An Introduction to Amateur Television - Part 2

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An Introduction to Amateur Television

Part 2: The Basic ATV Station

In Part 1 of this three-part series, I discussed some of the dimensions of ATV activity, the bands used, what sphere of coverage can be expected, and how to eavesdrop on the activities of your local ATV group. This month, I'll discuss a few of the equipment options and technical details involved in getting your ATV station on the air.

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Fig 1 is a block diagram of an entry-level ATV station. Other than provisions for connecting cameras, VCRs and so on, you can see that the installation is no more complex than that of a VHF/UHF FM transceiver. In part, this is because of the development of compact ATV transceivers available from three vendors. Each of the major elements of this diagram—the ATV transceiver, video sources, antenna, transmission line and optional power amplifier—are discussed briefly in the sections that follow.

ATV transceivers take all the fuss and guesswork out of setting up a basic ATV station.

ATV Transceivers

The AEA, P.C. Electronics and Wyman Research ATV transceivers (see Tables 1 and 2 and the accompanying photos) take all the fuss and guesswork out of setting up a basic ATV station. Although there are some real differences in engineering details, many functional aspects of these units are quite similar. The transceivers' power output range from 1 to as much as 15 watts PEP in the newer units. All operate from 12- to 14-V dc supplies, making them well-suited for mountaintopping or other portable, mobile or emergency use. Although the equipment dimensions vary, they're all quite compact: the Tridon 2000, for example, measures a mere 2.2 × 7 × 5.75 inches! Each transceiver has provisions for two video inputs and includes a power switch and 10-pin socket to handle cameras, along with a front-panel video-gain control.

All the transceivers have manual TR switches and PTT TR switching. Each unit offers subcarrier-sound transmission, a subject I'll discuss shortly. A single crystal of your choice (439.25 or 434.00 MHz are the usually chosen frequencies) is supplied with each transceiver, and you can switch-select a second operating frequency if you've purchased an optional crystal (for a small additional charge).

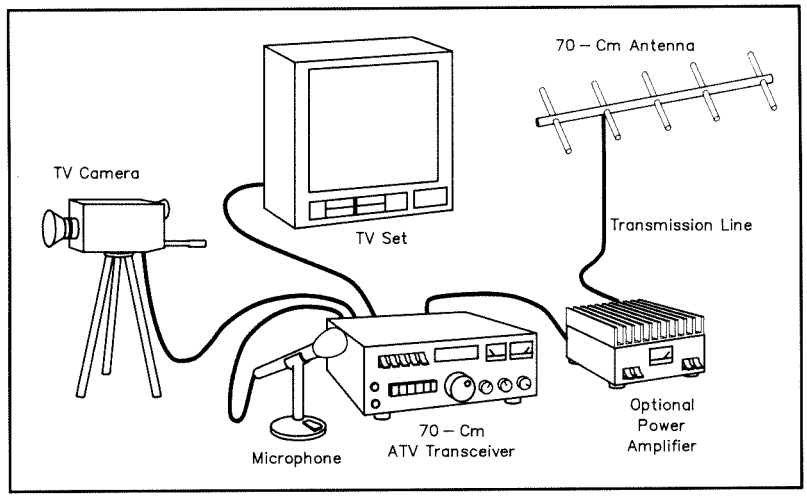


Fig 1—Diagram of a basic 70-cm ATV installation. The various station components are discussed in the text.

Each transceiver is equipped with a tunable converter (AEA's unit has provision for use with a crystal-controlled converter) that covers the entire 70-cm band (420-450 MHz). (Note: ATV transceivers are available for operation on the 900- and 1200-MHz bands, too.) The converters employ low-noise GaAsFET preamplifiers and provide output on TV channel 3. You can change the output frequency to channel 2 or 4, to place the output on a channel unused in your area. The receive and transmit circuits handle full-resolution NTSC color signals with excellent fidelity. For color operation, simply use a color camera or camcorder as your video source and a color TV for display. Because black-and-white operation is far less critical than color, these transceivers do an excellent job with monochrome cameras and displays.

