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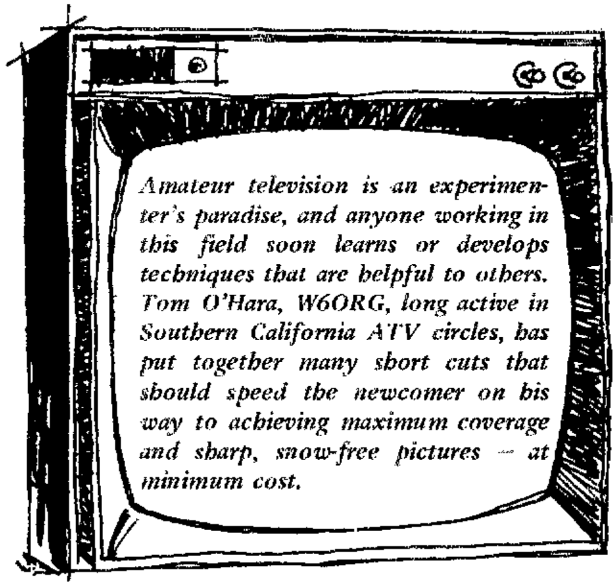

PRACTICAL IDEAS FOR THE ATV ENTHUSIAST

BY THOMAS R. O'HARA,* W6ORG

Part I — Receivers and Antennas

AMATEUR TELEVISION, using commercial video standards, should not be confused with slow-scan TV now popular on the hf bands. Both have their uses, but methods and results are very different. Slow-scan takes time — about 8 seconds per frame — whereas the TV we'll be discussing here is essentially instantaneous. Slow-scan is also limited in definition, but it has the marked advantage of being a narrow-band system, so it is permitted in our hf bands. What will hereinafter be called ATV is inherently a wide-band mode, so it is restricted to use above 420 MHz. (The U.S. 420-MHz band is 109 times the width of the slow-scan segment of the 14-MHz band!) ATV picture detail can be excellent — potentially at least equal to the best commercial TV.

You may like one or the other, or both. If worldwide DX using all-commercial equipment interests you, slow-scan can add a new dimension to an already exciting DX medium If you like building gear or revamping surplus equipment, and you think that televising a parade, or watching a friend's home movies on your TV screen might be fun, uhf ATV may be your field. It need not be expensive. Good ATV signals have been put on the air for a total investment under $200, and little more technical involvement is entailed than in getting on 2-meter fm with an old Motorola police rig. You may end up using ATV to brag about your 20-meter DX, as WB6MEU appears to be doing in one of the photographs.

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ATV DX may not be great in miles or countries, but consistent coverage with pictures of usable quality can be quite good. When tropospheric conditions are favorable, you may be swapping reports (visually, of course) over paths like the mountainous one between Los Angeles and San Diego. Several hundred miles up and down the Atlantic Seaboard, or 1000 or so across the Gulf, between Florida and Texas, is well within the bounds of possibility. A reliable rule-of-thumb for average propagation is that a distance you can cover satisfactorily with 5 watts on 2-meter a-m or fm will give good pictures with 15 watts and a good antenna in ATV work.

A Few Preliminaries

The block diagram of a complete ATV station is shown in Fig. 1. Most ATV beginners use equipment along the lines detailed here — inexpensive to buy and relatively easy to adapt to ATV needs. Once you're on the air you can refine and expand as time, talents, and resources allow. A desirable first step is to locate a fellow ham who is already on ATV or about ready to go on. Two stations working together is much better than one person working alone. Your friend can "talk your picture in" on another frequency, while you adjust for picture quality. Monitoring your own signal can be misleading, because of almost certain overloading of your receiver. Your picture may look fine on your own set, but have low contrast at distant points.

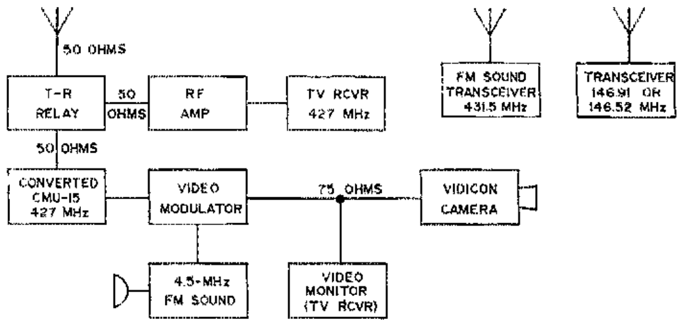


Fig. 1 — Block diagram of a complete ATV station. The beginner may go on the air minus one or more of the station components shown. Where frequencies are given they are channels commonly used in Southern California, and not necessarily applicable in other localities. The 146-MHz channels are used primarily for calling purposes. Local 2-meter repeater frequencies may be used briefly for this purpose, as well.

