this case) shows 30 dB plus fade range of received signal. Horizontal scales are in dBmV levels related to preamplifier input; vertical time marks are at one minute intervals.

Chart A shows a typical fade situation as received by a scatter-region receiving terminal under normal conditions. Normal is defined here as those conditions which exist a majority (more than 50%) of the time.

Note on Chart A that the fade signature is "pumping" in nature; that is, the received signal voltage varies widely in a highly modified sine-wave format. Maximums and minimums are indicated, which in turn reveals the *fade range.* These signals, on a scatter-region (i.e. distance) highband (VHF) signal, are typically representative on fading signatures on a horizontally polarized (90/270) receiving antenna when the transmitted wave front is also 90/270.

It is also useful to see a receiving condition such as this "clear itself"; that is, with the assistance of a *friendly* transmission medium, see how the transition from "scattering" to enhanced tropospheric bending looks. Chart B illustrates. Note that leading into the more stabilized signal levels (enhanced levels), the scattering mode appears as it does in Chart A. However, when the turbulence in the atmosphere slows down (i.e. the atmosphere *stabilizes*), *the effect of the globule propagation mechanism diminishes* and is masked by the extended range of the direct path (non-globule) signal. This sort of enhancement takes place when weather fronts provide enhanced signal levels, or the normal morning-and-evening heating and cooling process of the atmosphere provides short-term signal enhancements (see *September* and *October CATJ, 1974*).

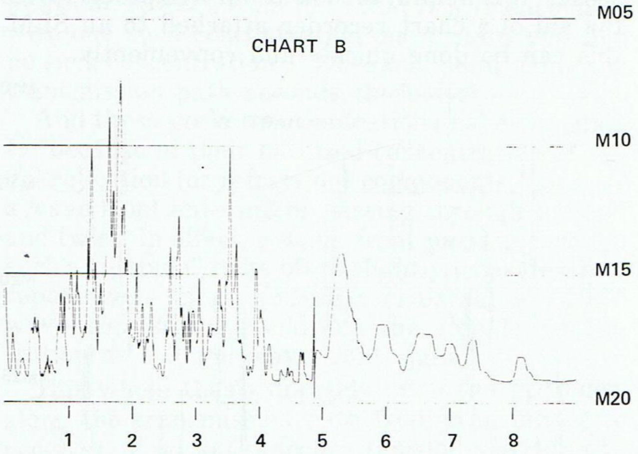


CHART B — Typical transition (at 5 minute mark) from tropospheric scatter propagation to tropospheric-stable propagation mode. Note fades do not abruptly disappear, but fade rate does stabilize as wave front polarization stabilizes.

In an enhanced-signal situation such as this, the important thing to remember is that globule propagation via globules) either ceases because of *stabilization of the globules*, or their impact is *masked* by the enhancement of the direct (non-globule) mode of transmission.

Chart C depicts the same globule enhanced or mode signal as received on a vertically polarized (0/180) receiving antenna. Note that for *brief* periods of time during the span of the chart, there is considerable enhancement of the signal level present on the 0/180 antenna. These enhancement periods are directly attributable to the *brief* intervals when the 90/270 polarized signal finds itself more *closely* 0/180 than 90/270 at the receiving site.

However, because the signal via the globule mechanism arrives at the receiver over a multitude of wave paths (i.e. paths direct and arced), it is *not* necessarily true that when the indicated signal on the 0/180 antenna is *high* the signal on the 90/270 antenna is *low*. It *can* happen, but it is not a certainty and is probably more in the nature of chance than probability.

The Chart C signal level averages far lower than a corresponding level would from a 90/270 receiving antenna, simply because the polarization sense of the *original* signal is 90/270; and any *deviation* from 90/270 always *starts off from* the 90/270 base or point of reference. Ending up at 0/180 is merely a way station or stop along the way, one of several hundred discrete way stations present.

It should be noted that a 90/270 antenna plane does not stop working for an 89/269 signal, or even a 60/240 signal. As the plane of polarization twists *away* from the plane of the receiving antenna (i.e. the sense changes), the fixed 90/270 antenna simply becomes less and less *efficient* as a resonant collector of signal. The *ultimate inefficiency* occurs when the two planes are *cross-polarized*, that is, a 90/270 antenna plane and a 0/180 signal plane. In *between* the two extremes, there are varying amounts of antenna-signal-voltage-capturing efficiency exhibited by the receiving antenna.

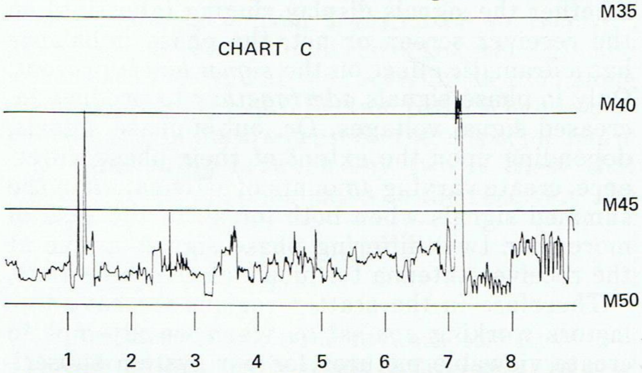


CHART C — Well beyond Grade B signal as received on cross-polarized antenna array (stacked vertically polarized Yagi-Uda antennae); note abrupt enhancements at 1.25 and 7.25 minute marks, denoting received front polarization "shift" to more vertical mode.

Circular Polarization

Because the scattered (globule propagated) signal knows no polarization loyalty *once it moves into the scattering region*, separate antennas for vertical and horizontal wave fronts are only a *partial solution* to the problem. Because a 90/270 antenna exhibits *some* degree of efficiency for off-plane signals (such as 60/240 through 120/300), logically the 0/180 antenna will do the same (i.e. 330/150 through 30/210). However, evidence indicates that the efficiency of the antenna does fall off quite rapidly as the plane of the signal *differs more than 10 degrees* from the plane of the received wave front.

One answer to this problem is to incorporate into the receiving-antenna array a circular polarization arrangement wherein the receiving antenna exhibits polarization response in *all planes* from 0/180 (vertical) through 90/270 (horizontal) through 180/0 (vertical again but *not* the same as 0/180) through 270/90 (again, horizontal but *not* the same as 90/270) and finally back to 0/180.

Accordingly, *CATJ* began a series of off-air receiving tests utilizing just such an antenna array on a scatter-region (distance) path in the late spring of 1974. This project has been continuing for nearly 18 months, and very extensive signal studies have been performed during that time.

From the thousands of feet of chart recordings accumulated during that period, a number of conclusions have been reached. It is our belief, based upon this series of tests, that extensive *new data*, as relates to CATV system operation, is now available. Accordingly, this series of reports is being inaugurated in *CATJ*.

Reference is made to Charts D and E. These charts show the same scatter-level signal as received on two separate antenna systems. One an-

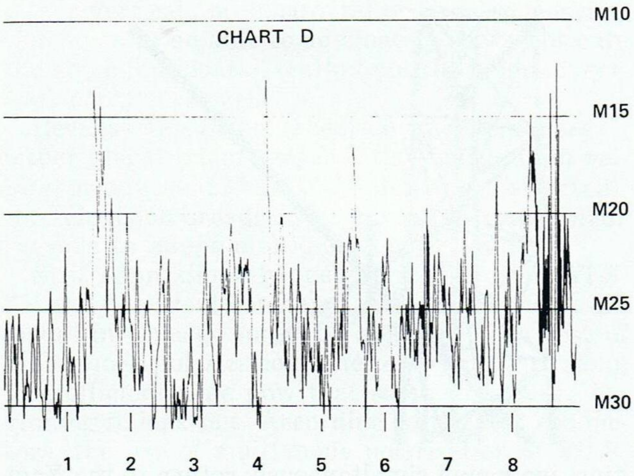


CHART D — Beyond-horizon high band (VHF) signal as received on 8 bay horizontal (polarization) log antenna array. Fade rate is through 20 dB swing range in this example. Time marks are in minutes.

tenna system is a standard horizontally polarized (90/270) antenna. The fade signature is not dissimilar to that found in chart A. Now study Chart E. This chart is made when the *same signal* was received on a *circular polarization* receiving antenna.

Instantly, it is apparent that the rate and depth of fades are *modified extensively* when the receiving antenna is *circular.* In fact, the *depth* of the fade swing evident on the 90/270 (horizontal) antenna is markedly reduced on the circular antenna.

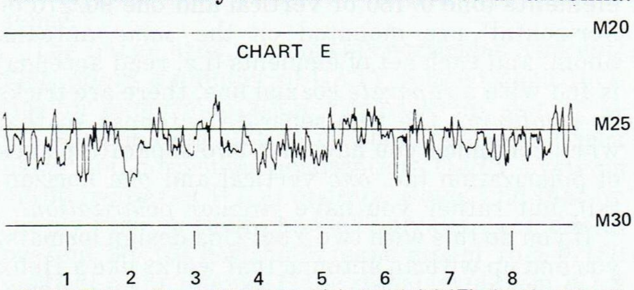


CHART E — Beyond-horizon high band (VHF) signal, same as chart D, except receiving antenna is circular polarized Helix antenna, single stack (i.e. bay). Note that fade rate is through only a 3 dB swing range in this example. Time marks are in minutes. **Charts D and E were made simultaneously.**

It would be well to remind everyone at this point that the transmitted wave front is horizontal, that is 90/270 with respect to the flat plane of the earth. The signal received on Chart D is being received on a horizontal antenna; the same 90/270 plane with respect to the earth as the transmitting-antenna plane. Chart E, on the other hand, is prepared from the received signal on a *circular* polarized antenna, one that exhibits a constantly changing, linear, twisting polarization sense.

From this simple graphic presentation, some conclusions can be drawn.

(1) The two antenna systems differ primarily in that *one* (D) responds only to a polarization format which matches the *original* transmitter polarization format;

(2) This particular receiving antenna shows widely varying signal voltage levels present, over a 10-15 dB fade range;

(3) A second antenna, with no *singular* polarization loyalty (i.e. responsive to all polarization formats), exhibits a fade rate more than 50% lower.

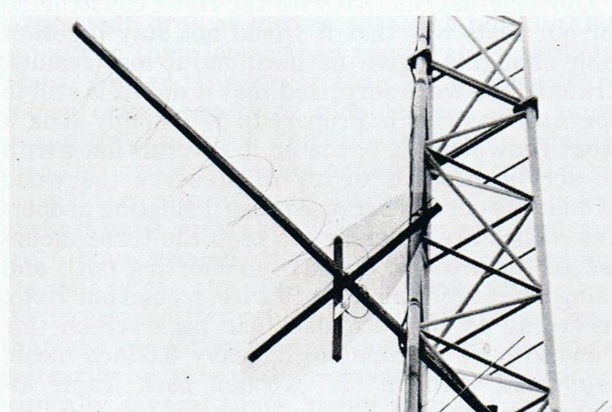
We must therefore assume, with few trepidations, that the multi-polarized receiving array exhibits *lower fade rates* simply because the twisting, skewing polarization of the *received wave front* is always matched plane for plane by the multi-polarization format of the circular antenna.

Or to put it another way, the big deep fades found on the 90/270 antenna are largely attributable to the received signal varying widely *away from the 90/270 polarization format.* That is, as the signal twists to an extreme of 0/180 during its flight to the receiving antenna, the 90/270 plane antenna captures less and less signal, which displays on the chart as a deep fade and a sudden signal reduction. Lower rates of skew (i.e. to 45/225) also produce fades (lowering in signal level present), but the 90/270 plane receiving antenna still captures *some* of the signal present; thus the fade at that point is *not as severe.*

Note if you will on Chart E that *we still have the smaller +/− 3-5 dB fades.* These are, we believe, primarily caused by the *phase addition and phase cancellation* of signals arriving at the antenna via paths other than the true shortest-direct path. Signals traveling arced paths add and cancel each other continuously, resulting in the lower fade rate shown.

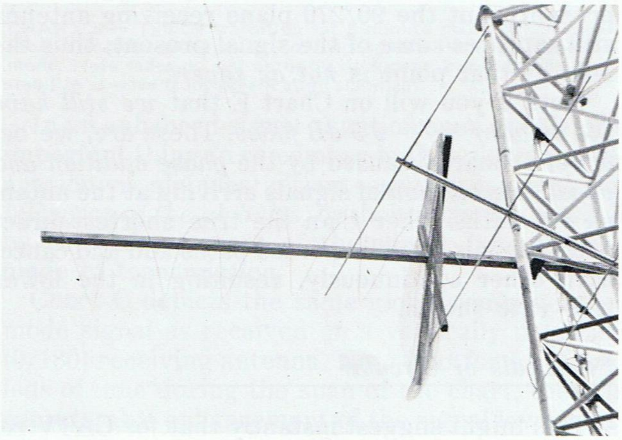
Practicals of Circular

This might suggest instantly that for CATV receiving paths that are operating in the scatter region one excellent way to greatly *diminish signal fading* (i.e. chopping) is to *replace* existing horizontal (90/270) antennas with circular polarization antennas. This is more than logical, but it is not altogether practical.



A circular polarization antenna is, in our 18-month test-situation, best represented by a *Helix* design. The Helix antenna, often employed in terrestrial-to-space communications, is *not* dissimilar to the Yagi-Uda in *response patterns and gain.* That is, most Helix antennas exhibit gain that is comparable (for the same boom length) as Yagi-Uda antennas (perhaps a bit lower than the Yagi-Uda). And the receiving pattern (i.e. response of the antenna to side and rear lobe signals) is equal to or again slightly *worse than* a Yagi-Uda.

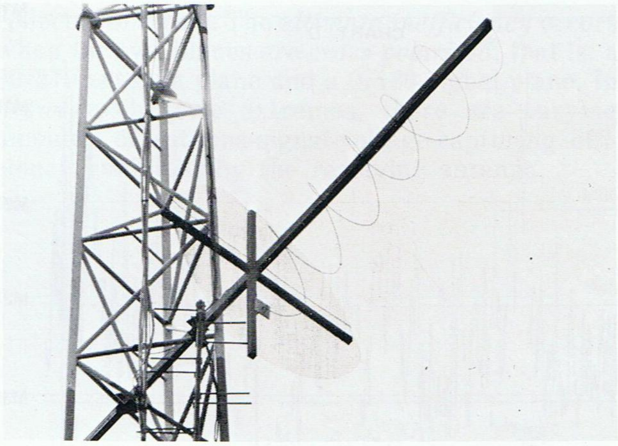
As you can see from the photographs accompanying this report, the Helix utilized by *CATJ* is constructed so as to end-mount from tower legs. The corkscrew affair is the actual antenna element, winding its way (as it were) from the nose (front) of the antenna to the rear of the antenna. The size of the "coil" (i.e. the diameter), the spacing between consecutive coil turns, and the number of complete rotations around the support structure (i.e. complete rotations) per wavelength at the operating frequency are all important *design* considerations. Additionally, the antenna tends to have a match that must be transformer-coupled to a 75 ohm unbalanced line.



In real VHF life, the Helix becomes *exceedingly* large (and therefore difficult to install and keep up) once we go *lower* in operating frequency than *highband* VHF. Or, it is *not* a practical antenna for channels 2-6.

Our original concern with the Helix constructed for our tests was that it would not stay together long enough to give us meaningful test results. Frankly, we were surprised that it did (it is still in operation as this is prepared). We simply took a stout redwood 2 X 6, coated it several times with an acrylic product to try to preserve the wood (wood was chosen because it has insulating properties, which are necessary to keep the turns mounted to the wooden boom from shorting out), and using some stout number 10 wire, wound our Helix according to the formulae. The back screen (for front to back and match) is heavy 0.5-inch mesh, supported with an "X" wooden back frame attached to the 2 X 6.

However, in addition to the problems associated with the construction and size of the Helix, we were also concerned from the very beginning that in the process of *potentially solving* the rapid fading-due-to-signal-repolarization aspect of our situation, we would simultaneously return to the Yagi-Uda era of *objectional co-channel interference.* (Once again, the Helix has pattern-response characteristics *similar* to the Yagi-Uda, only not quite so good in front-to-back or in side-lobe control.) To put it another way, we *might* cure or diminish the pumping/chopping fading problem, but if we brought co-channel back, what had we really gained as far as the viewers were concerned? Not much.



Other Forms Of Circular

There are other techniques to arrive at *circular* polarization. For example, if two discrete sets of elements (one 0/180 or vertical and one 90/270 or horizontal) are mounted on the *same* antenna boom, and each set of elements (i.e. read antenna) is fed with a *separate* coaxial line, there are tricks *in combining* the two separate antennas so that when combined you have not two separate planes of polarization (i.e. *one* vertical and *one* horizontal), but rather you have *circular polarization.*

If you do this with two Yagi-Uda design formats, you end up with an antenna that works like a Helix but looks like two Yagis on the same boom. This solves the low-band *size* problem, but it does *not* solve the antenna-pattern-response problem.

If you do this with two LPDA antennas (logs), you can solve both the polarization problem and the Helix construction problems, but you pick up a few new mechanical problems in the process. We will cover these aspects of the problem and apparent solutions in a later portion of this *CATJ* series.

Commercial Interest

Circular or crossed-polarization is not *new* at the broadcasting end of the circuit. For many years *FM broadcasters* have employed both cross-polarized antennas (i.e. *separate* transmitting antennas, one set vertical and one set horizontal), and more recently FM broadcasters have been installing *singular* antennas with *circular polarization sense.* FM broadcasters do this for one obvious commercial reason: as FM radios in automobiles have become increasingly popular, they have adopted either vertical and horizontal or circular polarization so as to be able to adequately serve not only the home (horizontal) market but the mobile (vertical) market as well.

Because television reception in automobiles is either illegal (many states if the vehicle is in *motion*) or unwise (at best if the driver is distracted), the television broadcasters have not found *similar* reasons to adopt multi-mode polarization.

Still, approximately one year ago, station WLS-TV and its parent company, the ABC network, did install in Chicago (on WLS's channel 7) a test of multi-mode polarization. The tests have run along for sufficient time now that some results are beginning to leak out. According to the test conductors, the use of multi-mode polarization at WLS-TV *has* brought *significant improvements* in signal coverage in (1) the close-in areas, especially with receivers equipped with (*vertical*) rabbit-ear or indoor antennas, and (2) in the fringe area where a measurable reduction in co-channel interference has been apparent.

Of course the close-in sets *could* be expected to have better WLS pictures on their indoor antennas with multi-mode polarization; after bouncing and twisting around the high-rise buildings near the downtown section of Chicago, the original horizontal WLS signal was *anything but* horizontal anymore. And with many indoor antennas more vertical than horizontal in receiving sense in the first place, the multi-mode simply makes good sense.

The fringe area, during this particular (current) test, offers a number of CATV-related opportunities for experimentation. For example, as long as WLS is the *only* station on channel 7 in the area using non-horizontal polarization, CATV systems in the *fringes of WLS coverage* would find that by simply *turning* their channel 7 array *over* from its present 90/270 horizontal-plane mount to a 0/180 vertical-plane mount (1) the signal level from WLS should remain the *same*, while (2) the co-channel interference from *other* channel 7 stations (or adjacent channel interference from channel 8 stations) should drop by 20-35 dB. The same thing would be true for home antennas erected for channel 7.

It should be emphasized that this is a useful trick *only* as long as WLS is the *only* user of multi-mode polarization; *as soon as others follow* (more about that shortly), your receiving installation will be right back where it is today with 90/270 plane polarization.

The success with the WLS test (conducted with the sanction of the FCC, which is participating in the analysis of the test results) has prompted ABC to work out an agreement with a UHF station in California: KLOC-TV, channel 19 in Modesto. There, in tests just now getting under way, the experiment will be repeated. The purpose of the UHF tests is to measure *not only* the changes in signal level within the respective KLOC contours (as measured on standard 90/270 horizontal antennas and as measured on *special* circular receiving antennas), but also to check out the signal quality from the KLOC channel 19 transmitter as received on the common back-of-set *loop* antennas employed for in-home UHF reception. The loop, you see, is basically a *circle*.

So there exists the possibility that at some *not-too-distant future point in time*, the FCC *will* authorize *all* television stations to employ circular polarization *if they so choose*. And *if* this comes to pass, a whole new set of rather exciting possibilities will be opened up for *the CATV engineer*. We will explore these one by one as this series continues.

Weather vs. Fade Signatures

Our original premise with out CATJ test program has been to determine *how today* we might improve CATV picture quality by designing a receiving antenna system which would be more responsive to the changing, twisting polarization sense of the received wave front.

The reason the Helix multi-mode polarization system responds so favorably to scatter-path signals is singular: *the received wave front is itself constantly varying in polarization*. That is the *only* apparent condition when there is an advantage to multi-mode receiving polarization.

Therefore *one* of our test program objectives was to determine, with a fair degree of accuracy, just *what percentage of the time* such techniques might be advantageous. If the time span was small (say 10%), we suspected that few if any systems would rush right out and replace their existing antennas with circular multi-mode plane antennas; it would simply not be a worthwhile exchange.

Propagation conditions vary throughout the North American continent. This is because the scatter mechanism depends to such a large extent on the presence in the lower atmosphere of globules of dense concentrations of moisture (an enlarged rain drop as it were, although not literally) or higher than/lower than temperature pockets. These wetter than/dryer than, or warmer than/cooler than pockets or globules are in a sense *miniature repeaters*. They take the wave front *in*, then through a reflection or refraction process release it (i.e. *retransmit* it). Because the globules or pockets exist several hundred to several thousand feet above ground, they are miniature *repeater stations in the sky*. The signals they capture and then release (through *re-radiation*) are stronger than we would receive with*out* their presence, primarily because of their elevation above ground, typically several times higher than our receiving antennas. *And because of their multiplicity*. That is, hundreds (or thousands) of them exist, and as each functions and re-radiates signals, there is some Rayleigh distribution of signal concentration at our receiving antennas.

