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More notes on interference-reducing antennas

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Back in the Bad Old Days (when the components parts of a radio occupied a whole table) it was necessary to connect a large outside antenna in order to capture enough signal to rattle the speaker. With the advent of tube sets and plentiful gain the size of antennas shrank until room antennas were common. The increasing use of electrical appliances in the 1920s and 1930s created so much interference with the new medium of radio that something had to be done: eventually legislation was introduced requiring certain standards of appliance suppression. Nevertheless, better antennas were required for reliable daytime reception of even local stations, let alone distant reception and this required that antennas be located where the interference wasn't. Technical writers in the 1930s lamented that the development of plentiful RF gain had led only to inefficient and interference-prone antennas being used. In our time, technical information on antennas readily available to BCB listeners is mostly written for radio hams who often use higher frequencies and much of this information is not directly useful for the BCB.

Investigation of interference showed that it was at its weakest above the house and signal strength at its greatest at this point. Dennhardt (1) gives the following figures for signals, relative to 1m above the roof ridge for a three storey house:

Attic	70-80%	(-3 to 2dB)
2nd floor	50%	(-6dB)
1st floor	20%	(-14dB)
ground floor	5-10%	(-26 to -20dB)
cellar	3-5%	(-30 to -26dB)

These figures give a clear idea why raising the antenna above a house can make such a difference to the signal-to-interference ratio and also show why even the owner of an active antenna should strive for a location as high and clear of the house as possible, even though it may be more convenient to dangle it out of a window!

Strange as it may now seem, coaxial cable was not readily available in the early 1930s and many improvised screens were tried so that the downlead from the antenna should not pick up interference. Although such "screened antennas" (i.e. antenna + screened downlead) picked up substantially less interference, they were criticised for their lower output, until the introduction of transformers at the antenna and receiver to compensate for the cable capacitance shunting effect. A number of such antenna kits were marketed in England with impressive-sounding names such as "Eliminoise" and "Rejectostat". However, then as now, having bought a radio, many people were reluctant to invest any money in a decent antenna and an "anti-interference" antenna in Germany cost as much or more than the "People's radio" (Volksempfänger VE-301). A constellation of circumstances conspired to improve the situation in Germany: In 1933 Hitler declared listening to the radio to be a civic duty and with his connivance the radio industry quickly organised a production monopoly of receivers and a hire-purchase system of payments for the Volksempfänger. Business acumen and communal antenna distribution systems did the rest: a single antenna was mounted at the highest point on the building (2) or at a suitable distance from the source of interference (3), amplified and then distributed to each household (4).

While the provision of a low-impedance ground connection usually improves the rejection of interference, some authors have noted that benefits can be noted when the receiver ground is lifted (5)(6). It should be remembered that interference, when generated with the aid of the mains power supply, may be assymetrical (unbalanced) or symmetrical (balanced) with respect to ground and that the specific characteristics of an antenna system may make it more susceptible to one of these modes of coupling. Experimenters are therefore advised to be aware of this possibility, and to ensure that the connection between the ground rod and receiver is actually low impedance; any wire has inductance and if this cannot be held to a negligibly small value, it can be tuned out (7). Insistance on any specific length or number of ground rods for a ground system ignores the fact that local ground conductivity may be good or poor so that what is good at one location may be poor at another. Information on measuring ground resistance can be found in (7) and (8).

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The use of a counterpoise system instead of a ground at the antenna location may amount to the noise-cancelling arrangement described by (9), based essentially on a patent by Beverage. If the counterpoise is correctly dimensioned, it can lead to a substantial reduction of interference, although this may only occur at one frequency, as independently observed by Dennhardt (10). Such counterpoise systems will demand considerable experimental effort, and the improvements may not be in direct proportion. My suggestion (11) that such systems may be tried where the antenna cannot be placed away from interference sources is subject to the restriction that the signal-to-noise ratio may be poor at this antenna site, even when interference has been removed. This was my practical finding from using an active antenna in a poor location (just below the roof) with an adjustable interference-cancelling circuit. However, after you have done the best you can with the location of an antenna, there may still be interference; in these circumstances, interference nulling arrangements, such as described by Nelson (12), can make a good antenna into an excellent one, thereby lowering the effective noise/interference floor of the whole receiving system. This will be most apparent during weak-signal, daytime BCB reception and the serious BCB DXer should not be without one.

