International Amateur Radio Union Region 1

Europe, Middle East, Africa and Northern Asia Founded 1950

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Subject	**Interference Database of Signatures and Remedies**		
Society	RSGB	**Country:**	UK
Committee:	**EMC**	**Paper number:**	**C7-07**
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Introduction

Most amateurs suffer from or cause interference at some stage. Many suffer without realizing, because they do not know how to recognize the interference. This paper proposes a database of signatures of different sources of interference. The database could include audio and SDR derived spectra / waterfalls which identify the characteristics of the source. Advice on best way to identify this type of interference will be given.

Examples of Interference signatures for VDSL are included in the annex to this paper. Suggestions are made (based on the experience of other amateurs) for steps that can be taken to minimize the impact. Other annexes will be added to cover Solar and windfarms.

For many amateurs the interference levels are now seriously impacting their ability to operate in contests or to contact distant stations. Having the ability to recognise the source is the first step in solving the problem.

Background

The Essential Requirement of the EMC Directive is intended "to ensure that the electromagnetic disturbance generated does not exceed the level above which radio and telecommunications equipment or other equipment cannot operate as intended".

With the advent of emerging technologies many devices that would not be expected to cause problems now do. Broadband Digital Subscriber Line (DSL) now covers most of HF and is expanding through VHF any imbalance can cause leakage emissions which can be louder than the signals the amateur is attempting to detect. The ever increasing appetite for higher bandwidths stretches the technology further, resulting in more interference.

Green energy in the form of Solar PV or wind turbines reduces atmospheric pollution but in many cases adds to electromagnetic pollution. Many other emerging technologies like wireless battery charging and LED lighting also cause problems. In most of these cases good design choice of compliant components and correct installation can result in devices meeting the essential requirement.

The RSGB EMC Committee has measured interference levels shown in Figure-1. Some of these levels are 60dB above the background levels.