Therefore, rapid, erratic fading conditions are a "signature" of the presence of polarization skewing and multi-mode plane transmission. By the same token, regions of the North American continent where such weather conditions exist to spawn this type of globule are regions where this condition is most prevalent.

Moisture is a *major contributor* to globule or pocket formation. Moisture is regularly present at virtually all times over or near large bodies of water. Therefore signal paths that run along the shores of the Great Lakes, or across the Great Lakes, or along or over the Gulf Coast, East or West Coasts are major examples of multi-mode plane situations. Reception over extreme distances along the Mexican portion of the Gulf of Mexico (where some systems carry off air signals *350-400 miles before cable carriage*) occurs almost exclusively because of the presence of these globules or pockets.

Throughout the Midwest and over much of the South, especially in the spring, summer, and fall, the same type of condition exists. In the winter, the situation exists over large bodies of land *primarily* because of *temperature pockets*, not moisture pockets or globules.

Analyzing 18 months of chart recordings is quite a task. Still, patterns do evolve quite early, and it is therefore possible running through a year-plus of tests to pick out examples of periods when the 90/270 (horizontal) plane antenna is inferior to, equal to, or superior to, the circular (Helix in our test case) receiving mode.

Inferior To...

The 90/270 plane antenna is *inferior to* the circular-mode antenna system whenever there is *no signal enhancement* due to tropospheric bending (see Page 14, September 1974, *CATJ, VHF-UHF Wave Propagation*). This is reflected in Charts D and E here.

There is also the *slightest hint* that *perhaps* frequency-diverse fading (i.e. when the audio and video fade *separately*) is lower on the circular mode antenna than on the horizontal 90/270 mode antenna. This requires *additional study*, however; said study *should* be conducted in a region of the United States where such conditions are more frequently encountered (i.e. for example, in the Florida Keys).

On the average day, the circular multi-mode antenna is *superior* to the 90/270 horizontal-mode antenna (for reducing fade rates) as follows:

(1) From 0600-0900 local time....*30-50% of the time*

(2) From 0900-1800 local time....*60-80% of the time*
From 1300-1700 local time.....*80-90% of the time*

(3) From 1800-2400 local time.....*40-60% of the time*

The multi-mode superiority is *greater* in the mid-summer and winter and *slightly lower* in the spring and fall.

Equal To...

The 90/270 horizontal-mode antenna and the circular multi-mode antenna *are about equal* for fade rate depths *only* when an enhanced signal condition *is forming*. That is, when there is a *transition period* between rapid-fading scatter-type signals and enhanced propagation level signals, the two arrays exhibit *very similar fading rates.* See Chart F as an example of this comparison.

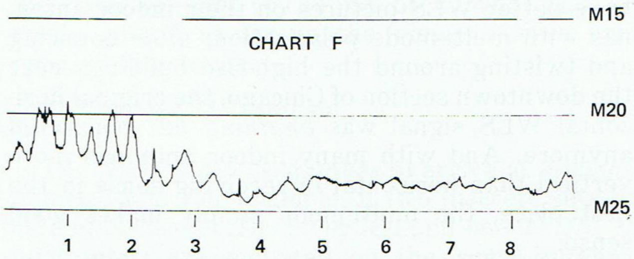


CHART F — Typical transition from tropospheric-scatter mode propagation to tropospheric-stable mode propagation (between 3 and 4 minute mark) with Helix antenna. Note fade swing range has reduced from 3 dB nominal to less than 1 dB nominal.

As a rule this transition stage between scatter and enhanced conditions lasts for a relatively short period of time, often just a few minutes or less (see Chart B). It may last for a full evening, in rare circumstances; occurring perhaps 3-4% of the evenings in a year for a period of from one to five hours.

Superior To...

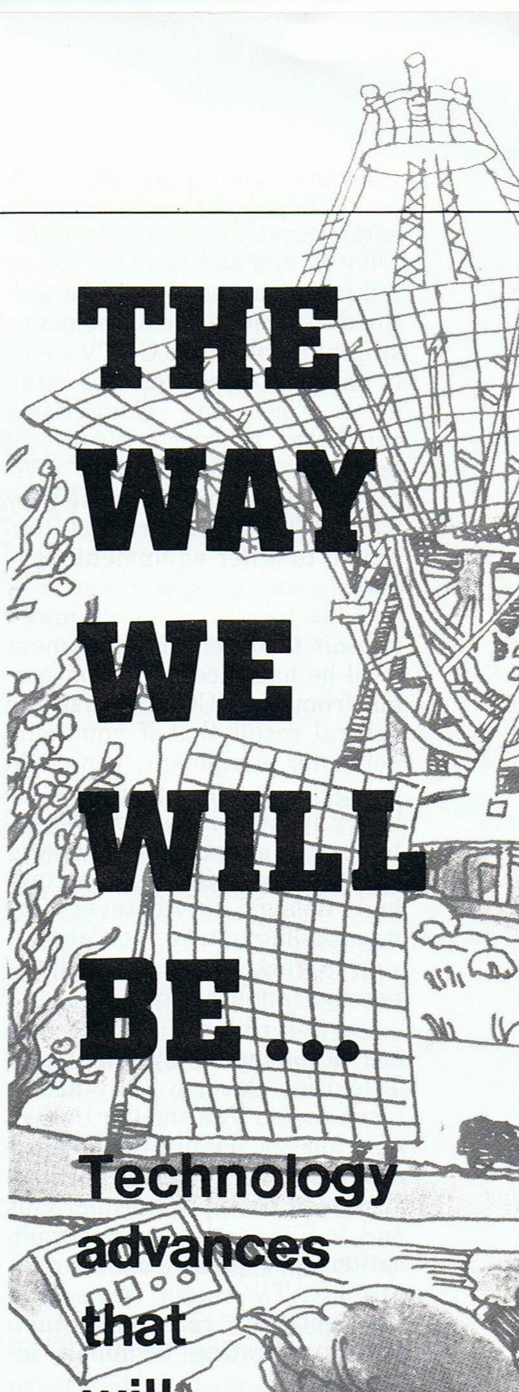
The 90/270 horizontal plane antenna *is superior in fade-rate* reduction to the multi-mode circular polarized antenna-receiving system *almost none of the time.* If both arrays have equivalent capture area (i.e. both occupy the same physical cubic feet in space), the advantages of the horizontal-plane array occur with such *rarity* that for all practical purposes they may be *discounted.*

To Be Continued...

This *CATJ* series will continue with practical examples of multi-mode antennas your system can build and additional discussions of test results during the first 18 months of *CATJ*-conducted experiments.

THE WAY WE WILL BE...

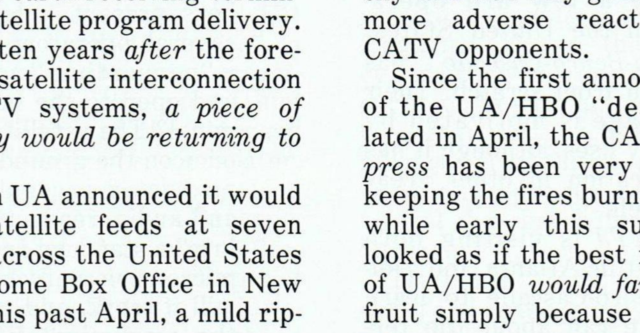
Technology advances that will affect CATV



An event of singular importance for the future of the CATV industry was scheduled to take place during September: the installation, in Fort Pierce, Florida by UA Cablevision of the first earth receiving terminal for satellite program delivery. Nearly ten years *after* the forecast of satellite interconnection of CATV systems, *a piece of blue sky would be returning to earth.*

When UA announced it would take satellite feeds at seven points across the United States from Home Box Office in New York, this past April, a mild ripple of interest slithered through the CATV community. Many people had heard the *same kind of talk* previously, *and nothing had come of it.* Others were concerned that this additional blue-sky talk was only going to bring more adverse reaction from CATV opponents.

Since the first announcement of the UA/HBO "deal" circulated in April, the CATV *news-press* has been very active in keeping the fires burning. For a while early this summer it looked as if the best intentions of UA/HBO *would fail* to bear fruit simply because the FCC



was (they admitted) not equipped to process very rapidly earth-terminal applications. Then in mid-summer the FCC acted in two areas that were destined to remove one of the major stumbling blocks to CATV's early entry into the world of satellites. First the Commission ruled that prospective users of terminal equipment (i.e. UA) did *not* have to wait *until* they had FCC earth-terminal *approval* to order equipment. *Previously*, any prospective user of satellite terminals was required to *wait* to order his equipment until he had a construction permit from the FCC. This had the natural result that if you could not order equipment, you could not get into the equipment-delivery processing line. Therefore your actual getting-on-the-air date was going to be accordingly delayed by whatever time it was going to take the Commission to work its way through the pending applications.

Earth-terminal applications are *not* handled by the Cable Television Bureau. They are in fact handled by a smaller bureau with only a handful of employees, a bureau that has been accustomed to approving perhaps *two to five* earth-terminal applications *per year*. And at that rate, CATV would be a long time getting a reasonable number of operating terminals installed.

So the FCC decision to allow CATV systems to order equipment in advance of approval was *an important one*, because it removed the logjam that was sure to follow at the supplier end of the train.

Then the Commission announced it would take immediate steps to expand the earth-terminal processing capabilities of the agency and showed it was capable of moving more swiftly then 2-5 per year by approving the UA permit for Fort Pierce.

It should be noted that earth-terminal applications require a *30-day-public-notice* phase, just as do CATV applications for new or expanded service, and that if the 30-day period lapses with no objections filed, then the Commission has to buckle down and process the application *on its technical merits*. The UA Fort Pierce application drew no objections, and at this stage it is difficult to envision who might be filing objections in the future (but there will be some, nonetheless).

With that background, *CATJ* has developed its own program of providing *earth-terminal technical data* for the industry. Here is how we envision it working at the outset.

(1) There are several suppliers with earth-terminal packaging capability. Two of these are heavily into the CATV business. *Scientific-Atlanta* has produced more than 300 earth terminals to date, and while most have been for foreign delivery, quite a few are operating in the United States. *Delta-Benco-Cascade* has begun from scratch. Their package is motivated by CATV uses, although it has application in other areas as well.

CATJ is visiting both Scientific-Atlanta and Delta-Benco-Cascade to learn all we can about the terminals they offer. We will report accordingly here, with the first report on the Scientific-Atlanta package in this issue of *CATJ*.

(2) The first installation, in UA's Fort Pierce, Florida system, is an event of double interest. It is historical *because it is the first* to be made. It is also important because it is an early warning system for all that follow. *Whatever the problems* uncovered at Fort Pierce, they serve as a useful learning curve for later installations.

(3) The *economics* of an earth-terminal installation *are elusive* at best. Seemingly, if you know how much it costs to put in the terminal, and how much it costs to operate and maintain it, and you know from HBO (or some other future satellite delivery program supplier) how much your gross profit will be for each home you deliver signal to, calculating whether or not you can afford to get into pay-TV via the satellite route *should* be fairly simple arithmetic.

It turns out that it is not so simple. We will explore that in considerable detail in November and December *CATJ*.

(4) Finally, there is the likelihood of shared terminal costs by two or more separate (non-commonly-owned) systems. If one system is too small to support and amortize the going-in plus operating costs, given the gross-profit-per-home numbers present, what about several operators forming a "consortium" to install and operate the earth terminal? The satellite signal, once on the ground and demodulated, is regular video and audio, ready to "dump into" a standard terrestrial microwave network. How will it work, and what are the economics? *We'll look into that also.*

At the present stage of CATV satellite entry, there is for all practical purposes only one viable program source for *satellite* delivery: HBO. But the time is probably not very far away where HBO *will have competition*. That means the CATV system operator will be faced with competing sources for programming, something that is bound to bring per-home charges down while at the same time expanding program services available. The whole satellite business is very fluid at the moment, difficult to get a hard handle on or to find a fix. But it is real, *for the first time*, and *CATJ* will attempt to separate the wheat from the chaff for you, beginning with this issue.

PRACTICAL SATELLITE EARTH TERMINAL RECEIVING STATION DESIGN CONSIDERATIONS FOR CATV

Sending a signal into space and having it return to earth is *not a new form* of technology. The earliest experiments, performed by the U.S. Army at the close of World War II, used a frequency just above the FM broadcast band to "pulse" a signal toward the great *repeater* in the sky (*the moon*) and then detection of the returned "echo" a couple of seconds later.

Later experiments involved orbital passive reflectors, streamers of aluminum reflectors, and the release of special gases in the 50-90-mile ionospheric layers from rockets launched in Virginia and New Mexico. In short, for nearly thirty years man has been directing signals upwards and hoping (or planning) for their return.

These experiments, considered crude today, were for the brave and the foolish. They attempted to *prove the feasibility* of getting something for nothing, that is, shooting a signal skyward and getting it back at some distant earth point *without the expense* of launching an active (electronic) repeater. In the main they did *not* work, that is, they had no *commercial* application and perhaps very limited experimental application.

The next phase of earth/sky/earth transmission paths came with the launching of various military satellites in the early 60's. If passive devices, the moon and ionospheric-released gases, were not reliable enough the plan was to put a *real*-life receiver and transmitter into the upper ionosphere. And, let it receive an *uplink signal* on one frequency, change the frequency, and then re-transmit back to earth again with an onboard active transmitter. Early communication satellites *orbited* the earth and worked *well enough* to fuel the search for a better program.

The early "birds" orbited the earth and consequently were radio-visible for only a small percentage of the time from any *single* earth location. When the orbit brought the satellite on a "pass" within radio-reach of your transmitter (or receiver), the sky-box worked fine, up to its design limits. But as it moved (it was always moving), you had to *track it* with your transmitting or receiving antenna, and pretty soon the sky-box disappeared over your horizon. *Which put you out of business with the machine* until another pass brought it back within your radio horizon.

One proposed solution to this "constantly on the move" sky-box problem was to launch *a series of satellite boxes* so spaced in orbit that one of the boxes always was within your radio horizon. Like *a train of repeaters*, they would constantly circle in their intended orbit, and you would in effect track one from entry-horizon to exit-horizon, and then swing back again to the entry point and pick up the next "car" in the train, following it to the exit point, and so on. This approach seems pretty unrealistic today, but it had serious interest only ten years ago.

Then the untimate solution was to "throw" the satellite far enough into space that it *hung in an orbit* which tracked or moved with the *same speed* and direction as the rotation of the earth on the earth's axis. When all of the numbers have been put to paper and all of the calculations have been completed, it turns out that the orbit we need is at an altitude of approximately 22,400 miles. If you send a satellite *bird* there and stabilize it with respect to its attitude and spin, it will continue *to circle the earth* at more or less *exactly the same speed as the earth turns* under it. Or to put it another way, it moves around the earth, while the earth moves around its axis. And the satellite in this geo-synchronous orbit always *stays put* in space (i.e. it is in the same location) *with respect to earth points below* it.

With the development of the geo-sync orbiting spacecraft, the problem of *tracking* a "moving bird" was solved. Now with the bird in space and in proper place, two earth points *within view* of that space-point could point their respective antennas at the bird and communicate through the transponder (i.e. receiver-transmitter) housed in the bird.

All of this *sounds* pretty exotic. It was when it was *first* proposed, but now there are more geo-sync birds in orbit than you can shake a dish at, serving a wide variety of private, governmental, and military users and applications.

When you stop and think about it, an orbiting satellite is *very similar in function* to a garden variety terrestrial microwave repeater. *Diagram 1 illustrates.* The inbound signal, from the originating point on earth, is called the uplink. The frequency of the uplink is selected so that receiving the uplink will not be a problem with the onboard (i.e. in satellite) transmitter, which is called the downlink. In our *example,* the uplink frequency is in the 6,000 MHz (6 GHz) region, while the downlink is in the 4,000 MHz (4 GHz) region.

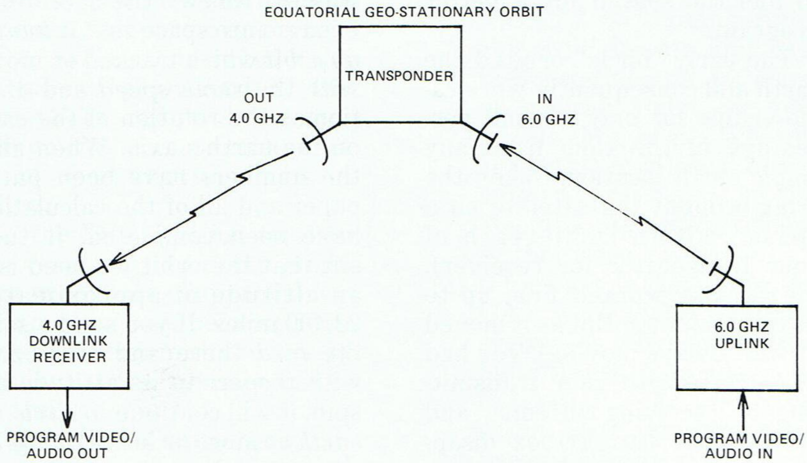


DIAGRAM 1

The *only difference* so far from a common terrestrial microwave network is the frequency; most terrestrial microwave systems operate with *closer in and out frequency pairs* than the 2,000 MHz (plus) separation afforded to the satellite.

The uplink signal is received through a directional receiving antenna, frequency converted to the downlink outbound channel, and then rebroadcast back to earth with a second directional antenna array.

There are therefore three primary "packages" of equipment in any satellite system. At some point on earth, an origination point with uplink transmitter which sends data skyward toward the "bird"; at some precise (pre-programmed) point above the earth, the satellite transponder which *receives* the uplink signal, *converts* it to a new downlink frequency, and then *retransmits* down; and finally at another point on earth, a downlink receiving terminal.

The important parameters *at the uplink earth terminal* are as follows:

(1) The uplink transmitter must be on a frequency which the transponder will accept;
(2) The uplink transmitter must have sufficient transmitter power to reach the transponder;
(3) The various modulation formats employed by the uplink transmitter must be compatible with the transponder acceptance parameters, so that when the transponder receives the uplink signal, the signal passes through the transponder without degradation.
(4) The uplink transmitter and its antenna must be located at some point on earth which the satellite receiving antenna can "see."

The important parameters for *the "bird" itself* are:

(1) Ability to be deployed in the planned location and to hold "attitude" so that it is stable with relation to the earth;
(2) Self-powering through onboard solar cells;
(3) Maintenance-free (service calls are a tad expensive).

Finally, on the ground *at the receive site,* the important parameters are:

(1) Capable of receiving the proper downlink frequency and modulation mode(s) of the "bird";
(2) Sufficient receiving-system sensitivity to produce full-time useful signal products from the transponder transmitter;
(3) Reliable enough so that the receiving terminal is not the weak link in the total up-through-down system reliability equation;
(4) Economical enough so that its cost is equatable with the value that can be assigned to the signal service it provides (i.e. allow the user to make money with it);
(5) And finally, be selective enough so that now and more particularly in the future the downlink receiving terminal is able to differentiate between the desired bird signal(s) and other existing or future birds.

In Diagram 2 we see the real-life parameters of a typical CATV up-through-down system. The most significant points for the CATV person to grasp are:

(1) An earth terminal is nothing more than another antenna / signal processor, and;
(2) Many of the same design considerations which go into an off-air CATV processing package apply to earth-terminal equipment;

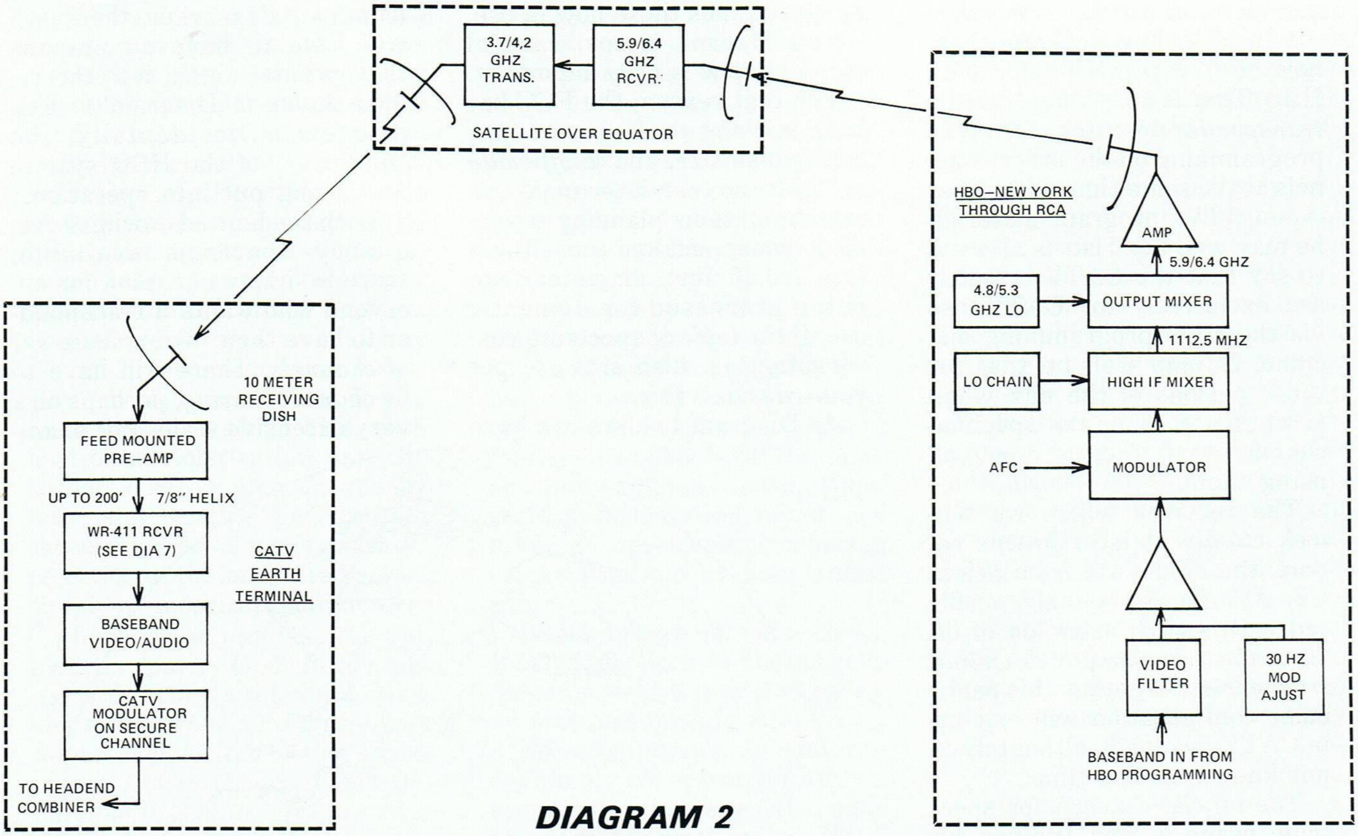


DIAGRAM 2

(3) If you have any background in microwave (point-to-point) terrestrial systems, you are several legs up on the earth-terminal basics because where the earth terminal differs from a standard *off-air* CATV headend system, it complements in equipment technology and function a microwave receiving system package.

