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## **VDSL Measurements**

Field measurements of VDSL emissions at RSGB radio amateurs' stations

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**Report:**

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# 1. Overview

- 1.1 This report documents further<sup>1</sup> technical surveys conducted by Ofcom focusing on the effects of electromagnetic emissions from Openreach cables carrying VDSL (Very high bit rate Digital Subscriber Line) services. This survey was undertaken to assess the efficacy of corrective measures achieved by Openreach intended to ameliorate any impact on radio reception.
- 1.2 Representatives from the Radio Society of Great Britain ('RSGB') have attributed VDSL emissions as interfering with radio amateur's reception of high frequency ('HF') wireless telegraphy. VDSL facilitates high speed internet access to many of the 30 million households and business using the existing 'copper' infrastructure.
- 1.3 The RSGB nominated six affected sites operated by their members for the purpose of this survey. Representatives from their EMC Committee acted as observers.
- 1.4 The methodology involved surveys before and after Openreach carried out remedial activities. Follow up measurements were limited to three sites, two of which Openreach had discovered anomalies in VDSL installations in the surrounding areas.
- 1.5 The current band plan used by Openreach is Band Plan B8-11 (998ADE17) an extract from ITU-T G.993.2 Amendment 4 (08/2013) is shown in Annex 2.

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<sup>1</sup> Following on from the report published 23 May 2017 Spectrum Group (Spectrum Assurance) analysis of BT Openreach VDSL Measurements at amateur radio stations

## 2. Background

- 2.1 The Radio Society of Great Britain (RSGB) is the United Kingdoms recognised national society for radio amateurs.
- 2.2 The RSGB have been receiving complaints from their members regarding the impact of Very High Bitrate Digital Subscriber Line<sup>2</sup> (VDSL) to the quality of the reception of distant transmissions. A test methodology to measure the VDSL radio frequency (RF) emissions at amateurs' locations was proposed by Ofcom and agreed with members of the RSGB electromagnetic compatibility (EMC) committee.
- 2.3 The RSGB EMC committee are there to help and offer advice to members who have EMC problems, lobby regulators, guide standards to protect the spectrum and investigate emerging EMC threats.
- 2.4 To identify locations for the measurements the RSGB conducted a survey to identify respondents who detected possible VDSL emissions on their receiving equipment. Visits were made to six identified amateur locations and measurements of the VDSL emissions taken and analysed. Representatives of RSGB EMC committee attended the visits and made their own independent measurements.
- 2.5 Following the measurement visits the RSGB passed the addresses to Openreach<sup>3</sup>, an arrangement is in place where they will test the telephone lines for a radius of 200 meters around the address for faults. They will rectify any problems and report back to the RSGB on action taken.
- 2.6 Second visits were made when Openreach had carried out remedial action and the results were added to the plots in this report, the traces from the second visits are in green.

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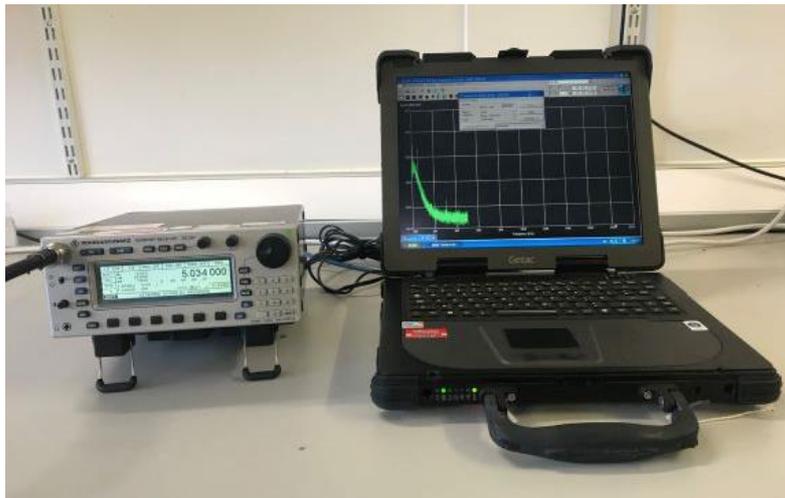
<sup>2</sup> VDSL allows Internet Service Providers to provide fast connection speeds via legacy copper lines.

<sup>3</sup> Openreach is a division of telecommunications company BT plc, that maintains the telephone cables, ducts, cabinets and exchanges.

### 3. Measurement Methodology

3.1 A scan of the frequency band used for VDSL was made at the locations supplied by the RSGB using a Rohde and Schwarz EB200 receiver connected to a loop antenna. The receiver was controlled by a Laptop running Argus<sup>4</sup> software. The receiver performed a band scan using the parameters in Table 1. The laptop recorded the plots taken at each location, the data was subsequently exported in Excel file format for inclusion in this report.

