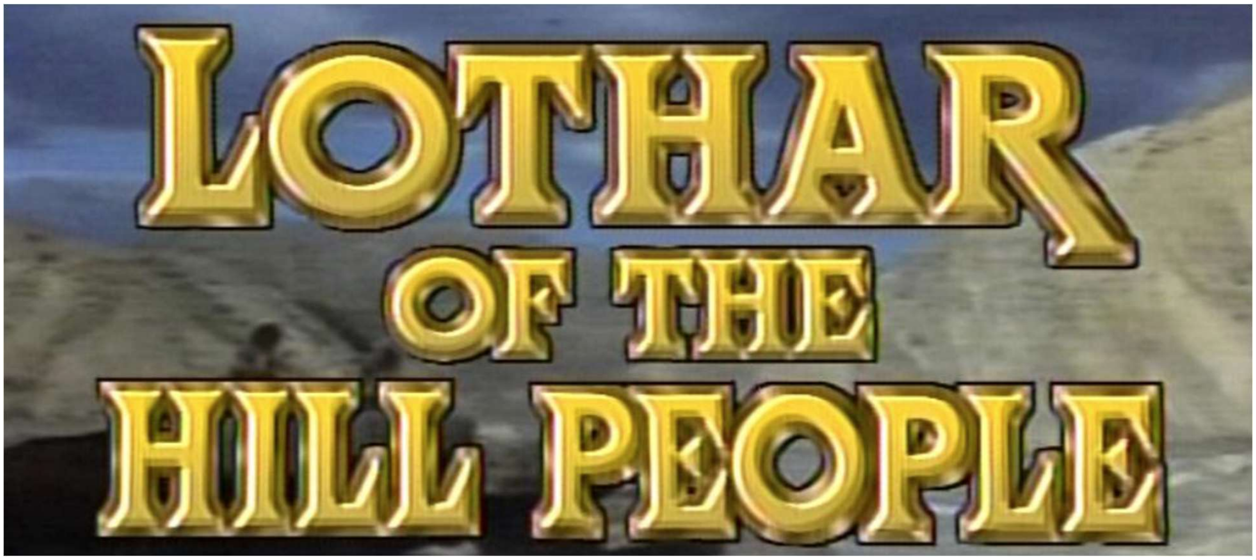

Lothar of the Hill People's Guide to Armchair Antenna Site Planning – August 2024 – Rev. 2

Disclaimers: USA Specific Information and for educational purposes only, may contain opinions, oversimplifications for non-engineers that RF Engineers can quibble over, peanuts, shellfish, raw fish with Wasabi and other allergens. YMMV. Please report corrections and suggestions to @Lothar_of_the_Hill_People on Discord.

Proper Planning Prevents Piss Poor Performance (The 5 P's). My intent is to help you to find the least cost, complexity but best performance within your budget for typical hobby grade SDR reception of common HF/VHF/UHF aircraft signals and other similar telemetry using relatively inexpensive components.

There are a lot of online resources to research your proposed antenna installation location that apply to any RF you want to receive that you should investigate before you go nuts buying antennas, low noise amplifiers (LNAs), bias tees and software defined radios (SDRs) for any hobby grade but credible receiver system. Antenna location selection for what you can reasonable "see" and what potential interferences you might receive at that location is the first step in the process. Once you have done these steps, you should take a look at problematic frequencies with a cheap SDR and spectrum analysis software.

While you can search for possible interference across all bands with an SDR and spectrum analysis software, it is cumbersome compared to having a real hardware based spectrum analyzer and search antenna.

I recommend that you try the armchair approach first before you buy your antennas, cables, filters and LNA system components. You should get an understanding of your RF environment before deciding what antennas to buy and more importantly, what RF filtering and LNAs you might well need and have some real world expectation of what radio range and signal to noise ratio (SNR) performance is possible at your particular geographic and RF environment. This armchair survey method consists of:

1. Go to HeyWhatsThat and find your proposed antenna location and set a marker by clicking the New Panorama button. Expand Parameters, add your frequency of interest, set to curved earth, etc. Then click the Up in the Air button at the top of the map and set the altitudes of interest you need for visual or RF line of site (LOS). For ADS-B at 1090 MHz, you might start with 5000'

and 30,000 feet. The Horizon button will show you the optical horizon at the antenna location. Keeping with the ADS-B example, the 30,000 foot outline will give you a pretty good idea of what area your antenna "should" cover. You can even save the outline to your local TAR1090 map. Instructions are here: GitHub - wiedehopf/tar1090: Provides an improved webinterface for use with ADS-B decoders readsb / dump1090-fa You can use this outlining system for other frequencies and graphing apps as well including most graphical information systems (GIS) like ArcGIS and the open source similar systems. Use this theoretical outline as a rough comparison as you tweak antennas, LNAs, feed cables, filters and gain settings.