When all is said and done, what comes from the output spigot on an earth terminal is *baseband video and baseband audio.* That is, hook a video monitor to the video-out spigot, and you have the *picture;* hook a speaker or earphones to the audio out spigot, and you have *sound.* Interconnect *both* to a standard CATV modulator, and you have the earth-terminal-received signal shown on your CATV plant on the channel determined by the modulator. *That is about all there is to it!*

12 Channels Wide

In the 3.7 to 4.2 GHz satellite downlink *band*, there are 12 channels, each of which is 40 MHz wide. This works out to a channel arrangement such as that shown in Diagram 3. *Each* of the 12 *transponder channels* has an assigned usage, which simply means that the *operator of the satellite* designates *which* of his users will utilize *which* of *his* operating channels for *what portion* of the total day.

The transponder output on one of the 12–3.7 to 4.2 GHz channels is frequency modulated (FM), the deviation being +/— 18 MHz. The aural program material is carried on a sub-carrier 6.8 MHz away from the visual carrier frequency, and it is also FM.

For all initial practical purposes, the CATV system taking a feed through the transponder

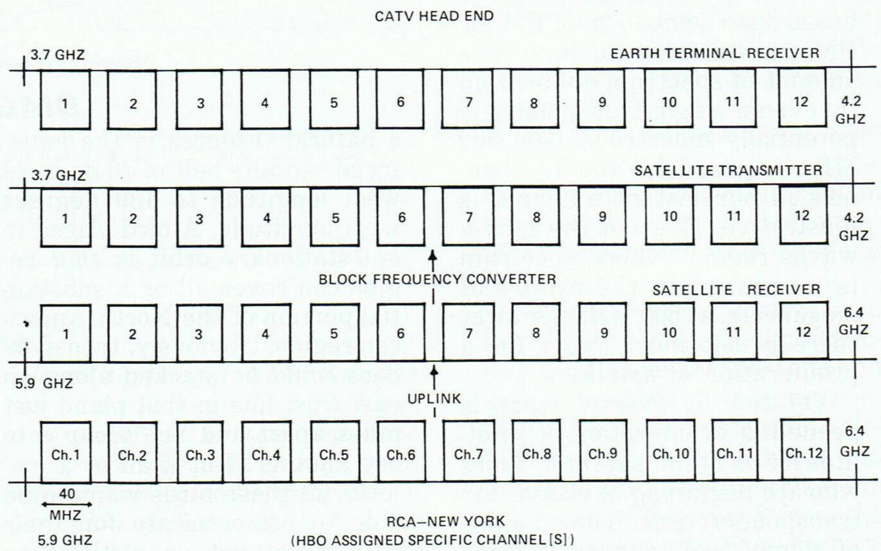


DIAGRAM 3

will have no use for *more than* the 1 or 2 CATV program channels he is contracting for with HBO. That is not to say that the *transponder operator* will *not* be programming on the other channels at the same time with other (*non*-CATV) program material; he may well be. That is also *not* to say that the CATV channels are exclusively for CATV use via the HBO programming machine. It *may* well be that for those periods of the day when HBO is *not* using the specified channels that other users *will be* using them.

The receiver which we will look closely at later in this report, the Model 411 from Scientific Atlanta, is nominally outfitted with switch selection of *all 12 of the transponder downlink frequencies.* Whether this particular configuration will end up in CATV headends ultimately is not known at this time.

The official concern for spectrum usage is best typified by *Henry Marron* of Scientific Atlanta.

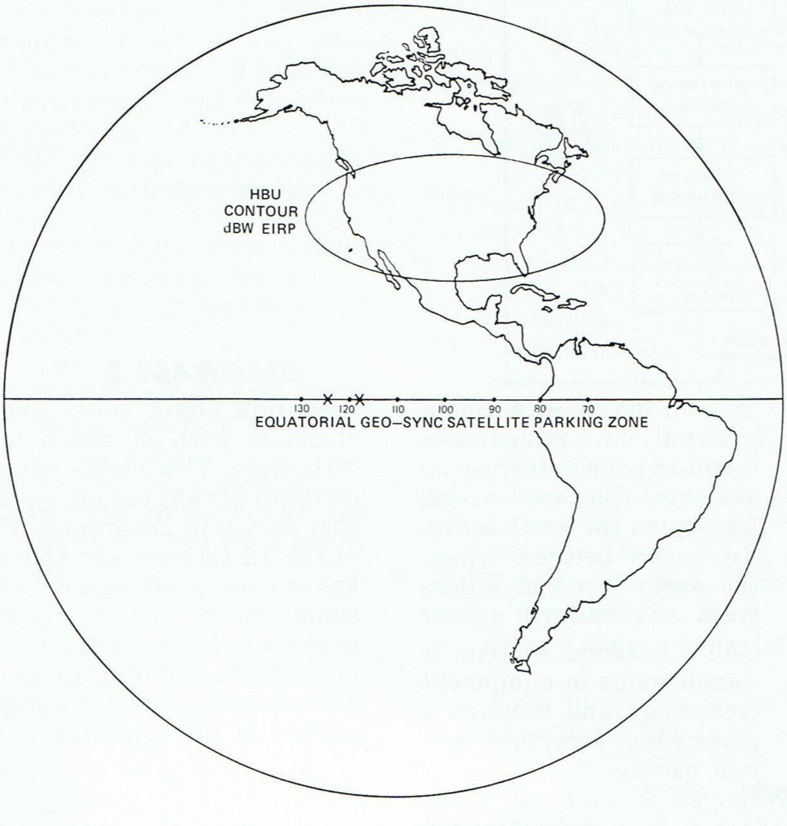
"What we have in the equatorial satellite geo-stationary belt where the transponders park is a valuable natural resource. We have to be concerned not only with today's use of that resource but tomorrow's use as well."

Because virtually all up-through-down packaging for commercial satellite usage is based upon some form of FM (or PM) modulation format, the amount of spectrum gobbled up by even a single transponder is potentially monstrous. The 500 MHz required for the 12 channels in our instant example is illustrative. Even in the microwaves region, where spectrum is measured in thousands of megahertz, at 500 MHz per swat there is not much room for a proliferation of satellites.

Yet that is exactly what is needed: a proliferation of satellites for *all of the potential users* who are beginning to clamor for transponder time. The number of commercial (domestic) birds to be in orbit by 1985 is likely to be 10-20 times those now in use. So as Marron notes, careful planning now is *very* important.

For that reason, the FCC has been sticking to its guns on receiver-dish size, and *unofficially* at least no earth-terminal receiving stations planning to employ dishes smaller than 9 meters (29.25 feet diameter) are being processed for domestic use. If the *logic* of spectrum conservation vs. dish size escapes you, *consider this.*

As Diagram 4 shows, we have



EARTH AS SEEN FROM SATELLITE

DIAGRAM 4

a natural resource in the equatorial satellite belt of 70 degrees west longitude to 130 degrees west longitude. A bird placed in geo-stationary orbit in *that* region can cover all or a substantial portion of the North American region. Obviously, transponders *could be* stacked along an east-west line in that plane just miles apart and not *bump* into one another. But if all or a majority of these birds want to be able to communicate for their respective purposes with all or most all of the domestic U.S. (continental) market, then each will have to have an antenna that radiates signal into the region shown in Diagram 4. This diagram is, incidentally, the *"footprint"* of the HBO system now being put into operation.

With the limited downlink frequency spectrum available, there is simply *not room* for everyone who wants a transponder to have their own *private set of channels.* There will have to be *channel sharing,* perhaps on a very extensive scale. For example, if a bird parked at 80 degrees west longitude was using channels 1, 3, 5, 7, 9, and 11, another bird parked at 110 degrees west might also be forced to use channels 1, 3, 5, 7, 9, and 11. And if *both* birds had footprints similar to that shown in Diagram 4, we have the potential that users of Bird A at 80 degrees west on channel 1 would find themselves getting co-channel interference from Bird B on channel 1.

There are several clever things that *can be* done to minimize interference between two birds operating on the same channel at the same time. For example, the polarization of one bird's transmitting antennas could be vertical, while the polarization of the other bird's transmitting antennas could be horizontal. About cross-polarization Marron says, *"We have found on our test range that it is possible to achieve as much as 50 dB cross-polarization rejection."* Which means that if you were linked with a bird with horizontal polarization and the second bird on your frequency was using vertical polarization, there *could be* as much as 50 dB rejection of the unwanted signal simply by polarization diversity.

However, *in practice*, the polarization purity of the bird's signal is difficult to maintain. Marron notes *"that 50 dB rejection for cross-polarized waves is extremely critical and almost impossible to maintain in practice. A better number is in the low to mid-30's someplace."* Which, again, means that you would have in actual practice something like 30-35 dB rejection from an unwanted bird signal by simply being in the *opposite* polarization mode.

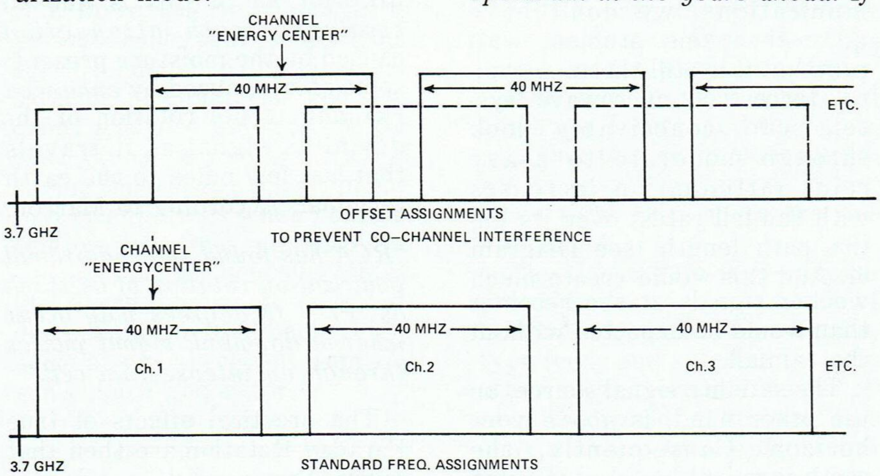


DIAGRAM 5

Then there is frequency offset (shades of TV channel offset!). By employing a method apparently offered by RCA, the 12 channels in the 3.7-4.2 GHz region are offset approximately one-half channel each, as shown in Diagram 5. In this way. the "energy center" of channel 1A (the offset channels) is offset from the energy center of channel 1. Much in the way this helps reduce off-air co-channel interference in CATV, this should also help reduce "cross-talk" interference between two birds operating into the same coverage area.

Theoretically, with all of the various co-channel-sharing plans now employed or scheduled to be employed, a *discrete receiving site* could utilize from two to four *separate* birds on the *same* channel at the *same* time, through polarization, offset, and other interference-reducing tricks planned or now under way.

Which brings us, via a circuitous route, back to the original question, which was *dish-antenna size* and design.

The Commission is *considering* simply not approving any receiving terminal sites that plan to use dishes smaller than 9 meters (roughly 29 feet). The reasoning, as explained by S/A's Marron, is this: *"The receiving pattern of the dish becomes very important when you look at the potential users of this spectrum in the years ahead. If the FCC allows too small dishes to be employed, their patterns are too broad. Or their side-lobe control is not good enough. As a consequence, they may sit in Poughkeepsie and be looking at 80 degrees west while their side-lobe control for a second bird on the same channel parked at 110 degrees west is only down 20 dB or so. This means that they could experience interference from the second bird at 110 degrees."*

So one of the primary concerns going in is the future, and seeing that early users of this particular HBO-leased bird do not become so numerous and so geographically spread with the wrong type of receiving antenna *side-lobe control* that they preclude the FCC from authorizing some other bird to use the same frequencies at some later date from another geo-sync location.

Hopefully that explains to all why the FCC is being hard-nosed about the dish-size requirement at this time. There are other reasons for the common 10-meter size, and we'll address ourselves to that shortly.

About Polarization

Every transponder bird will have a polarization sense, that is, it may employ vertical, or horizontal, or right hand circular, or left hand circular polarization. The earth terminal must *match* that sense for obvious reasons.

Polarization is *much more* important to transponder systems than it is here for terrestrial systems. We are concerned, yes, but we are seldom in real trouble when our receiving sense deviates a few degrees (on a 360-degree arc) from the transmitting sense.

This is not necessarily true with up-through-down systems. First of all, polarization control is an important ingredient in future transponder stacking along the equatorial geo-sync belt.

Secondly, sense control is a key ingredient at the transponder itself. Considerable time and money is spent in designing an attitude-control system into the bird so that once parked and checked out, the polarization sense can be fine-tuned from the ground (via command circuits) to match the original planned-for design. Once set, it would seem that it becomes merely an adjustment problem of matching the earth terminal sense to the transponder sense. And it is, but there are a few *hookers* in the story.

First of all there is something called *Faraday Rotation:* a mysterious *wandering* of the polarization sense that occurs as the transponder downlink signal travels from the bird through our ionosphere to the earth terminal below. Faraday Rotation causes the *original* sense of the transponder signal to deviate just a little bit. It is frequency sensitive, which means that Faraday Rotation is much worse at some frequencies than at others. In the 3.7-4.2 GHz region, it amounts to a gradual twisting of the sense from the nominal value (call it horizontal at 90/270) to as much as +3 degrees (i.e. 93/273) on the positive side to as little as —3 degrees (i.e. 87/267) on the negative side. This Faraday Rotation does two things: it causes the received signal level to drop (less than 1 dB), and it *destroys* whatever finely tuned *cross-polarization isolation* that you might otherwise have. For example, Henry Marron notes, *"On the test range we can measure up to 50 dB of cross-polarization isolation when the polarization senses are* exactly *opposite. However, when we get that 3-degree maximum Faraday effect, the isolation drops down into the 30's very quickly."*

The chances are that the less than 1.0 dB drop in signal level, due to Faraday Rotation, won't take any HBO receiving system out of the class A picture and into the noise. *"Yes, we could design and sell polarization tracking feeds for the dish,"* notes Marron, *"but the cost of the tracking mechanism coupled to a polarization sense mechanism would possibly be more than the dish itself. Is it worth it to keep that less than 1.0 dB maximum deviation stable? I think not."*

Ok, so we have a new form of

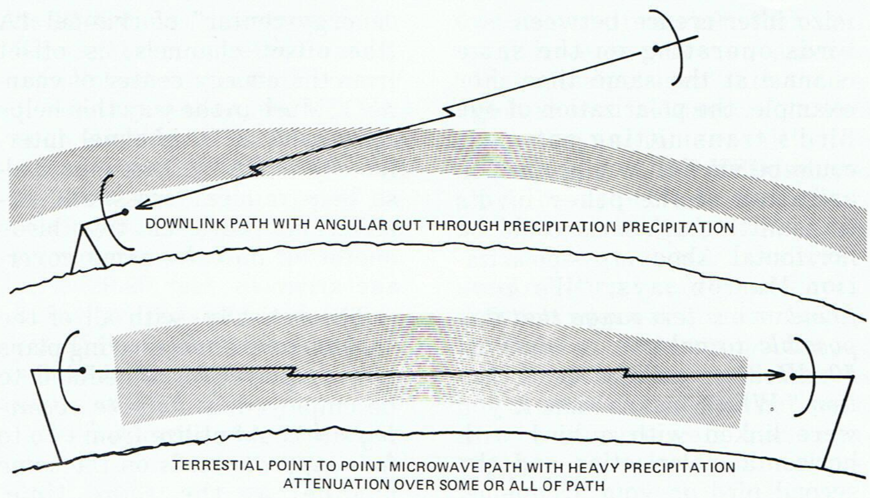


DIAGRAM 6

"fade" with up-through-down (link) systems: Faraday Rotation. Is there more to that problem?

Yes, *there is rain.* Rainfall is a well-known anti-level phenomenon in the microwave region. It is a depressant whose effects increase with frequency. In fact, by the time CATV systems climb into the 12 GHz CARS band, rain attenuation due to increased path loss is one of the most important system-path-length limiting factors we have to play with.

Fortunately for satellite communications, we don't have quite the same problem with rain, but it is still there. A typical terrestrial microwave system can conceivably look through moderate to heavy rains (attenuation increases with rainfall rates) over its entire path length (see Diagram 6). And this would create much weaker signals at the receiver than would be expected without the rainfall.

The satellite signal source, on the other hand, is *above* your horizon. Consequently, the earth terminal *looks up through* the lower atmosphere, and it seldom has more than a few (semi-vertical) miles of precipitation to pass through *before* it reaches the clear sailing of the upper atmosphere, ionosphere, and beyond. *But,* a terrestrial microwave system looks at *dispersed moisture,* moisture dropped by a cloud formation and no longer heavily concentrated. The earth terminal may, however, be looking diagonally *through the cloud formation itself* where the moisture is *very concentrated* and where the movement of the moisture droplets is exceedingly complex and fast.

The result is that under less than ideal (i.e. dry) conditions the earth terminal *may* experience during such a local weather condition *additional signal loss* of as much as 4 (or more) dB. Not all of this is due to *straight - path attenuation* caused by the moisture present; some of it is caused by *enhanced Faraday* (type) rotation of the downlink signal as it travels that last few miles to the earth terminal. According to Marron,

"RCA has found that additional polarization rotation of as much as +/— 15 degrees may occur when a downlink signal passes through an intense rain cell."

The practical effects of true Faraday Rotation are then that given the normal +/— 3 degree twist signals experience every day (they follow pretty much the *same* Faraday rotation schedule *each* day) and the occasional additional polarization rotation caused by heavy local rain cells, the receiving terminal operator should *plan* for a 5 dB (1 plus 4) path loss *safety margin.*

Sun Noise

Man has long known that solar bodies emit *radio frequency noise.* Our sun is such a solar body, and it is constantly emitting "solar noise." Solar noise varies as a function of receiving frequency, receiving system gain and the extent of solar storms (i.e. sun spots) present. One of the favorite techniques of amateur (ham) operators who specialize in large, sophisticated VHF-UHF communication systems is to *purposefully point their receiving antennas* just ahead of where the sun is "moving" and allow the sun to *drift through* their antenna receiving pattern. By *recording* the amount of solar noise they receive as the sun (noise source) moves through the antenna pattern, a crude (but accurate) plot of the antenna receiving pattern is obtained. And the amount (i.e. voltage level at the detector) of noise recorded is a *rough* measurement of the overall sensitivity of their receiving system (antenna plus pre-amplifier).

In any geo-sync orbit, given the certainties of the rotation of the earth on its own axis and the revolution of the earth about the sun, *there will be a handful of periods each year* when your earth terminal, pointing at the satellite in equatorial geo-sync orbit, *will also be dead on the sun.* Which is another way of saying that during those annualized brief periods when your receiving dish lines up with the sun, *behind* the geo-sync satellite, there is going to be a sudden enhancement of background noise at your receiver from the sun's noise generator.

S/A's Marron points out, *"Operators can expect perhaps five dates a year when for short periods of perhaps ten minutes the sun will be so positioned that solar noise will cover their satellite signal."* The amount of noise depends upon your receiving system sensitivity, but 30 dB of noise enhancement with a 10-meter dish seems to be in the right ballpark.