P.C. Electronics and Wyman Research are small, direct-sales operations, but each is operated by an ATV veteran, and each has an exemplary record of product and customer support. Their transceivers feature highly refined (but more or less standard) approaches to generating the transmitted signal: a small, video-modulated UHF transmitter strip, producing a DSB AM signal.

AEA is a much larger company with an extensive dealer network, probably best known for their data controllers, antennas and other products. Their VSB-70 transceiver[7] is a relatively recent introduction and takes a different approach to signal generation.

[7]Notes appear on page 47.

Although ATV transceivers are definitely the easiest way to put a signal on the air, you have alternatives.

This transceiver is designed for vestigial sideband (VSB) AM transmission, which involves suppressing much of the lower sideband (by more than 60 dBc), just like commercial broadcast TV stations. The VSB-70 transmitted signal is generated at a lower frequency, then converted to 70 cm. The benefits and trade-offs of VSB represent a relatively complex subject that we'll look at in greater detail in Part 3 of this series.

Advanced Electronic Applications VSB-70. This unit produces a near-broadcast-standard vestigial sideband (VSB) video signal, in contrast to the double-sideband (DSB) signal output by most ATV transmitters. *(photo courtesy of AEA)*

Any of these ATV transceivers will do a good job for you. Chances are, an ATV group has at least one of each type, and you'll most certainly get plenty of advice in making your purchasing decision. Although these ATV transceivers are definitely the easiest way to put a signal on the air, you have alternatives. P.C. Electronics and Wyman Research offer a wide variety of kits; send for their catalogs. Also, low-power UHF transmitter strips are easy to video-modulate (see the Image Communications chapter of any recent edition of *The ARRL Handbook*), and will work well with any of the converters mentioned in Part 1 under "Looking In." If you already have a multimode UHF transceiver or transverter with a tube-type linear amplifier, you can try grid-modulating the final amplifier. Indeed, video modulating a solid-state transceiver's driver stage is *possible*, but few would venture to do the needed surgery! In such a case, operating the transceiver in FM provides on-carrier sound modulation and reception capability as an added bonus (see the discussion in the "Sound" section to follow).

Video Sources

For many ATV newcomers, the most common video source is the family camcorder. Usually, these gadgets just gather dust between family events, so why not get a little more mileage out of the investment and use it for ATV? If you don't have a camcorder, and ATV isn't a sufficient inducement to get one, you have other choices. First-generation portable VCR systems typically had a remote camera that mated with the recorder using a cable equipped with a 10-pin connector. You may be able to get one of these outdated systems at a bargain-basement price by shopping the classified ads, or scrounging through the back room of video-service shops. That 10-pin socket on the AEA, PC-Electronics and Wyman Research transceivers mates with the camera cable and is used to feed power to the camera.

With the consumer rush to buy compact 8-mm and VHS-C models, older, full-sized VHS and Beta camcorders are now passé; you can sometimes find them in the classified ads at attractive prices. Because the item most likely to fail on such systems is the *recorder mechanics*, many owners faced with a big repair bill elected to buy a new unit. Video-service shops frequently have the older camcorders on hand. As long as the *camera electronics* are functioning, they'll work just fine for ATV. Black-and-white surveillance cameras—generally exhibiting excellent resolution and good sensitivity under low-light conditions—can be purchased new for as little as $150; I've seen serviceable units at hamfests for $10-20! One of these will work just fine as your first camera and serve for handling station-ID chores if you later upgrade to color.

Table 1
Some ATV Equipment Vendors

Advanced Electronic Applications, Inc
2006-196th St SW
PO Box 2160
Lynwood, WA 98036
Literature request tel: 800-432-8873
Tel: 206-775-7373; fax 206-775-2340

Down East Microwave
RR1 Box 2310
Troy, ME 04987
Tel: 207-948-3741; fax 207-948-5157

P.C. Electronics
2522 Paxson Lane
Arcadia, CA 91007-8537
Tel: 818-447-4565; fax: 818-447-0489
Tom (W6ORG) and Maryann (WB6YSS) O'Hara

Rutland Arrays
1703 Warren St
New Cumberland, PA 17070
Tel: (orders) 800-536-3268,
(info): 717-774-3570

