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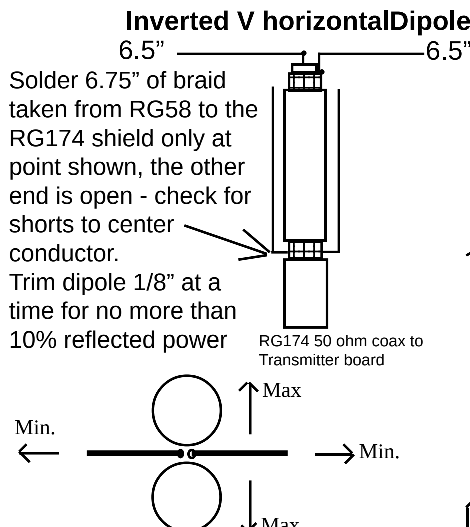
ATV In Amateur Rockets

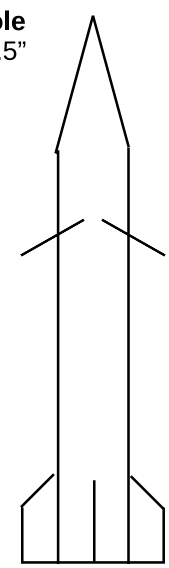
Rockets, balloons, kites or other vehicles that are predominantly overhead and using ATV present a unique antenna radiation pattern problem. For strongest picture and best distance (DX) , antenna radiation patterns should have their major power lobes pointed at each other and the same polarity. A vertical dipole omni directional antenna in the vehicle is fine for best DX on the horizon where the receive end will be at no more than a 15 degree angle perpendicular from the antenna. For example if the vehicle is expected to go 1 mile vertically, those at 4 miles or more away will be with in the maximum radiation lobe of the antenna and get the best video. Those less than the 4 miles would be within the null or minimum radiation patterns with weaker and erratic signals. If the rocket antenna is a 1/4 wave vertical spike on the nose and the body of the rocket the ground plane, the main lobe can have an uptilt of 15 to 20 degrees above the horizon where some of the signal will be wasted. So we suggest using a horizontal dipole on the vehicle and circular polarized antenna on the ground if received directly below. Circular polarity is necessary to minimize the signal strength variation as the vehicle spins.

One watt on 426.25 MHz with our TXA5-RCb transmitter, dipole antennas at both ends will give good snow free line of sight color pictures to over 2 miles. With beams on the ground, each 6 dB of antenna gain or power doubles the distance for the same signal strength at the receiver. If snow free (200 uV) is 2 miles dipole to dipole, color will start to drop out around 8 miles, but still be seen out to 20 miles or more. Also note that given the same power and antenna gains, the lower the frequency, the farther the distance. For instance the 902-928 MHz band goes half the distance as the 420 MHz ham band, 1.2 GHz 1/3 & 2.4 GHz 1/6. Payload weight, most will be in the battery you select for length of transmit time - TXA5-RCb is 2oz and the BC-20 color camera 1.5 oz. For more general information on ATV and all facets of ham radio, I suggest reading the ATV section in the ARRL Radio Amateurs Handbook beginning on page 12-46 (check your library or order from ARRL at 1-888-277-5289). For more info on amateur rockets with ATV go to page 3 of our web site for links.

ROCKET ANTENNA. It is difficult to place an antenna on a rocket that will have any radiation efficiency and a power pattern that favors the earth directly below. For non-metallic diameters more than 4.5" a copper tape dipole around the inside diameter, or epoxyed embeded on the outside can be used. Try to keep anything metalic as far away as possible from the antenna to minimize the effects on the antenna radiation pattern. For smaller diameters or metallic body, an inverted V dipole antenna mounted on the side can be made with two 6.5" pieces of piano wire which are crimped into #6 solder less ring tongues - Radio Shack RS64-3030. Two 6-32 screw holes are drilled in the rocket body 3/8 inch apart. If the rocket body is conductive, the screws must have insulation around them. Mount the two dipole elements and angle about 30 degrees from horizontal to help with the aerodynamics. Use #6 solder lugs inside for the RG174 coax connections. Carefully solder the sleeve balun and check for shorts. Trim for minimum VSWR. Epoxy in place. Cameras are usually mounted inside with the lens facing out on the horizon through a small hole - try to keep the spin to a minimum or you might get dizzy watching. You can also use a prism or split mirrors outside to show above and below split screen or a single mirror just for below. Your Call ID with GPS data can also be overlayed using a OSD-GPS board and GPS receiver like the Garmin 35. You may need a MiniCircuit Lab VLF-490 low pass filter in the antenna line to keep harmonics out of the GPS receiver.



