An Introduction to Amateur Television - Part 3

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An Introduction to Amateur Television

Part 3—Part 2 of this series introduced the basic components of an ATV station. Now, we'll look at a variety of technical topics including power amplifiers, vestigial sideband and ATV repeaters.

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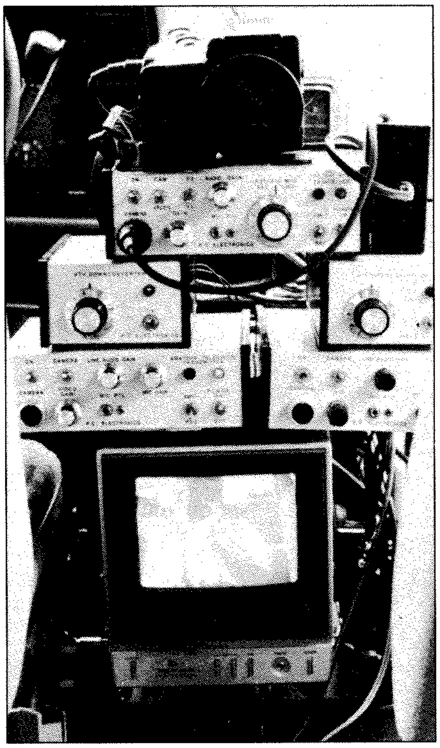
Although monitoring an ATV channel with your TV set will help you spot some stations, the directivity of most effective ATV antennas limits the effectiveness of a video CQ. Most day-to-day activity revolves around monitoring the intercom frequency: typically, 2 meters.[9] A short call quickly hooks you up with other stations, providing the necessary information as to where to point the antenna. Our Central Michigan Amateur Television Society (CMATS) group, centered on Lansing, Michigan, now has 13 stations equipped for two-way ATV. Contacts can be had at any time in the evening, and most informal operating sessions involve about half a dozen stations. Another five or six stations at the "looking-in" stage add to the fun.



An ATV station in a car? That's right! At left, Henry (KB9FO) Ruh's well-stacked station. Dave (AH2AR) Pelaez's quick and easy set-up is shown at right. (Better tie down that gear, fellas!) *(photos courtesy of KB9FO and AH2AR)*

Getting Organized

Once a local ATV group develops, it's often advantageous to set up a regular time that serves as "local ATV night." It need not be as formal as a net, but it does serve as a focal point for those operators who have to parcel out their operating time. It's also useful for those who are just getting to the looking-in stage. Given the receiving limitations of such stations, being assured of seeing a wider range of stations can help to boost interest on the part of potential new operators.

ATV demonstrations at local radio club meetings can serve to recruit new members. Although video tapes depicting activity are effective, greatest impact is achieved when stations can be worked live at the meeting. This requires a bit of coordination and planning because a complete station—including a moderately effective antenna—must be in place at the club site for the demonstration. The exercise of assembling equipment and coordinating activity can be a useful focus for the local ATV group. Any focussing project can be a great asset in maintaining a high level of local activity and recruiting new members. Providing video communications for public-service activities, building an ATV repeater, mounting a balloon project, or a variety of other activities can serve to keep things lively and interesting.[10]

Pleasant Surprises

One spark that can add the element of surprise to day-to-day operations is the tropo DX band opening. The key is in knowing *when* the band is open, or *enhanced.* In most cases, 2-meter band conditions can provide a reliable guide, based on hearing "new" stations on the ATV intercom frequency, or the ability to access repeaters at greater distances. When conditions favor both 2 meters and 70 cm, 2 meters can be used to alert distant stations that you're on, serving as a guide for orienting the more directional arrays used for ATV work. If there are regional variations in ATV intercom frequencies, check out alternative channels on a regular basis.

Although tropo openings typically enhance both 2 meters and 70 cm, this is not *always* the case, nor is the geographic pattern of enhancement equivalent. Repeaters on 70 cm can provide a guide to band conditions, as can DX activity centered on 432-MHz CW and SSB. Stations at the lower end of the UHF broadcast band act as useful beacons for evaluating band conditions. Keeping at hand a log sheet that lists the location of UHF stations[11] within a radius of a few hundred miles will prove helpful in evaluating where to look for ATV activity. When the band is *really* hot, UHF broadcast stations are wall-to-wall well up into the band!

During all but the strongest openings, expect significant signal fading on long paths. If there is a great power/gain differen-

[9]Notes appear on page 41.