**Figure 1: R&S®EB200 Miniport Receiver and Laptop**



**Table 1: Measurement parameters**

EB200 Parameters	
Frequency	range 10kHz to 20MHz <sup>5</sup> .
Bandwidth	1.5kHz
Step Width	1kHz
Detector	Average

<sup>4</sup> R&S®ARGUS Spectrum Monitoring Software performs an automated RF band scan.

<sup>5</sup> The frequency range of the first location was 18MHz this was increased on subsequent locations to 20MHz to establish if any artefacts were visible above 18MHz.

Figure 2: Wellbrook Active Loop at a typical measurement location

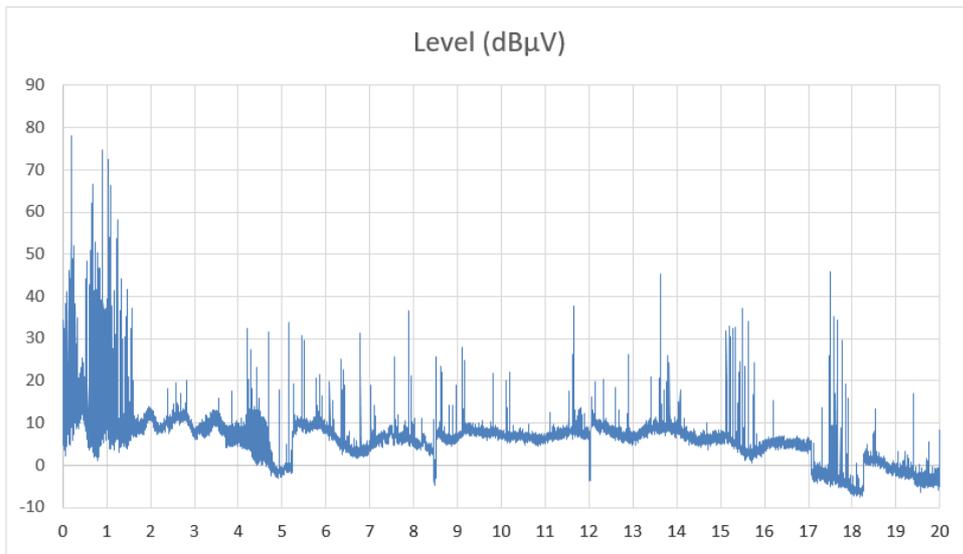


- 3.2 A Wellbrook ALA1530 active loop antenna was chosen for the tests because of its flat frequency response across the HF band, this characteristic helps with the identification of VDSL band edges.
- 3.3 Measurements were also obtained using the antenna being used at the time by the station operator. However, as the amateur's antennas were tuned for specific bands the results were inconclusive and have been excluded from this report.
- 3.4 For each of the test measurements, the Wellbrook ALA1530 active loop antenna loop was positioned midway along the amateur station's long wire antenna one meter above ground.

## 4. Identifying VDSL

- 4.1 VDSL modulation schemes appear like background 'noise' compromising identification. Accordingly, multiple VDSL channels were scanned identifying the 'guard bands' facilitating measurements at the band edge.

**Plot:1 Location CB8**



- 4.2 In the example plot:1 of the measurement taken at location CB8 the VDSL band edges are clearly visible at 5.2MHz, 8.5MHz, 12MHz and 17MHz.
- 4.3 The plot X axis is the frequency in MHz and the Y axis is the RF level detected at the receiver in dBµV. The VDSL emissions are judged to be from the noise floor at the band edges to the raised noise floor, in this case around 10dB.

## 5. Results

**Table 2: Locations of measurement visits**

Date of visit	Post Code	Town	Area
19 January 2018	MK16	Newport Pagnell	Suburban
9 February 2018	SG4	Hitchin	Rural
16 February 2018	PE16	Chatteris	Rural
23 February 2018	CB1	Cambridge	Urban
29 June 2018	PE28	Huntington	Rural
20 June 2018	CB8	Newmarket	Rural

Table 2 shows the first visits made to record the VDSL band scan the results are in the following results plots.

