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Notes on the RSGB Observations of the HF Ambient Noise Floor

1 Background

The RSGB has been involved in discussions relating to the noise on the HF amateur bands since 1996 when we were first advised of proposals to use "existing copper infrastructure" to carry high speed data. It was soon appreciated that there was very little data on the levels of ambient noise which might be experienced by a typical amateur station.

Since most of our members operate from suburban residential locations and use antennas located in the garden, our activities were concentrated on examining this scenario.

2 Measuring the Ambient Noise Floor

To simplify the problem it was decided to consider a horizontal half-wave dipole, erected at least 10m away from the house. After a few preliminary tests, it was evident that there is no easy way to get a general picture of the typical noise in residential locations. It was noted however, the background HF radio noise observed on the horizontal half-wave dipole was usually quite low, with relatively high bursts of locally generated noise lasting for periods of a few seconds to a few minutes. It was found that the best way to characterise noise on the HF band was to divide it into three components.

a) The background "ambient noise floor" which, in a residential location, is relatively constant and probably consists of the atmospheric noise from distant thunderstorm activity arriving by ionospheric propagation, cosmic noise, and the sum of noise from a number of distant man-made sources. This noise appears fairly "white", but there are usually occasional short bursts probably from local atmospheric activity or switching transients.

b) Man-made noise from specific local sources. This was called "incidental noise".

c) Narrow band interference which is a common feature of HF communications and can be combated by operating procedures such as changing frequency or by using an appropriate mode. These notes are confined to the consideration of interference from broadband noise.

In most residential locations broadband incidental noise is significant for only a small fraction of the time. For most of the time the effective signal-to-noise ratio is set by the ambient noise floor. (Of course there are residential locations where broadband incidental noise is high 24 hours a day. Fortunately these are rare, and when they do occur it is sometimes possible to identify the source and take action to reduce the interference).

3 The Effect of Incidental Interference on HF Communications

The statistical nature of noise is very important for HF communications where the operator expects to have to combat occasional high local noise by waiting until it goes away, or by changing frequency. (On automatic systems such procedures may be built into the operating protocol). It is important to note that the current product standards such as EN 55022 do not prevent interference to small-signal services, they simply provide a tolerable balance between the requirements of radio services and the needs of industry. If broadband noise were present, all the time, at the maximum levels permitted by EN55022, then small-signal services such as amateur radio would be very seriously affected.

The RSGB has published a leaflet (EMC 04 - Interference to Amateur Radio Reception) advising its members on identifying sources of local noise.
http://www.qsl.net/rsgb_emc/emcleaflets4.html

Most of the interference mentioned in this leaflet will be from equipment compliant with the appropriate EMC standard. This emphasises the vital significance of bandwidth and duration when considering the effect of radio noise.

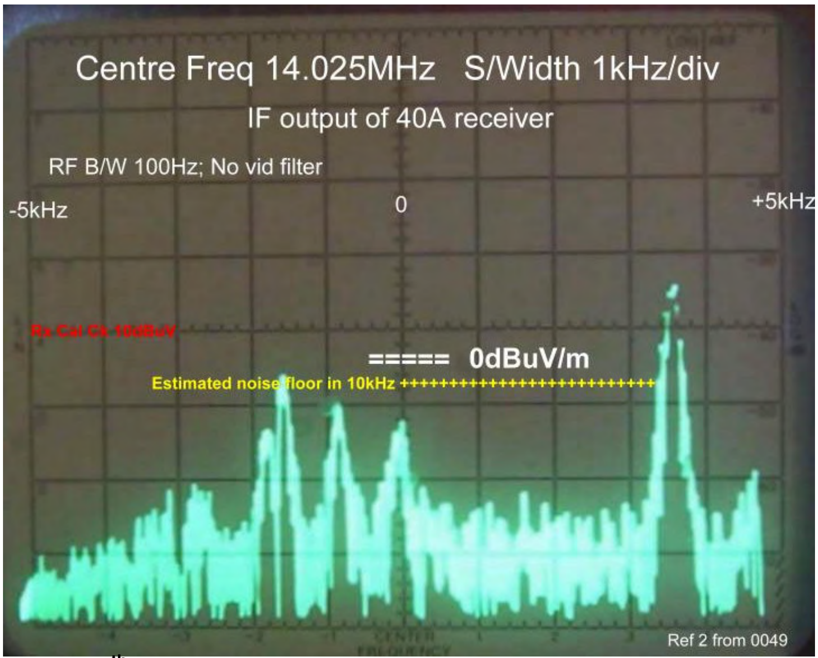
4 The Practical Arrangement Used by the RSGB.