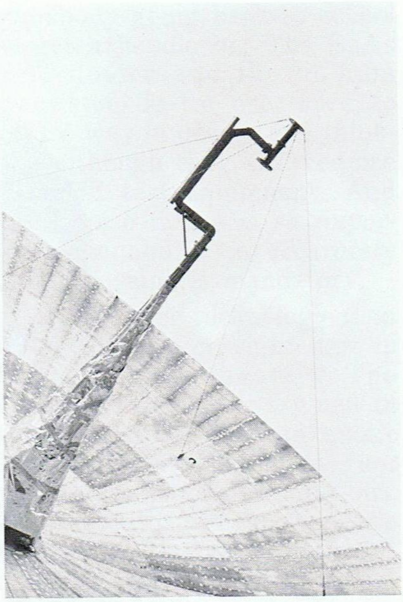
Is there a solution to this problem? Marron continues, *"Not today, but perhaps in the future there will be sufficient birds up that an operator can simply switch birds for that 10-minute period, five times per year, to escape the problem. We have been assured by RCA that there will be advance notice for each earth terminal; they will know when this is going to happen, and probably for such brief outages nobody is going to be concerned about the problem."* And then he quipped, *"Of course if that outage occurs right at the* climax *of an 'X' rated movie, somebody may have to re-run a movie or something. . . ."*

Dish Feeds

There is apparently some type of *antenna-supplier debate* going on about dish-feed antennas. *"Our main concern is with the pattern of the 10-meter dish,"* says Marron. *"We have decided to employ a button-hook type of feed, which admittedly has a dB or more lower receiving signal gain than the more universal Cassegrain-type feed. However, the* total *pattern of the dish with the button-hook feed is cleaner from the side-lobe-control point of view."* Again, S/A is very concerned about the future, and they indicate that they want their antennas to pass FCC muster if and when tight FCC specs are put into effect.

The Cassegrain feed supplier probably has *his own* version of this. S/A *does* make Cassegrain-type feeds and supplies them to other earth terminal users all over the world. Given the fact that S/A *could supply* either one, but chooses to supply the button-hook feed, with the explanation they give for better or improved side-lobe control, makes a strong case for their point of view.

Marron points out, *"The most important segment of the side lobe, in our view, is going to be that area 20-40 degrees off of the main lobe. This is the area where equatorial belt stacking of other birds is going to become most taxing on the system using a downlink channel that has two or more birds operating on the same channel simultaneously. This region, 20 to 40 degrees, is where the button-hook feed shows better side-lobe rejection than the Cassegrain-type dish-feed system."*



Button-hook feed on 10 meter dish undergoing test range pattern checks. Waveguide on CATV dish versions is end-supported with four angular rods tieing back to dish surface.

At the present time the FCC is *not* equipped to verify anyone's receiving antenna pattern. Which is another way of saying that if someone wanted to slip a slight pattern discrepancy by the FCC, they probably could. *"But the day will come where they will be able to come down here to our range and ask us to back up our pattern claims,"* notes Marron. *"We want to be ready in advance."*

Talking to Henry Marron, you quickly get the impression that Scientific Atlanta is *very serious* about their own responsibility as a supplier for this new technology in CATV.

Carrier to Noise

In CATV we have a creed based upon our system signal to noise levels. Or as more correctly stated, signal plus noise to

Aside from the elevated building structure housing the test range antenna measurement facility, this 10 meter dish could well be located at a CATV facility.

noise (s+n/n). At the output spigot of the earth terminal receiver, the signal plus noise-to-noise ratio is still of vital concern. And all of the usual parameters go into computing it. For example, the amount of available signal from the bird (represented in something called EIRP) within the footprint (coverage area of the bird transmitting antenna) is important. This is pretty well known, to the point that when Marron calls up RCA with longitude and latitude coordinates for a potential terminal, RCA cranks back a number in the 31 to 36.3 dBw range. This indicates the *amount of relative signal level* to be expected from the transponder *at a specific point* within the footprint. From this level Scientific Atlanta is able to design the system parameters at the earth terminal.

If the dish size is pretty well frozen in the 10-meter range, and the gain is known of the antenna in that range (50 dB minimum gain is the spec), the next consideration is the preamplifier noise figure. If you are a preamp devotee in CATV and you have always been interested in purchasing the best gain/noise figure combination for your "distant channels," the preamp selection game *will be especially interesting* at 4.0 GHz. You have three choices at the present time. All have about the same voltage gain (40 dB), but they vary in noise figure (or figure of merit). The *lowest* grade unit is a 3.5 dB noise figure transistor pre-amplifier priced in the $2,000 range (noise figure and gain come with expensive devices at 4.0 GHz!). The *next* performance level is a 2.6 dB noise figure pre-amplifier, commonly referred to as a GaAsFET (Gallium Arsenide Field Effect Transistor) device. For approximately 0.9 dB better noise figure you spend around $6,000 ($4,000 more than a ho-hum transistor unit). Finally there is the "top of the line" rather exotic *parametric amplifier*, with a 1.6 dB noise figure and a price tag of near $14,000. In each case the preamplifier is dish mounted. About which C. David Smith, the man at S/A responsible for field installations of earth terminals, notes, *"Changing out a preamplifier is not going to be complicated; the housing for the unit is part of the feed system on the dish. There are four screws that come out, and the preamp fits directly into the flange fitting on the 7/8 inch coax line. I estimate about twenty minutes time to change one out, although the man doing the work will need a 20-foot step or extension ladder to get to the preamp and feed."*

Why a person would ever *want* to change out the preamp is of interest. We are dealing with some frightfully weak, but fortunately *stable* signal levels from the transponder. In CATV off-air (VHF or UHF) systems, worrying or agonizing *between* 3.5 dB noise figure and 1.6 dB noise figure preamplifiers would seldom occupy too much of our time. Especialy when there was *$12,000 price differential* between the 3.5 and the 1.6 noise figures! *But this is a different kind of problem.* As Marron points out, *"The relationship in signal plus noise to noise at the 411 receiver·output spigot for video and audio is more than the 1.9 dB difference in preamp noise figure. As a matter of fact when you drop from a 3.5 to a 1.6 dB noise figure there is a 3.5 dB change in signal plus noise to noise at the receiver video output."* Even that may *not* seem significant, but it is. Remember however that getting 3.0 dB more signal (or signal to noise) in any receiving system is the equivalent to doubling your antenna capture area. To make the same kind of received signal quality *change* at your receiving location that a *change out* from a 3.5 dB to 1.6 dB noise figure preamp would require you to *up* your receiving-dish *size* from 10 meters to more than 20. Remember that these are meters, *not feet.* And in simple language, you can*not* begin to think about building a 20+ meter dish for 12,000 *more* dollars than a 10-meter dish.

So the preamplifier, *in this type of system*, has more importance in dollars and cents than might initially meet the eye. It not only helps you keep your dish size *relatively* small, but it also is the most significant contributor to system signal plus noise to noise ratios at the video output.

With this kind of money involved, one would *also* wonder what the *vulnerability* of a dish-mounted preamp might be. Marron notes, *"The most common*

S/A 10 meter dish atop test range facility in Atlanta; showing rear rib construction.

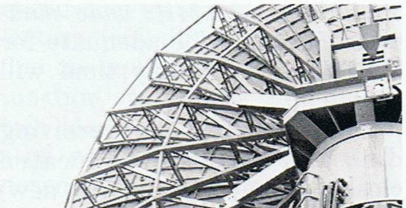
preamp in our systems around the world has been the GaAs-type unit. We have approximately 200 in operation, and I believe two have failed." Seemingly a 1% failure rate, for whatever the reasons, is tolerable.

Which preamp are most CATV systems opting for? To date there has been a surprisingly high number of system operators showing immediate interest in the top of the line parametric unit. Next has been the GaAs FET device, followed last by the ho-hum 3.5 dB transistor unit. *"There are some arguments to be made for a backup preamplifier,"* notes Marron. *"While the whole antenna system is at ground* (DC) *potential vis-a-vis lightning, there is concern about losing a preamp at a crucial moment."*

Few systems, if any, will have on-the-spot preamp repair or maintenance capabilities. David Smith notes, *"We priced the equipment required to service the top of the line parametric unit; it comes to between 18 and 20 thousand dollars."* Then there is the ability to do the job, on top of the price tag of the test equipment.

Parametric amplifiers are complicated animals to service; there is a whole new technology there (if *not* new to the world, *new to CATV*) that requires somebody going back to school to get a handle on. The GaAs FET device and the ho-hum transistor device are *more* to CATV way of design and thinking, although they *still* require 4.0 GHZ test equipment. And since noise figure *is so important*, the ability to *accurately* measure same is mandatory.

Preamplifier technology *is in a state of change* right now in the microwave industry. The GaAs FET device is very new in terms of time. It is an exotic kind of FET device that does *not* yet know its own limitations. Even as this is written there are GaAs FET device manufacturers talking about *their* "new" devices that have 1.9 dB noise figures at 4.0 GHz. As Marron notes, *"The GaAs FET technology should ultimately make the parametric amplifier nearly obsolete at 4.0 GHz. This may be late this year, next year, or the year after, but I do see it happening. Suppliers of these devices are working on thermo-electric cooling, which means that the preamplifier devices operate in a cooled environment or atmosphere. By cooling the GaAs FETs their real-life noise figure drops quite a bit, and while the cooling may present*



Rear of 10 meter dish showing rib structure; Az-El tracking mount on right is remote controlled for test-range purposes.

some initial additional mechanical problems, ultimately I believe that the GaAs FET preamplifier will become the standard for 4.0 GHz receiving system preamplifiers."

And the price... will it come down off of the present $6,000 range for a 2.6 dB GaAs FET pre-amplifier? The answer is *probably* yes, and when the price does drop, it is *likely* to be *quite dramatic.* Some believe it may even eventually settle down around $2,500 for a 1.6 to 1.9 dB noise figure unit, certainly a far cry from the present parametric unit price tag of $14,000 for the same noise figure. As for time, most educated guessers suggest "within two years."

There is one more problem that devoted followers of preamplifier technology should be aware of. The present units are *broadbanded* to cover the 3.7 to 4.2 GHz range. Their noise figure and gain spec (i.e. 2.6 dB and 40 dB gain for the GaAs FET) is for the *whole* 500 MHz slice. The newer thermoelectric cooling systems for GaAs FETs with the lower noise figures (1.9 is now quoted) *is* for a trade-off price. The noise figure and other parameters are only over an 80-100 MHz range at 4.0 GHz, *or roughly two 40 MHz wide channels.* That *may* be adequate for CATV use, but only time will tell.

The earth terminal receiving dish will normally be located close to the existing (or new) CATV headend facility. Mostly, as Marron points out, *"It needs a clean shot at the bird, and the pad needs to be positioned so that the antenna can be swung along the equatorial plane to cover the full active belt region from 70 west to 130 west* (longitude)." David Smith notes, *"The maximum downline length we foresee, and recommend, is 200 feet from the dish to the 411 receiver input terminal."*

It established that *dish size* and *preamplifier choice* are important ingredients in signal-to-noise ratio at the video output of the 411 receiver, some mention needs to be made of the methodology involved with FM (frequency modulated) systems.

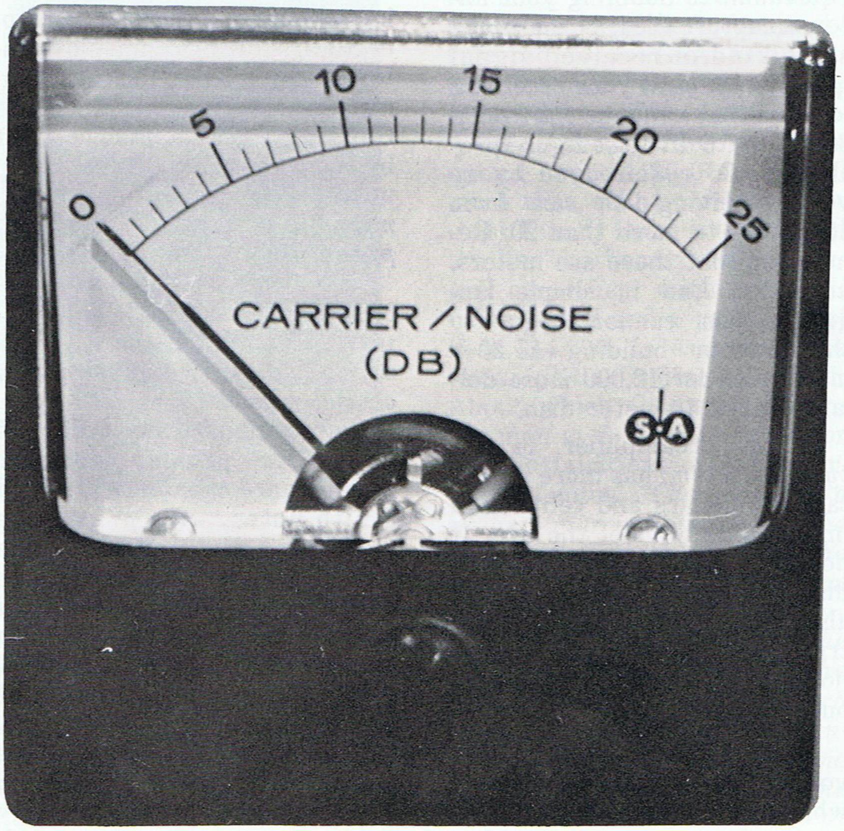
When you have an AM system, as we have in standard television broadcasting and reception, there is a *direct one-to-one relationship* between input signal to noise and output signal to noise. That is, if you crank in 1 dB of additional attenuation (call it pad loss) between the antenna and the input to the preamp, the output signal to noise ratio from your processor *suffers 1 dB* signal-to-noise ratio loss.

This is not always true with FM systems.

The 411 receiver specs talk about a 52 dB video signal/noise ratio at the output spigot of the receiver. If this were an AM system, we would be forced to have similar *input signal to noise* at the *output* of the preamplifier.

In the FM system employed, the designers talk about a C/N or *carrier-to-noise* ratio at the *input* to the receiver and a S/N or *signal to noise* at the *output of the receiver.* Fortunately for everyone concerned, it does *not* take a 52 dB C/N to produce a 52 dB S/N. As a matter of fact, it takes something much less in the C/N department: approximately 14 dB C/N produces a 52 dB S/N. We say fortunately, because if there was a one-to-one relationship as in AM systems, the power output of the transponder plus the dish size at the receiver would have to be increased to astronomical numbers to make the system play.

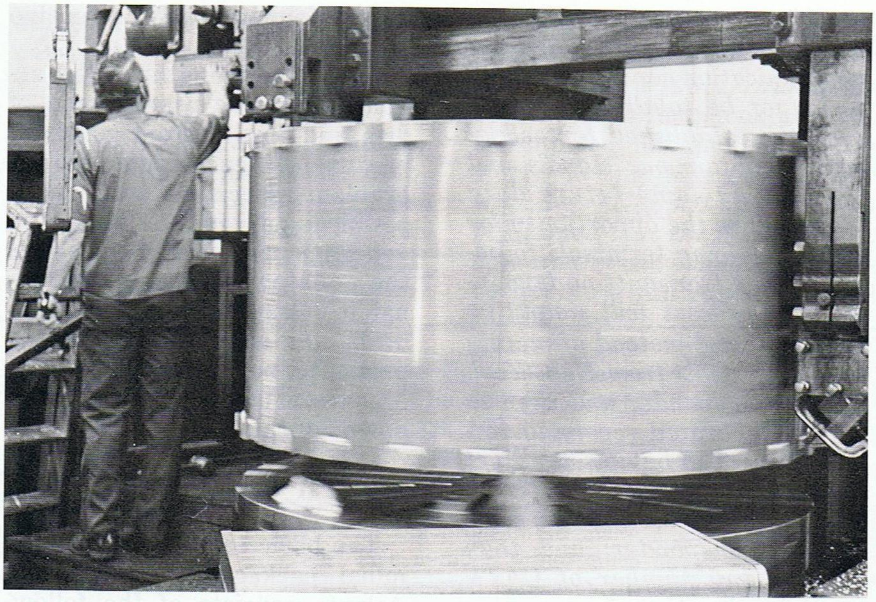
We will leave a detailed discussion of the FM C/N concept to a later time; it is worthy of a special report all by itself. In the interim, keep in mind that for relatively small changes in C/N we *can* have sudden and dramatic differences in S/N. And all of the C/N numbers are keyed to the relative differences in things like the preamplifier system and antenna-feed system. Marron notes, *"When the C/N drops*



Carrier/Noise meter will become important new measurement criteria for CATV earth terminal locations; see text.

down into the 9 dB region there is the start of a noise problem which gets pretty severe by the time the C/N gets to 8 dB. Our design criteria is to keep the system out of the noise spikes for 99.99 percent of the time. And that includes computations for the occasional Faraday Rotation problems in heavy rain, the everyday Faraday Rotation problem, and whatever slight changes may occur in received signal level due to heavy winds that buffet the receiving dish."

As the industry will note, the 411 receiver *includes* a C/N (Carrier to Noise) meter on the front panel. Its presence should give aid and comfort to system techs charged with the responsibility of keeping the system flying correctly.



10 meter dish hub assembly being milled; hub is spinning on milling wheel, creating blur in photo.

99.99% Reliability

One of the major problems with terrestrial path systems is applying all of the known and unknown factors involved in keeping a desired signal usable *all of the time.* Once the A contour region of any standard television broadcast station is left behind (i.e. we are into the B or beyond region), the ability to produce *100% reliable pictures* all through the year diminishes rapidly. The most pronounced depressant effect is of course the weather and the varying signal (and co-channel) signal levels present *some* of the time.

In the downlink business, weather plays a *very minor* role. In fact, about the only thing we have to worry about in the way of weather is heavy storms *in the immediate vicinity* of either the uplink or the downlink.

The design criteria for most *terrestrial* microwave systems is in the 99.9 to 99.99% region. That is, applying all of the known depressant effects to the overall system calculation, the designer opts to maintain something greater than 99.9% path reliability for his path.

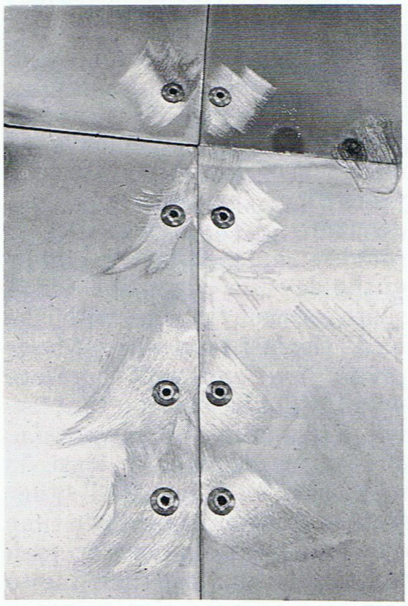
In a standard year, there are 8,760 hours in a 365-day span. This means that if the designer achieves his design signal to noise ratio 99.9% of the time, he will lose 8.76 hours (525.6 minutes) per year for outages caused by one or another phenomenon. Backtracking, that is an average of 1.44 minutes *per day* outage. And that is *in a 24-hour day,* which if your system is programmed only 12 hours per day, works out to 50% of 1.44 minutes per day or 0.72 minutes *per programming day* of down time. *That is for 99.9% reliability.*

Now if the reliability increases by design from 99.9% to 99.99% the total amount of down or lost circuit time is 52.56 minutes *per year.* Or 3153.6 seconds per year, which if you again diminish by a 12-hour programming day works out to 1,576.8 seconds per year. On a daily basis if you blink slowly you will miss the 4.32 seconds of down time for that day.

By theory, 99.99% reliability is *almost* impossible with a downlink *if you consider and include* the lost time just due to the five annual solar-noise passes. If the solar-noise eruptions last 10 minutes each and there are five of them, we have 50 minutes of lost time for the year. Since the solar noise is a daytime phenomenon and is roughly centered in the middle of the day (i.e. when the sun is south of you, in line with the bird), the lost time will *not be in prime time* and will therefore possibly not be an important factor. Still, on a *24-hour-per-day* circuit, we do have at least 50 minutes of lost time. If all other factors, including any down time due to equipment loss or malfunction or any lost time due to rain loss or excessive rain-created polarization twist, are ignored, the solar-noise loss time amounts to nearly the total permissible lost time in a year, for 99.99% reliability. At some point between 99.9% and 99.99%, the system *should prove* more than satisfactory to the CATV user.

Future Expandability

There is one more consideration in the antenna department, and that is future *transmit* capability. As S/A's Marron points out, *"We are now on the threshold of* really *entering the national communications grid. Our* *earth terminals will put us in direct contact with national communication centers. We will no longer be totally dependent upon the established terrestrial links to obtain our signals and service. At some future date there will be the opportunity for earth receiving terminals to become earth transmitting terminals. The process will simply be reversed, and instead of merely sending signals from New York to the transponder and then to widely separated receiving terminals, we will be able to direct signals from CATV earth terminals all across the country back to the transponder; and then back to any number of CATV receiving locations."*



Close-up of small section of 10 meter dish panel; when assembled, dish holds parabolic curve design to within 0.025" over full surface.

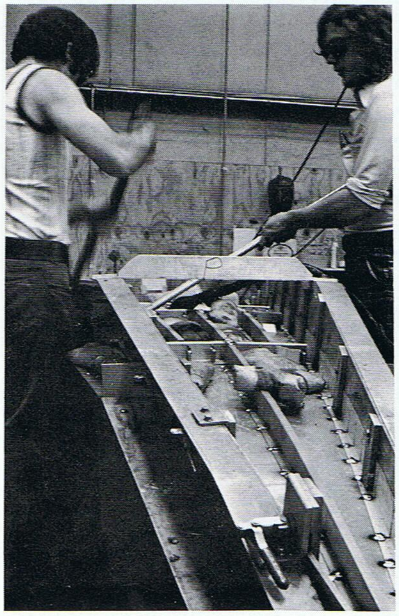
What Marron is saying is that the dish antenna, an important part of the overall initial expenditure *today*, will have the ability (with a new, uplink frequency feed) to function as an earth-to-transponder *transmit terminal* as well. It may be some time before systems in western Kansas have anything worthwhile to contribute back into a satellite distribution network for other systems to distribute, but the day is probably not very far away when systems in cities such as Tulsa will become origination points as well as receive terminals.

