Appendix I *(27/03/02)*

Submission by the Radio Society of Great Britain

The following slides are selected from presentations made over the years since the RSGB became involved in discussions on the proposed use of existing copper infrastructure for the transmission of broadband data signals.

The RSGB first became interested in 1996 when they were advised by BT of a proposal to use telephone lines for a high speed Video On Demand service. This involved using a broadband signal in the lower part of the high frequency band. At that time the Society had only limited information on the ambient noise at typical amateur locations. Data gathered over the years has confirmed the view that the ambient noise floor is lower that many people think. Generally lower than 0dBuV/m - and in some instances much lower. It is acknowledged that locally generated man-made noise is quite high in some locations but fortunately, in residential areas, the degradation of communications is usually limited because the noise affects only a restricted frequency range or occurs for only a limited time.
The term "incidental noise" has been coined to describe this local man-made noise.

Unless otherwise indicated measurements by the RSGB are quasi-peak in a 9kHz CISPR bandwidth. Measurements and interpretations are put forward in good faith with the sole intention of illustrating how broadband interference will affect small-signal services such as amateur radio. Figures quoted are not intended to be considered as formal engineering measurements.

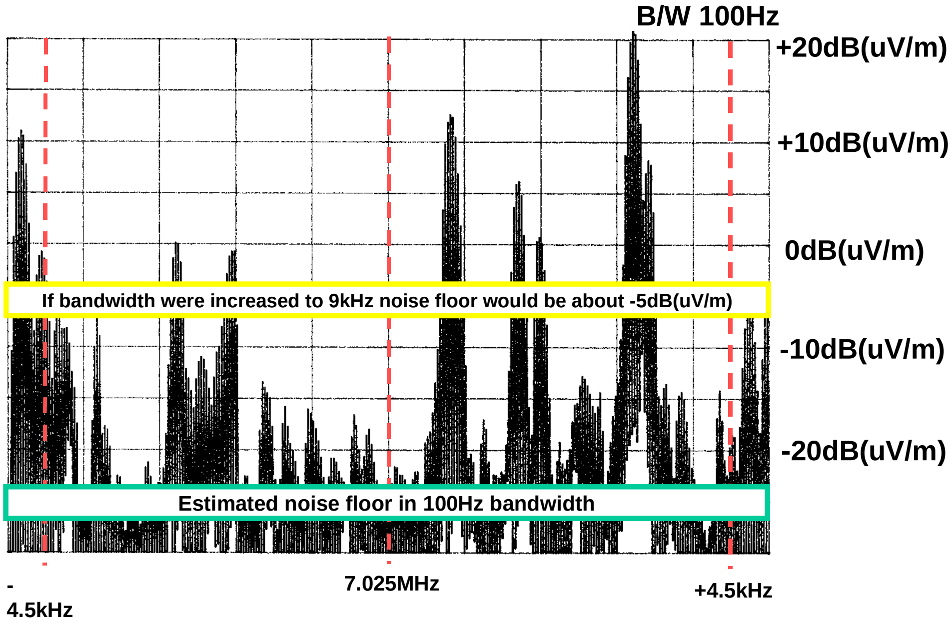
Where Is the RSGB Coming From?

19th February 1998 RSGB asked the RA to advise them on the significance of PLT.

3rd April 1998 The RA hold first PLT/DSL meeting Radio Users asked to advise on the level of interference which can be tolerated for each service.

