CATJ

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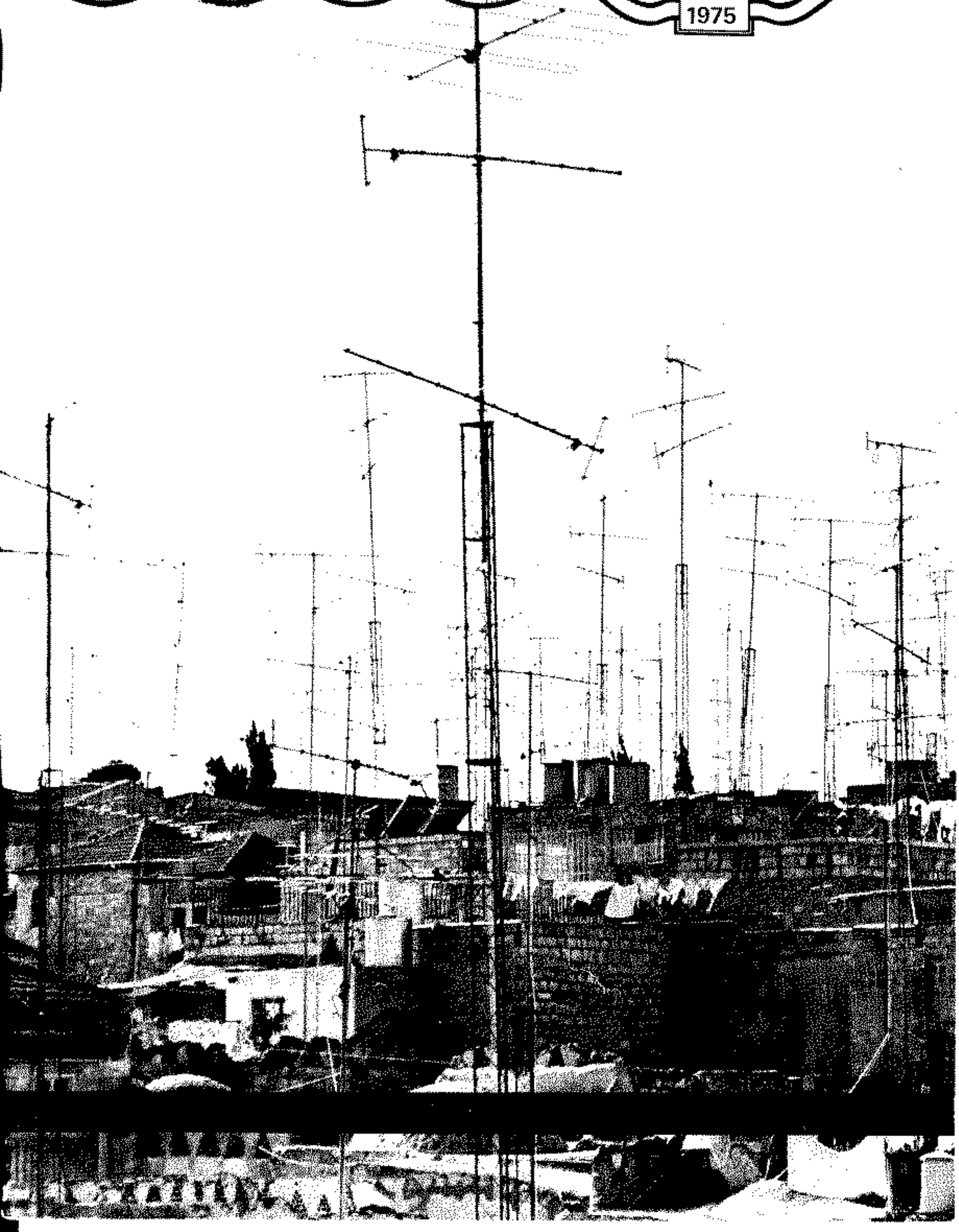
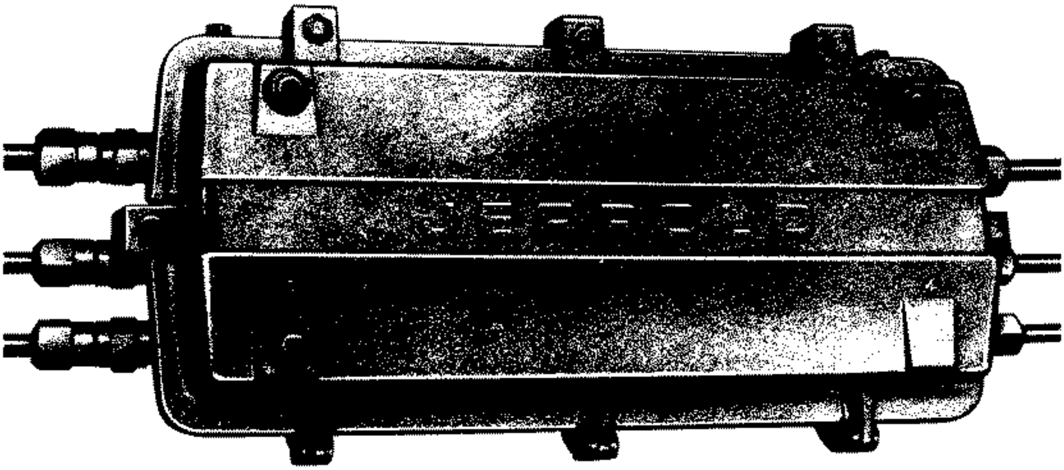
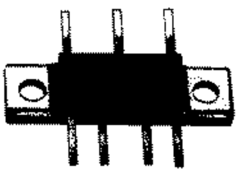


A GREAT BUY IN DISTRIBUTION SYSTEMS



Starline 20/300 distribution systems combine superior performance with timely engineering innovations.

ADAPTIVE POWER CONTROL provides continuous power to CATV distribution amplifiers for interruption-free service to subscribers by automatically adapting to, and compensating for, overvoltages and transients; also protects power supplies and amplifiers from damage and substantially reduces costly maintenance. Patent pending.



THE QUAD, a convenient IC, combines the reliability and performance benefits of ICs with unprecedented versatility. For new systems, typical noise figure is 8 db with nominal 30-channel output of 48 dBmV per channel. For difficult drop-in rebuilds, the quad will provide —on a custom-tailored basis—up to 28 db minimum full gain.

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—CONTENTS—

OUR COVER

Somewhere out in this big wide world this community exists; waiting for an enterprising cable entrepreneur to drop in and pick up the franchise. A free CATJ Headend Wall Chart to the first correct guess as to where this community is!

CATA-TORIAL

KYLE D. MOORE, President of CATA, INC.

HUNG UP ON POLES

If there is any singular problem which traces back to the earliest CATV systems in Pennsylvania and Oregon, it is the pole-attachment problem. Early pioneer Ed Parsons of Astoria, Oregon, inaugerated **his** CATV system service on Thanksgiving Day, 1948. To cross streets in Astoria, **without a permit,** pioneer Parsons set up a small yagi antenna on one side of the street, fed from his tapped trunk line, and "squirted signal" across the street to a companion receiving yagi that fed into a piece of cable that served the next block. To make his way along each block, Parsons attached to trees, backyard fences and house eaves. Thus Parsons in 1948, aware that the telephone utility owned the poles, and the town owned the streets, avoided both the utilities and the town fathers. Life is not that simple anymore.

Part of this industry is wooing the FCC to "assert jurisdiction" over CATV/utility company pole attachment contracts. **This part** of our industry wants uniform, **national** pole attachment formulae, which would lead to uniform principals of determining attachment rate bases, and seemingly, uniform national pole attachment rates. With the FCC involved in the "jurisdictional administration" of such "uniform contracts" the feeling is that everyone would stay honest. To his credit, FCC Chairman Richard E. Wiley has again and again asked that the two sides (NCTA, speaking **they** say for the CATV industry, and, AT&T speaking for its affiliated companies) **go back to the bargaining table.**

AT&T wants no part of FCC "jurisdiction assertion." They also probably want no part of cable, but they are too far along now to simply kick us off their poles.

The history of FCC involvement in cable is resplendent with examples of the FCC mouthing "an inch" and "swallowing a mile." And our fear is that if they assert pole jurisdiction, and it sticks after the **sure** court-test, that this industry will long wish we had never asked for their "help" in the first place.

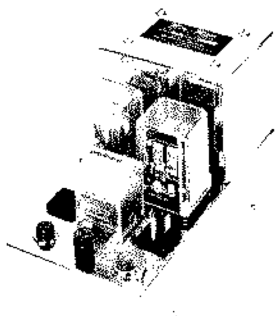
A national uniform pole attachment rate is inherently unfair; to someone, someplace. If pole attachments go for $2.00 each in Oregon and $6.00 each in Florida, and the national uniform rate becomes $4.00, Oregon operators are mad and Florida operators are happy. If poles cost less to purchase, cost less to install, and last longer (with longer depreciation term) in Oregon than in Florida, the Florida operator goes into business **expecting** to have higher pole-attachment rates. But a national, FCC administered pole rate base becomes a subsidy for Florida operators (in our example, we choose Florida only for illustration). They win, Oregon loses.

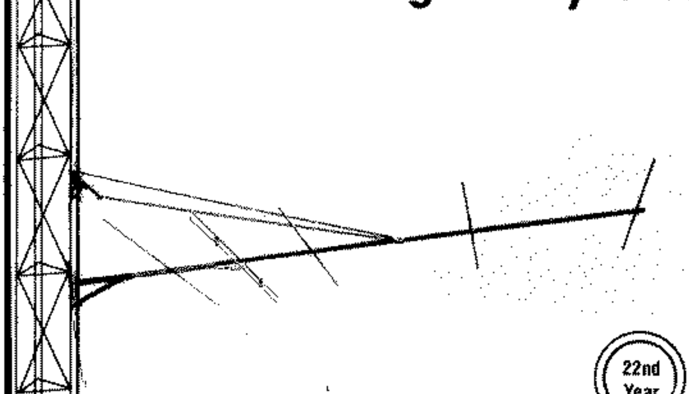
To our point of view, we as an industry have no business trying to nationalize poles. Sure, this industry could produce hundreds of specific examples of utility company heavy-handedness. Many utilities have gone out of their way to keep us stirred up, and they give us grief daily. And even **if** this grief originates in **one** master corporate planning center, are we **really** better off trading **possible relaxation** of that grief for FCC administration and national pole rates that end up being subsidies?

Sitting down with AT&T is probably constructive. But it should be done on a state (or, at largest, a regional) basis. In that way we talk about pole costs that relate to **that area,** problems that relate to **that specified region,** and we settle on rates that reflect the state or regional costs involved. And most important of all, we avoid the FCC's needless meddling. Something that Chairman Wiley himself shows every indication he wishes to avoid.

And what about power companies? Kentucky CATV operators **may** have the answer to that one. They have obtained a ruling from their state Attorney General which says that Kentucky municipalities have the **legal right** to institute and follow through on condemnation proceedings for utility poles in that state. After condemning the poles, the Kentucky municipalities would purchase the poles in their towns, and then re-let space (i.e. rent it) back to the power, telephone and CATV companies. This has the attraction of keeping pole rate negotiations on the **local** level.

We think Ed Parsons would have liked that idea.





For As Little As $50.00

WOULD YOU BELIEVE A LOW COST SPECTRUM ANALYZER FOR CATV?

Low Cost S/A For All People

The advantages of having access to a spectrum-analyzer-type display for regular CATV system work, or critical analysis of system desired and undesired signals are well known by all system personnel. Unfortunately, the cost factor for even a moderate-grade spectrum analyzer puts you into the four-figure numbers just for openers.

On the other hand, if you *already have* a suitable signal-level meter (virtually any CATV meter with a video-output jack will suffice), a DC-coupled scope, and approximately $50 for a Jerrold RSC-3 set-top converter and the parts required to construct your own adapter box (a sawtooth generator), *you can have a spectrum analyzer* that will get extremely satisfactory service for everyday system shop or headend work.

The Jerrold RSC-3 converter was chosen because of its ready availability; however, with minor modifications, virtually any set-top converter that employs varactor tuning diodes can be employed. The varactor is a very clever little device, because its capacitance changes with operating voltage. In the language of solid-state-device designers, the varactor is a reverse-biased PN junction diode that decreases its capacitive value as you increase the reverse bias (voltage). In any set-top converter that utilizes varactor tuning, the channel selector changes the bias voltage each time you push a new channel-selector button, thereby changing the capacity of the diode, which changes the tuning of the tuned circuit that determines the channel you select.

If you could push the buttons on the RSC-3 fast enough, you could *"sweep"* the converter through the low-band, mid-band, high-band, and super-band range. Naturally even the most nimble-fingered amongst us cannot push the buttons that fast, but we can accomplish the same thing by applying a *ramp voltage* (sawtooth) to the varactor. Then if this ramp voltage is also applied to the horizontal-input jack of a (DC) scope, and the detected output of the converter is applied to the (DC) scope vertical jack, a spectrum analyzer is the result!

Please refer to Diagram 1. The signal under test is applied to the input to the converter through a 1 dB step switchable attenuator. The addition of the attenuator allows you to make accurate measurements and to calibrate the display in precise attenuation steps. The output of the RSC-3 conver-

by
Jerry Laufer
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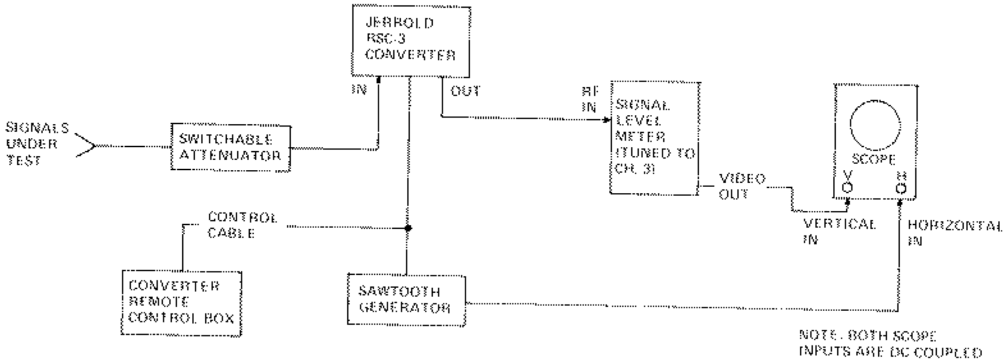


EQUIPMENT CONNECTION DIAGRAM

DIAGRAM 1

ter is connected to the input of a signal-level meter. In our tests for preparation of this report, we utilized a Jerrold 727 meter. The SLM is tuned to the output channel of the RSC-3, or channel 3. The *detected output from the SLM*, or the voltage from the video-output jack, goes to the vertical-input jack on the DC (coupled) scope.

The ramp voltage generator (sawtooth generator) drives the varactor in the RSC-3 and provides drive for the horizontal-input jack on the DC (coupled) scope. *This is the complete package*. To save on having to construct an external or separate power supply for the sawtooth generator, we "robbed" the modest requirements of the unit *from the RSC-3 power supply.*

So actually, to be in the S/A business, the only "box" you need to construct is the sawtooth (ramp) voltage generator. The box has a sweep rate control, sweep width control, and a

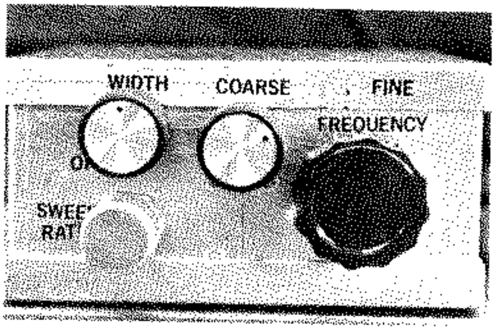
CATJ Author Award

With this construction-and-theory article detailing the design and construction of a low-cost spectrum analyzer for CATV, **CATJ** makes the first of a new series of irregular awards to be known as the "CATJ Author Award."

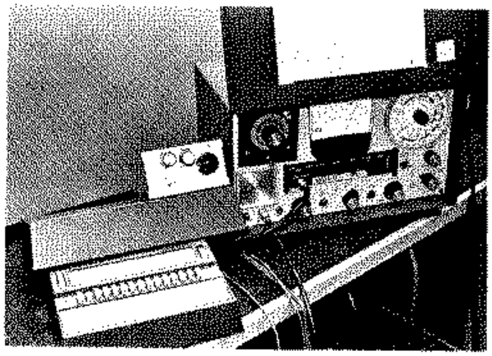
For some time now we have invited CATV technicians, engineers and system-operating personnel to submit material for publication. Laufer, no novice at preparing material for print, is one of the first to be accepted by **CATJ**.

