Spectrum Group (Spectrum Assurance) analysis of BT Openreach VDSL

Measurements at amateur radio stations

Research document

Publication date: 23 May 2017

About this document

The Radio Society of Great Britain ('RSGB') have made complaints to Ofcom and BT Openreach on behalf of its members, predominantly radio licensed amateurs, stating that the deployment of VDSL (very high-bit-rate digital subscriber line) technology by BT Openreach has resulted in interference to radio reception.

Following a meeting with representatives from the RSGB, Ofcom and BT Openreach, it was agreed that surveys would be conducted to assess the effects of VDSL on amateur radio reception.

Ofcom Spectrum Engineering Officers carried out surveys at three locations, where RSGB members had experienced problems associated with VDSL deployment and where BT Openreach had previously visited.

The methodology involved a physical examination of the affected station and tests using calibrated apparatus. The overall conclusion was that there was no evidence that emissions from BT Openreach VDSL drop wires was causing harmful interference to the amateur radio reception.

Contents

Section 1

Introduction

The RSGB have made complaints to Ofcom and BT Openreach stating that VDSL technology has resulted in interference to radio reception.

To gain a better understanding of the issues, representatives from Ofcom, the RSGB and BT Openreach agreed to cooperate in an exercise that would involve Ofcom conducting field surveys.

The RSGB nominated several locations where experienced radio amateur operators had reported VDSL related problems, three were selected, two in North London and one in Nottinghamshire.

Ofcom Spectrum Engineering Officers carried out surveys on 8 September and 4 October 2016.

The methodology involved site visits a physical examination of the affected station, tests using calibrated apparatus.

BT Openreach engineers had previously carried out tests at each site and identified and rectified some issues, i.e. rebalanced lines, at the site used by [✂].

Section 2

Locations and affected bands/frequencies

2.1 Location one

[✂]Enfield, [✂]Reported Bands Affected:

- 160m (1.8MHz - 2MHz)
- 80m (3.5MHz - 3.8MHz)
- 60m (5.258MHz - 5.4035MHz)
- 40m (7MHz - 7.3MHz)
- 30m (10.1MHz - 10.15MHz)
- 20m (14MHz - 14.35MHz)

2.2 Location two

[✂]Herts, [✂]Reported Bands Affected:

- 30m (10.1MHz -10.15MHz)
- 80m (3.5MHz - 3.8MHz)

2.3 Location three

[✂]Shireoaks, [✂]

Reported Bands Affected:

- 80m (3.75MHz – 3.8 MHz)
- 40m (7MHz – 7.2MHz)
- 30m (10.1MHz – 10.15MHz)

Section 3

Heading Equipment under test (EUT)

VDSL is a technology that uses existing copper phone lines to supply high speed broadband services to consumers.

BT Openreach deploys VDSL using an International Telecommunication Union (ITU) standard as part of its fibre network. This system is termed Fibre-To-The-Cabinet (FTTC) employing fibre to street cabinets with the remaining run completed using VDSL over copper wires, including drop wires, to the subscriber.

Section 4

Methodology

The methodology employed by Ofcom engineers involved a physical examination of the affected station.

Assessing the effectiveness of the antenna and ability to receive radio communications at the site station on the frequency bands affected using a calibrated professional radio receiver (Rhode and Schwartz EB200).

Measuring the levels or electromagnetic energy emitted from BT Openreach VDSL drop wires in the vicinity of the affected station using a calibrated Agilent Field Fox RF analyser N9912A and an active magnetic loop (Schafner HLA6120).

Section 5

Findings

5.1 Survey one

The survey was conducted [✂] Enfield, [✂], the home of [✂]. Mr [✂] reported that he was experiencing issues on all bands from 1.8MHz to 14.350MHz.

At the time of the survey Mr [✂] stated that the spectrum coverage of his current antenna system was not configured to facilitate reception for frequencies below 7MHz.

Mr [✂]normally communicates using Morse code, sometimes referred to as CW or continuous wave communications. He does not use single sideband (SSB) modulation as used in many voice applications and may operate on the fringes of feasible communications, in or near the 'noise floor'.

Mr [✂]stated that when he experienced reception problems on 1.8MHz to 14.350MHz he was using a 'Fun Cube Dongle'[1] SDR (software defined radio) USB radio receiver.

Mr [✂]stated that the reception problems were limited to the 14MHz frequency band and all the other bands were not affected.

Ofcom engineers substituted the Yeasu FTDX-5000 used by Mr [✂]with an EB200 receiver, measured signal levels were considered acceptable, SSB radio activity was detected on the 14MHz Band.

A Field Fox spectrum analyser was connected to the HF antenna co-axial cable used by Mr [✂]. Measurements taken between 3.6 MHz to 3.8 MHz indicated a 15dB step rise in the noise floor -103dB to -87dB at approximately 3.7MHz. (this is characteristic of emissions from VDSL).

Mr [✂]stated that he was aware of this phenonium, however it did not affect him as he did not operate below 7MHz. and did not have antennas suitable for 3.5 MHz to 3.8MHz.

Off-air measurements were taken outside the property, this showed comparable signal levels to those found when connected to the antenna co-axial used Mr [✂] inside his house, including the 15dB step rise.

5.2 Survey two

The survey was carried out at [✂], Herts, [✂], the home of [✂], he had indicated issues receiving radio communications on 3.5MHz – 3.8MHz and 10MHz – 10.150MHz.

Tests were conducted using [✂]TS-850 SAT transceiver, there was no indication of an abnormal level of electromagnetic disturbance on 3.5MHz – 3.8MHz or 10MHz – 10.150MHz however an elevated background noise floor was observed.

[✂]TS-850 SAT transceiver was replaced with the EB200 receiver. It was evident that that CW transmissions were capable of being received using the installed antenna system. There was no noticeable rise in noise and no evidence of an electromagnetic disturbance capable of causing harmful interference.

Ofcom engineers declined a proposal to repeat the tests substituting the EB200 with a Funcube Dongle. This decision was made on the basis that this was outside the scope of the methodology and concerns over the Funcube Dongle effectiveness as an HF receiver.

Further tests were conducted using the EB200 receiver connected to [✂]antenna system on HF (high frequency) on bands often used by amateurs. There were no abnormal levels of electromagnetic disturbance capable of causing harmful interference to radio reception detected.

Subsequent measurements were made using the Field Fox spectrum analyser and an active magnetic loop to measure emissions from a BT Openreach drop wires in the vicinity. There was no evidence of excessive levels of electromagnetic disturbance capable of causing harmful interference to radio reception detected.

5.3 Survey three

The survey was carried out at the home address of [✂]on the 4 October 2016 he stated he was experiencing particular problems on 3.75MHz – 3.8MHz, 7MHz – 7.2MHz and 10.1MHz – 10.15MHz.

Three sets of measurements were taken at seven locations around [✂]property: 3.5MHz-5.5MHz, 3-12.5MHz and 7-13MHz.

Initially [✂]demonstrated the detectable noise floor using his WiNRADiO SDR (software defined radio) receiver and Wellbrook AL1530 active loop antenna (the antenna was situated near a BT Openreach dropwire).

Ofcom engineers substituted the WiNRADiO SDR receiver connecting the EB200 receiver to the Wellbrook antenna. There was no perceptible elevation of the noise floor on the 3.5-5.5MHz, 3-12.5MHz and 7-13MHz bands. However, it was subsequently established that the Wellbrook antenna was not active when connected to the Ofcom receiver.

Tests were conducted using Field Fox spectrum analyser and an active magnetic loop to measure emissions from a BT Openreach rising copper cable at the foot of a telegraph pole in the street outside the curtilage of [✂]property. This indicated a rise in the noise floor of approximately 20 dB between approximately 4MHz and 5.1MHz (this part of the spectrum is not the subject of primary allocations for amateur use).

Section 6

Conclusions

The test methodology was designed to assess the effect of electromagnetic emissions from BT Openreach VDSL technology on amateur radio reception.

Noise floor measurements were taken from all three sites and compared with that of Baldock radio monitoring station, this showed that the base noise floor levels were comparable at all locations.

Tests at the two North London test sites on the bands that the complainant’s regularly use and where suitable antennas were in use, showed that there were no abnormal levels of electromagnetic disturbance capable of causing harmful interference to radio reception.

Tests carried out at the third site indicated that the problems affecting [✂]were likely to be associated with the extremely close proximity of his antenna to an BT Openreach drop wire ([✂]stated he would ask Openreach to reconfigure their system to relocate the particular cable).

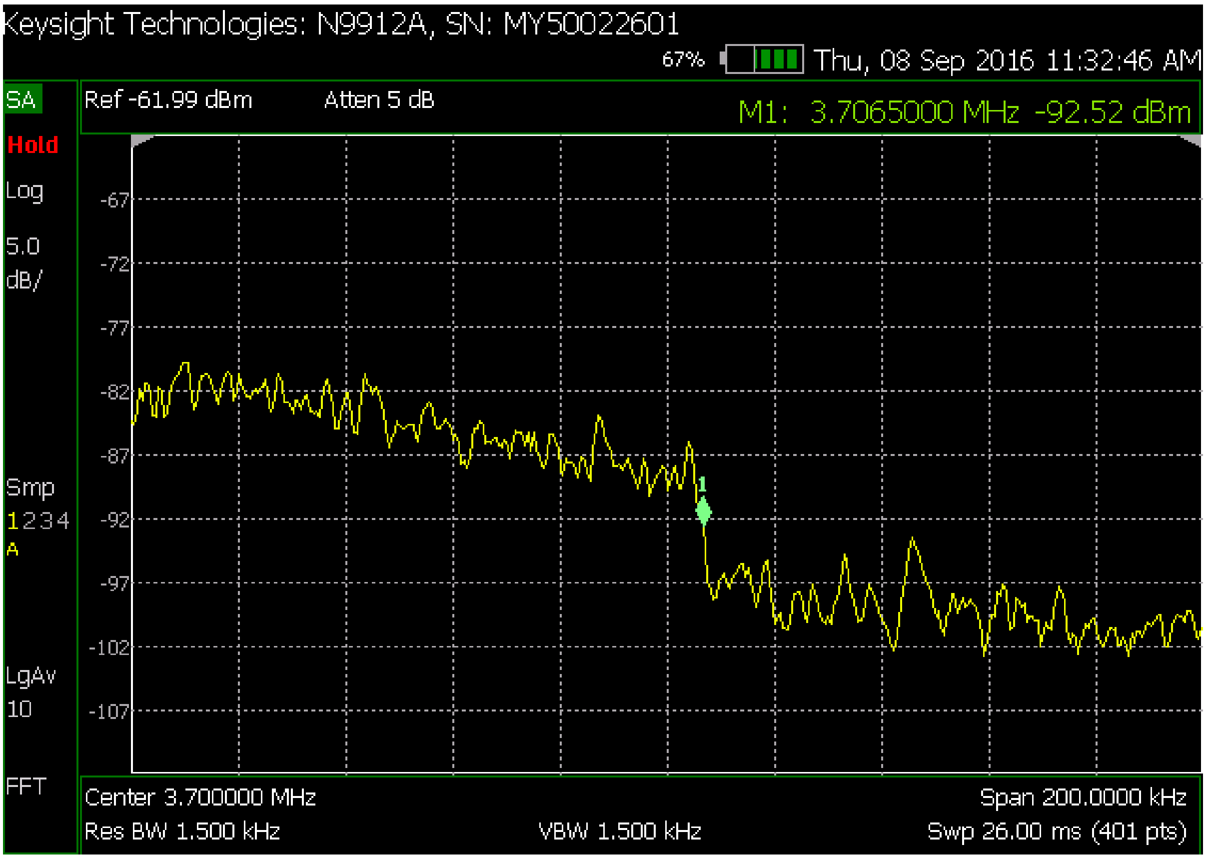
Annex 1

Measurement Results

1.1 Disclaimer

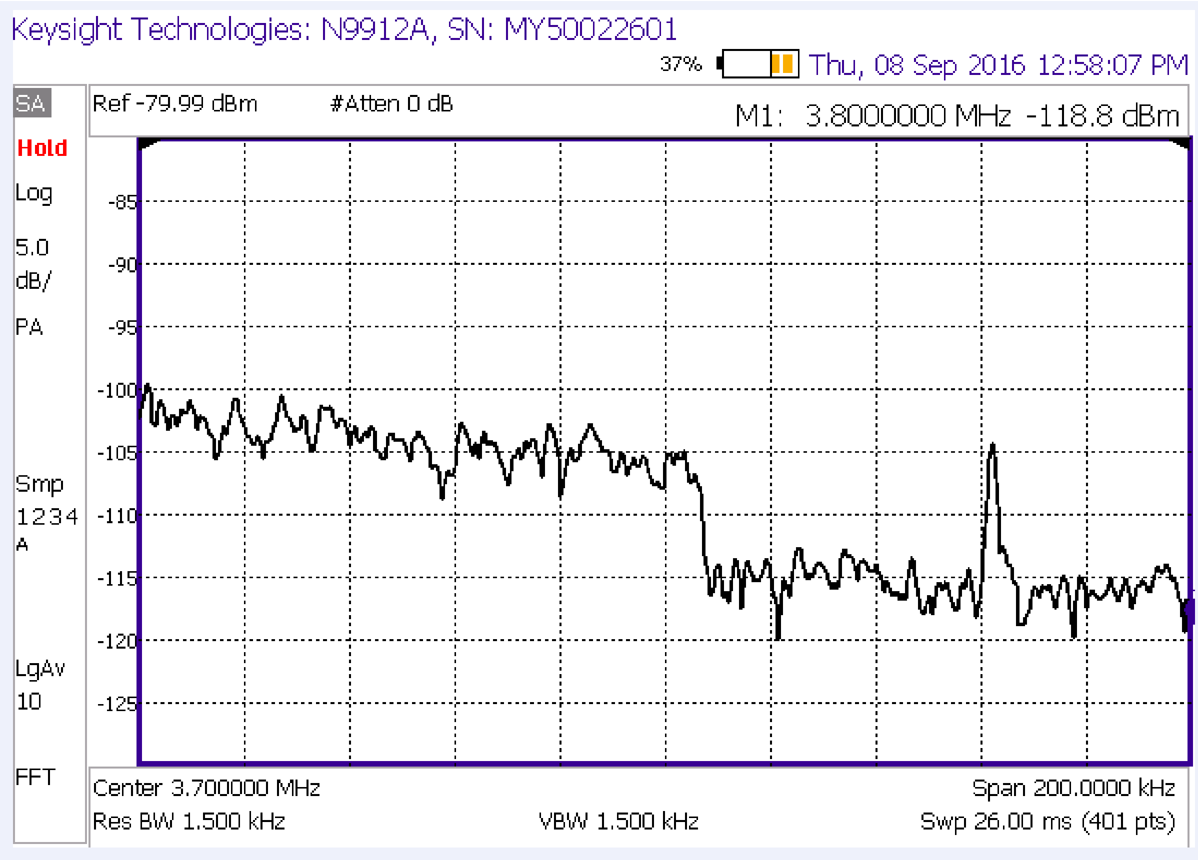
The results detailed in this section apply only to the tests made at that time, using the test equipment detailed. They do not indicate that on another date an identical set of results may be achieved, due to changes in local environmental conditions or other factors which may or may not have an effect on the measurement results obtained at that future time.

