

An Introduction to Amateur Television - Part 1

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An Introduction to Amateur Television

Part 1—"As soon as there is general recognition of the fact that a radio receiver need no longer be blind, the acceptance of television is inevitable."

—Vladimir K. Zworykin and George A. Morton, 1940

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When Zworykin and Morton penned these words at the end of their classic text, *Television*,¹ NBC had concluded a major test of the RCA TV system, and tens of thousands of people had had their first glimpse of television at the 1939 World's Fair. World War II would delay further TV experiments, but would also provide technical advances that set the stage for the widespread introduction of broadcast TV service. Fifty years later, TV has impacted our lives in ways Zworykin could never imagine in 1940. Full color and stereo sound, cable distribution, TVRO satellite dishes, laser video disc, the ubiquitous VCR and the camcorders that have eliminated the movie camera from family events—all of these are the bits and pieces of the mosaic we grandly refer to as the "Video Age."

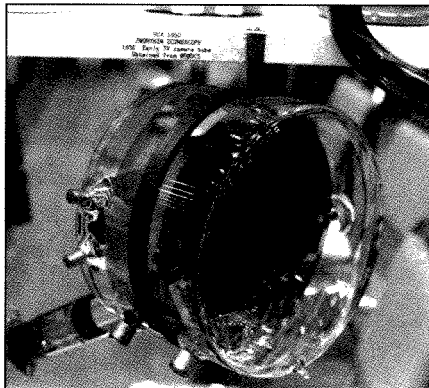
Almost anyone's vision of the future seems to incorporate TV as a medium of personal communication. From the video phones in *2001—A Space Odyssey*, to Captain James T. Kirk "opening a channel" from the bridge of the starship *Enterprise*, communications with a future slant seem incomplete without a live-action picture to accompany the interplay of voice communication. If, indeed, this is the future, we ought to be able to see some faint prophesy of things to come among the ranks of the penultimate communicators—radio amateurs. Strangely,

An ATVer's view of earth and space from an altitude of 125,000 feet. This picture was transmitted to earth from a balloon-launched, 1-watt ATV transmitter. (photo by WB8ELK)

although video technology has invaded the home, it has largely stopped short of the ham shack. With all of its high-tech sophistication, most of our equipment is just as blind as it was when Zworykin uttered his prophesy!

Changing Times

Amateurs have been involved with TV



In the beginning...a 1935 Zworykin iconoscope TV camera tube. (photo by KB9FO)

since the days of mechanical scanning disk systems of the 1920s, yet only a few thousand amateurs are active on this mode. This is all the more amazing when you realize that practically everyone has one or more TV sets, and each year that passes makes it more likely that we'll also have a camcorder gathering dust between family milestones!