The AEA mast-mount amplifier RLA-70 power amplifier/preamplifier and MPS-100 power supply. *QST's* May 1992 Product Review column looked at these items and the VSB-70 transceiver.

tial between two stations attempting to confirm a two-way contact, 2-meter coordination can be the key to success. One strategy that works well is to have the more powerful station transmit, watching for peaks in the received signal. When band conditions peak, a quick shift to transmitting by the low-power station can often result in a readable image. *What* you transmit under such conditions can be critical. Images that work best are large, blocky, black-on-white or white-on-black call signs. Such ID transmissions can be prerecorded on video tape, or generated by computers or dedicated image generators. The universal criterion for a two-way contact is that your call sign can be read—however momentarily—at the other end. Live camera views of the operator work well when conditions are very good, but are not effective when the path is marginal.

One way in which ATV operations differ from the typical CW or voice contact is the use of the "P" system (akin to the better-known RST system) for reporting the strength/quality of the video signal. Reports can range from P0 (some sync, but video not discernible) to P5 (noise-free, "closed-circuit" pictures). The system is certainly subjective (see Fig 16-3 on page 16-4 of the current edition of the *ARRL Operating Manual*), but usage is typically quite consistent, and the reports are a valuable aid in making incremental improvements in your station. Conditions over even relatively short paths can vary quite a bit from day to day, and variations of a P unit are not uncommon. When you have made some change in your station, it is useful to evaluate the effect over several days to ascertain the impact of the change.

RF Power Amplifiers

The most common upgrade of a basic ATV transceiver/antenna combination is the addition of a "brick" amplifier. These are available in a wide range of combinations of power input/output levels, and some models include GaAsFET receiver preamplifiers. Models I know of that have provided good performance in ATV service are listed in Table 5. These amplifiers are quite easy to use because most employ automatic TR switching using RF sensing. This means that you simply stick the amplifier in your transmission line with no switching provisions other than turning the unit on and off (if you don't intend to use it all the time). The RLA-70 looks expensive compared to the other amplifiers listed, but that price includes AEA's MPS-100 power supply. This supply provides power to the VSB-70 transceiver and to the remote RLA-70 amplifier through the coaxial transmission line. Power supplies are *not* included in the prices for the other listed amplifiers.

Where you install the amplifier can greatly impact your system line losses. If an amplifier with an integral receiving preamp is installed close to the antenna, line losses between the amplifier and the transceiver are relatively unimportant. That's because the first RF stage sees only the short length of transmission line connected to the antenna, and the gain of this first stage is usually sufficient to overcome moderate line losses and still control the receiving system noise figure. Line losses impact the drive level to the remote amplifier, resulting in less-than-maximum possible output, but the system is still more effective than if the amplifier were installed at the transceiver end of the line.

The AEA RLA-70 amplifier (see Table 5) carries this strategy to its logical conclusion: The amplifier mounts at the antenna. The 50-watt PEP output of this unit represents an effective power level for local work and will net you *plenty* of contacts during band openings. It's also worth noting that 50 watts generated *at the antenna* is equivalent to a 75- to 100-watt amplifier operated in the shack, given typical line losses! Although many members of our CMATS group can run 100 watts or more into the antenna, they don't do so during local operation. The "afterburners" get fired up during band openings and the occasional test transmission to someone's cable-ready TV set. Otherwise, power levels in the 5- to 15-watt range are the norm.

Uh-Ohs

One of the major problems—particularly with solid-state amplifiers—is sync compression resulting from amplifier non-linearity. To understand this, we have to delve a bit into the nature of the video waveform. There are four significant signal levels: the sync, blanking, black and white levels. How these are expressed depends on how you analyze or measure the signal. In terms of RF power, a properly modulated signal has the following power-output relationships:

Waveform	*%PEP*
Sync	100
Blanking	75
Black	62.5
White	12

Lou, K7YZZ ("The Wizard"), built this ATV repeater for the Seattle, Washington, area group. *(photo by K7YZZ)*

Table 5
Some Solid-State Power Amplifiers Suited for use with Available ATV Transceivers

	Peak Power		List		
Model	*Input*	*Output*	*Price*	*Vendor†*	*Notes*
D-15N	2	18	$160	PCE,WR	
RFC 4-32	3	20	$183	WR	(1)
RLA-70	1	50 PEP	$699	AEA	(1,3)
D-100-ATVN	1	52	$349	PCE,WR	
D-1010-ATVN-R	4	80	$519	PCE,WR	(2)
RFC 4-110	10	100	$349	WR	(1)
RFC 4-310	30	100	$352	WR	(1)

All of these amplifiers feature RF-sensed switching, so no provisions for manual TR switching are required. Prices shown are manufacturers list prices; discounts are common. Because many of these amplifiers are widely used by SSB and FM UHF operators, they're available off the shelf from local dealers and Amateur Radio equipment suppliers. The D-series amplifiers are produced by Mirage/KLM; the RFC series are manufactured by RF Concepts/Kantronics.

