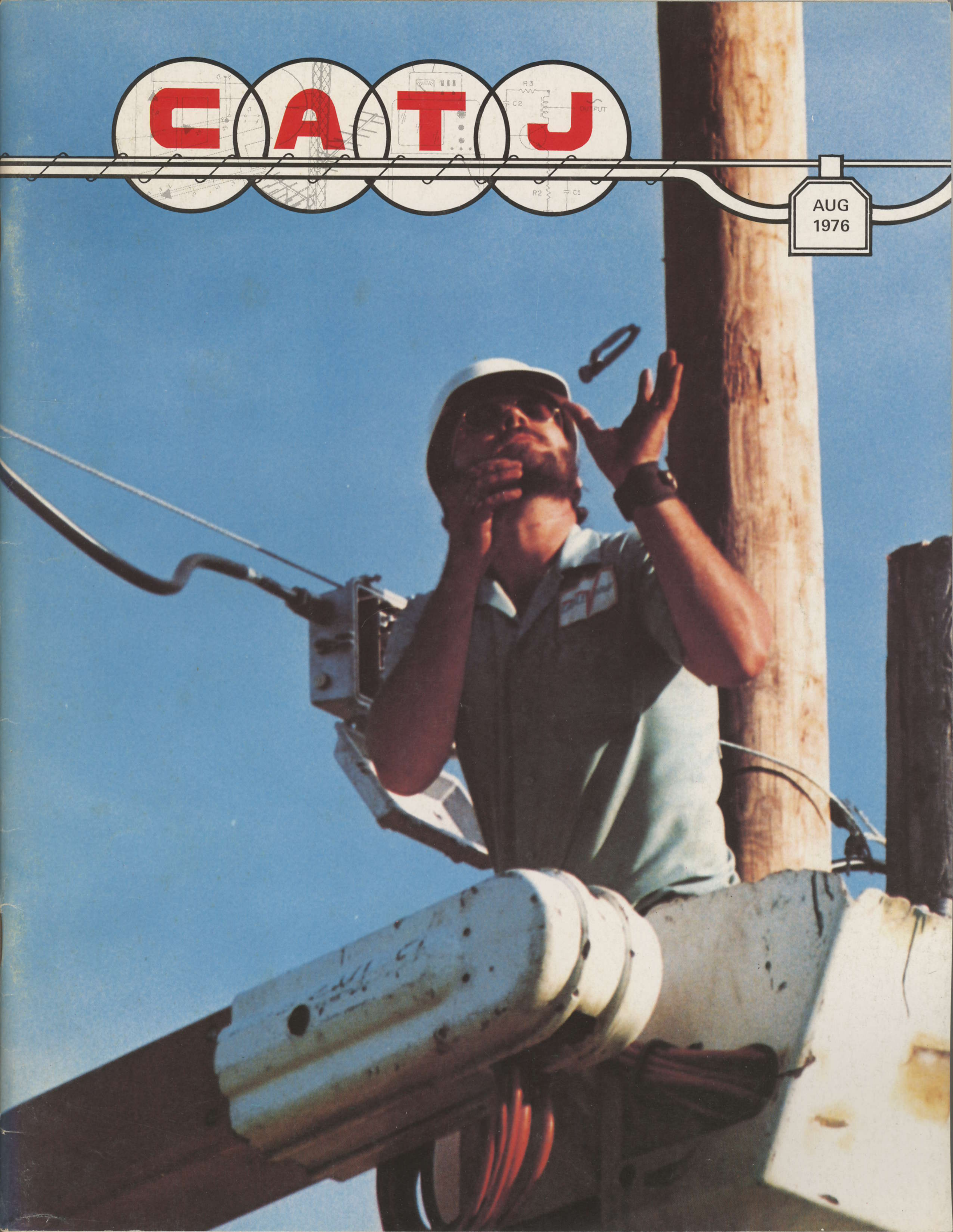
CATJ

AUG 1976



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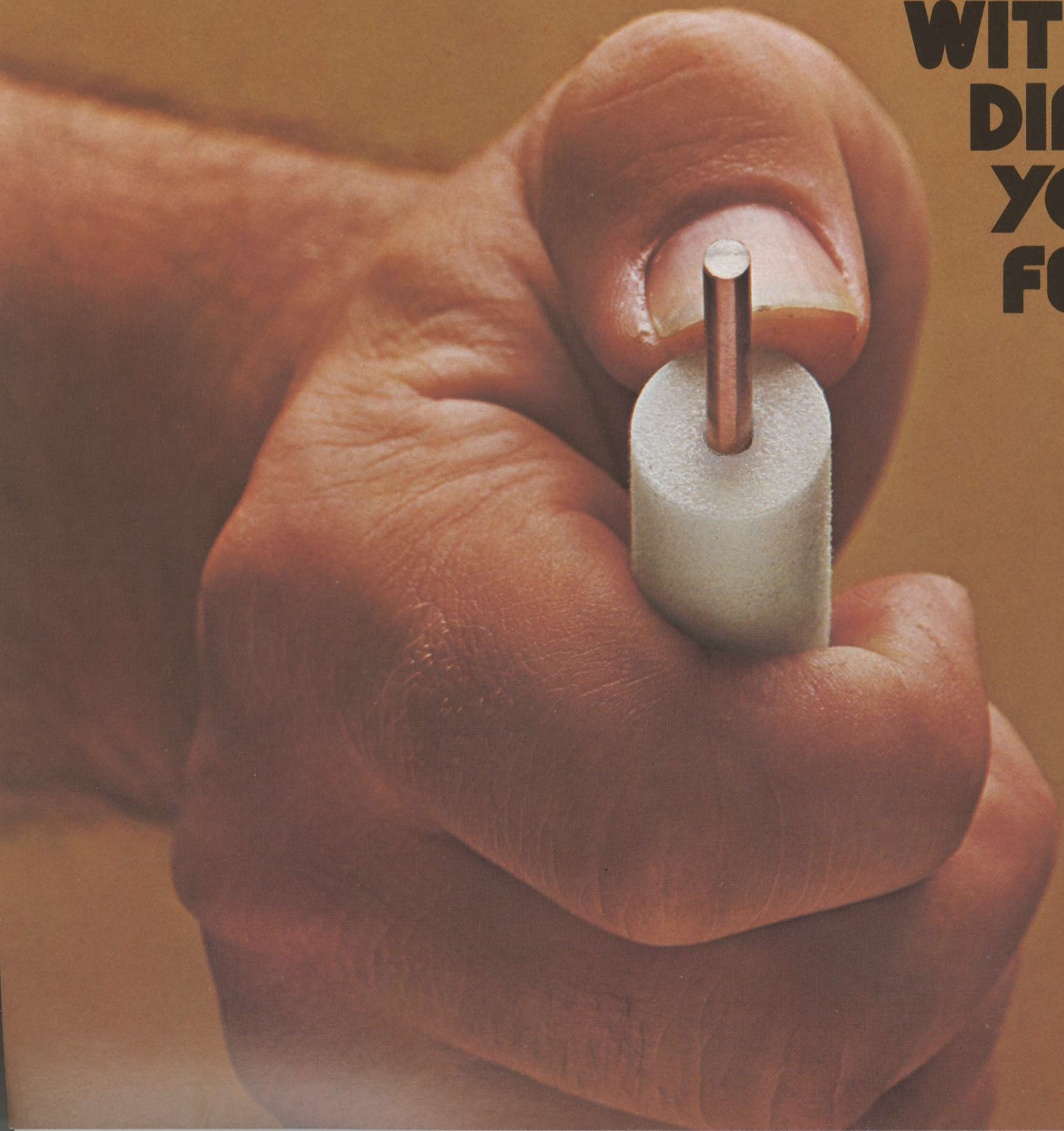

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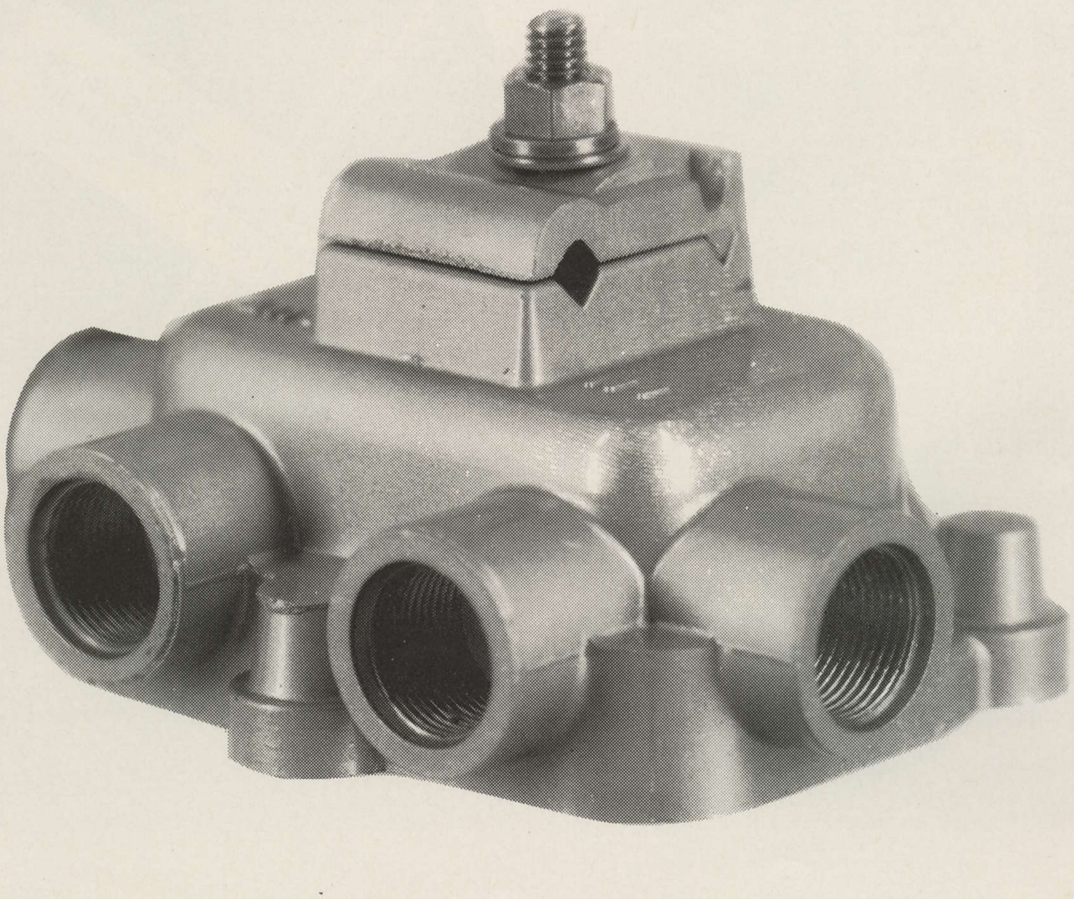

CATJ

AUG 1976

VOLUME 3– NUMBER 8

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–CONTENTS–

OUR COVER

Colorful. A hard working CATV technical type, the backbone of this industry, demonstrates his manual dexterity and his great fielding ability as a pair of bolt cutters heads his way. Photo courtesy of S.K. Wigh (where are you now Stanton!!).

CATA-TORIAL

KYLE D. MOORE, President of CATA, Inc.

Small Earth Terminals and Politics

As reported last month in CATJ (see CATA-torial and July CATA NEWSLETTER), the Community Antenna Television Association has filed with the Federal Communications Commission (on June 24) a "Petition For Rulemaking Or For Declaratory Ruling", requesting the Commission revisit the matter of limiting domestic satellite receiving terminals to antenna sizes of 9 meters or greater.

The case for smaller terminals has been made by CATJ numerous times during the past six months, beginning with our February 1976 issue. There is nothing to be gained by reciting these contentions here again.

When it first became known that CATA would "push" for an official relaxation of earth terminal antenna size, there were mixed reactions and reviews. After CATA testified before the House Communications Subcommittee on May 20th (during which CATA explained how the present 9 meter limitation works against the development of CATV terminals at smaller or remote systems), Subcommittee head Lionel Van Deerlin directed his staff to make official inquiry at the FCC as to the "rationale" for this 9 meter standard. FCC Chairman Wiley subsequently advised the Subcommittee that the 9 meter standard "was intended to achieve an equitable compromise between dish cost and minimizing required satellite orbital spacings."

Chairman Wiley also added "A 'strong showing' that the public interest won't be harmed **might** convince the Commission it should make an **'occasional exception'** to the 9 meter standard."

So the battle lines are drawn; CATA says that as long as the Commission stands tough on its 9 meter standard, smaller CATV served communities will not have the free market determination of adding HBO, Optical, etc. programming to their systems, at least not via **their-own** system owned and operated receive-only terminals.

The scene shifts to a small CATV system in Florida which operates with**out** its own headend. The smaller system buys trunk signal from a larger nearby system. The larger nearby system has recently added pay-cable programming, and the scenario to date has gone like this:

Small system "I am trapping out the pay cable channel where I take my trunk feed; I am not ready to offer my 400 subscribers pay cable yet."

Large system: "If you trap out the pay cable channel, we will cut you off from all trunk signal."

Small system: "But I am not equipped or prepared to offer pay cable, and I can't afford to pay for it when I am not using it."

Large system: "We will come into **your** area and **we** will market **your** subscribers for pay cable, only. They will connect to your system and pay **us** for their pay cable service. You won't even know we are there. . . ."

Now the scene travels to California where an independent type system with around 2,000 subscribers **is intensely interested in pay cable**, and **wants** HBO programming. But the $100,000. price tag on the terminal is stopping them. However, all around this 2,000 subscriber system in this densely settled area larger systems offer one form of pay cable or another, and subscribers who know people who have it on these **other** systems are raising bloody hell with the 2,000 subscriber system operator.

"I am caught between a rock and a hard place" the operator laments. "I **would** install HBO programming **in a minute** if I could install a 4.5 meter terminal for say $25,000., but I can't because the FCC won't let me."

Both the Florida operator and the California operator are in a spot. Neither can offer pay cable without giving up something important. In Florida, the operator would lose his independent status, and probably eventually find he was forced to sell out to the larger system he buys trunk signal from, at a price below the fair market value, simply because the larger operator was already in his town and dealing with his customers with pay programming. The California operator is large enough to justify a 4.5 meter terminal, but not a 9 or 10 meter terminal. His subscribers want pay programming, and he wants to give it to them!

Switch now to Alabama. A new system, about to begin construction and to pass 10,000 homes in a number of small but contiguous (or nearly so) communities, was prepared to file it's own 10 meter terminal application in May. They had the Compucon study completed, and the FCC application in the **final** polishing stages with the Washington attorney. Then the operator saw the CATJ report on **small** terminals, and decided that $25,000 was alot more in line with the budget than the $92,000 quoted by a supplier for a larger terminal. This operator contacted a 4.5 (7) meter antenna supplier for help in revising his in-process application, around a smaller terminal antenna. The antenna supplier turned the operator over to the Stanford Research Institute (SRI) which is as this is written completing an exhaustive computer program study of all possible interference potentials for the 4.5 (7) meter antenna at that Alabama location. The preliminary computer study indicates the 4.5 (7) meter antenna **will** satisfy **every** FCC technical consideration. Armed with the SRI study, this system operator plans to file with-haste at the FCC for what Chairman Wiley calls an "occasional exception".

Now switch with us to Columbia, that South American country named after Christopher Columbus. It seems the geo-stationary equatorial orbit space where SATCOM and WESTAR and so on do or will "park", **passes over** Columbia. And Columbia is now appearing before the United Nations to ask for support of **their claim** that this space-in-space some 22,300 miles up is subject to **their** earthly control. What Columbia will do, through the **International** courts of law should the U.N. agree with their contention, is an interesting question to be answered. At the least, they will probably ask for some form of annual ''rental'' from the owners of the satellites for the ''space'' they are using.

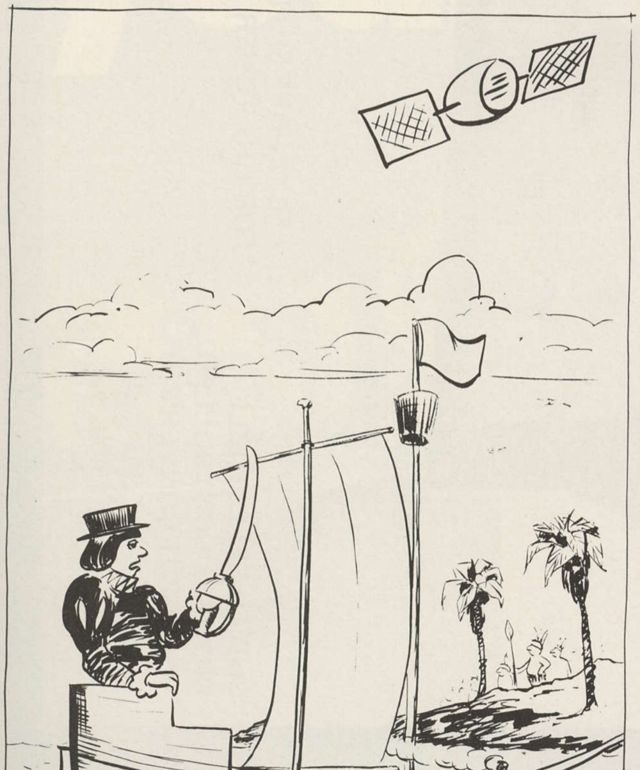
Move ahead with us now to 1979; a year when most people expect something called SBS (**S**atellite **B**usiness **S**ystems) to be operational. SBS is a partnership of IBM, COMSAT and Aetna Life and Casualty Company. It will provide point-to-point communications, from one terrestial location to another terrestial location, **via** a yet-to-be-launched 12-14 GHz ''bird''. SBS has a projected need by 1986 (or ten years from now) of 7,900 individual, independent, earth terminals. With giants such as IBM, COMSAT and Aetna behind this project, one has little doubt that such projections are **at least** the product of careful study.

What does all of this have to do with CATV's presently operating 50-plus 10 and 11 meter antennas, and, the CATA proposal for smaller earth terminals? Just this. Scientific-Atlanta's Sidney Topol, commenting on the SBS program, recently was quoted as noting ''. . .a system such as SBS will open the market for 12-14 GHz earth stations with antennas in the 3-5 meter range.''

With IBM, COMSAT and Aetna (life et al) behind the SBS program, and an active date of 1979 forecast for first operations, shouldn't there be lots of muscle behind the CATA proposal for smaller terminals? One would think so. . .yet there is a ground movement of resistance that **almost** defies description at this point. For one thing, where a 9 meter antenna is the ''standard'' for 4/6 GHz band(s) now in use for HBO program relay, the (3-) 5 meter antenna terminals would be the **equivalent standard** for the 12-14 GHz band. So the SBS program doesn't really need to visit the FCC on antenna terminal size, as we do at this time.

The cable TV industry, for the moment, is **almost alone** in the need for smaller terminals. There isn't much help out there, and even with**in** the industry there are those who would **prefer** to see that terminal sizes be **kept large** enough that smaller ''independent'' systems are precluded from gaining **their own** terminal-independence.

The satellite terminal issue should be a purely technical issue. **It is not.** It is a complicated, constantly fluid ''can of worms'' with new players being added almost daily. It would be to the credit of the FCC that they make a real effort to eliminate the really minor CATV size criteria for receive-only terminals from the rest of the can of worms. It will take a dedicated and sincere Commission to wrestle with this problem, and to come to a determination at an early date. We would like to believe that inspite of the problems, the FCC is capable of such action.



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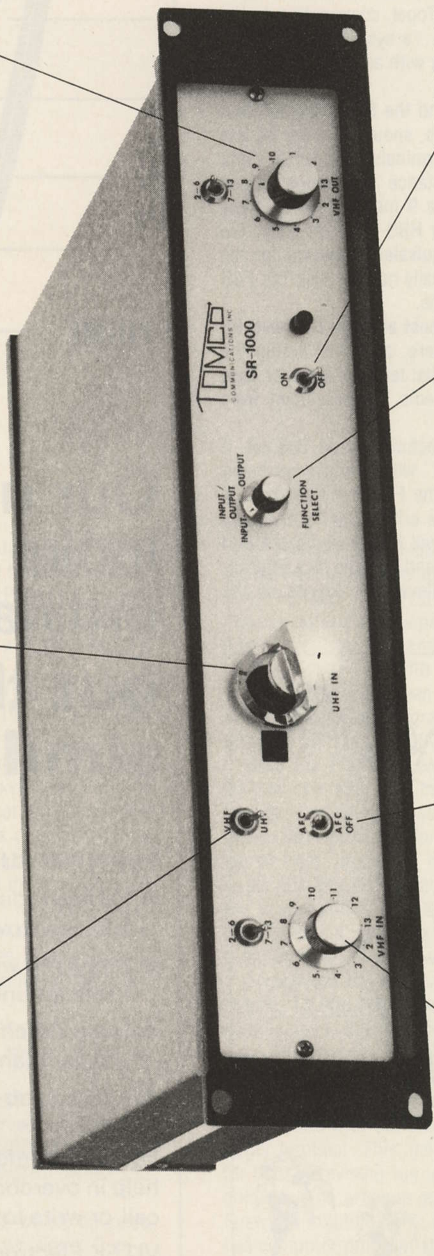

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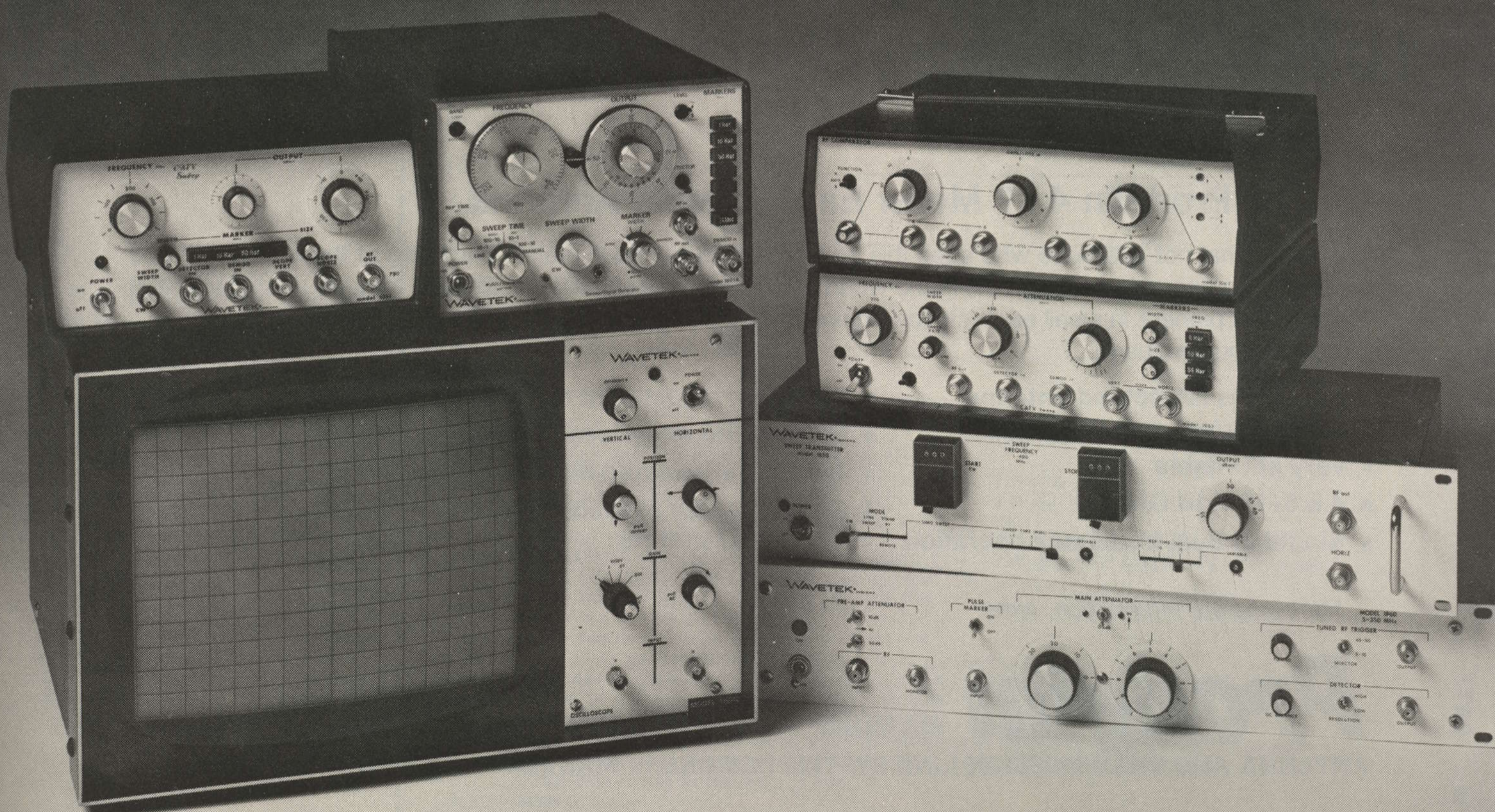

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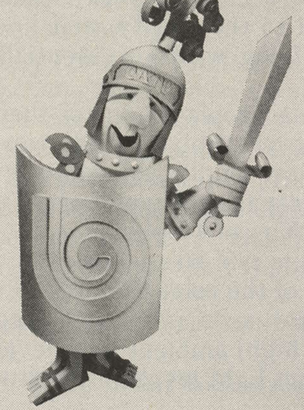

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Localized Interference

The May 1976 and June 1976 issues of CATJ contained parts one and two of this series; dealing respectively with the "Margin of CATV Difference," and, "Finding Signals." The next two portions deal with localized interference problems and various methods of curing same.