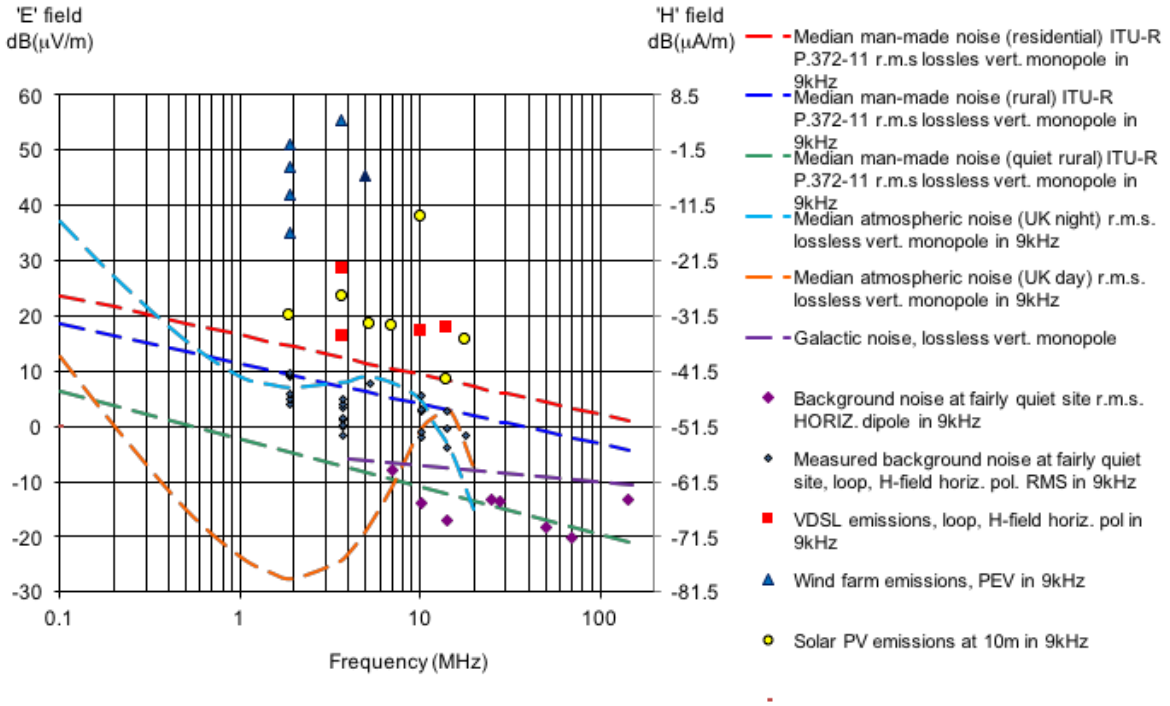


Figure-1: Examples of Measured Interference Levels

Identifying problems early provides evidence for the Amateur to tackle the enforcement agencies to prevent the widespread proliferation of problem devices. This is the subject of a separate paper at this conference.

Amateurs also understand the issues and armed with evidence supplied by others can work at National Society level with suppliers to improve design and practice and minimise interference.

Key Points and Proposal

Individual societies would be encouraged to collect information about interference signatures and solutions. These would be shared amongst societies to add further information. They will be published on the web for amateurs to access.

Suggestions for the best tools and techniques for identifying the source will be included.

Mechanisms to minimise the emissions which can be found successful will also be included.

The database should be accessible to all amateurs and they should be encouraged to report their own examples back to a central pool which can track the growth of problems from these devices.

Recommendations

Member Societies are invited to discuss and agree how best to coordinate the above proposals, and submit recommendations to the Plenary.

RSGB, January 2016

EMC Leaflet 15 - VDSL Interference to HF radio

Introduction

VDSL (Very High Bit Rate Digital Subscriber Line) delivers broadband to over 5 million UK subscribers (January 2016) and is available in over 80% of properties in the UK. It is supplied directly by BT but also by others like Sky broadband, Talk Talk, Plusnet as resellers. VDSL or FTTC (Fibre To The Cabinet) uses fibre-optic for high speed data between the cabinet and the exchange. Equipment in the cabinet then sends data signals over the twisted pair telephone lines to the subscriber's premises. The telephone lines may be underground or overhead or, most likely, a combination of both. On an overhead system the connection from the nearest pole to the subscribers premises is called a "dropwire". Normally problems only occur from overhead distribution.

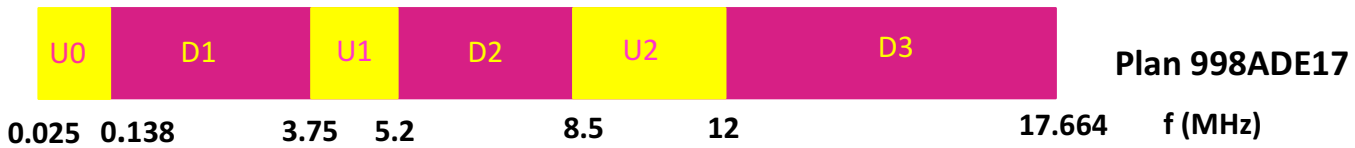
Since the RSGB convention 2014 when the EMC Committee (EMCC) started validating reports of interference on HF bands from VDSL broadband systems we have confirmed 68 cases. The 2015 RSGB Amateur Radio Survey indicates many amateurs believe they suffer from this, but less than 1% report the issue to the EMCC. Knowing the full extent of the problem allows us to lobby Ofcom and suppliers more effectively so please report EMC problems.

RSGB has been involved since the earliest days in standards and trials work on VDSL in efforts to protect the HF spectrum. Readers who wish for more background can find the RA document "The compatibility of VDSL and PLT with radio services in the range 1.6 to 30MHz" on the OFCOM archives at: http://www.ofcom.org.uk/static/archive/ra/topics/interference/documents/twg-finalreport.pdf

How do I detect interference from VDSL?

The emissions from VDSL are continuous and often indistinguishable from white (pink) noise making them difficult to identify. In effect the receiver sounds insensitive but the S meter reads higher than would be expected. Since the VDSL service sends data even when not in use, the noise is permanent. As a consequence, many people see a significant increase in noise levels at HF but do not know the cause.