And this strengthens the argument for the proper type of dish and feed system going in, because of the aforementioned problem associated with multiple birds parked in a line in the geo-stationary orbit plane above the equator. A transmit terminal in Tulsa that feeds *back into* birds *not* associated with the particular network HBO (or others) were using would be shut down quickly.

The S/A Package

The basic earth receiving terminal package from Scientific Atlanta consists of the following:

(1) 10-meter dish (32.8 feet)
(2) Az-El mount (permits tracking to the stationary position of the bird over a 90-degree elevation range and 95 degrees of azimuth)
(3) Dish-mounted preamplifier (three configurations available)
(4) 7/8-inch feedline from dish feed/preamp to receiver
(5) Antenna pad
(6) WR-411 series earth terminal receiver.



10 meter dish panel in S/A manufacturing facility during fabrication; panel is assembled upside down in jig.

The 10-meter dish assembly has a dead weight of 9,000 pounds (shipping weight of 12,000 pounds), The dish employs a prime focus (buttonhook) type feed system. The dish is made up of 24 factory-fabricated panels, which are for the most part interchangeable in location (there is one lead panel with guide holes and four special panels for anchoring the feed horn mount). Each 10-meter dish is assembled *twice:* once at the factory and once in the field by the installation crew. The dish maintains a parabolic accuracy of within +/— 0.025" over its full surface. Should there ever be a need for replacement of a panel, replacement panels should be easily inserted into the damaged section(s). A panel weighs approximately 200 pounds, which means that it can be handled by human lift power if the need arises.

Because not all CATV sites are readily accessible (David Smith: "*I envision the day coming where we are backpacking the whole rig onto a mountain top someplace, and we will be able to do it*"), there are two basic approaches to assembly. The panels at approximately 200 pounds each are (with one exception) the heaviest pieces in the package (Smith: *"Four men could carry the panel a considerable distance if they had to . . ."*). The *exception* is the hub assembly, which weighs approximately 750 pounds. None of the whole affair is too big or bulky that a small two-man copter with 800-1,000-pound lift ability could not handle it to a site.

The dish on its S/A mount is made to withstand direct winds of 125 miles per hour with 1/2-inch ice loading. In far northern locations, heating of the dish or of the feed *may* be required (Marron: *"The first installation that went into Alaska a couple of years back went with a radome covering, heating, deicing, and the whole package. Then the next installations went* *bare, with no covers or heating. Even in Alaska they function all right without elaborate accessory equipment...").*

On its own mount, with the mount installed on a *proper* type of pad, the dish is not apt to flex more than 0.1 degree in a 60-MPH wind (Marron: *"At 60 MPH of wind load, there may be sufficient dish-and-feed error to cause the received signal level to drop 0.8 dB or so...").* The pad is usually provided by the CATV company, although specifications for same come from S/A in the form of "suggestions." S/A urges the CATV company to employ a qualified local civil engineer to draw up the pad plans for each locale. (*Note:* Request Antenna Mount Foundation Plan, *Drawing D-10110-141024* for a look at what is required for the pad.) It is worth noting Marron's earlier warning: *"The pad should be so positioned that the dish azimuth adjustment can swing the antenna over the full range from 70*

SATELLITE COMMUNICATIONS IN CANADA

While the U.S. interest in use of satellites for program transmission has centered around delivery of pay television programs, Canadian interest has taken a different approach. In Canada, the official government sanction for pay television is still in limbo. Consequently, satellite delivery of pay programming must await permission **for** pay cable operation.

The Canadian's are actually **ahead** of the United States when it comes to development of a domestic satellite program. ANIK-I, put into operation November 9, 1971 was intended to provide television broadcast (and telephone, data communications) to a wide range of users. ANIK-I brought the first television service to many regions of Canada, including the far northern regions. Some of these regions previously had tape-delayed programs, others had no programs at all. ANIK-I is primarily utilized by the CBC, CN/CP and Bell Canada.

Subsequently ANIK-II, launched into service April 20, 1972 expanded domestic satellite capabilities for Canada; although three channels on the 12 channel transponder were initially leased to RCA-Global and RCA-Alaska. On May 7, 1975 ANIK-III was launched, its primary purpose at the moment being testing and standby for the earlier two "birds."

For going on two years the Canadian Cable Television Association (CCTA) has been carrying on "talks" with the private Canadian corporation charged with the operation of the ANIK birds. This corporation, **Telesat**, is naturally interested in leasing transponder-channel time and the Canadian CATV industry is equally anxious to make use of the service. Interestingly, the primary focal point for CCTA seems to be the **"delivery to Canadian systems of American (U.S.) network programs."** As is well known, Canadian systems currently rely on off-air signal service for their U.S. programming, and many (example: Winnipeg) have invested very large sums of money in huge multiple tropospheric scatter dish antennas to make the U.S. signals useable for an acceptable percentage of the time. By taking the U.S. network signals off of the air near the border, and carrying them throughout Canada via satellite delivery, the Canadian CATV subscribers would be assured a much better quality picture from U.S. network stations.

On June 11, a new Canadian Company, **Cablesat**, was incorporated to turn this "dream" into reality. **Cablesat** and **Telesat** have now reached an agreement whereby Cablesat will have an exclusive option on use of one or more Telesat ANIK transponder channels for delivery of programs to Canadian CATV systems.

What remains now is a set of number games. First of all, the Cablesat people feel they need approximately 800,000 cable connected homes involved in the program to make a go of the program. This number, while much larger than **U.S. satellite connected homes** at the outset, is understandable when you consider that the programs to be delivered via satellite by Telesat and Cablesat will be at "no extra charge" to Canadian viewers; whereas in the United States the programs delivered via RCA and HBO will be for "pay" per channel purposes.

The other number game being studied is the earth terminal question. As noted in our report here, the U.S. position has been that parabolic dish sizes smaller than 9 meters are to be avoided; in the interest of future "conservation of spectrum." In Canada, the approach is slightly different. There, the cost of going in (i.e. of building each initial earth terminal) is perhaps taking on greater importance than the cost of future frequency conservation. Consequently, there are engineering studies underway to determine **what engineering trade-offs** are required for the use of smaller (4.5 meter) dishes. Naturally as the dish size diminishes, there is less ANIK signal to work with in the demodulation process. To offset the lower gain of a smaller dish, the Canadian's are studying options available for pre-amplifiers. I.e., if gain is lost in the selection of a smaller dish, can that gain be made up with a higher quality pre-amplifier? At the 4.5 meter dish region, nothing less than a 1.6 dB noise figure parametric (cooled) pre-amplifier is adequate. So the study is concerned with the purchasing and maintenance costs for such a pre-amplifier, vs. simply using a larger dish initially and sticking with a less exotic pre-amplifier. The dish size most often quoted in Canada for the top-size-end is 32 feet or approximately a 10 meter dish. The CCTA is recommending that all downlink designs work towards a minimum signal to noise ratio of 44 dB. This "cost-effective" study is one of the prime areas of interest at this time in Canada.

Involved in the Canadian development program has been Delta-Benco-Cascade, a prime manufacturer of CATV equipment in Canada, which distributes in the United States as well. During this past June DBC demonstrated a 4.5 meter dish and receiver package for interested members of the industry. This 4.5 meter package, with associated electronics, will be the subject of a report and review in **CATJ** in a future issue.

degrees west to 130 degrees west, at the outset. That will ensure that any future birds carrying CATV programming will be within reach of the azimuth control adjustment on the dish without having to build a new pad."

The preamplifier options have already received considerable discussion. All that is really left is the WR-411 series receiver!

The receiver is a double conversion job that takes the 3.7-4.2 GHz downlink input and delivers a pair of baseband outputs: one video and one audio. Interconnection to a CATV modulator is identical to any other video and audio source package at this point.

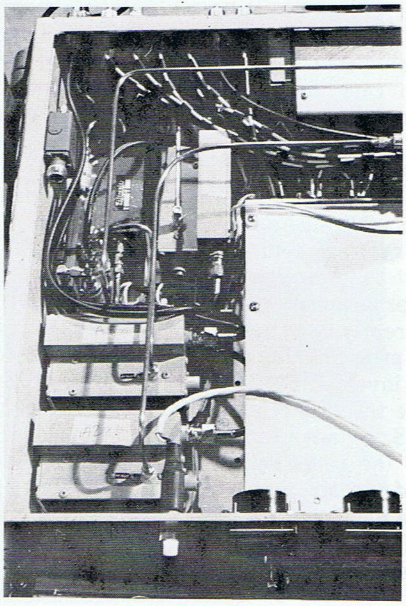
As noted previously, the most common 411 series format receiver is a 12 channel front-panel switch selectable unit. CATV units *may* be of this configuration, or they may have *one or two* switch selectable channels to choose from. This will depend upon the final operating arrangements between HBO (the program supplier) and the operator of the satellite. If there *may* be some channel switching of the HBO-use channels over a period of time, then the full 12 channel options *may be* the way that most CATV earth terminals will go. This will assure that the CATV systems are capable of receiving *any* of the 12 transponder channels should the need arise. Moreover, because the transponder is a commercial package that *rents time* to *any and all* qualified applicants, there may well be some special occasions when CATV systems will want to *switch* their operating input channel (s) to contract-carry a special program or series of programs from someone *other than* HBO. It is unlikely that the FCC will ever adopt anything like the "All Channel Receiver Law" for earth terminals, so it pays for the CATV operator to *consider* maximum flexibility going in.

The 411 receiver is available in a number of *different* formats, partly because S/A already has some 300 units operating throughout the world in a number of *different* transponder situations. And while there may be the marketplace development of a "CATV version," it is unlikely that all systems will order *identical* units. Some of the options available include the aforementioned "Agile/Switch Selectable" down converter channel switching, with either (1) manual tuning, (2) synthesizer tuning, or (3) remote (point) frequency selection.

The 3.7-4.2 GHz signal is first down converted to the upper (or high) I.F. of 1112.5 MHz. Then there is a second conversion to the lower frequency I.F. of 70 MHz. The package has the following gain parameters:

(1) Dish-mounted preamplifier —40 dB
(2) First Mixer/Preamplifier— 20 dB
(3) I.F. amplifier 60 dB maximum to 20 dB minimum (AGC'd).

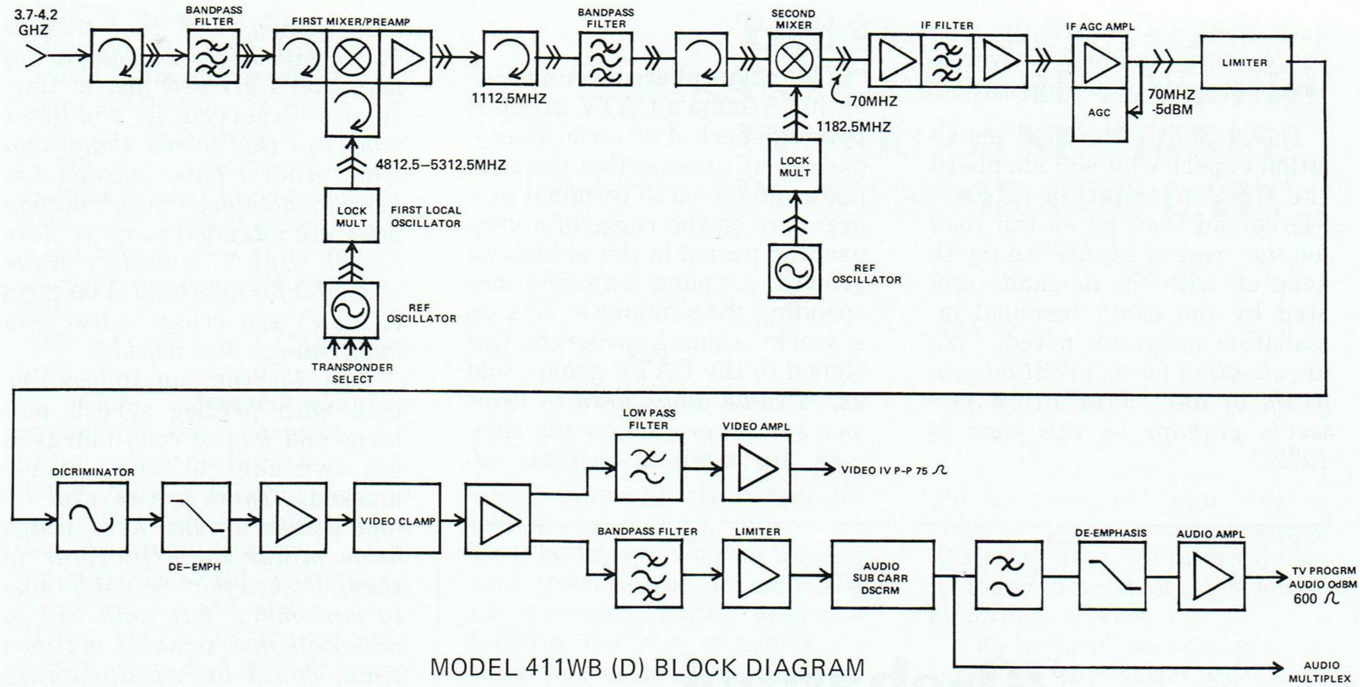
The whole package is 50 ohms from antenna to input port to the 411 receiver; the output video is 75 ohms unbalanced, 1 volt peak to peak. A +/— 3 dB output (video) level control is provided.



Model 411 S/A 3.7-4.2 GHz receiver is essentially modular; inspection reveals myriad of sub-assembly boxes interconnected with low-loss coaxial line that looks very much like copper tubing!

The 70 MHz I.F. amplifier, with 40 dB AGC control range, has filtering designed to complement the +/— 18 MHz FM modulation format. The I.F. drives an FM discriminator, which provides linear wideband demodulation of the incoming signal. The limiter consists of series limiter circuits optimized for minimum AM to PM conversion (i.e. to maximum suppress the AM component which would manifest itself as a hum component in the detected video signal). A wideband demodulator provides linear discrimination over a 70 MHz center range of +/— 18 MHz. A baseband (video) amplifier follows the discriminator. As shown in Diagram 7, a video clamping circuit follows the discriminator (demodulator) and a network of filters after a signal splitter separates the video signal for its own amplification from the audio sub-carrier. The audio is carried on a 6.8 MHz sub-carrier, and has a 0 dBm level across 600 ohms at the aural output of the 411 receiver. The 6.8 MHz audio sub-carrier is recovered initially by the wideband video demodulator, but audio appears *only* after the video information has been separated from the 6.8 MHz audio sub-carrier where a second discriminator (preceded by an input bandpass filter and a limiter stage) does the audio recovery job. The "format" also *allows* for two additional *message* audio channels in the network; they are SSB (single sideband) AM multiplexed onto the 6.8 MHz signal.

The entire receiving station package is housed in a standard 19-inch-wide, 5¼-inch-tall rack panel. There is *very* extensive use of *modularization* in the 411. David Smith of S/A's field installation team notes, *"The factory is well adjusted to prompt delivery of replacement modules when needed. With so many receivers already in service in places like India and Africa, we have developed a well-coordinated program of prompt-*



MODEL 411WB (D) BLOCK DIAGRAM

DIAGRAM 7

ly handling any needs when they arise."

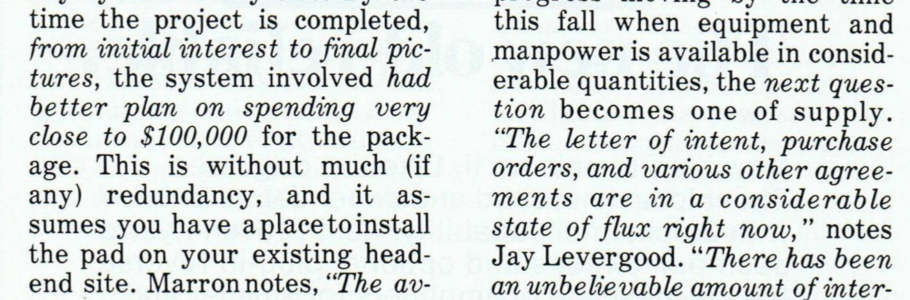
Marron says, *"With over 300 receivers now in use, we are really coming into CATV with a very well-defined product. This is the fifth year of this concept, and this is the third phase of the 411 receiver. There are, coincidentally, 200 additional receivers now in various stages of production here."*

Redundancy and Wrap-Up

Marron declares, *"A large number of the MSO's we have been talking with have been vitally interested in redundant equipment. I can appreciate that they do not want to lose any signal time if they can help it, but I am reminded that a tremendous number of overseas installations don't have any redundancy."* If there is a *case* for backup equipment, it might be in the area of the preamplifier, in the average CATV engineer's *mind*. Still, even the arguments for a backup unit here *are questionable* when the cost is weighed against Marron's comment that of 200 in the field, he believes only two have failed for whatever reason.

On the other end of the stick is the fact that an earth terminal is a considerable investment for any system of any size. By the time the project is completed, *from initial interest to final pictures*, the system involved *had better plan on spending very close to $100,000* for the package. This is without much (if any) redundancy, and it assumes you have a place to install the pad on your existing head-end site. Marron notes, *"The average cable person has grown up accustomed to fighting for the last $500 of his purchase; he needs to justify every dollar of the purchase, and unlike some of the foreign customers where a $10,000 option is quickly bought, the CATV operator has to agonize for some time on every part of the system."*

Assuming the FCC licensing bottleneck is broken soon enough to keep the wheels of progress moving by the time this fall when equipment and manpower is available in considerable quantities, the *next question* becomes one of supply. *"The letter of intent, purchase orders, and various other agreements are in a considerable state of flux right now,"* notes Jay Levergood. *"There has been an unbelievable amount of interest in this whole concept. It would be improper for me to give you any numbers, but you can see for yourself the activity around here."* We could. The afternoon we were in Atlanta, in August, a crew of telephone men were on hand moving telephones around so that the S/A CATV staff could participate in musical offices the following Monday. The phones rang fre-



WR-411 earth terminal receiver; down converter module drawer is at lower left (with 12 channel switching shown), followed to right with IF filter, IF amplifier, Demodulator, Video Clamp and at far right Audio Demodulator. Left hand meter is carrier-to-noise (input) monitor; meter to right is multi-purpose function and voltage check meter.

quently if not constantly, and there were huddled conversations throughout the operation.

David Smith, the field installation expert who will shepherd the first installation at Fort Pierce and then go on the road for the *"rest of his life"* to try to keep up with the demands created by the earth terminal installation program, noted, *"We are shooting for an eventual program of one installation per week, perhaps by this time in 1976."*

Summary

The atmosphere around Scientific Atlanta's CATV group is nothing short of electric. Everyone seems to *sense* that the company and its earth terminal program are on the verge of a very exciting period in the industry's growth. A young man who was spending the summer at S/A on a work training program, assigned to the CATV group, told us, *"I came down here to work on a special project for the summer. My major is business administration, and that project has received only a small part of my time. I arrived* just in time *to get involved in the first stages of this whole thing, and while what I have learned has been invaluable, I didn't accomplish my intended purpose here at all. But I wouldn't have missed it for anything.* You guys (CATV) are crazy...*but you may change the world."*

And Marron, an impeccable man with precise speech patterns and *lots of cool*, betrayed his own control when he remarked, *"There are several 12-foot dishes around here which have minor imperfections in them. Dishes that cannot be sold to customers, but with $50 of materials and some of my own time, could be whipped into shape for installation in my own backyard. I would still have the preamplifier problem, and my pictures wouldn't be nearly as good as with the commercial 10-meter dish installations. But think of watching movies and sports in my own living room for $8-$10 per month! Oh, I'd pay HBO of course...."*

Really Henry, is it the movie/message, or is it the satellite *medium* that gets into your blood?

MOVING? CHANGE ADDRESS!

One of the dis-advantages of mailing **CATJ** via third class mail is that the post office refuses to forward copies when you move.

Statistically, one person in 4 will change his permanent address this year. That means we have more than 1,000 address changes per year. 1,000 potential magazines that won't get delivered. Egads. Do your part. Help **CATJ** find its way to your new address.

(Attach label here)

Tell us when you move.
Tell us where you move to, and do it by snipping, cutting, tearing, gnawing or ripping the address label on the rear cover of your magazine out, and sending it to us along with your new address.

THE TOMCO "ANY-IN" / "ANY-OUT" VHF AND UHF HETERODYNE SIGNAL PROCESSOR FOR CATV

When the first CATV system delivered the first CATV pictures in November of 1948, in Astoria, Oregon, *"it was a conversion job"*. Oregon pioneer Ed Parsons received Seattle's channel 5, and converted the station to cable channel 2. Litle did he realize what a dangerous precedent he was establishing!

By the early 50's CATV systems were routinely moving off - air - assigned channels around and about for cable carriage; primarily because if you ran a *fully loaded* system in that era (three channels were the maximum carried), you typically used cable channels 2, 4 and 6. Since few areas accomodated you with off-air-signals on precisely 2, 4 and 6; somebody got converted somewhere.

Then we ran into the 60's with systems filling up their channels faster than customers could count the new channels; as the new "all channel" (12 cable channels) systems were born, and stations continued to come on the air in increasing numbers.

So here we are in the mid 70's, with converters still following us around. When the first heterodyne signal processors appeared in the mid 60's, the serious cable operator found a new way to handle the exploding cable-signal problem. The first processors offered the cable operator a turret tuner selectable 12 channel (VHF) input, with a fixed (usually crystal controlled) output channel. Which meant the cable operator was able to select at will (by turning the turret tuner knob) any of the 12 standard VHF channels for his input signal, *locked only* to an *output* channel. This was a considerable advance *for that era;* a "new" type of system headend flexibility that operators quickly found dozens of uses for in everyday service.

