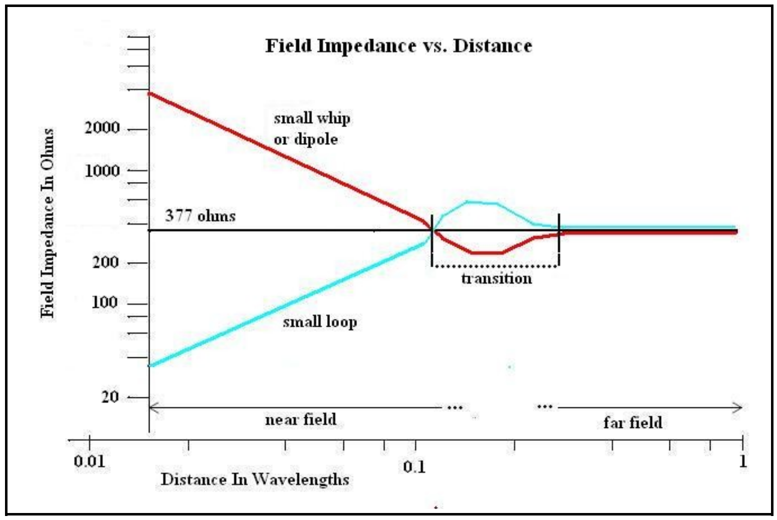
Measurements Of Some Antennas Signal To Man Made Noise Ratios
In The Daytime MW And LW Bands Plus Some Nighttime And Other Observations

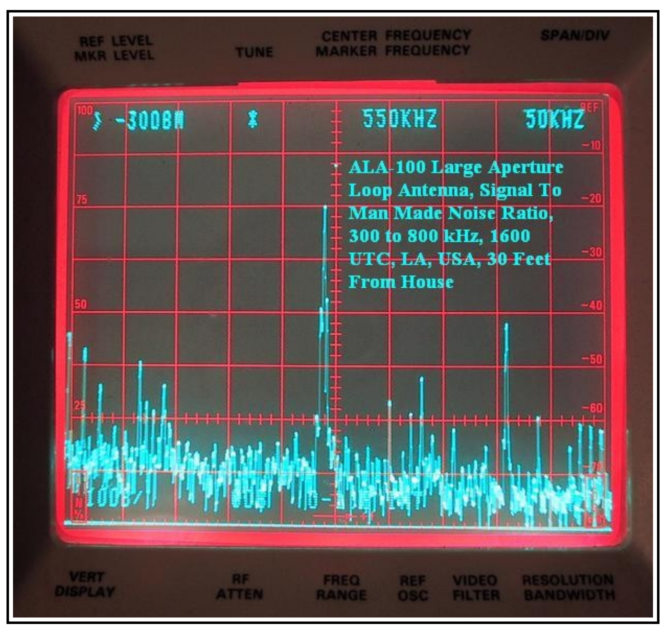
Dallas Lankford, 9/20/06, rev. 7/10/09

Over the years I have read repeated claims that loop antennas are more immune to man made noise than other kinds of antennas. And over the years I have used many kinds of loop antennas myself; yet I have never been able to discern that loop antennas are more immune to man made noise than other antennas except when a loop antenna is used to null man made noise, which, of course, isn't the same thing as immunity to man made noise (or unless both are inside your house, which is ridiculous for DXing). In and around the MW band man made noise often has a stronger highly directional component and a weaker more or less omni-directional component. Perhaps it is this aspect of man made noise and a loop's nulling ability which has caused some to claim that loops are more immune to man made noise than other kinds of antennas.