Notes

(1) Amplifier features built-in GaAsFET receiver preamplifier.
(2) Ruggedized model designed for continuous duty/repeater service.
(3) Unit enclosed in weather-resistant housing for mast mounting with the power supply (designed to power the remote amplifier via the transmission line) included in the list price. See the text discussion for the significance of the power-output ratings of these units.

†Contact information for Advanced Electronic Applications (AEA), P.C. Electronics (PCE) and Wyman Research (WR) is given in Table 1 in Part 2 of this article. See May 1993 *QST*, page 44.

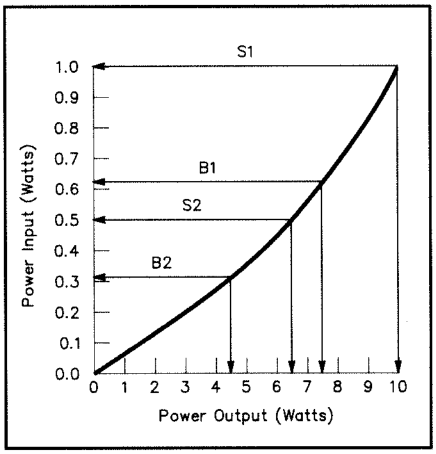


Fig 2—Power output as a function of input for a hypothetical solid-state power amplifier. S1 indicates the input and power output levels on the sync tips for a drive level of 1 watt peak. B1 indicates the relative input and output power for the blanking pedestal (0.5 watt drive). S2 and B2 represent the analogous power relationships when the amplifier is driven at the 0.5-watt input level at a more linear portion of the input/output power curve. The text discusses the effect of amplifier nonlinearity on the transmitted video waveform.

When the transmitter's modulator circuits are properly adjusted for a standard NTSC video signal, the video-waveform sync tips represent 100% transmitter power output (let's say about 1 watt). The blanking pedestal should be 75% of peak output (0.75 watt), black level is at 62.5% (0.625 watts), and white represents 12%, or 0.12 watts. The *difference* of 37.5% between the black level and the maximum power at the sync tips is needed so that the receiver can reliably separate the sync pulses from the rest of the video waveform, locking in (synching) the picture. If we want to amplify this signal, we must do so in a way that preserves the relative power relationships: This is impossible if the amplifier stage(s) *are not strictly linear.*

Fig 2 shows a hypothetical input versus output power curve for a 1-watt input/10-watt output, solid-state amplifier. No matter how carefully you can control the bias in one of these circuits, there's always a certain amount of *gain compression*: The harder you drive the stage, the less power output you get for a given change in drive level at the upper end of the power curve. This nonlinearity matters little for CW or FM service. Some SSB operators see it as a distinct advantage because it affords the equivalent of modest speech compression, if the nonlinearity is not severe. (However, a nonlinear, splattering SSB signal won't endear you to your neighbors on the band.) The graph shows, however, what happens if we drive this amplifier with our hypothetical 1-watt video signal.

With 1 watt of sync (peak) drive from the exciter (S1), the amplifier delivers the expected 10 watts of sync output. With black-level video, the amplifier is driven with 0.625 watts (B1), resulting in a power output of 7.5 watts, 75% of the peak sync level. In this case, the sync pulse has only 25% headroom instead of the proper 37.5% (100–62.5). This *sync compression* makes it difficult to lock the picture (it will roll and tear on the screen) at all but very high signal levels. In effect, the amplifier substantially improves your power output, but at the expense of making the signal unstable at the other end of the path! In practice, the effective sync compression is much worse because the input/output power curve used for Fig 2 is a great deal more linear than that of many "brick" amplifiers, and the problem is often compounded by overzealous operators who overdrive amplifiers!

Remedies

There are only two easy solutions to the problem. One is to reduce the drive level to the amplifier so it's operating in a more linear portion of the input/output curve. If we attenuate the drive level from the exciter by 3 dB, peak sync drive will be 0.5 watt (S2) yielding 6.5 watts of output on the sync tips. The black drive level will have been reduced to 0.31 watt (B2), resulting in a blanking power output of 4.5 watts, about 69% of peak power. Although still higher than the optimum 62.5%, the result is significantly better than the 75% with full drive. Although this greatly improves synchronization, it's a bit frustrating having to operate the amplifier at significantly less than its rated output!