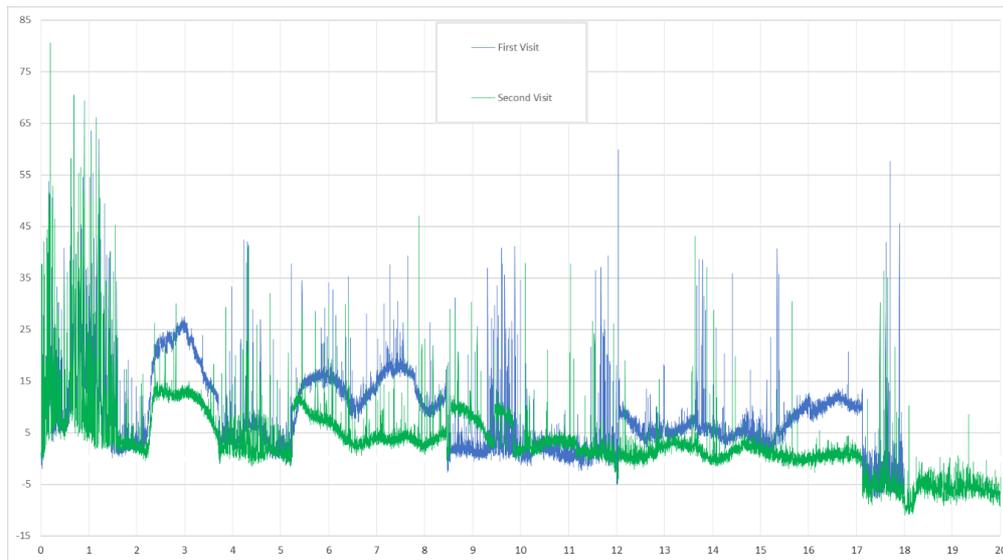
**Table 3: Locations of revisits**

Date of revisits	Post Code	Town	Area
19 July 2019	MK16	Newport Pagnell	Suburban
16 August 2019	PE28	Huntington	Rural
19 July 2019	CB8	Newmarket	Rural

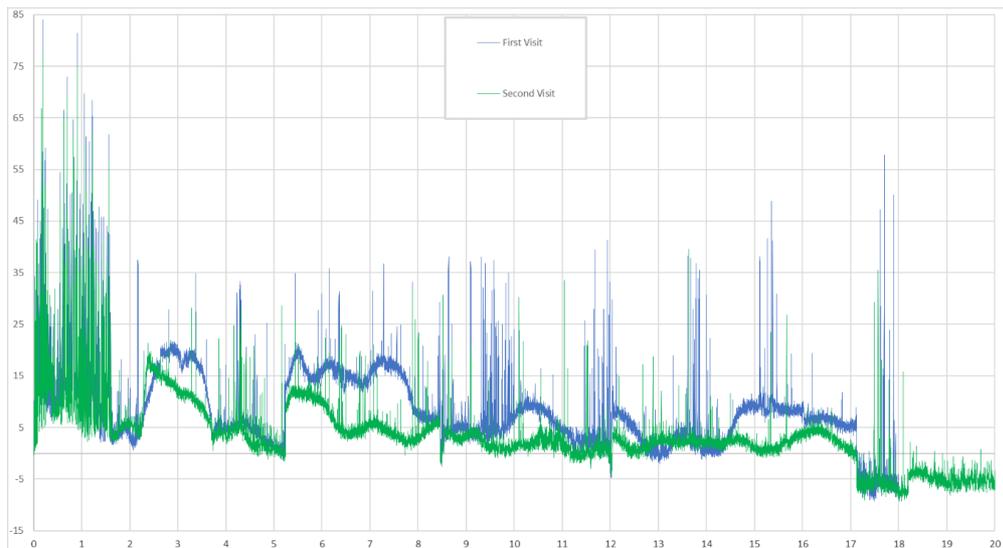
Table 3 shows the locations revisited following Openreach remedial action due to volume of work the action can take up to six months. Openreach reported faults rectified at MK16 and CB8 although they could still detect some internal house wiring issues that could still cause issues.