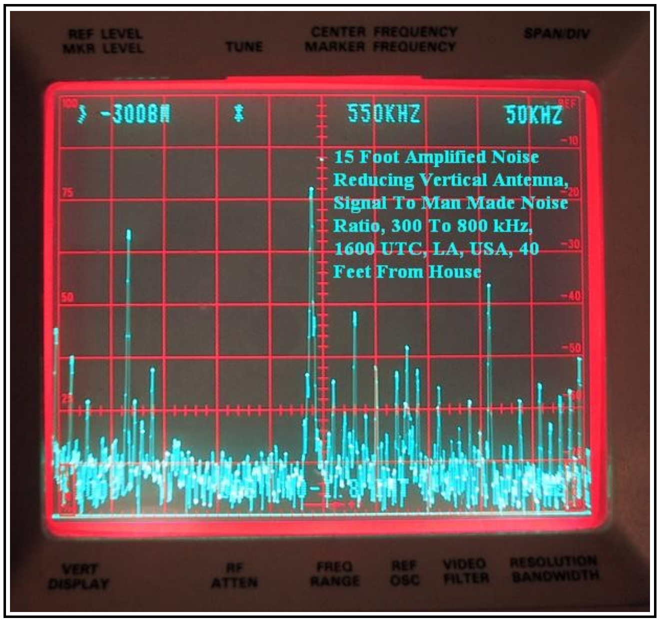


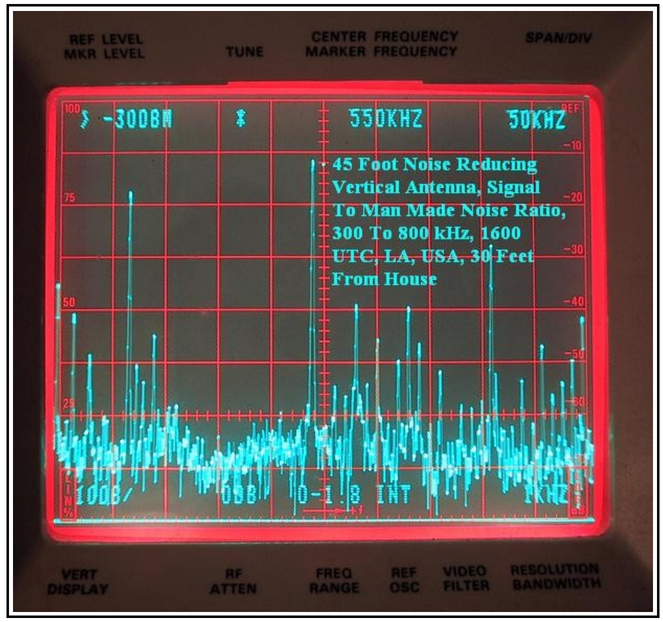
Sometimes a field impedance argument similar to the following has been given to support claims that loop antennas are more immune to man made noise than other kinds of antennas. ***If you consider that most sources of electrical noise, such as the dreaded PC, radiate their noise from the mains wiring, and that the near field E dominates, it is indisputably true that an antenna which responds to the E field and which is in a cloud of radiated noise will transfer the noise to your receiver and effectively blanket any wanted signals which are arriving from the far field, in other words, just those signals you want to hear and can't because of the electrical din created by your house wiring and all the devices connected to it.*** Sketches of the graphs of the field impedance of a small loop antenna and small whip antenna or dipole are given above. If the field impedance argument were true, then within about 0.08 wavelength of my house a loop antenna would have a better signal to man made noise ratio than a whip or dipole antenna.

For the MW band 0.08 wavelength is about 180 feet at 500 kHz and about 50 feet at 1700 kHz. I have a 45 foot noise reducing vertical about 30 feet from my computer, a 15 foot amplified noise reducing vertical about 40 feet from my computer, and a 60 foot circumference ALA 100 loop about 30 feet from my computer. As a long time MW DXer I was naturally interested to see if I could observe any signal to man made noise ratio (abbreviated S/MMN) differences among those antennas in and around the MW band. Measurements were made at mid morning to eliminate atmospheric noise (static from 100's of miles away at night). A frequency range of 300 to 800 kHz was used so that all antennas were well within the near field of my house, and so that MW and NDB signals as well as man made noise could be seen clearly on a Tektronix 495P spectrum analyzer using a 1 kHz resolution bandwidth. My computer was running during all of the measurements.