A second solution is to *predistort* the video drive signal so that it has excessive sync, resulting in the proper sync power ratio at the output. The three ATV transceivers discussed previously each have various forms of "sync stretcher" circuits to do just that, allowing you to push the amplifier harder. The solution isn't a perfect one because the nonlinearity affects the video dynamic range and color purity to varying degrees, but it does allow you to get more out of a given amplifier and still maintain acceptable video quality. The major disadvantage is that if you want to use the transceiver on its own, you'll have to readjust the stretcher setting, otherwise the exciter signal will have lower-than-normal video contrast.

AM Linear Service

Perhaps the most critical mode for any amplifier is AM linear service; you can expect to spend some time getting it right if you're using anything other than the AEA amplifier. You can assume that the manufacturer has set up your transceiver properly, but it's almost impossible to adjust an amplifier just by looking at your signal from the shack because you'll be overloading almost everything! Using a *line sampler* and an oscilloscope is ideal, but reports from other local stations (particularly if they can monitor your transmitted waveform) will get you in the ballpark. Line samplers are devices that are placed in the transmission line, sampling the RF envelope and providing enough amplification to drive a video monitor. PC Electronics, Wyman Research and Pauldon Associates market line sampler units; recent editions of *The ARRL Handbook* feature details on the construction of a suitable instrument.

Tube-type amplifiers are less fussy because they are generally more linear than solid-state devices, and tubes are used almost universally if you want power outputs much above 75 to 100 watts peak. Such amplifiers typically require a modest intermediate amplifier, however, if you are to develop maximum possible output from the final when using a 1-watt-output video transceiver. The 15-watt RF Concepts amplifier (and others of equivalent power rating) do the job nicely, allowing you to maximize the power output of your big amplifier.

Some experimentation with settings of the final amplifier's tuning, loading and bias controls is usually required to optimize power output while avoiding sync compression. Some tube amplifier circuits (commonly UHF transmitter strips from surplus commercial equipment) suffer from bandwidth limitations that make it difficult—or impossible—to push a color signal and FM sound subcarrier through the unit.[12] If careful grid tuning can't solve the problem, it's always possible to grid-modulate the final with excellent results, using the TV exciter as a driver with video input disabled. Recent editions of *The ARRL Handbook* feature a grid modulator designed by K2KQZ that can be adapted easily to work with a number of power tubes, with the advantage of significantly more amplifier efficiency than can be obtained in AM linear service. Most of the high-power amplifiers in the Lansing, Michigan, area use a single 4CX250 or 8930 in a coaxial cavity, or two tubes in a parallel stripline configuration (K2RIW design). All of these work well in AM linear service if set up properly, but have a narrow bandwidth.

Checking Power Output

Expect to be disappointed if you check the output power level using a wattmeter. The sync pulses, representing your peak power, won't be indicated unless the power meter has been designed to give a true peak power indication. Most "peak power" meters actually indicate on the basis of certain assumptions about audio-power distribution and won't do the job in video applications. Your "indicated" power on a typical wattmeter, often referred to incorrectly as "average" power, will typically be 50% (or less) of the peak power, depending on the modulator setup and drive level. A good wattmeter can be used effectively to help you set up an amplifier (if you don't have access to an oscilloscope and line sampler) and most transceivers come with guidelines that help you out. When noting their power output, most stations specify "average" or "peak" power levels and you can make the rough correction to see how you compare.

If you're using a vestigial sideband (VSB) filter (more on vestigial sideband in a minute), expect to see at least a 25% decrease in *indicated* power compared to the same amplifier operated with the filter out of line. Most of this power decrease represents energy in the unwanted lower sideband (which the filter is designed to remove) as well as a power reduction resulting from filter insertion loss. The carrier-power loss is equivalent to 0.5-1 dB, about 8 to 16%.

Looking nose-to-nose with my home-built autogyro you see the custom digital/analog instrument pod with a ⅝-wave 70-cm "rubber duck" antenna (off to the right). The antenna is used for ATV and FM communication with a 70-cm H-T. Either the ATV transmitter (a 1-watt P.C. Electronics unit) or the H-T is installed in a small pouch next to the seat. For voice work, the H-T is interfaced to an audio-equipped helmet; the PTT switch is on the gyro's throttle assembly. The ATV transmitter is keyed on and off with a small toggle switch mounted next to the seat. *(photos by WB8RJY)*

Here I am, flying by in my ATV-equipped gyroplane.

