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R/C RECEIVER APPLICATIONS NOTE

R/C model flying with ATV aboard is bringing in new hams from that hobby. There are a number of variables to consider first such as the type and size of the vehicle and the distance you want to cover before selecting the ATV transmitter. In R/C aircraft the limiting factor is how much payload weight you can add. If you only intend to fly within a 1/4-1/2 mile radius around a R/C flying field with an aircraft using a .40 or smaller engine, then the 50-100 mW Videolynx 434 ATV transmitter will probably work fine. For farther distances, the 1 watt TXA5-RCs and aircraft with .60 or larger engines is suggested. Test fly with equivalent weight at the CG first.

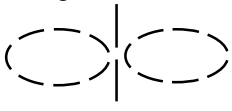
The key is using antennas physically mounted and aligned so that the maximum radiated power lobe point at each other. Omni directional vertical polarization is generally best mounted on the bottom of R/C aircraft and on the top of ground vehicles. A ground plane on the top of 10 ft of TV masting at the receive site will keep line of sight to the vehicle in most cases to prevent people and objects on the ground blocking the line of sight path.

Example: Putting ATV in an R/C helicopter

First and most important, the vehicle must be capable of lifting the additional weight of the ATV gear. The total weight of a Videolynx 434 transmitter, LB-1000 color camera, 9V alkaline battery and RH3 antenna is 7oz. The 434 MHz frequency can be received on most cable ready TV's or analog cable tuner to USB port and lap top tuned to cable channel 59. Most TV AFC's will lock on to the .75 MHz difference. If not, a TVC-4s downconverter can be used.

View from the bottom of the 25" rotor R/C helicopter

Total weight of Videolynx 434, 9V alkaline, LB-1000 color camera and Diamond RH3 antenna is 7oz. No extra shielding or filtering was necessary. Components are cable tied to the bottom of thebattery powered helicopter and placed to maintain the proper center of gravity in the vehicle. For smaller R/C aircraft the 1.75" Diamond RH3 antenna may be short enough not to interfere with the landing gear.



Vertical dipole radiation pattern.

The greatest power is radiated equally in all horizontal directions perpendicular to the wire and minimum off the ends. Straight and level flight will have strongest signal in all directions and decrease with increasing bank angles.

A vertical ground plane antenna can be made and used at the receive site. Mount atop at least two 5 ft sections of Radio Shack TV masting to get above head height and other obstructions that will attenuate the signal. Radiation pattern is the same as the dipole but with a 15 degree up-tilt - a plus for R/C aircraft.

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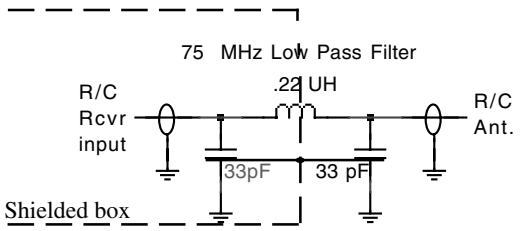
*Please read, especially before flying the 1W ATV transmitter.

Range testing is a must

With the ATV transmitter off, have some one walk the R/C vehicle as far as possible and maintaining antenna line of sight, until they note that the controls no longer function. Use thumbs up or down hand signals. Best R/C range will be with the control transmitter antenna held vertical, but most flyers angle the antenna toward the vehicle which actually gives the least distance. Then have them back up to the point that full control of all channels is restored. Then turn on the ATV transmitter and see if you still have R/C control. If not, you may have to do some shielding and filtering of the R/C receiver or play with relative antenna placement. Always separate the R/C antenna and receiver as far away as possible from the ATV antenna and transmitter on the vehicle.

Putting an ATV transmitter right next to an unshielded 50 or 72 MHz R/C receiver having little or no front end selectivity can overload and block the control signal. Senthesized ATV transmitters are less problem than crystal multiplier types because they do not have any leakage radiation from the crystal oscillator and multiplyer at frequencies near the R/C receiver band. R/C controls may work fine up close, but as soon as the ship gets out a little ways, the R/C signal gets weak enough that the ATV transmitters energy captures the first mixer and down goes the aircraft.