Horizontal dipole radiation pattern. The greatest power is radiated equally in all vertical directions perpendicular to the wire and minimum off the ends.



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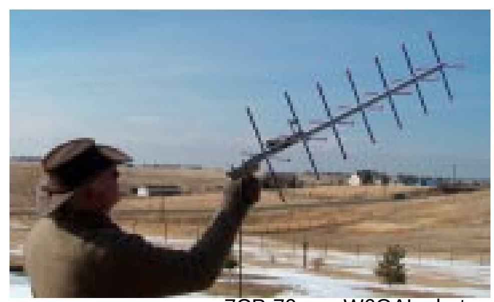
Antenna Considerations for Balloons, Rockets and other Airborne Vehicles with ATV

Antenna polarity and type on the vehicle should be determined by where you primarily want to transmit - back down to the launch site or to stations more than a few miles away from the site as well as physical considerations.

LAUNCH SITE RECEPTION. Horizontal polarization radiating downward is the most practical if launch site reception is the most important. As a rocket or balloon spins, single polarity horizontal antennas will go into a null as the two antennas rotate into right angles to each other and back out to maximum power when parallel. To prevent this spin amplitude modulation with either a rocket or a balloon, one end needs to use circular or cross horizontal polarization. On a rocket, a single dipole is the most practical and will give a good radiation pattern out to about 45 degrees - receive coverage horizontally out about the same distance as the rocket altitude to a circular or crossed polarized antenna pointed at the rocket. Balloons can hang a horizontal dipole and be received in the same way as the rocket, but conversely, it could also use a circular or horizontal cross polarized antenna like a Little Wheel on coax dangling below the transmitter payload package and be received by a horizontal antenna on the ground. The Wheel antenna has the advantage of radiating or receiving on the horizon quite well and cross horizontal polarized above and below it. The Little Wheel with reflector is a great low cost antenna to use at a rocket or balloon launch site when the vehicle antenna is also horizontally polarized. The circular polarized turnstyle is also popular for the home brewer and is shown later in this application note. A circular polarized beam like the OAL 7CP-70cm, will have some gain which can double the distance for the same picture for each 6 dB of gain or improve a weak picture by 1 P unit.

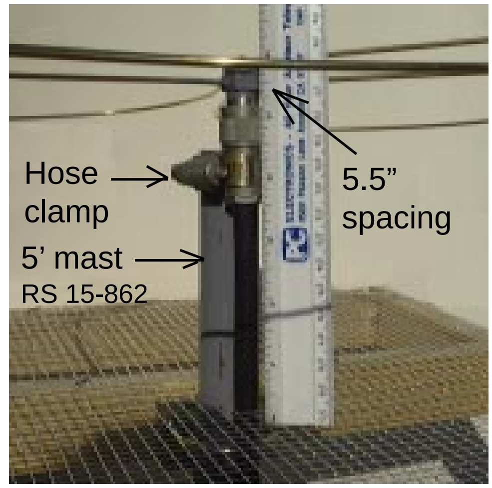
Big Wheel mounted to the bottom of a balloon paylod - ATV camera looks down through hole. N8UDK photo



