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ATV DX VARIABLES

By Tom O'Hara, W6ORG

What kind of distance (DX) can I expect with AM ATV on 70cm or higher is the most asked question from new people coming into this facet of the hobby. There are a number of variables such as band, antenn gain, transmitter power, receiver noise figure, bandwidth and coax loss, and only when you define these variables and have line of sight between the two antennas can you come close to predicting the distance for a snow free picture.

Line of Sight - The most important variable of all is having line of sight between the two antennas. If you theoretically have any obstacle in the path that prevented you from looking through a high powered telescope placed on the boom of the antenna and seeing the antenna at the other end, you don't have line of sight conditions. Without line of sight, it is very difficult and beyond what most amateurs can practically determine and calculate. Most effort then should be spent on antenna height and placement to get line of sight. Just one tree or person blocking the path can give 20 or more dB of attenuation (20 dB is the same as going from 1 Watt to 100 Watts). If you do not have line of sight, or cant see that far, a rough approximation can be made by seeing if you can communicate from the exact same antenna location with 2 meter walkie talkies. If the signal is noisy or nonexistent try moving around looking for the magic spot; you never know where the signal might have a hole through the obstacle or get a reflection off a metal object that does have line of sight between both locations. However, non-line of sight paths are more subject to multipath ghosting from the reflected signals being significantly strong and/or out of phase with the direct signal. The bottom line is that it is much more significant to add antenna height or optimum tower placement in order to get line of sight than any added coax length and its few dB additional loss. Line of sight over perfectly flat terrain for 10 miles takes an antenna at 50 feet above ground due to the curveature of the earth. The RF horizon miles is roughly two times the square root of the height in feet.

Band - Basically, the lower the frequency, the farther the distance all else being equal. What this means is that given the same transmitter power, coax loss, etc., due to antenna area, the signal strength arriving at the receiver input will be higher at lower frequencies. Since antenna capture area is two dimensional, the antenna size will decrease by 1/4 if the resonant frequency is doubled for the same antenna gain. The lowest amateur band with enough bandwidth to support ATV is at 420 MHz. Therefore, all other variables being equal, the 900 MHz band goes 1/2 the distance of 420 MHz band and the 1200 MHz band 1/3. To make up for the 6 dB for doubling or 9 dB difference for tripling the frequency, you can get some back by increasing antenna gain, antenna mounting a preamp, transmitter power or a combination. Coax loss increases with frequency as well as moisture effects.

Bandwidth, Noise Figure and Coax Loss - These somewhat all go together to determine the video to noise ratio seen on the screen. Most TV sets, VCRs, cameras, and camcorders themselves don't do better than 40 to 45 dB video to noise. So with ATV we define snow free as any video better than 40 dB S/N. The wider the bandwidth the higher the noise floor power from all those agitated electrons crashing around in a resistance. At standard temperature the noise floor is about -174 dBm (174 dB below 1 milliwatt into 50 Ohms) for 1 Hz bandwidth. The noise floor power goes up linearly at the rate of 10 dB every time the bandwidth is increased by 10 times. The nominal 3 dB bandwidth through a TV receivers IF and detector is 3 MHz which works out to be a noise floor of -109 dBm or .9 microvolts if there were no other factors. So a snow free picture as we have defined it and in this perfect receiver would have to have a signal strength of at least 40 dB higher than the noise floor or -69 dBm (80 microvolts). But we then have to add in the receiver system noise figure as determined mostly by the noise figure of the first preamp stage, its gain, losses of connectors, tuned circuits and mixer noise figures of the following stages. Bottom line is that the typical AM P5 picture will take between 100 and 200 microvolts at the ATV downconverter antenna input jack and even more with just a cable ready TV tuner. The coax loss from the antenna also reduces the signal strength. Below the snow free power level, the video will decrease one P unit for each 6 dB that is lost due to coax loss or first stage noise figure. Bottom line is use a downconverter with a low noise figure, minimize coax and connector loss by using the larger quality coax or hard line with N connectors and no adapters. You can also almost eliminate the coax loss with an antenna mounted low noise preamp. However, they are expensive if you also intend to switch the preamp out during transmit.