VDSL2 in the UK currently uses frequencies up 17.66MHz. The downstream and upstream bands alternate and the easiest way to detect VDSL is to look for magnitude changes in noise level at the band transitions. These transitions occur at 0.138MHz, 3.75MHz, 5.2 MHz, 8.5 MHz, 12MHz as shown below

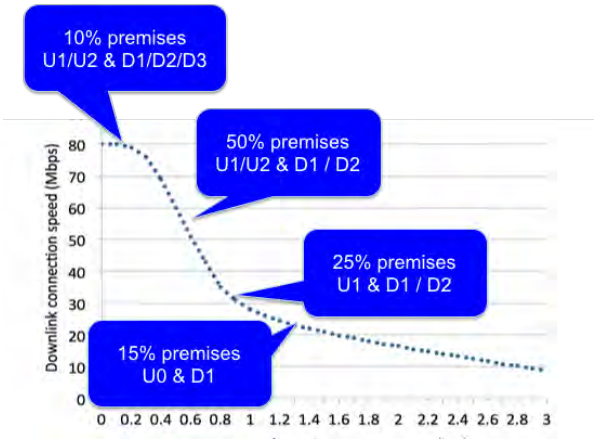


There is a small gap or guard-band between downstream and upstream bands. Tuning around these frequencies and listening while watching the S meter will show a noise step if there is VDSL interference. The signal first drops just before the transition (~50kHz) then raises after the transition. From reports of problems to date, typical levels of drop and rise are shown below. Note that level changes are shown, actual levels can be more than 30dB above background levels.

VDSL Band	U0		D1		U1		D2		U2		D3	
f MHz	0.03	0.133	0.143	3.700	3.800	5.15	5.25	8.45	8.55	11.95	12.05	17.664
% reported cases	0%		48%		42%		42%		55%		25%	
Typical Change*			+10dB	-7dB	+10dB	-10dB	+11dB	-10dB	+10dB	-7dB	+6dB	-12dB

*For each transition the drop in level before, and raise in level after is reported.

In many cases an amateur sees the summation of noise from many nearby VDSL subscribers. Often the interference is independent of the amateur's own VDSL service so that temporarily unplugging the modem is not a solution.