An agreed-on voice calling frequency in a well-used band is helpful in building ATV interest and activity. In Southern California, 146.91 MHz is almost universally monitored for ATV purposes. The 146.52-MHz fm simplex channel is also popular. In many areas local fm repeater channels are useful in initiating ATV tests and QSOs. (Video transmissions are made on a higher frequency band.)

Some standard for video carrier frequency is important. Most people find it hard to believe, but the 420-MHz band is filling up fast. The range from 442 to 450 is loaded with fm in many areas; 435 to 438 is satellite territory. The 431- to 433-MHz range is used for narrow-band modes, in DX and local communication, with moonbounce becoming ever more widely used. Californians have settled on 427.0 MHz for the video carrier, and 431.5 MHz for the fm-sound subcarrier.

Even though the sidebands in a good ATV system extend out to plus-or-minus 6 MHz, sync-buzz interference is troublesome out to only about 2 MHz on either side, as the instantaneous video power at any one frequency beyond that point is negligible. Crystal control should be employed, so that the transmitter frequency will not drift into other portions of the band. The modulated-oscillator approach, long used in getting started in ATV work, is no longer acceptable on this account.

ATV Reception

Amateur TV of the fast-scan (uhf) variety uses the same video standards as commercial TV, so the simplest way to receive it is to modify the uhf tuner in a conventional home TV receiver, to tune the 420-MHz amateur band. Rather than borrow the family TV set, it may be better to buy an inexpensive set, new or of recent manufacture. Some of the best are small Japanese models made after 1970, which usually have low-noise hot-carrier diode mixers. Before you dig into the set, get a service manual, a Sams Fotofact sheet, or at least a circuit diagram, if you can. Almost any TV receiver is usable, and conversion is not difficult.

A tunable converter ahead of a TV set having no uhf coverage will do, though such old sets may not have very good definition by now, and early uhf converters are generally low on sensitivity. Tunable converters are preferred over the crystal-controlled variety, for several reasons. ATV is normally a-m, with two sidebands, rather than the carrier-and-one sideband of commercial TV. For the clearest picture it is helpful to be able to tune off to one side or the other of the ATV carrier, depending on the shape of the receiver i-f pass-band, and local occupancy of the lower vhf TV channels. (A strong local vhf TV signal may ride through the uhf converter, or be picked up by the receiver circuits directly.) Crystal-controlled converters made for amateur narrow-band communication, mainly around 432 MHz, may have high-*Q* circuitry that restricts the receiving band-width to less than needed for high-resolution video. Adequate bandwidth is important in assuring really clear, crisp picture reception.

External uhf converters, such as those made by Blonder-Tongue and Archer, can be padded down easily. Practically all older uhf front ends in TV receivers are in converter form, designed to work into one of the lower vhf channels. Newer sets have provision for working directly into the receiver i-f system. Modification of a Sickles uhf converter, found in many home TV sets having uhf coverage, is described in two *QST* articles.[1] Procedure is likely to be more or less the same, regardless of tuner make or design.

The simplest way to get the tuning range down into the 420-MHz band is to add capacitance across

[1] Bertini, "Tunable 440-MHz Receiver," July, 1971, *QST*, and "Tuner for ATV Applications," October, 1973, *QST*. Condensations of this information in *Specialized Communications Techniques for the Radio Amateur*. ARRL, 1975.

the tuned circuits of the uhf converter. This may be desirable, as it will leave the receiver still capable of tuning the low end of the uhf TV range, and restoration of the original tuning range is fairly easy. Smoother tuning and much better reception will result from removing plates from each section of the variable capacitor and adding adjustable padder capacitors. Leave one stator and one rotor plate in each capacitor section, the rotor plate left to be that having radial slits for adjustment of tracking.

If the tuning capacitor is left intact, add trimmers of about 1-3 pF in range. If plates are removed for band spreading, about 9-pF maximum capacitance will be needed in the padders. In either case, the first alignment step is to locate the ATV frequency by adjusting the oscillator padder. Then peak the other sections for maximum signal, as in any receiver alignment. A signal generator is helpful, though not absolutely necessary.