The heterodyne processor established the basic processing criteria still with us today. That is, the input signal is received at RF and down-converted to the I.F. (intermediate frequency). The I.F. is the *same* regardless of the input frequency channel. In the normal heterodyne processor, the output frequency is derived by mixing the I.F. signal with a crystal controlled local oscillator, and arriving (after mixing) at a single non-tuneable output frequency. With the SR-1000, the output channel is operator selectable, just as is the input channel, through a front panel turret-type-switch.

In effect, *with the SR-1000*, the user has a choice of any VHF or UHF channel input (12 VHF channels are individual crystal control down converted to I.F.) and any VHF channel output (12 VHF channels, also with individually crystal controlled up conversion back to RF from I.F.).

This is no small trick. In fact, it is enough of a trick that others have not marketed such a device previously; *the SR-1000 is a first of a kind.* Getting control of all of the possible unwanted mixer frequencies is no simple task; even being sure of what control you do and do not have (i.e. measuring

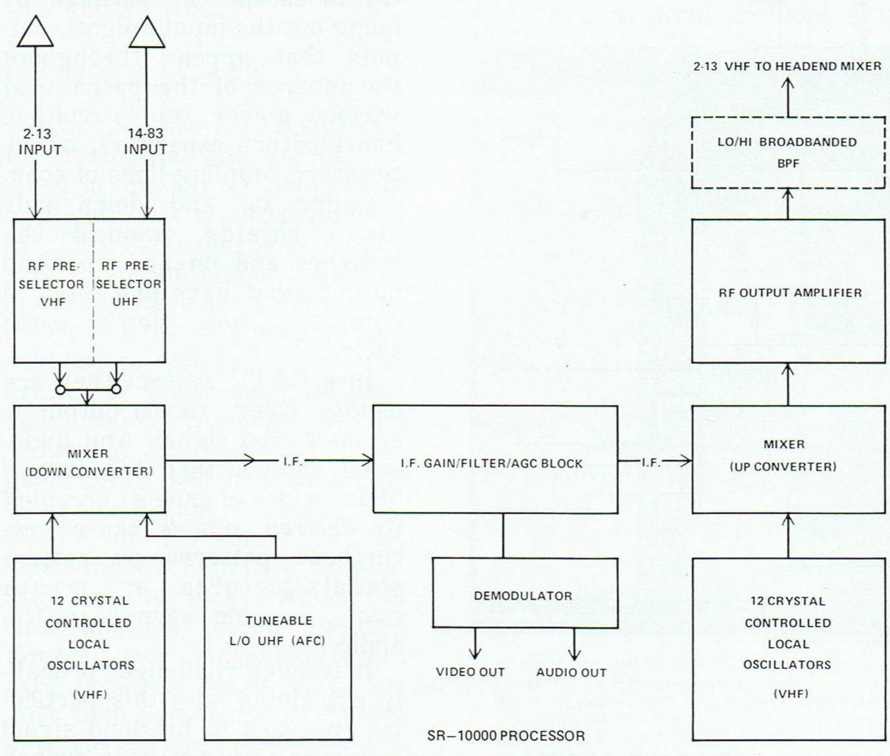


DIAGRAM 1

the end result) is no simple task, as we found out when we set out to review the SR-1000 operations. More about that shortly.

Beating The Beats

Reviewing the basic functions of a heterodyne processor, let's follow through diagram one. The RF signal is preselected through an RF amplifier, which has some amount of designed-in "Q" or selectivity.

The next stop for the signal is the mixer; a stage that defies simple explanation unless you are willing to accept basic truths. In this case the basic truth is that if two separate and descrete signals or frequencies are sent into a mixer, the output of the mixer is *not two* signals or frequencies but *three signals* or frequencies. The mixer takes the input signal (call it channel 2), mixes it up with a second *receiver provided* signal (called the local oscillator signal) and produces a mixer output that is (hopefully) neither of these. By simple numerical addition or subtraction, signal "A" (the input) plus (or minus) the frequency of signal B (the local oscillator) *produces signal C.*

Unfortunately, virtually all mixers, including those that do the above described job perfectly, also produce some extra (unwanted) signals at their output, in the process. For example, if the mixer output has been programmed to take signal A (55.25 MHz) and combine it with a receiver produced local oscillator signal B (on 101.00 MHz), the arithmetic difference in frequency (i.e. 101.00 — 55.25 MHz) is 45.75 MHz. This "difference frequency" (B-A) is the *intended* mixer output frequency for the visual carrier frequency of 55.25 MHz. It is also the I.F. input pass/through frequency. So far so good.

However, while the mixer is taking 101.00 and *subtracting* 55.25 MHz, it is also, simultaneously, *adding* 101.00 to 55.25 MHz and producing a second (unwanted) mixer output signal on 156.25 MHz. 156.25 MHz falls, unfortunately, into a CATV mid-band channel and it *can* cause trouble.

There are *other* unwanted mixer products as well, such as 2X 55.25 MHz (110.5 MHz) subtracted from 2X the 101.00 MHz local oscillator frequency (202.00 MHz), which creates an unwanted mixer signal on 202.00 — 110.5 or 91.5 MHz, 2X 55.25 MHz *plus* 2X 101.00 (110.5 + 202 = 312.5 MHz), and so on. There are more, but these will suffice. *And this is just the down converter!*

We won't belabor a point that is already well known and accepted by most CATV personnel; mixer stages are troublesome, and for *every* desired output product there are typically two to four potent *undesired* mixing products.

Therefore, the more mixers, the more output signals you have. Outputs that appear at the output of the whole package, outputs that appear "backwards" at the input to the whole package (i.e. signals that try to escape the package by going out-the-input spigot), outputs that appear throughout the innards of the package at various power supply voltage line feedthru capacitors, on inter-stage coupling lines of coax, crawling up and down substage shields, around the switches and on and on. And outputs that have one thing in common...*you don't want them.*

In a CATV system they are *deadly.* Every (beat) output is an undesired signal. And undesired signals that fall into 6 MHz wide channels occupied by *desired signals* cause herringbone patterns on system signals/pictures or create raspy, buzzing sounds in the audio.

It is some challenge; probably explaining why this particular approach to headend signal processing has not been rushed to the marketplace previously.

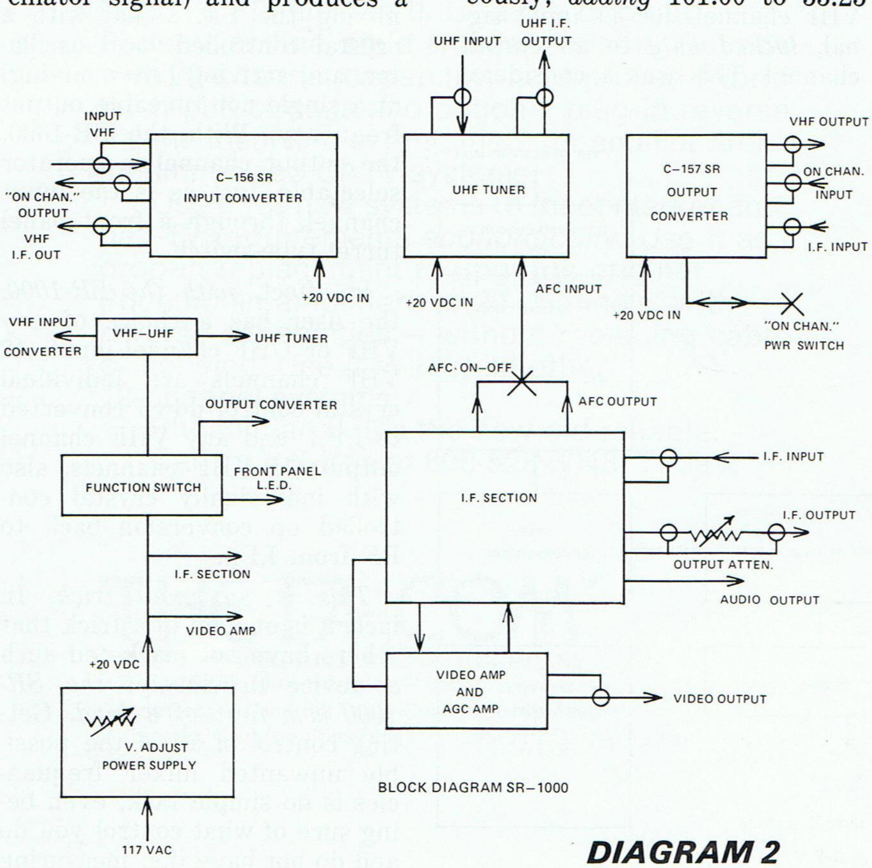


DIAGRAM 2

Not For Light Of Heart

Nobody in their right mind is going to buy a $1950.00 time bomb and stick it into their headend and "hope" the bomb does not go off. Therefore our concern in reviewing the SR-1000 centers in this order on these potential user oriented problems:

(1) Given a wide selection of input and output channels, *what is the extent of the beat problem potential?*

(2) If the beat problem is controllable, or satisfactory, *then and only then*, how does the unit perform as a *receiver?* I.e., if beats don't kill you, is the unit any good at producing pictures with a wide variation of weak, strong and adjacent channel signals?

Fortunately for TOMCO, *they did not fall off the turnip truck yesterday.* They have been at the converter business for quite some time, and because the conversion sections of the SR-1000 are so critical (first and foremost, before the processing amplification and I.F. shaping functions), they obviously have a head start in this department.

Limitations Of Time

The SR-1000 *CATJ* received for evaluation and review arrived in our lab on the 16th of September. It is serial number 24. This magazine goes to the printer on September 20th. We obviously have (and had) precious little time to prepare our evaluation, and get it set into print. For this reason our normally thorough review will be somewhat *less* thorough. However, *CATJ* will have this particular SR-1000 through the middle of November or so, when we will be *forced* to give-it-up to the lucky winner of this month's *CATJ Reader Contest* (see magazine insert card between Pages 40-41 for your own personal entry card; *you could win this $1950.00 unit!*). In that period we intend to *continue* running evaluation tests on the SR-1000, and we will be reporting to you on the results of these additional tests through our *CATJ Technical Topics* column in coming issues.

Well Sealed Up

One of the first design tricks any conversion-system designer learns is to *button up* the conversion sections of the processor with a very RF-tight set of metal containers. This shielding, if it surrounds the oscillator(s) and mixer is *one* effective control system for keeping unwanted mix products from getting loose into the world. As a photo here shows, the SR-1000 isolates the input converter (RF to I.F.) in a miniature RF shield "room" (right hand side of photo). This container accepts RF input from the rear apron F connector, performs the mixing process from RF to I.F., and through an output coupling of miniature coaxial cable, brings the I.F. from the mixer to the I.F. amplifier/shaping section (mid-left hand side of container). This is *no guarantee* that unwanted mix products won't get out of the mixer (such products routinely travel around and through container cracks, out through DC voltage lines that feed into the container, out along channel selector switch shafts, etc.); but if they get out, they will get out much weaker (read attenuated).

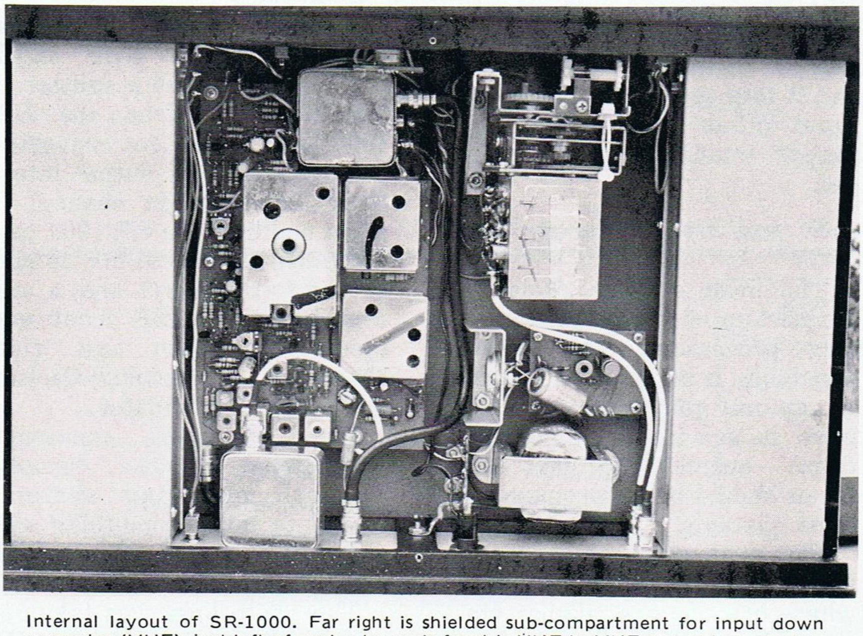
Versatile

The back apron of the SR-1000 has 11 "F" connectors, plus an audio output jack and a switch. This is all part of the programmable approach to doing just about anything you would want to do with a headend package.

As previously noted, the SR-1000 will take *any* VHF or UHF input channel and give you back *any* VHF output channel. It will also:

(A) Give you video and audio out (i.e. demodulator function), on the channel you send in on either VHF or UHF;

(B) Accept "in" from *another* source any I.F. signal (composite, with audio and video), for conversion via the output upconverter back to the output



Internal layout of SR-1000. Far right is shielded sub-compartment for input down converter (VHF); just left of center towards front is UHF to VHF tuneable converter. Right of center is I.F. amplifier, AGC, bandpass shaping section. Far right is output (up) converter. Unit has no external sound level control, operator must remove top cover and adjust I.F. aural trap adjustment inside in present series of units. I.F. board looks vaguely familiar, and "off-shore" markings surprised us. "It is the guts out of a good Sony receiver" remarked TOMCO's Olson.

channel selected;

(C) Take any input signal at VHF and UHF and allow you to feed it, either separately or simultaneously (via a splitter) to any *other* signal processor, at SR-1000 I.F.;

(D) Do "on-channel" conversion without frequency offset by utilizing the same local oscillator for both the incoming RF to I.F. conversion and for I.F. back to RF conversion.

If that is not adequate to satisfy your own versatility requirements, there are nine more SR series processors that run the gamut from the SR101 (VHF in, I.F. out) to the SR107 (I.F. in, superband switch selectable channel output).

It should be pointed out, boldly, *that TOMCO is not touting this unit as a device which you would normally utilize for your full headend processing requirements.* That is, TOMCO does not suggest in print or elsewhere that if you have a 12 channel system that you would install 12 SR-1000 units. Rather, the SR-1000 is promoted as a "Total Standby Receiver"; meaning that with one of these in your headend, you can at whim, will or option put it into service to place any input off-air signal onto any output (standard VHF) channel.

So how would you use this unit?

The most obvious choice is for backup of any of your existing processors. The output capability is as good as virtually any unit you would normally have in service (spec is +55 dBmV output), so matching levels should be no problem for most systems.

The next most obvious use (to us) is for that situation where one of your regular stations drops the network feed (with advance notice) of a program which you know your customers will want to see.

Then there is an almost endless set of channel duplication situations you can dream up, whereby you run for some special event one cable channel on another channel.

The SR-1000 has very wide applications.

So How Does It Work?

Well, it *may* be a month or two before we have the full answer to this one. Because the unit has so many operating variables, there is only so much you can accurately evaluate in a *short* period of time.

(1) Apparent picture quality using low band in, high band in, UHF in, with either low or high band out; vs. some straight 12 channel cable-type demodulators.

(2) Apparent ability to reject adjacent channel signals (i.e. pull the desired one out of a tough adjacent situation);

(3) Output conversion accuracy (both frequency and level stability);

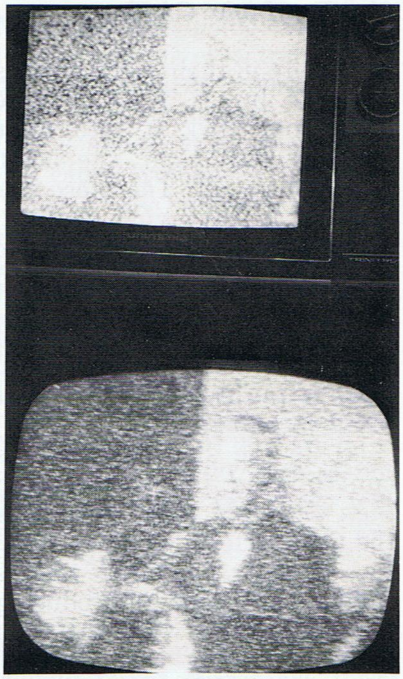
(4) Visual color fidelity checks for various input/output combinations;

(5) Beats.

First we took a weak (on purpose) distant UHF signal and ran it through a splitter to simultaneously feed the SR-1000 UHF input (we converted 21 to 3; ran the 3 output into a Sony Trinitron on channel 3, after padding the SR-1000 output down to +10 dBmV as presented to the Sony), and, a *custom* tuneable UHF front end (down converter) that runs ahead of a Setchell-Carlson DEM 919 demodulator.

Here we were concerned with signal to noise, visually, as both receiving systems fought to make something useable out of a —45 dBmV UHF antenna level signal.

The photo here was taken to show the quality of the SR-1000 signal (21 to 3 and 3 to video), on the top monitor, vs. the quality of the custom down converter signal (21 to 6 and 6 to video), on the bottom monitor. The *custom converter* wins, but then it has a *measured* 4.5 dB noise figure while the SR-1000 noise figure is (according to the spec sheet) "not over 12 dB. The difference is *not* dramatic, and we count this test *as a pass* for the SR-1000.



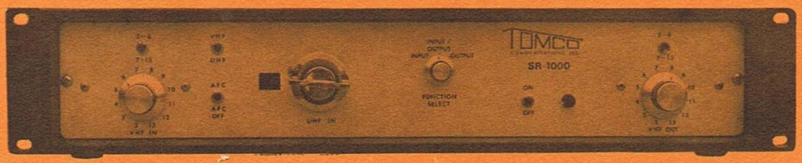
Top Monitor — SR-1000 functioning as 21-3 converter, feeding Sony receiver on channel 3.
Bottom Monitor — Same channel 21 signal, thru low noise tuneable converter and into DEM 919 demodulator.

What about the nitty-gritty functions? Like color purity. Now if you are exceedingly well equipped and have bunches of time, you can check for color phase shift and group delay. We did not have the time, so we did the next best thing; we set up two color receivers side by side and did a subjective viewing test. On one hand we ran typically 0 dBmV off air signals into the SR-1000, and into a DEM 919 demodulator. The SR-1000 then fed another DEM 919 so we were demodulating with the same basic equipment in both cases.

After trooping a dozen people by both receivers, we had them vote on which picture looked the best. The result was close; viewers felt the two pic-

NOW—this is SOME prize

THE TOMCO SR-1000 ''Any In/Any Out'' Headend Signal Processor — Valued at $1950.00!!!



AUGUST CATJ READER CONTEST WINNERS!!!

In August, **CATJ** reviewed the Mid State Communications RD-1 Radiation Detector and two units were scheduled to be given away. The winner of the non-Canada contest is:

Thomas GN Bethel
Chief Engineer
Westchester Cable Television
Mt. Kisco, New York 10549

The winner of the Canadian contest, of an RD-1 donated by Comm-Plex Electronics, Limited, Montreal is:

Dennis Tretiak
Sask. Telecommunications
Regina, Sask., Canada

Congratulations to both winners. Look for winners of the September contest (2903 co-channel eliminator) is this space in the November issue!

READ ALL ABOUT the fabulous SR-1000 on Pages **37** to **41** in this issue of **CATJ**. Somebody WILL win this $1950 signal processor; it could well be you. Then carefully read the rules to enter the OCTOBER CATJ READER CONTEST, on the reverse side of this card. Finally, complete fully the CONTEST ENTRY FORM found on reverse side of this card; afix postage to the perforated card and mail to **CATJ**.

SPECIAL DEADLINE— for SR 1000 CONTEST is November 15, 1975.

PLACE 8 CENT STAMP HERE

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THE RULES

1) To enter **OCTOBER CATJ READER CONTEST,** complete the entry card below, fully.
2) Post (i.e. mail) this card to **CATJ** so that it arrives in our offices not later than November 14, 1975.
3) Only one entry per applicant; however you do not need to be a **CATJ** subscriber to enter.
4) Additional entry cards available at **CATJ** offices and at TOMCO offices (2399 Charleswood Road, Mountain View, Ca. 94043).
5) In the case of a tie between entrants, all entry cards with correct answers are placed into a single sealed container. At noon on November 17 in the **CATJ** offices one card will be drawn at random from the container, and the individual submitting that card will be proclaimed the winner of the SR-1000.
6) Entry cards become the property of **CATJ** and TOMCO.
7) If the SR-1000 winner happens to reside outside of the USA, the winner agrees to be totally responsible for custom charges (if any) associated with acceptance of the prize.

COMPLETE ENTRY FORM COMPLETELY BEFORE POSTING ENTRY

1) The SR-1000 is a____ headend processor, ____ line amplifier.
2) If your luck runs out and you don't win an SR-1000, would you purchase one? ____Yes ____ No
3) What brand of headend equipment do you now have? ________________________
4) Do you presently have switchable up and/or down converters for your processors? ___ Yes ___No
5) Would you purchase a tuneable plug-in UHF down converter for your processors? ____ Yes ____ No
6) Did you know that TOMCO has standard 3 week delivery on UHF to VHF converters?
   Yes ___ No ___
7) Are you interested in MDS receivers? ___ Yes ___ No
8) Are you interested in an output channel switchable modulator? ____ Yes ____ No
9) Do you have need for a switchable midband input converter? ___ Yes ____ No

Entrant's Name ________________________

Position/Title/Job Function ________________________

Company/System ________________________

Address ________________________

City/Town ________________ State ____________ Zip ____________

Telephone Number _____ - ______________

NOTE: Entry card must be received by 11-14-75 to qualify

WIN TOMCO SR-1000!!!