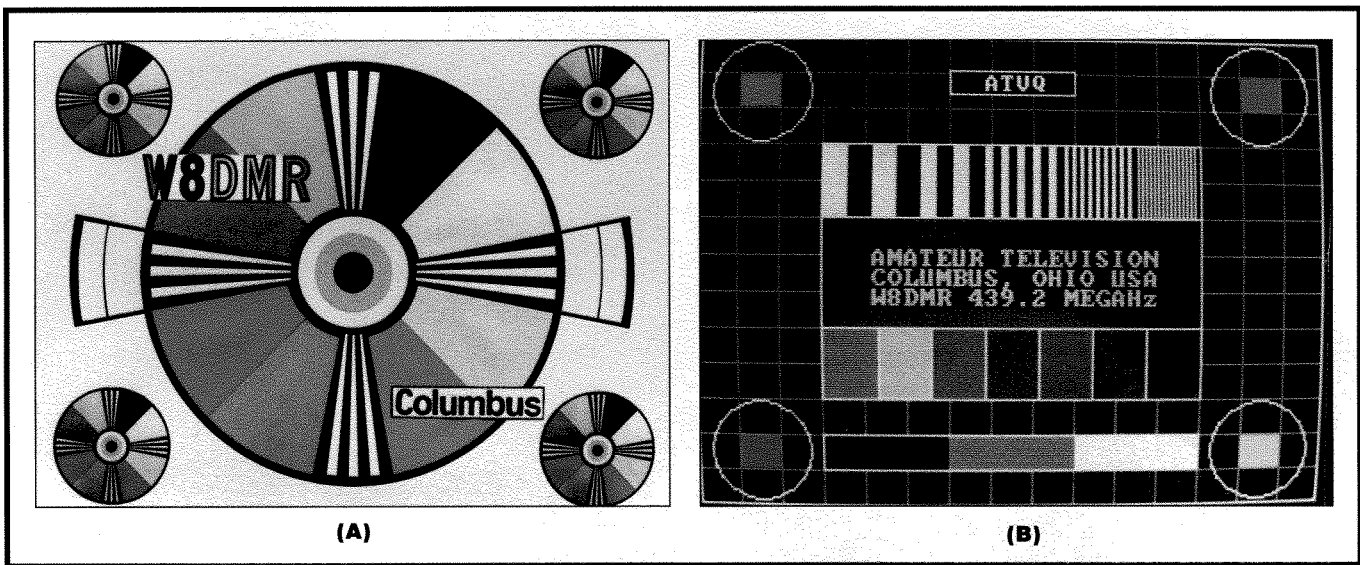
Many amateurs think: "It's too expensive!"; "You have to be a technical wizard!"; "Assembling a station is a major building project!" and "Why go through all that trouble to work across town?"

Like many misunderstandings, these have their origins in a kernel of historic truth. When I assembled my first ATV station in 1963, the effort took more than two years—including the construction of a camera—and I ended up with a rack full of equipment that could transmit a signal for all of two miles! Although I'm proud of the accomplishment, those days have about as much relevance to modern ATV as spark does to packet!

There's Lots to Tell...

There's a lot going on in ATV in the '90s, and it simply isn't possible to pack even an introduction to ATV into a single article. If you missed the earlier *QST* article "Smile—You're on Ham Radio,"² go back and read it.³ It contains an ATV resources guide (where to find out more about ATV and the equipment available) and lots of other useful information.

¹Notes appear on page 23.



Examples of homemade—and *handmade* ATV test patterns. The “wagon wheel” or “propeller” pattern at A is a product of handiwork and photography by Bill Parker, W8DMR. Bill used a thumbtack, string and marking pen to make the original (middle) circle. The white and colored wedges were cut from construction paper. Bill scissored his call sign from a QSL card, and the *Columbus Dispatch* provided the word *Columbus* (with a bit of help from a black marking pen). All this, combined with photocopying and photography, resulted in the attractive test pattern you see here.

At B, an IBM BASICA program written by Bill creates the computer-generated test pattern, which includes linearity bars (the gridwork), multiburst (the alternating white and black vertical bars used to check frequency response), and gray scale and color bars. The wedges are used to check horizontal and vertical resolution. Creativity at work here! (photos by W8DMR)

I'll break my presentation into three parts. In this first installment, we'll look at some of the things that are being done on ATV, take a quick survey of the bands being used and provide a few guidelines on how you can eavesdrop on existing ATV activity in your area. Part 2 covers the basics of putting an ATV station on the air: the antennas, transmission lines and the receiving and transmitting equipment you'll need to get started on ATV. In Part 3, we'll delve into slightly more technical areas: adding transmit power amplifiers, the how and why of ATV repeaters and a discussion of some of the experimental work with modes such as FM TV on our microwave bands.

As in most areas of Amateur Radio, there is more than enough technical detail to keep you fully occupied if you are so inclined, but technical expertise is *not required* to get a station on the air. The most complex pieces of the station—the TV cameras and receivers—you may already own and know how to use. Getting this equipment up and running on ATV is no more demanding (or expensive!) than adding a new FM rig to the shack, so let's start with *why* you might want to do just that!