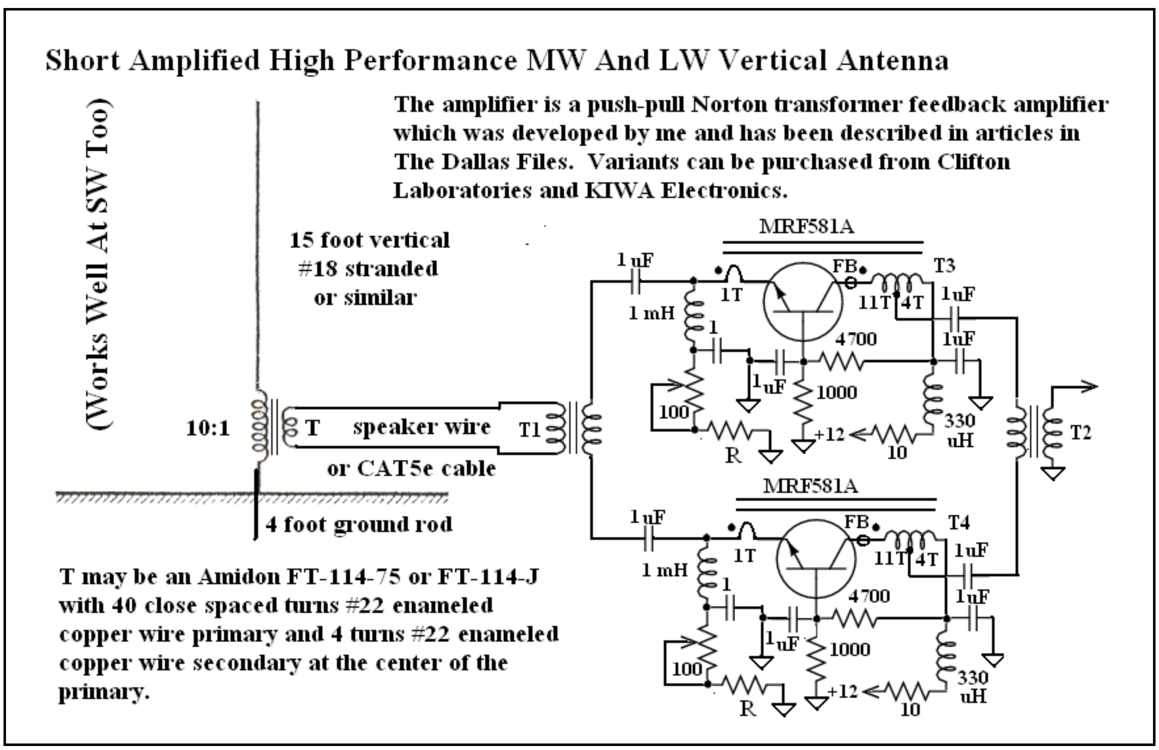


First we view the spectrum of the ALA 100 oriented for





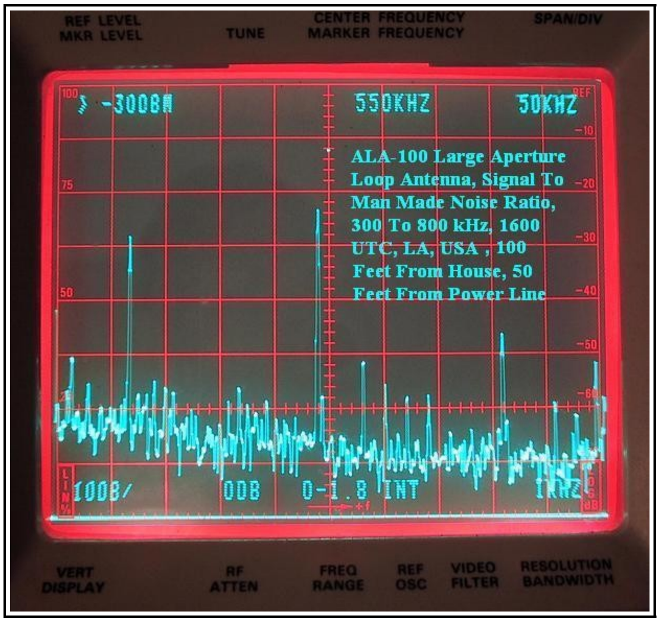
maximum signal pickup E-W. The ALA 100 was located 30 feet East of my house. The strongest signal visible is KNOE 540 kHz in Monroe, LA, almost due East of my house. Several other MW signals are visible, as well as several NDB's. Second, we view the spectrum of an amplified 15 foot noise noise reducing vertical antenna located 40 feet to the Southeast of my house. Examination shows that the 15 foot vertical has about a 5 dB better overall S/MMN than the ALA 100 loop. A schematic of the amplified 15 foot vertical noise reducing antenna is given below.