1.2 Mr [✂] – Investigation: [✂] Enfield [✂]

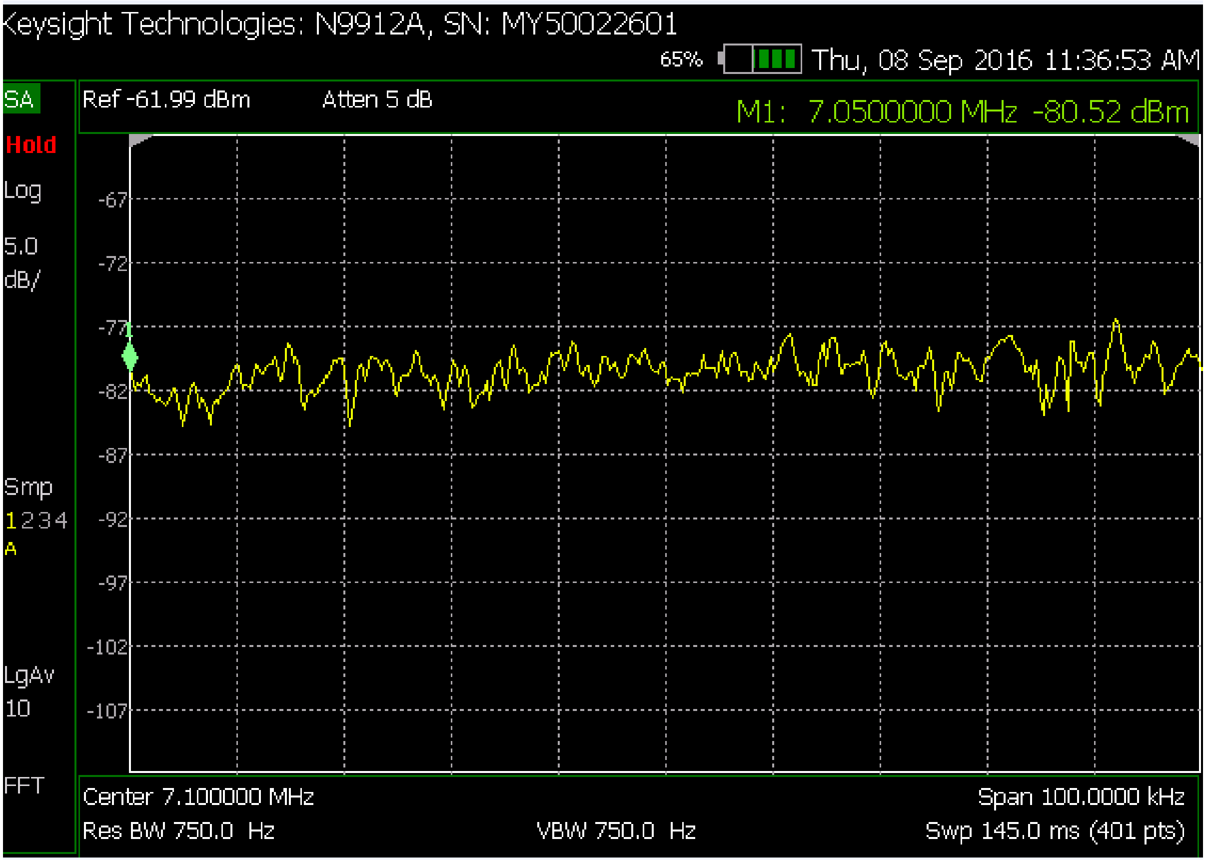


Plot 1: 3.7 MHz Measurement taken from Mr [✂] Antenna.

Plot 1 was taken using Mr [✂] antenna system. There is a step change between the Lower and Upper part of the band. This was replicated with a similar signature using an Active Loop Antenna, when siting the Active Loop Antenna close to the Openreach drop wires. The step change is approximately 15dB. This is characteristic of VDSL.

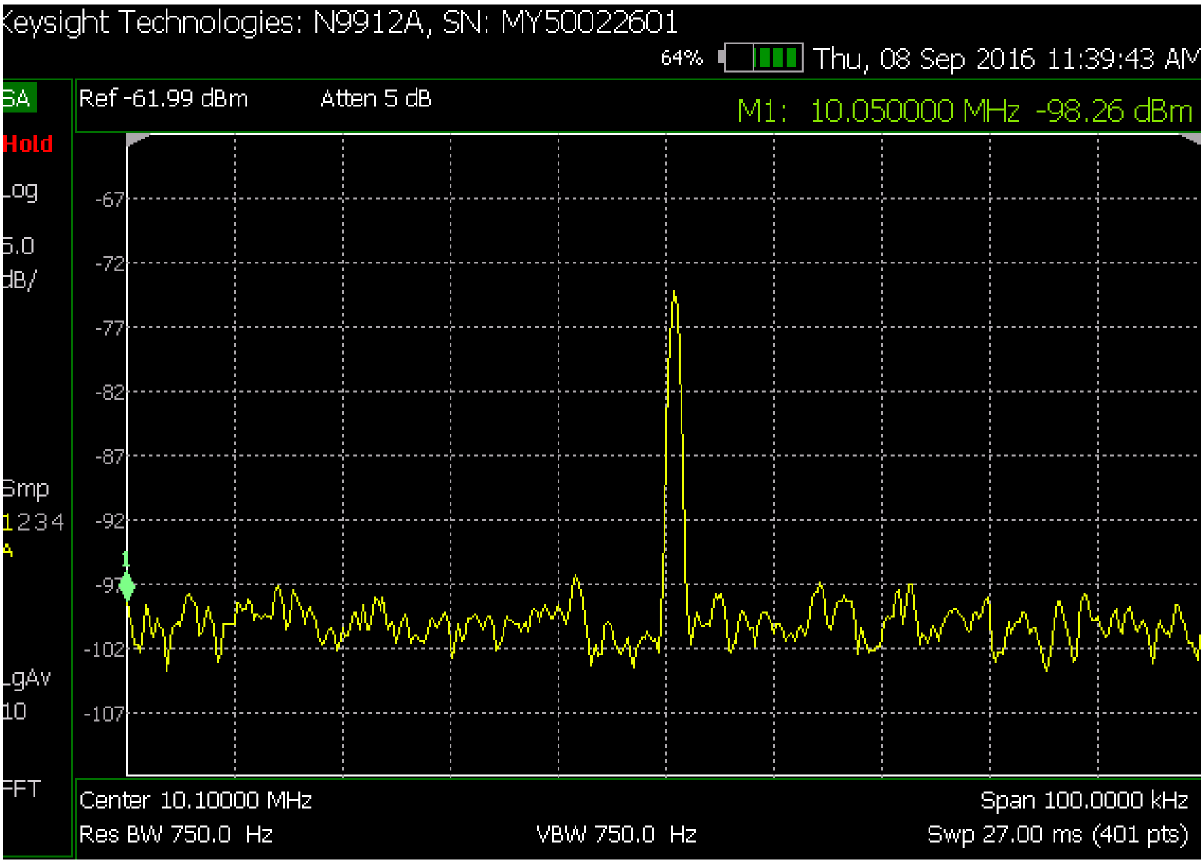


Plot 2: Fieldstrength = Upper: -105 dBm + 107 + 28.1 = 30.1 dBµV/m. Lower: -115 + 107 + 28.1 = -20.1 dBµV/m.



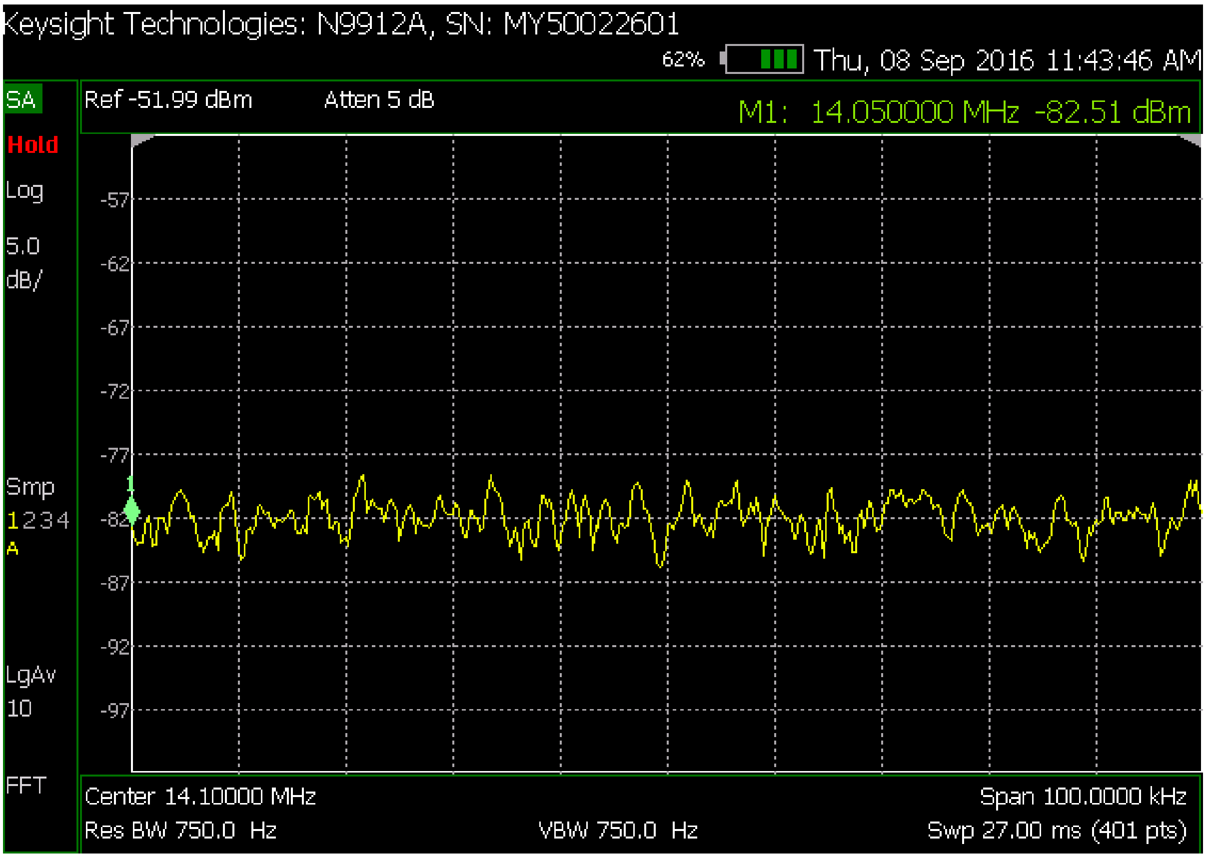
Plot 3: 7.1 MHz Measurement taken from Mr [✂] Antenna.

Plot 3 shows the noise floor in the 40m band approximately -80 dBm. Tests carried out with a calibrated Agilent field fox spectrum analyser N9912A and an Active Magnetic loop. This would be considered an acceptable noise level given the location and the frequency band.