## VDSL Measurements

**Plot:2 MK16 Loop aligned for Null at 10MHz**

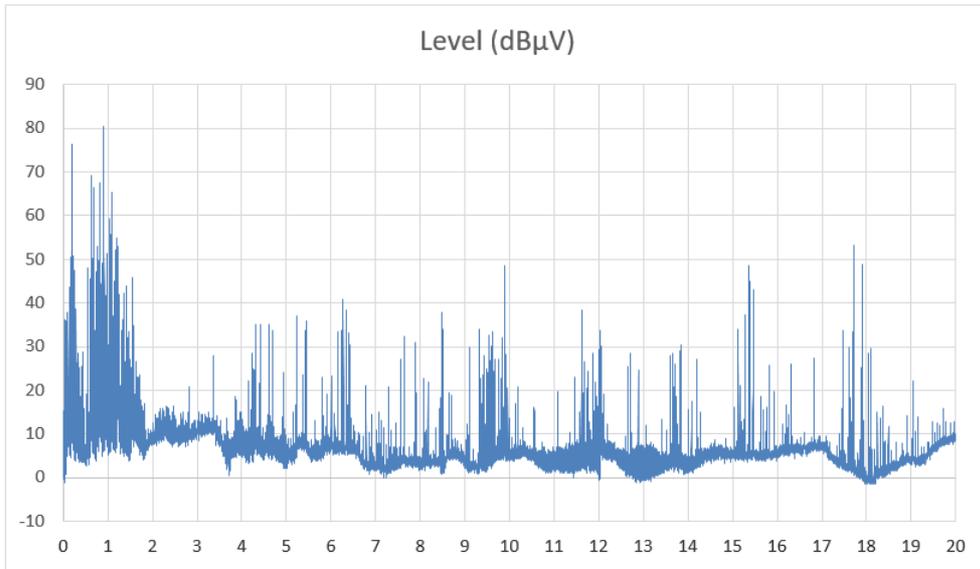


**Plot:3 MK16 Loop aligned for Peak at 10MHz**

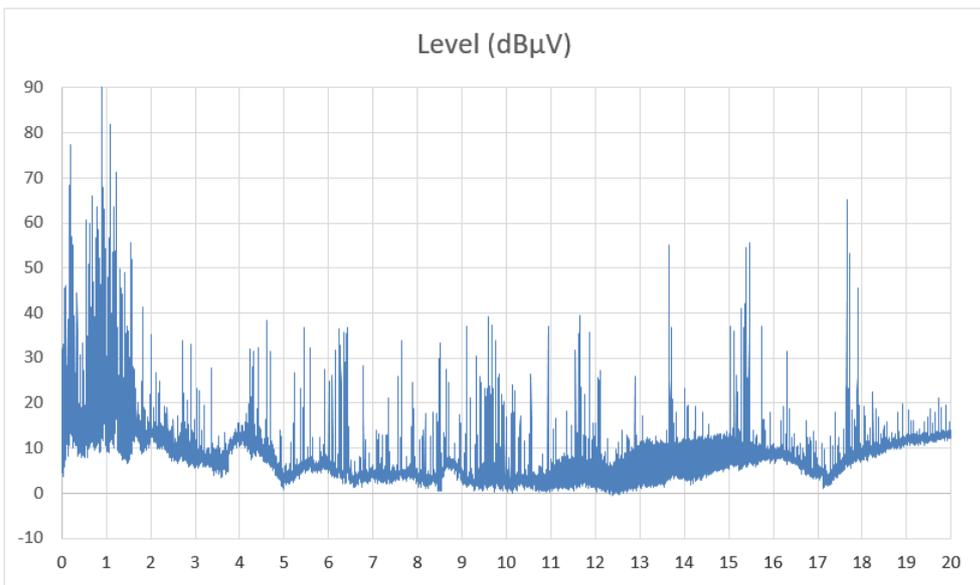


The amateur station had an ALA 1530 active loop installed in the rear garden area, this was used to measure VDSL emissions. The loop antenna was installed 18 meters from the rear of the house. Measurements were taken with the loop orientated to give a peak and null level at a frequency of 10MHz. Following remedial action by Openreach a second visit was made to the amateur station and the measurement repeated. The measured VDSL emissions had dropped as indicated by the green traces on plots 2 and 3.