Interference will be broadly interpreted in this segment as any non-desired signal, man-made or unknow in origin, which creates *any form of degradation* on the desired signal. Interference, for our purposes here, can be noise (i.e. black and white 'dancing dots'), or it can be adjacent channel signals (herringbone pattern, audio bars, cross mod, etc.), or it may be co-channel signal sources (the all too familiar horizontal lines from a same channel station). Or, it can be a high ambient man-made noise level from a noise source such as a busy highway, a defective motor, a welding shop, and so on. *Whatever the cause*, we must make a visible improvement in the pictures we deliver on our systems; a visible improvement over the picture the customer sees from his own antenna, *or*, our service will not be viable.

Sometimes the improvement can be so dramatic that a viewer will be oversold. A true case to point. While constructing a new system in 1965 in the hills of northern California, the operator was offering a free ten-day-cable-trial. The viewers in this town had been treated to not more than one viewable channel (typically 50-100 microvolts on a big outdoor antenna) and a couple more that were not only weak but loaded with ghosts. The cable acceptance rate of those who took advantage of the free ten-day-trial was 95%. So when a trial offer brough a negative response, the operator found time to visit with such people simply because they stood out from the crowd.

The would-be subscriber complained *"the picture comes and goes."*

The operator thought "we have an intermittent connection someplace," and he went by around Huntley-Brinkley time, just as the man got home from work.

"*Come in, have a beer and sit down,*" the trial subscriber offered. "*Sit here a few minutes and you'll see what I mean.*"

So the cable operator plopped himself down, took a beer and watched the NBC news offering.

Presently the man of the house popped up, "*There, did you see it...it came and went!*"

The cable operator not wishing to offend his host mumbled something under his breath and said, "*I'm afraid I missed it. Let me move in closer,*" as he repositioned himself directly in front of the receiver screen, a few feet away, and sitting on the floor sipped on his beer.

"*There...it did it again!*" exclaimed the host.

'Boy have I got a nut here — that is the *fastest* intermittent I've ever heard about,' thought the cable operator to himself. "*I'm afraid I missed it again,*" responded the cable man. And he repositioned himself barely inches from the 21 inch screen and putting the beer aside stared intently on the tube. Minutes passed and the news broke for a commercial.

"*There — can't you see it!*" shouted the by now irritated viewer.

The cable man froze in his mind everything he had seen in the last ten seconds and then turned off the receiver, turning as he did to face his detractor.

"*I'm afraid that what you are seeing is escaping me,*" he stated tactfully. "*Can you describe it for me?*"

The host, visibly flustered, took a large gulp of beer and blurted out, "*Look, the picture is stable and clear one second, and the next second the whole picture fills up with the head of the guy talking. Then it goes away, back to the whole body. Like I said, it comes and it goes!*"

The cable operator suddenly saw the light. Fighting back a laughter that he knew would result in his being kicked from the house without ceremony he patiently explained to the host that sometimes in television production the director of the program uses several cameras; that the director often switches from a 'long' or 'distant shot' to a 'close-up' of the person speaking or part of the scene.

"*This has the appearance of the scene coming and going, I grant you that,*" he explained cautiously, "*but that is part of television production.*"

Satisfied, the man kept the cable. "*I've had a television set for ten years and in that time I guess I never got a good enough picture before to even know that they had such things.*"

The moral? "*Interference*" can be *anything* the viewer finds objectionable. Sometimes the viewer will tolerate degradation *when he understands it*, or is accustomed to seeing it, and *never* complain. Other times, the picture may be perfect but the viewer still complains; because he is not accustomed to the clarity, and he has a difficult time identifying with an essentially blemish free picture.

Some people go out of their way to find fault, hoping probably to beat you down on the cable price or simply not wanting to admit they are impressed or (heaven forbid) *pleased* with the service. A case to point.

In the mid 60's when color was still fairly new, many of the color cameras in use by local stations for local news and studio programs required high (very high) ambient light levels. Without the high ambient light levels in the studio the pictures had a distinctive grainy look, not unlike noise (actually it was a *form* of noise, created in the video amplifier stage of the camera). But it took a mighty critical eye to see it.

"*I'm not satisfied with the cable. When KCRA switches from network programming to Channel 3 Reports the pictures gets all lousy,*" complained the customer.

"*OK, I'll come by this evening and we'll watch Channel 3 Reports together,*" said the cable man.

At the appointed time the cable man appeared at the complainer's doorstep. "*Come in, he's sitting in there waiting for the news,*" the wife announced as she opened the door. "*But before you go in, you should know that he really is very pleased with the 12 channels of television; this is just his way of being important.*"

The warning given, the cable man rounded the corner and strode into the living room. There, sitting not 6 inches from the 21 inch color tube sat an elderly gentleman in his 70's. His nose was literally pressed to the screen.

"*Does he always look at television this way?*" the cable man quietly asked of the woman of the house.

"*Always . . . at least since we got the cable. Before that he got as far away as he could, sometimes he even moved his chair back out in the hallway.*"

The news began and the elderly viewer motioned for the cable man to join him on the floor. "*I just want you to see how 'busy' the picture looks when they come on from their news studio,*" the subscriber remarked.

"*Don't you get eye strain this close?*" asked the cable operator.

"*This is how I enjoy my TV,*" snapped the subscriber, "*and don't you start telling me to sit back in the chair; she does it all the time and I'll sit anyplace I please!*"

The cable man took a deep breath, knowing full well that at a distance of 6 inches even a nearly blind person was going to see *every* dot in the picture, even when there was *not* a noisy color camera working in a studio not adequately lighted.

"*There it is, just a whole lot of busyness,*" proclaimed the subscriber.

"*Yup, that's a busy picture all right,*" agreed the cable operator.

"*Well, what are you going to do about it?*" asked the subscriber.

"*Does the busyness bother you when they have a filmed report?*" asked the operator.

"*No, and that is why I think you fellows can fix it up there at your antenna head, or whatever it is you call it,*" snapped back the viewer.

The operator pondered for a minute, started to explain that with his strip amplifier processors there was nothing he was doing to the signal that could possibly cause such a picture quality variation, and then thought better of that. Suddenly it hit him.

"*Have you read the current issue of Consumer Reports?*" he asked.

"*No, don't get that thing. What does it say about this problem?*"

"*Nothing directly. But it has a couple of pages warning people that when they get too close to a color TV picture tube they may be subjecting themselves to dangerous amounts of X-rays. I think the safe viewing distance*" (and he pondered for a second) "*is around 15 feet. Anything closer, and you may develop a medical problem.*"

The wife took the clue. "*Herman, you get back here in this easy chair immediately!*" she snapped. Herman scowled and with joints creaking rose and moved to the chair.

"*Won't enjoy the blamed thing as much anymore,*" he muttered.

"*Can you see the busyness you complained about now?*" asked the cable operator.

"*You know darn well I can't,*" came the reply.

On the way out the door the wife took the cable operator aside. "*I want to thank you for helping me with Herman. He was bound and determined that either you were going to fix that picture or he was going to have you take the cable out. He really enjoys those movies on Channel 19 at night, and I know that he'd be sorry when he had to go back to three channels on the antenna. But I couldn't get him to sit down where he belongs. And as long as he sat that close, I just knew he couldn't enjoy the reception. Thank you.*"

Alas, sometimes the best cable repair tool is a cable operator who is fast on his feet.

So much for interference that viewers create in their own minds. Now to the real stuff, which even a fast-on-his-feet operator would have trouble explaining away!

The Adjacent Channel

Of the many complex filtering problems faced by the system operator, the elimination of a non-desired adjacent channel signal is perhaps the most complex. "In-channel" non-desired signals (i.e. co-channel, noise) are virtually always eliminated (or attenuated) through clever application of antenna system designs. Adjacent channel signals often present problems that require combinations of antenna design, trapping and filtering.

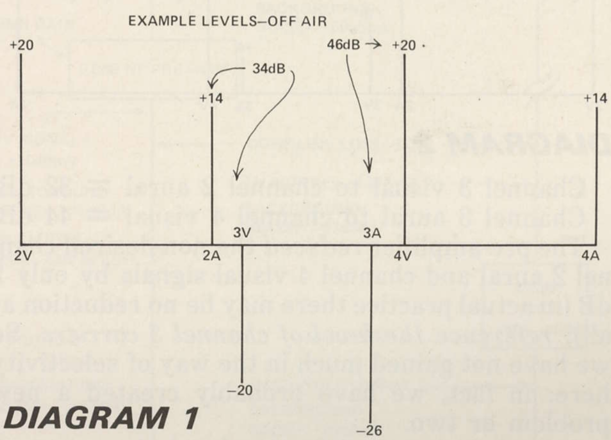


DIAGRAM 1

Example One: The desired signal is on channel 3. It is some 40 dB lower in level at the headend than non-desired signals on channels 2 and 4. In real life, off the antenna for channel 3 we measure —20 dBmV channel 3 visual carrier level, —26 dBmV channel 3 aural carrier level; and, +20 dBmV channel 2 visual, +14 dBmV channel 2 aural; and +20 dBmV channel 4 visual and +14 dBmV channel 4 aural.

Channel three obviously requires a pre-amplifier; a good one at that. Channel 3 antennas have probably been largely chosen based upon the weak channel 3 level, and perhaps some attention has been paid to co-channel sources for the channel 3 signal. For now let's assume that everything possible *has been done* in the design of the channel 3 antenna array to maximize the channel 3 level and minimize the channel 2 and 4 levels.

Our relative level differentials are respectively:

Channel 3 visual to channel 2 aural = 34 dB difference.

Channel 3 aural to channel 4 visual = 46 dB difference.

If we install a 30 dBg (dB gain) channel 3 pre-amplifier at the antenna, with no other precautions, our relative levels change as follows:

Channel 3 visual becomes +10 dBmV

Channel 3 aural becomes +4 dBmV.

However, in this process, because there is but 1.5 MHz frequency spectrum between channel 3 visual and channel 2 aural, and, channel 3 aural and channel 4 visual, we can reasonably expect some amplification of *both* the two non-desired carriers as well by the channel 3 pre-amplifier. How much amplification is determined largely by the 'Q" or selectivity of the pre-amplifier chosen. Let's assume a near best-case situation, based upon today's state of the art. This results in a pre-amplifier gain of 28 dBg on channel 2 aural and channel 4 visual, which creates a new after pre-amplification differential as follows:

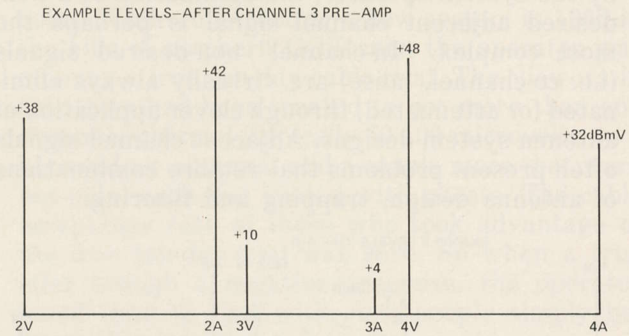


DIAGRAM 2

Channel 3 visual to channel 2 aural = 32 dB

Channel 3 aural to channel 4 visual = 44 dB

The pre-amplifier *reduced* the non-desired channel 2 aural and channel 4 visual signals by only 2 dB (in actual practice there may be no reduction at all); *reference the level of channel 3 carriers.* So we have not gained much in the way of selectivity here; in fact, we have probably created a new problem or two.

Our after pre-amplification levels become:

Channel 2 visual (down 12 dB on the gain skirt of the channel 3 pre-amplifier) went from +20 dBmV to +38 dBmV

Channel 2 aural (down 2 dB on the gain skirt of the channel 3 pre-amplifier) went from +14 dBmV to +42 dBmV

Channel 3 visual went from —20 dBmV to +10 dBmV

Channel 3 aural went from —26 dBmV to +4 dBmV

Channel 4 visual (down 2 dB on the gain skirt of the channel 3 pre-amplifier) went from +20 dBmV to +48 dBmV

Channel 4 aural (down 12 dB on the gain skirt of the channel 3 pre-amplifier) went from +14 dBmV to +32 dBmV.

Now for the new problems we may have created. The pre-amplifier has a maximum output voltage (handling) capability. This varies from unit to unit, but typically with six potent carriers such as this (channel 2 A and V, channel 3 A and V, channel 4 A and V) we have either exceeded that "maximum output rating" or we are pushing it very hard. The slightest increase in level from *any* of the six carriers might well push the output capability of the unit over the brink, causing cross-mod (overload) of the pre-amplifier. Even if the channel 2 and 4 signals are Grade A (i.e. local) in stability the channel 3 signal will at times come way up, typically by 20-30 dB, all by itself, as tropospheric (weather) conditions change. This enhancement in channel 3 signal level will easily be sufficient voltage increase (as the channel 3 A and V input carrier levels to the pre-amplifier rise) to push the unit into cross-mod. We'll come back to this problem shortly.

Then there is the processor problem. Obviously, any type of processor (i.e. heterodyne, strip [on channel] or even demodulator) is going to have difficulty "resolving" the desired channel 3 signal when it is *sandwiched between* the two bodacious channel 2 and 4 signals.

How do you resolve the problem?

The first option is a bandpass filter; one designed to pass only channel 3 (A and V) but to reject channel 2 (A and V) and channel 4 (A and V). A bandpass filter is a mixture of tuned circuits, designed to pass channel 3 and to reject all others. Like all highly selective (i.e. Hi-"Q") tuned circuits, it is temperature and environment sensitive. When initially aligned, the capacitors and coil or other formed inductors are in a moderate (lab) room temperature. When you install the unit in an environment that is similar in temperature (and humidity), you can expect the *same* approximate results as the original alignment technician achieved. But, if the unit is installed in an environment which is much colder, or warmer, and/or much wetter (i.e. more humid) or much drier, the physical characteristics of the capacitors and more precisely the coil or formed inductors change. In a word, the unit "re-tunes" because of the environment. And where there had been a sharp, deep trap-null (i.e. rejection) of say channel 2 audio (59.75 MHz), the changed characteristics of the filter may now locate the deep channel 2 aural carrier trap/null a few hundred kHz higher or lower in frequency. So rather than concentrating maximum trapping *on 59.75 MHz*, as the unit was originally designed to do, the trap circuit *now* is centered on (say) 59.95 MHz. And rather than 25 dB of channel 2 aural carrier rejection, the environment re-tuned unit now has 10 dB of channel 2 aural carrier rejection.

So for obvious reasons, a bandpass filter must be installed in a stable, reasonably comfortable operating environment. *This typically means the headend facility itself*; which rules out climbing the tower with the channel 3 bandpass filter under your arm and installing the unit in a box (weatherproof or otherwise) several hundred feet above ground. If you have chosen a comfortably mild day to install the unit, things may work fine at first. But if the weather turns cold, or hot, with or without a dramatic change in the moisture index (humidity) of the air, the outdoor filter will change characteristics on you.

Yet we do need to filter ahead of the pre-amplifier. *So what to do?*

There has been a general rule of thumb in CATV for years that you should always install the pre-amplifiers at the antenna, before any downlead loss. Let's see why this is typically the best procedure to follow.

(1) Downleads have loss, being passive in nature.

(2) Any signal loss of a passive nature, ahead of the first amplification stage (i.e. ahead of pre-amplification), contributes to the *noise figure* of the pre-amplifier.

How is that possible? At the antenna we have two forms of antenna induced voltages present; a signal voltage from the desired station, and, a signal voltage from background noise factors (i.e. power lines, the atmosphere, etc.). If you connected an *infinitely* long piece of downline to the antenna, the signal voltage and the background noise voltage would diminish *at the same rate per foot* or hundred feet of downline. However, at the first stage of amplification, there is a *new type* or form of noise present: *amplifier noise*. Because there is no such thing as a perfect (i.e. noisefree) amplifier, any amplifier must, in the process of amplifying whatever input signal it sees at its input, also contribute some amplifier noise to the signal. This is unavoidable, although by careful selection of a quality "low noise" pre-amplifier, we can minimize the amount of noise contribution from the first amplifier stage(s).

So let's assume we have a —20 dBmV TV carrier, and a —50 dBmV background noise, at the input to the channel 3 pre-amplifier. If the pre-amplifier has 30 dB of gain, and a 2 dB noise figure, what have we accomplished through amplification?

The signal to noise ratio at the input to the pre-amplifier is:

TV signal level = —20 dBmV
Background Noise = —50 dBmV
The ratio is therefore 50 — 20 or 30 dBmV.

Now the 30 dB gain pre-amplifier raises the TV

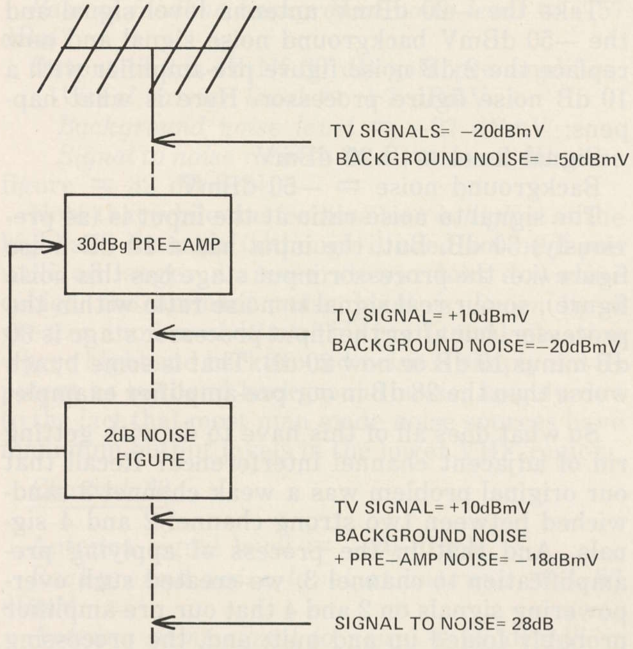


DIAGRAM 3

signal to +10 dBmV and the background noise to —20 dBmV. Our ratio at this point is still 30 dBmV, right?

Wrong. The pre-amplifier has a noise factor or figure *of its own* of 2 dB. Therefore, *for our purposes*, the noise level or background noise changed from the —50 dBmV present at the input to —48 dBmV. So now we have —48 dBmV plus the 30 dB of gain or —18 dBmV; with a signal level of +10 dBmV. The signal to noise ratio now is:

Signal level = +10 dBmV
Noise level = —18 dBmV
The ratio is therefore +10 minus —18 or 28 dB.

And all of this time you thought that pre-amplifiers provided improved noise figure and signal to noise ratios! Well they do, but *only as a relative number* when you *compare* them to say a 10 dB noise figure processor front end noise figure. For exercise, let's look at how that is possible.

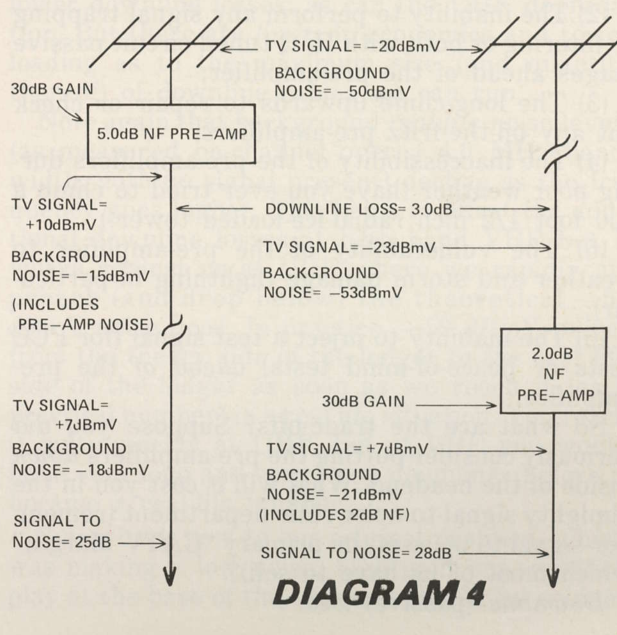


DIAGRAM 4

Take the —20 dBmV antenna level signal and the —50 dBmV background noise signal and now replace the 2 dB noise figure pre-amplifier with a 10 dB noise figure processor. Here is what happens:

Signal level = —20 dBmV

Background noise = —50 dBmV

The signal to noise ratio at the input is (as previously) 30 dB. But, the input has a 10 dB noise figure (i.e. the processor input stage has this noise figure), so our real signal to noise ratio within the processor, but after the input processor stage is 30 dB minus 10 dB or now 20 dB. That is some bunch worse than the 28 dB in our pre-amplifier example.

So what does all of this have to do with getting rid of adjacent channel interference? Recall that our original problem was a weak channel 3 sandwiched between two strong channel 2 and 4 signals. And that in the process of applying pre-amplification to channel 3, we created such over-powering signals on 2 and 4 that our pre-amplifier probably folded up and quit; and, the processing unit would function poorly if at all.

So we suggested perhaps we needed a bandpass filter, to separate three from channels 2 and 4. Only the pre-amplifier needs to be at the top of the tower, and the bandpass filter because of its environmental sensitivities will not play there.

So, do we really need the bandpass filter at the top of the tower? We certainly do need to attentuate channels 2 and 4 *ahead* of the pre-amplifier; that is unquestioned. Years ago there was evey argument for putting the pre-amp up-top. Perhaps times have changed.

What is the primary advantage to a top-located pre-amplifier?

(1) At the antenna it is located where the *maximum amount* of off-air signal is available; at any point thereafter the signal is attentuated by whatever passive loss there is in the downline.

Are there other advantages to being up-top? No, there are none. So are there dis-advantages to being up-top? Yes, and *some* of them are:

(2) The inability to perform any signal trapping or filtering or both with Hi-Q tuned circuit passive stages ahead of the pre-amplifier;

(3) The long-climb upwards to repair or check out any on-the-fritz pre-amplifiers;

(4) The inaccessibility of the pre-amplifiers during poor weather (have you ever tried to climb a 400 foot 1/2 inch radial-ice-loaded tower!)

(5) The vulnerability of the pre-amplifier to weather and storm damage (lightning in particular);

(6) The inability to inject a test signal (for FCC tests or peace-of-mind tests) *ahead of* the pre-amplifier.

So what are the trade-offs? Suppose you *did* seriously consider putting the pre-amplifiers *down* inside of the headend. What will it cost you in the almighty signal-to-noise ratio department (remember signal to noise is the primary "CATV Margin" which most of us have to sell)?

Downline (passive) *loss.*

How about some numbers. If you are using downline cable with 1.0 dB loss per 100 feet at your operating channel, and you have 300 feet of downline, your loss is simply 1.0 dB times 3 or 3.0 dB. Now, if your present pre-amplifier is a 5.0 dB noise figure device (only the newer pre-amps produced in the last few years have *real* noise figures down in the 2.0 dB region), what you presently have is a situation where if you *took out* your present antenna mounted pre-amp (5.0 dB noise figure) *at the top of the tower*, and replaced it with a 2.0 dB noise figure unit *at the base of the tower* or in the headend, you would come out as follows:

TV signal level at antenna = —20 dBmV

Background noise at antenna = —50 dBmV

Input to pre-amplifier signal to noise is 30 dB.

With your 5 dB noise figure pre-amplifier, the output of the pre-amplifier signal to noise will be 30 dB minus 5 dB or 25 dB.

Now swap out to a 2.0 dB noise figure pre-amp *at the base* of your 300 foot tower.

TV signal level at antenna = —20 dBmV

Background noise at antenna = —50 dBmV

TV signal level at base of 300 foot downline (with 3.0 dB downline loss) = —23 dBmV

Background noise at base of 300 foot downline = —53 dBmV

With your 2.0 dB pre-amplifier, the input signal to noise is still 30 dB, and the output becomes 30 dB less the 2 dB noise figure, or 28 dB. Son of a gun, we are *3 dB better off* than we were with the 5.0 dB antenna top pre-amp.

Haven't we forgotten something? Like bandwidth noise?

Bandwidth noise is the theoretical noise-floor created when the noise in a 4.0 MHz (TV video information) bandwidth is measured after the receiver (or receiving) input stage is *terminated* in a 75 ohm resistive load. Theoretically, the noise floor (i.e. *the lowest noise we can have with a 4.0 MHz wide bandwidth at 75 ohms*) is —59 dBmV. That is as close to *no noise* as we can get with a (U.S. standards) 4.0 MHz bandwidth TV picture. And that assumes that there is *no noise* contribution to the receiving system save the noise of the properly terminated input to the receiver.