What constitutes a "noise-reducing" antenna is a matter of definition, but the description runs the danger of encouraging unrealistic expectations. For Dome (13), a balanced feeder is an essential part, but most of the literature refers to a screened, coaxial cable feeding an antenna located away from interference sources as a "noise-reducing antenna". Balanced cable has practical advantages over screened coax, but I would like to correct the emphasis given in (11) that it is a necessary part of a "noise-reducing" antenna.

A configuration of an interference-reducing antenna described by Strafford (14) and cited in (11) showed the feeder-matching transformer at the junction of the vertical and horizontal parts of an inverted "L" antenna. Strafford argued that this arrangement would bring the best interference reduction when the antenna is subject to a non-uniform interference field. Recent practical tests, and some older ones (3), have shown that there is not always an audible reduction of interference when using the transformer at the vertical/horizontal junction of an inverted L antenna vis-a-vis the base feed. Assuming that Strafford's description of the operation of the antenna is correct, the specific conclusion could be drawn that the interfering field was not uniform across the antennas investigated, or that the interference was reaching the antenna proper rather than being induced in the feeder. On the positive side, it has been found (15) that an "anti-interference" antenna reduced the effect of strong interference although it was known that the interference source was several hundred yards distant, a distance at which one would expect the antenna to respond to interference in the same way as to wanted signals. It may be supposed that the interference was conducted down the mains and re-radiated near the antenna, since examples of exactly this problem have been reported.

In more general terms, it is likely that at some antenna locations unexpected results will arise and that the causes must be experimentally investigated: Moebes gives such an example that the German Post Office had to deal with and Nelson's book contains many interesting RFI problems. It is hoped that these notes and reference (11) will enable the interested experimenter appreciate what improvements in reception are possible and to troubleshoot his own antenna system.

1. A. Dennhardt, Elektrizitätswirtschaft, vol.34, no.9, March 1935, "Über Störempfindlichkeit von Empfangsanlagen und ihre quantitative Beurteilung", pp197-204.

2. H. Schindler & O. Schneider, Veröffentlichungen aus dem Gebiete der Nachrichtentechnik vol.6, 1936 (published by Siemens), "Über störungsarmen Rundfunkempfang".

3. Moebes, Telegraphen-, Fernsprech-, Funk- und Fernsehtechnik vol.29, 1940, "Die Gemeinschaftsantenne als Mittel zur Verminderung von Rundfunkstörungen durch Hochspannungsleitungen" pp 5-9.

4 F.X.Rettenmeyer, Proceedings of the Institute of Radio Engineers vol.23, 1935, "Radio-frequency distribution systems" pp 1286-1307.

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5. W.L.Carlson & V.D.Landon, RCA Review vol.2, 1937, "A new antenna kit design" pp 60-68.
6. B.Ehlermann, Veröffentlichungen aus dem Gebiete der Nachrichtentechnik vol.6, 1936, "Quantitatives über die Störschutzwirkung abgeschirmter Antennenleitungen".
7. W.R.Nelson, Interference Handbook, Lake Bluff,IL, 1981.
8. J.Sevick, QST Apr. 1978, "Short ground-radial systems for short verticals" pp 30-33.
M.A.Logan, Ham Radio July 1984, "Ground rod resistance" pp 95-101
J.M.Bruning, QST May 1951, "Ground resistance and its measurement" pp22-27. These last two references were kindly communicated to me by Dallas Lankford.
9. V.D.Landon and J.D.Reid, Proc IRE vol.27, 1939, "A new antenna system for noise reduction" pp 188-191.
10. A. Dennhardt, Hochfrequenztechnik und Elektroakustik vol.53, 1939, "Über die netzseitige Einwirkung von HF-Störspannungen auf Rundfunknetzempfänger" pp 45-50.
11. D. Wraight, DX Monitor vol.28, no.33, July 25 1991, "Interference-reducing antennas for the BCB.
12. Nelson, op. cit. pp 125-130.
13. R.B.Dome, General Electric Review vol.40, 1937, "Radio receiving aerials of the noise-reducing type" pp 580-583.
14. F.R.W.Strafford, Wireless World 1939, "Vertical or inverted L aerials" pp 575-577.
15. Dallas Lankford, private communication 1991.

The bibliography contained here and in (11) is not exhaustive but contains the most important or practical material. References 5 and 13 are particularly recommended for USA readers although their essence is reported in (11). The German articles cited here are included for the sake of completeness even though they may be difficult to obtain, but they are from professional journals and are particularly thorough in their treatment.