Material to be eligible for the "CATJ Author Award" must come from a totally non-commercial source (i.e. the writer or his company must have no possible pecuniary gain potential, should we publish the material submitted). Jerry Laufer went to considerable trouble to tell you about this unit, not the least of which are the fine photographs that accompany this report. In accepting this paper for publication, **CATJ** is awarding a cash token to author Laufer in the form of an award for this contribution.

Author Laufer in San Jose



Front view of sawtooth generator


RSC-3 remote-control box (front, left), converter with sawtooth generator on top, and right, 727 meter utilized for signal detection. Scope not shown.

center frequency control. The center frequency control has a coarse and fine adjust option. There is also a provision for an external (optional to you) channel-select input. By including this option in your own box, you can select certain preset channels by pushing a button. The outputs from the box include varactor drive, sweep out, and sync out. The circuit has been constructed on a printed circuit board (see board layouts here) and is mounted in a small readily available enclosure. You might want to use a slightly *larger* box than I did; in my mania for compactness, I probably got my pot controls too close together to comfortable tuning, and you would do well to buy a slightly larger box!

Please refer to Diagram 2: the schematic diagram of the sawtooth generator circuit. The heart of the sawtooth generator is a *quad operational amplifier* (quad op amp), which has four amplifiers in one integrated circuit (IC)

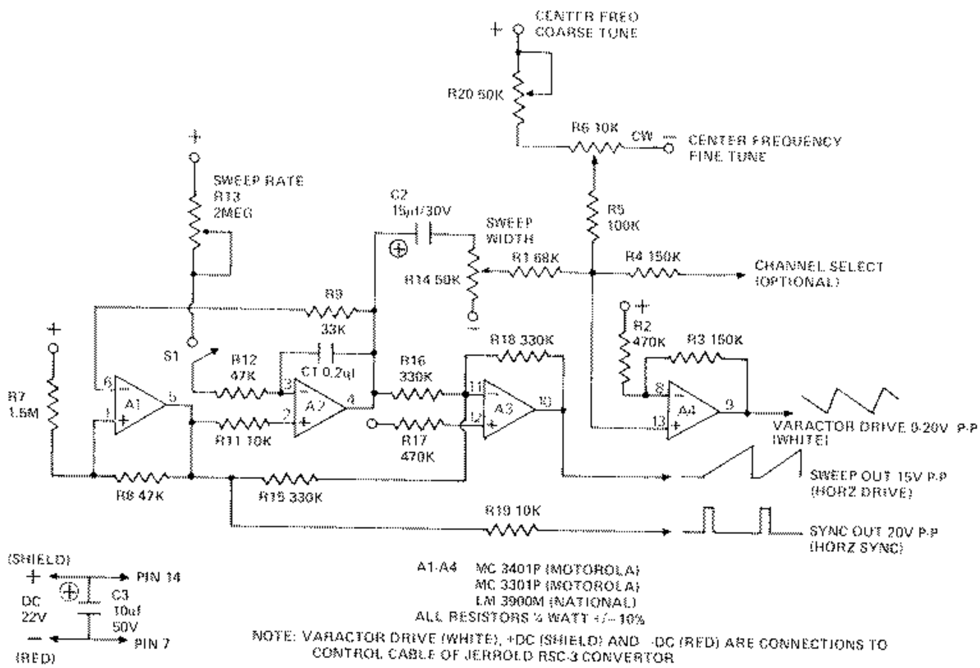
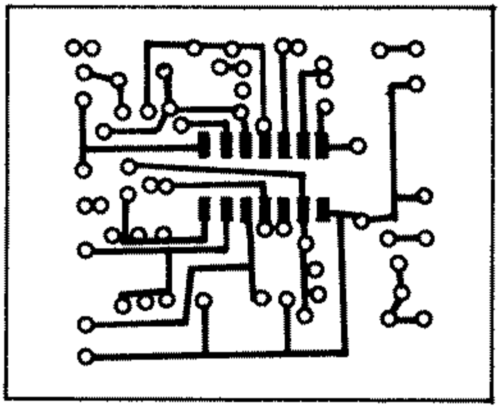
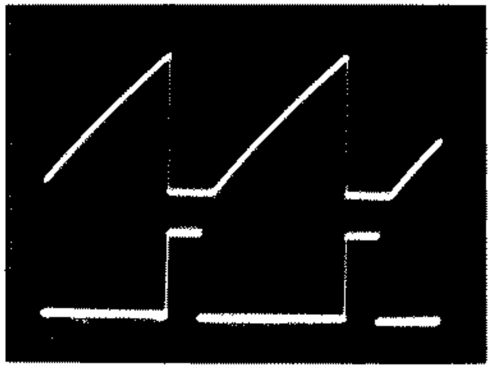


DIAGRAM 2



LOW COST SPECTRUM ANALYZER - COMPONENT SIDE OF BOARD



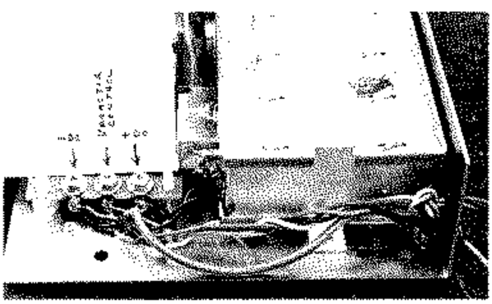
Dual-trace display of voltage outputs of sawtooth generator; lower trace is sync at 20 volts peak to peak; upper trace is sweep out (horizontal drive) at 15 volts peak to peak.

DIAGRAM 3

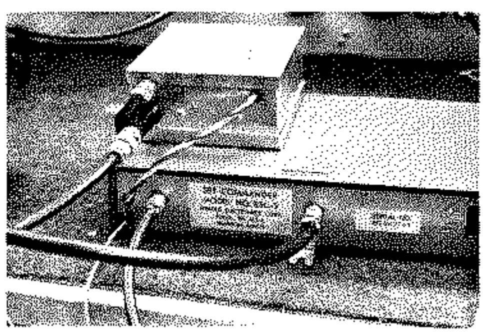
package. This 14-pin dual inline package (DIP) contains about 40 transistors, 8 diodes, 12 resistors, and 4 capacitors. If the internal portion of this unit is of interest to you, you should request data sheet *AN72* from *National Semiconductor Corporation*, 2900 Semiconductor Drive, Santa Clara, CA. (95051).

A1 and A2 form the basic sawtooth and pulse generator. R12, R13, and C1 set the frequency of the oscillation, with the sawtooth output coming on pin 4 of A2. This output is coupled through capacitor C2, R14, and R1 to the non-inverting input of A4. R14 sets the amplitude of the sawtooth waveform and determines the total frequency width scanned. R6 and R20 select the center frequency, which is added to the channel-select input. R1, R4, and R5 are summing resistors that combine all of the voltages feeding the varactor drive. The output of A4 drives the varactor in the converter. On a scope, you can see that the actual waveform is a nonsymmetrical triangular wave.)

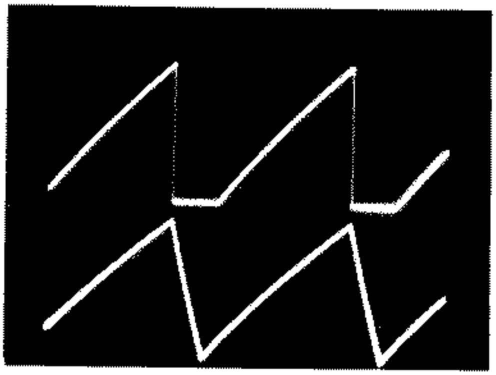
The output of A1 is applied to the inverting input of A3 through the summing resistor R15. This is added to the sawtooth output of A2 through resistor R16, which results in a fast retrace time with a wait period to allow the converter to return to the start frequency (i.e. where the sweep begins). The difference in the fast retrace for the scope and the slower retrace for the varactor drive eliminates any scope display during the varactor retrace. The scope waits on the far left



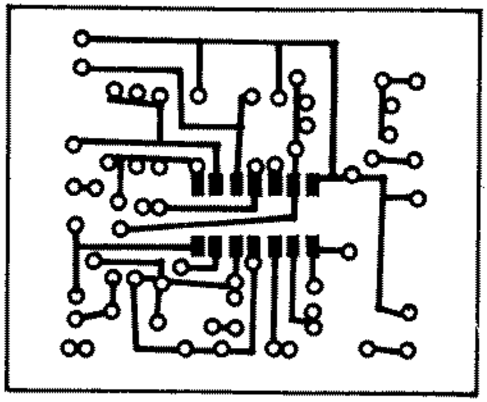
Connections inside of RSC-3. Note on far right side of photo that control wires route out of case back through hole drilled above control cable.



Package of sawtooth generator and RSC-3 converter; note horizontal-output connector and control wiring between generator and RSC-3.



Dual-trace display of voltage outputs of sawtooth generator; lower trace is varactor drive, 20 volts peak to peak; upper is horizontal drive at 15 volts peak to peak.



LOW COST SPECTRUM ANALYZER - PRINTED WIRING SIDE OF BOARD

DIAGRAM 4

side of the display while the varactor returns to the start sweep point. This appears as a momentary bright spot and a spike on the far left side of the scope screen while the varactor returns to the start sweep point.

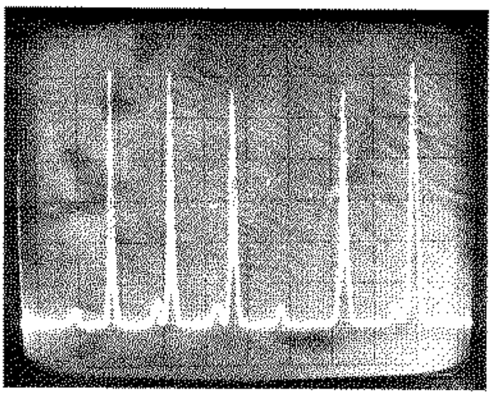
You can eliminate the retrace spike by driving your scope Z axis input or external blanking with the sync pulse. However, you must be sure of the correct polarity and amplitude and may have to add an inverter for proper operation (*).

The output of A3 provides the horizontal drive for the oscilloscope. The pulse developed by A1 is brought out through R19 to provide sync pulses if you want to use the internal horizontal (line rate) sweep on your scope.

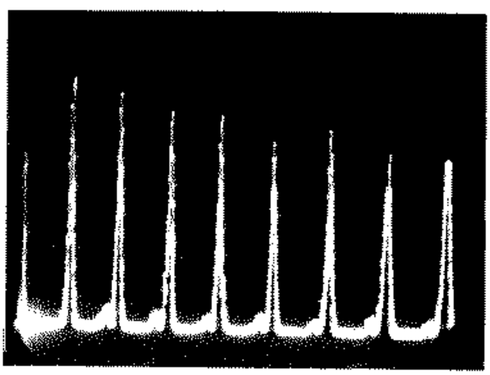
The horizontal sweep to the scope is 15 volts peak to peak. If your scope requires a larger drive voltage, you can *increase* the value of R18 until the peak-to-peak voltage available is (up to) 2.0 volts *less* than the supply voltage.

Connections to RSC-3

To connect the sawtooth generator to the RSC-3 converter, remove the converter from the case. Drill a hole in the converter chassis about 0.5 of an inch above the control-cable entry point (see photos) and install a grommet. Disconnect the *white* wire of the control cable from the middle terminal, in the RSC-3. The white wire in the



Scope screen display of low-band channels 2 (left) through 6 (right).



Scope screen display of high-band channels 7 (left) through J (right).

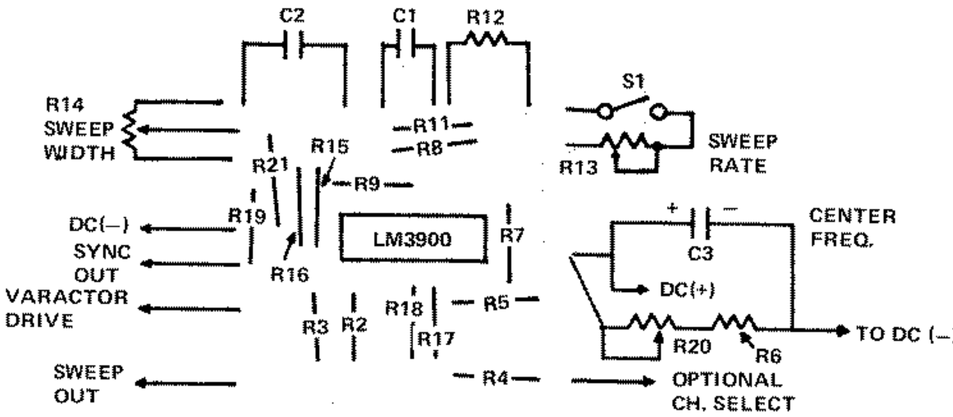


DIAGRAM 5

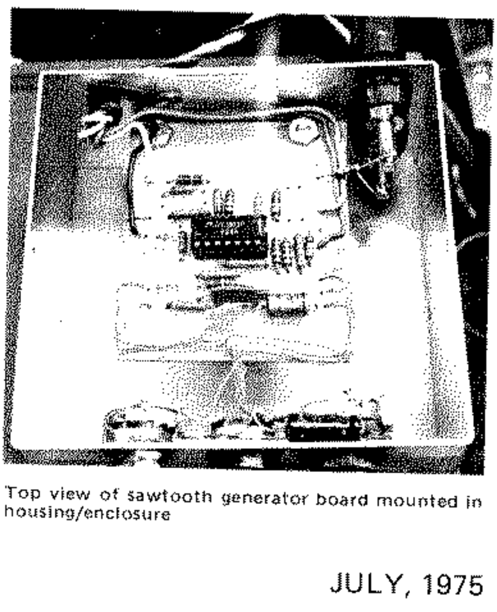
control cable is the "channel select" input to the generator that comes from the remote-control box of the RSC-3. The *varactor drive output* from the sawtooth generator is then connected to the terminal where the white wire was previously connected.

Positive DC voltage for the sawtooth generator is found inside the converter where the shield of the control cable from the remote control is connected. *Negative DC voltage* is found at the same terminal where the red wire of the remote-control cable connects.

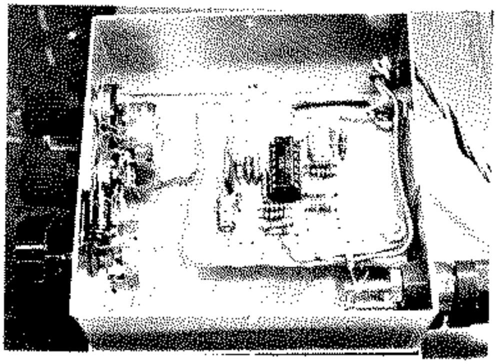
Operation

With the channel selector connected, set the width control to display about 6 MHz (it should display the visual, color-sub and aural carriers as shown in the photographs); and push button select the *highest* frequency channel you have on your system. Adjust the *center* frequency control on the sawtooth generator to display the channel (highest channel). With this adjustment made with the center frequency control pot, you can now change channels of display by simply pushing up the proper channel on the RSC-3 remote control. Only slight (if any) readjustment of the fine-tuning control or center frequency control should be required to obtain a perfect one-channel display as each channel is "punched up." To adjust the sawtooth generator for *"perfect tracking"* with the push buttons, you can adjust the values of R3 and R4. Holes have been provided in the PC board for this purpose.

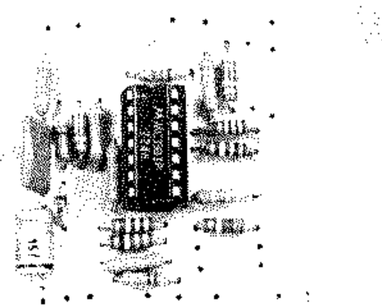
It has been my experience that a 1.5 meg resistor in parallel with R3 will set the push button tracking. To determine whether R3 or R4 should be low-



Top view of sawtooth generator board mounted in housing/enclosure



Side view of sawtooth generator board; note, as mentioned in text, that slightly larger enclosure would spread control pots apart and make tuning easier for "thick fingers."



Sawtooth (ramp voltage) generator component layout.