That's theory. But it is not real-life practice. In real life, there will *never be* a situation at VHF where the limiting factor in signal-to-noise ratio development is the 4 MHz picture bandwidth noise floor. In real life, the noise floor is the amount of noise the antenna intercepts from the atmosphere. It may be —57 dBmV, or it may be —47 dBmV. But it is a real-life, measurable number, whatever it happens to be. And it will always be larger a number than —59 dBmV.

It is therefore a real-live, *undesireable signal voltage*; a voltage made up of manmade or other source noise pulses. And as such, it *will* attenuate when passed down a passive downline just as the signal voltage will attenuate.

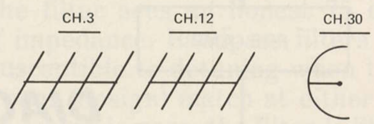
When does theoretical noise become a part of a receiving system equation? Only when you take the real-live (measured) noise floor and subtract the real-dead passive downline loss and create a dBmV number than is equal to or lower than —59 dBmV. An example:

Noise floor as measured = —55 dBmV
Passive downline loss as measured = 5 dB
—55 dBmV minus 5 dB = —60 dBmV.

—60 dBmV is *less than* —59 dBmV, so in *this* example we have just *passed* from the real-live noise floor being our limiting factor to the theoretical noise floor (—59 dBmV) being the limiting factor.

So why not place the pre-amplifier downstairs? And what else should you do if it does go downstairs?

There is every real-life reason to get it downstairs at low band VHF, and more often than not at high band VHF. At UHF...well, that may be another can of worms. Let's look at three typical real-life situations now, using *real*-life measured types of numbers:



	CH.3	CH.12	CH.30
ANTENNA SIGNAL LEVEL–	–20dBmV	–20dBmV	–20dBmV
BACKGROUND NOISE– AT ANTENNA	–50dBmV	–54dBmV	–57dBmV
ANTENNA SIGNAL TO– NOISE	30dB	34dB	37dB
300' DOWNLINE LOSS–	1.8dB	3.0dB	6.0dB
BASE FEEDLINE SIGNAL LEVEL –	–21.8dB	–23dBmV	–26dBmV
BASE FEEDLINE NOISE LEVEL –	–51.8dB	–57dBmV	–59dBmV (*)
OUTPUT OF PRE–AMP 1) VISUAL CARRIER LEVEL–	+8.2dBmV	+7dBmV	+4dBmV
2) BACKGROUND NOISE LEVEL –	–21.8dBmV	–27dBmV	–29dBmV
3) SIGNAL TO NOISE RATIO (INCLUDING PRE–AMP NOISE) –	28dB	32dB	30dB

DIAGRAM 5

Channel 3

Antenna signal level = —20 dBmV
Background noise level at antenna = —50 dBmV
Antenna (point) *signal to noise* = 30 dB
300 feet downline loss = 1.8 dB
Base of feedline signal level = —21.8 dBmV
Base of feedline background noise level = —51.8 dBmV
Output of 2.0 dB Nf 30 dB gain pre-amplifier:
Visual carrier level = +8.2 dBmV
Background noise level = —21.8 dBmV
Signal to noise ratio = 30 dB less 2 dB noise figure = 28 dB S/N.

Channel 12

Antenna signal level = —20 dBmV
Background noise level at antenna = —54 dBmV
Antenna (point) *signal to noise* = 34 dB
300 feet downline loss = 3.0 dB
Base of feedline signal level = —23 dBmV
Base of feedline background noise level = —57 dBmV
Output of 2.0 dB Nf 30 dB gain pre-amplifier:
Visual carrier level = +7 dBmV
Background noise level = —27 dBmV
Signal to noise ratio = 34 dB minus 2 dB noise figure = 32 dB S/N.

Note that while the feedline loss *is higher* at the highband channels (although it need not be if you utilized larger diameter/lower loss downline cable), the ambient noise level *is lower* by a greater number of dB(s). This is a typical situation where highband background noise is simply not as potent as lowband background noise; largely due to the fact that most man made noise sources have maximum output levels in the lower VHF region.

Channel 30

Antenna signal level = —20 dBmV
Background noise level at antenna = —57 dBmV
Antenna point signal to noise = 37 dBmV
300 feet downline loss = 6.0 dB
Base of feedline signal level = —26 dBmV
Base of feedline background noise level = —59 dBmV [*]

* — note that when we subtract the 6.0 dB feedline passive loss from the —57 dBmV background noise level *at UHF*, we fall *below* the —59 dBmV 4 MHz noise floor; therefore, now the —59 dBmV noise floor of a perfectly terminated receiver becomes our *real-life* noise floor.

Output of 3.0 dB Nf 30 dB gain pre-amplifier
Visual carrier level = +4 dBmV
Background noise level = —29 dBmV
Signal to noise ratio = 33 dB less 3.0 dB noise figure = 30 dB.

So whereas at low band we degraded the effective signal to noise ratio by 2 dB and at highband we degraded the effective signal to noise ratio by 2 dB again, at UHF our degradation is 7 dB.

The VHF degradation can be improved with lower downline losses; as can the UHF degradation. But there are *limits* in economics and tower loading as to the maximum size (and quantity thereof) of downline cables we can run.

Note again that background *real-life* noise levels (as measured on-channel over a 4.0 MHz bandwidth, with no signal present) decline as the frequency goes higher. This helps to offset the additional downline losses at high band VHF but it works against us at UHF where we rapidly approach (and drop below) the theoretical —59 dBmV noise floor. In practice, —59 dBmV moves from the theory side of the ledger to the real life side of the ledger as soon as we reach it (as a practical number) in a real life situation. You reach it quite quickly at UHF, but at VHF you would have very long and very lossy downlines before it became a real-life number.

Going back now to our original problem, which was making a low noise, high gain pre-amplifier play at the base of the tower; it should be evident that if you perform your own calculations, and carefully choose your own downline (to minimize downline passive losses) there should seldom be a situation where your signal to noise degradation exceeds 1-2-3 dB in real life; by moving the pre-amplifier downstairs. Perhaps your real life situation can even be held constant to your present signal to noise ratio, if you substitute a larger diameter, lower loss downline for that presently in use or presently planned. If you can save sufficient dB's of downline loss by going to lower loss downline cable, you may end up ahead or at least even with where you now are; and gain the advantage of being able to control the environment for the pre-amplifier and the associated bandpass filter and/or traps in the process.

What we are really talking about here is a trade-off. We know that at the very best, locating an unprotected (i.e. non-bandpass filtered) pre-amplifier on top of the tower in the presence of one or two very potent adjacent channel signals is going to cause us no end of grief. Sooner or later, and probably quite often, the channel 3 picture in our example is going to be degraded by either/or both channel 2 aural and channel 4 visual carriers. This may be there one minute and gone the next, as channel 3 goes up and down in level. It may be perfect for days on end and then degraded for more days on end as the weather changes about us. In any case, it is going to be a less than satisfactory arrangement, and destined to stay that way until we can give the much-needed channel 3 pre-amplifier a decent clean opportunity to do what it was intended to do; pre-amplify the weak channel 3 signal.

Now, do you filter or do you trap?

As Hansel Mead described in the March 1976 CATJ (see pages 40-45), a bandpass filter (or passband filter if you like) creates an acceptable-to-the-desired-signal match *within* the bandpass of the filter, but a very poor match for any spectrum falling outside of the desired passband. This means that in a sense non-passband frequencies are rejected by the filter through designed-on-purpose mis-match. The channel 3 bandpass filter faces the channel 3 signal with an acceptable match, and channel 3 energy passes on through the unit. But the match seen by the channel 2 (and 4) signal energy (and virtually all other frequencies) is so poor that the energy reflects from the input port on the filter (and heads back up the transmission line to the antenna).

On the other hand, a bandstop device (i.e. a signal trap) presents a poor or non-acceptable match *only to* the signal or frequency to which it is tuned. In our example, we originally had potent channel 2 and 4 carriers; visual and aural on both channels. To insure that all four carriers are not amplified by the channel 3 pre-amplifier (which is what causes us our problem in this situation) would require four separate tuned traps; see diagram 6.

There is a practical rule of thumb that says you should insert as few tuned circuits ahead of the

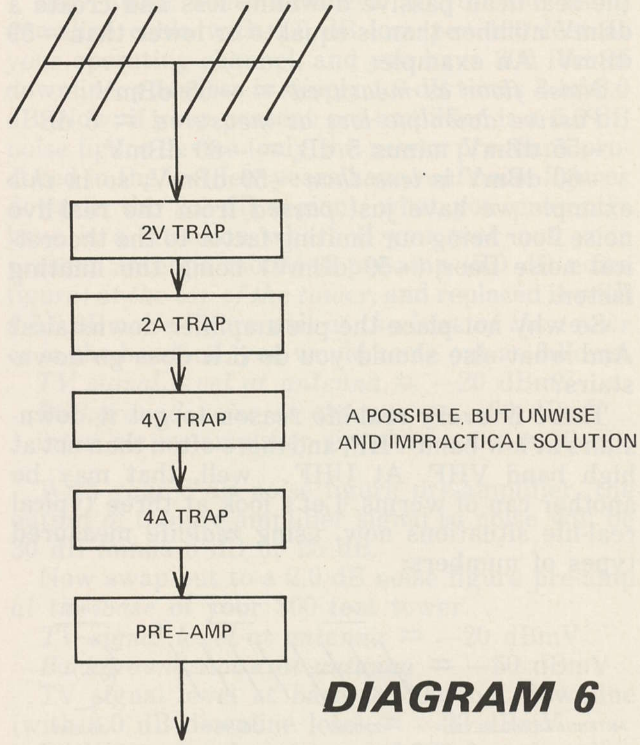


DIAGRAM 6

pre-amplifier as you can get by with. In other words, keep it simple before the first (noise figure establishing) stage in the chain; retaining any really "heavy" filtering and use of tuned circuits for *after* the first (pre) amplifier stage. The same general procedure is found in a heterodyne processor, for example, where bandpass shaping is done almost exclusively at i.f.

If you carefully analyze what you are really trying to do in our channel 3 situation, you will probably come to the conclusion that at the pre-amplifier segment of the system, you are really

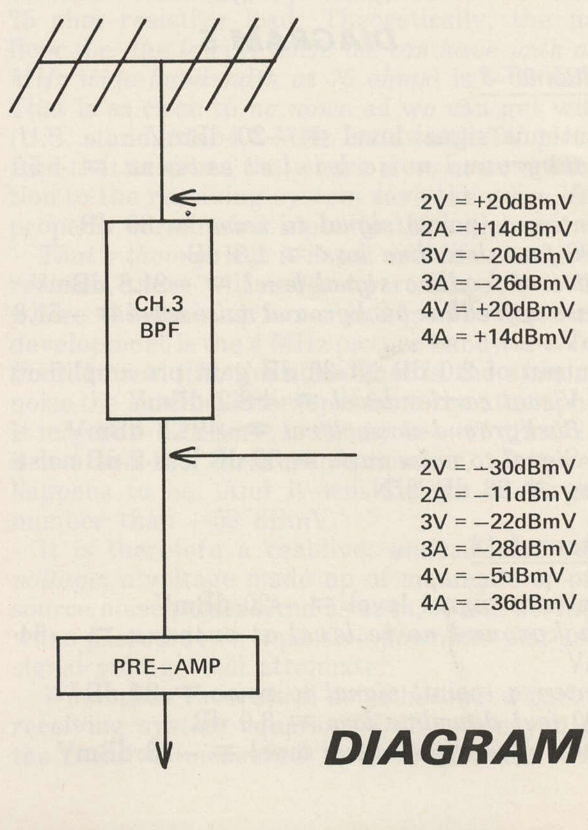


DIAGRAM 7

trying to do nothing more than selectively attenuate the bodacious channel 2 and 4 carriers; just enough so that the channel 3 pre-amplifier will function, as a low noise pre-amplifier, reliably.

Do you *really* need to get rid of the channel 2 *visual* carrier *and* the channel 4 *aural* carrier; at this point?

Here are the tradeoffs. You can install a Hi-Q bandpass filter at the base of the feedline immediately ahead of the channel 3 in-headend pre-amplifier. This will cost you 2.0 dB bandpass filter loss (see diagram 7), and it will attenuate channel 2 visual by 50 dB, channel 2 aural by 25 dB, (channel 3 V and A by 2.0 dB [thru loss]), channel 4 visual by 25 dB and channel 4 aural by 50 dB. There may be additional loss presented. If the bandpass filter is inserted into the downline at a point where the source (i.e. input) and load (i.e. output) match presented to the filter proper is poor (i.e. less than say 16 to 20 dB RTL minimum), it may be necessary to insert a match-pad at the BPF input or output port to insure that the filter sees an honest 75 ohm resistive type of impedance. Bandpass filters are generally very susceptible to detuning when they are looking at a poor (design) match at either (or both) ports. If the match is poor, the filter is likely to actually *detune* itself, because of the standing waves set up by the poor match. It takes at least a 3 dB (and possibly a 6 dB) pad to *re-establish* the match; and a 3 dB pad is another passive loss source that will further degrade the signal to noise. Needless to say, the pad is to be avoided.

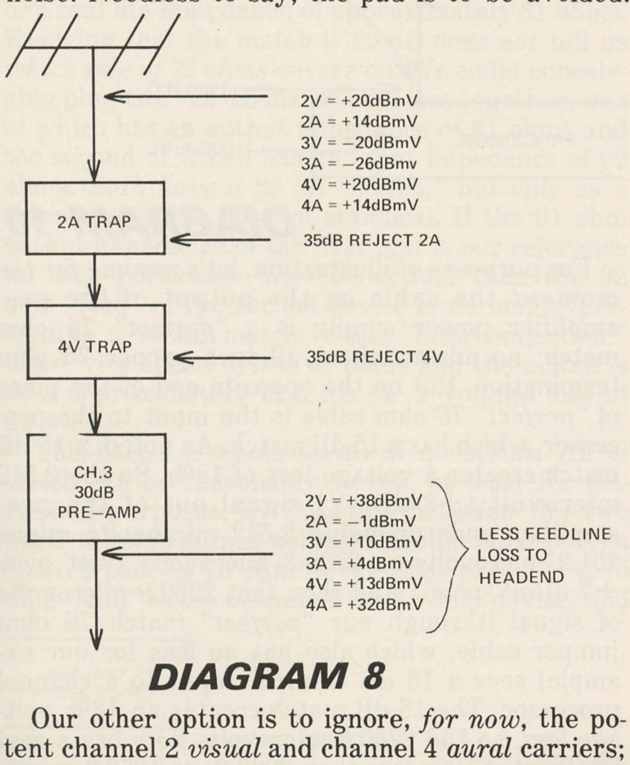


DIAGRAM 8

Our other option is to ignore, *for now*, the potent channel 2 *visual* and channel 4 *aural* carriers; they are far enough down on the gain skirt of the channel 3 "single channel" pre-amplifier as to not present a *summed-carrier* problem for overload potential of the pre-amp; in our example situation. If we ignore the two adjacent channel *far-away* carriers (diagram 8) we can concentrate on the two adjacent channel *near-by* carriers; or channel 2 aural and channel 4 visual. This suggests that ahead of the pre-amplifier where attenuation must be selectively applied to *these two carriers* that narrow bandwidth deep notch traps should be employed.

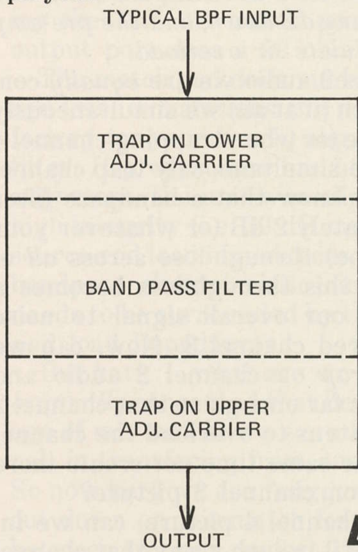


DIAGRAM 9

Most high quality bandpass filters currently on the market for CATV applications are actually bandpass filters *plus* traps. The filter portion has certain parameters; which are augmented or expanded with the addition of trap networks (see diagram 9). Standing *alone*, the *filter* provides passband characteristics for the desired channel; but contributes very little attentuation to the *nearest two* immediately adjacent channel carriers. A channel 3 BPF, for example, *less the traps*, typically has an attenuation factor on channel 2 *aural* of less than 4 dB and a similar amount of attenuation on channel 4 *visual.* It is the built-in traps, *within the filter*, which really do the "number" on these two *immediately adjacent* carriers.

The trap creates a frequency-selective *mismatch.* That is, a trap tuned to channel 2 aural carrier frequency intentionally creates such a poor match for energy on *this frequency* that the energy is blocked or reflected at that point. A trap has a bandwidth just like any other tuned circuit device; and the mismatch created can be plotted in any of several ways. It can be plotted as:

(1) The amount of attenuation present (through the trap) at any *specified* frequency;

(2) The actual 75 ohm match (or VSWR) at any given *specified* frequency;

(3) The percentage of power present at the *specified* frequency which passes *through* the device, as a function of the total power present at that frequency at the *input* to the device.

(4) The *bandwidth* of the mis-match, at any specified through-loss parameter (i.e. the width of the frequency spread, specified by the upper and lower frequency at which the loss is [say] 3 dB or greater; due to the presence of the trap).

(5) The phase-error created by the trap, in degrees of phase "change", as a function of the frequency range immediate adjacent to and within the trap bandwidth.

For different purposes, we have different measurement concerns. In the simple "how far down must I trap channel 2 audio (or 4 picture) to keep the channel 3 pre-amp from overloading?" department, we are dealing with a not complex black and white number. *So many dB down, and the pre-amp ceases to cross modulate or overload.*

In trapping channel 2 audio we are *equally* concerned with how much (if at all) we simultaneously trap channel 3 picture (or when trapping channel 4 picture how much we simultaneously trap channel 3 audio). We already know that a bandpass filter will create approximately 2 dB (or whatever your unit's number may be) through-loss across *all* of channel 3; and that this through-loss becomes a degrading factor in our overall signal to noise scheme for the desired channel 3. Now, can we insert a *tuneable trap* on channel 2 audio and knock the audio down far enough so that channel 2 audio no longer threatens to overload the channel 3 pre-amp, and, at the same time *not create* more than 2.0 dB of loss on channel 3 picture?

And, in trapping channel 4 picture, can we insert the *trap* and tune it in such a way that channel 4 picture no longer threatens to overload the channel 3 pre-amp; but still not:

(1) degrade channel 3 audio by more than say the 2.0 dB example for our channel 3 bandpass filter, or,

(2) degrade the channel 3 color sub-carrier region so as to create color smear (phase error) on channel 3 with the channel 4 picture carrier trap?

Fortunately, a quality tuned trap will do the proper job on channel 2 or 4 non-desired carriers, with only minimal damage to any of the channel 3 components.

Why use *two* traps in our example rather than a *single* bandpass filter? Primarily because there is less opportunity with two traps to degrade channel 3 than there is with a single bandpass filter, and a channel 3 bandpass filter contains two traps anyhow.

Now if you can attenuate the non-desired channel 2 audio and channel 4 video carriers with two traps *ahead of* the channel 3 in-headend pre-amplifier, so the channel 3 pre-amplifier can function as it was originally intended to function, are we *now ready* after trap / trap / pre-amplifier to process the channel 3 signal for system carriage? *Probably not.* Coming out of the channel 3 pre-amplifier we still have some mighty potent non-desired carriers. Channel 2's video and audio carriers and channel 4's video and audio carriers may not be high enough to create problems *with the channel 3 pre-amplifier*, but they are still plenty high enough to cause problems with virtually any available present day signal processor. So before we can AGC, shape and control the channel 3 signal, we are going to have to do some more clean up work.

Because the channel 3 level is now sufficiently high to stand some additional through-loss, this is the spot to put in the bandpass filter for channel 3. Again, there is the endless problem with proper impedance matching. Just because the pre-amplifier power supply output says "75 ohms" and the processor input says "75 ohms" does not mean that the match at 75 ohms is (1) particularly good, or, (2) is purely resistive. In fact, a typical pre-amplifier power supply output jack has a match of around 20 dB (which translates to a *voltage loss through mis-match* of 10%); and the typical processor input has an input match no better than 15 dB (which is a voltage loss of 18% due to mis-match). The voltage loss due to mis-match is bad enough. But there is more to it than that.

Let's say the *real life* match integrity of a pre-amp power supply output spigot *is* 20 dB. This is, as noted, a voltage loss through mis-match error of 10%. In other words, if the *real* signal voltage out of the pre-amplifier power supply is supposed to be +8 dBmV (2,512 microvolts), a *10% voltage loss* though the 20 dB match translates to as much as 251.2 microvolts *lost* in the transfer from the pre-amplifier power supply output spigot to the device connected on the output (typically a piece of 75 ohm cable).

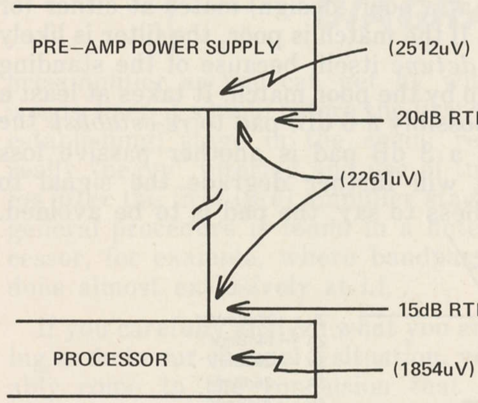


DIAGRAM 10

For purposes of illustration, let's assume *for the moment* the cable on the output of the pre-amplifier power supply is a "*perfect*" 75 ohm match; no mis-match at all to a proper 75 ohm termination. But on the opposite end of the piece of "*perfect*" 75 ohm cable is the input to the processor, which has a 15 dB match. As noted, a 15 dB match creates a voltage loss of 18%. So the 2,512 microvolt (+8 dBmV) signal out of the pre-amplifier ends up being 2,512 microvolts minus 251.2 microvolts or 2260.8 microvolts (just over +7 dBmV now). And then that 2260.8 microvolts of signal (through our "*perfect*" match 75 ohm jumper cable, which also has *no* loss for our example) sees a 15 dB "match" input to a channel processor. The 15 dB match creates an 18% voltage loss, so the 2260.8 microvolts *now* has a *real* life level of 18% less than 2260.8, or 1853.9 microvolts. That is very close to +5.5 dBmV. In our little "linking" game from pre-amplifier power supply to inside of the processor, we have just given away 2.5 dB of our signal voltage!

That is one very lossy jumper connection.

As bad as the loss due to mis-match may be, there are worse problems when a bandpass filter with an extreme sensitivity to match is inserted into the line between the pre-amplifier power supply output and the input to the processor (diagram 11).

Mis-match is actually nothing more than a convenient "scale" to measure voltage loss due to unmatched inter-connecting impedances. If the *standard of reference is 75 ohms*, as it is in CATV, then any device with a *non*-75 ohm port is out of step with *our* standard. A 20 dB return loss match

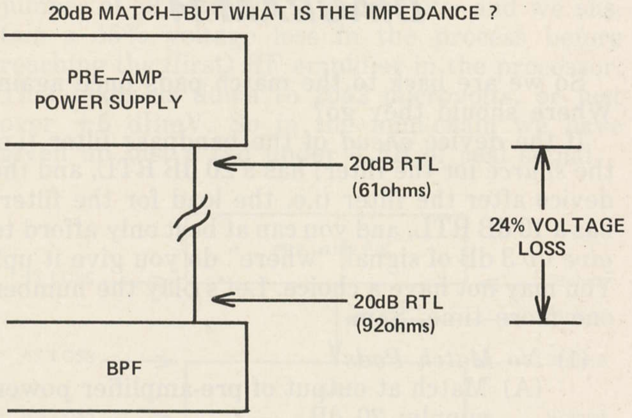


DIAGRAM 11

(RTL) may have a real life impedance of 92 ohms or a real life impedance of approximately 61 ohms. Knowing that the match is 20 dB does *not* tell us *which side of 75 ohms* we are on. We could conceivably plug two "20 dB match" devices together; one of which has an output impedance of 61 ohms and the second of which has an input impedance of 92 ohms. *Both have a 20 dB "match,"* but only as a *reference to* the 75 ohm standard. If the 61 ohm output impedance of the *first* unit is our reference for *this particular* interconnection, then the 92 ohm "load" of the second device is no longer presenting a 20 dB match to the "interconnection;" the device ahead of it is 61 ohms and the match is *now* approximately 12.5 dB (or a voltage loss of 24%).