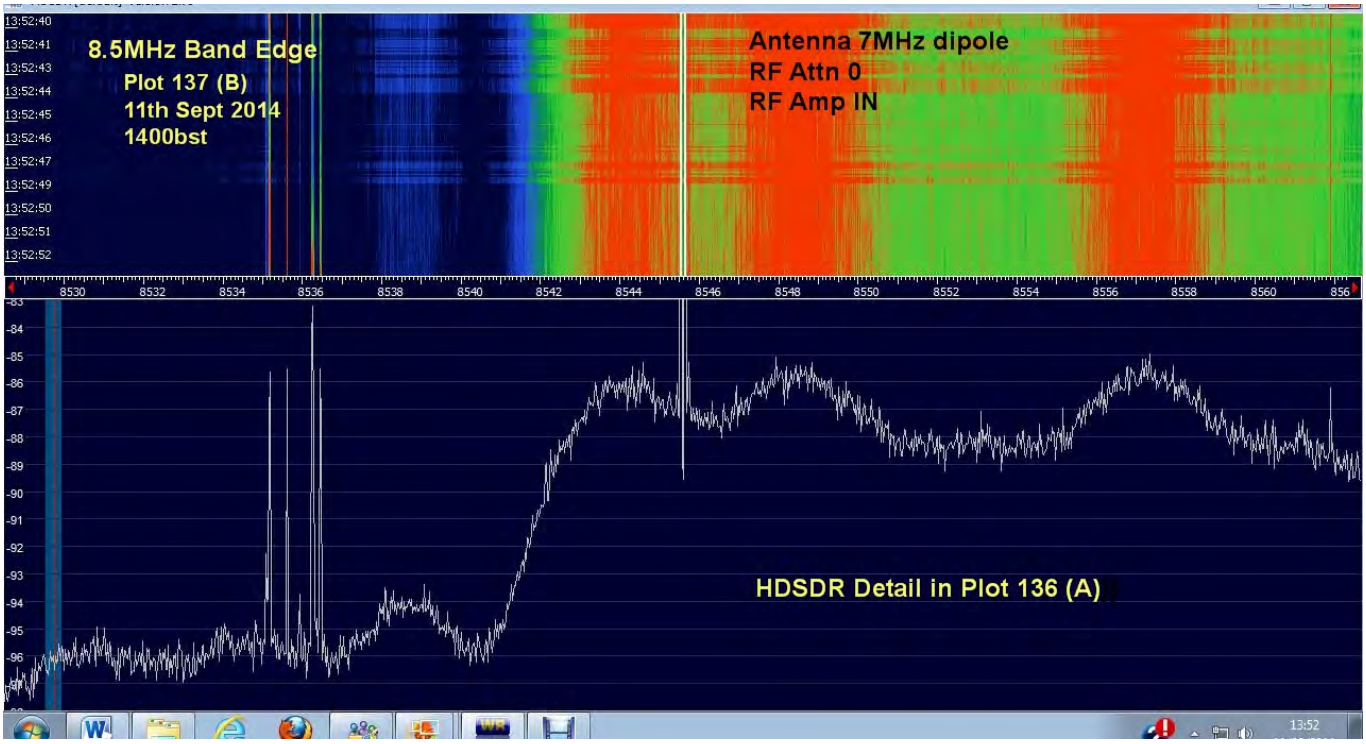
The band that predominates in a given location depends on distance of the property from the fibre cabinet. The higher frequencies are not used further from the cabinet. Most problems are seen when the connection to houses in the area are via overhead cables. We have very few reported problems from underground distribution systems. Lengths of >1km are rarely used. Remember the problems may come from neighbouring properties not your own.

To check for VDSL emissions tune to the band edges of a VDSL band. Ignore off air signal and local incidental noise tune across the transitions and record the level changes.

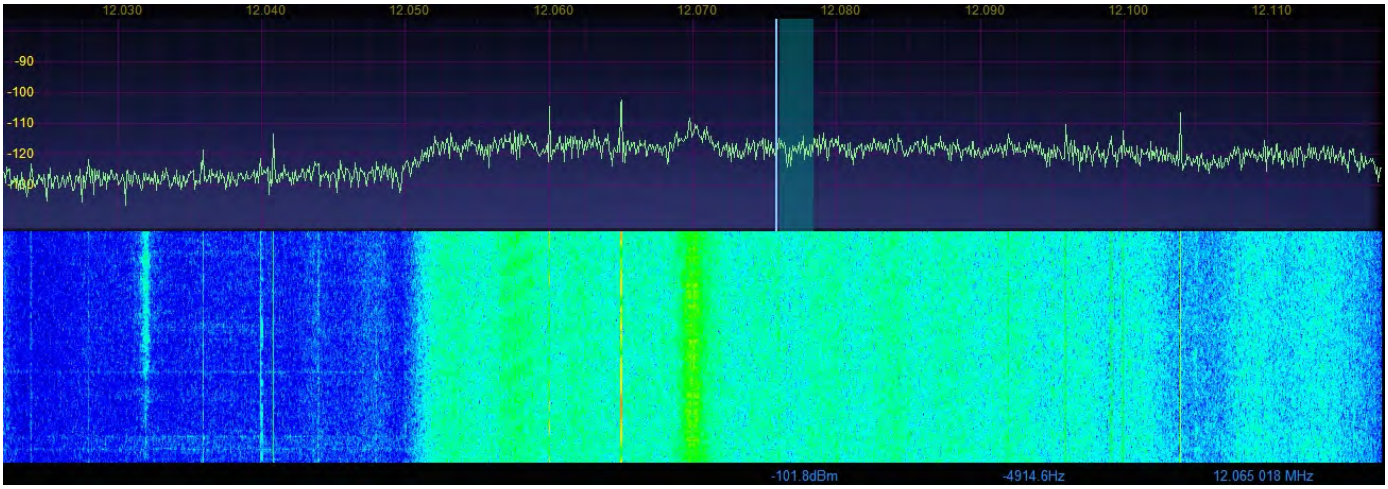
If you have VDSL turning the VDSL modem (the one that plugs into the phone socket) off will remove your VDSL noise, but remember it may be neighbours VDSL you are seeing, most often it is the cumulative effect of several. Please also record level changes with your modem turned off.