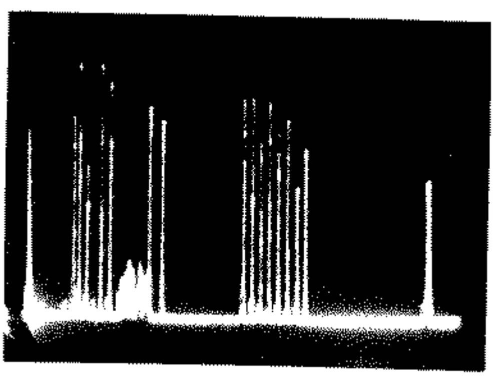
ered by a parallel resistor, set up on channel 13 as described in the previous paragraph, and switch to channel 2. If channel 2 is displayed to the *left* (on the scope display) of the *reference* display (as centered) for channel 13, the gain of A4 is *too high.* To reduce the gain, *lower* the value of R3. If, on the other hand, channel 2 is to the *right* of the *reference* channel 13 display, the gain of A4 is *too low.* To increase the gain, lower the value of R4.

Performance

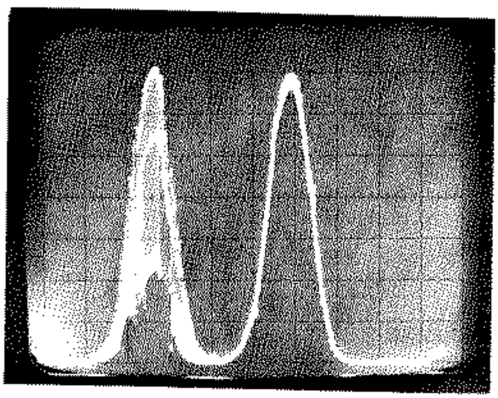
The Jerrold RSC-3 converter we utilized for our tests had a very flat reponse. We measured it as being within +/— 1.0 dB. For your own reference in determining whether the unit you use has similar characteristics, we are supplying the measurements from our RSC-3 here as Table 1. We began with the signal level on channel 2 as our reference, and deviations shown are referenced to the channel 2 signal.

With this kind of response, you can see that it is *possible* to set up headends, calibrate SLM's and all of the other things that require a flat response. It may be that you will want to *verify* your own RSC-3 response with a known output level variable frequency signal generator in advance, if you are going to use your low-cost spectrum analyzer for critical setups.

You will notice, in operation, that when you are on maximum-scan-width



Scope screen display of low-band (channels 2-6 left), FM, 109 and 118 MHz pilots, channels 7-13 plus J, and 271 MHz pilot (far right).



Scope screen display with channel 7 visual carrier (left) and a CW (AØ) insert carrier for level reference (right).

ranges (i.e. over the full low band, mid band, high band *and* super band) carrier levels *appear* to move up and down. This is due to scan loss. Since we have a fixed (i.f.) bandwidth of 600 kHz *established by the SLM*, the relatively *short* period of time the converter is sweeping each channel does not allow enough time for the detector *to reach full response* (i.e. output level). This could be corrected by a slower scan rate, a wider (i.f.) bandwidth, or a narrower scan width (**).

—The polarity of the sync pulse can be inverted, something CATJ *will discuss in the August issue.*

**—*The actual use for detection of an SLM is not mandatory; the user could substitute a diode-detector circuit.* CATJ *will discuss this in August.*

TABLE 1

The following measurements were made of the RSC-3, which was utilized as an "RF head" for the spectrum analyzer.

Channel	Deviation	Channel	Deviation
2	Reference	8	−0.1
3	+0.2 dB	9	−0.4
4	+0.3	10	−0.6
5	+0.6	11	−0.8
6	+0.7	12	−0.9
A	+0.5	13	−0.7
B	+0.3	J	−0.8
C	+0.2	K	−0.8
D	+0.1	L	−0.8
E	0.0	M	−0.6
F	0.0	N	−0.5
G	+0.1	O	−0.6
H	+0.1	P	−0.7
I	+0.2	Q	−0.7
7	0.0	R	−0.7

Safety In Numbers

AN ANALYSIS OF EMERGENCY MESSAGE OVERRIDE SYSTEMS

EMERGENCY OVERRIDE SYSTEMS

Over the past few years there has been a continuing increase in interest among CATV operators to provide their community with the capability of distributing emergency messages over all channels of their cable system. The availability of Civil Defense funds for financing, coupled with humanitarian concerns of the operator in offering an added public service to his system, have been the primary reasons for the increased interest. Some communities *require* the emergency message feature as a part of their franchise, while others *permit* a rate increase when an operator adds the service.

Various techniques have been used to provide such service, but all are essentially reduced to eliminating the normal programming on every channel of the system and substituting the emergency information. A discussion of how this may be accomplished in headends utilizing conventional heterodyne signal processing equipment is the purpose of this article.

Signal Generation

The simplest approach to providing emergency audio alert on all channels of the system requires an additional sound modulator for each channel and a switch at the input to the cable system to select the normal or emergency headend. Diagram 1 is a block diagram of such a typical system.

This system may be the simplest in concept, but the initial cost and the added maintenance problems make it the least attractive solution. A further drawback stems from a corollary of Murphy's Law: "Anything used only in emergencies will not work when needed." Any system, regardless of the approach, will require some element used only in the emergency mode. The objective is to minimize the number of elements restricted to emergency usage, thus improving the overall reliability.

Most headends consist of a combination of heterodyne processors, baseband modulators, and microwave modulators. Each of these devices accepts an input signal in a specific format, operates on this information in some manner, and generates a conventional television signal on a specific channel for application to the cable system. For emergency alert purposes, we wish to interrupt the normal flow of signal at a point where commonality of formats exists and a minimum of special-purpose emergency equipment is required. Let us consider the three basic devices and their component sections.

Heterodyne Processors

Diagram 2 is a simplified block diagram of a conventional heterodyne signal processor. The incoming off-the-air channel is converted to a lower-frequency IF signal where amplification and automatic gain control are applied before the signal is converted to the desired channel for application to the

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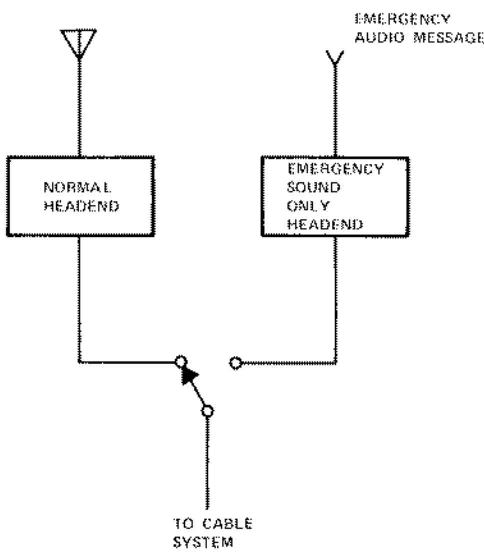
cable. Most processors contain circuitry to generate a standby signal during those times when the off-the-air station is not transmitting, and in modern processors this standby signal can either be modulated or unmodulated. As shown in Diagram 2, the video and sound IF signals are not separated and treated individually through amplifiers and AGC circuitry, although this is the modern approach actually practiced.

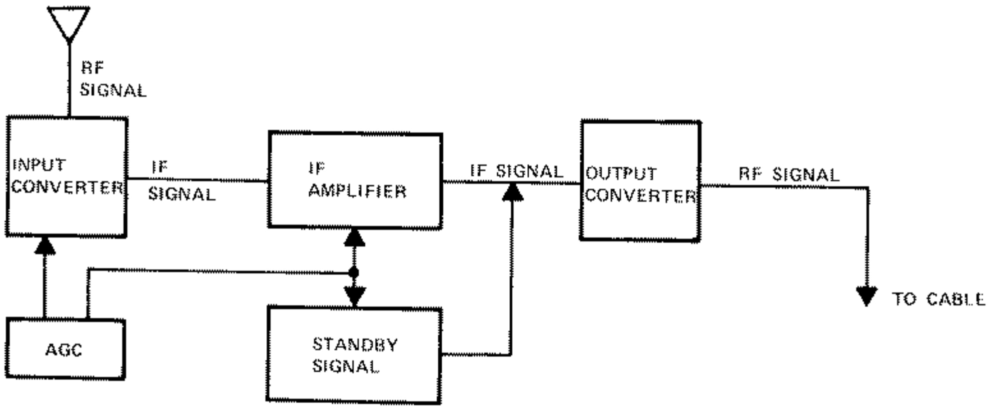
Baseband Modulators

A basic, simplified block diagram of one form of CATV modulator is shown in Diagram 3. The video and audio signals are converted to separate IF signals, then combined and converted to the desired frequency for the cable. AGC circuits and standby signals are



EMERGENCY AUDIO ALERT CONCEPTUAL APPROACH

DIAGRAM 1



SIMPLIFIED HETRODYNE PROCESSOR

DIAGRAM 2

not needed and therefore not included in a typical modulator.

Microwave Modulators

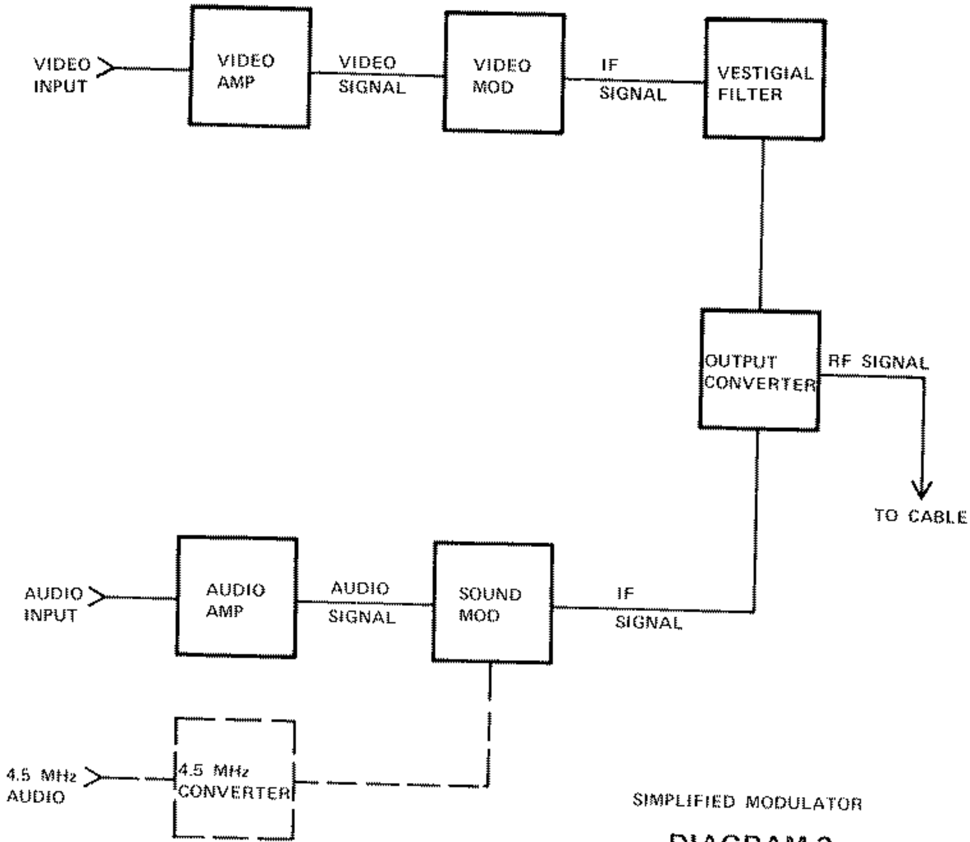
In those headends where one or more channels are received by microwave, a modification to the baseband modulator will provide the proper signal conditioning. A microwave signal is often supplied as 4.5 MHz video and audio, and in such circumstances circuitry is used to convert the 4.5 MHz audio signal to the proper format for application to the sound modulator.

Commonality

It can readily be seen from the above discussion that IF signals are common to processors and many modulators. If one were to provide a scheme to interrupt the normal IF signal and substitute the emergency message, the alerting system objectives would be met. Many of the earlier systems used this technique. A means of converting audio to sound IF in conjunction with a suitable IF amplifier and coaxial switching relays (normal operation to emergency audio-only modulation) for all processors and modulators are the essentials of such a system.

Providing override at IF remains a valid technique, but a degree of *custom design* will be required. In the processor, the point at which the IF signal is injected must be chosen consistent with the (signal) level of the emergency IF, ideally a point *ahead* of the AGC circuitry to permit ease of maintaining a *consistent output level* and to minimize the drive requirements of the emergency IF. However, most modulators typically do *not* contain IF amplifiers with AGC circuitry, and therefore a stable, relatively *high* level "emergency" signal will be required.

One technique for implementing IF override including a modulator is shown in Diagram 4. In this scheme, a switch is installed in the audio input of the system modulator to select between the normal and emergency audio sources. With the switch connected as shown, the modulator operates in the conventional manner for which it was installed in the system, but in an emergency the switch is transferred to the "emergency audio" position connecting the sound portion of the modulator to the emergency message. If the low level sound IF line in each processor also contains a switch connected to one of the "low level IF to processor" lines, override



SIMPLIFIED MODULATOR

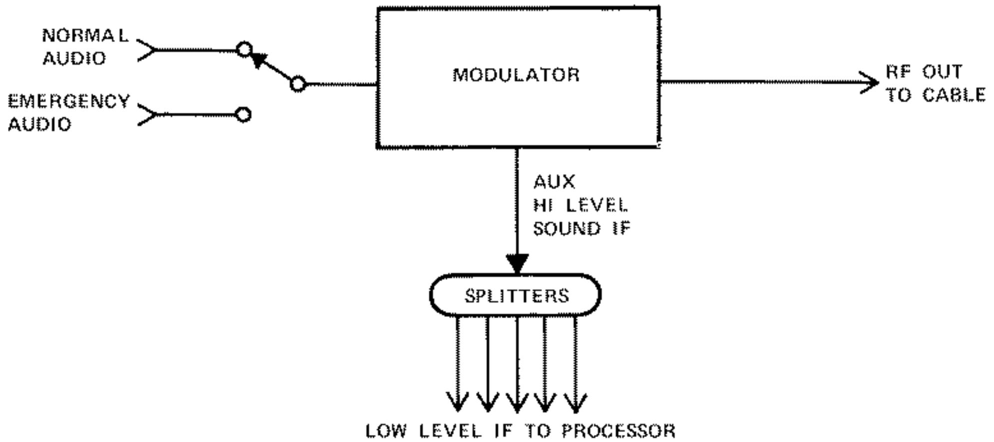
DIAGRAM 3

will be accomplished on *all* channels. Caution must be exercised in selecting the IF switches for the processors to insure reasonable impedance match, termination of the unused input, and *isolation* of 60 dB or better. (1)

Black-Out

The system just described will interrupt the normal *sound* on all channels while not disturbing the video and can be an inherent disadvantage in the sys-

(1)—In any carrier-substitution system, where the normal aural or aural/video carriers are removed from the system trunk input at the headend, and emergency or standby carriers are substituted, the switching mechanism isolation is a key ingredient to system acceptability. Normally, when two carriers on the same channel (frequency) are isolated from one another (i.e. signal voltage ratio) by 40 db or greater, there is no visible-to-the-eye beat (co-channel interference). However, many commonly available coaxial relays suffer in port-to-port terminal isolation, offering 30 db or less at high-band (VHF) frequencies. A shorting-type coaxial relay, which not only chooses between carrier signals "A" and "B," but which terminates the unwanted carrier source in 75 ohms, is preferable to a simple "A" or "B" relay. Another approach is to double-relay the switching, providing two relays in series to make the "break"; thereby increasing the isolation by a factor of two over a single relay.



IF OVERRIDE

DIAGRAM 4

tem. The *casual* viewer's attention is gained *only momentarily* by *only interruption* of normal sound. If, however, *a complete loss of video occurs simultaneous* with an interruption of sound, there is a greater likelihood of gaining the immediate and undivided attention of the viewer. In planning the system consideration may also be given to substituting an *emergency video message* as an alternate to switching to a blacked-out screen. Whatever scheme is employed, the *normal video program should be removed* during the emergency announcement.

System Security

In the great majority of situations the origination point of the emergency message will *not* be the cable system headend, since it is desirable to permit *local officials* to transfer the system to the emergency mode and originate an emergency message from one or more remote points, typically from a standard telephone. Remote activation of the switches necessary to control the system is relatively easy to accomplish, but means should be provided to prevent unauthorized accidental or malicious seizure of the system. The standard Touch Tone® system in use by a large segment of the telephone industry in the United States is particularly attractive for signaling the switches at the headend, and a three-digit confidential number will usually provide adequate security to prevent unauthorized access.