This raises a whole series of questions. All of which can be reasonably solved, at least for discussion purposes, by inserting between the two ports (61 ohm *output* port and 92 ohm *input* port) a "match pad;" a 75 ohm device that presents a 75 ohm "load" to the output of the 61 ohm device, and

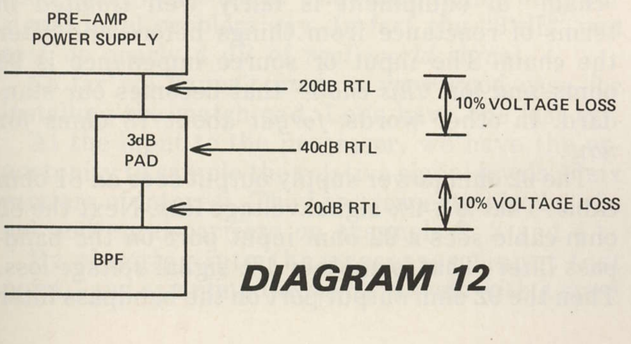


DIAGRAM 12

a 75 ohm "source" to the input of the 92 ohm device (diagram 12). Now rather than creating a *singular 24% voltage loss* we create two 20 dB match, or 10% voltage losses. It may not seem like much of an improvement, but it is far better than sustaining the 12.5 dB match possible when a 61 ohm output port sees a 92 ohm input port.

The match pad does more than reduce the voltage loss; it maintains the integrity of the original factory (or your bench) alignment of the bandpass filter. If proper care has been taken in the filter alignment, the unit was aligned between a set of high integrity (i.e. 30 dB match or better) 75 ohm source and load impedances. To duplicate the same bandpass characteristics in field use, the filter needs to be surrounded by the *same type* of source *and* load impedances.

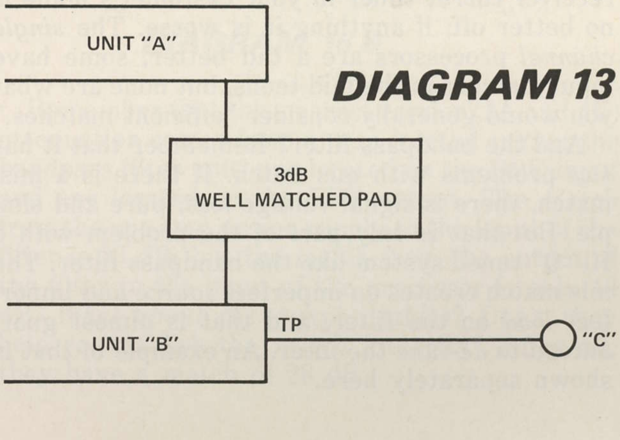
But hark . . . what are we doing here? We were *originally* concerned that because of some percentage of mis-match, we were losing voltage (i.e. signal) in transfering from one unit to another unit. So now here we are "suggesting" that one way to cut down on mis-match loss is to insert a pad in between two non-perfect 75 ohm devices, thereby *forcing* a match to 75 ohms. This may cut down the 75 ohm mis-match loss, but what about the passive through-loss of the pad? Is that not also a voltage loss?

Alas, there is no such thing as a free lunch. Somebody has to pay for the hard boiled eggs and potato chips; and in this case the price of the beer just went up.

So what type of trade off *is satisfactory*? Are we trading a dB or two of mis-match loss for 3 dB of pad loss (plus yet some more mis-match loss)? *What kind of* "good deal" *is this*!

If you could *correctly* determine the match (and impedance) of every input and output port in your headend system (i.e know the *direction* either side of 75 ohms the match is centered), you could probably laboriously compute the trade offs with inserting 3 dB (or 6 dB) match-pads between every improperly matched set of units. But making this type of impedance measurement is beyond the test equipment capacity of most CATV systems, so we pretty much have to revert to a cut and try approach when it is pure *voltage* levels we are concerned with. If you can insert a 3 dB 75 ohm pad in the line between units "A" and "B" (diagram 13), and measure *less than* a 3 dB voltage drop at point "C" you can be reasonably sure that there was a

DIAGRAM 13



mis-match of some nature between "A" and "B". You might even find that the 3 dB pad created *no voltage change*, and in some rare circumstances, you may find that inserting a 3 dB pad between "A" and "B" actually *raises* the signal level at point "C". No change (i.e. no 3 dB drop) or a positive change (i.e. insertion of 3 dB pad results in more signal voltage present) strongly suggests that your A to B match was at best poor.

Which leads us back to inserting the bandpass filter *between* the pre-amplifier power supply out put and the input to the processor. In our examples previously, we attributed the match at the input to the processor as 15 dB; or an 18% signal voltage loss at the input port of the processor. Unfortunately, of all of the ports between the antenna *output* and the headend channel combiner, the weakest one of all (as far as match integrity) is invariably the *input port on the processor.* This is especially true with processor units which have multiple channel (i.e. turret tuner) inputs. If you have ever had occasion to check match integrity on say a Channel Commander I, as you twist the turret tuner from channel 2 to 3 to 4 (etc.) through 13, you probably *already know* that in *most* situations the turret tuner has a match between 6 and 8 dB. That's right, a match which results in a voltage loss in transferring from the input coaxial connector to the first active stage of the processor of from 40% (8 dB match) to 50% (6 dB match). *That is a bunch of loss*! You may have a marginal (as far as AGC is concerned) 0 dBmV input *to* such a unit; 0 dBmV as measured *at the end of the last cable connecting to* the processor input connector. Now if the match is 6 dB, what is the "real" signal voltage that ends up tickling the grid of the RF amplifier stage in the turret tuner of the processor? Fifty percent less than 1,000 microvolts, or 500 microvolts. That is a whopping 4 dB signal loss, and a 4 dB degradation in noise figure (or a loss of 4 dB in signal-to-noise) *at that point*. This is often "more signal voltage *loss*" than you have managed to accumulate all the way through the mis-matches between the antenna and the downline and the pre-amplifier and the traps and even the bandpass filter.

We are not picking on the Commander I; it is no worse than virtually all other turret tuner (i.e. 12 channel) RF front ends on processor units. And if it makes you feel any better (or worse), the TV receiver turret tuner in your customer's home is no better off; if anything it is worse. The *single channel* processors are a tad better, some have input matches in the mid-teens, but none are what you would generally consider "efficient matches."

And the bandpass filter? Remember that it has *two* problems with mis-match. If there is a mismatch, there is signal voltage loss; pure and simple. But that is only part of the problem with a Hi-"Q" tuned system like the bandpass filter. The mis-match creates an imperfect *source* and imperfect *load* on the filter, and that is almost guaranteed to *de-tune* the filter. An example of that is shown separately here.

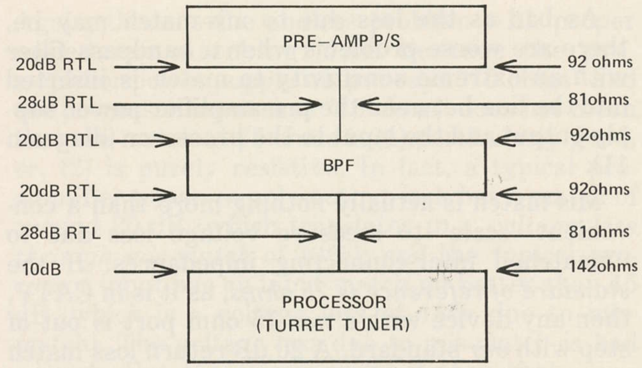


DIAGRAM 14

So we are back to the match pads once again. Where should they go?

If the device *ahead* of the bandpass filter (i.e. the *source* for the filter) has a 20 dB RTL, and the device after the filter (i.e. the load for the filter) has a 10 dB RTL, and you can at best only afford to *give up* 3 dB of signal, "where" do you give it up? You may not have a choice. Let's play the number one more time, Sam.

(1) *No Match Pads*
- (A) Match at output of pre-amplifier power supply: 20 dB
- (B) Match of interconnecting 75 ohm jumper cable: 28 dB
- (C) Match of input to bandpass filter: 20 dB
- (D) Match at output of bandpass filter: 20 dB
- (E) Match of interconnecting 75 ohm jumper cable: 28 dB
- (F) Match of input to (turret tuner) processor: 10 dB

What signal voltage losses are involved here? First we will assume (which is not only dangerous but an unlikely happenstance) that *all* of the non-75 ohm matches are on *one side or the other* of 75 ohms. Let's say they are all *high*, just for sake of uniformity.

- (A) Pre-amp power supply output: 92 ohms
- (B) Interconnecting cable: 81 ohms
- (C) Input to bandpass filter: 92 ohms
- (D) Output of bandpass filter: 92 ohms
- (E) Interconnecting cable: 81 ohms
- (F) Input to processor: 142 ohms (ouch!)

We have "deep" matching devices on both ends (i.e. pre-amp power supply on the source end and processor input on the load end) of our "chain." So we can conclude with some accuracy that this little "chain" of equipment is fairly well *isolated* in terms of reactance from things before and after the chain. The input or source impedance is 92 ohms, and for "*this chain*" that becomes our standard. In other words, *forget* about 75 ohms *for now*.

The 92 ohm power supply output sees an 81 ohm cable. That is a 4% signal voltage loss. Next the 82 ohm cable sees a 92 ohm input port on the bandpass filter. That is another 4% signal voltage loss. Then the 92 ohm output port on the bandpass filter sees another 81 ohm piece of cable; another 4% voltage loss. Finally, the 81 ohm piece of cable sees a 142 ohm input load on the processor tuner; a 27% voltage loss (81 ohms is referenced to 142 ohms, not 75 ohms).

Now let's run that through in microvolts. If the output from the pre-amplifier power supply is +10 dBmV (3,162 microvolts), the first 4% voltage loss drops us to 3035.5 microvolts. The next 4% voltage loss drops us to 2914 microvolts. The next 4% voltage loss takes us down to 2797.5 microvolts. Now we are going into the tuner from our 81 ohm jumper of 59 with 2797.5 microvolts, and we sustain a 45% voltage loss in the process before reaching the (first) RF amplifier in the processor. That takes us down to 2042 microvolts, or just over +6 dBmV. So in the mini-chain we have given up just a tad under 4 dB of real signal.

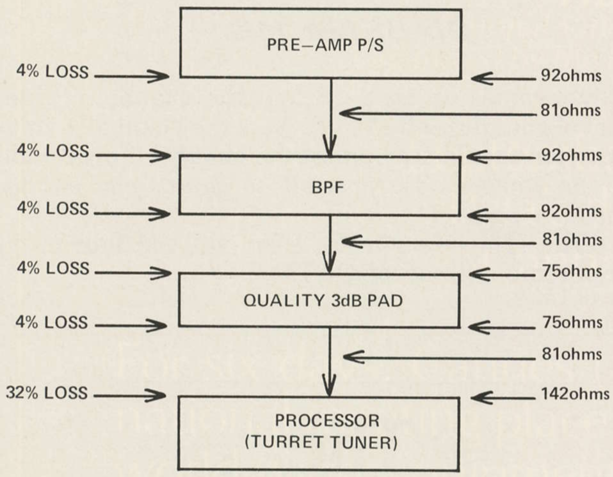


DIAGRAM 15

Now suppose we insert a 3 dB pad *in just one spot*; between the output of the filter and the input of the tuner. Let's assume for discussion the pad match is so good that there are no significant voltage losses at either of its ports.

At the output of the filter (92 ohms) we see a 75 ohm 3 dB pad. That is a new 4% signal voltage loss (dropping us from 2797.5 microvolts to 2685.6 microvolts). *Thru the pad* we sustain 3 dB of voltage loss, which takes us down from 2685.6 microvolts to 1890 microvolts. Now our 75 ohm match pad sees the 142 ohm input port on the processor tuner; and that is a 32% voltage loss. The net is 1285 microvolts. *Ouch.* That sure didn't help our signal level problem any. In fact the "3 dB" pad cost us nearly 4 dB of *real world* signal.

So far we haven't made a very good case for installing the match pad. Let's have one last try.

At the input to the processor, we have the opportunity to sample the relative signal levels of six carriers of interest. They are respectively the visual and aural carriers on channels 2, 3 and 4.

By plugging into the processor "input test point," and sampling the carrier levels with a spectrum analyzer, here is what we find when several variations of system are employed (diagram 16):

(1) *No bandpass filter* (A)

Our pre-amplified channel 3 signal measures +10 dBmV visual and +5 dBmV aural as monitored at the input to the processor. However, the channel 2 carriers are respectively +5 dBmV (video) and +10 dBmV (aural); and the channel 4 carriers are respectively +13 dBmV (video) and +5 (aural). The channel 2 aural carrier is sufficiently high to cause herringbone beats into the channel 3 visual signal level and the channel 4 video carrier will create similar problems.

(2) *With bandpass filter* (B)

The bandpass filter inserts between the pre-amp power supply and the input to the processor. The bandpass filter spec calls for 2 dB *through loss* on the desired channel, and 25 dB of rejection on the channel 2 aural carrier and a like amount on the channel 4 visual carrier.

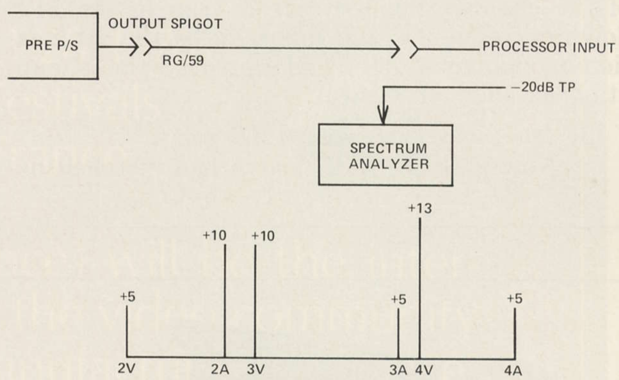


DIAGRAM 16 A

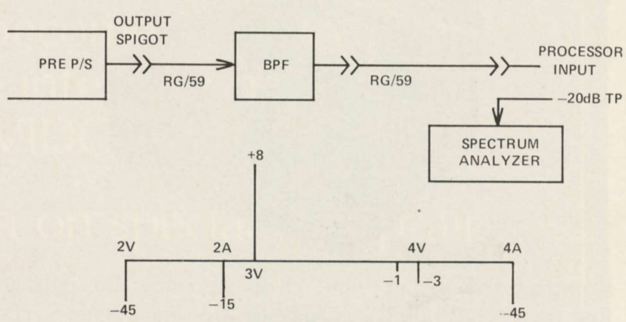


DIAGRAM 16 B

Remember that this nearest-carrier (2A and 4V) attenuation comes from a *trap* located *within* the bandpass filter unit; one located on the BPF input and one located on the BPF output. The match from the pre-amp power supply to the input of the filter is 20 dB; but the match from the output of the filter to the input of the processor is only 10 dB. *What about the jumper cables*? Don't they help re-establish the match integrity? After all, they have a match of 28 dB.

No, for all practical purposes they are "opaque" to the 10 dB match at the processor end and the 20 dB match on the power supply end; simply because they are *too short* (as jumpers) to have much influence on the match at all. It takes *several wavelengths of cable* to create a "forced-cable-match" and most jumpers are but a *fraction* of a wavelength long.

So look closely at the levels in diagram B; which indicates what the BPF *actually does* when it is mis-matched so severely at the *output* terminal. Note that rather than 25 dB of attenuation on channel 4 video, we have but 16 dB of attenuation. And moreover, the channel 3 aural carrier went down not 2 dB (the through-loss amount) but 6 dB.

Why?

Because the mis-match at the processor *detuned* the output trap on the bandpass filter; it moved the "trap" portion down in frequency where rather than *sitting on 67.25 MHz* (channel 4 visual), it was down straddling *between channel 3 aural* (65.75 MHz) *and channel 4 visual.* This shifted the notch of the channel 4 video carrier trap in the BPF down in frequency, and this *reduced* the attenuation on channel 4 video and *increased* the attenuation on channel 3 aural.

(3) *Bandpass filter and 3 dB pad (C).*

Now with the 3 dB match pad installed between the output of the BPF and the input to the processor, the BPF works better. It sees a better match, and consequently the trap built into the output of the filter works as originally aligned at the factory (or on your bench). All of the levels go down by 3 dB except for two; the channel 3 aural level comes *up* by 2 dB and the channel 4 video level goes *down* by 13 dB. *Now* the channel 4 video carrier should stay out of the channel 3 processor.

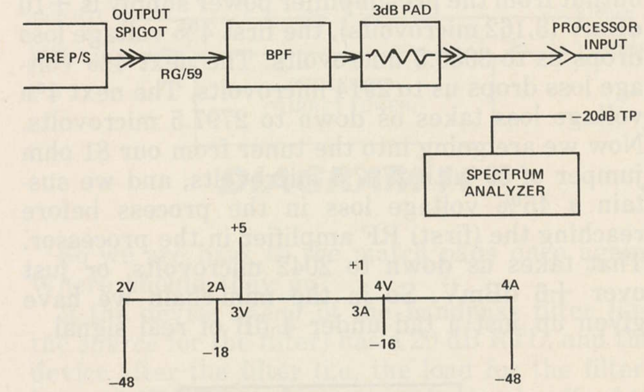


DIAGRAM 16C

So you see, *it is possible to gain signal voltage with a pad!*

The "Thin Margin of CATV" will continue in the September issue of CATJ.

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VIDEO ALARM WARNS OF PROBLEMS AT REMOTE MICROWAVE SITES

William H. Ellis, Jr., Technical Director
Telesis Corporation

As a major user of CARS band microwave systems, we were (and are) faced with the realities of microwave system maintenance without the hot standby capability of common carriers. Furthermore, our microwave equipment purchases did not include manufacturer supplied alarm equipment since the alarm equipment is a considerable additional expense and activates alarms at unattended headend sites.

Although all unattended repeater sites utilize standby battery power, our maintenance personnel were faced with power outages on many occasions since they had no way to know *when unattended repeaters were operating on batteries* until the batteries were finally drained.

To alleviate this problem and provide for other types of alarm situations (such as tower light failure, low transmitter output power, etc.), we designed an alarm circuit which places a *visible alarm indicator* on the transported television picture. This alarm signal is in the form of a *digital character* located somewhere on the periphery of the TV picture. The character itself designates the *location* of the failure or alarm and the *type* of difficulty.

Design Criteria Included:

A. Ability to generate a significant number of unique characters to permit utilization of the alarm equipment within a relativity large microwave system without character duplication.

B. Ability to place the character at any location on the television screen.

C. Ability to operate the alarm equipment from the same battery supply which powers the microwave equipment.

D. Ability to generate several different characters at each alarm location.

E. Ability to automatically choose a "priority" alarm condition when more than one alarm occured at the same time.

The first item was accomplished through the use of a character generator LSI chip Signetics 2513. The chip can generate 64 different unique characters.

Two PotentioMeters permit horizontal and vertical positioning of the characters on the TV raster by adjusting the pulse lengths of one shot multivibrators. Figure 1 shows a logic diagram of the equipment with the positioning shown as Mv and Mh.

Because several voltages are required for the character generator chip and the remaining circuitry, the requirement for operation from the *same* battery source as the microwave equipment caused some difficulty. Obviously no purpose would be served if the alarm equipment were operated from the AC line since it would not be functional when an AC power outage occured.

Finally the decision was made to use a DC-DC converter supply. No readily available DC-DC converter transformer could be found which would supply the needed voltages. As a result, it was decided that an *audio transformer* might be satisfactory for the application. Instead of designing a self oscillating circuit, a brute-force approach was taken since it simplified the transformer requirements. A buffered two transistor multivibrator designed to operate at approximately 800 Hz was used to drive a pair of relativity high voltage transistors, which were connected in push-pull to the transformer primary. The resulting secondary voltages were then rectified and filtered as shown in the power circuit diagram (Diagram 2). Good results have been obtained from the circuit. Some transformer heating does occur, but ventilation holes cut in the chassis provide sufficient cooling to prevent overheating of any circuit components.

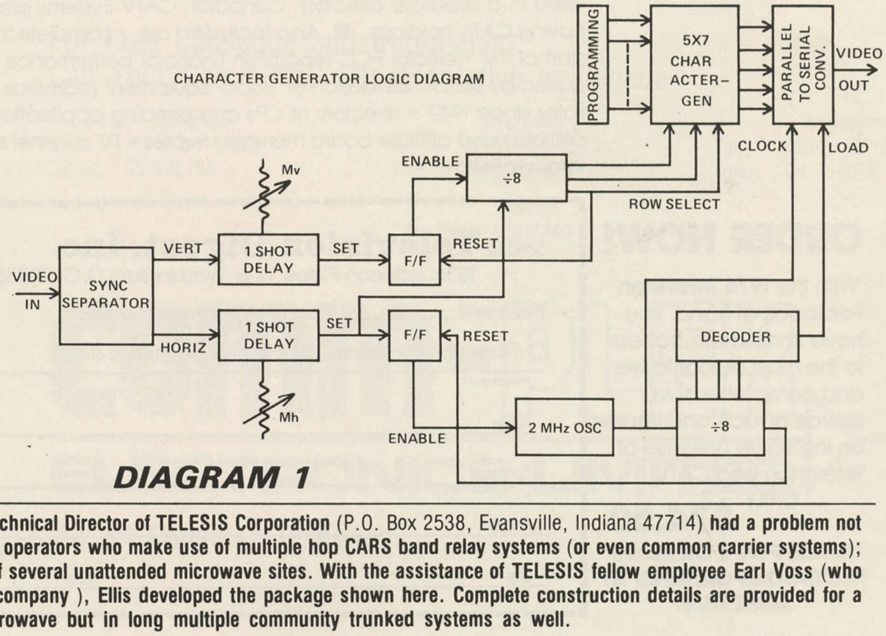
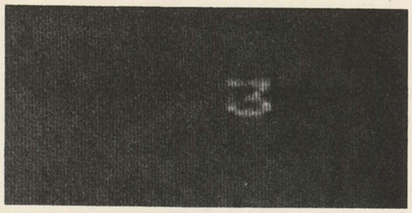


DIAGRAM 1

ABOUT THIS PROJECT — William H. Ellis, Jr., Technical Director of TELESIS Corporation (P.O. Box 2538, Evansville, Indiana 47714) **had a problem not unlike that faced by dozens of other CATV system operators who make use of multiple hop CARS band relay systems (or even common carrier systems); how to tell when an "emergency" exists at one of several unattended microwave sites. With the assistance of TELESIS fellow employee Earl Voss (who heads up a 'Special Projects Department' for the company), Ellis developed the package shown here. Complete construction details are provided for a system which should find uses not only in microwave but in long multiple community trunked systems as well.**

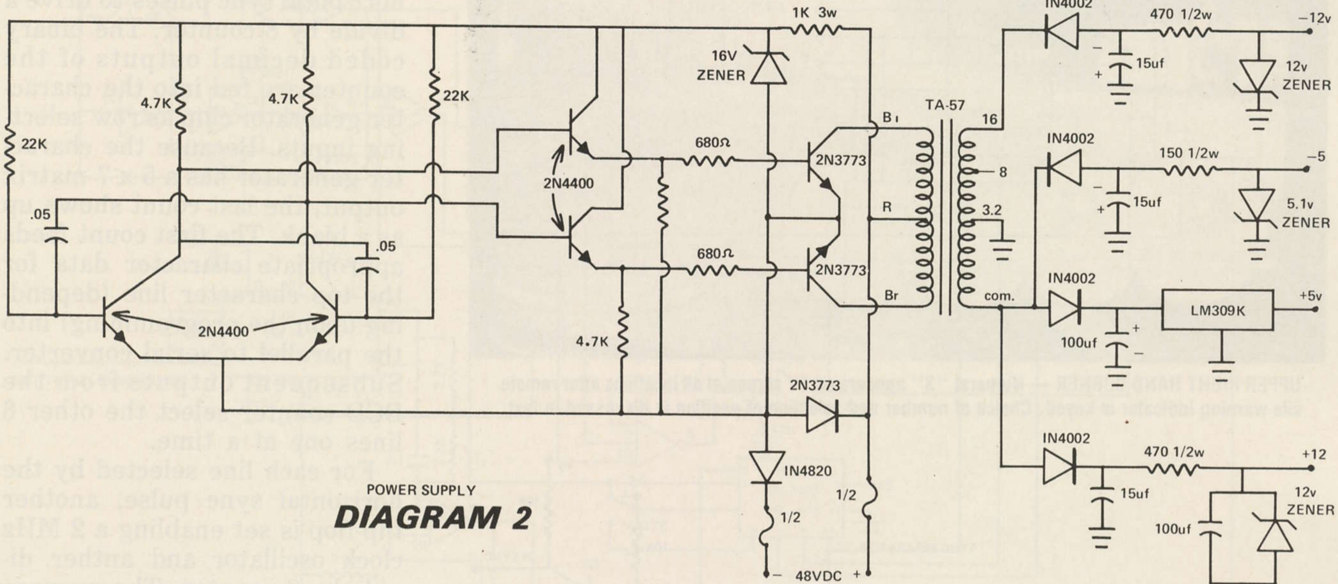


ENLARGED DISPLAY —
Portion of screen holding video alarm is enlarged to show numeral appearance.

A high pitched whine *can* be heard when the power supply is operating, which is normal for inverter circuits.

Diode coupling is used to provide the needed character selection at any one site. This selection circuitry provides the capability of meeting criteria D noted above. With the device *as designed*, the choice is limited to three (3) possible characters at any one site.