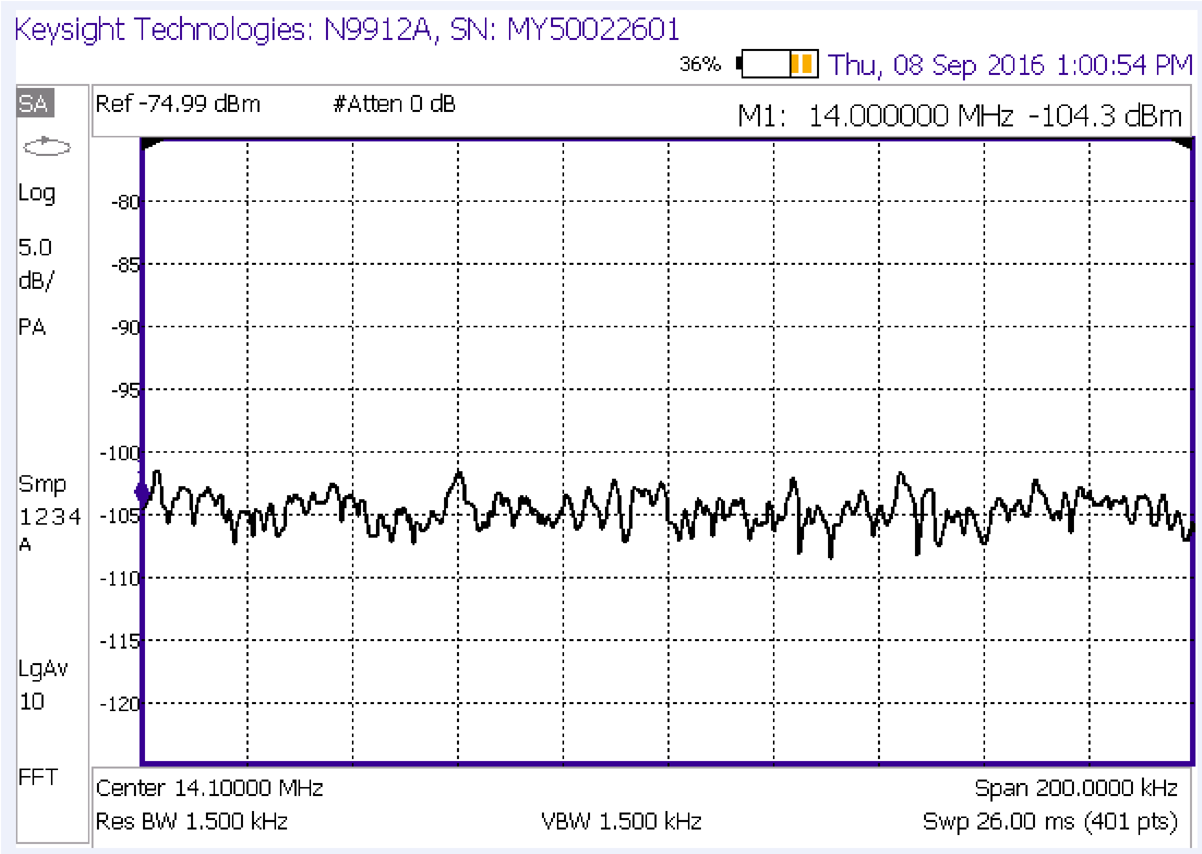
Plot 4: 10.1MHz Measurement taken from Mr [✂] Antenna.

Plot 4. shows the noise floor in the 30m band approximately -100 dBm. Tests carried out with a calibrated Agilent field fox spectrum analyser N9912A and an Active Magnetic loop. This would be considered an acceptable noise level given the location and the frequency band.



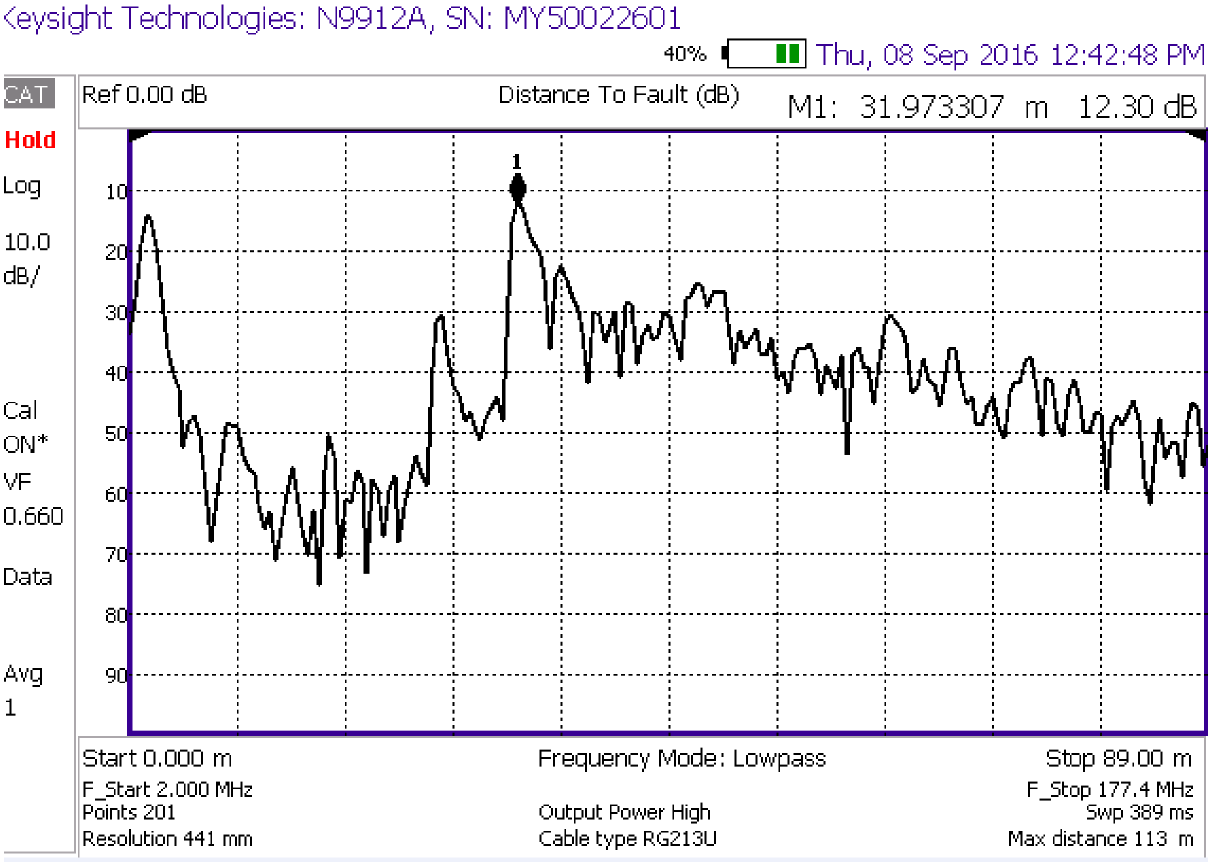
Plot 5: 14.1MHz Measurement taken from Mr [✂] Antenna.

Plot 5 shows the noise floor in the 20m band approximately -80 dBm. Tests carried out with a calibrated Agilent field fox spectrum analyser N9912A and an Active Magnetic loop. This would be considered an acceptable noise level given the location and the frequency band.



Plot 6: Fieldstrength = -105 dBm + 107 + 28.1 = 30.1 dBµV/m.

Plot 6 the measurement was taken using an Active Loop Antenna on a pump up mast close to the Openreach drop wires above.

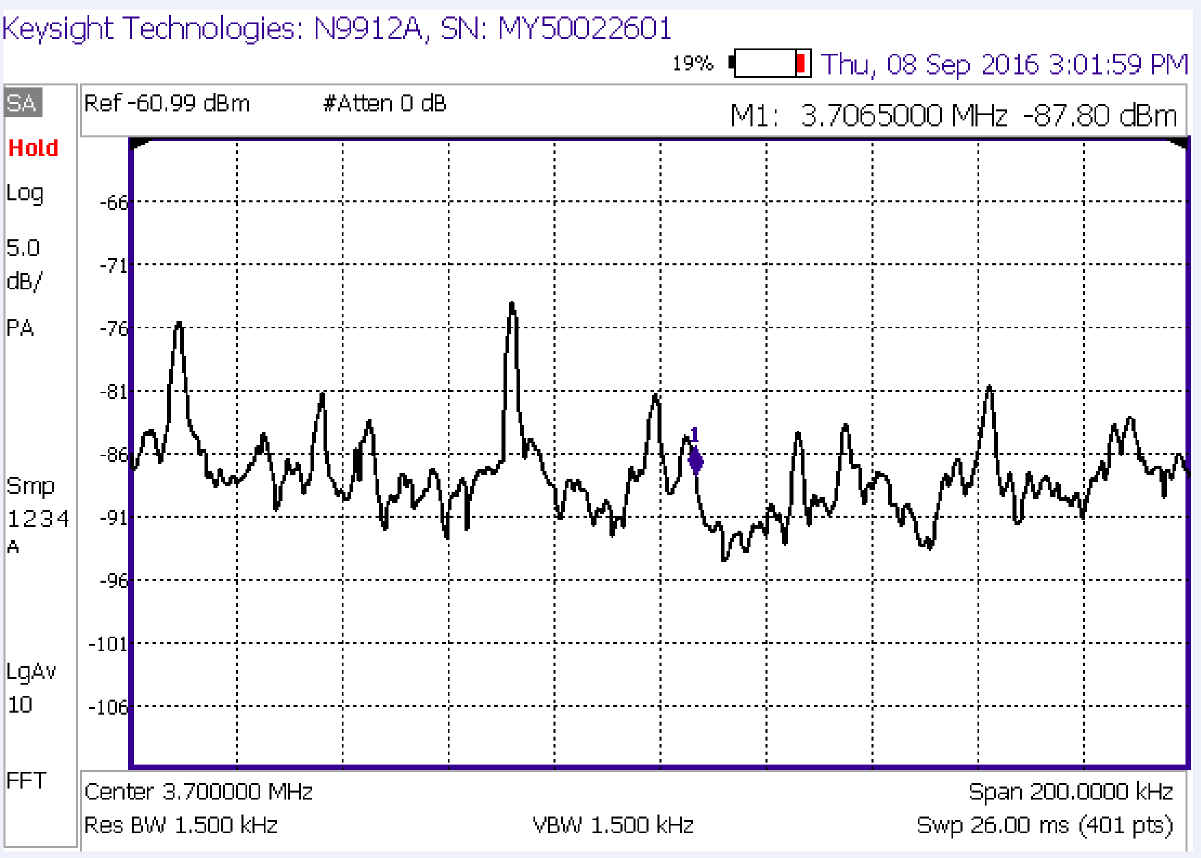


Plot 7: Distance to Fault Measurement to Vertical HF Multiband Dipole

Plot 7 is a Distance to Fault Measurement to ensure that the coaxial cable leading to Mr [✂] Antenna system had no faults. There is no impedance mismatch on the system. The above confirms to us that there are no serious issues with regards this and the coaxial cable terminates to the Antenna at approx. 30m.

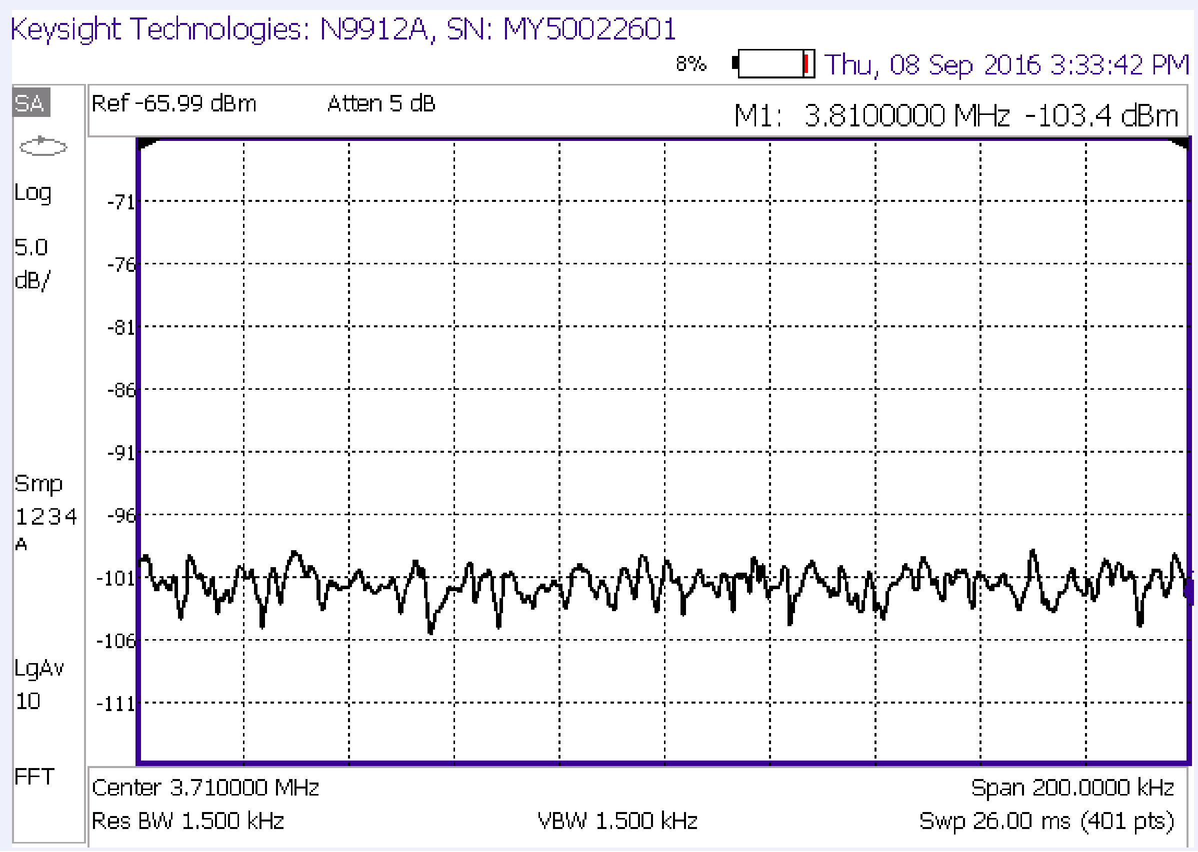
1.3 [✂] Barnet [✂]

Reported Bands Affected: 30m (10.1 MHz-10.15 MHz), 80m (3.5 MHz - 3.8 MHz)