If an SDR is available the step will be clearly seen and the 4.3125kHz patterning of the VDSL signal may be visible on a waterfall display, but careful adjustment of the contrast may be required for this. Some examples from different SDR's are shown below

3.75MHz transition looks like a raised noise floor, detect VDSL by frequency of step transition. This shows raised noise floors in D1(~10dB) and U1 bands (~15dB above D1 but >20dB above background signals)

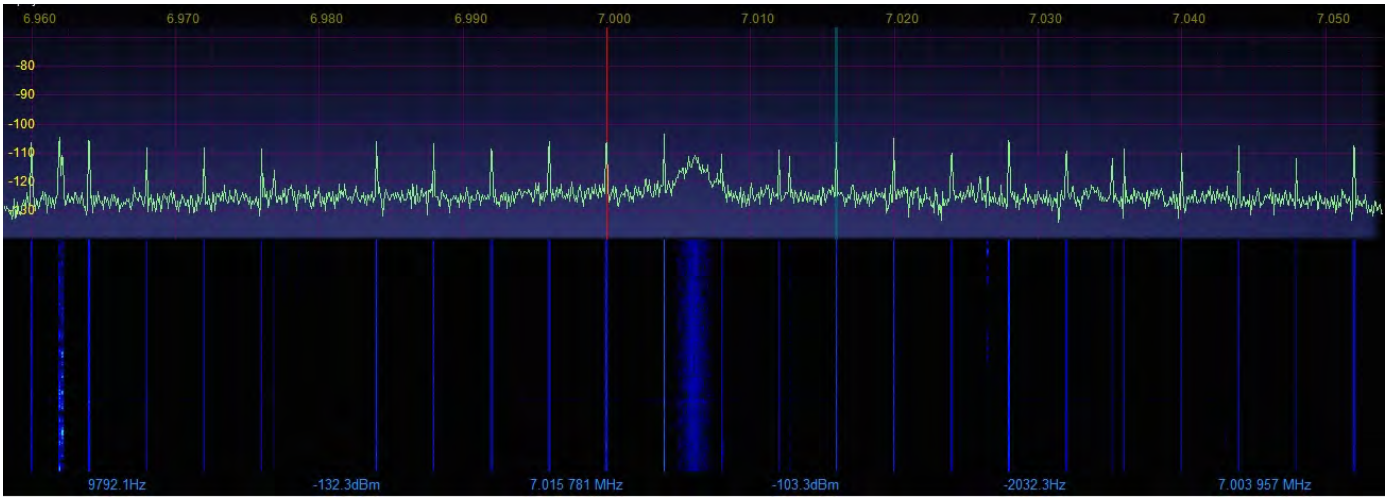


8.5MHz transition



12 MHz transition

If the VDSL signal is not getting through (perhaps because of HF Transmissions nearby) then the system enters a retraining mode and sends carriers exactly 4kHz apart (some carriers may be omitted) these carriers are much higher level than normally used by vdsl and appear as a comb on an SDR



VDSL retraining showing 4kHz carrier comb.

Please report your Problem to us

We need the following information so we can lobby collectively on your behalf with suppliers and Ofcom. You are welcome to pursue the issues yourselves but please still report as effective action requires a critical mass of reports for the problem to get the attention it deserves. In the 2016 RSGB survey only 1% of members suffering from VDSL interference had reported t theo EMC Committee. To date (January 2016) we have less than seventy confirmed reports but suspect thousands are effected.