Automatic priority coding is accomplished through the use of output relays as shown in Diagram 3. In most cases, the loss of AC power at the site (meaning that the system is on batteries) rates the highest prior-



POWER SUPPLY
DIAGRAM 2

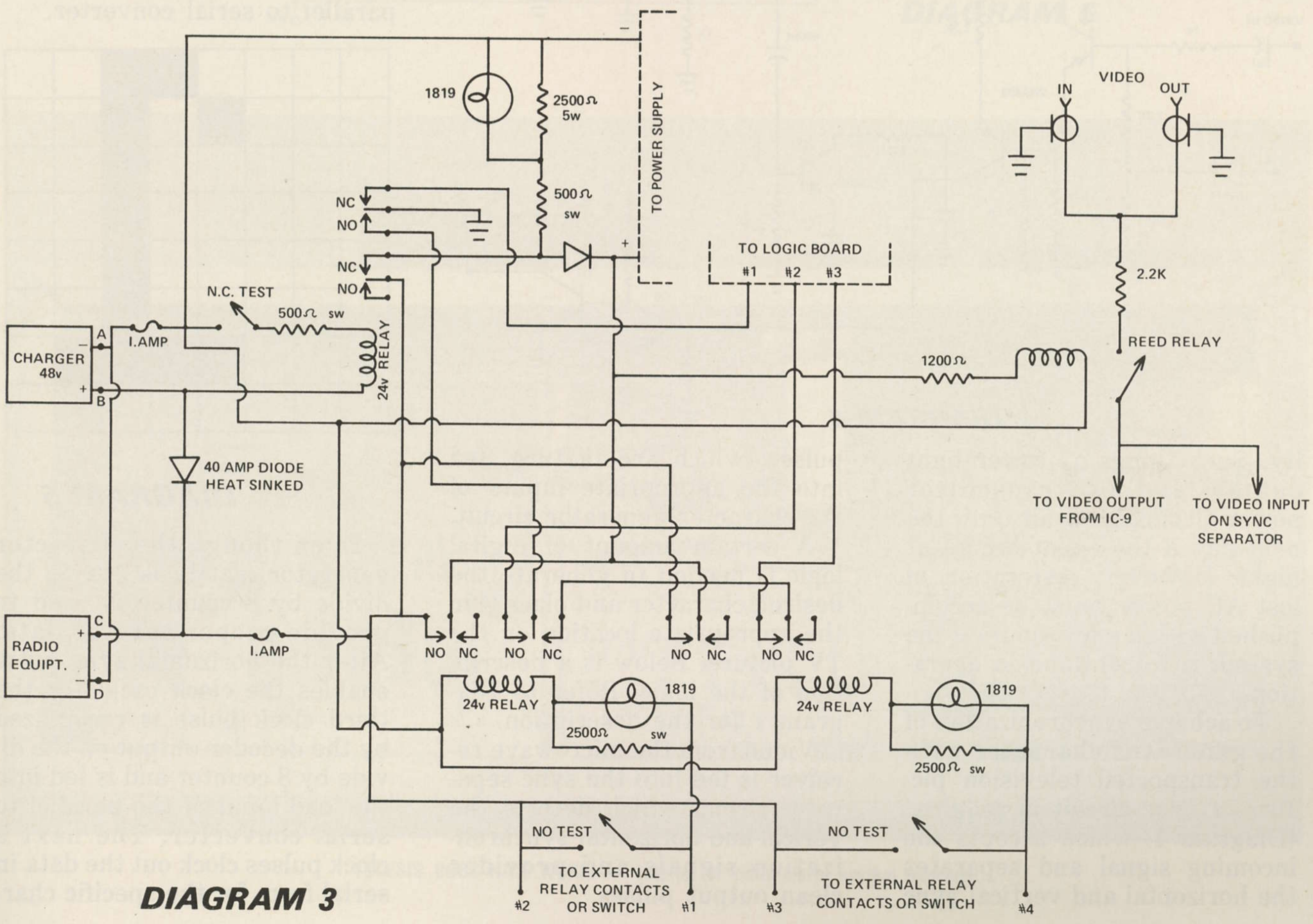


DIAGRAM 3

UPPER RIGHT HAND CORNER — Numeral "3" appears on TV screen at all locations after remote site warning indicator is keyed. Choice of number and selection of position is discussed in text.

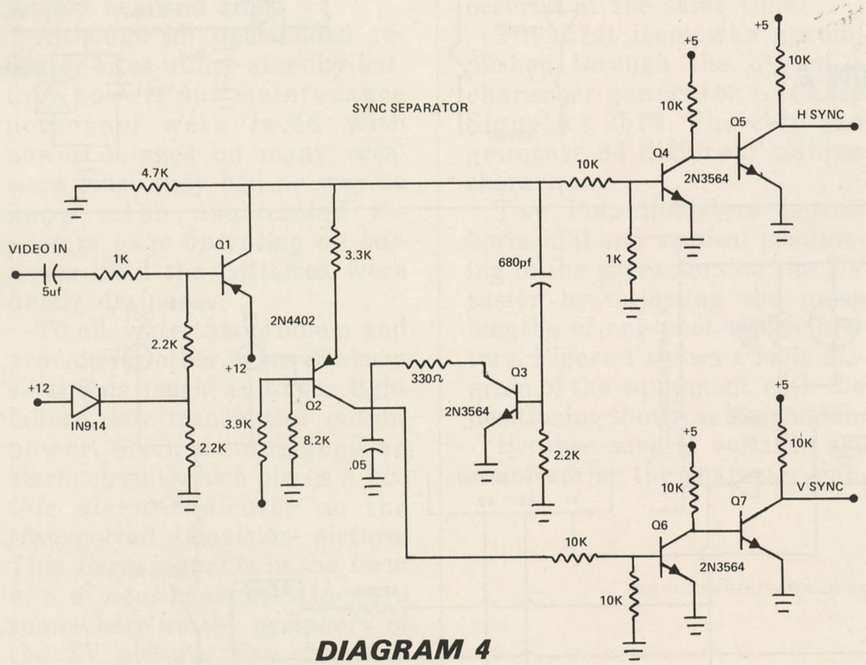


DIAGRAM 4

ity. Such things as tower light outages and low transmitter power alarms can wait until the next day if the event occurs at night. However, restoration of lost AC power must be accomplished within a few hours if the system is to continue in operation.

To achieve synchronization of the generated character with the transported television picture, a sync circuit is required (Diagram 4) which accepts the incoming signal and separates the horizontal and vertical sync pulses, which are in turn, fed into the appropriate inputs of the character generator circuit.

A certain amount of digital logic is needed to generate the desired character and place it in the appropriate location on the TV picture. Below is a description of the logic. Refer to Diagram 1 for the description.

Video from the microwave receiver is fed into the sync separator circuit which detects the verical and horizontal synchronization signals and provides clean output pulses.

Both sync pulses are used to trigger one-shot multivibrator circuits which function as time delays. The time delays of each multivibrator are adjustable. Adjustment permits the alarm character to be placed anywhere on the TV screen.

The vertical one-shot output sets a flip-flop which enables horizontal sync pulses to drive a divide by 8 counter. The binary coded decimal outputs of the counter are fed into the character generator chip as row selecting inputs. Because the character generator has a 5 x 7 matrix output, the last count shows up as a blank. The first count feeds appropriate character data for the top character line (depending upon the programming) into the parallel to serial converter. Subsequent outputs from the BCD counter select the other 6 lines one at a time.

For each line selected by the horizontal sync pulse, another flip-flop is set enabling a 2 MHz clock oscillator and anther divide by 8 counter. The purpose of this second counter is to provide timing information for the parallel to serial converter.

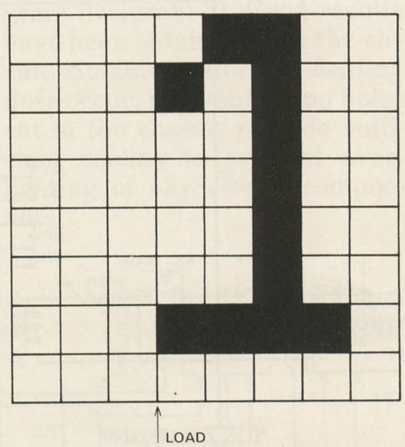


DIAGRAM 5

Even though the character generator matrix is 5 x 7, the divide by 8 counter is used to provide proper spacing data. After the horizontal sync pulse enables the clock oscillator the third clock pulse is recognized by the decoder output on the divide by 8 counter and is fed into the load input of the parallel to serial converter. The next 5 clock pulses clock out the data in serial form for the specific char-

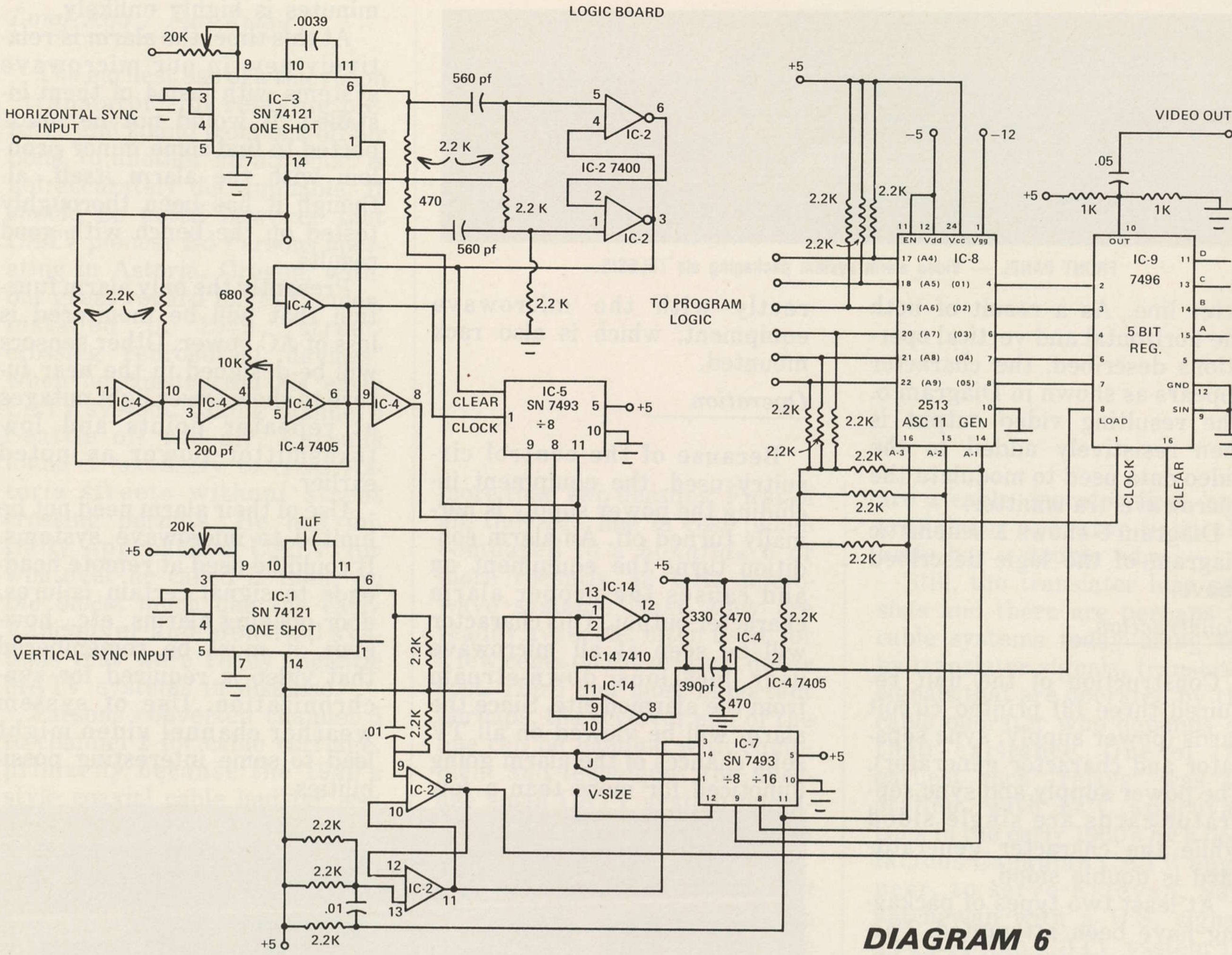
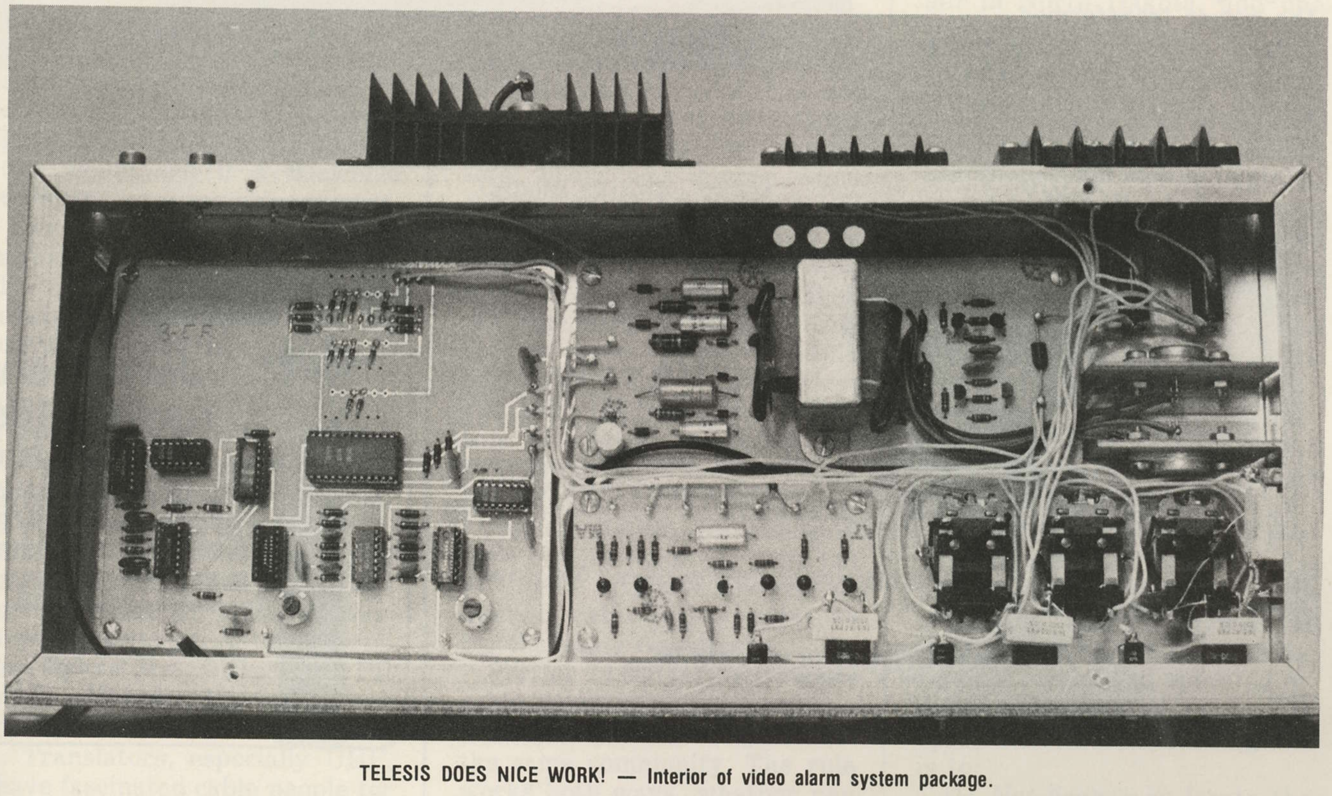
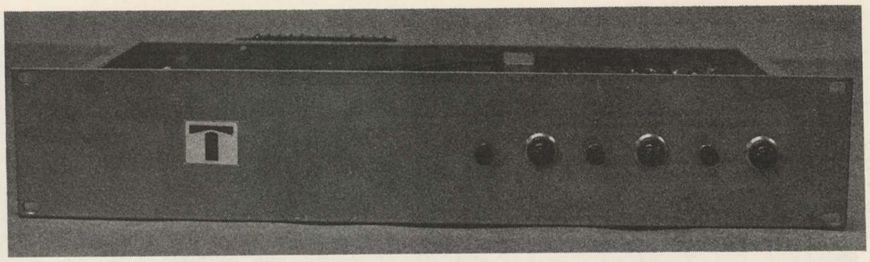


DIAGRAM 6



TELESIS DOES NICE WORK! — Interior of video alarm system package.



FRONT PANEL — Video alarm system packaging ala TELESIS.

acter line. As a result of both the horizontal and vertical operations described, the character appears as shown in Diagram 5. The resulting video output is then resistively added to the video data used to modulate the microwave transmitter.

Diagram 6 shows a schematic diagram of the logic described above.

Construction

Construction of the unit required three (3) printed circuit cards (power supply, sync separator and character generator). The power supply and sync separator cards are single sided while the character generator card is double sided.

At least two types of packaging have been attempted. Packaging layout appears to be unimportant; however, *it is necessary* to provide for ventilation of the power transformer.

Rack mounting of the equipment seems to be the best approach since it will be used directly with the microwave equipment, which is also rack mounted.

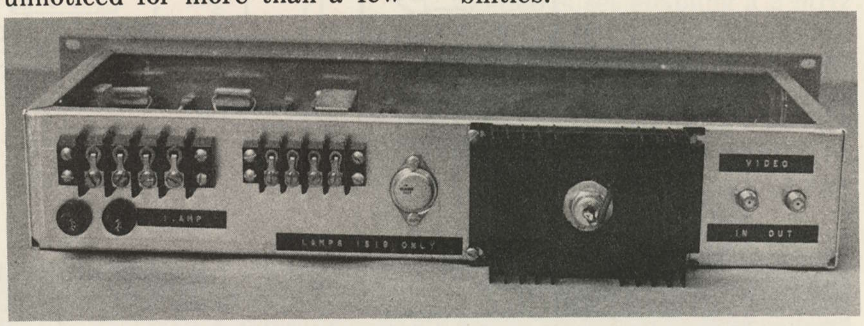
Operation

Because of the control circuitry used, the equipment including the power supply is normally turned off. An alarm condition turns the equipment on and causes the proper alarm character output. This character will be seen at all microwave user locations down-stream from the alarmed site. Since the alarm will be viewed on all TV sets, chances of the alarm going unnoticed for more than a few minutes is highly unlikely.

At this time, the alarm is relatively new in our microwave systems with just 4 of them installed. It would not be unexpected to find some minor problem with the alarm itself, although it has been thoroughly tested on the bench with good results.

Presently the only alarm function that will be monitored is loss of AC power. Other sensors will be designed in the near future to show tower light outages at repeater points and low transmitter power as noted earlier.

Use of their alarm need not be limited to microwave systems. It could be used at remote headends to signal certain failures, door opening alarms, etc., however, it must be remembered that video is required for synchronization. Use of system weather channel video might lead to some interesting possibilities.



REAR PANEL — Video alarm system packaging.

IS THERE A
(dirty word)
translator
IN YOUR FUTURE?

Long Ago / Far Away

The earliest use of a television "translator" for relaying pictures and sound from one off-air point to another off-air point is not accurately determinable. It should be noted however that CATV pioneer Ed Parsons operating in Astoria, Oregon, without great regard for FCC rules, installed in 1949 "street-crossing rebroadcast devices" when he constructed his early CATV system. Taking channel 5 Seattle off the air, Parsons found it necessary to cross Astoria streets without street crossing permits. He had initially approached CATV (or whatever he called it then) *by the block*, much like the early Vancouver and Montreal systems that were really gigantic MATV systems in disguise.

Parsons converted channel 5 to channel 2 for cable carriage, primarily because the 1940's style coaxial cable had far less loss at channel 2 than at channel 5. When he came to a street crossing, he dumped several thousand microvolts of channel 2 into a simple Yagi antenna, and then went across to the other side and picked it up again with another simple Yagi antenna. By terminating both ends of his in-block runs with Yagi antennas, he covered much of Astoria before the city finally gave in and gave him a permit (we would call it a franchise today).

The first UHF translator was apparently built in western Pennsylvania by some Sylvania engineers in the year 1950. By coming in on VHF (off-air) and going back out in the region of (there were no UHF assignments then) channel 50, the Sylvania engineers covered around ten miles to get their one off-air signal down into a valley community which they promptly cabled. The FCC got wind of this one, because of some inadvertent publicity given to the project by a "proud" Sylvania PR man, and closed the installation down.

Translators, especially UHF, have fascinated cable people for more than two decades. First of all, they *are* low in cost (when compared to a *bonafide* 6 or more recently 12 GHz microwave system). Next, they are readily available, often used, for a few cents on the original dollar cost. Third and most important perhaps, the receiver end of the line can be handled with equipment and techniques the average small CATV system operator can identify with and lay his hands on.

The FCC of course does *not* allow CATV systems to (1) own and operate translators in the *same community* as their cable systems, and, (2) does not allow the operation of UHF translators for "relay" purposes. The same thing applies to VHF as well. The Commission has not always been so narrow minded about co-facilities for translators. There was a time when cable companies *could* own and operate translators in the same region or area as they operated cable. The Commission changed that rule many years ago, acting largely in response to some pressure from the broadcasters and from the translator operators who did not in return also operate cable systems. There *are still a few* co-facilitated operations going on, quietly they have obtained *waivers* from the FCC and are still allowed to operate cable and translators for the same community.

Section 76.605 (a) (3) prevents cable operators from owning a cable and translator system in the same community. The rule works both ways, whether you are a cable operator first, or a translator operator first, the knife has a double edge.

Still, the translator lure persists and there are perhaps 25 cable systems today being fed by translator signals, translator signals that are operated by the cable operator who depends on their existence. One of the earliest such "relays" was installed, with FCC approval, back in the early 1960's by a now famous Canadian CATV engineer, to serve Estevan, Saskatchewan with a U.S. signal. The Estevan CATV system instigated the construction of a UHF translator *across the border* in North Dakota, and one way or the other, saw to it that when the translator was built, that it was located *so that* the UHF band signal not only served the small North Dakota community, but also managed to squirt sufficient signal across the border (and over some 45 miles) that near Estevan the cable operator was able to install his own 400 foot tower and then-exotic parametric low noise amplifier to bring the U.S. originated signal down the tower (and after conversion back to VHF) to the cable viewers of Estevan.

As noted, there are today perhaps 25 cable systems that depend partially or largely on translator "*relayed*" signals for their pictures, and the translators are owned and operated directly or indirectly by the cable operator. The trick in doing this is to:

(1) *Not* license or locate the

translator so that it serves the *same* community as the cable system.

(2) *Make sure* — very sure — that in the process of "relaying" the off-air signal(s) to your CATV headend, that some real live people get translator service along the path or along the way.

The FCC is more than a little sticky about UHF (and most VHF) translator antenna radiation patterns, and finds it *less than funny* when the translator operator applicant proposes to send his signals out over a 7.5 degree beamwidth in the direction of a *deserving* cable-served community. That looks very much like a "poor boy's microwave link" to the FCC, generaly, unless there are some special engineering showings, the translator radiation pattern *should be* fairly close to omnidirectional. Where there are obvious population concentrations only in a single direction, some modification of the omni-approach is possible, but very narrow beamwidths (such as might be produced with 20 foot dish antennas) are *certainly* suspect. It probably is no surprise to learn that any attempt to bugger-up the UHF translator signal, so that it cannot be received by anyone who happens to stick up an antenna in its radiation pattern, is also a 'no-no'. Some people have *suggested* vertically polarizing the UHF translator transmit antennas, others have looked into various techniques to scramble or invert the video and audio signals as they leave the translator. These are all bad ideas at the FCC, even if they seem to have merit for the operator.

So there are two approaches to using a translator as a signal relaying device. One is to go into or be in the translator business. Run the translator like any other business, install the equipment, and contract for service with a town or group of rural residents based upon them paying you annually or monthly for the service. When they don't pay . . . well, *that is* a problem. Most translator systems not sponsored and paid for by something called translator tax districts rely on the good will of the viewers to keep them perking. That means that you go out and canvass the area *before* the unit(s) is installed and explain that the *only* way the unit *will operate* is if *everyone* is "honest" who uses the signal, and pays *their fair share* annually for its upkeep and maintenance. One of the favorite tricks is to issue window stickers to every home that *does* pay the bill, and insist that the window sticker be placed right there in the front window. *People know who watches* the translator and who does not, the rooftop antennas are a dead giveaway. And anyone with*out* a window sticker is *obviously* a freeloader. Then every September or so, the translator people announce that *unless* all deadbeats pay up for the year by a certain date, the translator(s) *will be* shut off. By timing this just ahead or coincidental with the start of the new fall season, or the World Series, or some other big event, the people served usually get the message. Although, many translators still find it necessary to *actually shut down* for a few days every year or so to move the deadbeats out of their comfortable TV chairs and into the translator money collection point.

Like we said, that is *one* way to do it.