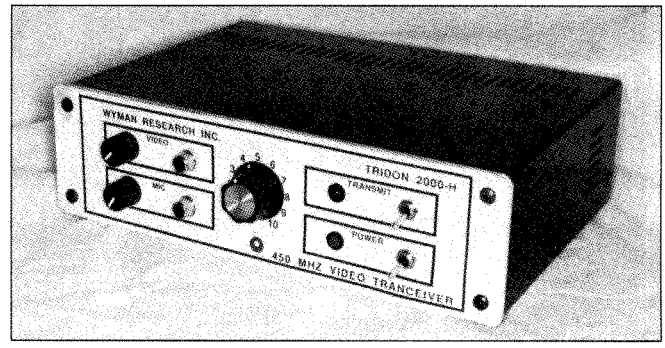
Spectrum International, Inc
PO Box 1084
Concord, MA 01742
Tel: 508-263-2145

Wyman Research, Inc
RR #1, Box 95
Waldron, IN 46182
Tel: 317-525-6452
Don (W9NTP) and Sue (W9YL) Miller

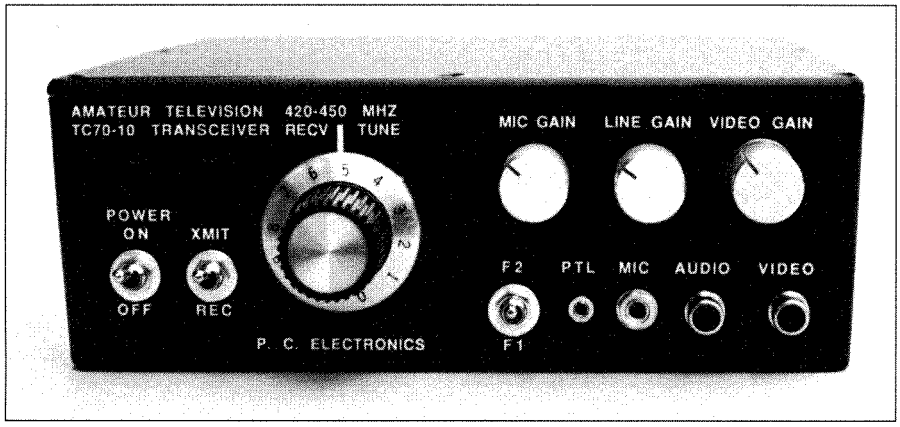
Table 2
A Summary of Features of Three ATV Transceivers

VSB indicates vestigial sideband format; SC = subcarrier FM sound; OC = on-carrier FM sound; NF = preamplifier noise figure (dB); Tune = tunable converter; Xtal = crystal-controlled converter. Prices are list and subject to change; AEA prices are discounted to varying degrees by dealers. Vendors include P.C. Electronics (PCE), Wyman Research (WR) and Advanced Electronic Applications (AEA).

	Transmitter						*Receive Converter*		
Model Price/Vendor	*PEP (Watts)*	*VSB*	*Sound SC*	*Sound OC*	*Video Inputs*	*Supplies Camera Power*	*NF*	*Tune*	*Xtal*
TC70-1D $329/PCE	1	N	Y	N	2	Y	1.0	Y	N
Tridon 2000 $320/WR	3	N	Y	Y	2	Y	0.8	Y	N
VSB-70 $350/AEA	1	Y	Y	N	2	Y	1.5	Y	Y



At left, the Wyman Research Tridon 2000, a 3-W transceiver. The latest addition to the line is the Tridon 2000H (right) capable of 12 W output. These units feature an attractive brushed-aluminum finish. *(photos courtesy of Wyman Research)*



The new P.C. Electronics TC70-10. You can adjust the PEP power output of this 70-cm transceiver from about 2 to 15 watts—quite a respectable signal. *(photo courtesy of P.C. Electronics)*

For many ATV newcomers, the most common video source is the family camcorder.