16th April 1998 RSGB advised the RA that the maximum level of specifically generated, continuous, broadband interference for the HF amateur bands should not exceed 0dBuV/m (in 9kHz B/Width at 10m)

Slide 1. Made for a presentation to the RA Technical Working Group



Signals and Noise in a 9kHz Band Centred on 7.025MHz

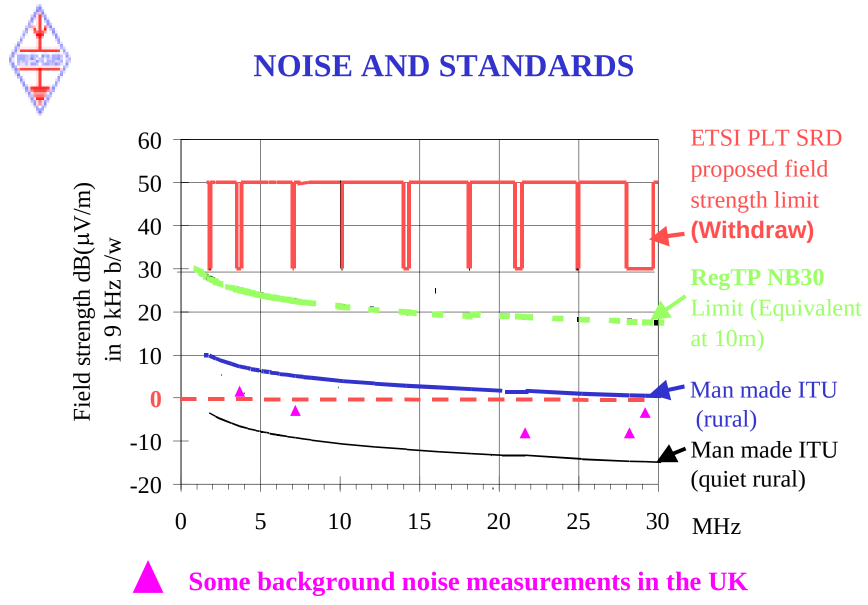
Mid-morning at a suburban location

Half-wave inverted V dipole

Slide 2. Versions of this slide has been used in many RSGB presentations

The basic plot was originally made for the "RSGB Guide to EMC" to emphasise the problems of making measurements in a 9kHz bandwidth. It has been used in various presentations to illustrate the RSGB's contention that the ambient noise floor is lower than is generally thought. The field-strength is nominal, being calculated from the measured signal level using the standard dipole formula. The relationship between the noise in 100Hz and 9kHz is illustrative only since the noise is not really white.
Measurements on spot frequencies, such as this one, are simple to carry out requiring only a dipole antenna and an accurate measuring receiver. The plot was obtained by feeding the IF output of the measuring receiver into a spectrum analyser.
This plot highlights the importance of making sure that any plot of signals and noise on the HF band actually indicates the true ambient noise, and not the instrument noise floor.

Slide 3 (below) illustrates the significance of ambient noise levels and proposed standards in the HF band.
The NB30 curve is a peak limit. It has been calculated for 10m from the original 3m limits.
The ETSI PLT SRD limit was from a draft document which has since been withdrawn. It is included as an indication of the magnitude of the regulatory problems.



Slide 3. Made for a Presentation to the RSGB's HF Convention.

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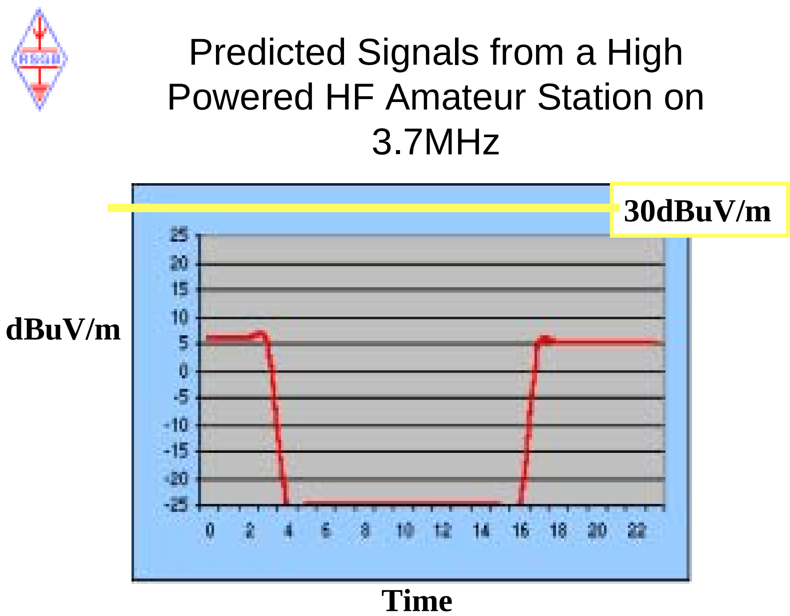
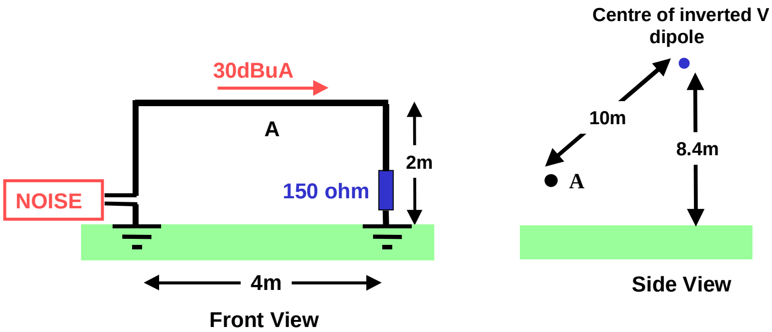