Or, you can take another approach, and consider the translator installation and maintenance expense as *part of the cost* of doing business with your *cable* system. Let's assume you are down the road twenty miles or so with the translator and it's off-air pickup point. In truth, what you are after is a way to get the off-air signals from the translator pickup off-air point back to your CATV headend. *Sort of like in microwave.*

If you can install the translator *and* meet the FCC requirements for the operation of the translator, and just *happen* to *also* be able to pick up the translator signal(s) at your headend and *also* use them for your cable community, you may have the best of both worlds. That is, a relatively speaking low cost relay system, no particular hassle with the FCC, and better (or the first) pictures for your CATV service area. The primary requirement for installing the translator is that *it serves somebody* directly, not through the attached customers at the CATV system some miles distant. Several operators we talked with, who are doing this today, admit that they have gone out and provided a UHF antenna and some tuning instructions for a few farm houses along the path from the translator to the CATV headend, "Just to insure that we have legitimate homes being served by the translator, homes that are not interfaced with the cable system." Most operators maintain letters of "thanks" in their files, from the farm house dwellers served, just as a "back up" to the possibility that at some future date the FCC might find the installation suspect. Others go through the subterfuge of getting the translator licenses in the name of somebody else in their business or family, although as long as the translator and cable do not serve (i.e. are not licensed to) the *same* community, this is not *really* necessary.

Some translator businesses are run very well, and they *actually* make money. That is, to be sure, the exception. But CATJ found one three-channel (UHF) translator installation that is owned by a group *not* (originally) in the cable business that operates in a region where the principal translator community has a cable system. The cable system has some 1500 subscribers, and the translator has around 500 in-town paying viewers as well. Outside of town, where the cable company does not serve, the translator company has *another* 500 "subscribers". Using this three-translator (i.e. all networks) base, this particular translator operation has also gone into four nearby (25-40 mile) small towns of from 150 to 500 homes each. Using *their own* translator signals, they have applied for *regular* cable franchises, and built the communities following accepted CATV practices. This may be part of the reason *their* translator business is viable and actually making money, when so many *are not.* The incentive to keep the translator signals looking good is very high, not only to keep the approximately 1,000 translator homes in the translator-licensed town happy, but because around the translator town four *additional* towns with an *additional* 1,000 or so cable customers are *dependent upon* the translators for service.

Dirty Word

For more than a decade, the very mention of the word translator in a cable meeting has been reason for ostersizing the speaker. That stigma is *still* there. But the fact remains that quietly (very quietly) some cable operators have found that without a friendly boost from a translator or two, their cable business might not be nearly as viable as it now is. And if the signals brought in by translator are critical to the survival of the cable system, then the quality of the translator signals is of paramount importance to the cable operator. Which usually boils down to the cable operator, where possible, *owning and operating and maintaining* (maintaining *is* the key word) the translators himself. For like the translator people who have also gone into the cable business, unless the translators are maintained and kept running *properly*, the quality of the pictures through them deteriorates badly and quickly. That fact has contributed to the majority of the problems most translator systems have had in keeping *their* own supporters.

The cable operator, with the test equipment and personnel and expertise, was and always has been a "logical owner" of translator systems. *Perhaps*, in the gradual shifting of positions in the industry, the day will return where the FCC recognizes that the *best* public interest is served when the public gets the *best* possible picture quality the highest possible percentage of the time. *If this means* full-time maintenance personnel, and full-time maintenance responsibility *for the cable operator*, that just may be the reason why the Commission *will* one day re-visit the "separation of powers" that now officially exists between translator operations and cable operations.

WHEN IS AN ANALYZER 'ENOUGH' ANALYZER?
VSM-5 Review

The Test Box

If and when a CATV system determines that it is sufficiently moved by FCC dictums concerning annualized system performance tests to do something about those tests, one of the first things a system so inclined must do is to sit down and map out the test requirements, and the equipment on hand to make the required tests.

If there is a *singular* piece of test equipment on the market today which offers the capability of making *all* tests (including a couple which the FCC has suspended from the active roster for the time being), it is the TEXSCAN/JERROLD model VSM-5 spectrum analyzer (field strength meter). Long time readers of CATJ will recall that in a past issue (January 1975) CATJ wrapped up a then running four month series on field strength meters with an analytical look at the low-cost analyzer offering from TEXSCAN/JERROLD; the VSM-1 unit. At the time we poked some harmless fun at Texscan and Jerrold suggesting that they were *determined* to call the VSM-1 analyzer a field strength meter (which they still do on the front panel of the unit) largely because we felt they might not want the "real purists" in the crowd who were accustomed to $7,500.00 do everything analyzers to turn their noses up at a low-cost "everyman's" sort of analyzer.

Now with the VSM-5 in hand, we note with interest that this hold-its-own against all comers do everything box is, like the VSM-1 junior member of the family, still being touted as a "field strength meter." Apparently they know something we do not about the marketing program for analyzers!

If the VSM-1 is *not* enough machine for the $7,500.00 fanciers, the VSM-5 can hardly be faulted for the lackings of the smaller brother version. If the VSM-1 will not read co-channel or intermod beats to the satisfaction of the enthusiasts of such measurements, *the VSM-5 will.*

Inspite of its "better-than" specification, vis-a-vis the VSM-1 "everyman's analyzer," the VSM-5 is still in a relatively compact, battery operated and field portable package. In short, it goes with you and operates even where 110 VAC power is not available and without cumbersome external battery packs, inverters and the like. And the price . . . well, it is more money than the VSM-1, but it is also a whole lot less than the $7,500.00 machines.

How It Works

At the risk of turning off readers who by now may figure "all spectrum analyzers are born

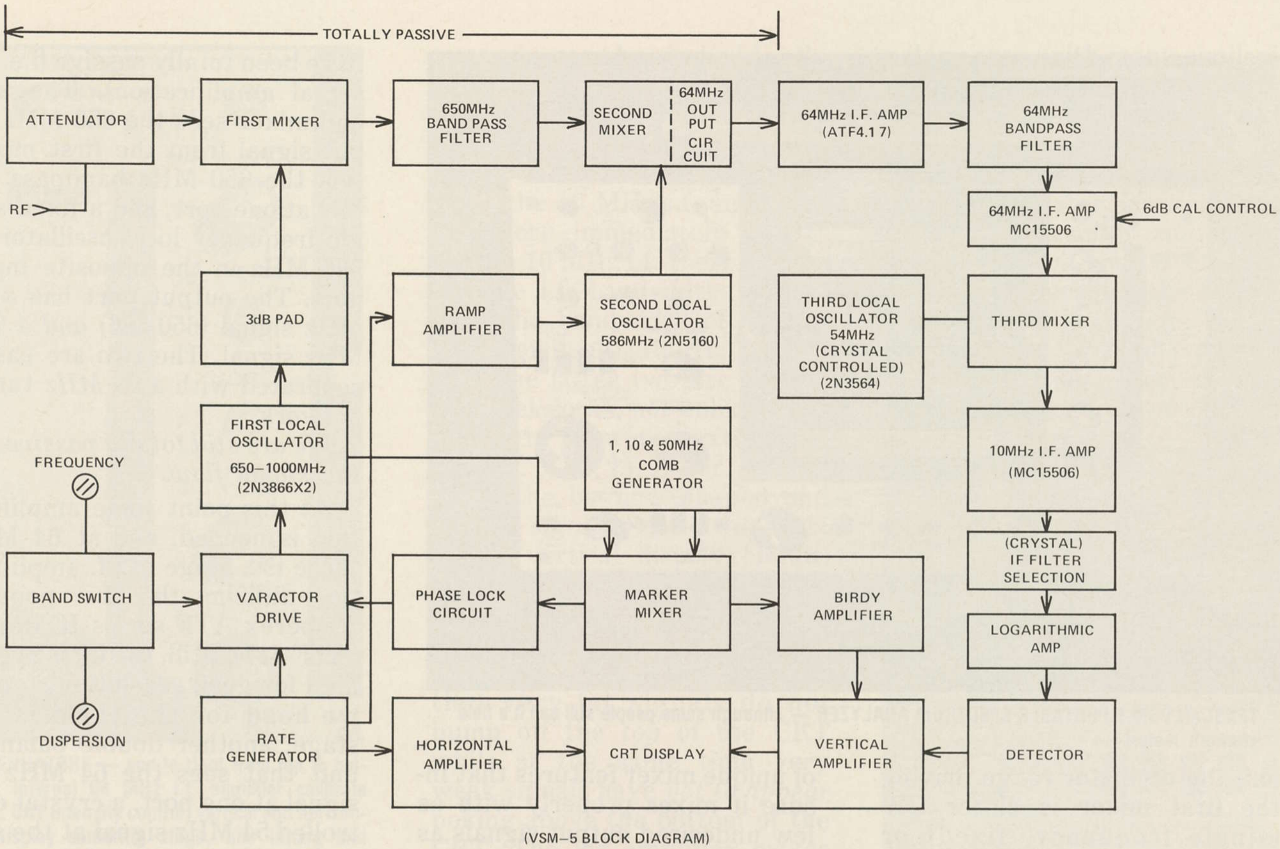


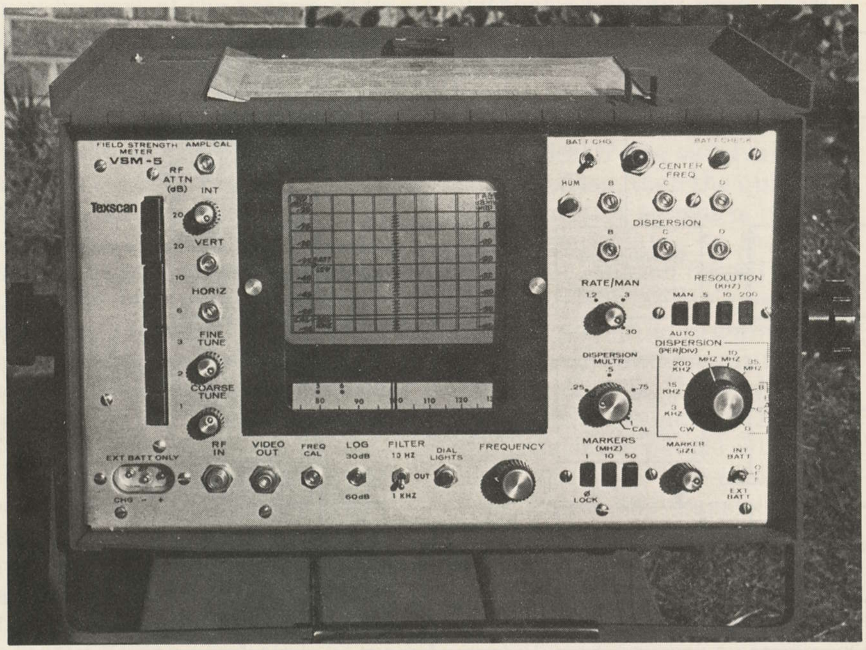
DIAGRAM 1

Device — Texscan VSM-5 Spectrum Analyzer
Frequency Range — 4 to 350 MHz
Frequency Programming — Three programmable bands (B,C,D) front panel adjustable to cover any portion of 4-350 MHz
Dispersion — 3,15 and 200 kHz per division; 1,10 and 35 MHz per division, continuously variable and CW
Frequency Accuracy — +/— 5.0 MHz with front panel calibration and tape-rule dial
Frequency Stability — After 10 minute warmup, 10 kHz per minute
Residual FM — Less than 10 kHz p/t/p; 200 Hz with phase lock
Resolution — I.f. bandwidths of 200 kHz, 10 kHz and 0.5 kHz at 3 dB points; 60 dB to 3 dB selectivity ratio 20/1
Noise Amplitude (i.e. noise floor) — —45 dBmV maximum
Noise Sidebands — Greater than 72 dB below CW signal-level, +/— 15 kHz from CW signal
Input Impedance — 75 ohms, unbalanced, 18 dB return loss or better **with** 10 dB input attenuation (or more)
Frequency Markers — 1, 10 and 50 MHz
Marker Accuracy — +/— 0.01% (i.e. 35 kHz at 350 MHz)
Measurement Range — —50 dBmV to +72 dBmV
Frequency Response — With 10 dB input attenuation, +/— 1 dB from 10 to 350 MHz
Amplitude Accuracy — For 60 dB log range, +/— 2 dB plus frequency response error
Amplitude Calibration — 60 dB log scale calibrated from —50 dBmV to +10 dBmV; 30 dB log scale calibrated —50 dBmV to —20 dBmV (**add** input attenuation for **absolute** level readings)
Selectable Attenuation — 62 dB total in 1 dB steps
IM Distortion — For two +10 dBmV input signals separated by 1.5 MHz or more, third order IM is down 70 dB or more. At separations under 1.5 MHz, third order is down 60 dB or more. For two +10 dBmV signals the second order is down 55 dB or more.
Sweep Rate — Continuously variable from 0.3 to 30 Hz per second
Operating Temperature Range — 0 to 110 degrees F
Powering — Internal rechargeable batteries (with accessory charger) provide 3 hours continuous duty use; intermittent use adequate for full day of normal testing sequences
Dimensions — 8 inches by 13 inches by 10.5 inches
Weight — Approximately 27 pounds including 5 pounds of batteries
Price — $3950.00
Source — **TEXSCAN Corporation**
2446 N. Shadeland Avenue
Indianapolis, Indiana
46219
(317/357-8781)
or
JERROLD Electronics Corp.
200 Witmer Road
Horsham, Pa. 19044
(215/674-4800)

under the same sign," reference is made to diagram 1 here. The first unit the input signal encounters in its quite long trek through the innards of the "5" is the input attenuator, a push button job that gives you various 1 dB step options from 1 dB through 62 dB. This gets the input signal in line for the display section, and as the manual warns repeatedly, it allows you to "pad down" any fat input signals so as to not (1) overload the mixer, thereby creating intermod products within the VSM-5 (this causes little blips to appear which look for the world like real life signals, but which are instead merely *spurious* beat products created by overdriving the VSM-5), and, (2) (so as to) not create such a high signal level within the VSM-5 that something goes on the fritz inside.

In a word, don't ever dump the 4-5 watt output of a CB set directly into the VSM-5. You will long regret the act.

The first mixer receives the input signal (after suitable padding) *and* from a local oscillator chain a 650-1000 MHz drive sig-



TEXSCAN VSM-5 PORTABLE SPECTRUM ANALYZER — although some people still call it a field strength meter!

nal, the oscillator range driving the first mixer is either CW (single frequency, fixed) or swept within the 650-1000 MHz range. The first mixer is of the general family of double balanced mixers meaning it is about as modern as state-of-the-art allows, and it has a number of unique mixer features that insure it mixes properly with as few undesired output signals as possible.

Following the first mixer is a bandpass filter tuned to 650 MHz and the filter in turn loads into a 650 MHz input circuit on the second mixer. So far we have been totally passive (i.e. no signal amplification). The second mixer sees the 650 MHz input signal from the first mixer (via the 650 MHz bandpass filter) at one port, and a fixed single frequency local oscillator at 586 MHz in the opposite input port. The output port has a 64 MHz signal (650-586) *and* a 714 MHz signal. The two are easily separated with a *64 MHz* tuned network.

We are still totally passive for the signal flow.

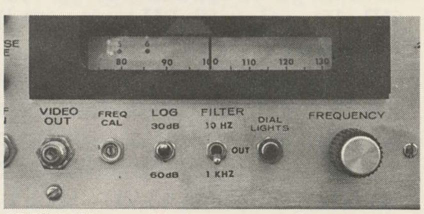
At this point some amplification is needed, and at 64 MHz there is a stage of i.f. amplification utilizing the now popular Amperex ATF series IC device (ATF-417). Still, the i.f. is pretty high for good resolution so now we head for the third mixer stage, another double balanced unit that sees the 64 MHz i.f. signal at one port, a crystal controlled 54 MHz signal at the second (input) port, and from the output spews forth a 10 MHz signal.

Up to this point we have been dealing with pretty straight forward signal amplification, filter-

ATTENUATORS — and to right from top to bottom, internal 64 MHz i.f. amplifier calibrate slug, CRT intensity control, vertical and horizontal display centering slugs, fine tuning and coarse tuning for tuneable RF range selection.

ing and mixing techniques. The VSM-5 to this point is not *all that much* different than say a Blonder Tongue UX-3 converter (see June 1976 CATJ, pages 18 to 29). Of course there *are more* conversions, but the *principals* of a UHF to VHF converter are followed closely in the analyzer to this point.

The i.f. bandwidth of the 10 MHz amplifier is 200 kHz, that is, the gain bandwidth product of the MC 15506 10 MHz i.f. amplifier is 200 kHz wide at the 3 dB points. This is too narrow for a 4 MHz broad TV channel to pass of course, but for a bunch of carriers with nothing broader than a typical FM modulation product, it is plenty wide. The trick to a high caliber spectrum analyzer is to produce sufficient selectivity so that several carriers, close together in frequency, can be individually "seen" or displayed on the CRT. Part of this is accomplished by taking a set of narrow i.f. segments "out of" the 200 kHz wide i.f. of the 10 MHz i.f. amplifier. Therefore immediately following the 10 MHz i.f. there are selectable i.f. bandwidths of 200 kHz (the bandwidth of the i.f. amplifier itself), 10 kHz and 0.5 kHz, the latter two are crystal filter networks, not unlike those found in communication receivers. The i.f. filter section sends the by now shaped and filtered signal(s) on to the heart of the vertical display circuit, the log(arithmic) amplifier. Now for the display to be really useful, we have to develop a way to "compress" the vertical scale so that very fat signals do not bump off the *top* of the CRT while at the same time very weak signals have *yet to appear* poking above the bottom of the CRT. The log amplifier makes all of this possible by tailoring the display range signal voltage with a 30 dB gain voltage shot.



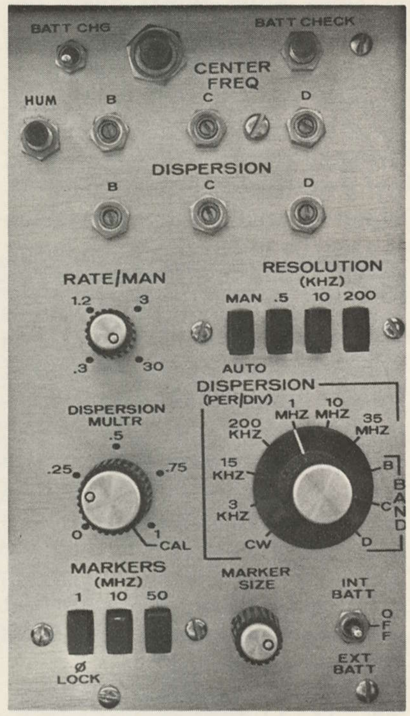
FREQ DIAL — with frequency calibration slug (lower left), 30 or 60 dB log display switch, 10 Hz and 1 kHz filter switch, and far right, tuning control.

Well, actually, there are two *separate* parallel type amplifiers in the log amp section, the 10 MHz (filtered) i.f. drives a pair of 30 dB stages. The two paralleled stages are "summed" (or added) in a clever device known as a differential (output). The output voltage that appears as a vertical (signal "present") line on the CRT is proportional to the sum of the logs (that's arithmetic talk, not Paul Bunyan talk) of the input voltages to the twin (or parallel) stages.

Now the really clever part. The summed outputs of the log amp now drives a special differential — input/ differential — output wideband IC amplifier which has twin outputs itself. These twin outputs in turn drive a *set* of HP2800 hot carrier diodes which are linear detectors. The detector diode sets are *added* and the *combined* output becomes the DC drive signal for the vertical amplifier that creates the vertical (base line upwards) display signal on the CRT.

From this point on we are either purely in the video technology area (with many similarities to basic TV set design) or we are in the "frosting" area.

The *frosting* area includes things like the 1,10 and 50 MHz (comb) generator markers, the phase lock circuitry and so on. The phase lock area is of some interest because it is this add-on that creates the *stability* that is so necessary for field measurements of closely spaced (in frequency) signals.



PRIMARY OPERATING CONTROLS — top two rows of slugs marked "B", "C" and "D" allow you to set (1) center frequency for sweep range for respective three pre-set bands, and (2) dispersion (or scan width) for each.

The phase lock technique is one of comparing an unknown *signal or voltage* with a known (stable and regulated) signal or voltage. For example, in the VSM-5 there is a 200 kHz reference oscillators with exceptional stability. The frequency and the phase of the first local oscillator (the one operating in the 650-1000 MHz range) is electronically compared to the frequency and phase of the 200 kHz reference oscillator. If the circuitry finds there is a difference in either frequency (by comparison) or phase (by comparison) an adjusting voltage (called an error voltage, which is itself a mis-nomer) is created. This adjusting (error) voltage is applied to the 650-1000 MHz local oscillator to correct the detected frequency and/or phase error. Once the frequency/phase between the two is "locked" together, the local oscillator in the 650-1000 MHz region continues to track or hold with the reference oscillator. One might wonder how a 200 kHz reference oscillator can be possibly precise enough to insure that a 650 or 1000 MHz second oscillator is not "wandering." By taking a 1 MHz internally generated (comb) signal and heterodying it against the 650-1000 MHz first local oscillator signal, and then dividing the 1 MHz comb signal by 5 (through a frequency divider network) the comparison is actually made at a much lower frequency.

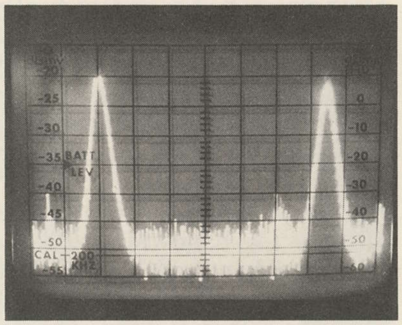
The wonder of all of this is that after all of this magic, you can still pick up the box that houses all of the electronics necessary to do this complex work, that you can operate the box in the rain or snow or sleet from a portable self contained supply, and you can use the box on the pole or in the bucket truck with the same inherent accuracy that you might find in a sterile kind of lab environment!

The Machine In Use

The VSM-5 has its detractors. People who find it *not adequate* like to point at their $7,500. or $13,000. machines as the "only way to go." Perhaps it is fairer to say that *any machine* that costs less than $7,500. or $13,000. has its detractors for surely the VSM-5 has not and should not be singled out for any failings.

True. . . and that we always try to be. . . that there are *some* things you can*not* do with the VSM-5 which you *can* do with say. . . a Hewlett Packard machine. Perhaps it would be fair to say that in a succession of test instruments which you may be fortunate enough to go through in your CATV life, the VSM-5 will be the penultimate machine for you. Penultimate you will have to look up in Webster.

Or, it may be *your* ultimate



SINGLE CHANNEL DISPLAY — level is —20 dBmV and color sub-carrier is barely out of noise (just left of aural carrier).

machine. It largely depends on whether you find yourself satisfied with a 50 cent cigar or a $5.00 cigar. Like George Burns says, they both fit into his cigar holder.

The VSM-5 is a lot of box for the money. The very complete manual (which we suspect has some of Raleigh B. Stelle's handiwork in it) tells you almost everything you would ever want to know about the unit, although the theory of operation section does not track completely with the schematic diagram. The manual also has a comprehensive section dealing with how you can set up the VSM-5 to make every test which the FCC requires, including the less-than popular co-channel and intermod tests.

In making signal level checks, signal-to-noise level measurements, channel frequency response checks (requires an external broadband VHF sweep as well), hum modulation checks, radiation measurements and subscribers isolation checks, the VSM-5 type of machine is without a doubt the fastest (accurate) way to come down the pike.

The intermod beat and co-channel tests (both are performed in the same manner and indeed could be performed at the same time) are not complicated to make with the VSM-5, but are (*in our opinion*) subject to a fair amount of operator error. This is perhaps the region of VSM-5 capability where the $7,500. and $13,000. box users find the greatest picky-picky-picky faults with the VSM-5. To read *accurately* the location and level of very weak signals which are often very close in frequency to desired signals is largely a function of the selectivity and log scale range of the spectrum analyzer.

For reasons best known to the drafters of the "document" the FCC requires that any co-channels signals be down no less than 36 dB when you first take the cable carried signal out of the ether within the Grade B contour of the station. The *typical* co-channel situation offsets adjacent - geographically-assigned stations on the *same* channel by 10 or 20 kHz. This means that if you are going to accurately measure the relative signal voltage level difference between two carriers say 10 kHz apart, your analyzer needs to be able to resolve or separate two signals that close together but separated by no less than 36 dB in amplitude (and preferably *more than* 36 dB in amplitude in as much as that is the go-no go point).

The VSM-5 will do this, the "everyman's analyzer" VSM-1 will not. And the higher priced units will also do this. Where do they differ then, after you leave the VSM-1 grade of instrument? Primarily in *how far down* you can detect and measure a carrier say 10 kHz removed from a desired carrier. With the VSM-5 it is approximately 67 dB down or to put it another way, if the 10 kHz in frequency removed signal is *more than* 67 dB below the level of the desired carrier, you won't be able to display it on the CRT. Seemingly, for most fellows, that should be adequate. It is *not* state-of-the-art however, and *that* is probably the primary reason people who *claim* they will settle for nothing less than a $13,000. box look down their nose at the VSM-5 type of machine. State-of-the-art is someplace up there in the 100 dB down (at 10 kHz removed) region.