Please supply to emc.chairman@rsgb.org.uk your name, callsign (these will not be released without your permission), Postcode (we use the first 3 characters to identify your entry). Tell us what equipment particularly antenna(s) you used to make the measurements and how far the antenna is from the telephone lines. If you know where the FTTC cabinet (the one which says your superfast broadband is here) is, tell us approximately how far it is from the antenna.

If you want us to ask BT to investigate your line balance we need your telephone number, DP number from suspect pole, the premises you think the interference is coming from and the level information at frequencies below.

VDSL Band	U0		D1		U1		D2		U2		D3	
f MHz	0.03	0.133	0.143	3.700	3.800	5.15	5.25	8.45	8.55	11.95	12.05	17.664
Level Change			+?dB	-?dB	+?dB	-?dB	+?dB	-?dB	+?dB	-?dB	+?dB	-?dB

If you take a spectrum or waterfall please include this and if you see retraining carriers report the frequencies you see them on.

You can also report your problem on emc matters forum (but omit your personal details as it's a public forum). http://forums.thersgb.org/index.php?forums/investigations-new-technology/

Why do some places seem to have worse interference than others?

VDSL sends differential signals down twisted pair to minimise crosstalk between different pairs. However, any imbalance in the lines will result in a common mode signal and if the cable is above ground it will radiate. The overhead lines may be of a length that supports standing waves from these common mode transmissions which give "antenna gain". The amount of interference is affected by the line imbalance this can be high resistance joints, or loading from coupled stubs either in the feed wires or from extension wiring in the house which is rarely balanced. Other electronic equipment close to the modem/router can cause interference to the upstream signals. VDSL modems normally use upstream power backoff to minimise crosstalk. Local interference may increase VDSL error rate which can cause higher upstream powers to be used. Downstream is also adjusted to minimise errors but no power backoff is deployed.

An unused extension is an open circuit stub which will resonate at quarter wavelength multiples. This will give losses to VDSL at that frequency which may result in higher powers being used or ultimately that frequency being omitted by VDSL as data is not getting through.

VDSL is provided at 3 different service levels "up to 40Mbps/10Mbps", "up to 55Mbps/10Mbps", "up to 80Mbps/20Mbps". In some locations vectoring is used to reduce across lines crosstalk. The level of interference seen will depend on how many of which of these services are deployed near you.

What can be done to reduce interference?

First check that it is VDSL by checking for level changes at the upstream / downstream transition, record the frequency of any training carriers and check their separation. Make sure that other items associated with the broadband are not the source by temporarily disconnecting them.

Then try to find the source is it yours or a neighbours or the cumulative effect of many sources. Turning the modems off in different combinations or tracing the phone lines that radiate most strongly using a

portable receiver helps to identify the source. A current transformer coupled around the phone line can detect signals. The line may have energy coupled into it and not the direct source so results can be confusing.

BT Openreach can check line balance on installations near you and potentially rectify any problems. You have to request this via your broadband service provider, or if it's a neighbours line they need to report through their broadband service provider. Regulations don't allow customers to contact Openreach directly.

Eliminate unused phone extensions as these cause imbalance - if possible just use the master socket.

Isolate the modem/router from other sources of noise by moving it clear of other electronic equipment. Locate it as far away from the shack as possible.

Don't use home hubs or other PLT devices these reduce VDSL bandwidth and cause higher interference levels, older PLT's may radiate themselves in the amateur bands.

Try common mode filters (Radcom April 2015) to reduce common mode signals.

Optimise the receive antenna, use a balanced system with a suitable choke balun to minimise unwanted noise pickup. Consider using a separate receive antenna located further from the source perhaps a small tuned loop located to null the interferer but still receive the desired signals.

Connect a quarter wave stub (remember velocity factor) made from hookup wire to the modem socket this should stop that frequency being used for VDSL

Remember only by collecting data on the number and severity of the interference can we effectively lobby for resolution.

RSGB EMC Committee

January 2016