CommAlert System

The Scientific-Atlanta Series 6120 CommAlert System was developed to provide a versatile emergency override system which would permit the cable system operator reasonable latitude in configuring an alerting system for his community. The CommAlert provides the necessary supervisory control and signal conditioning to permit substitution of emergency message material for the normal programming through use of a telephone remote from the headend or through use of a microphone and video source located at the headend.

Proper selection of plug-in modules for the 6120 and proper system cabling enables the operator to select generation of sound emergency messages at audio, 4.5 MHz, and sound IF frequencies. Provisions are also included to add local video override. The remote telephone may control the system over a dedicated pair of wires used exclusively for the CommAlert System, or the telephone may be part of the local telephone network. In either case, the only equipment required at the remote location is a standard Touch Tone® telephone. No auxiliary equipment requiring additional maintenance is required.

The CommAlert System includes a basic chassis, power supply and six signal conditioning modules. In operation, the remote telephone contacts the CommAlert and the operator hears a dial tone generated by the Scientific-Atlanta 6120 system. This tone is distinctly different from the tone used by the telephone company, thus insuring instant recognition by the user. Upon hearing the CommAlert dial tone, the user presses the proper three-digit code on his Touch Tone® telephone and immediately hears an alerting tone of approximately one-second duration. This alerting tone will also be heard by every subscriber who has his television set turned on. The originator of the emergency call gives his message and hangs up to restore the system to normal.

Line Supervision Module

The Line Supervision Module of the 6120 provides the required supervisory commands in the system regardless of whether the remote telephone is connected through a dedicated pair of wires or through the local telephone network. If the telephone is connected through a dedicated pair, direct current is supplied from the Line Supervision Module to operate the voice circuit and the Touch Tone® oscillators in the remote telephone. The Line Supervision Module senses whether the telephone is on or off hook

Scientific Atlanta Series 6120 CommAlert package for CATV emergency messages

and provides this information to other modules in the system.

Operation of the CommAlert system with the conventional telephone exchange, permitting emergency-message origination from any normal Touch Tone® telephone, requires moving several jumpers in the Line Supervision Module. A telephone-company-provided coupler is installed at the headend between the Scientific-Atlanta 6120 and a regular telephone.

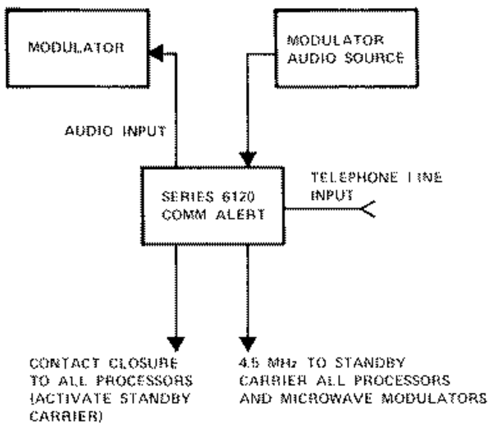
WHAT EMERGENCY?

CATV systems are increasingly being called upon to provide their communities with some form of civil emergency alerting system, for use in times of local weather emergencies, local health emergencies, or even as a means of "calling in" for duty the local volunteer fire department.

Perhaps 50 or more systems in the country now have this capability. Many more could and would have it if they were aware how simple it can be and how much goodwill such a system can create for the CATV service.

Additionally, federal matching funds through the Office of Civil Defense and Mobilization are now available, which, with local city or county government involvement, will pay up to 50% of the going-in **plus** the on-going costs of such equipment and its maintenance.

Author Giddens reviews the various approaches to this type of system, and while he makes positive points **primarily** for the Scientific-Atlanta Series 6120 CommAlert System, his review of the other basic technological approaches to emergency alerting should be interesting background material for all system operators.



PREFERRED COMM ALERT CONFIGURATION

DIAGRAM 5

In operation, one dials the number of the headend telephone, which is automatically answered by the coupler. The coupler alerts the CommAlert Line Supervision Module of an off-hook condition, and the 6120 dial tone is transmitted to the caller. If the calling party then dials the correct three-digit code, the system will transfer to emergency.

Touch Tone® Decode Module

The standard Touch Tone® system is a 3 x 4 tone matrix utilizing seven tones to produce twelve two-tone combinations, representing digits 0 through 9 plus two special-purpose codes. The Touch Tone® Decode Module recognizes the presence of any of the tone combinations and provides a dc output representing the incoming digit. In addition to the ten digit output lines, the Touch Tone® Decode Module also provides an output each time any input is received. The response time of the decoder is intentionally slowed somewhat to require positive, deliberate action by the user.

Decode Module

The CommAlert System uses a discrete three-digit code as the address necessary to gain access and control. The Address Decode Module contains three jumpers to enable the operator to change the address whenever desired. Each incoming digit is counted, and only the first three digits in the correct sequence will activate the override. Dial and alert tone generators are located in the Address Decode Module and operate in the sequence described above. DC output from the Address Decoder is used in the Override Control Module to operate the necessary relay driver circuits.

Override Control Module

Operation of the Scientific-Atlanta CommAlert from the headend may be accomplished through the use of a push-to-talk microphone supplied with the system which will preempt control by the remote telephone. The required preamplifier and control logic along with relay closure for external circuits are contained in the Override Control Module. A front-panel LED indicator illuminates whenever the system is in an alert mode.

Modulator Control Module

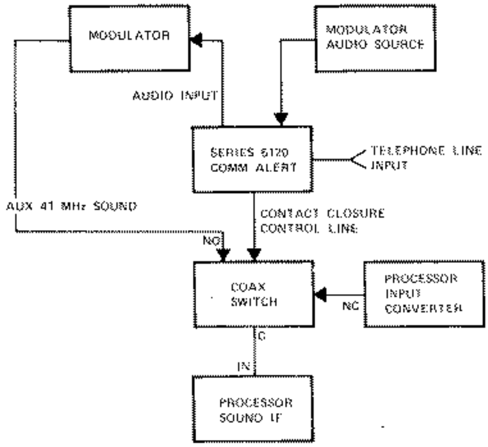
It is frequently more convenient to provide the override information to modulators at audio frequencies, eliminating the inconvenience of installing a coaxial switch in the sound IF line. Rack cabling becomes less bulky if the audio switching is performed in the CommAlert unit, a function performed by the Modulator Control Module. The regular audio input for a modulator is connected to the 6120 where normally closed relay contacts route this audio back to the rear panel of the unit for cabling to the modulator. In an alert condition the relay activates, disconnecting the normal input and supplying emergency audio to the modulator. Compensation for different input levels is accomplished through the proper selection of resistive attenuators contained in the Modulator Control Module.

4.5 MHz Converter Module

Modern signal processors contain facilities for externally applied 4.5 MHz modulation to the substitution carrier and internal switching to select this modulation. For processors so equipped, this is the most advantageous method of application of the emergency alert signal. Coaxial switches are eliminated, relying instead on signal selection within the processor. The normal video signal is automatically removed when the substitution carrier is selected, and a locally generated video may be easily added to the sound signal. The CommAlert 4.5 MHz Converter Module contains a frequency-modulated, phase-locked varactor diode oscillator and amplifier circuits to supply adequate signal level to drive all the processors in the headend.

CommAlert System Configuration

Diagrams 5 and 6 are block diagrams of the two basic system configurations utilizing the Scientific-Atlanta 6120 CommAlert in an emergency alert system. Diagram 5 is the preferred approach, requiring a minimum of external switching and cabling. The system configuration of Diagram 6 is useful in those applications where the signal processor's substitution carrier cannot be externally modulated or where it is desirable to interrupt the sound while not disturbing the normal video. This application does require the inclusion of a coaxial switch in *each* processor.



ALTERNATE COMM ALERT CONFIGURATION

DIAGRAM 6

Summary

The addition of an emergency alert system can benefit the CATV operator through improved community relations and may be justification for a rate increase. In planning the installation of an alert system, careful consideration should be given to the number and type of remote control points (whether dedicated line or dial-in access), the type of system security provided, and the complexity of the alert system. A simple straightforward approach will produce a system capable of reliable operation with a minimum of increased maintenance costs.

USING A RHOMBIC?

Is your CATV system utilizing a rhombic receiving antenna? **CATJ** would like to hear from you if you are. We have been gathering together material about the rhombic antenna for a full report to readers, but lack specific CATV system data on this most versatile antenna.

If you happen to be a "hoarder" of old publications, and have the March 1960 issue of the **RCA REVIEW**, we would very much like a copy of that issue, in particular the article starting on page 117 (Improved Art of Rhombic). A copy of same to **CATJ Editorial**, 4209 NW 23rd, Suite 106, Oklahoma City, Ok. 73107 would be much appreciated!

Part Two Of Three

ANTENNA BASICS FOR CATV SYSTEMS

Three Down

When we left the drama of the CATV antenna last month, we were through the basic problems associated with designing a resonant antenna (dipole) with the addition of one reflector (for front to back and added gain) and the addition of one director (for added gain and increased forward selectivity).

Perhaps it is best at this point to once again discuss the basic reason for making antennas larger.

If you have a cube of atmosphere (any cube) with boundary markers placed around the edge, it is filled with a multitude of RF signals. Inside of that cube of air you have several signals *you want*, and the rest *you do not want*. At least not at the moment.

Some or most of these are *frequency diverse;* that is, these signals are separated throughout the radio spectrum (from VLF-very low frequencies to UHF-ultra-high frequencies), and *most* of our selection process is handled by the normal selectivity parameters built into our receiver (or signal processing equipment). Still, *not all of the frequencies* or signals available in our imaginary cube of atmosphere are frequency diverse; some have the bad taste to be either on the same frequency, or on immediately adjacent frequencies. So if you merely stick a "resonant" dipole antenna into that sphere and plug the dipole into your receiver or processor, those two or more signals that happen to be *not frequency diverse* end up traveling jointly into the receiver/processor input port. One may be stronger than the other; the stronger of the two (or more) *may not* necessarily be the *one* you desire.

If the signals are on the exact same frequency (within normal tolerances), the receiver/processor is uncertain which one to deliver to you; and it does what comes naturally, receiving or processing the stronger of the two. It may display some interference *from the weaker of the two* in the process.

If the signals are on adjacent frequencies (i.e. frequency offset by some relatively small offset amount), and the one you desire is weaker (or considerably weaker, as the case may be) than the non-desired signal, the processor or receiver has to work extra hard to produce an acceptable signal from the weaker signal, sandwiched as it is right adjacent to a strong(er) non-desired signal.

Clearly, *some form of pre-selection is required* in either case; pre-selection being some method of separating the desired signal from the non-desired signal(s), so that the receiver/processor is capable, within its design limits, of producing the signal you really want.

If the two signals are frequency offset, you might be able to add selective filters ahead of the processor, but after the antenna, and sufficiently attenuate the off-frequency signal so that the receiver/processor can do its job on the desired signal. You might be able to... and then again you might not be able to separate the two adjacent signals with a filter. On the other hand, if there is no frequency diversity between the two signals, that is, both are camped upon the same nominal frequency, then any pre-selection ahead of the receiver (and it will have to be ahead of the receiver) must come from selectively separating the desired signal from the non-desired signal. *This can only be achieved by building additional pre-selection* (i.e. directivity) *into the antenna receiving system.*

Non-desired signals do not have to be RF in the sense of radio carrier signals. Non-desired signals can be (1) noise interference radiated by nearby power lines, (2) or a busy highway, (3) or an electric fence (etc.); or, (4) reflected signals (delayed in time) from the same transmitter you desire, only arriving at your receiving site after traveling billard effect via a nearby building, mountain, etc. on a non-direct route to your receiver. In short, a non-desired signal *can be any type of signal*, interference, or even the same signal which results in a marring or case of imperfections to the desired signal you are attempting to receive.

Clearly, in CATV, the one thing we have to sell is clear pictures. Anything that mars our pictures must be dealt with, and eliminated, or we will not survive as a commercial entity.

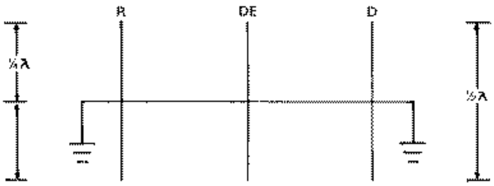
So there is a reason—*a good reason*—to have an antenna array that is capable of not only receiving the desired signal but also capable of eliminating (or greatly reducing) interference from non-desired (signal) sources.

The ideal antenna would be sharp as a tack; when you pointed it at the station you wished to receive, the picture would come in strong and clear, but when you pointed it *in any other direction* there would be no signal at all from the desired station. An antenna this selective would not only produce good pictures from desired stations, it would *not* respond to signals from *any* non-desired sources.

There is no such antenna.

But that does not stop people from trying to build one. The first step in that direction in the VHF range came in the '30's when a couple of Japanese physicists named Yagi and Uda got together and designed the first directional antenna with three or more elements. Dr. Yagi must have been the heavy because few people claim they have a Uda on their tower. (Larry Dolan of Mid-State *claims* he once met a girl in San Francisco with a Uda on her tummy, *but that is another story....*)

And they are still trying to build the perfect antenna (some are still looking in San Francisco, according to Dolan). Soon after the Yagi-Uda design came out, someone took the basic three-element antenna and decided that if three were good, four or five would be better. After they shook the bugs out of four or five elements, somebody else decided to go for ten (elements, not Udas on her tummy). By the end of World War II hostilities, the art had progressed to about ten elements, but with the progression came the recognition that *every time an element was added to a Yagi the usable bandwidth of the antenna went down*, perceptibly if not dramatically. This led a fellow named Kennedy to observe one day that the Yagi antenna was really an "inside-out bandpass filter." If the logic of that escapes you, see Diagram 1. Most of us accept that if we start out with a "three-element" *bandpass filter*, change the design slightly to allow expansion to say seven elements in the filter, we have just *increased the selectivity of the filter*. In the Kennedy logic, *that is what happens to the Yagi antenna.*



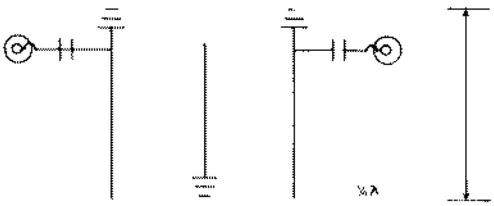


DIAGRAM 1

That as Yagi antennas increase in elements the bandwidth of the antenna decreases, did not detour designers who could not care less about 6 MHz chunks of spectrum from expanding Yagis to some 30-plus element monsters. But these (long) Yagis, as they are known, are primarily *limited to narrow-band circuits* where at most radio-telephony is being transmitted and received, usually over a narrow hunk of spectrum a few tens of kHz wide.

In CATV, there are a few designs around which feature more than ten elements in a line (one reflector, a dipole, and eight directors are the common ten-element line-up). In the home-antenna racket, there are still a few 20-30-element multi-channel Yagi antennas sold (although home antennas are predominantly logs now); but the black art of combining *so many elements* on such a *short boom* and covering so wide a chunk of spectrum (such as channels 2-13) is elusive at best.

Now to broadband a Yagi antenna (and here *broadband means to detune the antenna from maximum forward gain on a single frequency*—such as 55.250 MHz—*in favor of broadening the useful gain over say 55.25 MHz to 59.75 MHz*, or channel 2), you do two things. First you stagger the lengths of the elements. That is, you cut the dipole element so it is resonant on one portion of the desired channel (say 55.25 or the video carrier frequency), and you cut the length of the reflector so it is sufficiently longer than the dipole to create a desirable front-to-back ratio. Then you start with the number one director (the first one ahead of the dipole), and you cut it for say 55.75 MHz; the second director you cut for say 56.25 MHz; the third director you cut for 56.75 MHz, and so on, until you get to 59.75 MHz, *or the channel two aural carrier frequency*. There is nothing magic about moving up in 0.5 MHz steps with the directors; you can find (or create) an argument for a dozen different "formulae" anytime you stumble into a men's room frequented by antenna design engineers.

As shown in Diagram 3, this creates a special situation of sorts: it allows you to *spread* the useful frequency range of an antenna that is *essentially a narrow-band device* over something approaching a 4.5/6.0 MHz wide television channel.