In some converters the *L/C* ratio may get too low to sustain oscillation. If this happens, cut the oscillator line and insert a loop or turn of No. 20 wire, about 3/16 inch in diameter. When the additional needed inductance is found, a similar change can be made in the other lines, to maintain tracking.

In lieu of a signal generator, the signal from a nearby ATV station can be used for alignment. If you have the other's cooperation, start with a strong signal and progress to a weaker one as circuits are adjusted. The third harmonic of a 2-meter rig can be used, but be sure that you have tuned in the desired frequency, not a spurious product of the oscillator or multiplier stages. A reliable indication of any improvement can be had by monitoring the agc voltage developed by the signal, whatever its source.

A standard reference for minimum usable signal in ATV is the lowest level at which the receiver's horizontal oscillator will lock the signal in. With a well-peaked average front end, this will be somewhere between 5 and 10 μV. A good preamplifier can bring the usable level down to around 1 μV, which will really help in reception of all but the stronger local signals.

RF Preamplifiers

One rarely finds top performance in either uhf or vhf home TV, in part because of the wide tuning ranges that must be covered by the rf circuitry. We are interested in a relatively narrow band, so a simple transistor preamplifier for the ATV frequency can help. Up to 20 dB gain is readily obtainable, with a noise figure well below that of the best manufactured home TV sets. A real joy in ATV is reception of clear high-definition pictures. A low-noise rf amplifier will extend the range over which such reception is possible.

The inexpensive rf amplifier shown in Fig. 2, originally appeared in *The Radio Amateur's VHF Manual*, Edition 3, Chapter 13. Improvements made recently provide better stability under varying load conditions, and higher rejection of out-of-band signals. A 9-volt supply is recommended, whereas the earlier version used 12. In this form the preamplifier will be less susceptible to over loading from a 2-meter rig running in the immediate vicinity, which may be important in ATV communication. For still better suppression of your own TVI from 2-meter operation, add a simple strip-line filter in the line to the ATV receiver. (Suitable filters are described in all editions of the *VHF Manual*.) If insertion of a strip-line filter affects picture definition adversely, try tapping the input and output directly to the inner conductor instead of using coupling loops.

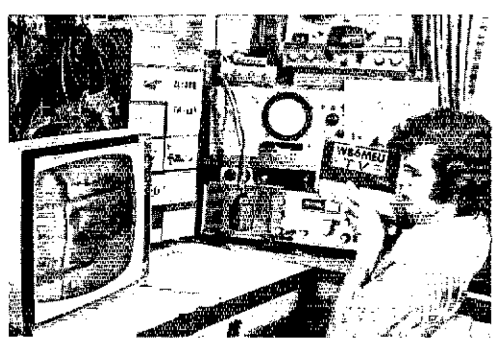
The amplifier is assembled on a single-sided circuit board 2-1/4 inches square, with a simple 3-pad pattern that can be etched, milled or cut with a sharp knife. The only critical item is to keep bypassing leads as short as possible. Ready-made boards and completed preamps ready for use are available from W6ORG.[2]

Requirements as to noise figure are not as critical in ATV work as in weak-signal DX communication. Any reasonably good rf stage will help any conventional uhf TV front end. By contrast, most receivers and converters used for 432-MHz communication are likely to be rather good already, and improving them appreciably takes some doing.

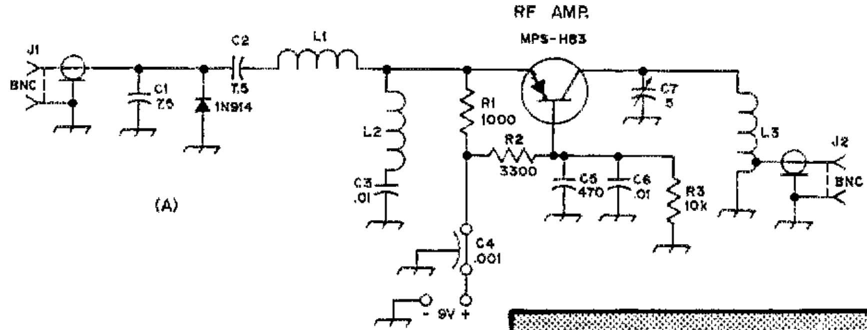
Conversion to Coaxial Input

Most home TV equipment is designed for 300-ohm balanced input. Conversion to coax and unbalanced input is desirable in ATV work. This requires modification of the TV set's uhf input circuit, also a must if an rf amplifier is to be used

[2] Ready-made circuit boards are available for the rf preamplifier, video modulators, and fm subcarrier generator. Send stamped self-addressed envelope to the author for further information.