Bands and Formats

Worldwide, there are three major TV formats in use: NTSC, PAL, and SECAM (see the Glossary of Terms). Each format differs in the number of lines that make up a TV picture, the rate at which individual pictures or *frames* are transmitted to give the illusion of motion, the details of the modulation formats and how they handle color. The technical details need not concern us since you'll be using equipment compatible with standard

TV broadcasting in your area. For those of us in North America, that's NTSC; PAL and SECAM are used throughout Europe. Which format is used in other parts of the world is largely a matter of political history and who got the contracts for installing the first national TV systems!

Wherever you live, the ATV activity uses the *same standards* as that of the TV broad-

cast stations in your area—that allows the use of readily available cameras, VCRs and TV receivers. My discussions will center on equipment suitable for NTSC standards employed in the United States, Canada, and Mexico, but most of the principles apply to areas where other formats may be in use.

Where Do We Operate?

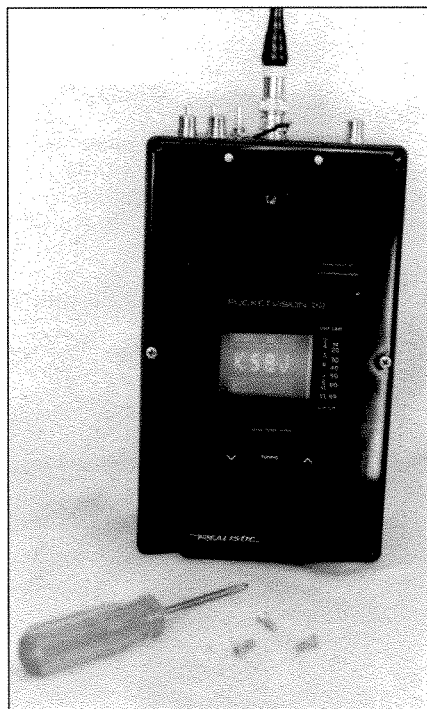
The vast majority of ATV operation is in the 70-cm band, the lowest amateur band authorized for ATV operation. There is some simplex operation on the 33- and 23-cm bands (particularly in urban areas), but these frequencies present problems in designing and building equipment to handle higher transmitter power levels. Experience shows that path losses caused by obstructions (buildings, trees, etc) are significantly higher there than on 70 cm.

ATV Repeaters?

Yup. There are now one or more ATV repeaters operating in over 40 states and around the world. Many of these repeaters are “in-band,” using 70-cm frequencies for input and output. Where the 70-cm band is particularly congested—or where proximity to line “A”⁷⁴ limits the frequencies available—repeaters typically use a 70-cm input or output frequency, cross-banding to 33 or 23 cm. Unless you have a local ATV repeater, 70 cm is the band of choice, combining excellent receiver capabilities, easy power generation, compact antennas, moderate path loss, and the opportunities for DX contacts when the band is open.

What Do You Do On ATV?

Why spend the time and money to watch



This hand-held ATV transceiver and camera (a “walkie-lookie”) was built by Earl Campbell, KS8J. (photo by KS8J)

the same people night after night? Good question! Why do so many amateurs talk to the same folks again and again on 75 or 2 meters? With ATV, you get to see friends rather than just staring at the LEDs and meters on the front of your transceiver. With ATV, you also get the bonus of seeing spouses, kids (and their birthday parties), parades, the new car, antennas, towers, the latest gear, and—of course—anybody who happens to stop by for a visit!

What the Local Folks Do

Here in the Lansing, Michigan, area, the dozen or so members of the Central Michigan Amateur Television Society have a wide range of interests in addition to radio, all of which can be shared, courtesy of modern video technology. If a space shuttle mission is in progress, Jeff, WB8RJY, will be relaying NASA Select video from his TVRO installation. Bruce, KA8ZXX, owns a marvelous collection of pictures covering the entire manned space program. Andy, W8AHY, has a collection of videotape shot at

steam-engine shows, and Steve, N8LWX, is our roving video reporter at hamfests, antenna raisings and club meetings. I don't require any real persuasion to air the latest weather satellite pictures, videotape shot at ultralight aircraft fly-ins, or footage shot from my ultralight gyroplane (which he built himself.—Ed.)