**Plot 4 SG4 test loop aligned parallel to the amateur's antenna.**

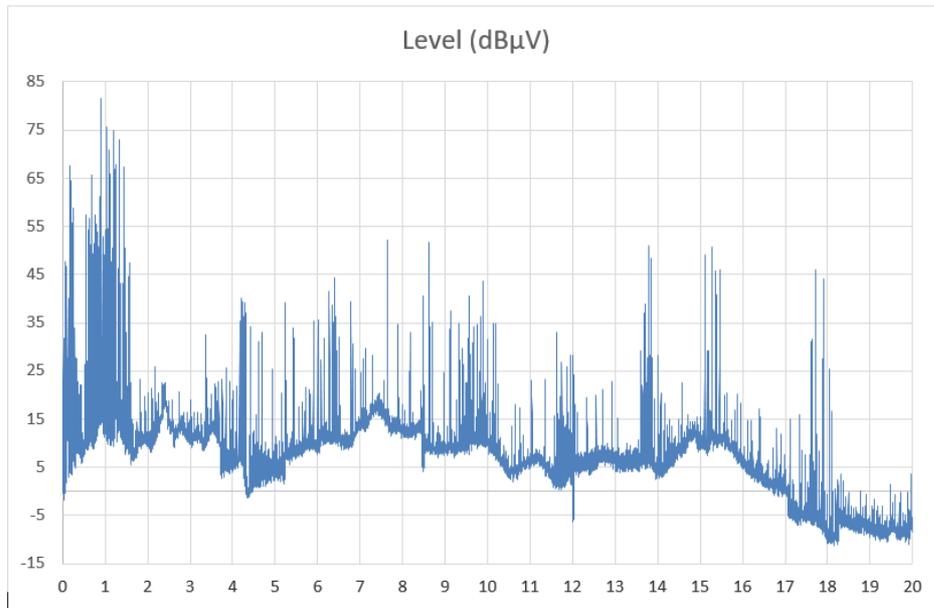


**Plot 5 SG4 test loop aligned at right angles to the amateur's antenna.**

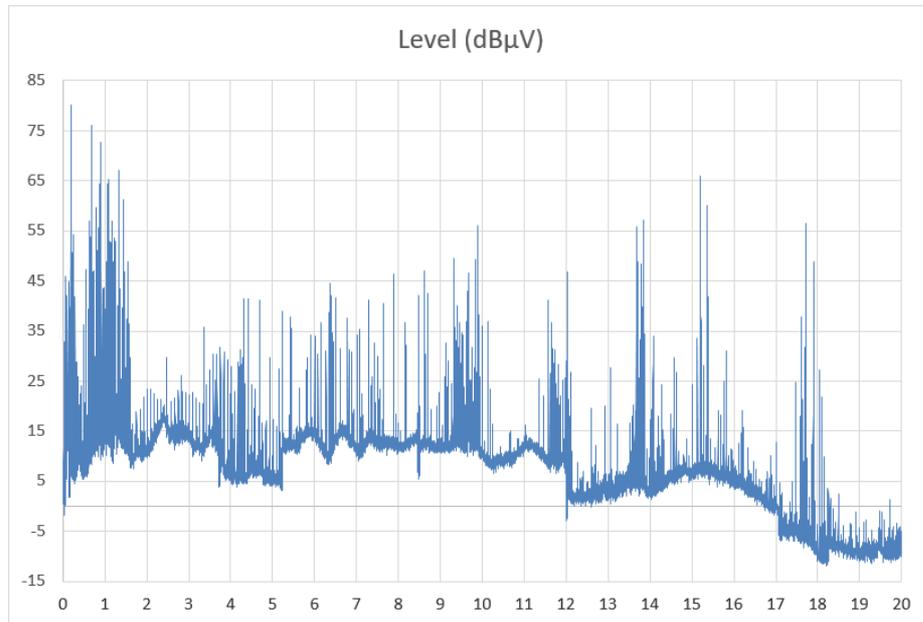


Measurements were taken using a Wellbrook loop type ALA 1530 serial number 7000 active loop. During the survey intermittent noise (emissions) were observed. The source was traced to the central heating boiler installed in the property. The measurement plots in the report are with the boiler switched off, some noise was still visible; this was thought to be from other similar types of boilers in the area.

Plot 6 PE16 test loop aligned parallel to the amateur's antenna.

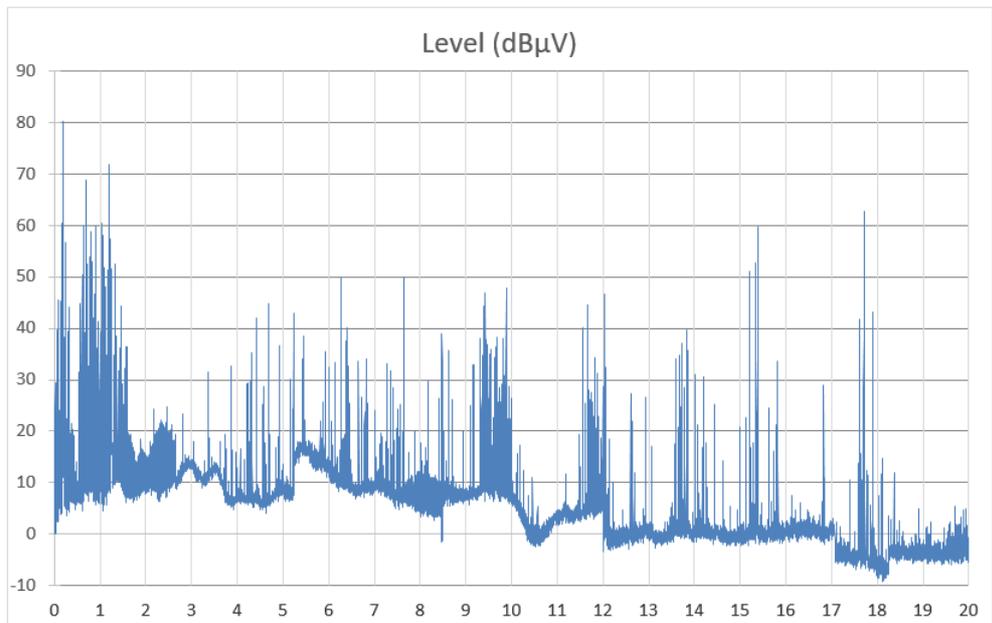


Plot 7 PE16 test loop aligned at right angles to the amateur's antenna.