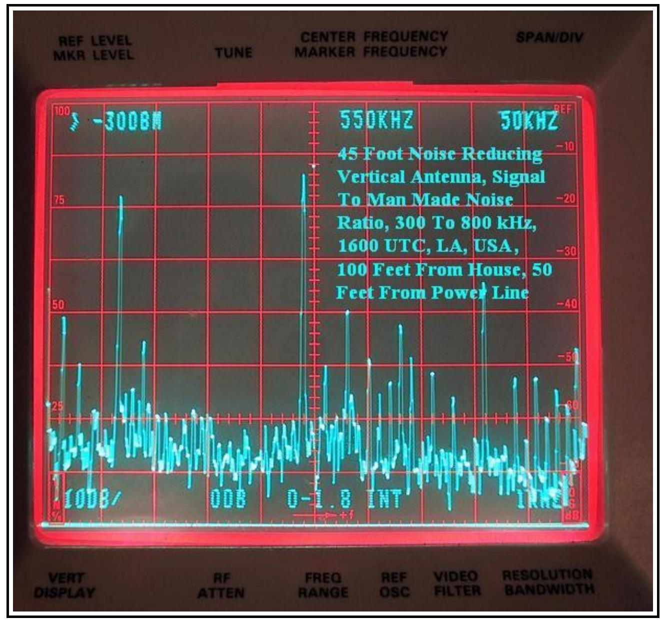


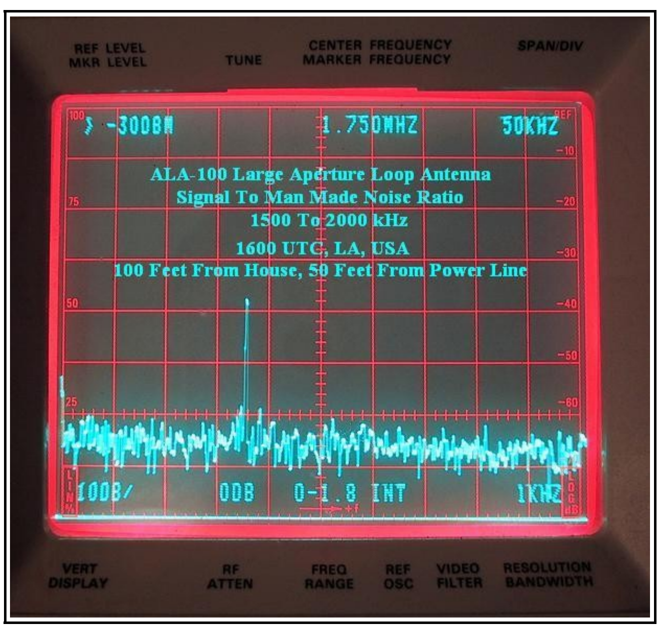
Third, we view the spectrum of a 45 foot noise reducing vertical antenna (described in "MW and LW Noise Reducing Antennas") located about 30 feet South of my house. Overall it has about a 5 dB better S/MMN than the 15 foot vertical, and about 10 dB better than the ALA 100 for the 300 to 800 kHz frequency SA display above (and also throughout the MW and LW bands based on other observations not shown).

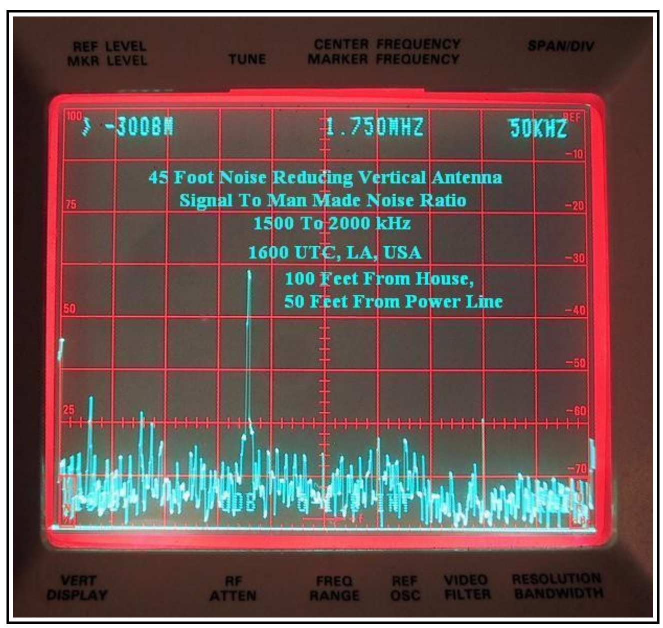
Based on these and other measurements made over many hours, the field impedance argument that loop antennas always have better S/MMN's than other receiving antennas in the near field of houses is clearly without basis in fact. In fact, these measurements have shown that noise reducing vertical antennas generally have better S/MMN's than an ALA 100 for MW and LW reception when the antennas are located within the near field of my house.