Gentlemen:
Yes I am interested in the product advertised in this months issue of CATJ. Please send additional information on this product immediately.

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In Canada—Deskin Sales Corp.

tures *looked the same* to them.

Then there was frequency stability and output level stability. We ran the output of the SR-1000 into a splitter (through a DC-20) and "beat" the SR-1000 signal against *off-air signals* on all 12 channels. In effect, we utilized the broadcast TV signals available to us on channels 2-13 as *references*, and critiqued the beat-note-bars on the receiver screen for signs of frequency deviation. With one single input signal (channel 4 was selected) and stepping through the output channels from 2-13, we found the apparent frequency accuracy of the SR-1000 up converter to be (as a whole receiver package) within +/— 10 kHz on all 12 VHF channels.

For level stability, we ran a + 10 dBmV local off-air signal into the SR-1000 on channel 6, and then fed the output of the SR-1000 into our VSM-1 analyzer. Starting at channel 2 and working up through 13 we checked the visual carrier output level of the SR-1000 as measured on the VSM-1, here is what we found:

TABLE ONE
Output Stability

Input level on 6 — +10 dBmV

Output Channel	*Level Indicated (visual)*
2	+57 dBmV
3	+58 dBmV
4	+58 dBmV
5	+58 dBmV
6 (*)	+58 dBmV
7	+56 dBmV
8	+56 dBmV
9	+56 dBmV
10	+56 dBmV
11	+56 dBmV
12	+56 dBmV
13	+57 dBmV

* — on channel (same L/O)

Then there are the beat conditions. Like we said early on, if the unit is loaded with beats, the rest is of little interest.

SR-1000 SPECIFICATIONS

Input—Any UHF,VHF channel
Input Control—
VHF—crystal controlled, .0025%
UHF—AFC control, +/— 25 kHz
Output Level—+55 dBmV RF
Output (demod) *Video*—1 volt p/t/p
Output (I.F.) — +35 dBmV
Return Loss Match—12 dB minimum
Nearest Adjacent Carrier Reject — 35 dB
Segment Gain—
UHF to I.F.—17 dB
VHF to I.F.—17 dB
I.F. to VHF—17 dB
I.F. max gain—45 dB
I.F. AGC range—40 dB
Price—$1950.00
Manufacturer—
TOMCO Communications, Inc.
1132 Independence Ave.
Mountain View, Ca. 94043
(415/969-3042)

First of all, the pictures on all 12 *output* channels were free of internally generated beats. That is, we could find no situations (by varying input and output channels) where we created beats on ourself. So far so good; and our tip of the hat to Tom Olson and the gang at TOMCO.

Then we set out to measure the beat products (they *are* there; that is *not* the question). This is some chore. First of all, there *are* plenty of beats. TOMCO'S Tom Olson advises "It is assumed that most headends utilize bandpass filters on the output of their processors. With this unit (single channel) bandpass filters are a necessity because of the broadband nature of the output converter. There are several types of inexpensive filters (*Editor*—Hamlin makes a set, which for 12 will run you about $150.00) available."

We agree with Tom, after looking at the output on the VSM-1. When the output was running in the +56/58 region, we found beats from 35 to 51 dB down. For example, with *channel 2 in* and *channel 4 out*, we found high band beats "near" channels 7, 11, 12 and 13. We also found low band beats around 5/6 that were down 30-35 dB. The SR-1000 has a switchable hi-low (band) filter on the output, and when you are going out on low band (for example) the hi-low in the low position cuts way down on the high band output beat levels. The same in reverse is true on low in/high out; the hi-low filter cuts down on low band output beats.

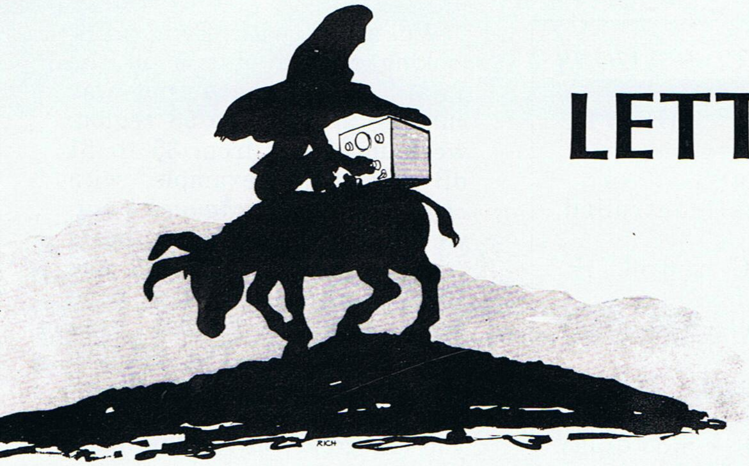
Allowing for the way most CATV headends are combined, with directional couplers, some external filtering *is* recommended.

Finally, there is the demodulator function. "This is not intended, as aligned, to be a demodulator; rather it is an RF signal processor" notes Olson. "However we had the ability to bring out the video and audio, so we did, as a spare backup for the guy that lost his regular demodulator and needed a back up."

Wrap-Up

The SR-1000 is a new tool for the CATV system operator. TOMCO reports a number of MSO's have purchased a unit for *each* of their systems, primarily for backup service. We believe the unit may also create a new era of system channel selection and programming versatility. Because for the first time *the operator* has virtually unlimited switchable control over which cable channel goes where, when. And that is nice.

If you have not yet completed the SR-1000 *CATJ READER CONTEST* entry form facing Pages 40 and 41, please do so now. *Someone is going to win serial number 024* and it could well be you!

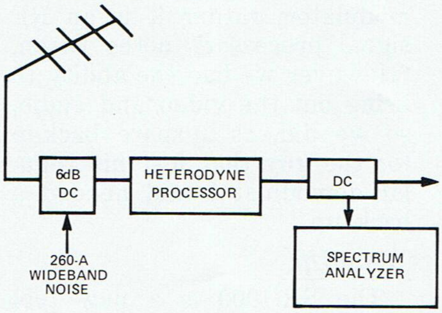


LETTER FROM JOSÉ

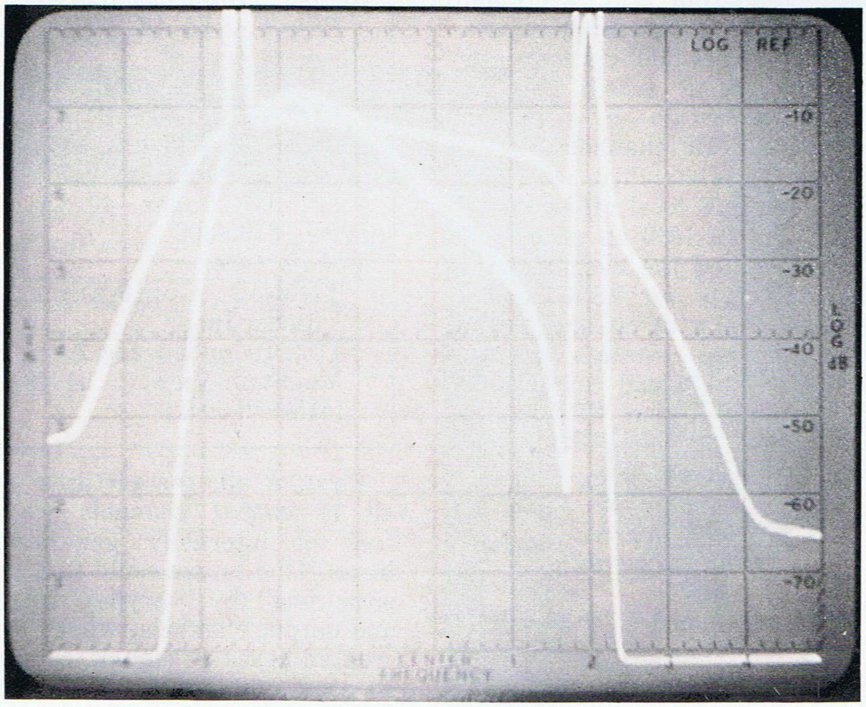
Senor Editor:

I am writing about your July issue of **CATJ,** but first a brief comment about utilizing a Sadelco 260-A Analyst (or other wideband noise generator) for headend testing.

I frequently use the 260-A to check the response curve of an operating processor while it is in service. I do this by inserting the noise output of the 260-A into the input of the demodulator through a directional coupler, and I run the 260-A noise output up to the highest level which does not affect the AGC circuitry of the demodulator. At this point the noise level is very noticeable for the duration of the test; i.e. the screen goes into heavy noise on the picture on the system.



CHECKING HETERODYNE RESPONSE WITH WIDEBAND NOISE SOURCE AND OFF-AIR SIGNALS AS "MARKERS"



The scope screen photo here is a double exposure from a Hewlett Packard spectrum analyzer. The analyzer had been adjusted as follows:

- Dispersion—1 MHz per division
- IF bandwidth—100 KHz
- Video bandwidth—10 Hz
- Vertical Scale—10 dB/division and 2dB per division

The aural and visual carriers present serve as convenient markers for the study of the response curve of the processor package. The double exposure shows the response at 10 dB per division (top trace) and 2 dB per division (lower trace). The storage feature was employed to hold the 10 dB per division, while we used the single shot trigger mode to display the 2 dB per division.

The noise from the 260-A is high enough that the color subcarrier is ''buried''; however with the accuracy of the H-P horizontal calibration (1 MHz per division) it is no difficulty finding the location of the 3.58 color subcarrier.

I point this technique out because I believe you will find that the relatively inexpensive Sadelco 260-A noise generator is a very useful tool, even when employed with a $12,000 plus spectrum analyzer.

I employ the noise generator especially in headend equipment because our tracking generator cannot function with heterodyne (conversion) systems.

A tracking generator/spectrum analyzer is however an excellent way to check frequency response. We particularly like the tracking generator approach because the ''energy'' is concentrated right in the passband of the sweeping detector in the spectrum analyzer. This gives superior sensitivity to a broad band noise generator system. In a noise generator/analyzer package, a very large portion of the noise signal is ''wasted'' or ignored at any instant because at that precise point in time the spectrum analyzer is looking only at a very narrow portion of the noise output. You can also easily overload some systems with broadband noise trying to obtain reasonable displays.

The ''problem'' with a tracking generator in frequency conversion equipment is that the generator tracks with the spectrum analyzer. Some very elaborate systems have a provision for ''offsetting'' the tracking generator.

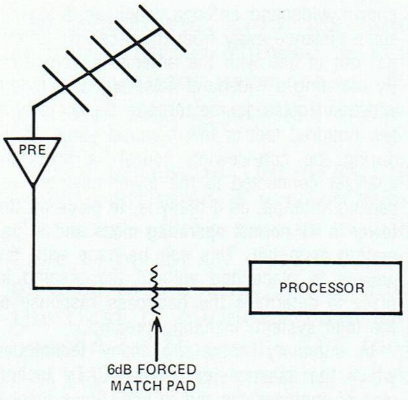
Returning to your July issue now, I am afraid that I fail to see the real utility of the Jerry Laufer ''everyman's analyzer'', except possibly as an **educational project** to demonstrate the principle upon which most spectrum analyzers are built. Perhaps I just don't understand the economics of cable systems in the U.S.A. How many of your readers, for example, have actually used a good quality spectrum analyzer (such as H-P or Tektronix)? **Our unit** is not relegated to our laboratory at all; quite the contrary, it has a shock proof mount and it goes into the field with us very often. They are the most useful instruments which a system can have. Technicians and engineers should be busting their rear ends to get one into their systems. I mean a real one, one that has sufficient versatility to do **all of the jobs** that have to be done. Perhaps your U.S.A systems should think about forming regional cooperatives to buy and share use of such units? Or perhaps your state or regional associations should spend some of their time, effort and money on a good set of test equipment for all of the member systems to be using. Once these systems have worked a good spectrum analyzer (preferably with a tracking generator), they will never go back to their ''old habits'' again. Why don't you show your readers what a real first class spectrum analyzer looks like and does?

I have also read carefully your article on Yagi-Uda antennas. I have not yet read Part Three of your antenna series (on logs) but I wonder why you waste time on Yagi-Uda antennas at all? The log-periodic has so many advantages over the Yagi-Uda for VHF bands that there is really no reason to use the Yagi at all. We have not used any Yagis here for more than five years and I doubt whether we will ever use them again. The L-P has an intrinsically broadband response; so broad that it works well for us even atop of our 13,000 foot mountain receiving locations when coated with ice that detunes a Yagi to uselessness. The L-P has a ''clean'' predictable response with very good front to back ratios. It is easy to cantilever mount on antenna structures.

Its one disadvantage is that it does have less gain than a Yagi-Uda of comparable size. However, it is my feeling that any receiving situation where the difference in gain between a Yagi-Uda and a L-P antenna is critical is probably a situation where there are many more serious problems, such as signal fading. And if the path has serious fading problems, the pickup point should be moved closer to the transmitter and microwave employed.

I also wonder about some of the reasoning in the review of the SITCO rear mount Yagi-Uda antennas. The review stated that when the test antennas were switched to the rear mount Yagi antennas, the apparent ghost levels went down. I believe this is faulty reasoning. It is likely that the proximity of the tower to the side mount Yagi antenna affected the impedance match of the side mount Yagi, thereby causing a ghost. You reasoned that the tower was creating a secondary signal path to the antenna, which while possible, seems less likely to me than **antenna detuning** due to tower metal detuning the side mounted Yagi. The moral is that **every antenna installation** should have its match checked. This is quick and easy to do utilizing conventional return loss bridge techniques. If the downline is not too lossy, this can be done from the bottom of the tower after bypassing the preamplifier. If the line loss from antenna to the base of the tower is excessive the line should either be replaced with lower loss line (for obvious reasons) or the check performed with some of the portable noise equipment such as the 260-A.

Ghosting caused by reflections on the downline can be prevented by using antenna preamplifiers right at the antenna. The preamp effectively isolates the antenna from the downlead. There is usually not (**and should not be**) sufficient cable between the antenna output and the preamplifier input for a visible ghost to develop in **that** short run. It is the longer run down the tower where the problem is usually seen or created. If there is a mismatch between the preamp output and the preamplifier power supply ''RF load'' at the base of the tower, someone should look into the preamp output match (assuming the downline cable is good quality with a good return loss match) of the preamp and the input match on the preamp power supply. Preamp power supply is usually very good (25-30 dB RTL or better) but **sometimes** lightning will damage the power supply **RF circuitry** when it does **not** blow up the power supply AC or DC voltage circuitry.

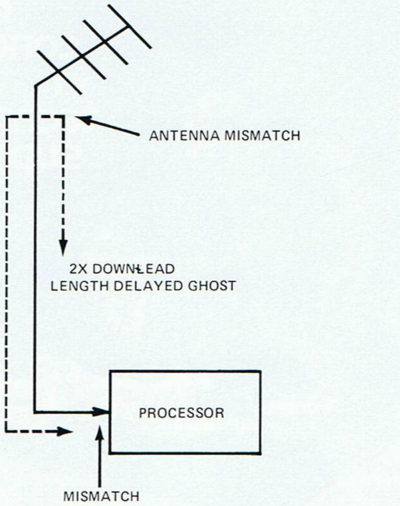


PREAMP WITH SUPERIOR INPUT/OUTPUT MATCH PLUS 6dB FORCED(PAD) MATCH AT PROCESSOR INPUT PREVENTS 2X DOWNLINE GHOSTS

If the power supply has a very good match (such as being as good or better than the downline itself), the preamplifier cannot guarantee no ghosts if the input match on the processor is poor. Many are poor, especially those with all channel tuners. I have measured many with factory adjusted matches in the region of 6-8 dB RTL. This poor match at the input to the processor can create a mismatch at the base or terminating end of the downline, which in turn sends a reflected signal back towards the antenna. If there is no preamplifier and if the antenna match is 10 dB and the processor match is 10 dB and the downline loss is only 2 dB, there can be a ghost that is created by the poor input to the processor, a ghost that is only 20 dB down or so.

The preamplifier helps prevent this problem because it isolates the frequently poor antenna match from the reflected signal caused by the frequently poor processor match. If the preamplifier has a decent output match, much or most of the reflected signal created at the input of the processor is absorbed on the return trip into the preamplifier output.

Additional insurance is found by installing a 6 dB resistive pad at the **input** to the processor. If the signal level from the antenna is not strong enough to afford giving up 6 dB of signal voltage by ''forcing the match'' with a pad at the input, the antenna level signal **definitely needs** a preamplifier. A preamplifier should be employed just as a matter of course except in truly local signal situations, so that matches can be **forced** at the processor input with external padding, and, the potential for antenna/downline mismatch can be controlled with the preamplifier and the pad networks.



PROCESSOR INPUT MATCH COUPLED WITH ANTENNA OUTPUT MATCH (BOTH POORLY MATCHED) CAN CREATE 2X DOWNLINE GHOST

We have occasionally employed a wideband noise source such as the 260-A, loading into a known wideband antenna (such as a log) at some distance away from the receiving antenna, but in line with the antenna's front end. By radiating a wideband noise signal with the wideband noise source through the air over a few hundred feet or few hundred yards (done during the non-viewing hours), a spectrum analyzer connected to the tower mounted receiving antenna, as it really is, **in place on the tower in its normal operating mode and in operating condition.** This can be done with the preamp in place and without the preamp in place to determine the bandpass response of the total system, including preamp.

In summary, there are many techniques which the inventive or creative CATV technician or engineer can put to use. Some involve test equipment which seems not to be generally in use in the U.S.A. Others just require a little imagination, such as using the 260-A as a noise source for all manner of system checks. Are U.S.A. system operators really that tied to their simple, basic SLM? There are other instruments available you know.

Your friend,
Jose Garcia Moll
Mexico, D.F.

Editors Note:

It may well be, Jose, that we depend upon our SLM's too often. We believe however that our major shortcoming is not totally of our own doing. Unlike Mexico, where you have been encouraged by your government to expand CATV by whatever technology you have at your disposal or can create, our CATV industry is severely restricted from innovation and development by federal government regulations which preclude us from developing the best possible receiving techniques.

Your government encourages you to bring as many signals as you can create or develop to any areas you wish to function in. Our government actually discourages creativity and innovation by severely limiting our signal carriage.

Your government recognizes that in Mexico CATV is basically if not totally an ancilliary service to broadcasting; a service devoted primarily to expanding the benefits of broadcast television service to as many of your country's residents as is possible with whatever technology you can create. Ours is insisting that we develop as a service almost totally independent of broadcast television.

While you concentrate on making off-air signals look the very best you can, we are forced to deploy our energies looking for clever programming sources that we must create on our own, to fill channels which you would simply fill with additional broadcast signals.

We are guilty, as you suggest, of falling behind in off-air-receiving technology. At one time U.S.A. operators led the world in this technology. Gradually in the 60's we lost much of that lead to Canadian operators. Now it appears that we may be falling behind the balance of the world as well. If our government will get off our back, it is possible that one day we may again rejoin you in advancing technology in this area. In the meantime, keep on writing letters to keep us advised of how far this industry is advancing in areas where government interference is not holding back the natural evolvement of technology!

The February 1960 issue of *DXing Horizons* carried a report on a very large multiple Yagi-(Uda) antenna array designed and installed by CATV antenna pioneer Stan Hosken. Operating from his home in North Bay, Ontario, Hosken was anxious to bring television reception approximately 290 miles north of the U.S. border from the then *nearest U.S. transmitter*, located at Buffalo.

According to the *DXing Horizons* report, early attempts at bringing television to North Bay had concentrated primarily on 100 foot towers and stacked channel 4 Yagi antennas, with mast or tower mounted amplifiers. Some were operating (so to speak) as early as 1951 according to Hosken. The results over this 290 mile path? Hosken reported "...distorted sound, a drifting frame bar which would lock into a reasonably stable picture *about once every four days* for 30 minutes time...." Hosken went the same route by installing a 100 foot tower on his 400 foot hill and connecting his field strength meter. "The needle barely moved (except when a car went by)" noted Hosken.