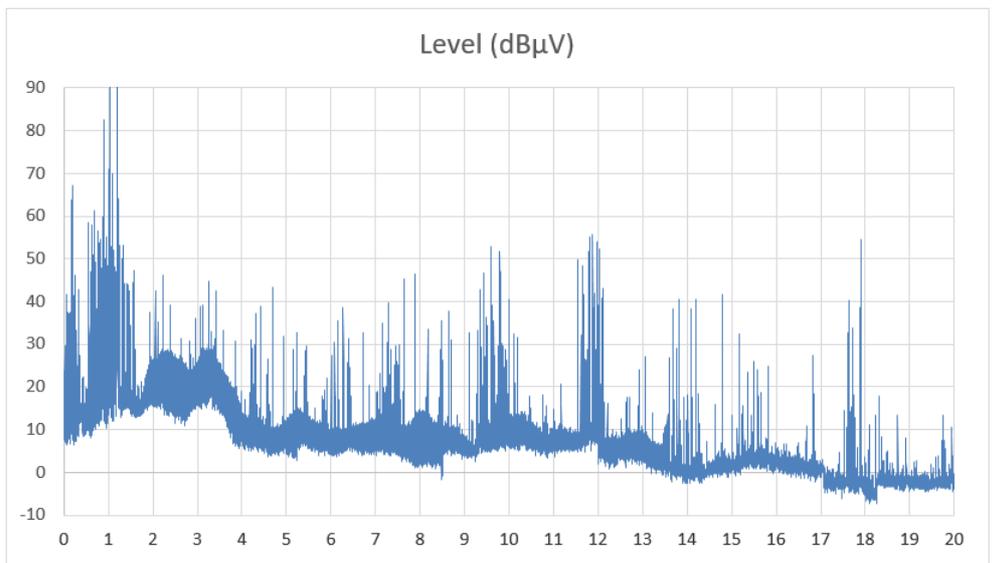


The measurements were taken with a Wellbrook loop type ALA 1530 Loop serial number 7474 orientated parallel and at right angles to the stations long wire antenna.

**Plot 8 CB1 test loop aligned parallel to the amateur's antenna.**



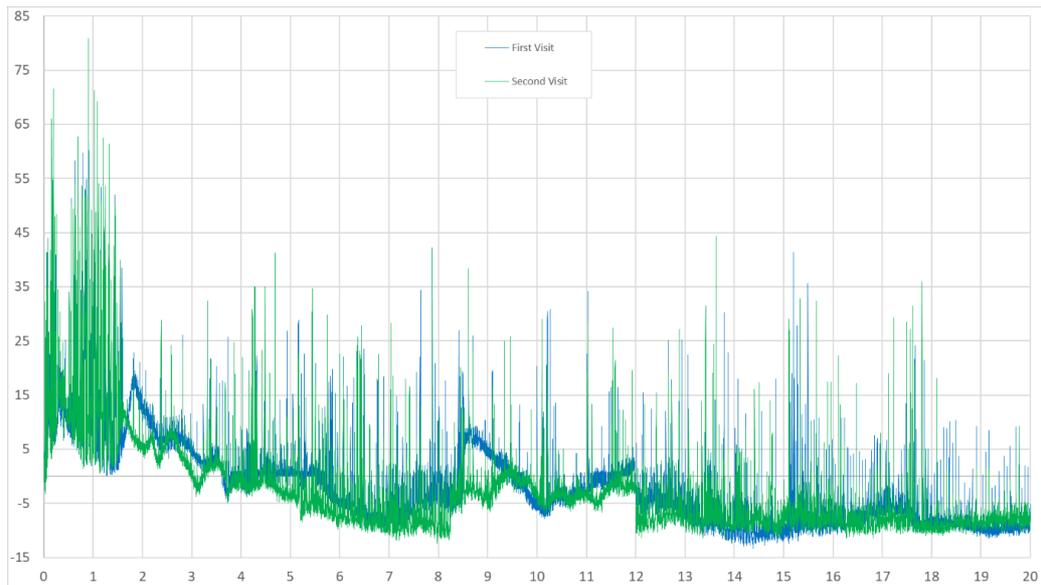
**Plot 9 CB1 test loop aligned at right angles to the amateur's antenna.**