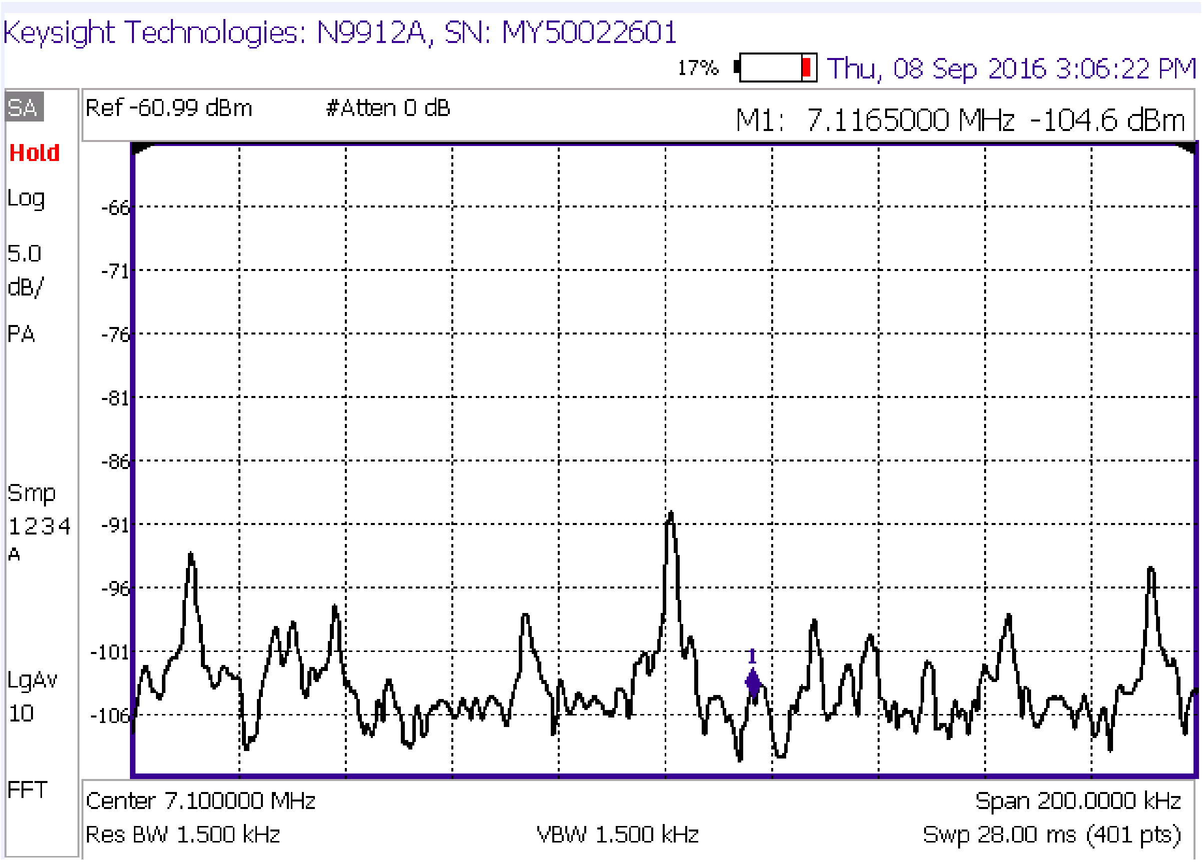
Plot 8: 3.7MHz taken from Mr [✂] own Antenna system.

Plot 8. Shows an approx. -90dbm noise floor level, the signature is indicative of what would expect to see given the equipment set up and distant transmissions being received.



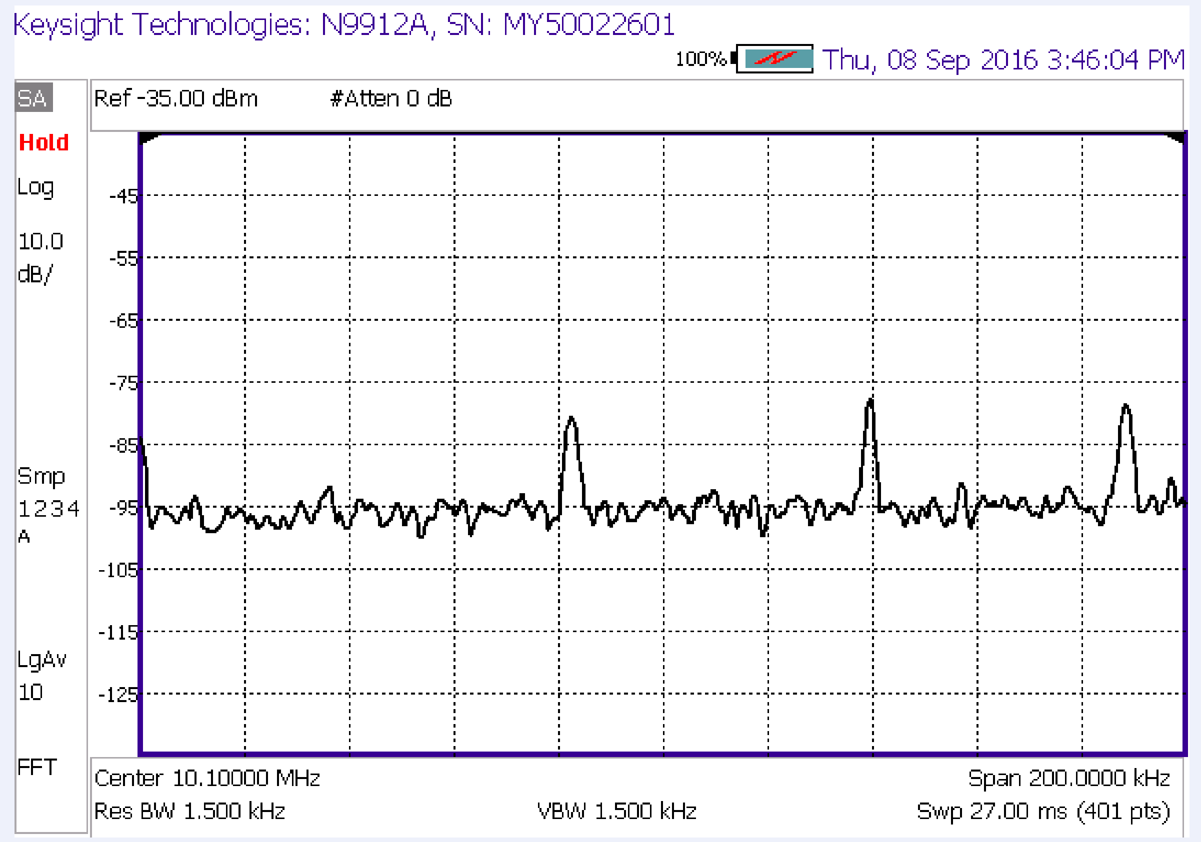
Plot 9: Fieldstrength = -102 dBm + 107 +28.1 = 33.1 dBµV/m.

Plot 9 Was taken using an Active Loop Antenna and placed on the pump up mast close to the Openreach drop wires. This would be considered an acceptable noise level given the location and the frequency band.



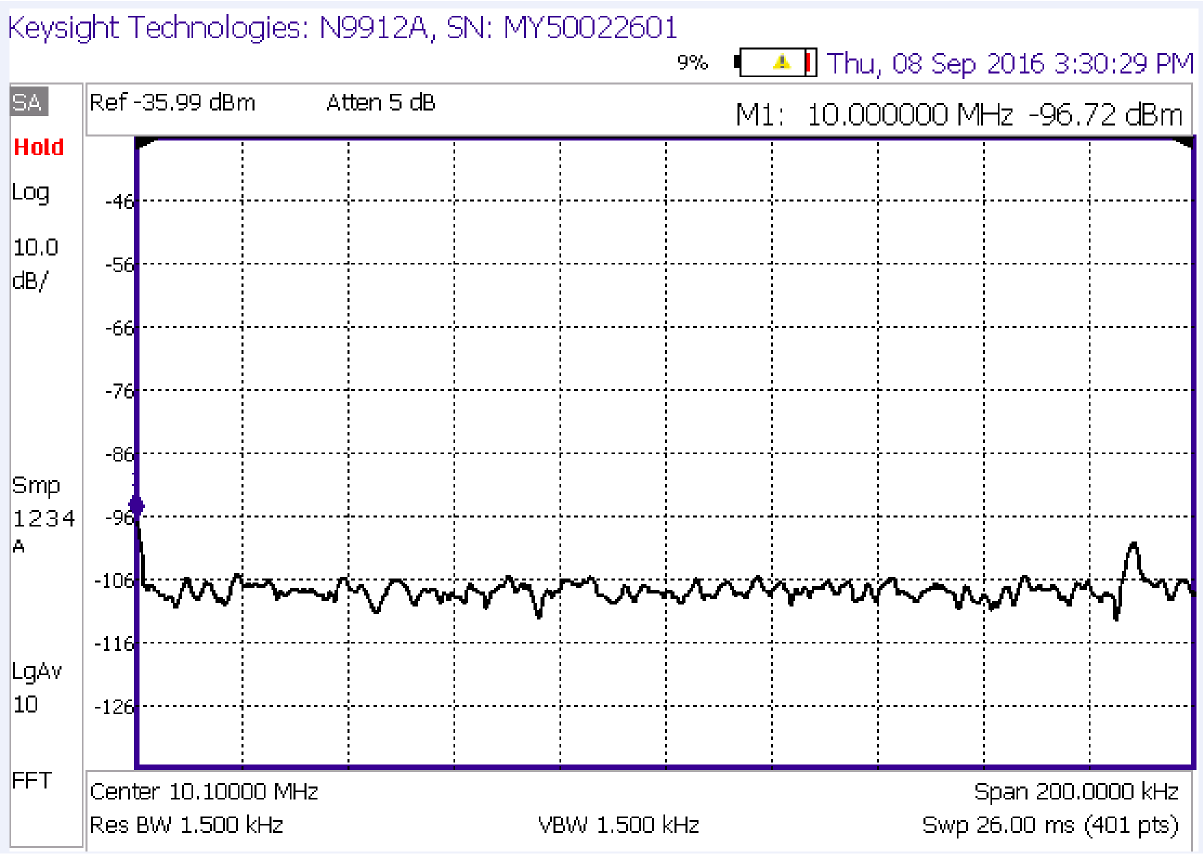
Plot 10: 7.11 MHz taken from Mr [✂] own Antenna system.

Plot 10 This band was taken as a means of reference; this was not a band that has been complained about. The noise at a mean level of -102 dBm. The spikes are long distant transmissions and not interference.



Plot 11: 10.1MHz taken from Mr [✂] own Antenna System.

Plot 11 the 30m band was taken as can be seen above. Distant transmissions coupled with a noise floor figure are as expect to see given the Frequency band in question and time of day.



Plot 12: Field strength = -106 dBm + 107 + 28.1 = 29.1 dBµV/m.

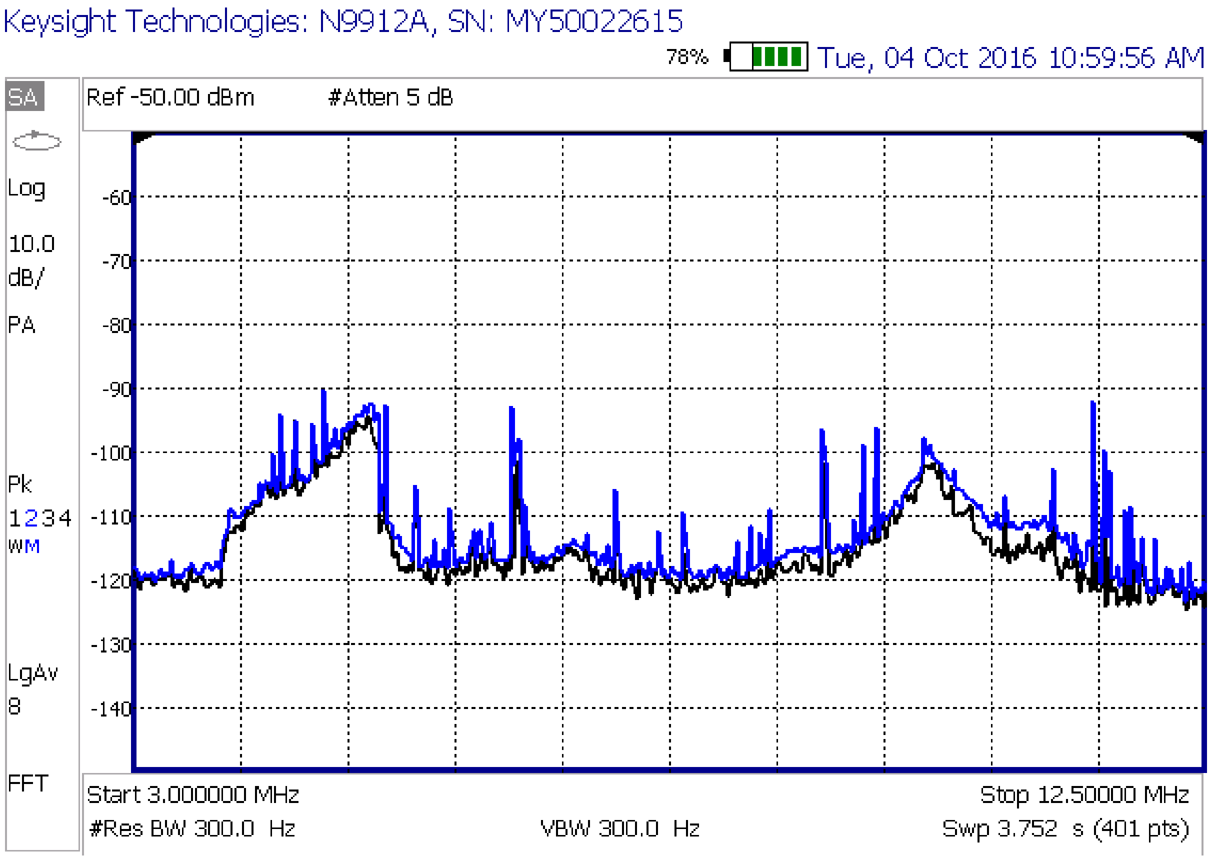
Plot 12 was taken using an Active Loop Antenna and placed on the pump up mast close to the Openreach drop wires. This would be considered an acceptable noise level.