So much for staggering the length of the elements. It is a useful design trick, and it works, after a fashion. You can also play with the "coupling" between the elements. Now elements couple, one to another, through a combination of induction (i.e. picture two RF coils in an amplifier, so placed as to *couple through the intervening air gap* one to another) and capacity (i.e. picture two plates of metal with a charge on one and *some leakage across the intervening air gap* so as to create some percentage of the charge of the charged plate on the (non-connected) second plate as well. If none of that turns you on, picture a girl in San Francisco with a Uda on her tummy.

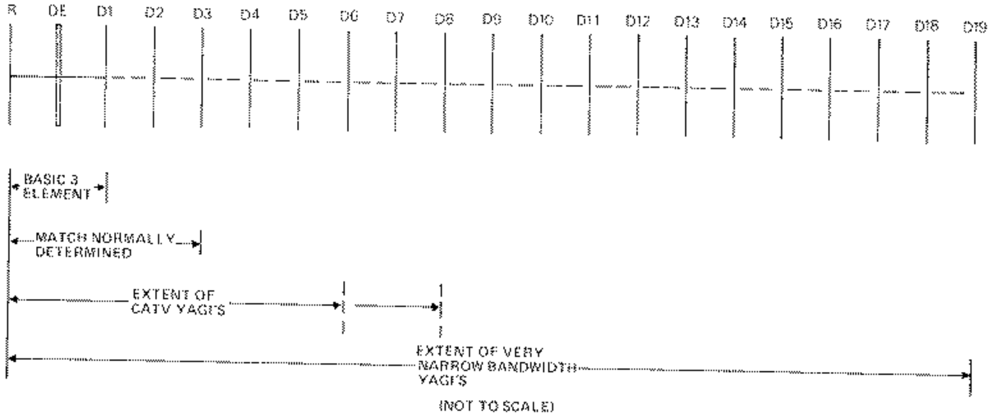


DIAGRAM 2

Some antenna-design engineers have found that by "playing" (they call it calculating) around with inter-element spacings, *that a situation can be created* where elements added to the overall array (i.e. *expansion* of the array *in length* or size by *number* of elements) do not *necessarily* reduce the useful bandwidth of the array.

Then there is a third approach to broadbanding a Yagi-Uda. It is *one* of the more or less *agreed-upon* parameters of a Yagi which states that if you take any Yagi antenna (say three elements or more), and tune it for resonance on the desired frequency, that the antenna will fall out of resonance faster on the low-frequency side than the high-frequency side (interpretation: a channel 3 Yagi will work *somewhat* on channel 4 but not worth a darn on channel 2). So the approach calls for designing *multiple dipoles*, say two for discussion, into the antenna. In the case of channel 2 you design in a reflector, a dipole at 55.25, and another dipole for say 57.5 MHz (*half way* to channel 2 audio), and ahead of these two dipoles you line up whatever number of directors you have in mind, stagger tuned for the region on up until 59.75 MHz. This *purports* to assist in the broadbanding process, simply because we have in effect tied two resonant dipoles together, each slightly staggered in resonant frequency from the other, to create a "broaden response curve" for the antenna as a whole.

However you do it, the end result of broadbanding a Yagi-Uda is *a series of*

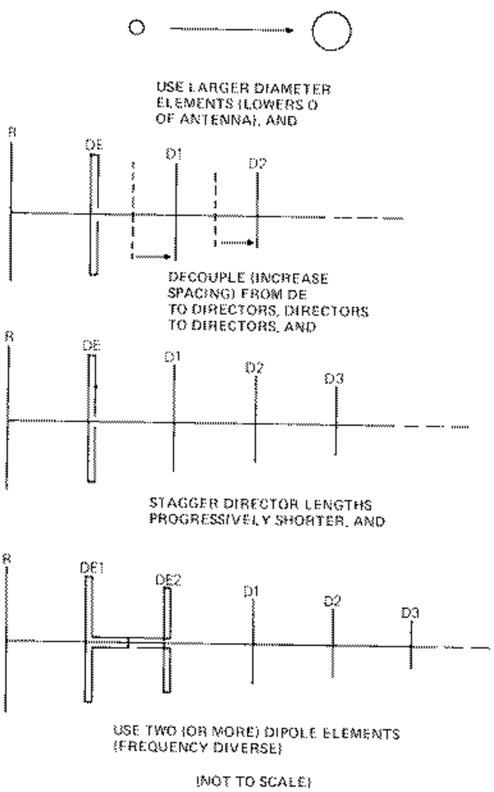


DIAGRAM 3

compromises, all of which inter-react one to another. And life is not easy for an engineer setting out to measure the results of his labors. Antenna *test-range measurements* are fraught with danger and inherent errors. The height of the antenna above ground, the nearby test range terrain (and trees, power lines, buildings, and parked cars, etc.) all present signal reflection or absorption problems. For this reason, many of the Yagi-Uda *hybrids* (and there are dozens if not hundreds) are initially built in the 400-500 MHz frequency range where elements are small and adequate clearance above terrain, etc. is not difficult to achieve. Then the results are scaled *down* in frequency (and up in size) to develop the end result: a set of antennas for the low and mid VHF range. Even this presents some problems for the semi-skilled practitioner, because element length changes and element-to-element spacing changes of 1/32nd of an inch in the 400-500 MHz range are *appreciable parts of the electrical length of the elements;* and erroneous results are often the rule, not the exception.

The long and short of Yagi-Uda design is that you are probably better off in San Francisco looking for a girl with a Uda on her tummy than trying to build a first-rate antenna in your backyard with nothing more elaborate than a hacksaw, a bundle of tubing, and a field strength meter.

Which Is Not To Say

That doesn't mean that *properly equipped*, you cannot do the job. Hundreds of others have done it before you, and on the assumption that there are *still* new bridges to be crossed with hybrid Yagi-Uda designs, some will pass through *after* you.

Still, the CATV industry has not *concentrated* on Yagi antenna designs for a number of years. And that is primarily the result of the unpredictable results one *often* has with a Yagi array.

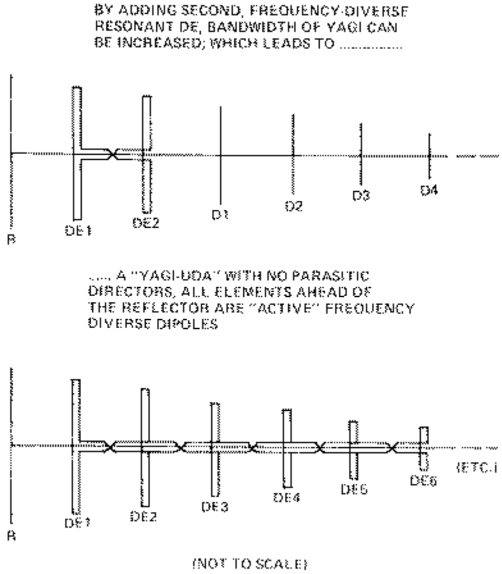


DIAGRAM 4

Recall that any time you introduce some new metallic object in (or near) the *field of the antennas*, you run the risk (even likelihood) that *some* parameter of the antenna (array) *will change* on you. Let's review what parameters might change, and then look at what types of metal fields within (or near) the antennas can affect the ideal "free space" antenna-performance parameters.

(1) *Front-to-back ratio*—largely determined by the presence *behind* the dipole of a longer-than-the-dipole element, spaced electrically (and physically) so that signals arriving at the array *from the rear* are phase-cancelled by the delay created by the reflector.

(2) *Front-to-side-ratio*—largely determined by the presence in *front* of the dipole of shorter-than - the - dipole element(s), spaced electrically (and physically) so that signals arriving at the array from the direct front

are *"focused"* directly on the dipole element, while signals arriving from an *off-heading angle* (i.e. say 30, or 60, or even 90 degrees from front heading) are *not* focused to the dipole.

(3) *Impedance match*—largely determined by the loading effects of the reflector and first director (or two or three directors) upon the dipole, and the compensations made by the design engineer after these "in-field pieces of metal" have been added and tuned for their specific performance parameter.

(4) *Broadbanding*—largely determined by tapering of element lengths *and* element-to-element spacings.

As you can see, most of the parameters (in fact all) are largely dependent upon making re-adjustments and more re-adjustments to the whole array *after each new "field affecting" piece of metal is incorporated into the design.* So what happens when you take this finely tuned, adjusted and re-adjusted antenna into the *real world* and hang it on, adjacent to, or above a tower or other support structure?

If you guessed that *some or all of the parameters are likely to change*, you get the girl with a Uda on her tummy (if you can get Larry Dolan to tell you where she is!).

Experienced Yagi-Uda antenna people caution you when stacking two (or more) same-channel, identical-design antennas (for additional gain) to *observe one cardinal rule of installation.* And that is, *always separate the antennas physically by at least 0.5 wavelength,* and if possible, separate the identical antennas you are stacking by *one full boom length.* Now we see in a special box insert in this report that boom length is a figure of merit for Yagi-Uda antennas. The longer the boom, the greater the gain. So it figures that if you have a large, multi-element Yagi *that has been designed properly,* you have a *long-boom* antenna. In fact, one of the tables presented here suggests that for a ten-element Yagi design antenna, the *shortest boom length* which will produce *full gain* for ten elements is 2.5 wavelengths. At channel 2, that is 44.53 feet of boom. Obviously the CATV industry does not have many 44+ foot boom channel 2 Yagis hanging about. Either the material we gave you previously is in error, or the antennas we do have (with 18-20-foot booms) are *compromised* somehow.

Are we making other compromises? At channel 2, ½ wavelength in free space is approximately 8.9 feet. That is

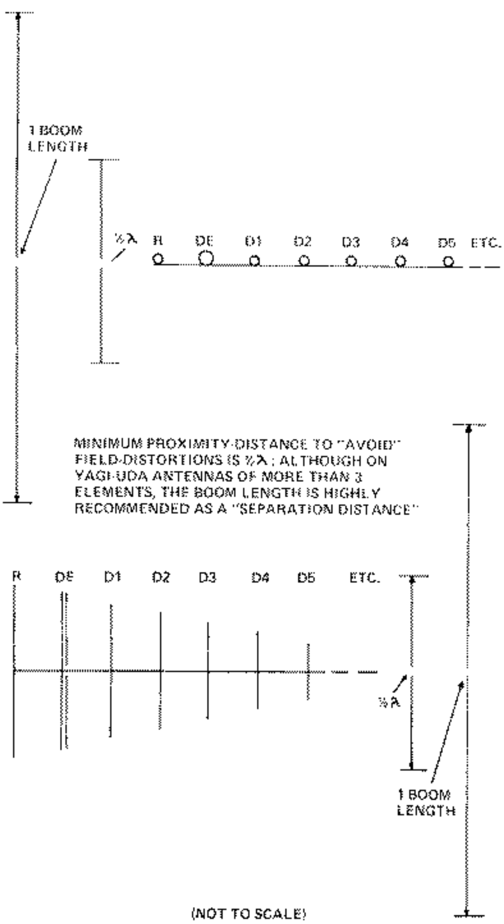


DIAGRAM 5

the *shortest* spacing distance we are advised to place two identical antennas for stacking purposes. And the *really recommended distance* for channel 2 becomes (for vertical stacking) at least the boom length, or 18-20 feet (it varies with the manufacturer and *his boom length* of course).

Why are there recommended minimums for stacking distance? Two reasons. One is that the two "fields of influence" for two (or more) stacked antennas *inter-react* (that is, fight one another) if the antennas are stacked *too close together.* And rather than getting the full advantage of stacking (which is theoretically 3.0 dB each time the *size* of the array *doubles*), we end up getting much *less* than 3.0 dB gain advantage. The second reason is more obvious perhaps: you get the elements of one antenna *into the field of the second antenna,* and the offending elements' metallic content promptly changes the "tuned" characteristics of the first antenna, and vice-versa.

Now if two antennas in the *same* (combined) array will have that effect upon one another, what about two tower-stacked antennas for *different* channels? The effect is the same: the *metal* of one antenna, placed in proximity to another antenna, "loads" or detunes the first antenna, and of course, vice-versa. What is the closest you can place arrays, on the tower, either vertically (i.e. one above the other) or horizontally (i.e. on gate booms) *and prevent inter-action?*

The answer is unclear, and therefore subject to debate. As we shall see, the two separate channel antennas (or arrays) are not the *only* metal around, and this makes accurate (*let's decide it*

BOOM LENGTH FIGURE OF MERIT

Numerous studies under controlled laboratory test range conditions by independent antenna designers have revealed that it is **not necessarily how many elements you have on the boom,** but rather **how long the boom is.**

Or to put it another way, if you have a boom of "X" length, and you have **properly spaced elements** on that "X" length boom (for best response characteristics for the TV channel of your choice), adding **additional** elements to the boom (with corresponding **re-spacing** of all prior existing elements) will **not** increase the gain or performance of the Yagi-Uda. It will, in fact, **reduce the gain,** mess up the match, and generally result in poorer performance.

It should not be too surprising, then, to learn that **for any given length of boom** (measured in wavelengths of boom, since every channel has different wavelengths), **there is an optimum number of elements,** and that **any** number beyond that number is questionable at best.

Of three independent and scientifically recognized tests in this region, no two agree. Yet if **all three are plotted on a curve,** one finds there are only minor (i.e. not significant) differences between the three evaluations. We have taken the average of all three here and present them as follows:

Antenna Array Length	Maximum Number Elements
0.2 wavelength	2
0.35 wavelength	3
0.55 wavelength	4
0.80 wavelength	5
1.15 wavelength	6
1.45 wavelength	7
1.80 wavelength	8
2.10 wavelength	9
2.45 wavelength	10

If the boom length is **the true figure of merit** of any Yagi-Uda design (i.e. even more so than number of elements), then it figures that researchers have determined the **maximum amount of gain** which can be developed for antennas of particular boom lengths (with *once and for all!*) measurements difficult. There are the *gate booms*, on side mounted arrays, for example. And the *tower*. And the *guy wires*. And even the sheathed *downleads*. *All exert an influence on every antenna pattern and match.* The whole installation becomes a giant bubble; push in one place and something pops up someplace else.

But there is an answer, or two if you will. One answer is that you never (*repeat, never!*) stack any antennas closer together vertically than ½ wavelength (in space) on the lowest channel. Or to put it another way, if you have a channel 2 array, and you need to mount another antenna below (or above) it, you should never (*repeat, never!*) be any closer to the channel 2 array than ½ wavelength at channel 2. If the channel 2 array was going to be stacked *above* by a channel 13 array, and *below* by a channel 4 array, the space above *between* 2 and 13 would be ½ wavelength *on the lowest channel* (2). And the space between 2 and 4 would also be ½ wavelength, *at channel 2*, the lowest channel. Now that is a bare-bones *minimum*, to prevent interaction. That is *not* guaranteed to be enough. In fact, the second school of thought insists that is *not* enough spacing.

The second school says keep *at least one boom length on the lowest channel array between stacked separate channels.* If you have an 18-foot boom on channel 2, which is decidedly more

---

the corresponding proper number of elements). The maximums to follow are referenced to gain over a tuned (i.e. resonant) dipole antenna, and **they tend to be larger than can be expected for CATV broadbanded antenna design;** simply because the studies done to date have primarily been associated with **narrow-band** response (i.e. ½% of operating frequency bandwidth, or lower) antennas.

Array Length	Number Elements	Maximum Gain (*)
0.2 wave	2	5.0 dB
0.35 wave	3	7.5 dB
0.55 wave	4	8.75 dB
0.80 wave	5	9.75 dB
1.15 wave	6	10.50 dB
1.45 wave	7	11.25 dB
1.80 wave	8	12.0 dB
2.10 wave	9	12.6 dB
2.45 wave	10	13.1 dB

*For these **maximum** numbers to be true, **all** parameters (including boom length and narrow-band operation usually **less** than adequately broad to pass a single TV channel [low band in particular]) must be met.

Correspondingly, for **typical** five- or ten-element Yagis to be **maximum effective** for CATV performance, their boom lengths should be fairly close to the following lengths:

Design Channel	5 element (0.8 wave)	10 element (2.45 wave)
2	14.25′	43.61′
3	12.85′	39.36′
4	11.71′	35.85′
5	10.19′	31.21′
6	9.46′	28.96′
7	4.49′	13.76′
8	4.34′	13.30′
9	4.20′	12.87′
10	4.07′	12.48′
11	3.95′	12.10′
12	3.84′	11.75′
13	3.73′	11.41′

Keep in mind when reviewing these numbers and equating them to Yagi-Uda antennas you may have on hand or be considering, that there are as many **"tricks"** to Yagi-Uda antenna design as there are practitioners. **Not all tricks are common knowledge,** and perhaps there are **subtle** tricks that allow the designer to telescope boom lengths (i.e. shorten them) and **still** maintain gain, match, and directivity parameters which are desirable for CATV uses.

the longest wavelength (lowest channel) if you are a gambler; one boom length on the longest boom if you are interested in being safe.