The question is, how many system operators need *that kind* of resolution? You can answer than one for yourself. . . we won't prod you.

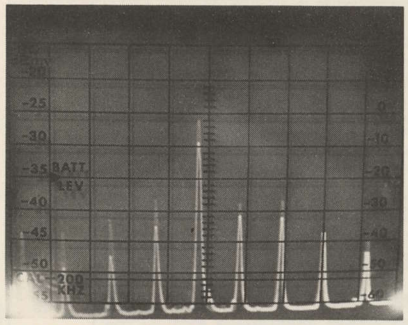
Because the VSM-5 is a field usable machine, people naturally wonder how well it will stand up to the normal shocks and rigors of field use. The manual has some sage advice that frankly you should repeat to anyone handling *any* of your test equipment:

"*Personnel unfamiliar with electronic instruments should be instructed to avoid dropping, throwing, bouncing, striking or otherwise mishandling the unit. When transporting the unit in a vehicle, care should be taken to cushion it against severe shocks that might occur.*"

Does that mean that you haul a special container lined with 3 inch foam rubber around to transport the VSM-5? Not necessarily, although that is not a bad idea. If the unit has a *designated* place on the service truck, a spot where three bolt clamps and come-alongs are not going to get tossed in the hurry to beat the rest of the crew to the watering hole at the end of the day, chances are the VSM-5 will last much longer for you. Frankly, it needs to be treated with the same respect with which you (hopefully) treat your Sony portable color receiver, maybe even a little more since unlike the Sony, you will not find a neighborhood service shop on every fourth corner.

So much for the lecture. Just because Texscan/Jerrold *insists* on labeling the front of the unit "Field Strength Meter" does not mean that you are free to treat it like your battered old SLM!

Back for a moment to the close-to-carrier measurements. As anyone who has played about with an analyzer is well aware, those beats which fall in close to the visual carrier are the worst ones to decipher with accuracy. The frequency-related (i.e. related in your mind because of known FCC/DOT frequency offset assignments) at 10 and 20 kHz offset are enough of a pain even *with* the phase lock circuit. But at least you know *where* to look for them on the screen, once you have identified the visual carrier itself. But *with* the visual carrier one *also has* those dratted 15.75 kHz sidebands created by the TV transmitter's horizontal sync pulses. As the



CARRIER AND 15.75 SIDEBANDS — note that sidebands progressively more removed from video carrier frequency (center of display) are progressively lower in amplitude.

not so hot photo and drawing here depict, they are resting either side of the visual carrier at precise frequency intervals. The drawing (diagram 2) illustrates better than we could manage at the CATJ Lab how a carrier *not* frequency related to either co-channel offset or the 15.75 kHz sidebands might appear. In diagram 2 it is conveniently mid-15.75 spaced so it shows up as a non-consecutive carrier present approximately 39 kHz *above* the visual carrier. If the visual carrier level in our drawing was 0 dBmV at this point, the intermod beat would be down (right hand scale on CRT display) 50 dB. Now as we move closer and closer to the actual carrier itself, which we shall assume is stronger on our display than any of the 15.75 sidebands, we begin to run into

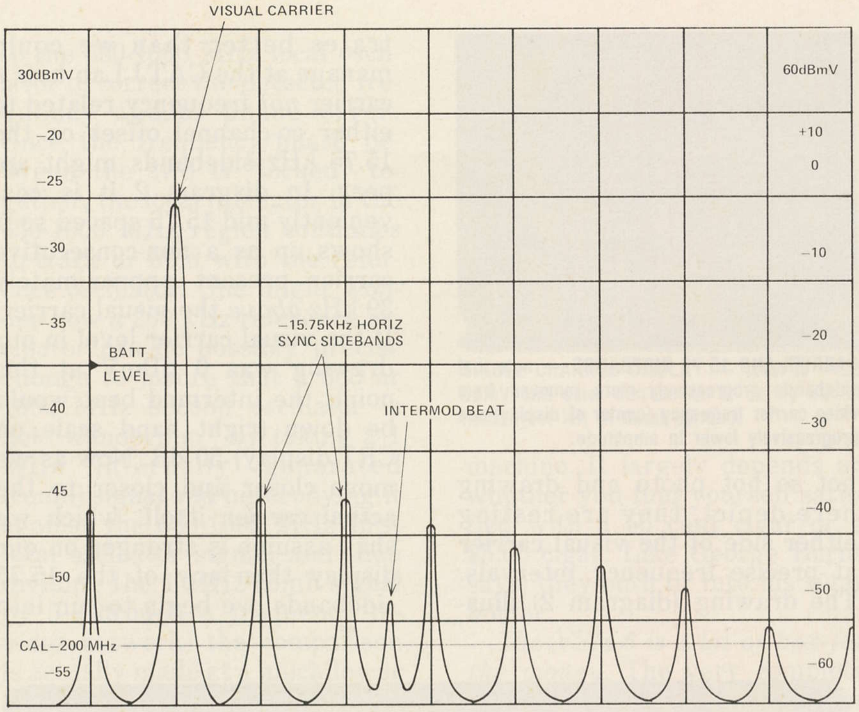


DIAGRAM 2

the resolution problem. At 15 kHz either side of the carrier, the VSM-5 can detect (i.e. display) the presence of culprit carriers that are approximately 72 dB lower in amplitude than the main carrier.

By 10 kHz away, we are down to 67 dB amplitude differential for display coherency. At 5 kHz away we are down to approximately 62 dB. Obviously at some point below 5 kHz away we lost the ability to resolve signals that are anything but almost the same level; and even at that, at some point the two carriers are going to "marry" as in one or be lost in "noise sidebands," and we can no longer separate them.

Any analyzer has this problem...at *some* point. The infinite analyzer (i.e. the machine that can resolve VHF carriers only hertz apart and widely separated in amplitude) is not yet a reality in the CATV world, or any other for that matter.

We dwell on this point largely because there tends to be confusion amongst those now looking seriously for perhaps the first time at analyzers over this very point. It is a trade-off, yes. You spend more money for better ability to resolve closely spaced-in-frequency but widely separated - in - level carriers. Where *you* draw the line on how much *you* will spend will depend largely on where you draw the line as to your *real* requirements. Everyone would like to own an ultimate machine, but when was the last time you observed a water buffalo flying!

One Cute Test

There is one "cute" test with the VSM-5 which we particularly like. That is the hum-mod test. Having lugged our share of display scopes and portable power packs and calibration equipment into unsuspecting subscribers' homes to check for whether or not we met the 5% hum mod test, we were delighted to find that to make a hum-mod check on your system with the VSM-5 you need the following:

(1) A CW carrier on the system (i.e. a pilot carrier)

(2) The VSM-5.

You set the VSM-5 up as you would to read the level of say a single visual (or whatever) carrier. Then you press a red colored button marked HUM. Looking at the display screen, you observe whether the flat trace line (flat with respect to horizontal-straight) is out of flat at all. *If it is*, you observe how *many* graticule marks or *parts* of a graticule mark it deviates and *that is your hum-mod* as a percentage.

Alignment

Anyone getting into regular analyzer use should be just as concerned about the *maintenance* on the unit as he is on the day-to-day operating capabilities of the device. For, while it is unlikely anybody will play drop kick with the VSM-5 and then attempt to patch back together the parts into a working machine, we all know *and expect* to find occasional adjustments that should be made to keep a unit as complex as the VSM-5 functioning according to specifications.

Can you do it in a normal CATV shop?

The normal manual for the VSM-5 contains general instructions for field adjustment of the following areas:

(1) Low-voltage power supply settings

(2) High-voltage power supply settings

(3) CRT focus adjustment

(4) CRT intensity (i.e. brilliance of display) adjustment

(5) Rate generator adjustment (the rate generator provides the timed waveforms which drive the horizontal circuits of the CRT and the varactor drive for the diodes which sweep the 650-1000 MHz first local oscillator to 'scan' the analyzer through the frequency coverage range)

(6) Horizontal Gain adjustment

(7) 30 dB offset adjustment (operating adjustment for the 30 dB log amplifier).

What you can*not* do, with VSM-5 manual information supplied, is fiddle with the RF (including attenuators, mixers, bandpass filters and any RF/i.f. gain stages), the detector or varactor drive circuits (other than the rate generator that provides *drive to* the varactor drive circuits).

The power supplies are probably the most common adjustment points, there are supplies delivering +26.2, +11.3, +9.2, +5.3 and —3.7V DC. There is also a high-voltage supply that delivers +4250 volts to the CRT anode. Instructions indicate that you must have (lower) voltage-reading capabilities down to .05 volts / .1 volt accuracy. This type of accuracy is *not common* unless you have one of the newer digital voltmeters; so when you are planning your VSM-5 test equipment *budget*, if you don't have a DVM in the shop, *include that in your budget* amount.

Other than the DVM, you will also need the ability to read a 60 microamp current for the intensity adjustment, a Tektronix 545 equivalency scope to set the rate generator, a 5 kV probe for the VTVM/DVM measurement of the CRT anode voltage, and a calibrated signal level source capable of providing a (calibrated) —50 dBmV level RF carrier for the 30 dB offset adjustment.

Finally, the manual suggests that you *should* also have a frequency counter "good to 1000 MHz", but then the manual neglects to tell you what to do with it. Setting up the 650-1000 MHz first LO (in the CW mode), the 586 MHz second LO and the 54 MHz third LO plus the 1,10 and 50 MHz birdy markers seem like natural spots for a counter's use. But *without* manual instructions, or even discussion, you probably would be better off to leave them alone anyhow. If you need to determine whether or not either the 650-1000 or 586 MHz oscillators are *functioning*, a piece of RG-59 as a probe inserted nearby to the circuit, and coupled to a $59.00 drug store TV with a UHF tuner would tell you that. Setting the 54 and 10 MHz oscillators (the 1 and 50 MHz markers are derived from the 10 MHz base) are crystal controlled, and for general all around work even if you knew what to do when you got into the package, a 100 MHz counter would more than suffice here.

The bottom line of test equipment is that you really should plan your own entry into any spectrum analyzer area by *including* the necessary analyzer test equipment, sort of to test the test equipment. It is kind of foolish to graduate into the analyzer era without being able to maintain your choice of unit in proper operating calibration.

Synopsis

The previous CATJ review of the VSM-1 (see CATJ for January, 1975) touted *that* unit because it brings visual displays of wide band signal levels to the hands of the system technician and engineer. Where the user might find the VSM-1 lacking (i.e. for some of the FCC testing requirements), the VSM-5 should fill the bill.

TECHNICAL TOPICS

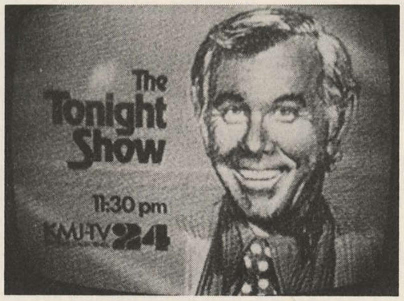
WHERE YOU FIND IT

"Have just read your extremely interesting 'Margin of CATV'; in which you made reference to a particular phenomenon called 'Knife Edge Refraction.' I couldn't help but recall some distant but totally regular reception that occured when I was living in Menlo Park, California. Menlo Park is 171 airline miles from the Bear Mountain (California) transmitter site of KMJ-TV, channel 24 in Fresno. In spite of this considerable distance, KMJ-TV was a regular signal at Menlo Park using a CW-1001 antenna and a 15 dB gain pre-amplifier (see photo).

If you look at a map, you find that the KMJ signal crosses over 4,213 foot tall Mount Hamilton (Lick Observatory is there). Because the Fresno transmitter site is 3,713 feet above sea level, the Mount Hamilton on-path protrusion can be 'seen' by both ends of the circuit; i.e. the KMJ transmitting antenna and my location at Menlo Park. Of special interest perhaps is the fact that at Lick Observatory there are three massive metallic domes (part of the observatory). Perhaps the peak plus the domes created the knife edge situation.

While living in Menlo Park and doing home antenna installations, I found that Menlo Park is the center of the KMJ signal; north or south of the community and KMJ disappears. And the two other Fresno UHF transmitters, located 30 miles north of KMJ's site, were not received; not even a trace. Their path to Menlo Park fell far north of Mount Hamilton of course.

Because Fresno was the closest TV market carrying the locally blacked-out Oakland Raider



(i.e. unsold out) football games, it was especially pleasing to be able to sit there within ear shot of the Raider home games and enjoy the games from Fresno!

John S. Phillips
PHILLIPS TELEVISION SYSTEMS
Pleasanton, Ca. 94566

John —

That story reminds us of "our" favorite knife-edge story. Seems a fellow building a CATV system in Angels Camp, California had found an area measuring 20 feet by 25 feet adjacent to his headend where he too found KMJ's channel 24 signal; all alone (i.e. no other Fresno signals), at a 126 mile distance. He installed a 7 foot parabolic but had only 30-40 microvolts of signal (although it was rock steady). So he built one of the early fore-runners to the modern day 20 foot parabolic antenna (see CATJ for July 1974) **which just about filled up the area where he had found signal. Then because there were horses and cattle running loose in the field where his headend was, he constructed a simple three wire barbed fence around the antenna. As he was finishing up the antenna a local resident drove to the top of the hill, climbed out of his pick-up truck and strolled over.**

"That's one of them radar things, ain't it," **the local resident queried.**

The cable operator glanced up, looked at his new twenty foot redwood strut dish and answered affirmatively.

"I was in the Navy and we used to have them on the ship," **the local went on;** "Boy-howdy they were powerful things."

A fiendish glint entered the cable man's eye as the local proceeded to crawl through the new barbed-wire fence and stroll into the focal point area of the antenna.

"Do you recall what they taught you in the Navy about getting too close to these antennas?" **the cable man asked.**

"You mean about getting sterile or something?" **the local asked, as he walked around the small feed antenna, studying it.**

"Yup — that's what I mean," **responded the cable man.**

"Yeh, they told us that the radar antennas were so powerful that if a fella got in front of them he might never be able to have any children," **remembered the local.** "Say, how long would a fella have to stand here before that happened?"

The cable operator smiled. "I'd say you've got maybe ten more seconds. . ."

Within ten seconds the local was over the top of the fence, into his beat up old pick up truck and headed back down the hill.

And the cable operator never had another visitor at his headend site and years later people in Angels Camp still cautioned others about journeying to the "top of TV hill." P.S. The local ex-Navy man has had four kids in the interim and all are healthy, normal kids; well, as normal as one could expect with him as their Dad!

CHART RECORDER FAN

"Recent articles on CATV systems utilizing chart recording systems to supplement tedious system performance testing, and to facilitate day to day complaints and problems at specific subscriber locations prompted Lakeland Cablevision to invest in a chart recorder.

We chose the Heathkit Strip Chart Recorder model IR-18M, a kit. This is a less expensive chart recorder than CATJ has previously reviewed (**see CATJ for May 1975 and March 1976**), but it fits our needs perfectly. Now that our system has been using the unit for several months, we wonder how we ever got along without it!

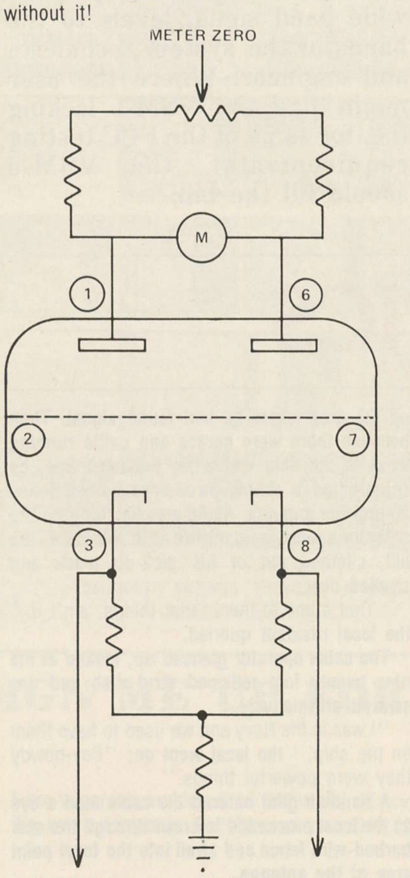


DIAGRAM 1

The IR-18 utilizes 10 inch wide recording paper, with a 140 foot roll. The chart paper is scaled from 0 to 100. This is a multiple speed recorder that has 12 speeds from 5 to 200 seconds per inch and 5 to 200 minutes per inch.

In our system we wished to "mate" the IR-18M with our Jerrold 704 signal level meter. The chart recorder requires a 10 mV balanced input line for proper operation, so we set out to find such a signal source in the Jerrold 704.

See diagram 1. V4, a 12AU7, has the proper voltage **source**, although the voltage present is

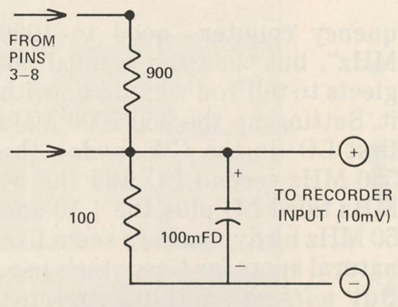


DIAGRAM 2

too high to drive the 10 mV input of the chart recorder. You can solder two wires to pins 3 and 8 of the 12AU7 to bring out the necessary drive voltage for the chart recorder. Bring them out into a set of 704 mounted banana jacks, or into a Cinch Jones plug, or most any two-circuit (open) plug you may have handy. Take care however, not to short the two take off leads together as this might damage the 12AU7.

To bring the voltage down to the 10 mV range required to drive the IR-18, see diagram 2. This is a voltage divider circuit that provides the proper 10 mV "signal" for operation of the chart recorder.

The recorder has the capacity to record any signal-voltage in the 1 mV to 10 mV range. We chose the 10 mV range because it seems to offer adequate sensitivity for our purposes. By operating the 704 so that it reads around 0 dBmV real signal level, you can manually adjust the IR-18 controls so that the recording line is on virtually any position on the chart recorder paper.

For slow recording speeds, we have found that a ball point pen sold under the Pentel label is superior to most recording applications. A regular ink pen will dig into the paper at slow chart recording speeds and felt tip pens we have tried tend to blot when first used and then dry out. Alternately, Heath has special pens they sell for us with the recorder.

Anyone having any problems is invited to give us a call."

Garret W. Johnson
Lakeland Cablevision, Inc.
Detroit Lakes, Mn. 56501

Garret —

We are pleased that the industry is beginning **to make use of the chart recorder device for system maintenance. As you note, once a person has used one, he instantly wonders how he ever got along without it. The price of the IR-18M kit from Heath, incidentally, is $189.95. If a system put it into service only one hour per week, in one year's time you would pay for the machine at a rate of less than $4.00 per hour.**

KUDOS TO KYLE

"The July CATJ CATA-torial dealing with the history of small town theater operations was square on the mark. I have lived in the theater business all of my life, although cable TV has become an equally important part of my life in recent years. Perhaps the independent program producers will save small town theaters... perhaps not.

In the meantime, we like many other smaller-town CATV system operators will move ahead (with caution as you suggest) into the Pay Cable area. After several decades of battling with the movie going public who complain if you show fairy tales, or complain if you show too much violence, and spits on your floors and sticks gum on your seats...there is a particular joy about delivering the movies into their own homes, where they can clean up their own floors and peel the gum off their own chairs!"

John Thompson
Atoka Cablevision
Atoka, Ok. 74525

And write on their own restroom walls!

An Honest Reply to An Honest Report

An article entitled, "Where are we with Multimode? (An honest phase II report)" appeared in the March 1976 issue of CATJ. The article starts with a statement that a horizontally polarized wave front beyond the visual horizon area no longer remains horizontally polarized. Interestingly, this phenomenon has troubled antenna engineers for the past seventy years. The problem first arose when it was found that at a large distance from a transmitting "Beverage Antenna" (a **simple** long horizontal wire antenna over ground) the polarization is no longer horizontal but vertical. In fact better reception was obtained by a vertically polarized antenna, than with a horizontally polarized antenna. Sommerfield (**1**) was the first to explain the phenomenon theoretically in 1908. Recently Sarkar and Strait (**2**) have published quite a few reports which actually compute the transmitted field strength at various distances for any degree of vertically or horizontally polarized antennas. It can be shown that the ratio of the vertically polarized wave field strength to the horizontally polarized wave transmitted from a horizontally polarized transmitter is approximately proportional to the ratio of the horizontal distance between the transmitting and the receiving antenna, to the **vertical height** of the horizontally polarized transmitting antenna above earth. It is also true that the depolarization effects would be more pronounced for high frequency of operation and for high conductivity and dielectric constant of the earth. For example, depolarization effects would be more pronounced over sea water than over a desert terrain for the same operating frequency. In fact, this possibly could be the reason why fading appeared due to depolarization for the (illustrated) KGO channel 7 in San Francisco over a 100 mile path over wet ground as the conductivity of wet ground is much more than that of dry ground. The randomness of the fading could be explained due to the change of the refractive index of air depending on the conditions of that day.

From the above discussion **it is quite apparent** that a circularly polarized antenna **would give a better reception** in the fringe areas than horizontally polarized antennas.

Next the authors of the article in the March issue go on to explain why two helices are bad and that the bottom line of stacking circular antennas by this way is that you do it in mul-

(1) **A. Sommerfeld, "Partial Differential Equations in Physics," Academic Press, New York 1964**

(2) **T.K. Sarkar and B.J. Strait, "Analysis of Arbitrarily Oriented Thin Wire Antenna Arrays Over Imperfect Ground Planes," on Contract F19628-73-C-0047, AFCRL-TR-75-0641, Syracuse University, Syracuse, New York 13210, December 1975.**

tiples of four. They even went on to explain why there is a problem with two helices by quoting an example from Kraus even though it was inapplicable to their experiments. Their explanation of the observed facts were quite erroneous.

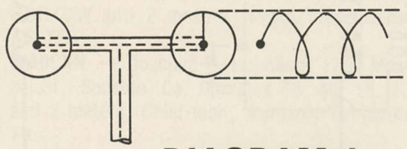


DIAGRAM 1

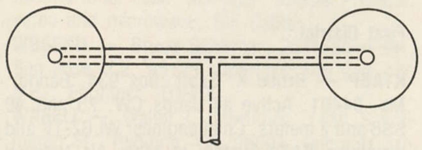


DIAGRAM 2

First the problem they experienced with two helices was not that they were combining a right handed helix and a left handed helix to produce linear polarization, but they were improperly phasing the two helices wound in the same direction, for proper phasing they have to be combined in the following way as shown in Diagram 1. Instead of combining them as presented in Diagram 1, if they are combined as shown in Diagram 2, then it is quite clear that the two voltages at the terminals of the helices would be 180° out of phase and there would be very little output. The authors **probably** drew their conclusions that two helices are bad (which is completely wrong!) from such a set-up as explained in Diagram 2. For other orientations the phase of the two voltages developed at the terminals of the helix would be different. At TACO, we have done extensive work with helices and we have found that if two helices wound in the same direction are properly phased then the gain would be 3db more than an individual one. In a similar fashion an array of three helices can be obtained. In fact, at TACO we do make tri-helical antennas model Nos. D-1386 and D-1387 for telemetry and other applications. Hence the statement that helices have to be stacked in multiples of four is completely false. If for any reason the four helices (as the authors claimed to be working) wound in the same direction are not properly phased as explained in the previous paragraphs then there would be problems even with multiples of four.

The greatest advantage of the helical antennas are that for half power beam width for both field components (i.e. for both horizontal and vertical polarization), the axial ratio in the direction of the helix axis and SWR change very little over almost a 55% bandwidth. Hence the hi-VHF, lo-VHF and the UHF band can be covered by one helix in each band.

The helix may be quite bulky for the VHF bands. But for the UHF band where most of the problems occur, the length of the helix would be approximately 30'' with the diamter of the ground plane being approximately 19''. Hence this is a very practical and useful antenna in the UHF range. We might have a little problem at the ends of the UHF band since the UHF bandwidth is 61.8%. But the helices could be designed to include one of the ends of the UHF band.

Next the authors mention about the possibility of using a QUAD antenna for circular polarization. First of all the QUAD gives only linear polarization. The cross-polarized component of a quad is extremely small because the voltages generated on the vertical arms of the quad are in phase opposition to each other. Hence according to diagram 11 presented by the authors, there is no way that the QUAD could deliver an appreciable vertically polarized voltage at the terminals.

The cross-polarized Yagis seem attractive since everybody in the TV area are quite familiar with them, but it seems that they are quite touchy and it is extremely difficult to phase them appropriately for circular polarization over a large band of frequencies.

Hence it seems that the helix has a great potentiality to generate circular polarization over a broad band without impairing its field pattern.

Tapan K. Sarkar
Technical Appliance
Corporation
Sherburne, N.Y. 13460

Mr. Sarkar —

Marconi once observed to a gent by the name of Godley who was about to journey to Scotland to listen for the first Trans-atlantic shortwave radio signals, ''My boy, we are all but amateurs and I too am one.'' **To that we would add,** ''Some of us are more amateur at our endeavors than others, and to this end we would hope that those who are more proficient would not belittle the attempts of those less capable. . . for they (**like Godley**) might just possibly discover something worth pursuing.''