1.4 Dr [✂] Shireoaks [✂]

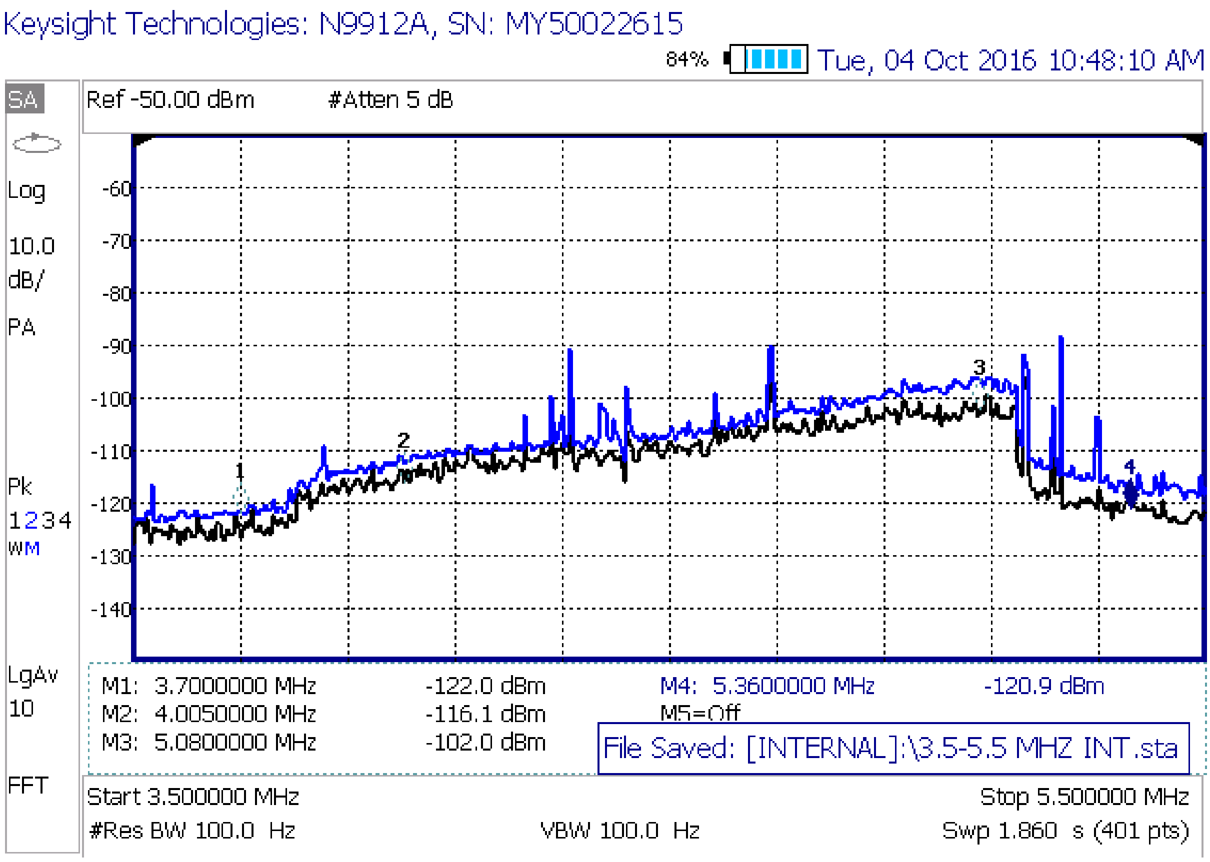
Measurements taken using Dr [✂] receive Loop antenna as no others were available.

[✂]

- Blue line - overhead twisted pairs
- Yellow numbers Measurement Points (MP)
- RX AE – the location of Dr [✂] receive antenna directly below the overhead twisted pair leading to number [✂].
- Pole – telegraph pole
- Area / land between Measurement Points (MP) 2 & 3 has been purchased by Dr [✂] and is now clear of trees. Trees are present from the South / South East directly behind MP 3 (approximately 22m from the pole in the middle of his garden



Plot 13: Initial plot of the spectrum between 3 MHz to 12.5MHz.

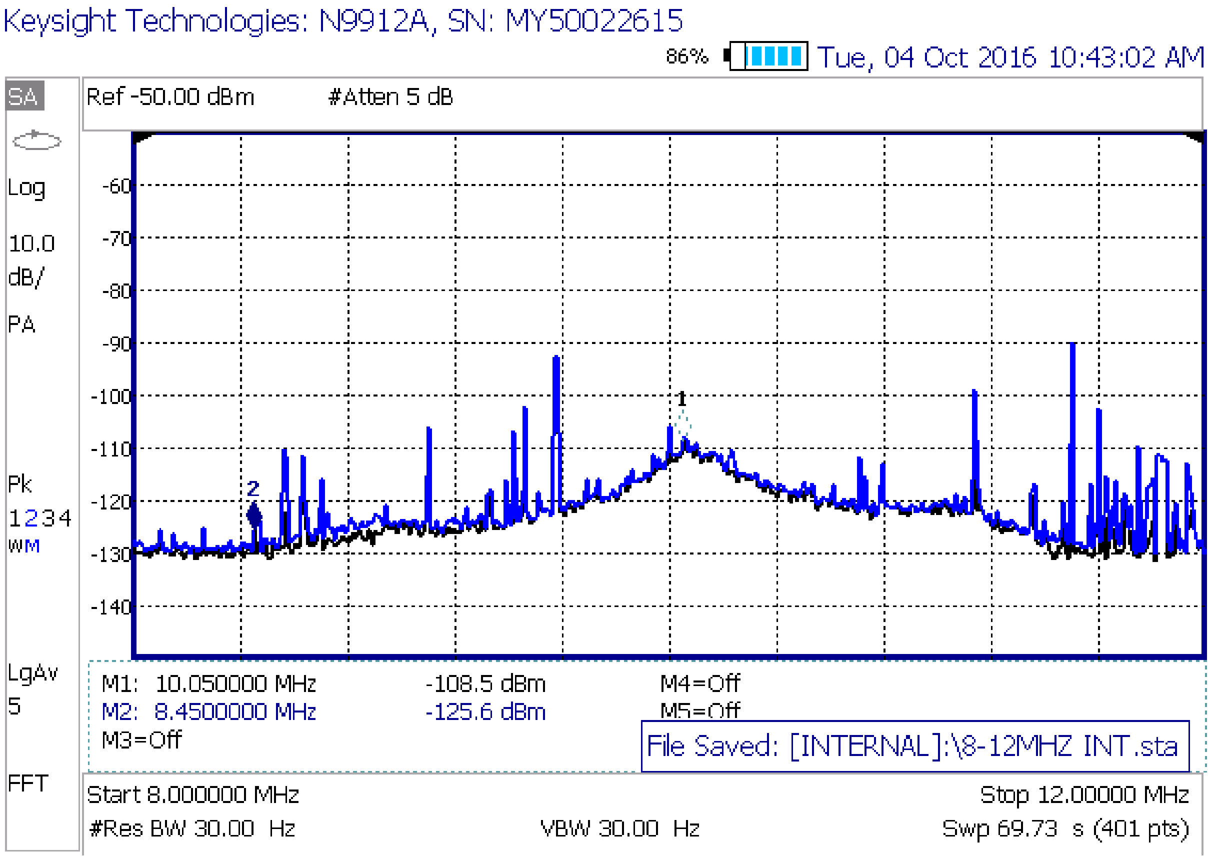


Plot 14: Measurement of the band between 3.5 MHz to 5.5 MHz

Marker 1 Value = -122.0 dBm + 107 + 28.1 = 13.1 dBµV/m

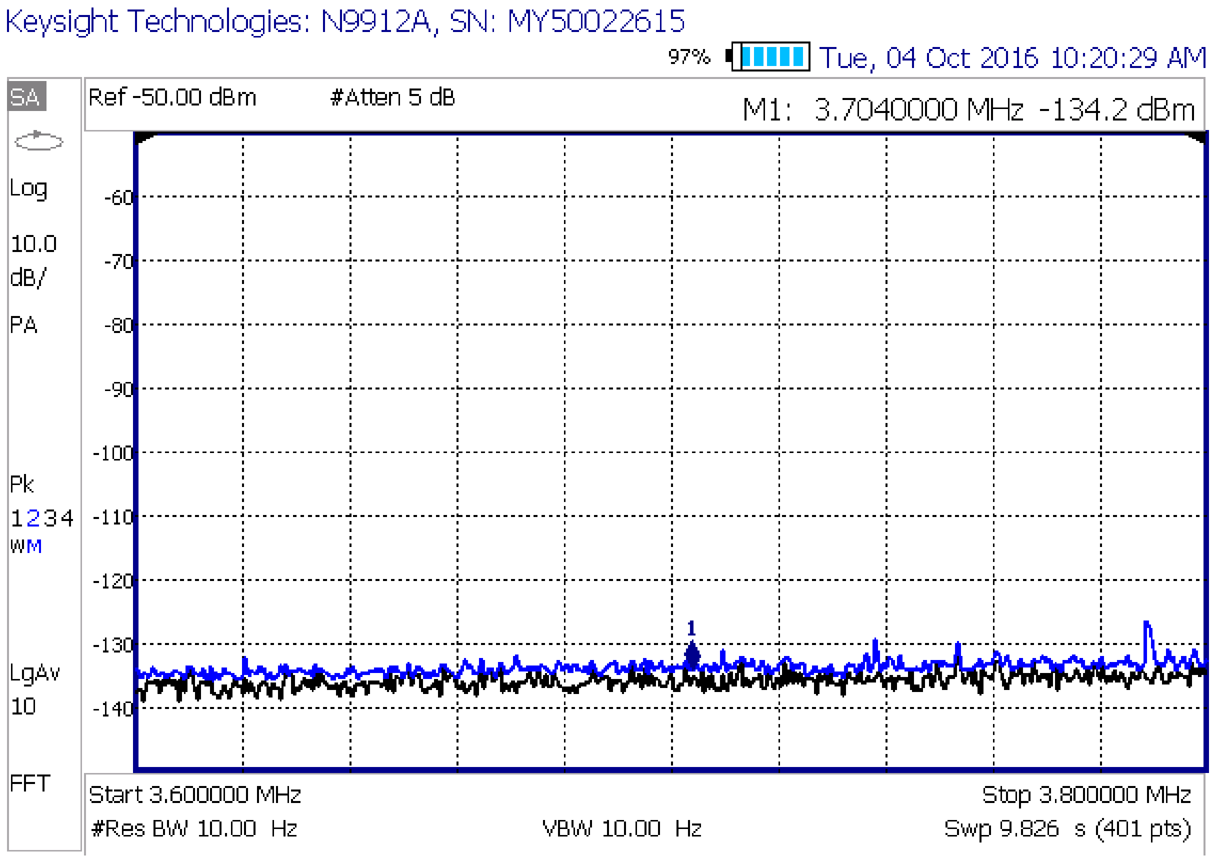
Marker 2 Value = -116.1 dBm + 107 + 28 = 18.9 dBµV/m

Marker 3 Value = -102.0 dBm + 107 + 28 = 33 dBµV/m



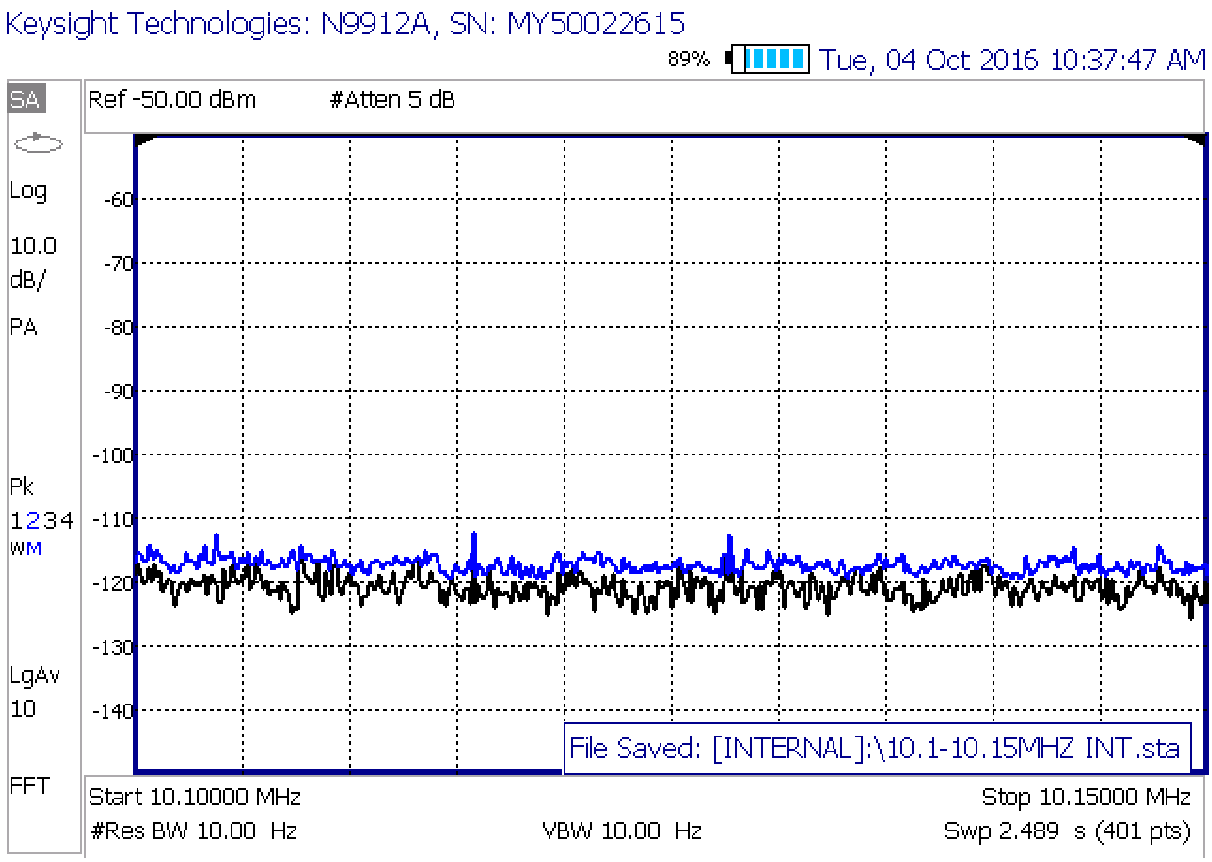
Plot 15: Marker 1 = -108.5 dBm + 107 + 28.1 = 26.6 dBµV/m

Dr [✂] expressed concern with regards to an area of spectrum centred around 10.05 MHz so a plot was taken of this band.