A gyro pilot's view of what's below. The photos are of in-flight ATV video received by Jeff, WB8RJY, located about 6 miles away. In this early test of the airborne ATV system, the antenna was attached directly to the transmitter. The pod-mounted antenna, however, has a much cleaner pattern. I was at an altitude of 700 feet when this video was transmitted and the little whip antenna worked well despite cross polarization. (The whip is vertically polarized, but the receiving ground stations use horizontally polarized antennas, as I do at home.)—*WB8DQT*

Vestigial Sideband

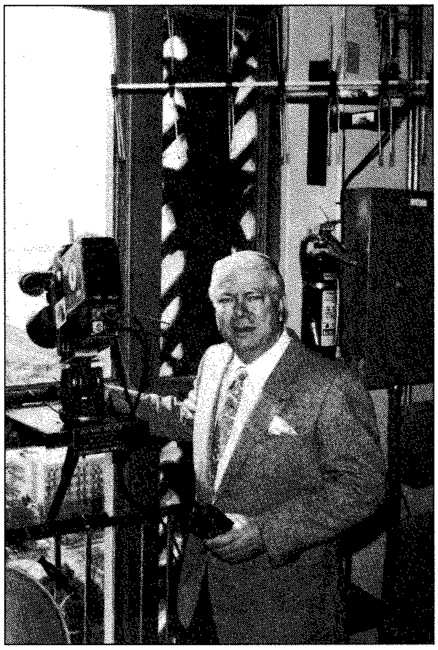
One of the most contentious subjects in ATV circles today concerns the merits of using vestigial sideband (VSB) for amateur video transmission. If we're going to approach the subject honestly, it's necessary to recognize that there are three dimensions to the discussion: the marketing climate, the technical side and the operational advantages that attend the use of VSB equipment. Of the various transceivers discussed in Part 1 of this series, only the AEA VSB-70 is designed for VSB service. AEA has invested time and money in the development of the technology, and they are understandably vocal about the advantages. It should not come as a surprise that manufacturers of conventional DSB tend to discount the impact of using vestigial sideband!

Vestigial sideband video transmission has no analogy to other amateur modes. VSB is *not* equivalent to single-sideband because the VSB signal retains the carrier and some lower-sideband components within 1 MHz of the carrier frequency, but with significant suppression of the rest of the lower sideband. That includes the LSB color burst signal and aural subcarrier (3.58 and 4.5 MHz below the carrier, respectively). VSB is used exclusively in broadcast television, allowing for 6-MHz channel separation.

Generating VSB

There are two ways to generate a VSB signal. The approach used by AEA involves the use of a surface acoustic wave (SAW) filter for the extremely low-level channel 3 video signal, followed by amplifier and mixer stages that are all conservatively designed to retain the VSB signal characteristics. The second approach is to amplify the conventional DSB signal to the desired power level, then route it through a sharp, vestigial sideband filter. At 70 cm, these filters take the form of multi-element interdigital filters that pass the upper sideband and carrier, but progressively attenuate the lower sideband components. Suitable filters are available from Spectrum International and International Crystal Manufacturing.[13] The Spectrum International filter is the less expensive of the two, but has a significantly higher insertion loss and lower power-handling capability than the ICM unit. One of the major limitations of add-on VSB filters is that they are single-frequency devices. If you operate more than one frequency, you'll need an individual filter for each of those frequencies. (Ouch!)

Linear amplifiers do provide an additional complication when used in conjunction with a VSB signal. With almost all amplifier circuits, intermodulation products result in the regeneration of the attenuated lower sideband. If a narrow band-pass filter is used to produce the VSB signal, it should be placed in the line *after* the power amplifier if you're expecting to produce a true VSB signal. The RLA-70 amplifier from AEA is specifically designed to maintain a high degree of lower-sideband suppression (equivalent to that obtained with most band-pass filters) when driven by their VSB-70 transceiver.



From this lofty perch, a remote camera and link antenna, part of the Baton Rouge, Louisiana, ATV repeater, allow area ATVers to watch the weather on the Mississippi River and downtown Baton Rouge. The man on the scene is Kenny, WB5JLZ, the repeater trustee and club president. *(photo courtesy of WB5JLZ)*

VSB is mandatory in two situations. One of these concerns the transmitter and receiver of in-band repeaters. Without vestigial sideband filtering, it's almost impossible to reduce desensing and intermodulation effects when the repeater receiver and transmitter are operating in the 70-cm band. Interdigital VSB filters are used in *virtually all* repeater installations, although new repeaters may make increasing use of the VSB capabilities of the AEA equipment line.