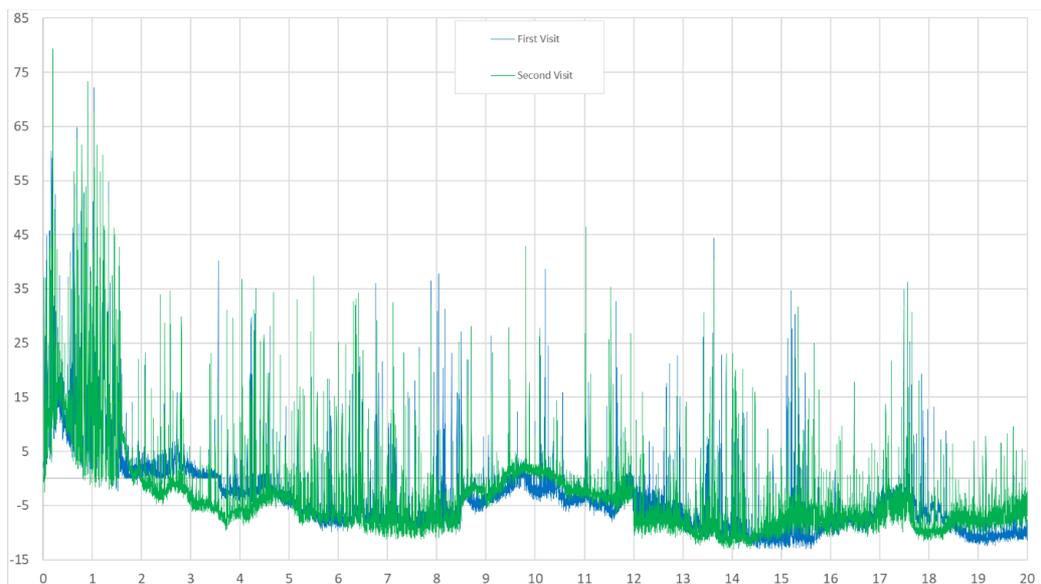
Measurements were taken with a Wellbrook Loop type 1530 serial number 7000 parallel and right angles to the long wire antenna, the maximum noise was at right angles. The house mains power was turned off during measurements, but wide band noise was still clearly visible on plot 9 of unknown origin.

## VDSL Measurements

**Plot 10 PE28 test loop aligned parallel to the amateur's antenna.**



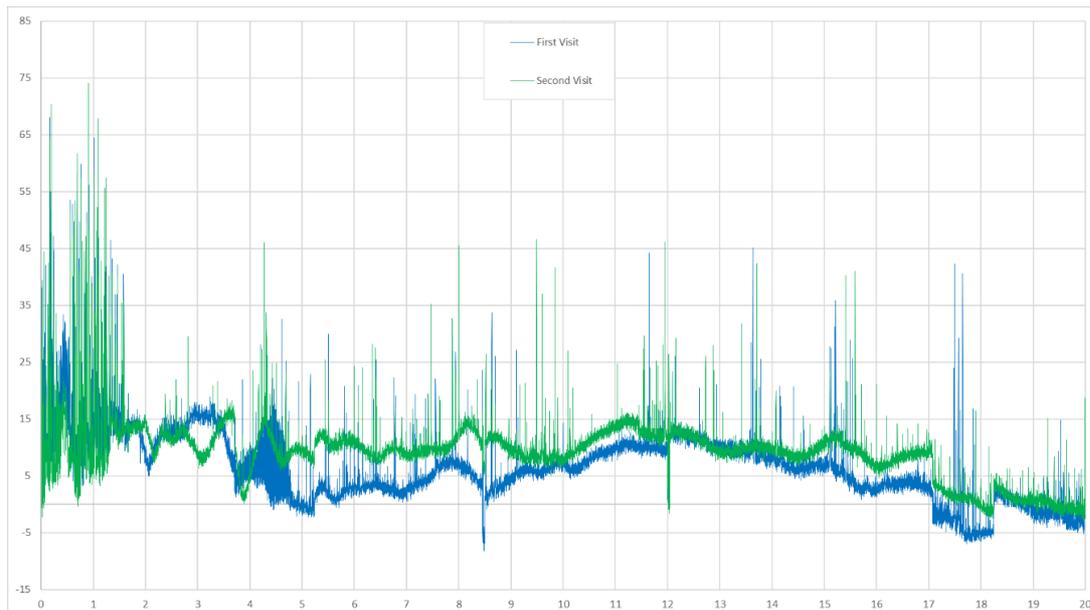
**Plot 11 PE28 test loop aligned at right angles to the amateur's antenna.**



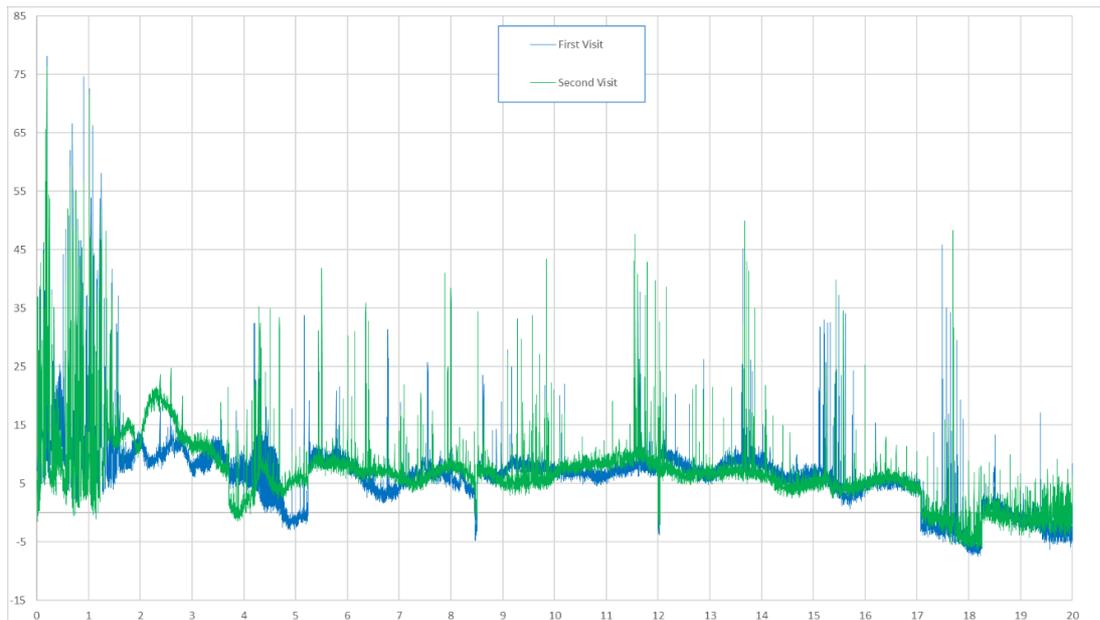
Measurements taken with a Wellbrook Loop type 1530 serial number 7000 aligned parallel and right angles to the long wire. It was noted telephone cables were running parallel to the station antenna approximately six meters away. This location was revisited even though Openreach had reported the area fault free therefore no remedial action had been taken. It was noted that there was little change in the VDSL emissions.