Fortunately a garden was available which was suitable for an exercise of this type. The location is a suburban area of typical semi-detached housing. An arrangement of dipoles is located about 17m away from the house. There are dipoles for 7, 10, 14, 18, 24 and 28MHz. (There is no half-wave dipole for 21MHz.) A 3.5MHz dipole is impractical in the available space, but the extending the limbs of the 7MHz dipole and bending the ends of the elements at right angles to give an appropriate length for 3.5MHz, allowed an approximate measurements to be made on this band. A similar arrangement was made for 5MHz. The results were in line with the other observations.

Signals from the dipoles are fed via baluns and coaxial cable to a measuring receiver. For convenience the dipoles were inverted "V" configuration with the centre support approximately 8.4m high.

There is, of course, the problem of avoiding "wanted" signals in the 9kHz band width of the measuring receiver. It is not easy to find frequencies in the lower HF amateur bands which are free from wanted signals. It useful to observe the IF bandwidth of the measuring receiver on a spectrum analyser. (The receivers used had an IF output socket). Using this technique it is also possible to make plots in narrower bandwidths, typically 100Hz (making allowance for the different detector in the spectrum analyser). Fig 1 shows a plot of CW telegraphy signals against the background noise on the 14MHz amateur band.

On the higher HF bands it is possible to observe the noise floor, very late at night, when the bands were completely "closed". It was noted that the noise floor was slightly lower under these circumstances, implying that at least some of the noise contributing to the noise floor arrived by ionospheric propagation.



Midday 7th March 2003 **vertical scale 10dB/div**

Fig 1 A Plot in 100Hz bandwidth

Plotted on a spectrum analyser connected to the IF output of a measuring receiver. The IF bandwidth is slightly off centre, accounting for the fall away of the noise on the LH side. Indicated levels are illustrative only and relate specifically to the conditions of measurement as described above.

5 Results and Conclusions

The aim was to observe and comment on the general situation rather than to undertake an extensive measuring programme for which we did not have the facilities. For this reason our findings are limited to a statement that under the specific conditions of measurement, the daytime ambient noise floor on the HF band is generally below 0dBuV/m, quasi peak, in a 9kHz bandwidth. (The night time conditions on the lower HF bands are more difficult to characterise due to the number of very strong "wanted" signals.)

This 0dBuV/m figure provided the background to the RSGB's position on protection of the amateur bands.

It is understood that similar measurements of the ambient noise floor by other organisations come to similar conclusions.

It should perhaps be emphasised that these observations refer to suburban residential locations. In industrial and commercial locations there may be almost continuous incidental noise which effectively masks the noise floor.

6 Definitions

While participating in various technical working groups, it became evident that there was confusion about the term "noise floor". The RSGB recommends the following definitions as applicable to ambient noise on the HF band.

Ambient Noise Environment:

The total noise entering a radio antenna in any particular location. It is the sum of the ambient noise floor and the incidental noise.

Ambient Noise Floor:
The irreducible background noise entering a radio antenna to which other incidental noise sources are added to form the ambient noise environment.

Incidental Noise:
Noise entering a radio antenna from localised sources. It adds to the ambient noise floor to form the ambient noise environment.

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