You can solder the seams of thin brass sheet (K*S Engineering #250 Brass .005 thick - www.ksmetals.com) or purchase a tin plated steel box from companies like Sescom (SB series, call 1-800-634-3457 for catalogue). Power each module from its own battery. The 12Vdc 1W TX battery will be the heaviest component. The 1 Watt TXA5-RCs transmitter can be packaged in a Hammond 1590B die cast aluminum box - 6.5 oz - see next page. Mouser (call 800-346-6873 for catalogue) has a variety of 12V batteries like the Eagle Picher CF12V1/2L 10oz gelcell which will work well. The Videolynx 434 ATV transmitter uses a 9V alkaline and the Z70A two in parallel.



Drill a hole in the shielded box and epoxy in place the .22 uH inductor half in and half out. Solder the 33 pF caps - one inside, one out - from the inductor to the box with very short leads. Solder the receiver board ground to the box near the antenna input as well as a few other places directly or with short buss wire jumpers. Reconnect the R/C receiver wire antenna on the outside.

Before the next flight, place the craft far enough away to be just within it's minimum signal strength range for full control. Then turn on the ATV transmitter and see if you still have full control. If not, as a progress reference, move slowly closer and note the spot where full control is regained. Then go back to the bench and try adding at the DC power input, a 1000 pF feedthru cap through the box. Same to the servo control or other leads if necessary. The servo ground leads should connect directly to the outside of the receiver shield can and power leads to the outside of the power feedthru. That should keep the leads from conducting the ATV RF inside the receiver. In addition try changing the positions of the two antennas or signal wires and separating the R/C leads from the ATV leads to prevent cross-talk. Go back out and see if the changes and additions improved the control range.

Cameras need to be the solid state type and RF kept from them to minimze distorting or shutting down the auto iris. We suggest our color LB-1000 camera which can run off a single 9V alkaline battery for over 8 hrs.

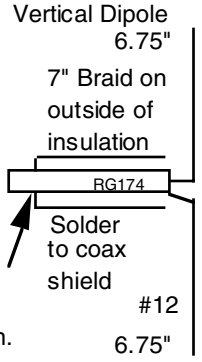
The 1 W ATV transmitter should be shielded and the power and audio lines filtered in the same way as the R/C receiver. Use small RG174 coax for the video lead with no bypassing greater than 100 pF. The camera may also need shielding if not in a metal case like the LB-1000.

Receiving the video can be done with a cable ready TV set to cable channel 58 or 59 and connected to the ground plane or OAL 5L-70cm 5 element beam However, for greater DX, a TVC-4S downconverter ahead of any TV set to channel 3 or 4 is best.

The TV will have to be in the shade or a cardboard hood made to keep the sun from washing out the picture. The Icom R3 portable receiver is good in bright sun light and is small and light enough to be used by the person controlling the R/C vehicle. It is difficult to control the vehicle by video alone, so start out by occasionally glancing at the video screen until you feel more comfortable with the operation.

The primary consideration for reliably receiving ATV is to have line of sight between the two antennas, So mounting the receive antenna above head height and in the clear with no obstructions is most important. Also the antenna on the vehicle needs to be mounted such that its main radiation lobe is toward the receive antenna and vice-versa.

Most effective antenna for a R/C aircraft is a vertical dipole embeded in the tail fin if >13" high. Run 50 Ohm RG174 coax from the transmitter to the dipole feed point. Slide 7" of braid from some RG58 over the RG174 and solder to the 174 shield only at the point 7" down from the feed point. Then solder the 6.75" pieces of #12, one to the center and the other to the 174 shield. Check VSWR and trim each end 1/8" at a time for minimum.