Other ATV groups are similarly diverse. Many have a long history of public service involvement, providing video coverage of parades and other events, volunteering for search and rescue work, undertaking video storm watches and a host of other activities that benefit the community and provide a high and positive profile for Amateur Radio.

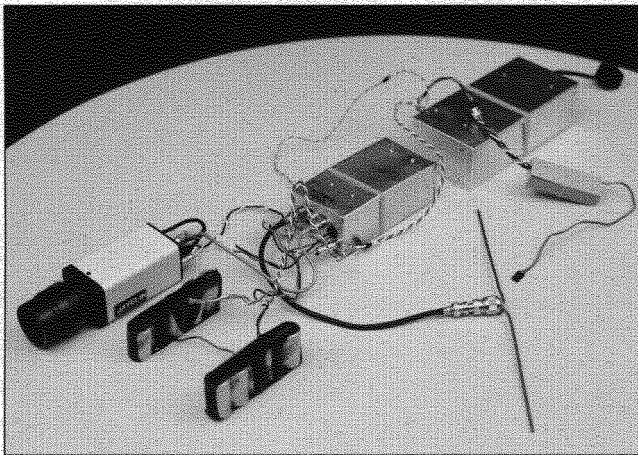
Other ATV Activities

Elsewhere, amateurs are launching model rockets equipped with miniature cameras and ATV transmitters, flying ATV gear in radio-controlled aircraft, and lofting balloon packages to the edge of space to provide spectacular pictures for hundreds of miles! Not very long ago, those of us here in Michigan had

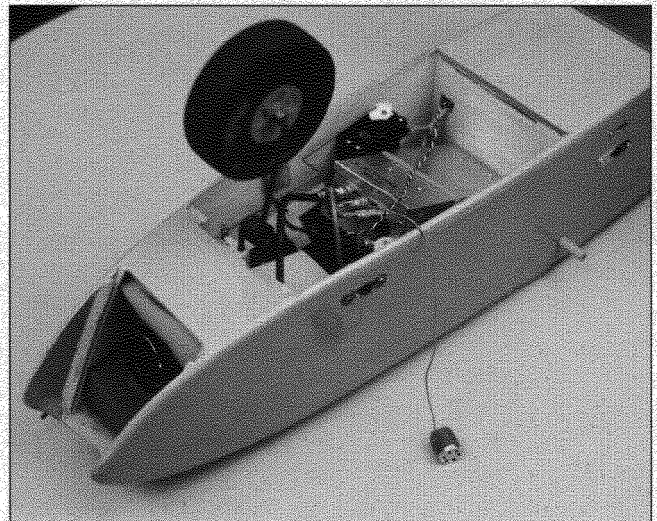
the opportunity to watch live pictures from an altitude of 138,000 feet, courtesy of a balloon-born package constructed, launched and tracked by the Dayton, Ohio, ATV group! Lofting repeaters to the edge of space in similar balloon packages is definitely on tap for the future. For those who would reach out a bit farther, there is the potential of amateur satellite TV activity, encouraged by successful ATV operations from the space shuttle (STS-37) as part of the SAREX program.⁵

How Far Can I See?

My predicting *your* reliable working range is difficult, because it involves a number of factors: the nature of the local terrain, where you and the folks you want to work are situated on that landscape, and items such as transmitter power, feed-line losses and antenna gain. One of the reasons ATV is limited to the 70-cm band and higher frequencies is the signal's wide bandwidth. A broadcast-standard color signal with sound has a bandwidth of about 4.5 MHz, and the transmitted RF bandwidth ranges from about



Combining two hobbies makes for some excitement! Here's how Larry, K5MWN, loaded his ATV gear into the nose of his radio-controlled model airplane.