ATV need not be all test patterns and tweaking. Here WB6MEU focuses on some choice DX QSLs from stations worked on the hf bands.



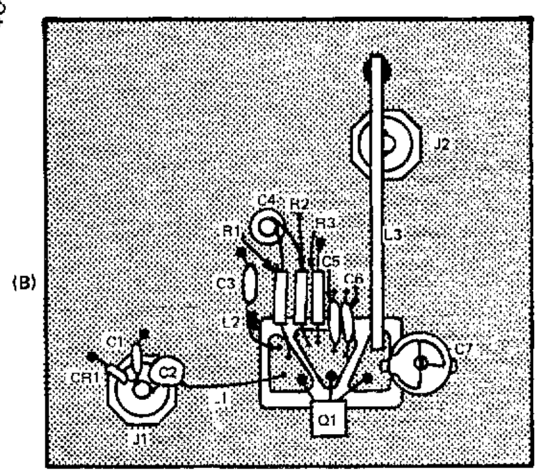


Fig. 2 — Schematic diagram and parts information for the W6ORG preamplifier, for use with uhf ATV receivers. Parts not described are numbered for text reference and identification in the layout, B.

C1, C2 — 7.5-pF disk ceramic. Lead to C2 makes L1.
C3 — .01-μF disk ceramic. Lead to C3 makes L2.
C6 — Subminiature variable, 1 to 5 pF (Johnson 187-0103-005).
L1 — 3/4-inch lead, C2 to emitter pad.
L2 — 3 turns, 1/8-inch dia., in lead from C3 to emitter pad.
L3 — 2 inches No. 20 wire 3/8 inch above and parallel to board surface. Tap for J2 at 1/2 inch from ground end.

effectively. If there is no room to install a coaxial connector on the uhf tuner, the direct-connection method, Fig. 3, is recommended.

Drill a hole large enough to pass the coax inner conductor and its insulating sleeve, at a point that will permit direct connection to the first section of the tuner as shown. Tap the inner conductor on the input circuit, adjusting the tap position in 1/16-inch increments for best response to a test signal. Precise adjustment will not be important if a preamplifier that is stable under varying load conditions is used, but optimum tap position will be desirable if the antenna feeds the tuner directly. Tinning the surface of the tuner around the hole, and also the coax braid, will help in getting a good clean bond at this point.

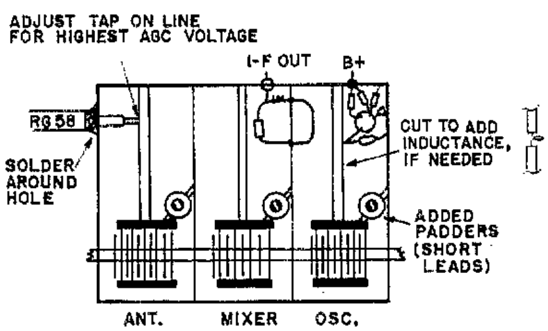


Fig. 3 — Typical uhf TV tuner, modified for coaxial input.

Warning: this grounded-input arrangement is usable only with receivers which do *not* have "hot" chassis. Also, watch for ungrounded input circuits in simple tuners having no preselection circuit (two-section tuning capacitor instead of three). If yours is a two-section front end, be sure that the low end of the mixer line is grounded directly to the frame, before installing the direct antenna connection described. In a mixer with a biased diode the cold end of the mixer line may be insulated from ground, in which case a series capacitor must be used to couple the antenna to the line. If there is room, use a small trimmer; if not, experiment with fixed values and various tap positions.