The tower itself is a considerable problem and not to be taken lightly. And whereas many systems go to gate (or side) mounted antennas to stack as many antennas as possible in the top 100 feet of tower, there is an even better reason to side mount: *the tower itself.* Consider this for a moment. At channel 13 (video frequency) the free-space length of ½ wavelength is 27.95 inches. If your tower face is (by happenstance) 27.95 inches on a face, you have a tower face (with horizontal support members) *that just happens to be* ½ wavelength long. Any time you intermingle the metal in the Yagi antenna elements with the metal of the tower, you have a whole series of *"horizontally stacked ½ wave elements"* (in our example-tower, on channel 13). The effects would be devastating. A 33.69 inch tower would have a face *self-resonant* on channel 7. And the face size does *not* have to be *exactly* the same as a wavelength to be "Field devastating." *Just close is enough.*

Nor does it have to be ½ wavelength; *even a ¼ wavelength tower face* (33.64 inches on channel 6 or 53.43 inch tower face on channel 2) if it gets

STACKING FOR SIDE LOBE CONTROL

Readers are referred to the **June 1974** issue of **CATJ** (see pages 7-16) for a special report on stacking of antennas for co-channel reduction.

Additional gain for antenna arrays is achieved by taking two or more identical antennas and arranging them in a format which allows the individual antennas to complement one another. When antennas are **stacked for gain** (i.e. with **no** attention to special antenna pattern nulls to "phase out" co-channel interference sources), there are certain **minimum** and **maximum** stacking distances to be observed. **Stacking of any antennas less than ½ wavelength apart is virtually without benefits.** A relatively small Yagi-Uda array, a single **three-element** antenna, has a half-power beamwidth in free space of approximately 75 degrees. Optimum stacking for **forward** gain, in a vertical stack (i.e. one above the other antenna) occurs at a stacking distance of just over ¾ wavelength (in free space). Generally speaking, as **larger individual arrays** (i.e. **more** than 3 elements) are utilized, the stacking **spacing** must be **increased** beyond the ¾ wavelength optimum for simple three-element antennas. The optimum stacking distance is basically a function of the half power (3 dB) beamwidth of a single antenna. As the half-power (3 dB) beamwidth **decreases,** the optimum stacking distance **increases.** Most antenna manufacturers specify 3 dB beamwidths, and if you know **that number,** you can go to the table here and determine the optimum stacking distance between two such identical arrays (**optimum is defined as the stacking distance which will result in maximum forward gain,** without regard to side-lobe control). In those situations where horizontal (or a combination of vertical and horizontal) stacking is utilized, it is often likely that when antennas are physically **close spaced in the horizontal plane** for side-lobe (i.e. co-channel) control that you obtain **no additional voltage gain** over that measurable with a **single** stack of the array; although **side-lobe control** does improve dramatically.

Individual Antenna 3 dB Beamwidth	Optimum Vertical Stacking Distance
75 degrees	0.8 wave space
60 degrees	1.0 wave space
50 degrees	1.2 wave space
40 degrees	1.5 wave space
30 degrees	1.95 wave space
20 degrees	3.0 wave space

stuck near the field of the antenna will cause problems. For this very simple reason, few systems attempt to hang Yagi-Uda antennas directly on a tower leg (i.e. antenna-to-mast clamp *directly to* the tower leg); because this places all of most of one half of the antenna elements (i.e. ¼ wavelength) inside or behind or ahead of the tower face. Even if you try to space yourself above or below a horizontal tower support member, you still have tower supports above and below the antenna-element line that are well within the taboo "½ *wavelength field region.*"

Rear Mounted Yagi

If the tower (plus the guys, etc.) are such potential problems for the "fields of influence" of Yagi-Uda antennas, possibly there have been a few "tricks" developed by CATV to help nullify these effects?

There have been. *One* is to utilize a rear-mounted Yagi. Such a Yagi mounts from the butt (reflector) end and hangs suspended out in front of the tower by itself. However, it is not entirely by itself (see separate report on *SITCO* rear-mounted Yagis in this issue of *CATJ*), because virtually any *practical* Yagi design has a *boom sufficiently long* that the boom must somehow be *supported* at some point other than at its very (butt) end. Thus we immediately have a *diagonal support brace* angling through the antenna field.

Another "trick" is to *not use the famed Yagi-Uda* at all (except perhaps in San Francisco, where Dolan has a Uda stashed). *Which brings us to the log* or log-periodic antenna: an antenna design that evolved out of the Yagi-Uda (we can hear the dissenters to that statement already!) fairly recently.

We'll tackle the log next month.

Inexpensive Insurance

CATJ REVIEWS THE JERROLD J283-X SEARCH ANTENNA

JERROLD J-283X
Not Your Basic Search

The search-antenna requirement for any CATV system is best explained from the viewpoint of *standby service*. Any CATV system worth its dB's recognizes that what it has to offer to the CATV-system customer is first and foremost picture quality: *consistent* picture quality. To achieve the desired quality of signal carriage, the system spends very large sums of money on precise antenna arrays, precise head-end electronics, and high-reliability solid-state CATV plant equipment.

Yet any system is only as good as its weakest point, when *reliability* is a factor overall. In the antenna/preamplifi-

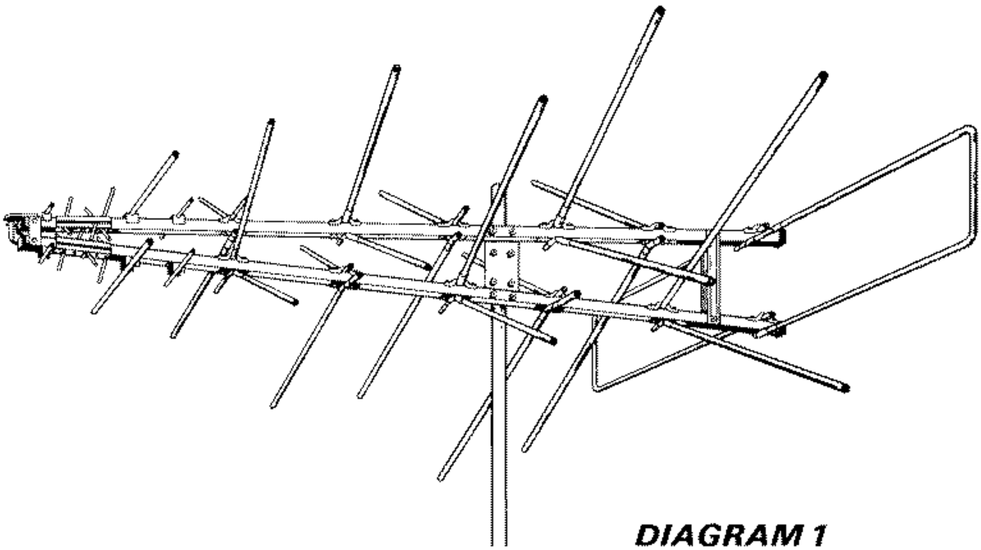


DIAGRAM 1

er / downline / filtering / processing package, any individual component may fail at any time. And as an Irish gentleman named Murphy once observed, "Anything that can go wrong, will" (the famous *Murphy's Law*). In any CATV headend, virtually anything can go wrong. And sooner or later, it will.

Naturally if you had giga-bucks available, you could simply duplicate, in spades as it were, every single piece of everything in the headend, for the eventual occurrence of Mr. Murphy's Law. And in a very large system complex (the Vancouver for example), such an approach *might* be very advisable. But in the average system, such extravagant duplication is out of the question.

If you were to rate the various elements in your system for vulnerability to outage, the antenna array for each channel would rank high, if not at the top of the list. With normal system design, an antenna array ends up being for one channel, or in some situations where you are reasonably close to the transmitter sources, for two or three channels (utilizing split outputs from the antenna). And short of a devastating wind or ice storm which damages numerous individual antenna arrays, outages that are related to the antenna arrays are usually limited to a single array at a time.

Seemingly, there is a very good argument for having some form of versatile standby antenna system, one which *could,* in a pinch, provide backup service for a damaged antenna array while repairs were being effected. Such is the logic, or part of the logic, behind a search antenna.

There is of course other logic to a search antenna. For maximum efficiency, the search antenna should be (1) equipped with an antenna-rotating device, and, (2) be atop the tower so that it has a full 360-degree sweep of the horizon without having to "look through" the tower metal in any direction. The rotator is necessary because you never know which direction you may need to point the antenna to provide a signal backup for a downed antenna. Additionally, rotating the search is important because:

(1) The antenna makes an excellent device for locating interference from either co-channel stations or man-made electrical sources;

(2) In the event that new stations come on the air, with the aid of a search, you can do some preliminary off-the-air signal-level monitoring as an assist to designing a permanent antenna installation for the new channel.

The logistics of providing a rotating mechanism will be covered by *CATJ* in the near future. Suffice it to say at this time that a $29.95 Alliance rotator is seldom capable of the job.

As the diagram shows (Diagram 1), the J283X is not your ordinary-looking antenna. It is a log design, and it does cover one heck of a lot of spectrum (channels 2-83). We shot several photographs of the antenna in place, and then decided that the drawing Jerrold provides is easier to follow than a typical skyview shot of the antenna mounted; against an uncertain sky coloring, that tends to lose the smaller elements in the haze.

Jerrold does a couple of interesting things with the J283X. The boom is, by any standards, pretty short. And since boomlength is a direct relative of gain, you would expect the gain of the antenna to be on the low side. Jerrold's specsheet gain is shown in the box insert here. As pointed out in the companion series on Antenna Basics, antenna test-range measurements are fraught with built-in dangers, especially when you are trying to *verify absolute gain* of a given antenna. Even front-to-side and front-to-back ratio measurements are subject to great debate in antenna circles, especially when your "test range" is cluttered (as ours is) with numerous other nearby towers.

Consequently, performance numbers for antennas are not and will not be our bag. I.e., if Jerrold says that this antenna has 6.4 dB gain at channel over a reference dipole, then that is what it has, as far as *we* are concerned.

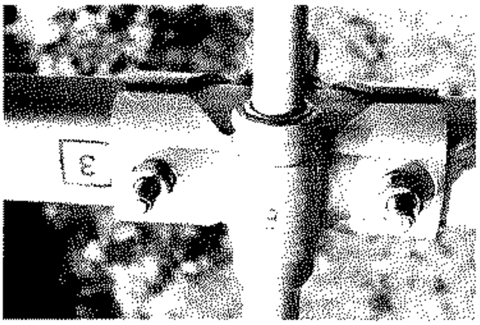
We will point out, however, that in classical *Yagi-Uda* antenna design (remember *this* is a log) there is only so much gain that can be squeezed out of a given length of boom, with optimized element spacing. The boom length on the J283X is 92 inches, which is something less than the 107 inches (in free space) of a half wavelength at channel 2. In fact, it works out to be about 86% of one-half wave or just over 0.4 wavelength long at channel 2. This would be sufficient boomlength for a Yagi of *between* three and four elements; and our Antenna Basics series tells us that *such an antenna* would have between 5 and 7 dB gain over a reference *dipole*. Seemingly, the Jerrold people read the same antenna reference material that we do.

Jerrold uses an unusual "fan element approach" to their log elements. When you first open the box, unless you notice all of the elements at once, the first one you pull out looks as if it were bent in shipping. It was not—it is in fact "canted upwards" at about 25

JERROLD J283X SPECS

Gain Channels 2-6	6/7.0 dB
Gain Channels 7-13	10/11.0 dB
Gain Channels 14-50	6/7.0 dB
Gain Channels 51-83	6/2.0 dB
Impedance	75 ohms, unbalanced
Match	VSWR 1.5:1
Wind Load	125 MPH
Front/Back Ratio	
VHF	18 dB
UHF	20 dB
3 dB Beamwidth	
Ch's 2-6	70 degrees
Ch's 7-13	45 degrees
Ch's 14-83	55 degrees
Boom Length	92 inches
Turning Radius	62 inches
Weight	20 pounds
Maximum Mast Size	2 inches
Connector	F
List Price	$90.00

Manufacturer—
Jerrold Electronics Corp.
CATV Systems Division
200 Witmer Road
Horsham, Pa. 19044



J283X elements bolt to square boom and are numbered to mate with corresponding numbers on boom

degrees (or downward, depending on where it mounts on which boom). This is a trick that allows the antenna to extend its bandwidth (ala the old conical antenna design in home antennas) beyond normally achieved bandwidth with a straight-tapered log approach. It should contribute to the flatness of the antenna in the gain-bandwidth department.

A search antenna is exposed, atop the tower where it would normally mount, to the worst kind of torture. It center-mounts on an insulated plate (logs are RF hot along their full boom lengths, except at the backend, where there is zero RF). We were pleased to to find that our original suspicions (that this would be a beefed-up, high-price *home* antenna) *were totally incorrect*. It is, in fact, considerably *more* rugged than many "ruggedized CATV antennas" which we have had experience with.

All of the elements are seamless chrome-aluminum tubing with ends sealed. The surface is coated with what appears to be a treated process that probably will protect the antenna against reasonable amounts of salt spray and atmospheric corrodants.

Coverage of channels 2-13 is accomplished through the basic longer log elements. A rectangular reflector, operating at the aft end of the twin booms, is *after* the booms have been "shorted" by a vertical set of metal plates. Most logs employ *no* reflector; passive, as it were, from the balance of the "hot" antenna. Another interesting twist by Jerrold.

The antenna also employs passive directors (in the Yagi-Uda format) at the very front region of the VHF section. Apparently these directors make up what amounts to be a three-four element Yagi-Uda (gain) *equivalent* for the *top* frequency end of *low* band (i.e. channel 6 or FM) and *high* band (channel 13).

The UHF portion snaps onto the front (actually it bolts on), and it would stand alone as a separate antenna. It also utilizes the "bi-conical design" of canting the elements in a fanned appearance.

The elements and the booms have numbers, and except for duplicate sets of elements marked with a *2*, there is no possibility of confusing which element goes where. The feedline is enclosed in the lower boom (which creates a decoupling network with the coaxial-cable shield). The boom is large enough for cable larger than 59/U (such as 11/U, or some equivalent low loss), although chances are the cable you feed the antenna with will be mated with a larger diameter aluminum jacketed cable for the down run to the headend, *below the rotor*, anyhow. Thus the cable choice in a normal situation is a small consideration, if the run from antenna to downline is fairly short.

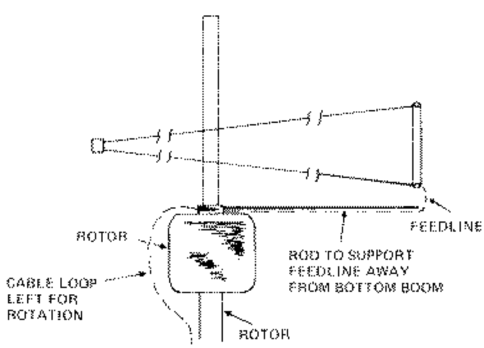
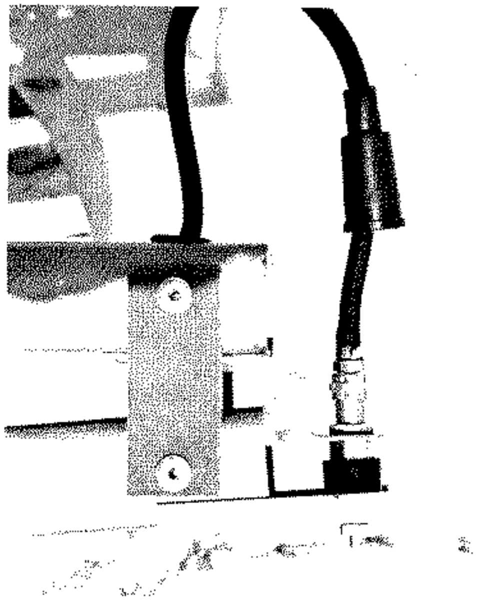


DIAGRAM 2



Feedline comes to antenna "nose" through lower (shield side) boom, F-connects to fitting mounted on standoff insulator on upper (center conductor) boom

And remember to seal the fitting with sealant before buttoning up the installation

The antenna is light enough (20 pounds) and the boom/elements are short enough that we had no difficulty hanging it onto a rotor mast/stub with one man.