The second mandatory use concerns stations north of line A (see note NG135 on page 2-42 of the current edition of the *ARRL Operating Manual*). Basically, stations near the Canadian border can only use the 430- to 450-MHz portion of the 70-cm band. Operation on 439.25 MHz presents no problem, but frequencies below 430 MHz cannot be used. The possibility of operation on 434 MHz is dependent on the use of VSB. A DSB signal has detectable lower-sideband energy (including the 4.5-MHz aural subcarrier) and these components *will be below* 430 MHz—and *illegal.* A VSB signal can operate at a carrier frequency of 434 MHz and not violate the current agreements between the US and Canadian governments.

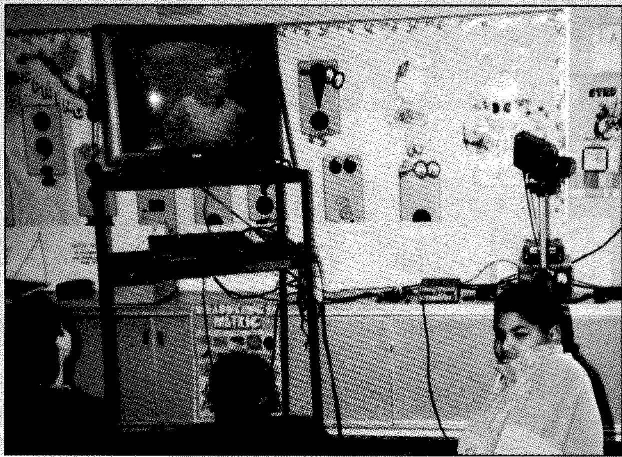
The remaining arguments about VSB are more subjective. The following represent a partial summary where I'll try to be as objective as possible.

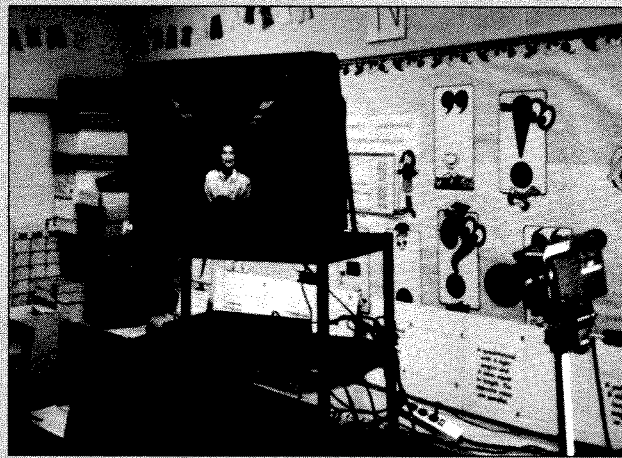
• *VSB allows more stations to operate in the 70-cm band.* We can start here with the recognition that although broadcast channel allocations in the US are made at 6-MHz intervals, TV-receiver selectivity limitations result in the FCC avoiding adjacent-channel assignments within a given geographic area. Cable companies achieve adjacent-channel coverage using careful signal filtering and close control of signal levels. Whether or not two channels (say, 439.25 and 434 MHz) can be used simultaneously is very much a factor of: the geographic distribution of the stations in question, how sharp the antenna patterns are, and the relative signal levels. In some cases, where antenna pattern nulls can be used to advantage, two VSB stations can operate simultaneously if power levels are reduced to the minimum necessary to give satisfactory (if not closed-circuit) results.

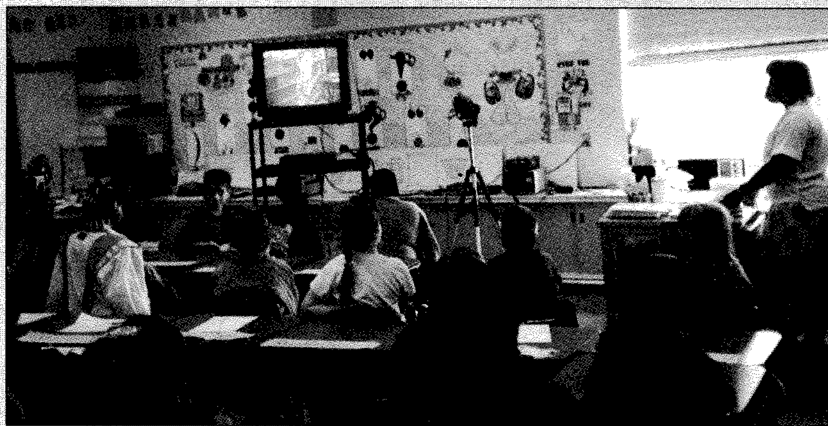
There are combinations of stations, however, where this isn't possible, given the antenna bearings involved. Also, adjacent-channel operation is usually not possible at all when one or more of the stations is using DSB. Below line A, operation at opposite ends of the band is generally possible with either VSB or DSB as long as power levels are kept to a minimum. VSB can certainly contribute to fitting more channels into the 70-cm band, but this always involves a high degree of coordination and cooperation and due regard to minimize impact on other services within the band.