Slide 4. Made for a presentation to the RA Technical Working Group.

The basic slide is taken from the predictions of signal strength in the UK for signals from an "expedition" station on the Comoro Islands. This would be running relatively high power to a good antenna. A 30dBuV/m line was added

because a 30dBuV/m limit for the amateur bands was under discussion at the time. The proposal which gave rise to this has since been withdrawn.
It should be noted that the "capture area" of a resonant antenna on this frequency is quite large so that 5dBuV/m represents a reasonably good signal at the receiver input (about S7).

Demonstrating the effect of broadband C-M currents (1)



Demonstration test rig

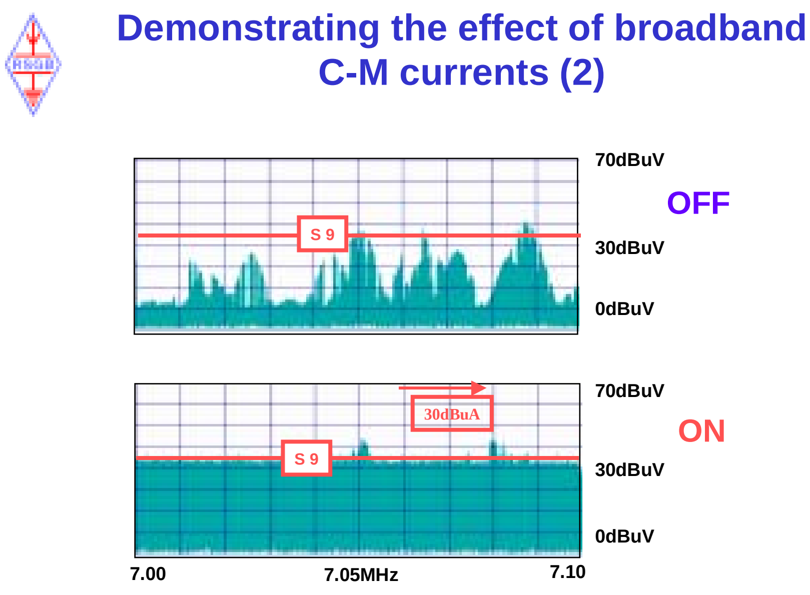
Slide 5. Made for a presentation to the IIR 4th Powerline Conference.

The intention of slides 5 and 6 is to draw attention to the fact that, where conductor deployment leads to a significant proportion of the energy being radiated, the levels of common-mode current permitted by product standards such as CISPR 22 would give rise to severe interference to small-signal services.
The current was measured with a current transformer and was constant to +/- 2dB throughout the wire between source and load.

On Slide 6 (below) The top plot shows signals in the band 7.0 to 7.1MHz when the noise generator is switched off. The lower plot shows the effect when the noise generator is switched on.