The screen shot below was taken while the aircraft was aloft, sending live ATV pictures to the ground. (photos by K5MWN)





Off-the-air video on 910.75 MHz using FM video. (photo by WB0ZJP)

6 to 10 MHz, depending upon factors we'll discuss a bit later. At the receiving end, bandwidth is effectively limited to about 5 MHz by the TV-receiver design.

For Example ...

Most amateurs have used H-Ts to operate VHF or UHF FM in their area, so let's use that as a reference. *Based on bandwidth*, an ATV signal is degraded by about 25 dB com-

pared to a 15-kHz FM signal of similar power. Although this sounds astronomical, let's look at a situation where you're able to maintain solid communication with another station using a VHF or UHF H-T or mobile rig running low power. Your mobile antenna gain is negligible, but a typical ATV system can easily contribute *at least 15 dB* of combined antenna and height gain, less reasonable line losses. Thus, although the ATV

signal is 25 dB down (based on bandwidth), it's only about 10 dB down when the ATV antenna and height gain are factored in. So, if you can work a station with your H-T or mobile rig (running somewhere between 1 and 10 watts), you should be able to span the same path with good signals on ATV running 10 to 100 watts output.

In general, if you can work a certain distance from the VHF mobile at relatively low power, you should be able to do the job on ATV with a moderate power output. Using the 1-watt transceivers I'll discuss in Part 2, you should easily achieve a 20-mile working radius with average terrain. Your reliable coverage area can be extended easily to 40 or 50 miles with the addition of a modest "brick" amplifier.

When Unusual Circumstances Prevail

All of the preceding comments apply to normal band conditions, in terms of what can be expected on a reliable, day-by-day basis. Nature has some pleasant surprises in the form of *tropospheric duct* openings that are particularly common in the summer months in the East and Midwest. The current ATV DX record stands at over 1000 miles, and a moderately well-equipped station can expect to work stations on 200- to 400-mile paths. Any ATV station here in central Michigan that has been operated regularly through a summer tropo season has QSL cards confirming two-way contacts with stations as far

Glossary of Terms

ATV repeater—A station designed to automatically retransmit amateur video transmissions. Repeaters serve much the same role in ATV that they do in the case of FM voice communications: They extend the operating range of relatively low-powered ATV stations. In addition, given the highly directive nature of ATV antennas, a roundtable is far more practical with a repeater because all stations in the group have their antennas aimed at the repeater site.

Aural—The audio component of a composite TV signal.

Cross-banding—Operation in which an ATV repeater receives signals on one amateur band while retransmitting the signal on another band. Cross-band repeaters are typically easier to get up and running because isolating the receiver and transmitter is relatively easy. **In-band** repeaters, where the signal is received and retransmitted on the *same* band, present a real challenge in terms of obtaining sufficient isolation between input and output.

NASA Select video—The National Aeronautics and Space Administration leases channel space on commercial communications satellites and uses this capability to provide live video coverage and related material for significant space-related functions. These include shuttle missions and planetary encounters. These signals are *not scrambled*—NASA encourages dissemination of the information for educational purposes.

NTSC—The National Television System Committee, responsible for defining the video and audio standards used in commercial broadcast television in the US and elsewhere. It's also the designation of the television standard used in North America, Japan and some other places.

PAL—Phase alteration line. Television standard used in Germany and many other parts of Europe.

SAREX—Shuttle Amateur Radio EXperiment. Operation of Amateur Radio equipment aboard a space shuttle, with the approval of NASA and the FCC. NASA's intent in making astronauts available for SAREX operations is to involve the largest possible numbers of people, particularly youngsters, in technology and the US space program with the help of Amateur Radio.

SECAM—Sequential color and memory. Television standard used in France and the Commonwealth of Independent States.

Subcarrier—A signal component of the modulated signal that itself carries information. In the case of a TV signal, a frequency modulated audio signal is mixed with the video in the video modulator, resulting in an FM aural subcarrier carrying the voice signal along with the video modulation of the primary carrier.