Plot 16: Radio amateur spectrum as used by Dr [✂], 3.6-3.8Mhz.

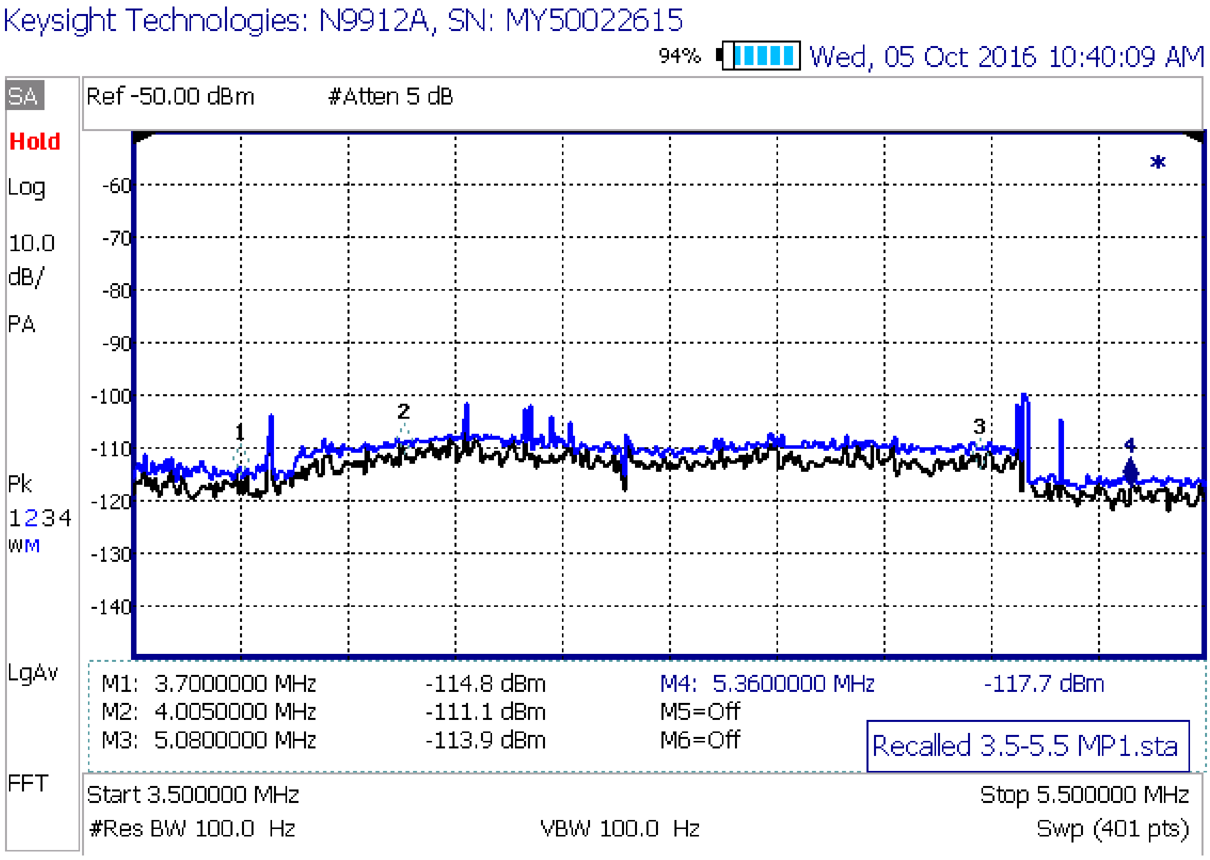
Marker 1 = -134.2 dBm + 107 + 28 = 0.8 dBμV/m



Plot 17: Radio amateur UK allocated frequencies from 10.1-10.15MHz

Ambient Noise Floor Level approximately -115.0 dBm + 107 + 28.1 = 20.1 dBµV/m

Measurement Point 1 – Near Window of Dr [✂] Shack Approximately 3m from his receive antenna and approximately 4m directly below the overhead twisted pair leading to number [✂]. The measuring antenna was at a height of 1.8m above the ground. This location was 20m from the base of the pole.



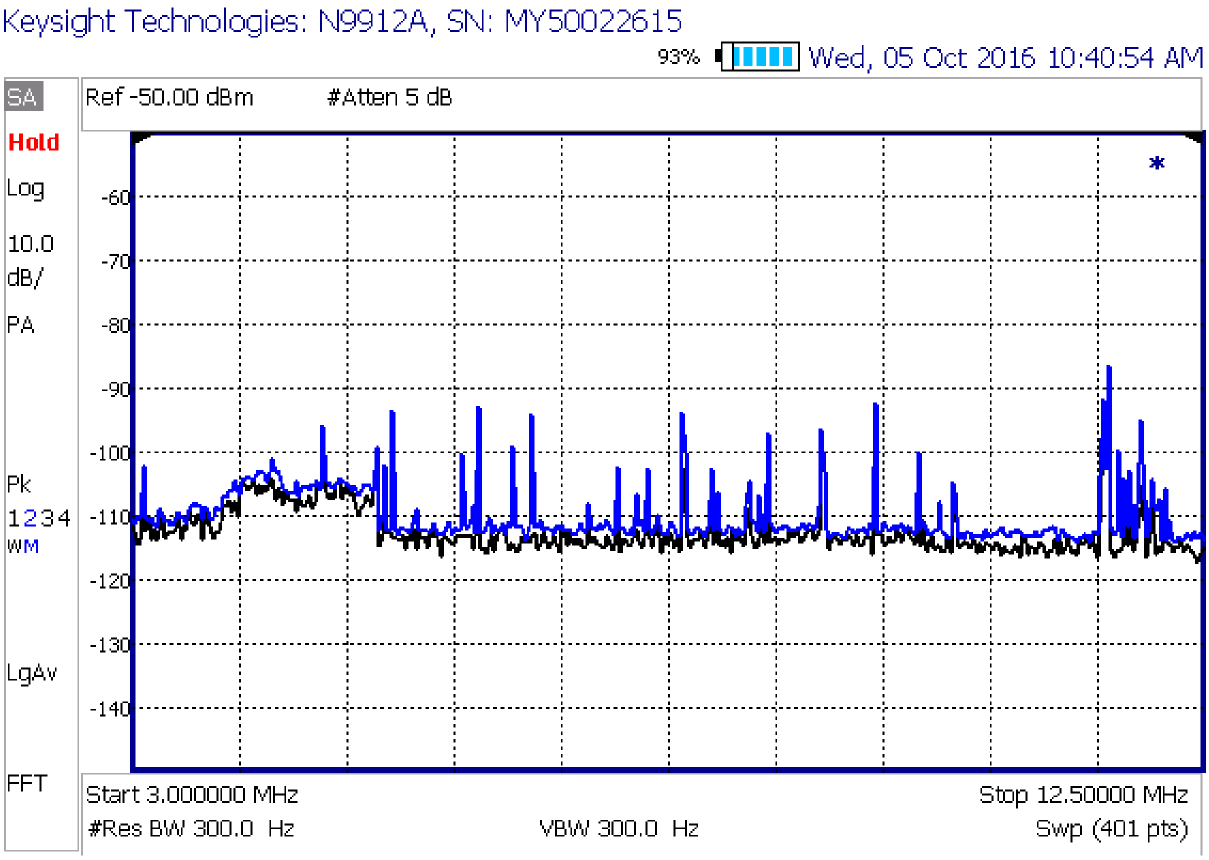
Plot 18: 3.5-5.5MHz

Marker 1 = -114.8 dBm + 107 + 28 = 20.2 dBµV/m

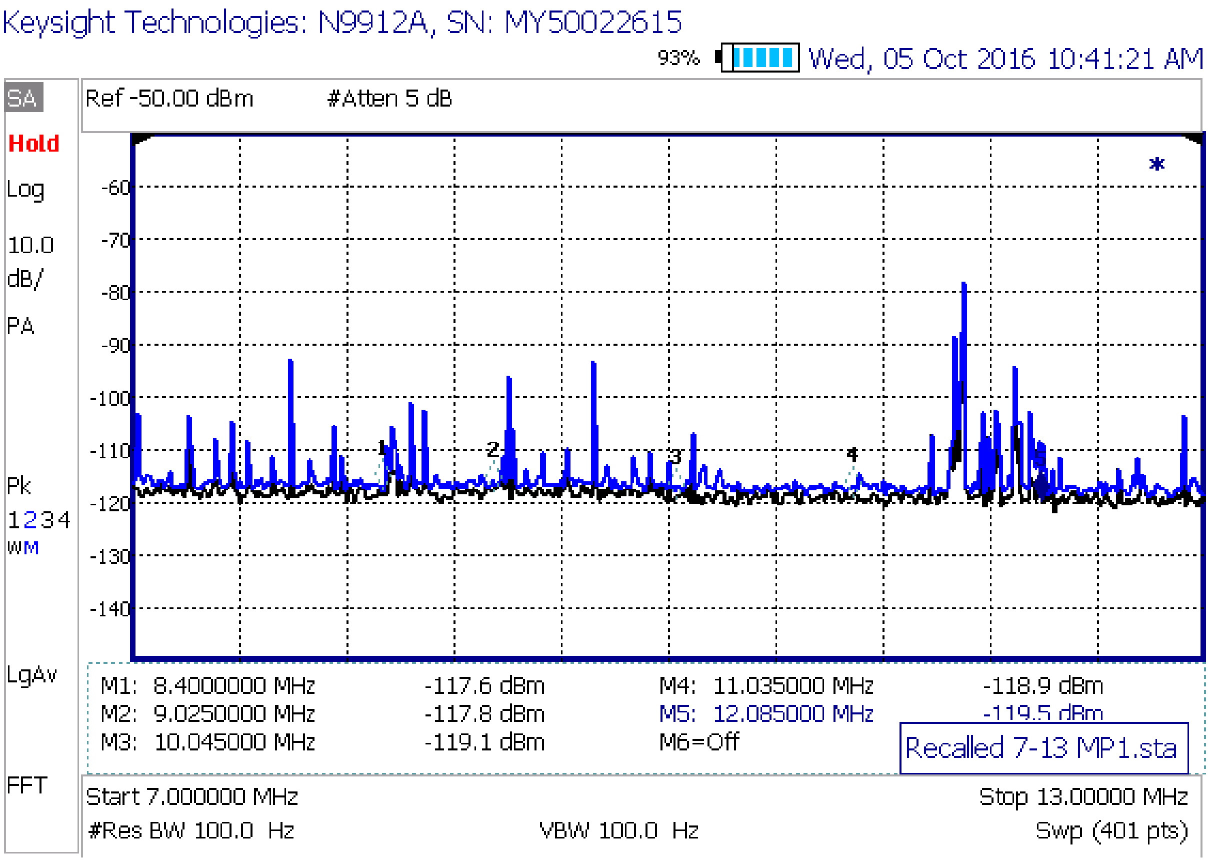
Marker 2 = -111.1 dBm + 107 + 28.1 = 24 dBµV/m

Marker 3 = -113.9 dBm + 107 + 28 = 21.1 dBµV/m

Marker 4 = -117.7 dBm + 107 + 28 = 17.3 dBµV/m



Plot 19 3.5-12.5MHz



Plot 20 7-13MHz

Marker 1 = -117.6 dBm + 107 + 28.2 = 17.6 dBµV/m

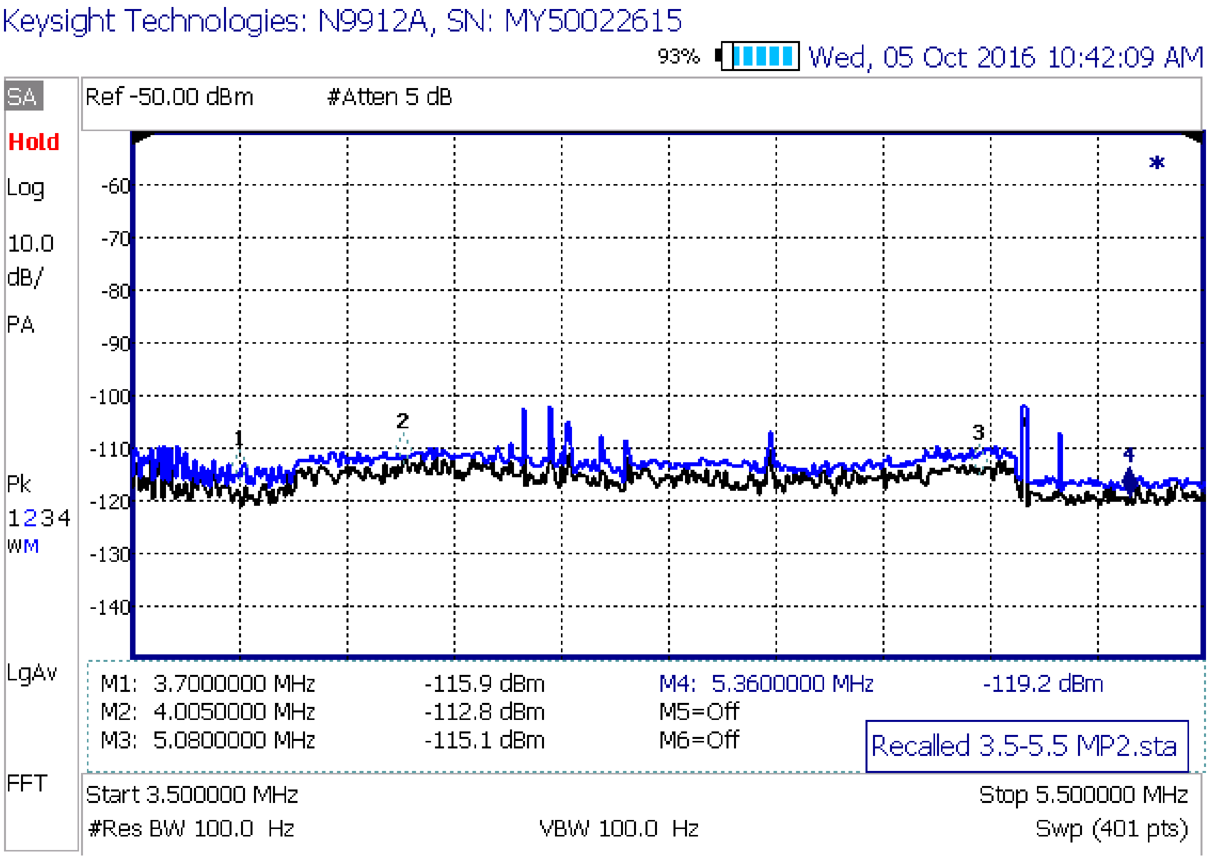
Marker 2 = -117.8 dBm + 107 + 28.1 = 17.3 dBµV/m