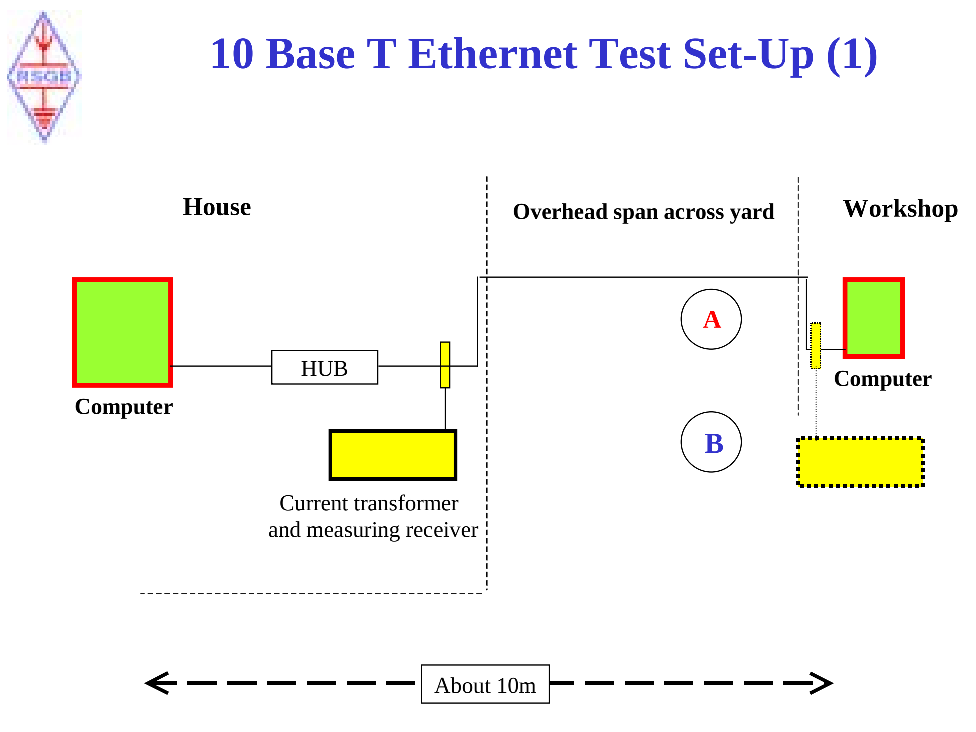
As a confidence check a communications receiver was connected in place of the spectrum analyser. The receiver was tuned to a signal of approximately S9 and an audio recording made. The wanted signal was strong and clearly audible but became unintelligible when the noise generator was switched on.

The measurement of noise current was quasi-peak in a 9kHz CISPR bandwidth. The plot of noise in slide 6 was taken in a 3kHz RF bandwidth with narrow video bandwidth and approximates to an average value.



Slide 6. Made for a presentation to the IIR 4th Powerline Conference.

The vertical axis is the signal from the inverted V dipole. The baseline of the plot is the instrument noise floor not the ambient noise (see slide 2 above).



Slide 7. Made for a presentation to the RA Technical Working Group

This simple home LAN was set up to investigate the effect of domestic Ethernet LANs installed in the vicinity of amateur radio stations. Additionally it was hoped to confirm the importance of balance and give a better understanding of possible mitigation measures. The home computer was installed in the house and the remote computer in an outside workshop about 5m from the house. The CAT 5 cable passed from the house to the workshop overhead about 2.2m above ground.

10 Base T Ethernet Test Set-Up (3)

Interference on Communications Receiver

Antenna inverted V dipole. Parallel to CAT 5

Distance ~ 20m

Normal balance (50dB at 7MHz))

Frequency	C-M Current	Interference
7MHz	8dBuA	Nil
10MHz	12dBuA	Nil
14MHz	2dBuA	Nil

Bandwidth 2.7kHz

Slide 8. Made for a presentation to the RA Technical Working Group

With the balance unimpaired no interference was experienced when tuning across the relevant band.