Of course, VCRs and many computers with composite video output (a VIC-20, Radio Shack Color Computer [CoCo], IBM PCjr, CGA-equipped IBM PC and others) are also potential video sources. Computers can be programmed to provide snappy ID displays that are great for use during band openings. Small, dedicated add-on boards with IDs, cartoons and color-bar patterns custom-programmed into EPROM are also available.[8]

Sound

Commercial TV broadcast stations use a wideband (25-kHz deviation) FM sound (aural) transmitter operating 4.5 MHz above the video carrier frequency. In most amateur systems, a 4.5-MHz oscillator is frequency modulated by the microphone audio. This signal is then mixed with the video going to the modulator to produce an *aural subcarrier* 4.5 MHz above the carrier (and 4.5 MHz below the carrier in the case of a DSB system). When the subcarrier is set to the proper level (–15 dBc), the TV set reproduces the sound signal just as it does for a broadcast station. Subcarrier sound is a standard feature with all of the transceivers mentioned earlier.

Although subcarrier audio is often used with repeaters and works well for simplex work when signals are reasonably strong, there are many reasons why it's rarely used as the primary audio-intercom link. (You're using the audio here to coordinate things, not necessarily add sound to the pictures.) First, in a typical group of ATV stations, high-gain antennas are moved around to favor some stations, while other stations temporarily receive a weak signal—or perhaps nothing at all. Under such conditions, the subcarrier audio system fails to provide the required audio-intercom function. Because TV sets don't have audio squelch, you're subjected to lots of noise during signal loss. Highly variable signal levels also make subcarrier sound unreliable during openings. Everyone should have subcarrier-sound *capability*, but it's not the best way to handle your primary audio needs.

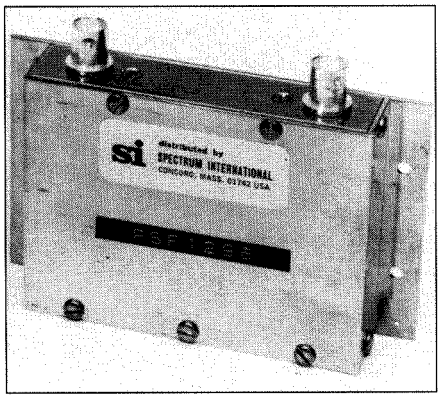
An alternative to subcarrier sound is on-carrier sound in which the carrier is frequency modulated (narrowband) during video transmission. An auxiliary narrowband FM (NBFM) receiver, tuned to the carrier frequency, is used to copy the audio signal. NBFM has a 25-dB advantage over a wideband video signal, so on-carrier sound provides excellent *audio* copy even when the *video* signal has dropped into the noise! Thus, it provides good results for ATV group communication and during band openings. Unfortunately, not all stations use the on-carrier system, partly because it requires a second receiver. Of the transceivers noted earlier, only the Wyman Research Tridon 2000 and 2000H incorporate on-carrier audio in addition to the subcarrier audio. Wyman also markets a small, crystal-controlled receiver board ($99) that mounts inside the Tridon (along with a speaker and a volume and squelch control) to take full advantage of the on-carrier feature.

Primarily, audio is transmitted by a 2-meter FM transceiver. Custom varies in different regions of the country but, here in the Midwest, 144.34 MHz is the common ATV intercom frequency. Because of the huge bandwidth differential between ATV and NBFM, a 10-watt transceiver and a modest vertical (or small beam) is entirely adequate for solid copy with any station you can work on TV!

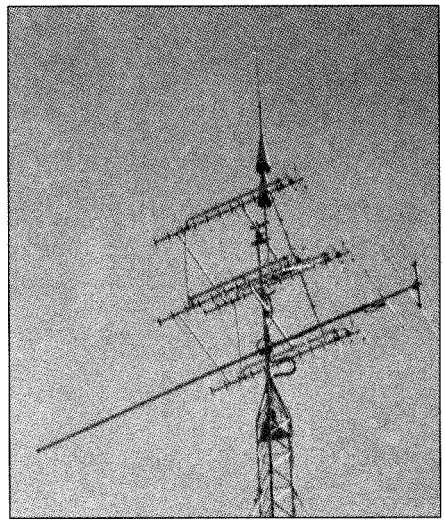
Table 3
Broadband 70-Cm Antennas Suitable for ATV Use

The models are listed from lowest to highest gain as claimed by the manufacturer over a range from approximately 9 to 16 dBi. Prices vary somewhat between vendors and are subject to change; some include shipping charges, others do not. Vendors include P.C. Electronics (PCE), Wyman Research (WR), Advanced Electronic Applications (AEA), Down East Microwave (DEM), Spectrum International (SI) and Rutland Arrays (RA).