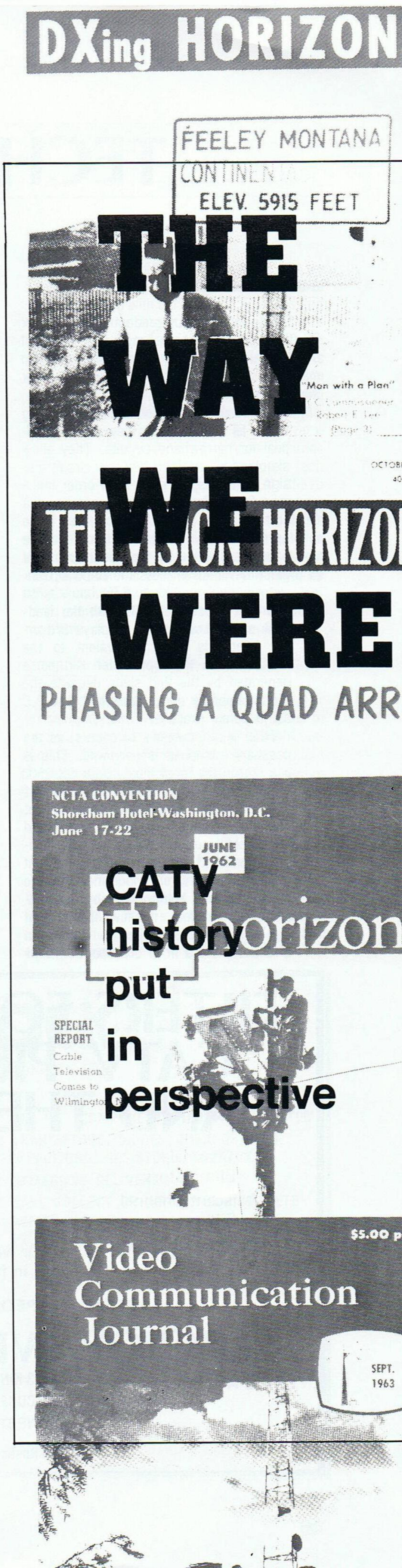
DXing Horizons went on:

"So Hosken put some of his wartime learned knowledge with the Canadian Radar Corps to work. 'To capture lots of signal in an area where there is only a little signal available requires an antenna with a big capture area'. This means the antenna array must be broad as well as tall, and all of this in addition to being super directive and super sensitive. Only one type of antenna at the time seemed to fill the bill...a Yagi. But Hosken had already tried a couple of stacked commercial channel 4 Yagis. So back to the drawing boards...from whence he emerged after nearly six months with the design data for a single long-long Yagi... 17 elements on channel 4, on a 30 foot boom! Hosken built one, tuned it, and stuck it on his 100 foot tower. Now his field strength meter showed a signal, sometimes *as much as* 50 uV; but *nearly* always something!

"As plans on the drawing board continued it was obvious the heart of the system would have to be the 17 element Yagi on a 30 foot boom. At the time the first 17 element Yagi appeared on Hosken's 100 foot tower, antenna-smiths were still cranking out 5 and 6 element 'long' Yagi antennas. The theory for more than six elements was still years away. Except not for Hosken. *He* was building stack after stack of the single channel arrays until in the end he had *16 separate* identical antennas. And with the aid of a catwalk·build between six 40-foot towers on the side of his private hill, he erected eight long Yagis over eight long Yagis...for a total of 276 elements (8 wide by two antennas high) on channel 4. The entire array stands 160 feet long, 30 feet deep and 9 feet high!"

Hosken's goal was 500 microvolts of antenna delivered signal. At 290 miles, this would be no small miracle even today. This was 15 years ago. The array made the grade, but *not* for long enough times (or consistently enough). What Hosken had in mind was a CATV system for North Bay.

"There *were* days on end where the antenna level signal stayed at or above the 500 microvolt level" noted Hosken. "There were also days on end where the picture was so far down in the noise that the meter needle barely moved, even with 16 long-long Yagis out there looking for signal. But Hosken did not give up; he graduated from his big multiple stacked Yagi-Uda antenna arrays to big parabolic dish antennas and later in the late 60's his company would provide dozens of very large Dew Line type parabolic antennas to CATV systems throughout the United States and Canada.



TECHNICAL TOPICS

Q-BIT SX-0500 REVIEW

"Thank you for your product review of our SX-0500 pre-amplifier in your July issue of CATJ. **Your** article did, of course, open up many questions I feel I must answer for your information.

1) We have done considerable experimenting with FET devices and they do have appeal for narrowband circuits. They allow simple and straight forward circuit design. They display good third order intermodulation characteristics considering the current they draw. However, we have never been able to obtain as low a noise figure as **claimed** by the manufacturer of these devices; whereas the bi-polar transistor we utilize (Nippon 875) has a noise figure of 1.3 to 1.8 dB. **With the feedback scheme we use,** it displays 3rd order intermods about equivalent to the FET. Loss in the input filter and noise generated by the 2nd stage degrade the overall amplifier noise figure to 1.8 to 2.5 dB in actual practice.

   Filter loss increases, of course, as the passband response is narrowed. This is one reason the input filter in our SX-0500 is purposefully kept broad. Any loss here adds directly to the system noise figure.

2) The bias arrangement, which you found of interest, does two things. As your article reported, it stabilizes the bias current which is of greater importance for the higher currents being drawn by the transistor device. **And,** it allows us to omit the emitter bypass capacitor which can give designers a fit in broadband circuits due to self-resonance of the capacitor.

   We have tested the SX-0500 amplifier in our temperature chamber from —50 degrees F to +175 degrees F with no noticeable change in gain. **Below**—40 degrees F the interstage filter detunes **down** about 250 **KHz** which would **not** affect preamp performance since the filter is flat over a 6 MHz bandwidth.

3) Now to get to probably the most controversial subject in CATV; lightning protection. I doubt if anyone knows of any way to give 100% protection against lightning damage. In our case, at least, we do what, in our judgement is best to minimize lightning damage. As we build up a history of this failure mode, we are constantly looking for ways to improve the situation. So far this summer we have had less than 2% of our SX-0500 amplifiers returned for repair due to lightning. In these cases, we **never** lost an RF or bias transistor. However, the surge protection zener (CR1) is fused (shorted) and the power choke blown to smithereens (it takes over 10 amps to do this!). The metal ends of the gas discharge device (which incidentally is a Signalite, not a Siemens brand as you reported) in the power source have turned a blue color indicating they have gotten right warm. We have over 1000 power sources in use similar to the SX-0500 model preamp. Since using the gas-discharge device, the main blast seems to be absorbed by it. **Before its use, everything including the PC board was blown to pieces with a good hit.**

   However, from all indications your report is probably correct. The downline cable to the headend is by far the most susceptible area for problems. Whether the surge comes **from the bottom up** or the **top down** is open for debate, but for sure there is a monstrous surge on the outer shield of the downline cable. We have had cases where the lightning came into the unit through the front end, but is **is rare** if a short antenna to preamp cable is employed, **and the antenna feed is a grounded type.** In many cases, the **MATV crowd** mount the preamplifier at the **bottom** of the pole or tower (for ease of service reasons). Now the input lines from the antenna become the downline cable paralleling the tower; and the rate of damage goes **way** up. **That** is a different ballgame.

4) We have had a lot of people ask us about corrosion problems because of the DC on the downline cable. We furnish a capsule of silicone grease compound (Dow Corning DC-103) for stuffing into the pre-amp connectors. We have not had any complaints of corrosion nor noticed any on units after several years in service.

   It has been our observation that some folks are using this black windshield sealing compound on F connectors, which we think is bad news. Units returned with this in the threads exhibit intermittent connections and are a dog to check out. The only thing we have found to remove this gunk is acetone. And if the user is real liberal with the stuff, it gets inside of the connector which causes poor center conductor to F connector contact; and we have to replace the connector.

Again our thanks for the exposure of the SX-0500 and your evaluation of it. From all indications the SX-0500 is being accepted quite well by the CATV market and our users have been pleased with its performance."

Hansel B. Mead
V.P./Engineering
Q-BIT Corporation
Melbourne, Fl. 32901

Hansel:

We suspect CATJ **readers will have learned as much from your letter as they did from our product review! As we noted in July, we wondered why you would continue to maintain a gas discharge device in the front end. Your explanation of zero failure since employing it is the best reason we can think of for your continuing to have it in the circuit. Are you people going to become involved in the 3.7-4.2 GHz preamplifier business for satellite receiving terminals? With the newly emerging Gallium Arsenide (GaAs) FET technology, we would suspect that your VHF experience would translate well to the new band.**

NPN Not PNP

The 'Economy Modulator', Page 62 of the March 1975 issue of CATJ depicts the 2N5139 transistors as NPN devices; when in fact they are PNP devices. A cursory glance at the circuit reveals that these devices as drawn are reverse biased. However, the article was very informative and the demodulator/modulator has many practical applications. I plan to build this project and put it to work here. **CATJ** is very well received in Canada and is establishing itself as an excellent training manual for our industry.

E.H. Williams
Trenton, Ontario
Canada

Reader Williams is correct; but as Richey says 'wire it up the way it shows and the PNP 2N5139 will function as intended'. CATJ now has more than 800 copies per month crossing into Canada, so apparently we are being well received!

G-Line ReVisited

Your article in the May CATJ ('G-Line Community TV System') is very interesting. I would very much like to obtain information on using the G-Line system. Where can I find it?

Euhlew Sales, Inc.
Junction, Texas 76849

The original G-Line concept was a licensed arrangement whereby anyone who used it was supposed to pay a license-use-fee to the agent of the system in New York City. We have checked and we find the company that was involved in this in the 50's is no longer around. Does anyone know of a current supplier of G-Line Technology? Or, has it simply passed into public domain through the passage of time?

Propagation Appreciated

I would like to congratulate the author of the very fine articles that appeared in the September and October (1974) issues of **CATJ.** The October (1974) **92 Miles Of Terrain** was especially fascinating since it deals with the KTEW signal.

Many years ago we utilized a rather primative battery driven chart recorder and SLM with a 50 foot test antenna to collect data on prospective sites at 72 miles out. At that time we noticed several of the signal anomalies mentioned in **CATJ.** The most predominant was the devil co-channel, from which there appears to be no escape.

One interesting phenomenon observed over this path was that the aural and visual carriers did not go through a simultaneous fade. Quite often we would find the value of the aural exceeding the value of the visual during a fade period.

Again my congratulations on a very fine publication.

John D. Barth
Chief Engineer
KTEW-TV
Tulsa, Oklahoma 74101

Separate aural and visual fading, or selective fading, is one of the particularly nasty problems associated with any beyond-B signal reception point. It seems to be particularly troublesome in the high plains (i.e. west Texas and panhandle) and along over-water paths. We intend to explore it in some detail in a future issue of CATJ.

System Set Recorder

Here is a service aid which we use in our system. The card is attached to and left with the receiver and in this way a serviceman from either the cable company or a TV set serviceman can quickly see when there has been a history of problem channels.

DATE TIME
METER TECH.

SIGNAL LEVELS

CHANNEL	PICTURE	SOUND
2		
3		
4		
PC		
5		
6		
FM		
7		
8		
9		
10		
11		
12		
13		
PC		

DO NOT REMOVE • PROPERTY OF
Kraus ELECTRONIC SYSTEMS
815 - 726-2466 - JOLIET

Arthur "Skip" Kraus
Kraus Electronic Systems
Joliet, Illinois 60432

Noise Not Funny

I work for a small TV cable company and we have a problem with AC voltage interference. We are picking it up with our headend antennas and it is quite distressing at times. I would like to locate a schematic for a detector to locate the source of this type of interference. The noise is in the form of a splatter across the television screen with a horizontal moving bar, moving from top to bottom. Damp days seem to hold this noise down to a minimum and at times zero.

Richard Cordes
Installer/Tech
Huntsville, Al. 35810

The reference you seek is the May and June 1974 issues of CATJ, with particular emphasis on Page 8 of the May 1974 issue. This includes detector and detection information. If you cannot see the problem at your headend, you might be suspicious of a bad power supply in your plant itself; especially if it shows up only on some segments of the system and not on others.

Cheap Movies Wanted

Can you recommend a feature film supplier for small systems? Everyone we have talked to wants an arm and a leg (i.e. up to $200.00 per film) for old films. We are hoping to attract more subscribers by running old feature films during the evening hours on our local channel, but we cannot afford what some suppliers are asking.

Joel Glass
Central Kentucky Cablevision
232 East Main Street
Lexington, Ky. 40507

We too would appreciate knowing more about low cost film feature sources Joel. Perhaps somebody in the 'CATJ audience' can enlighten both you and us.

cata ASSOCIATE MEMBER ROSTER

In recognition of the untiring support given to the nation's CATV operators, and their never-ending quest for advancement of the CATV art, the COMMUNITY ANTENNA TELEVISION ASSOCIATION recognizes with gratitude the efforts of the following equipment and service suppliers to the cable television industry, who have been accorded ASSOCIATE MEMBER STATUS in CATA, INC. for 1975.

Anixter-Pruzan, Inc., 1963 First Ave. S., Seattle, WA. 98134 (**D1**)
Avantek, Inc., 3175 Bowers Avenue, Santa Clara, CA. 95051 (**M8**)
Belden Corp., Electronic Division, Box 1327, Richmond, IN. 47374 (**M3**)
BROADBAND ENGINEERING, INC., 850 Old Dixie Highway, Lake Park, FL. 33403 (**D9, replacement parts**)
Burnup & Sims, Box 2431, W. Palm Beach, FL. 33401 (**S2, S7, S8**)
Cable Dynamics Inc., 501 Forbes Blvd., So. San Francisco, CA. 94080 (**S8, equipment repair**)
CABLE NEWS, 2828 N. 36th Street, Phoenix, AZ. 85008 (**S6**)
Cerro Communication Products, Halls Mill Road, Freehold, NJ. 07729 (**M3, M5, M7**)
COMM/SCOPE COMPANY, P.O. Box 2406, Hickory, NC. 28601 (**M3**)
DELTA BENCO CASCADE INC., 40 Comet Ave., Buffalo, N.Y. 14216 (**M4, M7, M8, D3, S8**)
Jerry Conn & Associates, 550 Cleveland Ave., Chambersburg, PA. 17201 (**D3, D5, D6, D7**)
C-COR ELECTRONICS, Inc., 60 Decibel Rd., State College, PA. 16801 (**M1**)
DAVCO, Inc., P.O. Box 861, Batesville, AR. 72501 (**D1, S1, S2, S8**)
DEVINES Trailers & Accessories, Grantville, PA. 17028 (**M9, cable trailers**)
ENTRON, Inc., 70-31 84th Street, Glendale, NY. 11227 (**M4, M5, D4, D5, S8**)
GAMCO INDUSTRIES, INC., 317 Cox St., Roselle, NJ. 07203 (**M5**)
JERROLD Electronics Corp., 200 Witmer Road, Horsham, PA. 19044 (**M1, M2, M4, M5, M6, M7, D3, D8, S1, S2, S3, S8**)
Kay Elemetrics Corp., 12 Maple Avenue, Pine Brook, NJ. 07058 (**M8**)
Microwave Filter Co., 6743 Kinne St., Box 103, E. Syracuse, NY. 13057 (**M5, bandpass filters**)
MID STATE Communications, Inc., P.O. Box 203, Beech Grove, IN. 46107 (**M8**)
Pro-Com Electronics, P.O. Box 427, Poughkeepsie, NY. 12601 (**M5**)
QE Manufacturing Co., Box 227, New Berlin, PA., 17855 (**M9, tools & equipment**)
RMS CATV Division, 50 Antin Place, Bronx, NY. 10462 (**M5, M7**)
Systems Wire and Cable, Inc., P.O. Box 21007, Phoenix, Az. 85036 (**M3**)
TEXSCAN Corp., 2446 N. Shadeland Ave., Indianapolis, IN. 46219 (**M8, bandpass filters**)
Theta-Com, P.O. Box 9728, Phoenix, AZ. 85068 (**M1, M4, M5, M7, M8, S1, S2, S3, S8, AML Microwave**)
TIMES WIRE & CABLE CO., 358 Hall Avenue, Wallingford, CT. 06492 (**M3**)
TONER Cable Equipment, Inc., 418 Caredean Drive, Horsham, PA. 19044 (**D2, D3, D4, D5, D6, D7**)
WAVETEK Indiana, 66 N. First Ave., Beech Grove, IN. 46107 (**M8**)

NOTE: Associates listed in bold face are Charter Members.

Distributors:

D1—Full CATV equipment line
D2—CATV antennas
D3—CATV cable
D4—CATV amplifiers
D5—CATV passives
D6—CATV hardware
D7—CATV connectors
D8—CATV test equipment

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Service Firms:

S1—CATV contracting
S2—CATV construction
S3—CATV financing
S4—CATV software
S5—CATV billing services
S6—CATV publishing
S7—CATV drop installation
S8—CATV engineering

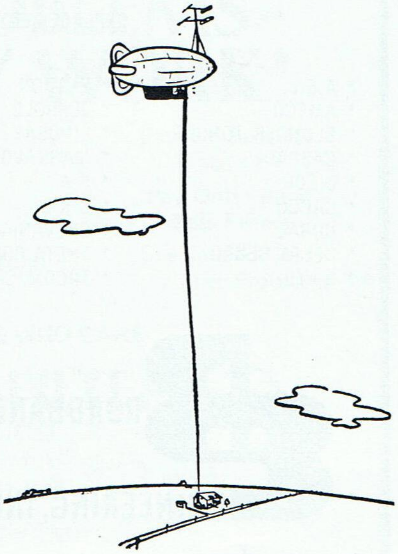
Cartoon Not Funny

Regarding your cartoon appearing opposite Page 56 of the March 1975 **CATJ**; it is much truer than you might believe.

.TCOM, Inc., a Westinghouse subsidiary, has been operating ZFHQ-TV, channel 11 over High Rock, Grand Bahama Island for more than one year using a tethered balloon with Yagi-Uda antenna to receive WTVJ-4 and WPTV-5. Then they rebroadcast the Florida signals in the Grand Bahama area by inserting their own ID slides, etc. I've seen them here in the West Palm Beach area on one occasion, and believe they are still operational.

Kenneth R. Simon
The Palm Beach Times
Palm Beach, Fla. 33405

The cartoon reader Simon refers to appears again here. Egads, and we bet they don't pay copyright either!



Bet you thought that a good solid-state sweep for your system would cost a grand or two—maybe more. Well, that was before Wavetek introduced the Model 1051, a rugged solid-state instrument that covers the frequency range of 1 to 400 MHz.

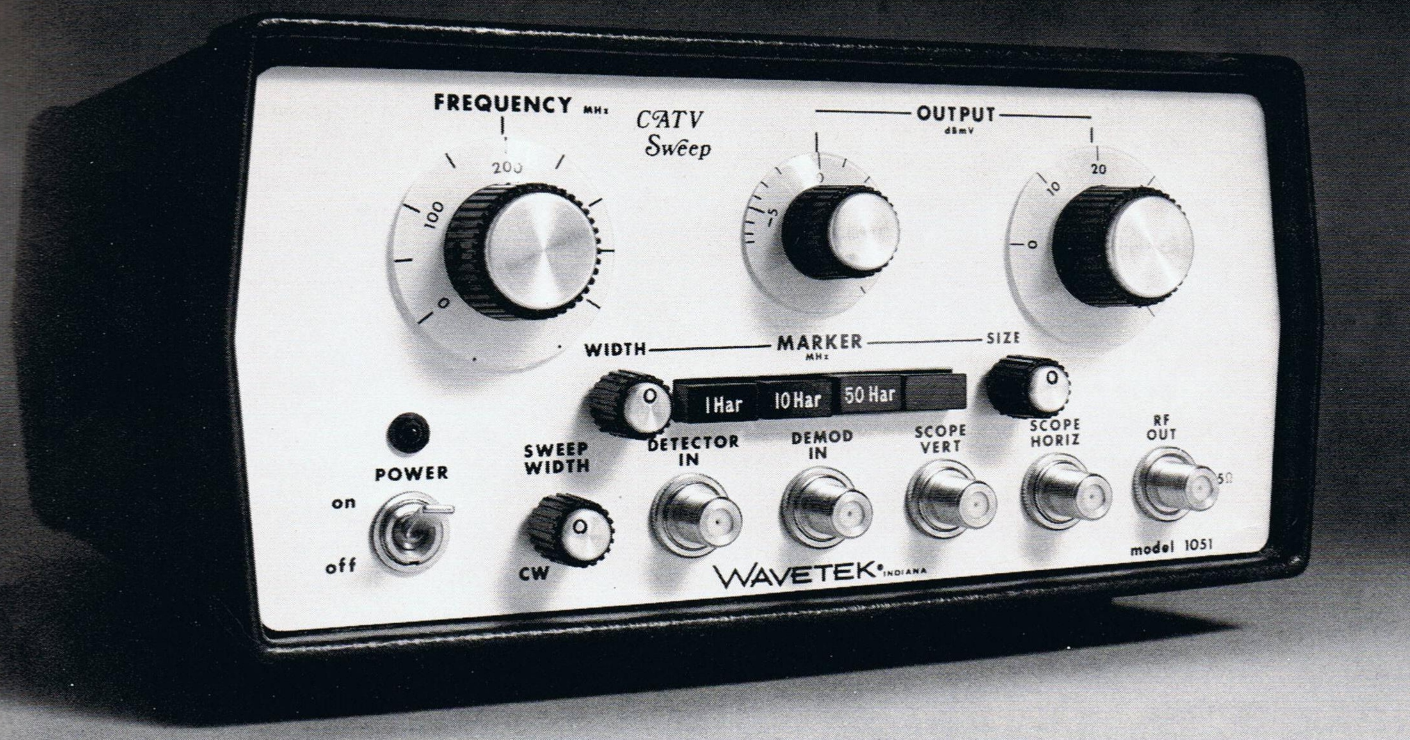
It was developed so that **every** CATV system could afford a high-quality sweeper.

The 1051 gives you F connectors, a built-in detector, 75-ohm output system calibrated in dBmV, provisions for six crystal markers and protection against accidental burnout through the use of DC blocks. Spurious signals are 30 dB below output. RF output flatness is 0.25 dB .

Besides being remarkably inexpensive, the 1051 is remarkably small and lightweight—just 7 pounds. So call collect for a demonstration. We'll bet anything that you'll order at least one when you find out more about it. WAVETEK Indiana Incorporated, P.O. Box 190, 66 North First Avenue, Beech Grove, Indiana 46107, Phone (317) 783-3221, TWX 810-341-3226.

WAVETEK®

$495 says you can now afford a CATV sweep.



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