Subcarrier-sound transmission—A system for simultaneously transmitting video and audio data (see *Subcarrier* above).

Tropospheric ("tropo") ducting—When air masses in the lower atmosphere differ significantly in temperature, conditions can exist where radio waves can be refracted. Temperature inversions, where warm air overlies cold air close to the ground, can cause some of the radiated signal to follow the curve of the earth (*ducting*) for many hundreds of miles.

TVRO—Television receive-only. An earth station installation for reception of television broadcasts from geostationary communications satellites.

Visual—The video or image component of the TV signal.

away as Iowa, New York, and Pennsylvania! Stations all over Illinois, Indiana, Ohio and parts of Ontario, Canada, are worked frequently enough to keep everyone on a first-name basis!

Looking In

If there *is* ATV activity within working range of your location, eavesdropping on the action need not involve a major monetary commitment on your part. Obviously, the first step is to determine *if there is* any activity in your area. Bring up the subject on your local repeaters and at club meetings; you'll soon find out. Chances are, if there is an ATV group, they'll be using a 2-meter FM simplex channel as an intercom, making it easy to monitor who is active. Audio-only check-ins are welcomed with open arms—and you would be hard-pressed to find a more missionary crowd!

Many active groups have one or more ATV converters that they pass around to let newcomers take a peek at what's going on. These simply install ahead of your TV set and output a signal to Channels 2, 3, or 4. Local ATV operators will give you plenty of help in using the converter—they *want you to succeed!*

If a loaner converter is unavailable, there are other options. Cable-ready TV sets can tune 70 cm (cable Channel 60 = the popular 439.25-MHz simplex frequency) and, although the converter's sensitivity leaves much to be desired, they can often be surprisingly effective when used in conjunction with an outside UHF TV antenna. Another option is to use one of the many models of 4- and 5-inch monochrome and color TV sets that are equipped with a slide-rule dial. These sets have an internal potentiometer that sets the range of the UHF varactor tuner. You adjust this control to shift a low UHF station up by about 8 channels. That done, you'll then be able to tune in 70-cm ATV at the low end of the UHF tuning range. Such a modified TV receiver can later serve as your station's transmitted-signal monitor.

Till Next Time...

I've only scratched the surface of the breadth of amateur TV operations. Adding the video dimension to your station operations has never been easier. In Part 2, we'll look at what it takes to actually get an ATV station on the air!

A note of special thanks to Henry Ruh,

KB9FO,⁶ and everyone else who contributed the photos used in this article.

Notes

¹V. K. Zworykin and G. A. Morton, *Television* (New York: John Wiley and Sons, 1940), 646 pages.

²See B. Battles and S. Ford, "Smile—You're on Ham Radio," *QST*, Oct 1992, pp 42-44.

³Back issues are available from HQ for \$3, postpaid. Contact Publication Sales.

⁴Covered by FCC regulations, §97.3(a)(26). See Chapter 5 of *The FCC Rule Book*, published by the League. You can find a copy at your local dealer, or order one from ARRL HQ. (See the ARRL Publications Catalog elsewhere in this issue; order number is 3304, price \$9.)

⁵To find out more about SAREX, contact the ARRL Educational Activities Department.

⁶Henry Ruh, KB9FO, is Director of Engineering at WSNS-TV in Chicago, Illinois. To say that Henry is an avid ATVer is an understatement. Henry and Bill Brown, WB8ELK, jointly edit and publish the *Amateur Television Quarterly*, 1545 Lee St, Suite 73, Des Plaines, IL 60018, tel 708-298-2269, fax 708-803-8994. *ATVQ* offers two introductory books for would-be ATVers: *ATV Secrets for Aspiring ATVers*, a 96-page nontechnical introduction; price \$9.95 plus \$2.90 shipping. The 292-page *TV Secrets, Vol II for Novice and Expert*, has 90 projects to keep you busy; price \$24.95 plus \$2.90 shipping.