There is one caveat in installation. As the antenna feedline comes out of the lower boom at the rear of the antenna, it should *not* be taped (or run parallel) to the lower boom. That is, exit out of the boom at some respectable (45 degree or better) angle, in effect "looping down" to the support stub or rotor housing. If you tape the feedline to the exterior of the lower boom, or run it parallel and close to same, your match will go to pot in a hurry. This sets up a new *coupling field* between the "hot boom" and coaxial cable shield, something to be *avoided.* This may present something of a problem in some installations. Normally the pipe stub that you stab into the rotor atop the tower to hold the search is purposefully short. You don't *intend* to have a long piece of pipe *above* the rotor, with the antenna more than a foot or so *above* the rotor, simply because if you do, the wind torque on the antenna creates a bending momentum on the pipe stub (mast) which can bend (or break) it out of the desired vertical plane. *Yet* if you do not mount the antenna some distance *above* the rotor, you cannot achieve the desired *angular exit* of the feedline from the lower boom to the mast/stub. This is a situation where you are cursed if you do, and cursed if you don't. One solution (see Diagram 2) is to install a floating non-metallic rod just below the lower boom, but above the rotor, to maintain the proper exit angle of the feedline from the "hot boom," and still provide a loop in the feedline for antenna rotation.

Jerrold is to be commended for providing the industry with a well-built, sturdy search antenna that the average system can handle atop their tower, and doing so at a price which the average system purchasing agent has no trouble justifying.

THE Q-BIT SX-0500 LOW NOISE PRE-AMP USES NOVEL CIRCUITS

A PREAMP IS A PREAMP

Through the twenty-five-year history of CATV, there have been any number of signal preamplifiers brought to the marketplace. Many of these have come from (relatively speaking) small companies trying to create their own niche in the CATV marketplace. Some have succeeded, and from the preamplifier success, an entire line of CATV equipment has evolved. Others have attained momentary success, only to be forgotten in time as new developments and new approaches to signal pre-processing left their designs antiquated.

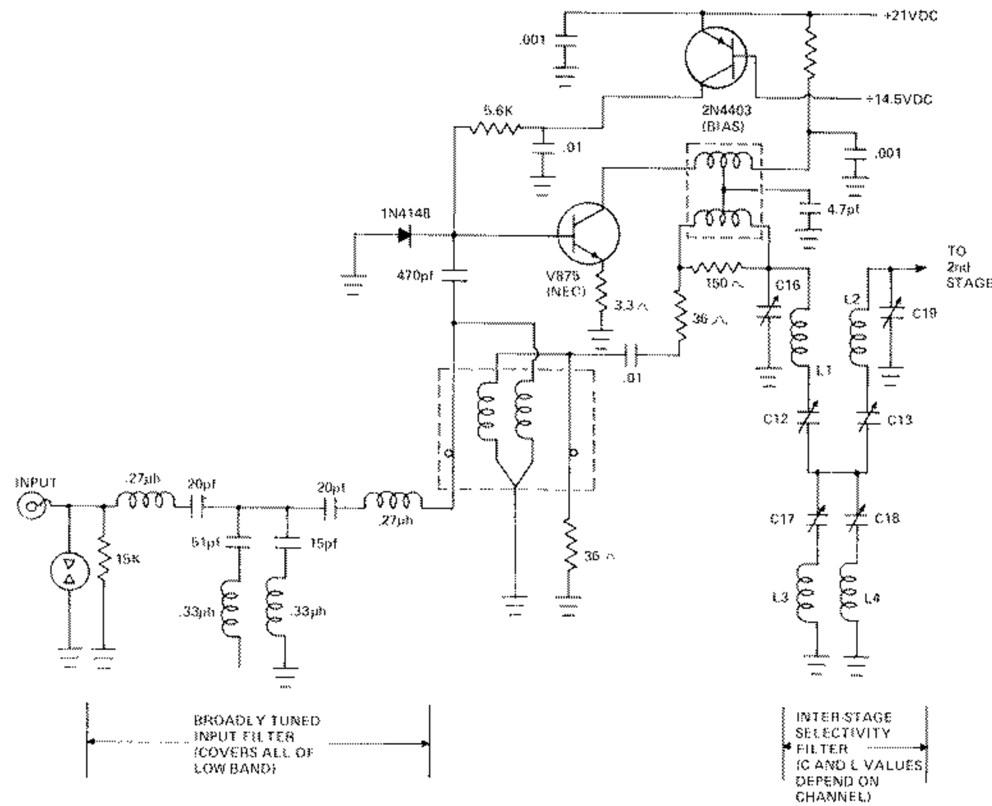
A preamplifier is something that virtually every CATV system operating in a TV wasteland can identify with. The purpose of a preamp is clearly understood by most, and performance is relatively simple to evaluate. Simply place the unit (often a demo unit from an eager new supplier) between the antenna and the processor, and view the results. On an "A" or "B" test, one is usually (1) worse than the other, (2) equal to the other, or (3) better than the other. Even non-technical types who don't identify with noise-figure measurements, selectivity curves, and signal-to-noise ratios can quickly (and accurately) "look" at a TV picture with "A" and "B" version preamplifiers, and reach an intelligent decision that one is the better of the two.

And, because preamplifiers are relatively inexpensive (usually in the $100-$200 price range), the amount of money to be *gambled* with a new-on-the-market unit, to see if it just *might* be as good as its makers claim, seldom stops a really concerned operator from testing a new device.

The current "state of the art" of VHF signal preamplifiers appears to be for a unit with 20-30 dB gain (amount selectable for your needs), a noise figure from 1.5 dB to 3.0 dB (lower is better), and either built-in selectivity (to avoid overload or signal degradation from off-channel signals) and/or a high-output-level capability to allow large input-signal voltages to go through the unit, amplify, and not create overload of the preamp.

The SX-0500 preamplifier from the Q-BIT Corporation is new on the CATV scene, within the past year or so. Within the CATV industry not a great deal is known about Q-BIT, which may lead some to suspect that it is a small operation on Florida's East Coast. It is *not;* the company has a fine name in military and space communication systems, and is well thought of in those respective circles.

The SC-0500's *initial* appeal is the price: it is rather dramatically *lower* than other preamps with similar gain, noise figure, and selectivity (including



Q-BIT SX-0500/FIRST STAGE

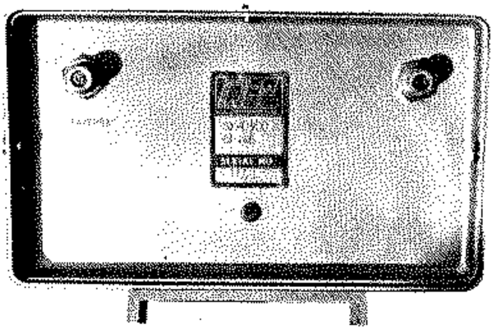
DIAGRAM 1

output capability) specs. The $139 price tag is based upon your ordering directly from the factory, and it includes a line-power supply that mounts in the headend in the traditional fashion.

If the price attracts initial attention, it is the operational specs (when combined with the price tag) that really *capture* the interest. Seemingly, if Q-BIT can produce a unit with these specs (*see box insert here*), and the unit *verifies* the listed specs, then either Q-BIT has an edge on technology that others with preamps in their line could do well to emulate, or, a price war on preamps is just around the corner.

The circuit of the SX-0500 is untraditional at best. First of all, it does *not* use FET devices (field-effect transistors); just when the CATV industry had about decided that the FET was a logical improvement over the older established bi-polar designs for preamp service, Q-BIT comes along with a few new wrinkles on the bi-polar transistor in small signal (preamp) service which questions over reverence for the almighty FET.

See Diagram 1. This is a simplified diagram of a *portion* of the SX-0500. The input signal first sees a Siemens device (more about that shortly), followed by a pretty conventional input bandpass filter. This *particular filter* would, standing by itself, have pretty *broad* bandpass characteristics, meaning that several channels either side of the filter would make their way



SX-0500 preamp is housed in mast-mounting housing, circuit board comes out with three screws in case . . .

SX-0500 circuit board pops out of case easily; note Siemens device lower left on input side.

through the filter and into the first active stage.

Now in an FET amplifier stage at VHF, the most accepted design principle is to ground the gate of the stage (so-called grounded gate design) and feed the signal into the source, extracting the amplified signal from the drain.

In the SX-0500, which uses a bi-polar device for amplifcation, each amplifier stage requires some form of neutralization (that is, controlled feed-back) to stabilize the stage and to prevent it from "running away" with itself. As the schematic shows, Q-BIT utilizes bifilar wound torroidal matching transformers between stages, which also allows the designer to extract *some* of the stages output energy. This accomplishes the feedback/neutralization requirement.

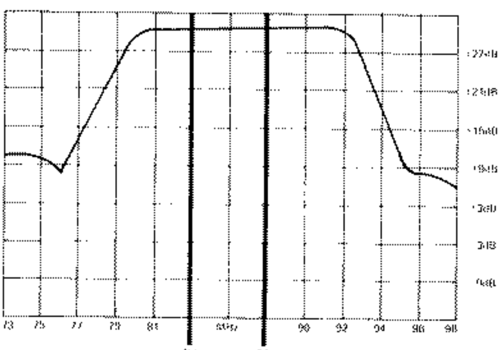
Where the SX-0500 apparently bridges new technology in the CATV preamp field is in their "bias transistors" (Q1 in Diagram 1). There are many cheap (i.e. inexpensive) ways to set bias on a transistor. The purpose of the bias is of course to place the operating characteristics of the bi-polar in the proper portion of its parameter-window. A common way to effect bias is to simply run a bias bus line and voltage drop through a resistor. Or, simply bias through a resistor to ground. In either case, the bias requirement has few component parts "tied up." But, in either case, *environmental changes* (i.e. temperature, humidity) can affect the bias voltage actually present to or at the transistor; and as the bias changes, so change the operating parameters of the bi-polar. In fact, one of the easiest ways to *change* the noise figure, overload point, etc. of a bi-polar is to "swing the bias" voltage present.

Perhaps this is the reason Q-BIT has incorporated three bias-setting *transistors* into their preamplifier, one for each stage of RF amplification. If this is the rationale behind the *unusual* design approach, and if it works (we believe it does, although *our inspection was limited* to a temperature range swing of 30 degrees F to 130 degrees F), there may well be a new era of preamp operating stability dawning for CATV systems.

In addition to the unusual use of biasing transistors there are a few other wrinkles to the SX-0500 design that are worthy of mention. The preamplifier is downline powered with 21 VDC. The DC component should not be a problem simply because at the low current levels present (electrolysis normally requires fairly substantial currents). At the preamp *on the output* to the downline, where the amplified signal is fed down the tower and DC operating voltage is picked off through an RF choke to power the unit, the SX-0500 has a zener device. This should serve as a clamp on the DC power in line to prevent surges or spikes that somehow couple into the downline at the *bottom* from blowing something in the preamp at the *top*.

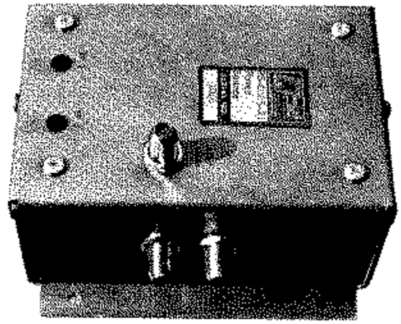
We mentioned earlier that a Siemens device is across the input. For some reason, design people *persist* in loading up the input circuits of preamplifiers with various lightning "protection" devices. The Siemens is commonly utilized; equally common are back-to-back garden-variety diodes. It is no fault of Q-BIT that they include it; but we do wonder (aloud as it were) whether anyone *really knows* just how effective either a Siemens or set of back-to-back diodes are in this application? Having experienced more than a reasonable quantity of lightning-blown preamps, it is our *opinion* (and labeled as such) that a very high percentage of lightning-damaged preamplifiers get zapped *from the bottom up*, through the downline. This is based upon our observation that in dozens of dozens of units inspected, the most common damage is to the *output RF stages*, working backwards to (but often missing) the input stage. The RF choke in the power-plexer (separating DC from the RF) is more often than not cremated beyond recognition, while the 500 pF or .001 input coupling capacitor is unharmed.

This is *not* to say that preamps do not get their licks on the input; it is



SX 0500 RESPONSE

DIAGRAM 2



SX-0500 power supply includes two sets of voltage test points (data sheet includes complete instructions for cross checking unit's operation from test point voltages) and —16 dB test point.

just to say that more often than not (i.e. *more than 50% of the time*) the repairs required indicate *the surge came up* the downline. And when the input gets zapped, well, as long as there is *any* form of direct capacitive coupling (as opposed to inductive coupling, such as is found in a Jerrold TPR), well . . . no Siemens, back-to-back diodes, or anything else is going to shunt the strike to ground before it blows the input circuit into the next county.

So we wonder why Q-BIT even bothers to put the Siemens across the input. Does it *really* serve any useful purpose?

Operational Check

We asked Q-BIT for the loan of a channel 6 preamp because we had a companion project going with some rear-mount SITCO five-element Yagis, on channel 6. Before we asked Hansel Mead at Q-BIT for the unit for test, we explained that the channel 6 we were interested in was 94 miles distant and would average minus 20 to minus 15 at the antenna. And to complicate life, we had a +18 dBmV semi-local channel 5 on the low-frequency side of the desired six, and three FM stations between 92 and 96 MHz which averaged +20 to +25 dBmV. Naturally, we were concerned about preamp over-

Q-BIT SX-0500 SPECS

Frequency	Single channel, VHF
Noise Figure	2.5 dB max
Gain	30 dB
Bandwidth	6 MHz min
Ripple	+/— 0.3 dB max
Selectivity	22 dB down, +/— 9 MHz center
Dynamic Range	+55 dBmV output, for —57 dBmV intermods
Input/Output	75 Ohms, F
Match	16 dB, input, output
Power Req	100 mA, 21 VDC (power supply included)
Devices	8 transistors
Price	$139.50

Source —
Q-BIT Corp., P.O. Box 2208,
Melbourne, Fl. 32901
(727-1838)

load and would not have blamed Hansel one bit if he tactfully suggested we try another channel. *He did not.*

Diagram 2 shows our measured response curve of the SX-0500. The solid line is the measured curve, while the points noted along the dashed line indicate the "spec response" indicated by the SX-0500 data sheet. Another way to look at this is to compare the input-and-output-level signals (i.e. before and after amplification). We did this on a few carriers available to us and found the following for our channel 6 unit:

Carrier Frequency	Thru SX-0500 Gain
67.25 MHz	11 dB
71.75 MHz	11 dB
77.25 MHz	18 dB
81.25 MHz	30 dB
83.25 MHz	**30 dB**
87.75 MHz	**30 dB**
92.50 MHz	23 dB
104.30 MHz	10 dB

With nothing but a preamp and an SLM, these are tests you can do yourself without sweep gear to plot on a piece of drug store linear graph paper the response curve (i.e. selectivity) of your own preamp.

With the assistance of an Anaconda 9952 Noise Generator and a 727 meter, we compared the apparent noise figure of the SX-0500 against another low-noise unit on the market. The *other* unit had a factory stamp of 1.7 dB noise figure, and we found the SX-0500 to be a few tenths of a dB higher than the compared-to unit. The difference, if real, was not visible in an "A" / "B" test between the two units on the —20 dBmV input signal on our 94-mile path.

Then we connected the SX-0500 to the search antenna and rotated the search toward the local channel 5 transmitter (fortunately it lays off to the rear and side of our normal channel 6 heading). We already knew that the SX-0500 gain on channel 5 visual was 18 dB; the data sheet on the SX-0500 said that when we hit +55 dBmV *output* from the SX-0500 we would have intermod products down —57 dBmV. With the search antenna rotated for the first detectable signs of preamplifier overload, we checked the input levels on channel 6 (—25 dBmV) and channel 5 (+26 dBmV visual, +21 dBmV aural). Additionally, we had several (six) FM band carriers in the 0 dBmV to +10 dBmV range. Naturally, where the non-desired carriers *fall on the gain curve* (i.e. how much level there will be from them *after* amplification), and the *quantity* of carriers present (i.e. the voltage sum of the carriers after amplification) will determine the point at which a specific unit overloads.