## VDSL Measurements

**Plot 12 CB8 test loop aligned parallel to the amateur's antenna.**



**Plot 13 CB8 test loop aligned at right angles to the amateur's antenna.**



The measurements were taken with Wellbrook Loop model 1530 serial number 7000 the loop was aligned parallel and at right angles to the amateur's antenna for the measurements. The second visit measurements following Openreach remedial work, show no change in plot 13 and slight increase in plot 12.

## 6. Conclusions

- 6.1 Ofcom tests indicate that wires used for VDSL emit an electromagnetic disturbance at levels capable of affecting HF radio reception. The degree of effect is contingent on several factors, the most significant being the proximity of the receiver antenna, other factors include the relative strength of the wanted signal, the local ambient 'noise', atmospheric conditions and the engineering of the VDSL installation.
- 6.2 Openreach have demonstrated that they are able and willing to investigate reports of interference to HF reception, and where they identify faults in their infrastructure, remediate them.
- 6.3 In this survey, Openreach found anomalies in two of the complaints they investigated, in one, remediation showed some benefit and the other, the outcome was at best inconclusive.
- 6.4 Openreach have stated that VDSL emissions can be affected by inadequacies in their customers in-home wiring, a matter beyond their control.
- 6.5 Against the backdrop of an estimated 25 million VDSL installations, overall the impact of VDSL remains extremely small. Over the past five years Ofcom has received an average of six complaints a year.

## A1. Test Equipment Used

Model	Manufacturer	Serial Number	Calibration due date	Scan Code
Laptop PC	Getac	RA363M0027	N/A	004287
EB200	Rohde and Schwarz	839784/023	18 October 2019	001711
HF Loop	Wellbrook	7000	N/A	N/A
HF Loop	Wellbrook	7474	N/A	N/A

## A2. Annex Band Edge Frequencies for European VDSL2 band plans

Table B.1 – Band-edge frequencies for European VDSL2 band plans

Band plan	Band-edge frequencies (as defined in the generic band plan in clause 7.1.2)										
	$f_{UL}$ kHz	$f_{UL}$ kHz	$f_1$ kHz	$f_2$ kHz	$f_3$ kHz	$f_4$ kHz	$f_5$ kHz	$f_6$ kHz	$f_7$ kHz	$f_8$ kHz	$f_9$ kHz
	US0		DS1	US1	DS2	US2	DS3	US3	DS4	US4	
997	25	138	138	3 000	5 100	7 050	12 000	N/A	N/A	N/A	N/A
	25	276	276								
997E17	25	138	138	3 000	5 100	7 050	12 000	14 000	17 664	N/A	N/A
997E30	N/A	N/A	138	3 000	5 100	7 050	12 000	14 000	19 500	27 000	30 000
	US0		DS1	US1	DS2	US2	US3	DS3	US4	DS4	
998	25	138	138	3 750	5 200	8 500	12 000	N/A	N/A	N/A	N/A
	25	276	276								
	120	276	276								
	N/A	N/A	138								
998E17	N/A	N/A	138	3 750	5 200	8 500	12 000	14 000	17 664	N/A	N/A
	N/A	N/A	276								
998E30	25	138	138	3 750	5 200	8 500	12 000	14 000	21 450	24 890	30 000
	N/A	N/A	276								
	N/A	N/A	276								

## A3. The amateur bands falling within the VDSL frequency range

Amateur Band	Frequency MHz
80 metres	3.5 – 3.8
60 metres	5
40 metres	7.0 – 7.2
30 metres	10.10 – 10.15
20 metres	14.00 – 14.35