Beverage antennas (which incidentally Godley employed in Scotland in his first-ever-reception of shortwave signals across the Atlantic) **may be a whole-lot-more complicated than the 'simple' you attribute to them. One could draw a mathematical analysis of the Beverage and conclude with some 'honesty' that this antenna might well be considered a helice in disguise; especially when one considers the very real ground effects of such an antenna.** (A Beverage antenna is a design that stretches a very long wire in a straight line from receiver towards the transmitter; the transmitter-end of the Beverage antenna is grounded, through an impedance network approximating the load effect of the antenna itself. The receiver end is inductively coupled to the receiver. Beverage antennas are employed widely for LF and low HF work and probably remain today one of the most effective 'simple' antennas for long-haul work in the 50-2,000 kHz range.) **But to assume that signal polarization integrity as observed with Beverage antennas in the 19 ought-ought era is comparable to the polarization integrity problems at VHF and UHF is, we feel, a mistake. As generations of 'amateurs' have discovered and re-discovered, skywave** (i.e. HF via skip) **transmissions are anything but polarization-constant. This is true at 100 kHz and this is true at 100 MHz. This is** not at issue; **for multi-path effects created by multiple reflection points within the ionosphere seldom if ever have any bearing upon tropospheric paths such as we must contend with at VHF and UHF.**

As noted, in the March report, we reported our observation that two helices were bad but one or four were good. You take exception to this. **In our tests, repeated over several months, here is what we found. By observing the 205 mile path signal level on KODE, channel 12, in Joplin, Missouri, we were able to** simultaneously **observe the signal levels on an ''in-line'' channel 11 in Tulsa, Oklahoma. When we switched from a single circular antenna to two antennas** (i.e. stacked), **the channel 11 signal** (87 miles) **went UP by the expected stacking gain of 2.5-3.0 dB. But at the very same time, the channel 12 signal, over the longer 205 mile**

path, went down. And if you did instantaneous measurements, there were times where it was as much as 20 dB lower in level with two antennas than it was with a single antenna. If, as you suggest, the antennas were "improperly phased," one would logically expect both signals to go down by a similar amount. Yet they did not. **To which we deduced that by phasing the two circular-logs, we had in fact destroyed the circular integrity of the singular antenna(s). We stick by that observation, especially when we subsequently found that there are occasions** (perhaps 1-1.5% of the total time) **where the two antennas did produce 2.5 to 3.0 dB additional path gain.**

All of this suggets to us that the antennas were functioning correctly but that perhaps we do not yet **understand the modulating-influence of the transmission medium; the troposphere.**

ON THE FLIP-FLOP

"Pleased to see articles on use of quads and helical antennas in CATJ (**see October 1975 and March 1976 CATJ**). This reinforces our own confidence as we have been using quad antennas for three years on Buffalo stations (155 miles) and our findings agree with those in the CATJ articles. We are planning construction of a helical antenna (per CATJ March) on one Buffalo channel. CATJ is the best technical magazine on CATV available. Keep up the excellent work!"

M.A. Spence
Maclean Hunter Cable TV
Midland, Ontario
L4R 1Z5

Mr. Spence —

Anyone planning construction of helical antennas would do well to see page 60 of April (1976) **CATJ as well, updating our detailed construction plans in the March issue.**

NOT RENEWING

"I am not re-newing my CATJ subscription because after 23 years in the CATV business I am getting out. The New York State Equalization and Tax Board raised my tax assessment $11,000. last year. I sold my entire system, with new cable and on my own poles, for $13,000., or the equivalent of one year's cable service gross income. I sold it for 29% down and the balance. . .so the bastards won't get it all. I am quitting in disgust. . .I've had it."

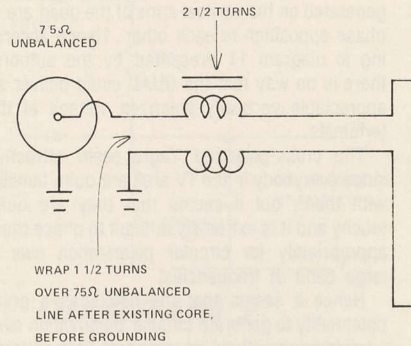
H.H. Hammel
Lindley, N.Y.
14858

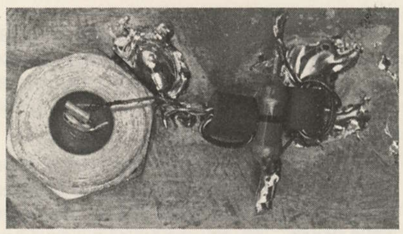
Mr. Hammel —

In the last ten years, six out of every ten new 'jobs' were created by the federal government. Therefore the majority of the "new" tax payers are now paid for their endeavors by the tax collection agency. Your former 220 subscriber system is but a sacrificial offering to the increasing expansion of big government, at both state and federal levels. We fear the worst is yet to come.

ONE MAN'S BALANCE

"Recently CATJ carried discussions concerning the instant problem presented when someone tries to make critical (in level accuracy) CATV line radiation measurements (to check for compliance with FCC requirements), when one is using a balanced type of 75 ohm dipole (and





conversely an unbalanced 75 ohm downline and meter instrument).

The enclosed data shows a very high quality straight 75 ohm balanced (one side) to unbalanced (other side) transformer which can be put together in the CATV system shop. The measured specifications are as follows:

Conversion loss	—	Less than 0.1 dB
RTL (match)	—	Greater than 25 dB
Bandwidth	—	5 to 800 MHz

The unit shown here was constructed on a piece of circuit board (G-10 will do), single sided. The windings are loose-twisted number 30 wire bi-filar wound on an MO=850 bead.

Hansel Mead
Q-BIT Corporation
Melbourne, Fl. 32901

Hansel —

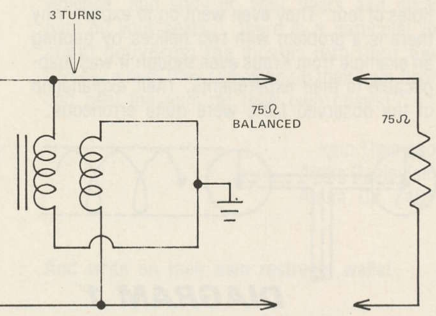
Of all of the busy suppliers we know, you are the most consistently "helpful" to the guy at the system-bench we have run across. Thanks for your genuine concern for the guy at the bench!

MORE HAMS

The June 1976 issue of CATJ contained an up-dated listing of Ham (or amateur) radio operators employed in CATV and related industries, largely people who are Ham radio operators, and who **also** read CATJ. This was the outgrowth of a February 1976 CATJ "card query" in which we asked readers to register with us if they happened to be amateur radio operators, promising nothing in return but the opportunity to be put in touch with fellow "CATV types" who shared the common interest.

At the 1976 industry annual gathering in Dallas, the folks at **TOMCO** (Mountain View, California, supplier of headend gear) allowed us to set up a small registration area where hams in attendance could register with us, and receive a nice three inch multi-colored badge that identifies a fellow as a "Ham In CATV".

From little acorns large trees do grow. And thus we come to this up-dated list of "additions" to the **CATJ Hams In CATV Roster**. To make this list work properly, **add** all of the following to the June CATJ listing appearing on pages 44 to 46.



MEAD'S TRANSFORMER

First District

K1AGP — Bruce K. Scott, Box 934, Bangor, Me. 04401. Active all bands CW, 75 and 40 SSB and 2 meters. Chief engineer WLBZ-TV and maintains CATV system at Main Air National Guard in Bangor; maintains 34/94 repeater at WLBZ-TV site.

K1BNQ — Jim Monahan, 20 Edlie Ave., E. Norwalk, Ct. Operates 40 CW, Production manager International Microwave Corp.

WA1MNL — Stanley P. Lapin, 176 Broadway, New York, N.Y. 10038. Operates 80-10 and 2 meters; VP Engineering Microband (MDS).

Second District

WB2YIK — William D. Cooley, 300 First Ave., Vestal, N.Y. 13850. Operates 80-3/4 meters, ATV, RTTY, FM, SSB, CW and OSCAR. Technician for Newchannels Corp., interested in skeds.

VP2SM/W2 — Vincent L. Bacchus, 130-72 227th St., Laurelton, N.Y. 11413. Operates 80-10 meters, mostly 14.280, SSB, CW, RTTY. Manager Field Repair and Service Department, CORAL; interested in weekend skeds.

Third District

W3HTE — Tony Rutkowski, % FCC Cable Television Bureau. 1919 M Street NW, Washington, D.C. 20554. Operates 40 CW, employed in Cable Television Bureau engineering group.

Fourth District

K4QWK — Grady E. Gardner, Jr., Rt. 1, Box 287, Laurinburg, N.C. 28352. Operates 80-3/4 meters, SSB, ATV, RTTY, OSCAR. General Manager Community Antenna, Inc., interested in skeds; operates 07/67 repeater on CATV headend tower.

Fifth District

K5BFT — Robert T. Williams, 16922 Creekline Drive, Friendswood, Tx. Operates 75 and 15 meters; Manager Engineering, Cablevision Construction Corporation.

WB5KEJ — Russell H. Dodson, 403 N. West, Cordell, Ok. Operates 80-10 and 2 meters; Chief technical staff, Dorate, Inc.; interested in skeds.

WA5MYF — C.L. "Brownie" Brownlow, 403 E. Main, ElDorado, Ok. 73537. Operates 75 thru 2 meters. Owner El Dorado TV system; interested in skeds.

Sixth District

WA6BIN — James R. Meek, 1129 Piedmont Ave., Pacific Grove, Ca. Operates 80-10 and 2 meters. Bench tech, MPTV.

W6BWB — Jay Shaffer, Felton, Ca. 95018. Operates 80-3/4 meters. Bench tech, TelePrompTer of Santa Cruz.

W6CMJ — Paul E. Leake, Sacramento Army Depot, Sacramento, Ca. 95813. Operates HF SSB/CW and 2 meters. Project engineer, AFRTS.

WA6CXN — Joachim H. Hofmann, 1752 Mescal St., Seaside, Ca. Operates 80, 40, 15, 10 and 2 meters. Chief tech, Monterey Peninsula TV.

W6DFI — George E. Sears, 225 Union Ave. #139A, Campbell, Ca. 95008. Inactive, but returning to air soon. Manager, Special Projects, video and microwave, Gill Cable.

WB6EKU — Bruce Schirmer, 2641 Carol Dr., San Jose, Ca. 95125. Operates 146 and 440 MHz; Engineer, TOMCO.

WA6ELI — Walter L. Mortimer, 1438 Sacramento St., Redding, Ca. 96001. Operates 10-15-20 meters. System Tech, Finer Living; interested in skeds.

K6HJU — "Jr." Ruchuck, Box 532, Felton, Ca. 95018. Operates 80-10 SSB/CW and 2 FM. TelePrompTer CATV, Santa Cruz.

WA6KYZ — Edward K. Tipler, Box 1613, Ridecrest, Ca. 93555. Operates 144,220 and 432 MHz. Engineer, China Lake Cablevision.

W6LWA — Robert J. Kreis, Sacramento Army Depot, Sacramento, Ca. 95813. Operates 80-10, 6 and 2 meters. Radio-TV Engineer, U.S. Department of Defense.

W6NTI — Ronald L. Manning, Sacramento Army Depot, Sacramento, Ca. 95813. Operates "all" bands. Project Engineer, AFRTS.

Seventh District

W7ILH — Serg Ticknor, P.O. Box 21652, Phoenix, Az. 85036. Operates 80-6 meters. President, Wideband Engineering, Inc.

W7KCZ — Hilmer Taxdahl, 21617-88th Avenue West, Edmonds, Wn. 98020. Operates 80-10 meters and 2 meter FM. With Cablevision Services.

WA7ZIO — Larry E. Royal, 2500 NW Regency #91, Bend, Or. 97701. Operates 40 and 15 CW. Technician, Central Oregon Communications Systems; interested in skeds.

W7ZQB — Jack C. McKenna, Box 267, Mt. Vernon, Or. 97865. Operates 75 and 2 meters. Owner Blue Mtn. TV Cable Co.; interested in skeds.

Ninth District

WA9HCU — Charles Nydegger, 122 S. Washington St., Crawfordsville, In. 47933. All bands, especially 6 and 2 meters. Engineer, Crawfordsville Community Cable.

WB9MEM — Arnold Hobson, Jr., 122 S. Washington St., Crawfordsville, In. 47933. Active 6 and 2 meters; Technician, Crawfordsville Community Cable.

W9NKX — Anthony C. Fratia, 633 W. Center St., Paxton, Il. Operates 75, 40, 20, 10 and 2 meters. Co-owner Paxton Community Antenna System.

WA9OGD — Red Hurmon, 413 Chesnut St., Fairbury, Il. 61739. Operates 160-10 meters. Chief Technician, Cable Television Company of Illinois.

Tenth District

WØAKB — Neil A. Webster, 314 S. River Park Dr., Guttenberg, Ia. 52052. Operates 80, 75, 40, 20 and 10 meters. Partner, Guttenberg TV Cable System; interested in skeds.

KØELB — Vernon Duffy, Mexico, Mo. 65265. Operates 75-10 meters, SSB. Consultant, See TV Co.

WBØJAE — Ron Hutsel, Mexico, Mo. 65265. Operates 160-10 and 2 meters. Plant Maintenance, See TV Co.

WØKMJ — Ernest A. Sivesind, 901 Walnut St., Decorah, Iowa. Operates 80-2 meters; Owner J and E Cable Co., Inc.

KØMUL — Bill Clough, Mexico, Mo. 65265. Operates 75, 40, 15 and 10 meter SSB and SSTV and 2 meters. Chief Tech, See TV Co.

Canadian

VE2ARN — Peter Hame, 149 Principale, Ste. Agathe, Des Monts, P.Q. Operates 2 meters. Owner Laurentide Cable Ltd.

VE3AQN — Ian MacFarquhar, 1906-40 High Park Ave., Toronto, Ont. Sales Engineering, Comm-Plex Electronics, Ltd.

VE3EA — M.A. Spence, 410 Elizabeth St., Midland, Ontario L4R 1Z5 Manager, Maclean Hunter Cable TV.

VE3HHV — Norman Duncan, 238 Cranbrooke Ave., Toronto, Ont. M5M 1M7. Operates 20, 15 and 10 meters. Marketing Representative, Anaconda CATV Ltd.

VE3AMJ — Nick Waite, 93 Victoria St., W. Allison, Ont. Operates 160 CW/SSB and 2 FM. Manager of Borden Cable Television Ltd.; interested in skeds.

VE5QZ — Denny Tretiak, 2034 Wascana St., Regina, Sask. Operates 80 and 20 meters; Design Engineer, Sask. Tel.

CATV vs. FIBER OPTICS

Optical (Fiber) Advances

One of the most touted operational advantages of a CATV system is its ability to carry a wide spectrum of signals (typically 50-300 MHz in a modern system) simultaneously. The practical limits of wide spectrum carriage are *largely active electronics;* that is, the cable itself has no particular characteristics which limit useful spectrum space to the 50-300 MHz range. Rather, the amplifiers which show up at regular intervals along the system are by nature limited to useful amplification curves in some portion of the total spectrum which is smaller than the typical cable-useful spectrum.

As much as cable exceeds the channel capacity of a single television station (i.e. *40 plus* channels for one facility versus a *single channel* per station for broadcast TV), the same ratio exists in another order of magnitude with a new emerging technology known as *fiber optics.*

Fiber optics technology is approximately ten years old. In a fiber optics system, the transmission medium is a glass-type "cable" which replaces the familiar "coaxial" cable utilized presently in CATV. The frequency range of signals "carried" by a fiber-optics cable system is in the "light range." That is, rather than carrying RF signals as we know them, in our present 50-300 MHz region, all "carriers" transported by fiber-optic "cables" are in the micron-meter (micrometer) region (a micron-meter is 1/1,000,000 or one-millionth of a meter). Frequencies in this region are far above that range normally associated with "RF" (for comparison, 100 MHz is approximately the wavelength equivalent of 3 meters; UHF TV is in the 0.7 to 0.5 meter region.)

At such exceedingly high frequencies, normal coaxial cable techniques simply will not function. On the other hand, anyone with a powerful spotlight on a dark night is "transmitting" a "signal" in the same *general* frequency-range as we are dealing with in a fiber-optics transmission system.

A standard television signal requires a 6 MHz wide spectrum for full carriage of all necessary modulation information. *Without regard* to receiver interfaces or amplifier capabilities, the modern CATV system is *capable* of transporting 41-plus such 6 MHz wide channels in the 50-300 MHz region. This would be a "fully loaded" system based upon current CATV technology.

The fiber-optics bandwidth is measured in terms of "thousands of megacycle - equivalents." Rather than the capacity to carry (i.e. transport) say 41 TV channels simultaneously, the fiber-optics transmission medium is capable of handling perhaps a thousand channels at one time. Obviously, that is more channels than anyone could ever use for standard television signal transportation; but the capacity *is* there.

The development of the fiber-optics transmission medium, or the "cable," has been underway for about ten years. In the earliest "cables" the losses per increment of measurement (typically measured in dB loses per foot in the early days; then per hundred feet and most recently per kilometer) were very high. Today the advances in fiber-optic "cable" technology has advanced so far so fast that the losses being quoted are down in the 1-3 dB per kilometer range. A kilometer is equivalent to 1,000 meters or roughly 3274 feet.

The earliest fiber optic cable commercially available, *Corguide* (Owens-Corning), now has losses of approximately 20 dB per kilometer; and it is priced at around 70 cents per foot. This is commercial cable you can buy today. At the same time Siemen's has developed in their lab a 1.35 dB per kilometer cable, Corning has another laboratory cable with 2.0 dB per km and Bell Labs reports a 1.06 dB cable per km.

Additionally, Corning believes the present Corguide cable will come down to 10 cents per foot (for the 20 dB per km loss cable) shortly, as production increases.

So today you can build a fiber optic transmission medium, with 20 dB loss every 3,274 feet, for 70 cents a foot for the "cable"; and shortly you will be able to build the same system at 10 cents per foot for the cable. This compares favorable with a .500 style trunk line for pricing (roughly $100.00 per thousand feet) but losses (0.61 dB per 100 feet) are far better (i.e. lower). The trade off, interfacing not included, is that rather than carrying 250 MHz of spectrum (with a capacity of 41 TV channels) the fiber optic "cable" would be capable of several thousand "MHz" of spectrum space with the capacity for perhaps 1,000 channels.

When the 1-3 dB per km cables become available (and that should be within 1-3 years) at prices near those of the present Corguide "cable," the long-haul advantages to fiber-optic systems become evident. If you were spacing "amplifiers" at the *present* 22 dB spacing employed by many CATV systems, you would go 24,009 feet between amplifiers (4.55 miles).

All of this sounds a little bit like a fairy tale. It would be if the commercial interest in fiber-optics were not so high. In particular, the telephone industries are looking at the ability to multiplex hundreds of thousands of telephone conversations *along with* hundreds of TV channels *all on one fiber-optic cable.* One whole large metropolitan area such as Tulsa could be served with a *single* "cable." With those kind of rewards at the end of the R and D period, the investments in time and dollars at this point seem minuscule by comparison.

The "cable" is only part of the new hardware or technology required. One early problem, for example, was "splicing" sections of cable together. Unlike CATV splicing where fittings can be employed, the fiber optic system employs coherent strands of fiberglas material. The light beams travel through these strands and when there is a junction or splice the coherent light from one strand must mate exactly with the corresponding strand in the second piece of cable. Otherwise there are high "splice/transfer" losses. The solution to this problem comes from an apparently little known company in Banning, California called Deutsch Company. Early attempts at splicing cables involved grinding down the ends, buffing them to a smooth close tolerance finish and then glueing the two ends together; *precisely.* That was a bad, critical (for field application), lossy approach. The Deutsch people have developed a plastic cylinder that allows a matrixing of the two ends together in a "butting" arrangement; and connector losses are now *down to* 0.3 dB per "splice connection".

Getting signals into and out of the fiber optic cable is another problem to be totally solved. Light sources are introduced into one end, carried by the fiber optic cable as long as the source power overcomes the cable attenuation; and then a "line amplifier" is required to re-amplify the attenuated signal. So far it sounds like a CATV plant. A line amplifier is more of an optical box than an electronics box however; it takes coherent light at a

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.

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Burnup & Sims, Box 2431, W. Palm Beach, FL. 33401 (**S2, S7, S8**)
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DELTA BENCO CASCADE INC., 40 Comet Ave., Buffalo, NY. 14216 (**M4, M7, M8, D3, S8**)
ENTRON, INC., 70-31 84th Street, Glendale, N.Y. 11227 (**M4, M5, D4, D5, S8**)
FARINON ELECTRIC, 1691 Bayport, San Carlos, CA 94070 (**M9, S9**)
GAMCO INDUSTRIES, INC., 317 Cox St., Roselle, N.J. 07203 (**M5**)
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JERROLD Electronics Corp., 200 Witner Road, Horsham, PA. 19044 (**M1, M2, M4, M5, M6, M7, D3, D8, S1, S2, S3, S8**)
Kay Electronics Corp., 12 Maple Avenue, Pine Brook, N.J. 07058 (**M8**)
LRC Electronics, Inc., 901 South Ave., Horseheads, N.Y. 14845 (**M7**)
Magnavox CATV Division, 133 West Seneca St., Manlius, N.Y. 13104 (**M1**)
Microwave Filter Co., 6743 Kinne St., Box 103, E. Syracuse, N.Y. 13057 (**M5, bandpass filters**)
MID STATE Communications, Inc., P.O. Box 203, Beech Grove, IN. 46107 (**M8**)
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Manufacturers:

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low level, amplifies the light waves to a higher level, and then sends them on down the "Cable" to the next amplifier. To modulate the light beam, a multi-plexing approach is used wherein all of the desired carriers (such as at the head end) are introduced at one time into the cable via the light transportation mode. This is not dissimilar to the AML *approach* to CATV microwave. But the input transducer or the output point(s) demodulator is unlike anything we are familiar with.

The fiber optics rate of technology advancement is so rapid that at the present time there are studies underway to deal with the practical problems of protecting fiber optic cable from the environment. Two installations are nearing completion in the United States; one by Bell near Atlanta and another by GTE in California. Other systems, including one long-haul system, are under construction in Europe.

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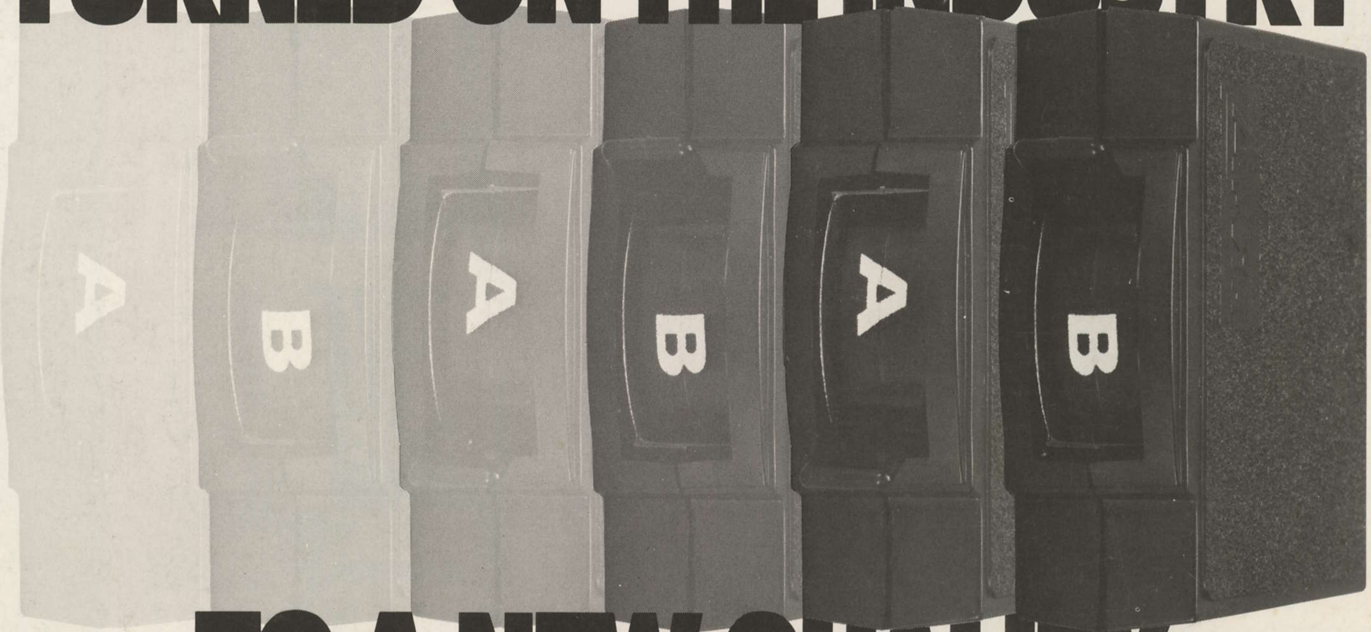

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