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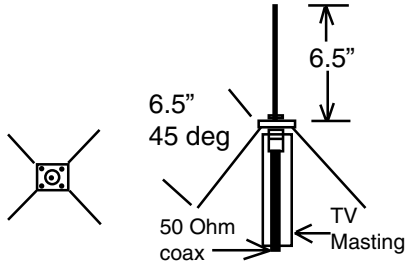
ELECTRONICS

Ground Plane made with #12 solid copper house wire and UG-58 type N flange mount jack for the receive site.



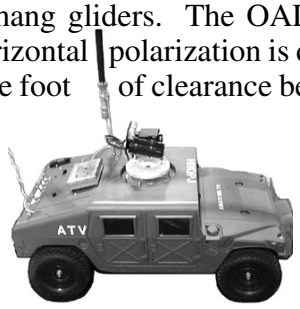
Solder the quarter wave vertical wire to center socket and measure from flange surface to the top of the wire for the frequency in use. Start with the wire a half inch longer, then measure and trim after soldering. The formula is 234 divided by Frequency in MHz. Solder the 4 radial wires to the respective holes in the UG-58 jack or bolt on solder lugs and solder to them. Bend the radials to a 45 degree angle away from the coax and masting. Then trim to length measuring from the edge of the flange to the tip of thewire.

Frequency MHz	Length In.
426.25	6.5
915	3.0
1265	2.2
2398	1.2

Use Belden 8214 coax and UG21 type N plugs to the downconverter. Hold the N plug to the top of the TV masting with hose clamps. Align the 1/4 wave vertical element to be as perpendicular to the ground as possible. Place high and in the clear in order to maintain line of sight to the transmitter antenna.

For R/C cars and boats, the ground plane can be used on the vehicle with the same 1/4 wave vertical length, but at least the same length from the braid side of the coax must be run with wire or preferably glueing aluminum foil on the inside surfaces directly below the 1/4 wave vertical and mechanically connected to the coax shield by a screw or RF jack. To receive from a R/C car or boat, the 5L-70cm beam will give the best DX and minimize multipath ghosting and has a wide 60-70 degree beam width for easy tracking.

Upside down ground planes (1/4 wave wire pointing toward the ground) are used hanging down from ATV balloons, kites, skydivers or mounted on the bottom of ultra-lights or hang gliders. The OAL Big Wheel is also good if horizontal polarization is desired and you have at least one foot of clearance below any metal.



R/C OR PORTABLE ATV DX

The antenna is the most important factor in effective radiated power rather than the transmitter power. You want an efficient antenna that has a radiation pattern maximum in the direction and polarity of the receive antenna. The vertical dipole imbedded in the tail fin of R/C aircraft is most efficient, but the short RH3 may be the most practical physically. For ground R/C vehicles, a 6.5" whip with a 13" ground surface is best. For portable use a Diamond RH77CA or RH519 antenna with a ground plane or build your own ground plane as shown. A ground plane has about a 15 degree up tilt from the horizon for its main radiation lobe. The receive antenna must be above head height (6 to 10 ft) to maintain line of sight and minimize multipath ghosts.

Line of sight distance can be predicted given power, antenna gain, coax loss, receiver noise figure and bandwidth. Non line of sight cannot - you just have to try it to see what you get. 426.25 or 434 MHz is suggested for R/C and simplex because the 900 MHz band goes half the DX as 400, and 1200 goes 1/3 Also the higher the frequency, especially with ground R/C vehicles, the more chance of mulipath problems.

If you increase your radiated power or receiver antenna gain by 6 dB (4 times) you double the distance for the same picture. On 426.25 MHz, the snow free P5 line of sight DX dipole to dipole, aligned in their maximum radiation lobe to each other for 100 milliwatts is about 1/4 mile and goes to 1 mile if a OAL 5L-70cm beam is used at the receive end. With 1.5 watts it is 1 mile and 4 miles respectively. Past these distances the P rating drops by 1 every doubling of distance. Color drops out about P3 or 4 times the P5 distance. 100 mw on an R/C could still key up and be seen with a lot of snow in a repeater 10 to 15 miles away. Local frequency selection and 2 meter ATV coordination channel use is strongly recommended to minimize interference during operation.