Because of space constraints one of my 45 foot noise reducing vertical antennas for my MW phased array is in the near field of the elevated power lines on the poles along the road in front of my house. To determine if an ALA 100 would have a better S/MMN in this setting, I put an ALA 100 at the same distance from the power line as the vertical. Below are typical S/MMN's which I observed for these antennas and placements.









As can be seen, the 45 foot noise reducing vertical has about a 10 dB better S/MMN than the ALA 100 for the MW and LW bands when the antennas are in the near field of the power lines in front of my house. Similar measurements were made during many hours of observation.

Again, the field impedance argument that loop antennas always have better S/MMN's than other antennas located in the near field of man made noise sources is clearly without basis in fact.

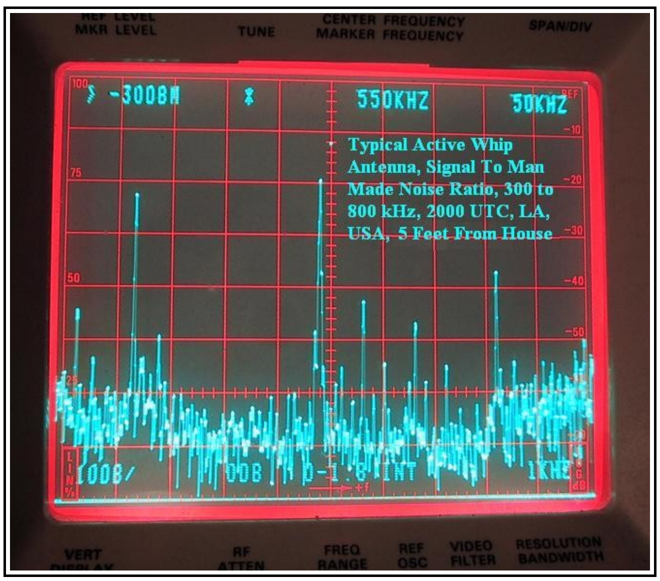
The following quote is due to: http://www.aa5tb.com/loop.html . ***"It is often believed that magnetic antennas will not respond to local noise because local noise is mostly composed of electric fields. This is ONLY true if the offending source is in the extreme near field (reactive field) of the loop antenna AND if the source is truly of electric field origin. An example of this might be a high impedance power transmission line that had an arcing insulator and was right next to the antenna. In this case a small loop may not respond to the interference as much as say a dipole would."***

The following quotes are due to W8JI.

"The difference in noise response between a magnetic loop and a small voltage probe is actually caused by the amount of common mode rejection of unwanted feedline conducted signals. The overall antenna pattern also has a large effect. It is possible either an electric field probe (very small dipole or monopole) or a magnetic loop will be "quieter". Which works best depends on local near-field noise field impedance and how the antenna is constructed. There isn't anything that causes one field to always be the dominant field of noise sources."

"There is something that [sometimes] causes loop antennas to appear to work better. It is much easier to build a "magnetic loop" that is decoupled from the feedline (which connects to noise sources) than it is to build a voltage probe that is properly decoupled. "

"Field impedance noise rejection is probably one of the deepest rooted falsehoods in amateur and SWL receiving."