CONTEST COMING—AUGUST

The CATJ Reader Contest starts in July. Readers will answer one or more readership-quiz questions on a CATJ provided questionnaire card, and be eligible for CATV equipment prizes offered by CATJ and participating CATV manufacturers/suppliers. Make sure your subscription is current!

REAR MOUNTED YAGI-UDA ANTENNAS FROM SITCO

Hang It Up

The Simplicity Tool Company (SITCO) has been around the CATV scene since *shortly* after Ed Parsons founded the CATV industry in Astoria, Oregon on Thanksgiving Day in 1948. Actually, SITCO entered CATV in the winter of 1952, and the company introduced factory-ready quad-antenna arrays in 1954. SITCO says that more than 1,800 of these quad arrays are now in service and that many have been in faithful service for 15 to 20 years. Clearly, SITCO has been around through the thick and thin of CATV, and a lot of CATV customers are viewing a lot of pictures through their SITCO antennas.

Most Yagi-Uda antennas, as our separate series on antenna notes, are center-suspended from a clamp-to-mast assembly usually located at or very near the mechanical weight-center of the individual antenna. However, as our separate antenna series notes, any time you hang a Yagi-Uda in, near, or adjacent to a "foreign field of metal," you run the risk of distorting the Yagi-Uda receiving pattern (in both the V and H planes). And you run the risk of "modifying" the carefully constructed antenna impedance match so that *what is supposed to be a 75-ohm antenna* may be anything but a 75-ohm antenna.

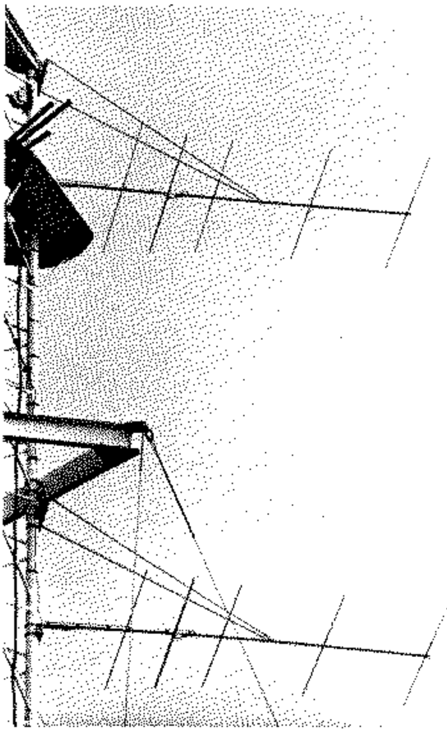
And, as we also note in our companion antenna series, one method of preserving a measure of the original antenna spec integrity is to mount Yagi-Udas in such a way that they do not "pear around" or "through" foreign metallic fields. In the case of (steel) tower mounting, this means hanging the antenna from the rear so that *all* of the Yagi-Uda elements are *out in front* of the tower steel members.

So the answer to this problem is to hang the boom from the rear, and then place a diagonal brace from above (or below) the boom-to-tower mounting point to the Yagi-Uda boom, approximately half way out along the boom length. But then you run smack dab into the problem of the diagonal brace having its own 30-45 degree angle) foreign-field metal. And bang, there (*the book says*) go *many* of the advantages you picked up by rear-mounting in the first place.

Actually, the diagonal brace, even if metal, runs pretty much *parallel* to the boom of the antenna; and as such, it is at a 90-degree angle with the elements. So if there has to be a diagonal brace (and there does for most rear-mounted antennas of any gain/length), this is *probably* the *least* destructive location for such a foreign-metal field.

A Kit

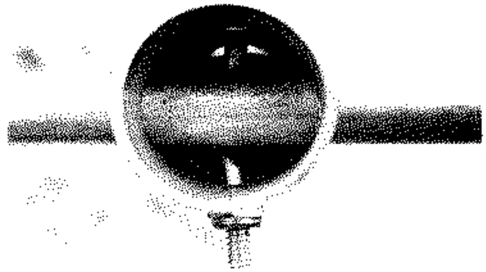
SITCO antennas come to you in a fiberboard container, knocked down. This saves plenty of money on ship-



SITCO MA-5-6 dual stack, rear-mounted on 42-inch face tower; guy wires are to be avoided!

ping, and it also saves you money (the trade is for *your own* final assembly time) for the antennas. All SITCO antennas, regardless of whether they are rear-mount, or center-mount, feature pretty much the same construction format.

The antenna boom comes to you in one or two pieces (depending upon the number of elements you order and the channel). The element holes are predrilled, and each hole is *factory outfitted* with something SITCO calls the screw-wedge fastener (which SITCO has a patent on). This works in this fashion. Taking the proper color-coded element from the bundle and matching it with the color code on the antenna boom, you insert the element through the factory-drilled hole and center the element in the hole (so that *equal* amounts protrude out of the boom on both sides). Then you take a wrench and tighten down the nut on the screw-



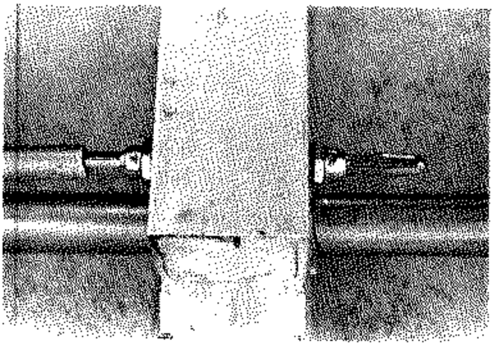
SITCO screw-wedge fastener secures element in place with pressure-fit.

wedge fastener. As the nut torques down, the patented curly-Q screw swings *into* the element and *binds or bites it* so that the element cannot move or turn under pressure. It takes about as long to tell you about it as it takes to do it, and it is *really* a pretty neat scheme.

The elements are 3/8 inch *solid* (6061-T6) aluminum rods, with 1/2 inch (OD) sleeves in the center where the elements center in the boom. By utilizing solid-bar elements, SITCO gets around the problems usually associated with open tubing (static buildup, especially during precipitation), including element fatigue under constant heating, cooling, and wind. The solid-bar element ends are rounded off ala the *theoretical* dissertation that rounded elements tend to improve static voltage discharge.

The booms on SITCO Yagi-Uda antennas vary in size from 1-3/8 inches OD down to 1-1/8 inches OD, depending upon the number of elements and the channel (bigger booms on lower channels where antenna weight increases). The result is a *frightfully lightweight* antenna. Four of the antennas in a quad array for channel two, for example, weigh in at 145 pounds, or averaging 28 pounds per antenna equivalent in the array.

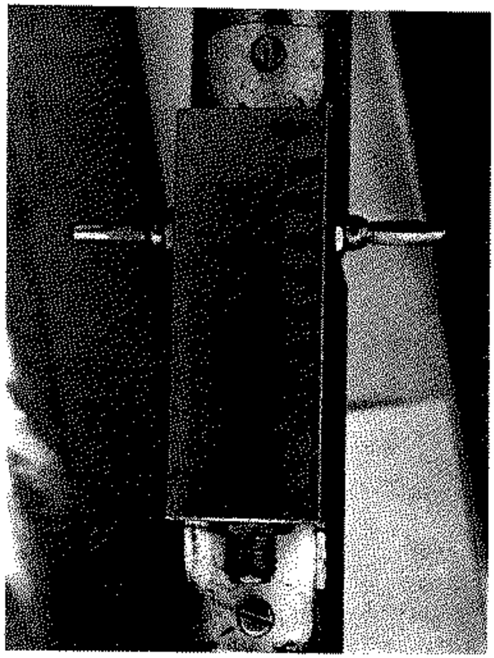
SITCO attacks the dipole element pretty much out of the textbook: they utilize a "ratio dipole" where the through-the-boom portion of the dipole



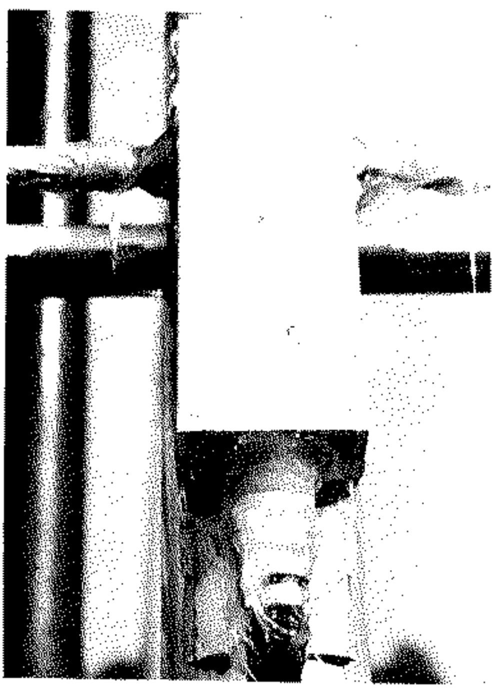
SITCO integrated balun transformer mounts on antenna boom.

element is 0.5 inches OD, while the bottom portion of the dipole is 0.25 inches OD. This results in a dipole that internally transforms itself into a feed impedance of (we suspect) approximately 150 ohms (balanced).

To turn this balanced *relatively* high-feed impedance into something more closely approximating the 75-ohm unbalanced characteristic transmission-line impedance of a CATV downline, SITCO utilizes something they call an *"integrated balun transformer"* (see photo). This device mounts directly to the boom of the antenna (with two metal screws), and it has an unusual mechanical mating approach to the dipole element. Note (in photos) that the lower or 0.25-inch portion of the dipole has an ID (inner diameter) which just slips over the banana plug jacks protruding out of both sides of the "integrated balun transformer" assembly. By this ploy the dipole attaches to the "transformer," housed inside the aluminum case.



Banana plug inserts into 0.25-inch tubing forming bottom portion of dipole.



Use a good-grade sealant, such as Silastic 732 RTV adhesive/sealant, to coat all dipole connections after assembly.

If the "connection" is not sealed at the time of installation, sooner or later moisture *will* seep into the fitting formed by the ID of the dipole smaller tubing piece and the OD of the banana plug. This moisture will *corrode* the banana-plug surface contacts, and this will cut down on the amount of RF (signal) transferred from the dipole to the "transformer," and then to the downline. This would of course cut the effective "gain" of the antenna so that eventually the antenna would have no

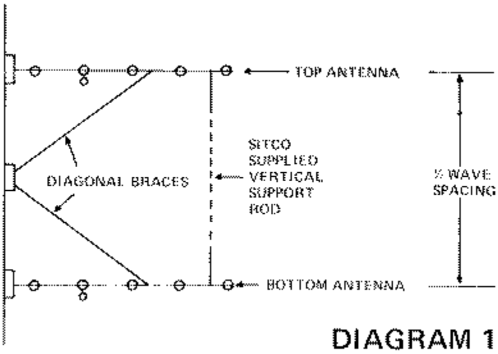


DIAGRAM 1

(or negative) "gain" over a reference dipole.

What Can Rear-Mount?

Basically, *any* Yagi-Uda can be rear-mounted. The SITCO MA-5 series (*low*-band five-element Yagis) have *boom* lengths that vary from 127 inches for channel 2 down to 71 inches for the FM band. The SITCO CA FM band series has a boom length of 146 inches; these are 8-element Yagi-Uda antennas. The SITCO CA high-band Yagi-Uda series antennas (12 elements) have boom lengths from 116 inches down to 97. All of these SITCO antennas *can* be rear-mounted with the SITCO rear-mounting kits. The rear-mounting kits consist of special boom extension kits (to extend the boom length backwards beyond the reflector), special boom to tower leg mounting kits, and twin diagonal braces with a tower leg mounting support, and hardware.

Normally, with the antennas center-mounted, the "F" connector on the *integrated balun transformer assembly* points *toward* the clamp that mounts the antenna boom to the vertical support mast. However, it is a nice attention to detail with the rear-mounted versions that the *integrated balun transformer assembly* turns around so that the "F" connector *points to the back* of the antenna. This allows the installer to route the feedline cable directly toward the tower leg where either his aluminum-jacketed feedline is housed, or, to combining networks when the antennas are used two or more to a channel. This is a *nice* engineering touch; it shows that somebody at SITCO is either (1) *responsive* to field feedback, or, (2) *knows* from personal experience about some of these little tricks that make a good antenna design even better.

Performance

The mechanics of measuring antenna performance are beyond *CATJ*, simply because we do not have (few do) the proper kind of antenna test range, uncluttered with nearby metallic fields.

However, we set out to compare on an "A" and "B" basis the performance of the SITCO MA-5 rear-mounted antennas on two long observed over the horizon signals.

With the cooperation of Axel Tyle of SITCO, we chose to test a pair of MA-5-2 (rear-mounted five-element channel 2 Yagis) and another pair of MA-5-6 (rear-mounted five-element channel 6 Yagis). Both the channel 2 and 6 signals are in regular use at our test location, over paths of 90-95 miles. The reference antenna for channel 2 is a ten-element popular-brand channel 2 Yagi; the reference antenna for channel 6 is the same popular-brand channel 6 Yagi.

The rear-mounted SITCO dual five-element arrays were combined with equal lengths of RG-59/U into a hybrid combiner, and into low-noise single-channel preamplifiers respectively on channels 2 and 6.

Note that the total elements were identical for both sets of antennas: *ten elements in all.* In the reference antenna, they were all in line, while in the SITCO MA-5 arrays they were five in a line times two stacks of antenna.

In their instructions for stacking two (or more) MA-5 antennas, SITCO shows an approach that results in the antennas being effectively 1/2 wavelength in free space apart. They provide a vertical support rod that connects the front end of both antennas together (see Diagram 1). The rods provided simply limit you to 1/2 wavelength stacking. We had *difficulty* with *rationalizing* stacking these antennas *that close together* (we opted for *1 full wavelength* stacking in the vertical distance between two same channel antennas). Consequently, we did *not* utilize the boom-to-boom support rod provided by SITCO. This could result in the antennas not being as structurally sound *as SITCO would like;* and if this "omission" worried someone in the field (*we were not* concerned), other longer rods could be substituted of a proper length to "make the connection" between bays.

Both the channel 2 and 6 signals have always exhibited a slight (25-30 dB down) trailing edge ghost with the side-mounted antennas. We could never determine *for sure* that the reflected path signal was coming *from* the towers on which the side-mounted arrays are mounted, *but we were suspicious.* The ghost was always more pronounced on channel 6, and the 42-inch face tower the antennas are mounted on would just naturally be more (i.e. higher percentage) of a wavelength at channel 6 than at channel 2. The ghosts all but disappeared with the rear-mounted MA-5 Yagi-Uda antennas, *on channel 2.* And on channel 6, with the MA-5 antennas, they were noticeable *only* when the signal level off the air built up to 20-30 dB *above the average levels* (for short periods during inversions). This *very definite improvement* in monitor signal quality *may* not have been directly attributable to the rear-mounted antennas, *but* it fits the general theory for using rear-mounted Yagi-Uda antennas in the first place.

SITCO MA-5 SPECS

Forward Gain	11.0 dB
Front-to-Back	16.9 dB
Front-to-Side (*)	18.5 dB
3 dB Beamwidth	35 degrees
Weight	
Channel 2	18 Pds. (**)
Channel 6	12 Pds. (**)
Boom Length	
Channel 2	127"
Channel 6	73"
Greatest Width	
Channel 2	108"
Channel 6	73"
Booms	1.25" x 0.058" thickness
Elements	
Solid 6061-T, 3/8", 1/2" sleeves	
Pricing (with end-mount kits)	
Channel 2	$107.70
Channel 6	$ 93.30

*—Best Case
**—Less end-mounting assembly
Manufacturer—SITCO, Inc., P.O. Box 20456, Portland, Oregon 97220 (503/253-2000)

Frankly, we expected the two-stack array to show from 1-3 dB improvement in fade margins (i.e. we expected the signals to average 1-3 dB higher on the bottom of fades). We were not surprised: *this is* what we found. We were reminded of a particularly difficult over-mountain-path in California of some years ago where every conceivable stacking configuration and antenna type had been tried to cut down on rapid "pumping-type-fading" being experienced on channel 2, from San Francisco. Then, in 1966, we had finally settled on an *8*-high array of five-element Yagi-Uda antennas. They were stacked down the tower at one-wavelength intervals to cure that problem.

Rear-mounted Yagi-Uda antennas are *not* new. Nor are they the right antenna for *every* application (i.e. when horizontal stacking techniques are required for co-channel elimination). But where Yagi-Uda antennas *are* to be utilized, and where vertical-tower-mounting space *is* available, they *should* be seriously considered.

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