ATV requires about 150 to 200 microvolts at the downconverter input for a snow free picture compared to 1 microvolt for good readable audio in a FM voice HT. This is due to the much wider bandwidth - 3 MHz vs. 15 kHz - resulting in a 23 dB higher noise floor. ATV requires a little more attention to minimizing any RF losses (coax, connectors, construction, etc.), antenna gain, polarity and directivity than you would on FM voice. Cable ready TV's can be used, but they are typically not nearly as sensitive as a downconverter like the TVC-4S for our DX examples. See our ATV DX Variables App note.

73, Tom O'Hara, W6ORG (c)4/2010

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IDing on R/C ATV

Minimizing payload weight, size and location on R/C models are major considerations and IDing your amateur call on an ATV transmitter from the craft is probably the last thing you want to have to add. However, you need to decide how and then if you want to add your call ID per loose or strict interpretation of FCC Rules. The ATV R/C application is not directly addressed in the Rules.

The simplest way to ID is to somehow put your call letters within view of the camera. While on an R/C aircraft most cameras are mounted on the belly, WA5FRF strapped his ATV transmitter, antenna and camera on top of the wing of his Tower Hobbies ARF TH-60 Trainer, and glued a triangular piece of balsa with his call on the nose. Depending on the camera depth of field, you may be able to paint or letter your amateur call on the belly forward of the camera. The letters just have to be large enough to be easily recognizable so the color of the letters should have high contrast to the color of the craft. Some experimentation with camera angle, placement and moving around call letters written on a piece of paper while watching on a monitor can be done.

If you have a few more ounces of payload available, the OSD-GPS+ video overlay board can not only give you your call ID overlaid on the camera video, but by adding a GPS receiver, gives you speed, altitude, heading, bearing and distance to your launch point. You can just display your call if no GPS data is plugged in to the OSD-GPS+, but if all you want is the call, the OSD-SA or OSD-PC will do the job. The OSD boards weigh 2 oz and are 2.5 x 3.5 inches. Power requirement is 8 to 14 Vdc at 80 ma. There are many small GPS receiver boards now available, like the Garmin 15, that are small and output the standard NMEA 0183 two line serial data which the OSD-GPS+ video overlay board accepts.

Identifying your call every ten minutes of continuous transmission and at the end of a transmission is required with the ATV mode as it is in all the others - 97.119. However, R/C transmitters under 1 watt are not required to ID per FCC Rule 97.215. The old R/C Rule was broad such that one could interpret that any transmitter used to control an R/C vehicle under 1 watt did not have to ID. Therefore, if an ATV transmission from the craft was used as a visual aid to Radio Control the craft, the ATV transmitter did not need to ID if its power was under 1 watt. When the R/C Rule and many of the amateur Rules were revised, the actual wording was changed to "transmissions directed only *to* the model craft." Strictly speaking the ATV transmitter would have to ID, but a 6 meter R/C control transmitter would not. One could argue that the spirit of the Rule is still being followed for the ATV transmitter if under 1 watt and no ID, but the wording does not cover transmissions *from* the model craft.

Another Rule to be concerned with is 97.111 which, with 7 exceptions plus the 97.215 R/C and 97.201 Auxilliary Rules, prohibits one way transmissions. If the video is used as part of controlling the R/C craft by the R/C operator watching for visual clues, and the transmitter is under 1 watt, it is a legal one way transmission. If over 1 watt, however, you would have to direct your ATV transmission to at least one other ham.

Control of an ATV transmitter on the craft is another question that often comes up. 97.109 says that each station must have at least one control point. You cannot use a channel on your 6 meter R/C receiver since it is below 222 MHz (97.201), but you could with a 72 MHz R/C receiver legally. But practically speaking, you only need to be able to switch off the transmitter with in a reasonable time. So in my opinion, the short time it takes to land at the flying field, the control point, to turn it off would not require a separate control transmitter and receiver.