2. Go to FCCInfo - Now on Google Earth! This is a service of a well-known broadcast industry Consulting Engineering firm that monitors the USA FCC database. It is a KMZ file that opens with Google Earth. It can also be used with many other GIS applications. Use this tool to identify all of the USA broadcast transmitters on AM/FM/TV bands near you. Jot down the stations, frequencies, transmit power and distance from your proposed antenna location. Pay attention to the microwave links as well. These include the 950 MHz band set aside for radio station studio to transmitter links (STL Authorization). These are quite close to the Aircraft 978 MHz UAT frequency used for light General Aviation (GA) aircraft. These STLs are usually bidirectional and have transmit power from 5 to 50 watts into high gain directional antennas. These point to point links are actually more powerful than cell antennas, if you are in a direct path. Look at all of the other off the air (OTH) TV station STLs, common carrier and private microwave links that pass over your location on the other bands as well as they apply to your receive frequencies of interest. If you want to do detailed calculations of the total RF power densities at your site, there are tools for that too.
3. Go to AntennaSearch - Search for Cell Towers & Antennas and look at your nearby cell towers. This site is very good for showing the actual FCC licensed tower locations and what carriers operate from the towers but does not provide frequency data. For further information on what is near you, and the frequency bands in use, See this link - Cellular Frequency Bands Chart | Cell Phone Frequency Bands (powerfulsignal.com) for useful info on bands (frequencies) used by the carriers and a couple of good ways to use your Android or iPhone cellphone to ID what signals are near you by band. These apps use your carrier, but you can use friends and family's phones on other carriers to get a good picture what bands are potentially problematic for reception of your desired frequency(s). There are some crowd sourced tools that ID received cell phone frequencies and RX power levels, and even outline the supposed coverage but you should not rely on the stale reports on most of those sites. Cell site downlink transmitters can be up to 40 watts transmitter power output (TPO), each TX feeding 3 or 4 way clusters of directional sectoral antennas with fairly high gain. Using these tools, find your 3-4 closest cell sites and see what frequencies are in use and the comparative elevations and LOS to your proposed antenna.
4. Go to FM Fool - Home and input your location. This site will estimate signal levels from the receivable FM stations based on calculated distances from your receive site. This site is very useful for Air Band interference issues. Also look at the sister site TV Fool and check the local TV station signal levels. This is useful for ADS-B reception issues.
5. Look for and suppress local sources of electromagnetic interference and radio frequency interference. (EMI/RFI). This is "noise" in the sense of them being un-wanted signals can come from switch mode power supplies, rooftop solar power panel inverters, Triac based lighting

dimmers, LED bulbs and any other source where a DC/AC power transformation in either direction occurs.

Now that you have collected this information about your receive site, think of the frequency(s) of interest for your receiver(s). To keep with the ADS-B / UAT example above, say you want to receive Air-band voice, ACARS and VDL2 between 108 and 136 MHz and you have a high power FM broadcast station near you, you will probably need a low loss FM band high pass or band stop filter. For example see the Mini-Circuits ZBSF-95+ for a filter that will kill the FM band and allow Air-Band to shine through and frequencies below 88 MHz with minimal loss. Nearby high density cell site interfering with ADS-B at 1090 MHz will likely require filtering, either by a filtered SDR with a surface acoustic wave (SAW) filter from Taisaw or others, a lumped constant (LC) filter like the Flight Aware "Blue Tube" or in some use cases a cavity filter similar to mine or the Sysmocom or JetVision offerings. You must also consider the losses through the filters as part of the overall system noise figure (nF). Feed line losses also have to be calculated as part of your overall system performance and these too affect your overall system nF.

Other related reference links from Lothar for PDF downloads

Cable attenuation - Lothar of the Hill People new Cabling TL:DR Cheatsheet - General - Airframes Community

1090 ADS-B Filter information - 1090 ADS-B Filters - Hardware - Airplanes.live (beta) (airplaneslive.discourse.group)

General reference data on SDR and LNA topologies for hobby use - Lothar of the Hill Peoples SDR Topology - amp>filter or filter>amp Roundup - General - Airframes Community