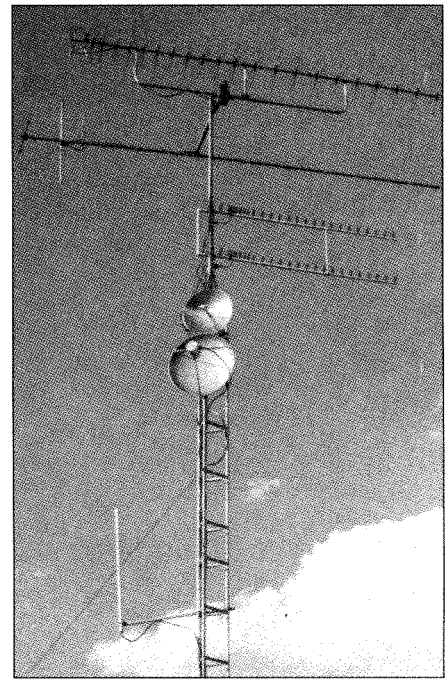
Model Number	*Boom Length*	*Approx. Price*	*Vendor*
KLM 440-6X	28 in.	$ 57	PCE, WR
KLM 440-10X	64 in.	$ 68	PCE, WR
MBM 28-70	48 in.	$ 65	SI
KLM 440-16X	10.5 ft	$119	PCE, WR
MBM 48-70	6 ft	$ 90	SI
AEA 430-16	10 ft	$120	AEA
FO22-ATV	14 ft	$ 99	WR, DEM, RA
MBM 88-70	13 ft	$135	SI



Spectrum International offers a VSB filter that can be added to existing ATV transmitters. *(photo by KB9FO)*



When beginning ATVers grow up: Bob (W5DS) Edlund is prepared for ATV using four stacked J-beams at 100 feet in addition to other aluminum assistants. *(photo by W5DS)*



Badly ATV-bug-bitten W8DMR has a hunk of aluminum to help him snag signals. On top is an 88-element J-beam that can be rotated to provide vertical or horizontal polarization. Next to it is a 2-meter Yagi. Just below that are 23-cm loop Yagis: one for transmit and one for receive. Below them are two dish reflectors for 13-cm operation. At the bottom is a 2-meter coaxial dipole antenna. *(photo by W8DMR)*

Antennas

ATV operation requires high-gain, wide-bandwidth antennas. The models listed in Table 3 have long track records of good service in this mode, and all have a low SWR across the entire 70-cm band. If assembled according to directions, each can be placed into service without further adjustment. The smaller, lower-gain arrays are excellent for local work because of their relatively wide beamwidth; they also do a superb job in portable service. If you have a long path to be covered, one of the longer, higher-gain units is the best choice. The larger antennas also provide an edge during band openings, but their very narrow patterns put a premium on pointing accuracy.

Antenna polarization used to be a matter of local custom, but now most groups use horizontal polarization on 70 cm unless vertical polarization is required for a specific repeater installation. The biggest potential for mutual interference is between ATV and the proliferation of FM repeaters and remote-base installations on 70 cm. Because the FM crowd's signals are vertically polarized, using horizontal polarization on ATV provides at least 20 dB of mutual attenuation between the two modes.

Proper antenna siting is often more important than gain. A high, unobstructed location gives the best results because *any* obstructions, including foliage during the summer months, can severely degrade signal strength. A well-placed, smaller antenna often outperforms a high-gain array that's not optimally located. These antennas are small enough to be turned by a TV antenna rotator, so installation need not be expensive. With the shift to CATV in many areas, you may already have a TV tower or tripod that can be put to good use without disrupting your other antennas. Using commercial power dividers or homemade phasing lines, any of these arrays can be phased to achieve higher gain and greater capture area. Some of the smaller arrays, such as the KLM 440-6X, can be phased to produce a high-gain system that can be set up on a side-arm secured to your tower whereas one of the longer antennas would have clearance problems.