I have been asked how an active whip, as opposed to the amplified whip and noise reducing vertical antenna above, compares to the ALA 100 with 60 foot circumference. So here is a signal to man made noise spectrum for one of the typical active whip antennas I have used. Unless an active whip uses isolated DC power and signal lead in, and is grounded with an outdoor ground rod, man made noise may couple into the signal path. One or more common mode chokes may also be necessary to eliminate undesired pick up which is common with active whip antennas. Consequently, the power leads were isolated from the signal path and from the AC power supply with a common mode choke, and the signal was brought to the receiver with twin lead. Without these measures, man made noise was sometimes 15 dB or more higher than shown on the spectrum snapshot, i.e., the S/MMN was sometimes 15 dB or more worse. Furthermore, depending on the AC/DC power supply you use for the active whip (or dipole), the rectifier diodes in the power supply can cause noise in the lower MW band which gets progressively worse as frequency decreases. Doug DeMaw discovered that noise due to the power supply rectifiers can be eliminated by paralleling each rectifier diode with a capacitor. For one power supply which I built, 0.1 µF capacitors were satisfactory for the MW and NDB bands. Careless installation of an active whip antenna might cause one to conclude that a loop antenna has a much better S/MMN than an active whip antenna. The whip I used for this measurement had short signal and power leads, and so it was located only 5 feet from my house. My computer was turned on and located about 25 feet away from the active whip antenna. The whip element was 5 feet long, and the output was amplified with a 10.8 dB gain push-pull Norton transformer feedback amplifier so that man made noise could be seen clearly on the Tektronix 495P. The active whip signal to man made noise ratio was essentially the same as an ALA 100 located about 30 feet from my computer.

Again, measurements show that there is no basis in fact for claims that loop antennas are always more immune to man made noise than other antennas when the antennas are in the near field of man made noise sources.

Recently I had opportunities to observe other occurrences of man made noise in the vicinity of my house. Strictly speaking these are not measurements of S/MMN, but rather comparative observations, and some were made at night. While testing a low noise 12 VDC active antenna power supply I had clear receptions of 183 kHz Felsberg, Germany and 162 kHz Allouis, France shortly after sunset on an active whip antenna about 30 feet from my house, while at the same times the receptions were poor or nonexistent using a 60 foot circumference ALA 100 and a 45' noise reducing vertical antenna at about the same distance from my house. Fortuitous placement of the active whip turned out to be the reason the active whip produced clear audio while the ALA 100 and 45' vertical did not. I am not the first or only one to have observed that placement of a short active whip antenna can have a beneficial effect on the S/MMN. For example, John Plimmer has an interesting review of the DX-1 Pro that includes a discussion of antenna placement during installation which minimized the S/MMN for the DX-1 Pro at his location. Also, while testing a Sony 2010 whip antenna modification of mine which consisted of an inductor in the whip base tuned by varactor diodes that made a very sensitive antenna, I noticed again what I have observed before with other portable receivers modified for greater sensitivity by me, namely that the “man made noise halo” of my house did not extend very far from the walls of my house, often hardly 10 or 15 feet. If I walked a few paces away from my house, daytime MW reception was usually about as good with my 2010 with modified whip antenna as with an R-390A and a 45' noise reducing vertical antenna. Of course, with my modified 2010 inside my house, weak daytime MW signals were covered with man made noise. It follows that for a good S/MMN an active or noise reducing MW antenna often does not need to be located at a great distance from your house, and that additional improvements in S/MMN can sometimes be obtained by careful placement(s) of the antenna(s).

But wait... Previously I thought I had tamed active antenna man made noise pick up in the lower NDB and below with low noise AC-DC power supplies, and indeed the power supply source of man made noise in active antennas is solved by low noise AC-DC power supplies. However, as I have learned during the past few evenings in the lower NDB and at lower frequencies that even when low noise AC-DC power supplies and common mode chokes are used the signal to man made noise ratio of active antennas may still not as good as the signal to man made noise ratio of noise reducing verticals. I don't know where my new LF (150 ~ 200 kHz) noise is coming from (one of my neighbors has a new noise toy?), or how it is entering my active antennas, or if, perhaps, better active whip antenna placement might reduce or eliminate it, but it has caused me to reconsider using active antennas as my primary antennas. If your neighbors do not have “noise toys,” or if you want a neat portable antenna to take to quiet listening locations, then an active whip may be a good choice. Otherwise, a noise reducing vertical or inverted L antenna appears to be a better choice when space permits. If a smaller noise reducing antenna is needed or desired, a 15' noise reducing vertical with push-pull Norton amp is an equally good choice, especially where noise immunity is concerned. Another reason to opt for a non-active noise reducing antenna is that their intercepts are not degraded when used with a high intercept filter, while active antenna intercepts, especially their 2nd order intercepts, are generally degraded when used with reactive loads.