Marker 3 = -119.1 dBm + 107 + 28.1 = 16 dBµV/m

Marker 4 = -118.9 dBm + 107 + 28.1 = 16.2 dBµV/m

Marker 5 = -119.5 dBm + 107 + 28.2 = 15.7 dBµV/m

Measurement Point 2 – Base of telegraph pole in Dr [✂] back garden. The overhead twisted pairs were at a height of 9m approximately with the measuring antenna at a height of 1.8m above the ground directly below the overhead twisted pairs



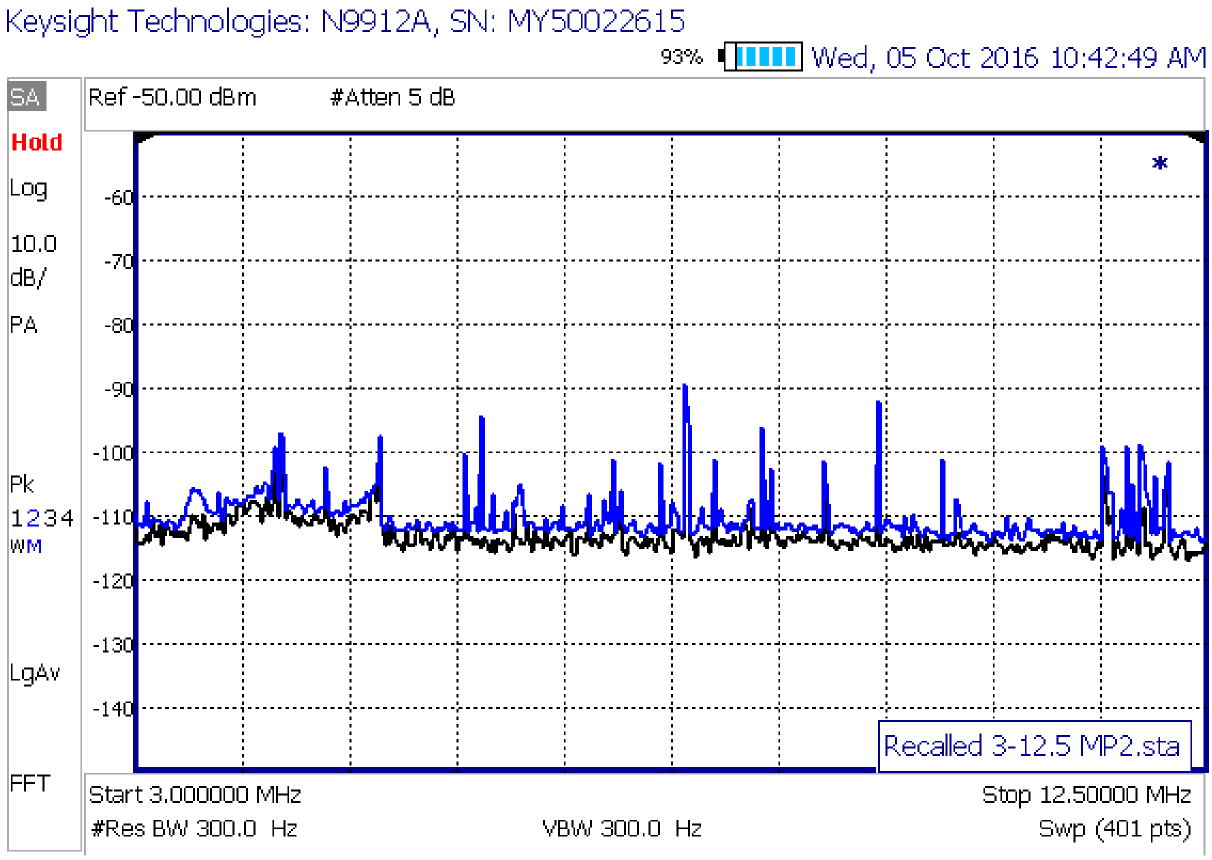
Plot 21 3.5-5.5 MHz

Marker 1 = -115.9 dBm + 107 + 28 = 19.1 dBµV/m

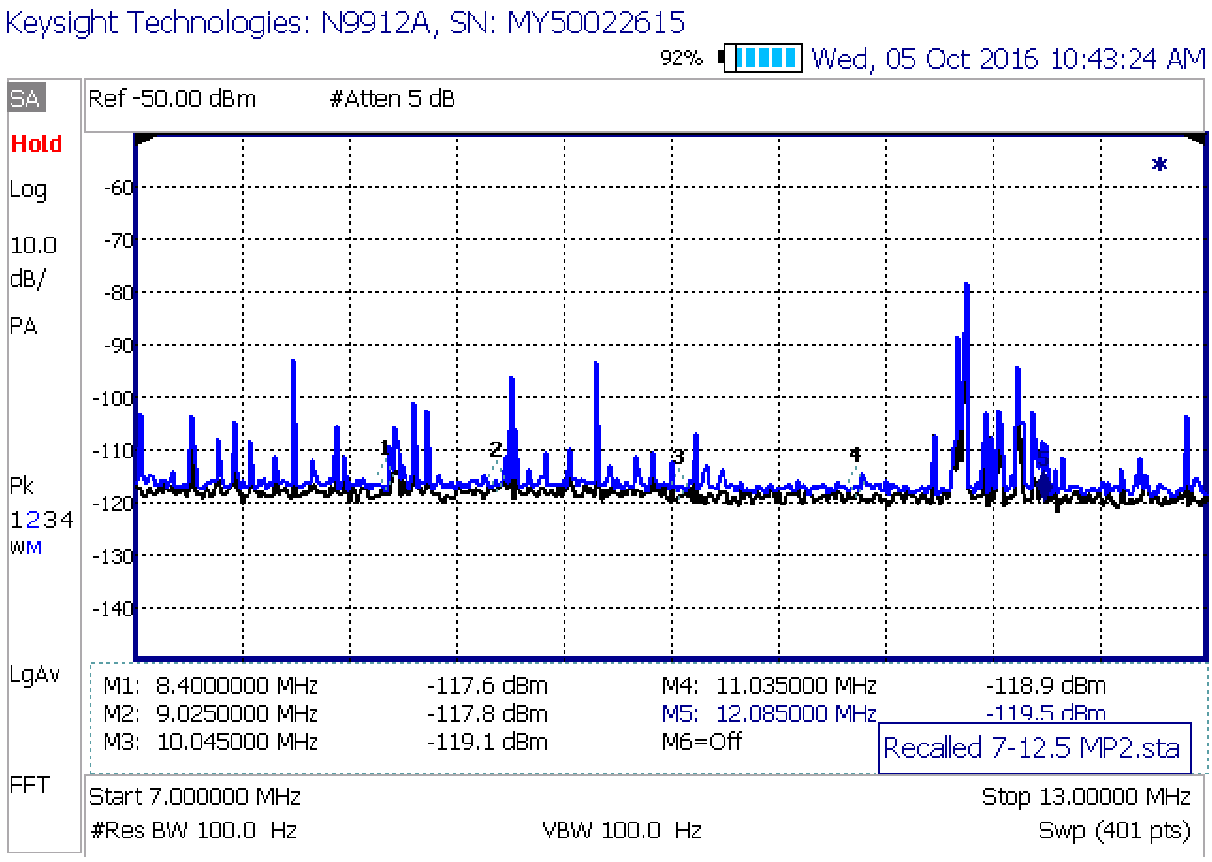
Marker 2 = -112.8 dBm + 107 + 28.1 = 22.3 dBµV/m

Marker 3 = -115.1 dBm + 107 + 28 = 19.9 dBµV/m

Marker 4 = -119.2 dBm + 107 + 28 = 15.8 dBµV/m



Plot 22 3-12.5MHz



Plot 23 7-12.5MHz

Marker 1 = -117.6 dBm + 107 + 28.2 = 17.6 dBµV/m

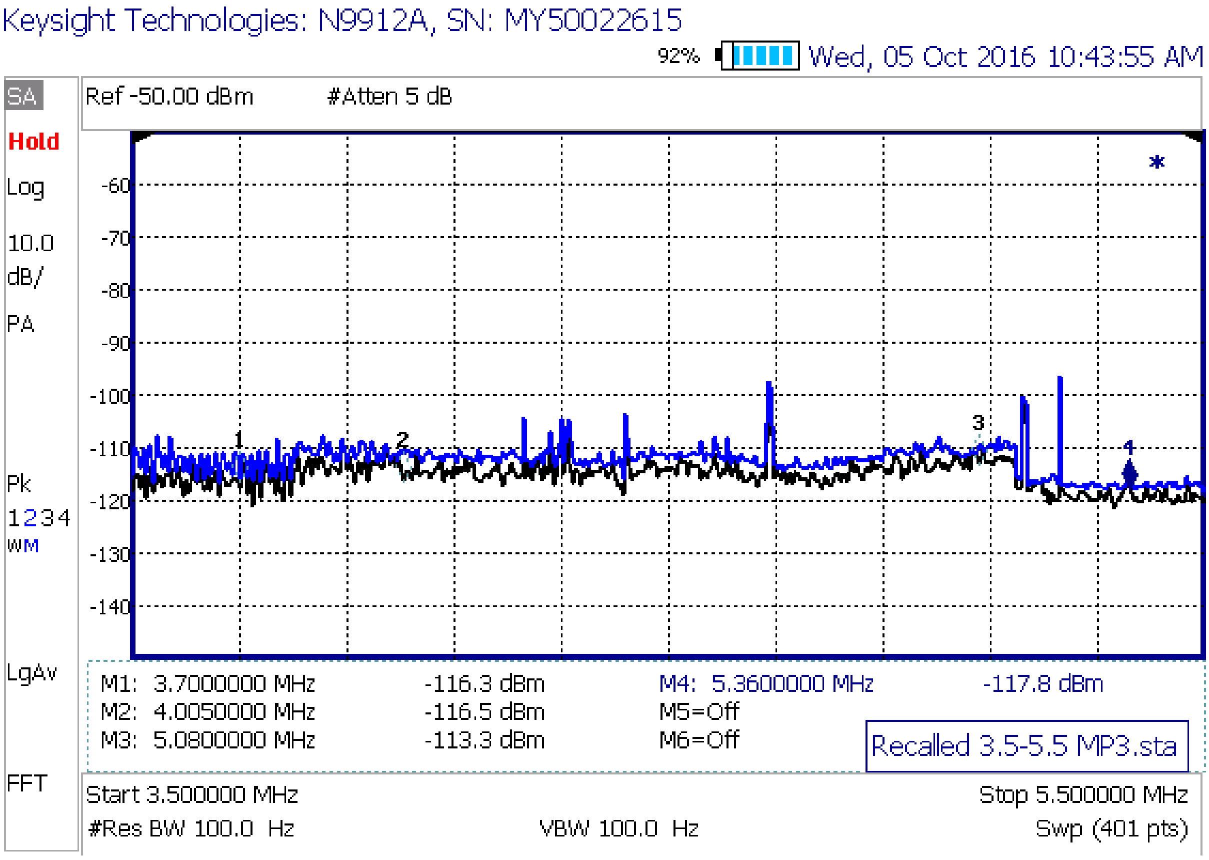
Marker 2 = -117.8 dBm + 107 + 28.1 = 17.3 dBµV/m

Marker 3 = -119.1 dBm + 107 + 28.1 = 16 dBµV/m

Marker 4 = -118.9 dBm + 107 + 28.2 = 16.3 dBµV/m

Marker 5 = -119.5 dBm + 107 + 28.2 = 15.7 dBµV/m

Measurement Point 3 – The Southern (S - S/E) curtilage of Dr [✂] property. The overhead twisted pairs were at an approximate height of 9m and the measuring antenna was at a height of 1.8m above the ground directly below the overhead twisted pairs. This location was 22m from the telegraph pole in Dr [✂] back garden.