Transmission Lines

In many ways, the single most important element in your station is the transmission line to the antenna. Table 4 lists a variety of common cables in terms of relative line loss. Using any of the readily available RG-58 and RG-8 cables impacts your installation in two ways: excessive power loss on transmit and degradation of receiver performance. The transmission losses are obvious from the table, but the effect on receiver performance is equally serious. Line losses add to the noise figure of the first RF stage. All the benefits of a state-of-the-art GaAsFET preamplifier can be nullified by line loss. The problem with line losses is most serious at weak-signal levels. ATV signals demonstrate a pronounced threshold effect between the point where sync is first detectable and where you can get enough of a signal to confirm a contact. Excessive line losses can raise this critical threshold by decreasing your transmitted and received signal power.

You can optimize all the other components of your station and still suffer from your choice of transmission line!

Table 4
Commonly Available RF Transmission Lines

Transmission lines are ranked by their attenuation (dB/100 ft) at 440 MHz. To emphasize the importance of line losses, I've shown the peak power output delivered to the antenna, assuming use of a 100-foot transmission line and a 10-watt-output transmitter. The cables in the upper half of the list are easy to obtain, but generally unsuited to serious ATV work.

Cable Type	*Line Loss (dB/100 ft)*	*Power (Watts)*
RG-58 (solid dielectric, 50 Ω)	12.0	0.6
RG-58 (foam dielectric, 50 Ω)	7.1	2.1
RG-8 (solid dielectric, 50 Ω)	5.0	3.3
RG-8 (foam dielectric, 50 Ω)	3.9	4.2
½-inch Hardline (75 Ω)	2.0	6.7
½-inch Hardline (50 Ω)	1.8	7.0
¾-inch Hardline (75 Ω)	1.6	7.3
½-inch Heliax (50 Ω)	1.5	7.4
¾-inch Hardline (50 Ω)	1.3	7.8

Although premium transmission lines such as Andrew Heliax or Hardline (aluminum-jacketed coaxial cable) are expensive when purchased new, you have to take a realistic look at the consequences of making do with lossier cable. As an extreme case, compare the results obtained with RG-58 cable and ½-inch Hardline. Using Hardline and a 1-watt exciter, you actually have more power delivered to the antenna (0.78 watts) than you would with a 10-watt amplifier and the RG-58 cable (0.62 watts). You'd also achieve a 10-dB receiver noise-figure improvement by using the Hardline. With the RG-58, you've wasted the investment in the amplifier and completely nullified the effectiveness of a perfectly good preamplifier! It's extremely frustrating to watch snow on the TV screen while neighboring stations are describing the incoming picture from a DX station!

Fortunately, there's a way to obtain premium transmission line without investing a lot of money. CATV companies use large amounts of ½-inch and ⅞-inch 75-Ω Hardline. Cut-off lengths (useless to the cable company, but more than enough for a typical ham antenna installation) can often be had for the asking. To use the cable, you have to solve two problems: Find suitable connectors and determine how to use 75-Ω cable with equipment and antennas designed for 50-Ω systems. Both of these problems are easily overcome using custom-made connectors manufactured by ZD Engineering (605 Balsley Ave, Findlay, OH 45840, tel 419-424-8765). The N connectors, which sell for about $25 a pair (specify the 70-cm band when ordering), feature a built-in balun for efficiently transforming the 75-Ω line to 50 Ω. A pair of these connectors can make a length of 75-Ω cable completely compatible with your ATV system. A short length of flexible cable (such as Belden 9913) is required to connect the Hardline to the antenna, and some short cable runs are required in the shack, but this is the case even if you're using 50-Ω Hardline or Heliax. A good transmission-line installation is a long-term investment. You can change all the other components of your station and still limit your total effectiveness by the decisions you made when you installed your transmission line.

In Part 3 of this series, we'll look at equipment options and the technical details of putting an ATV power amplifier into service and some aspects of the current debate over vestigial sideband. We'll also take a peek at ATV repeaters and experimental subjects such as FM TV transmission.

Notes

[7]R. Taggart, "Advanced Electronic Applications Fast-Scan Television System," *QST*, Product Review, May 1992, pp 56-59.

[8]Such ID generators and programmed video sources are available from P.C. Electronics and Elktronics. See Table 1 for addresses and telephone numbers. QST