Antennas and Transmission Lines

It has been said many times, but nowhere is it more important than in the ATV station: cutting costs by using cheap transmission line is false economy. Published tables indicate that Twin-Lead may have lower loss than coax, but adverse effects of weather make the advantage largely illusory, even if the convenience of coax is ignored. Equally important is the choice of coax, after the balanced-vs-unbalanced argument is settled in favor of the latter. Beware of bargains in coax. They may have inadequate shield-braid density, which you can

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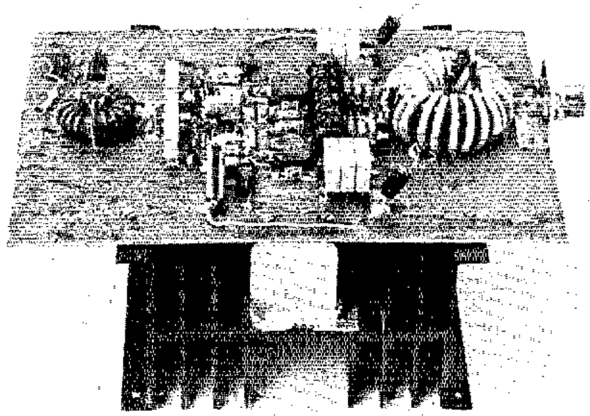

Here the amplifier is tilted to show the solid-aluminum block, center, that becomes part of the heat sink system. One fin of the heat sink (right side of the aluminum block) is removed to permit mounting the bias-regulator board directly to the block. The bias-regulator assembly is not visible in these pictures. The large toroid assembly, right, is the output transformer, T3.

amplifier will pass on unwanted frequencies as well as the desired ones.

Regulation of the 28-volt supply should be good up to 10 amperes drain. Any drop in supply voltage under normal current loads will result in distortion.

Laboratory tests made by Philips show quite uniform performance over the range 3 to 30 MHz, as to power output, efficiency, input VSWR, and third-order intermodulation distortion, with all factors off only slightly above 15 MHz or so. Motorola data presented in slightly different form show 100 watts PEP output at 4 MHz, with only 320 mW drive, whereas about 4 watts drive is needed at 30 MHz for the same output. The full range of laboratory measurements could not be duplicated in the amateur station, but efficiency and power-output checks made by the author follow data quoted by the manufacturers quite closely. QST

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check by visual examination, or they may be susceptible to moisture deterioration, which will be found out too late if the coax is not already in bad shape from use or storage in damp conditions.

Start with the best coax you can get. Foam-insulated RG-8/U is the minimum recommended quality, and that only for short runs. Be sure that connectors are properly installed, and taped and sprayed for waterproofing if they are to be out in the weather. Use constant-impedance connectors if you can afford them, but don't worry about the objections often raised to the inexpensive "uhf" series, PL-259 and SO-239. Properly installed and waterproofed, they will do as well as the more expensive types, for all practical purposes.

Every aspect of the transmission-line performance is vital in reception, perhaps more than in transmitting. Line losses can be offset by increasing transmitter power, to a degree, but they add to the system noise figure in receiving. Once the signal is lost or degraded through transmission line defects, there is no way to get it back.

Antenna Height and Polarization

Though horizontal polarization has demonstrable advantages on somewhat lower frequencies in certain kinds of terrain, there is little to choose from between horizontal and vertical in uhf work if everyone chooses the same, so practical considerations rule. Nearly all fm communication is with vertical antennas, to simplify the antenna problem for mobile operators. Repeaters are standardized on vertical for this reason, and in Southern California ATV is following the same course.

Height above ground is important. For practical purposes, "ground" is likely to be anything up to about 30 feet above actual earth, in the average urban residential area. Get up to at least 40 feet if at all possible, as absorption and reflections are likely to be bad below this height. Going up to 60 or 70 feet is usually helpful, but much higher may not pay off, unless very good transmission line is used. Height-gain and line-loss tables are helpful in determining your needs in these respects. (These are available in the *VHF Manual.*) Absorption by heavy foliage and reflections from buildings are very troublesome in the uhf range. A large tree or a three-story house with aluminum siding may be only an annoyance to the voice communicator, but to the ATV operator either can be disastrous, in signal loss and ghost effects.

Gain and Bandwidth

High-gain antennas are desirable in ATV work, but bandwidth is more of a factor than in other forms of amateur uhf communication. A yagi array designed for maximum gain may be selective enough to restrict the bandwidth of the ATV system, so collinears are generally preferred over yagis for medium- and high-gain systems. Corner-reflector and screen-reflector arrays are also recommended. There is plenty of information in the *ARRL Antenna Book*, *Handbook* and the *VHF Manual* for the ATV operator who likes to build his own arrays. One commercially available antenna that is popular with the ATV fraternity is the Cush Craft DX-420 collinear.

Part II will appear in a subsequent issue. QST