With this installation, no signals were detected on the CAT 5, when no traffic was being passed and the link was "idle". (Though no attempt was made to look for short signals at long intervals). This is important because it means that any interference would only be present for limited a time - in effect "incidental" interference. However it has been pointed out that this might become less true as householders install more complex digital systems.

The common-mode current was measured using a current transformer at the location in the house as in slide 7, and confirmed by a measurement near the remote computer. Balance was determined by measuring differential and C-M currents using a "CISPR" measuring receiver. Interference was checked using a communications receiver with a 2.7kHz bandwidth, connected to an inverted V half-wave dipole located about 20m away at a height of about 8.4m above ground and parallel to the run of CAT 5

10 Base T Ethernet Test Set-Up (4)

Balance 30dB (at 7MHz)

Frequency	C-M Current	Interference	
7MHz	27dBuA	Noticeable	13dBuV/m
10MHz	25dBuA	Noticeable	10dBuV/m
14MHz	12dBuA	Negligible	Negligible

Approx. field strength at dipole antenna

Slide 9 Made for a presentation to the RA Working Group

The balance was deliberately degraded to approximately 30dB measured at 7MHz. Interference was now evident on the 7 and 10MHz band, but was negligible on 14MHz. A measuring receiver was connected to the antenna in place of the communications receiver. The field-strength was calculated from the signal voltage at the dipole measured on the "CISPR" receiver.

100BASE-T

Extract from an E-mail circulated to the RA working group

A trial similar to that for 10BASE-T was set up, except that the hub was omitted and a simple cross-over inserted at the same point.
Unlike 10BASE-T, !00BASE-T sent "idle" signals continuously in both directions when no traffic was being passed. This happened all the time that both computers were operating (in Windows in this set-up). However on investigating the spectrum of the 100BASE-T signals it was evident that considerable ingenuity had been put into the question of RF interference. The "idle" signal consisted of a comb of discrete "carriers" spread out across the spectrum up into the VHF region. The good news is that these were pure unmodulated carriers - continuous wave (CW) in radio parlance - spaced about 30.5kHz apart. The levels of these carriers varied considerably in amplitude, but even the largest ones did not give rise to noticeable interference on a well balanced system. Again, if balance was reduced then interference became more significant. (Good balance was about 50dB, poor balance 30dB or so.) The really important point, however, is that the carriers are CW. Low level CW carriers are common on the HF communications bands and operating systems have evolved against this background.
A separation of 30kHz means that much of the spectrum is unaffected. Spectrum-efficient modes such as CW telegraphy or the computer generated mode, PSK31, can operate satisfactorily within a few tens of hertz of a CW

carrier of similar amplitude to the wanted signal. Wider band modes such as SSB employ notching, or more recently digital signal processing to eliminate CW interference.
It should perhaps be mentioned that the go and return idle signals were on slightly different frequencies - differing by less than 100Hz in the current set-up.
The situation when random data was passed was complicated. The general effect was that energy seemed to be concentrated around the frequencies of the "carriers" with decreasing amounts of energy in the intervening spaces.
Interference signals received on the dipoles were very low, even when the CAT 5 was deliberately unbalanced by quite a large amount.
The information on the spectrum was obtained by the use of current transformer and spectrum analyser.
On the 100BASE-T test, all the amateur bands from 3.5MHz to 28MHz were tested except for 21MHz for which there was no half-wave dipole available.

Conclusion:
The 100 BASE-T system seems to have been thought out with radio interference in mind. Home LANs are unlikely to be a serious problem to small-signal services in residential locations unless installation is exceptionally poor. In such cases it is likely that attention the installation and cabling would correct matters.

THE RSGB POSITION

We have no objection to any new developments

provided that

They do not cause interference to the Amateur Service

We also support the HF User Group’s position that all the radio services on HF should be protected from broadband, geographically widespread, interference.

Slide10 Made for a presentation to the RSGB's HF Convention.