• *VSB can reduce the potential for interference with other modes.* The potential for interference between operators using different modes varies greatly from one area to another. Obviously, frequency congestion is higher in urban areas. Power density of ATV sidebands tends to be very low beyond 1 MHz (typically –50 dBc) from the carrier frequency, but there are small power peaks associated with the color burst signal (3.58 MHz) and the aural subcarrier (4.5 MHz). The low power density and highly directive pattern of typical ATV arrays minimize the interference potential, but it can be a problem given geographic proximity. VSB, with its reduction of the lower sideband, can be of assistance in terms of minimizing whatever problems might arise with respect to satellite and weak-signal operators. Chronic interference problems tend to escalate into painful confrontations, so the general use of VSB in congested areas may be politically expedient, even if (from the perspective of the ATV operator) there is really not much of a problem. As in all areas of Amateur Radio, there is no substitute for mutual consideration of everyone's interests when frequency congestion is the issue.

Chronic interference problems are emerging in ATV operation on 439.25 MHz because of the proliferation of FM voice repeater outputs in the 440- to 445-MHz segment of the 70-cm band. The results range from mild to severe cross-hatching, loss of color caused by hits near the color burst, loss







These pictures of Mrs Plater's 5th-grade classroom at Harley Franks Elementary school in Lansing, Michigan, were taken by Jim Hein, WD8BDL. At the time, Jim was in ATV communication with Mark Lynch, KB8LKC, located in Mrs Drake's 5th-grade classroom at North Elementary school, also in Lansing. The two classrooms were linked on May 14, 1992, during the school district's Science Week.

of the aural subcarrier, or any combination of these effects. No filtering can mitigate the problem because the offending signals fall within the upper sideband video passband. Those of us located above the line A have no real alternate frequency options without the use of VSB. Some operators have modified the local-oscillator injection of their receive converter to use the lower sideband of the received signal, therefore escaping the bulk of the interference. Unfortunately, such an approach fails if you are attempting to receiving a VSB signal!

• *RF Power Efficiency.* One of the major advantages of SSB over DSB AM is that power amplifiers are used far more effectively in amplifying a single sideband: They don't have to bother with the carrier and unwanted sideband. The result is a definite improvement in signal-to-noise ratio for a given level of output power. There's a slight efficiency gain with VSB, but it's essentially insignificant because the VSB signal has a carrier and a significant LSB power component within the first megahertz below the video carrier.

What, if any, conclusions can be drawn from the comparison of the merits of VSB and the more common DSB format? VSB does represent a noticeable increase in system complexity and cost. The advantages are not nearly as obvious as the differential between SSB voice and DSB AM, but the differences are *real* and can be achieved *without any changes in the receiving system.* Responsible spectrum management is going to become an increasingly important issue, beginning in our congested urban areas. Our most valued ATV band is 70 cm. Although I don't expect the change to be rapid, the trend, in the long run, will be toward increasing use of vestigial sideband, if for no other reason than the fact that it is now feasible and is, ultimately, *the most responsible use* of valuable spectrum.

ATV Repeaters

In general, an ATV repeater is very much like a repeater for any other service. It needs a receiving antenna, receiver transmission-line filters, control circuits and signal patching, an output transmitter, output line filtering and the transmitting antenna. As is the case with other types of repeaters, ATV repeaters are located at the best possible sites to optimize coverage. ATV repeaters are of two general types: *in-band* systems where the transmitter and receiver operate in the 70-cm band, and *cross-band* systems where the repeater input is typically at 70 cm and the output is on 33 or 23 cm (with the latter option being the most common).

Operation of an in-band repeater is convenient for local operators because virtually everyone has tunable receivers, eliminating the need for new transmitting or receiving equipment to access the repeater. Such repeaters represent a major technical challenge, however, because the wide signal bandwidth makes it difficult to achieve the required isolation between the receiver and transmitter. Typically, 439.25 MHz is used for the input or the output, with 421 or 426 MHz for the reciprocal function. Sites above line A effectively cannot use an in-band repeater because it's impractical to achieve the required isolation with the existing frequency limitations.