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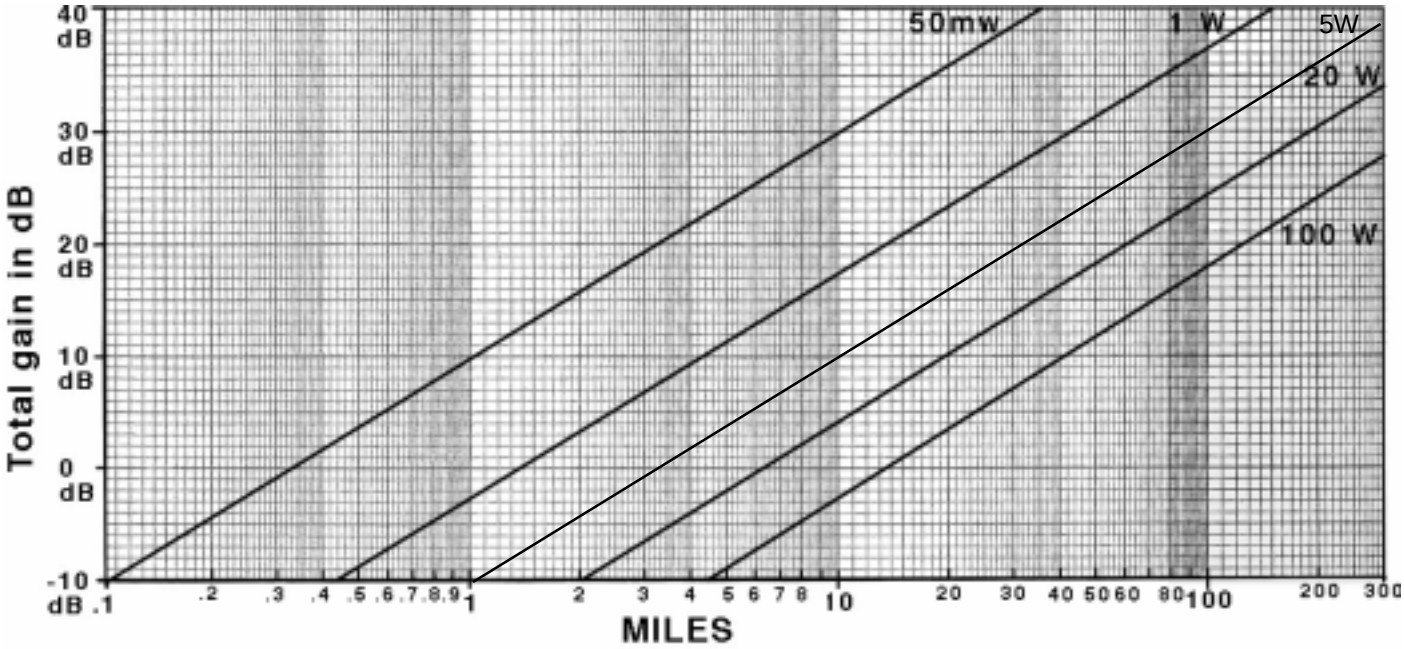
ATV DX VARIABLES cont.

Antenna - Unless you know you don't need or ever use a lot of gain to make the path, most hams get the highest gain antenna they can afford and practically put up - it is a factor in both transmit and receive and to a point, a less costly increase in dB than adding a transmitter amplifier. The trade offs are gain vs. size and beamwidth with beams, but more important for ATV is bandwidth. The antenna needs to have a low reflected power as well as gain over the whole 6 MHz AM ATV channel which can be somewhat independent. It is best to stay with reputable antenna manufacturers that have proven gains at antenna measuring contests and data to support the advertised bandwidth. Whenever you put up a new antenna, it is a good idea to verify with a RF power meter that the reflected power at the ATV video carrier frequency is no more than 10%, even if you have to get with local hams to borrow the meter or come over and help you. Most of the time, when a new system is put up and one is not getting the expected results it is due to a problem with the coax, connectors or antenna construction or moisture getting in and ruining the coax. Don't be surprised if during periods when the antenna is wet that signal strength significantly decreases. It is not path attenuation from rain so much as it is moisture conduction on the antenna and changing its tuning and characteristics - a quick check with a power meter usually shows a drastic change in reflected power. Above 300 MHz, antenna polarity is not significant unless you are opposite of everyone else in the area which can cost you about 20 dB. Polarity is usually determined by who was first on ATV in the area, but technically, the polarity should be chosen to be opposite of the neighboring mode. For instance if using 439.25 for ATV, horizontal would give the most rejection from FM voice repeaters above 440 MHz since they are vertical. If using 434.0, your neighbors are the weak signal people at 432 MHz who are horizontal and therefore you should use vertical. Beams are preferred over omni directional antennas to minimize multipath ghosting for home station use. However, at repeater sites or at emergency operations centers, omni's may be more practical. Vertically polarized antennas are more commercially available and smaller in size than the same gain horizontal omni's, but most areas polarity has long since been determined before a repeater goes on the air. Make sure to check with local ATVers as to antenna polarity per band and frequency before putting up the antenna system.



420-450 MHz Line of Sight Snow Free DX

Total gain in dB = add transmit end antenna gain in dBd (gain over a dipole) to the receive end antenna gain. Subtract each ends coax loss. Take that value across to your transmitters peak envelope power watt diagonal line and then down to the Miles from that intersection. For the 900 MHz band subtract 6 dB, 1200 - 9 dB, 2400 - 15 dB. This chart is for AM video with video to noise ratio of 40 dB being P5. Subtract dB's for preamp NF >2 dB - cable TV subtract 6 dB. For 4 MHz deviation FM ATV in a 17 MHz IF bandwidth receiver, add 12 dB. (c) 5/09