7CP-70cm - W6OAL photo

DISTANCE. For best DX away from the launch site an omni directional antenna needs to be on the vehicle so it radiates equally toward the horizon in all directions as it spins. Physical restrictions may prevent using an omni directional horizontal antenna on most rockets. If you are transmitting to another ham's home station, then the polarity will probably be determined by what they have up, and the standard in the area. If that is not a factor, a vertical omni will put the most power on the horizon by 3 to 5 dB - vertical ground plane vs. horizontal Wheel or crossed dipoles. On Baloons and kites, the easiest is to hang an upside down quarter wave vertical ground plane made from some wire and a coax connector (see our R/C ATV app note or ARRL Handbook page 20.53). An upside down ground plane will have maximum radiation about 15 degrees below the horizon and a null directly below at the launch site - the null may not be a significant factor with the vehicle close or if it travels off at an angle. With rockets, a vertical omni can be placed inside if the rocket body is not metalic and away from metalic objects. If you want both good launch site signal at a small sacrifice in power on the horizon, then a horizontal omni on the vehicle would be best. Beams of the same polarity of the vehicle can easily track the signal by varying the beam heading for best picture, however keep in mind the tradeoff of the higher the antenna gain, the narrower the beam width and tracking sensitivity. For instance, the DSFO-25ATV 25 element beam has about 16 dB gain over a dipole and 23 degrees of half power beam width that would have to be moved to follow the vehicle in both azmuth and elevation. In the field, the OAL 5L-70cm 8 dBd antenna has a forgiving 70 degree beamwidth and is quite easy to handle portable with its' 31 inch boom.

REFLECTOR FOR THE WHEEL ANTENNA. A reflector can give you 3 dB more gain compared to a single wheel antenna and concentrate the RF where you want it to go. The reflector is placed .2 wavelength below the antenna and it's diameter must be at least 5% larger than the diameter of the wheel. Construction is basically the same as the Turnstyle but I made it from 1.5 x 3/4 wood stock and mounted to a metal mast. It could also be made with sheet metal cut circular and no frame. Two pieces are 15.5 inches long and 3 pieces are 14 inches. The pieces are drilled and screwed together with two holes spaced 3/4" apart at each location on the 15.5" pieces using 1.5" #8 flat head wood screws. The center 14" piece has two 5/16 diameter holes drilled in the center for a Radio Shack 15-826 mast clamp and inside spaced 5" from one side. Two coats of spar varnish are put on the wood before fastening the 1/4" mesh 15" square hardware cloth with double pointed tacks. Cut a key hole in the hardware cloth sighting down through the mast clamp and allowing room at the bottom of the keyhole for the coax. The whole assembly is easily broken down for portability. Pass the coax through the keyhole, then drop the reflector over and down the mast. Mount the Wheel to the mast with a hose clamp. Move and measure the 5.5" spacing from the lower element of the Wheel to the reflector and tighten the mast clamp. For launch site use the antenna is best placed just above head height with plenty of clearance towared the vehicle.



426.25 MHz TURNSTILE CIRCULAR POLARIZED ANTENNA. The 146 MHz Turnstile is commonly used by home brewers for satellite work and originally from the ARRL Antenna Book 14th edition and Sept. 74 QST. We have scaled and noted the dimensions for 426.25 MHz. For those who want to buy a ready made antenna we suggest the M2 "Eggbeater" with reflector available from ham radio dealers.

CONSTRUCTION The mast used to support the two dipoles is made of wood, being 2 inches square and 8 feet long. The dipoles may be made of no. 12 copper wire, brass rod or tubing up to 1/4" diameter. Mount the two 6.5" dipole pieces on one side of the mast and centered and 1/8" feed point spacing with 3/4" long #6 wood screws. The other dipole is 1/4" above the other on another side. The RG-59 coax pigtails should not be longer than 1/4" long. Carefully solder on the coax and phasing line then check for shorts. Run the coax and phasing line down the mast. The spacing from the screen to the dipole is 9.5" for satellites and 5.5" for rockets and balloons. Two holes spaced 1" apart can be drilled for two 1/4-20 x 3.5" machine screws to hold the mast to the frame. Off set the frame cross piece so that the dipoles are roughly centered and snip a 2" square clearance hole for the mast and enough on one side to clear the coax and connector. Lash the coax to the mast with enough plastic cable ties that the coax cannot be pulled on and break the dipole solder connections. Drill the matching holes in the frame. For more portable use, the machine screws will allow removing the mast for transport. The mast can also be made in pieces. The reflecting screen is hardware cloth with a minimum of 1/2" mesh. It can be cut from a standard 18 or 24" roll to 15" inches square. The frame and mast is made from 1x2 inch wood. Cut two pieces 16" long and three 14" long. The screen is stapled or fastened with double pointed tacks to the 1" side. Before putting on the screen, a few coats of spar varnish is suggested on the wood. Cover the coax and dipole solder connections with silicon rubber.

Matching section and Phasing Line must be made with RG59A/U coax. Foam versions are longer depending on velocity factor. L=Vf times 234/FcMHz