Cross-band systems are less of a challenge because isolation is easier to achieve, but that approach requires that all stations equip themselves with 23-cm antennas and converters. Cross-band systems are ideal for urban areas because they minimize frequency usage in the 70-cm band, and the reduced coverage of the 23-cm output is not a major limitation. Cross-band systems are the only practical option for sites with line-A limitations. A cross-band repeater advantage is that you can monitor your signal on the repeater output—a great help in setting up amplifiers, modulators and the like.

Actuation of the system is typically achieved using a 15.734-kHz tone decoder connected to the receiver video output. The tone decoder is activated by the received sync signal, thus providing a very high level of immunity from triggering by other modes, unless these options have been included in the system design. Almost all repeaters feed any 4.5-MHz aural subcarrier through to the output, and many will mix the local intercom frequency as well, providing output audio compatible with a very wide range of stations. More-advanced systems incorporate DTMF decoders to enable additional functions, including weather radar displays, external storm-watch cameras, computer games and almost anything else imaginable.

Most repeaters use vertical polarization for ease in obtaining omnidirectional coverage, but this presents some problems. Because most ATV work uses horizontally polarized signals, stations either have to invest in additional antennas for accessing the repeater, or the local group has to go vertical. This makes it very difficult to work out of the local area during band openings because cross polarization results in path losses in excess of 20 dB. That same polarization loss works well to minimize interference from and to local UHF repeaters when horizontal polarization is used for ATV, but the advantage disappears when vertical polarization is used. Some innovative design work is being done to develop more effective omnidirectional horizontal antennas and hopefully these efforts will prove effective.

Summary

This has been a relatively low-level introduction to one of the visual sides of Amateur Radio. The emphasis has been on easy approaches to getting on 70 cm, our most popular ATV band. There are other ways to configure your station and many other equipment sources. Also, there are other bands in the microwave portion of the spectrum and the possibilities inherent in FMTV.

If you want to learn more about ATV and keep up with the latest happenings and equipment in the world of ATV, contact *Amateur Television Quarterly.*[14]

I hope this introductory series has served to whet your appetite to try a new operating mode. ATV's another way of having fun with Amateur Radio and a way of serving your community, too.

Notes.

[9]A listing of ATV intercom frequencies appears on page 9 of *ATV Secrets for Aspiring ATV'ers,* Vol I. See Note 6.

[10]A half-hour VHS video tape for club and public ATV demonstrations is available for $6.50 from *ATVQ.* See Note 14.

[11]Pages 38 and 39 of *ATV Secrets for Aspiring ATV'ers,* Vol 1, have a complete listing of US and Canadian UHF TV stations by channel.

[12]Interelectrode capacitance is the culprit here. Most commercial-service tube amplifiers use tubes designed for class C (FM) service operation. The tubes (4CX250s and others) have high interelectrode capacitance which effectively shorts out the higher modulation frequencies. Use of a tube designed for linear (class A or AB) service reduces this problem, and with the proper pre-emphasis of the video signal, they'll pass good color and sound. Tuning does help on any high-Q tube type amplifier, but you must always reduce the output power to gain bandwidth. Typically, a 1- to 2-dB power reduction is all that's required to gain sufficient bandwidth. This is accomplished by plate loading and plate-coupling adjustments, broadband input/output matching circuits, or use of designs that are inherently more broadband than a quarter wavelength tuned line or cavity.—*KB9FO*

[13]International Crystal Mfg, PO Box 26330, 10 N Lee, Oklahoma City, OK 73126-0330, tel 800-426-9825; 24-hour fax 800-322-9426; 405-235-3741; fax 405-235-1904.

[14]You can contact *ATVQ* at 1545 Lee St, Des Plaines, IL 60018-1950, tel 708-298-2269, fax 708-803-8994. A yearly subscription is $18 in the US, $22 in Canada and $29 for other countries. *ATVQ* offers several books, including a beginner's guide entitled *ATV Secrets for Aspiring ATV'ers.* This 64-page, highly illustrated text contains a wealth of information that new and prospective ATVers need. Price: $9.95 plus $1.50 postage in the US, $2.50 for Canada and $2.90 for foreign orders.

Other ATV publications include: *SPEC-COM,* The SPEC-COM Journal, PO Box 1002, Dubuque, IA 52004-1002, tel 319-557-1002, 24-hour fax 319-583-6462, ($20 per year [six issues] in the US, $25 in Canada and Mexico, $30 in other countries; *Amateur TV Today! Newsletter,* ($18.50 per year for 10 issues), 529 Cedar St, Tipton, IA 52272-1738; *CQ-TV, BATC* (a quarterly publication from the British ATV Club) and *VHF Communications.* In the US and Canada, the latter two publications are available from ATVQ: *CQ-TV* is $21 per year; *VHF Communications* is $27 per year. QST