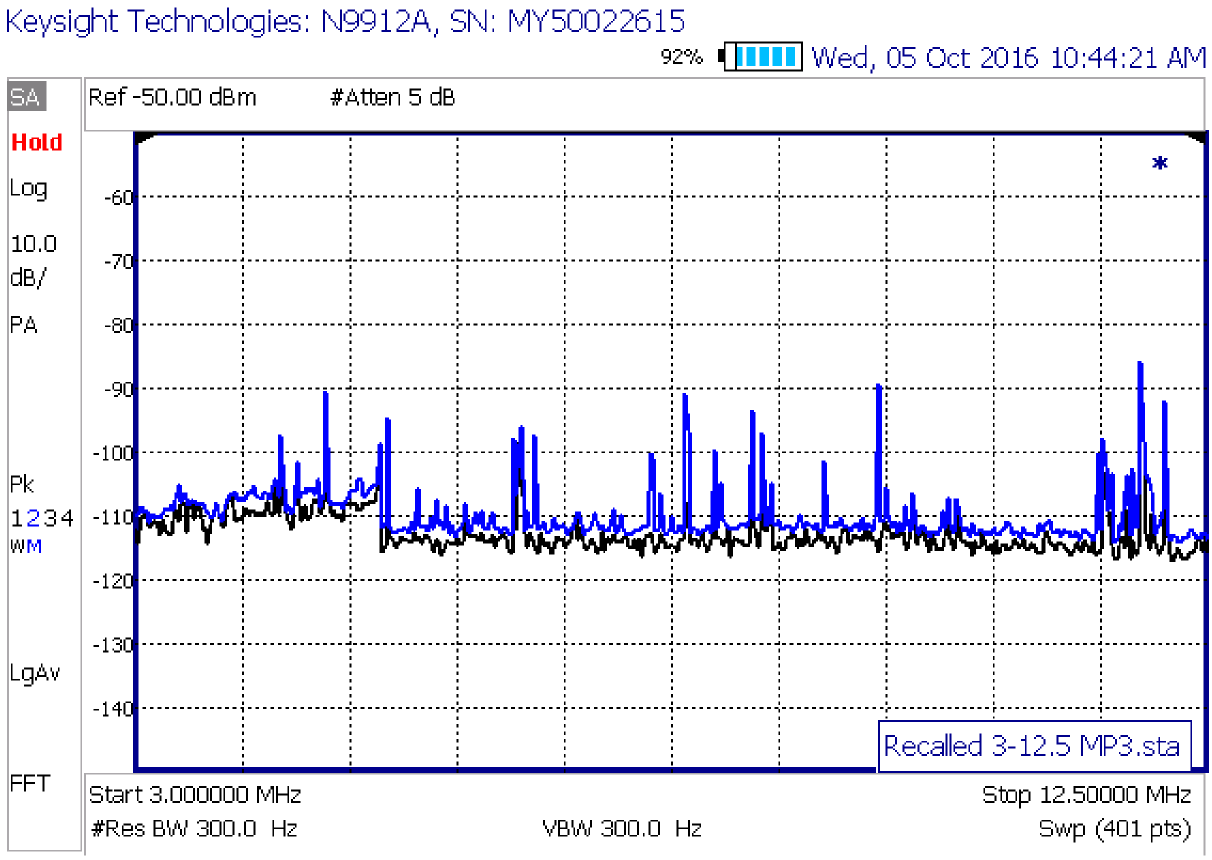
Plot 24 3.5-5.5MHz

Marker 1 = -116.3 dBm + 107 + 28 = 18.7 dBµV/m

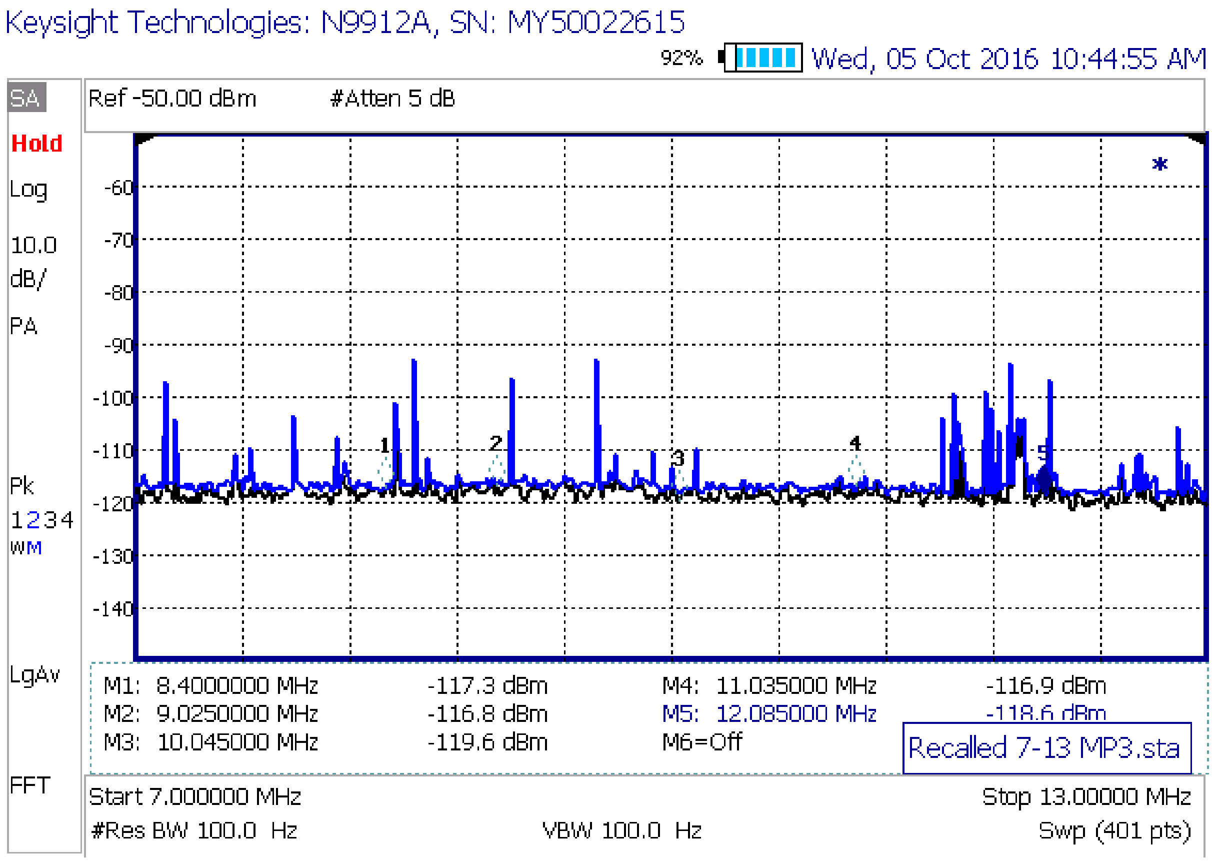
Marker 2 = -116.5 dBm + 107 + 28.1 = 18.6 dBµV/m

Marker 3 = -113.3 dBm + 107 + 28 = 21.7 dBµV/m

Marker 4 = -117.8 dBm + 107 + 28 = 17.2 dBµV/m



Plot 25 3-12.5MHz



Plot 26 7-13MHz

Marker 1 = -117.3 dBm + 107 + 28.2 = 17.9 dBµV/m

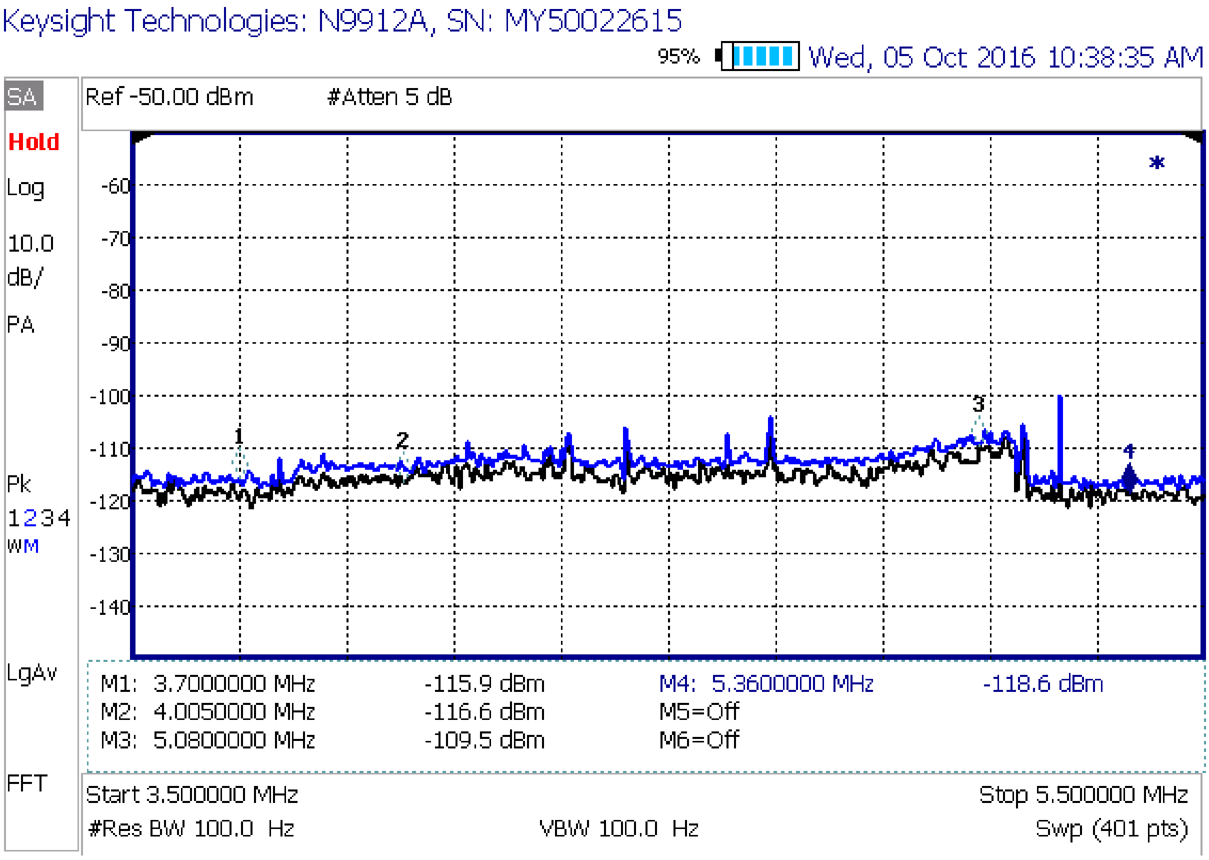
Marker 2 = -116.8 dBm + 107 + 28.1 = 18.3 dBµV/m

Marker 3 = -119.6 dBm + 107 + 28.1 = 15.5 dBµV/m

Marker 4 = -116.9 dBm + 107 + 28.2 = 18.3 dBµV/m

Marker 5 = -118.6 dBm + 107 + 28.2 = 16.6 dBµV/m

Measurement Point 4 – The front curtilage of Dr [✂] property 45.5m from the telegraph pole in his back garden and 13.8m from the front of his house. The measuring antenna was at a height of 1.8m above the ground and approximately 7m below the overhead twisted pairs.



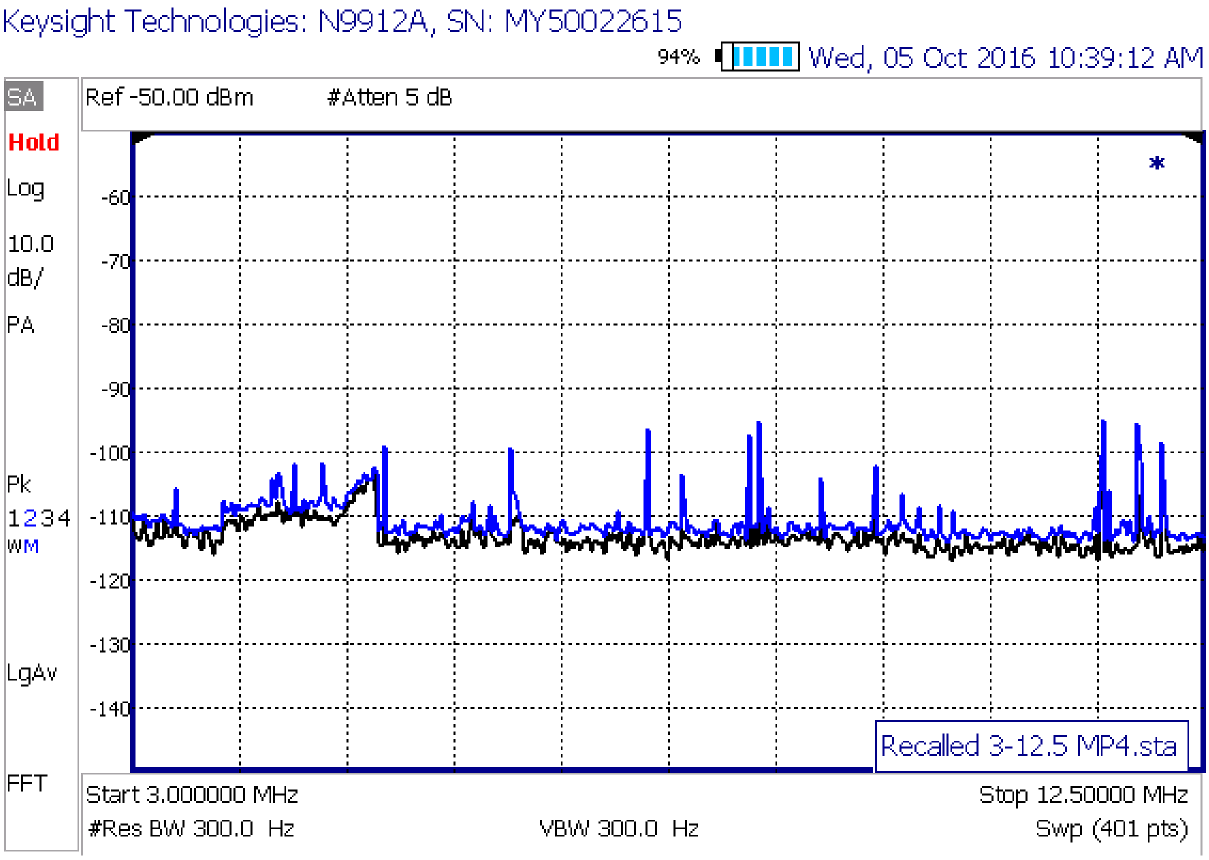
Plot 27 3.5-5.5MHz

Marker 1 = -115.9 dBm + 107 + 28 = 19.1 dBµV/m

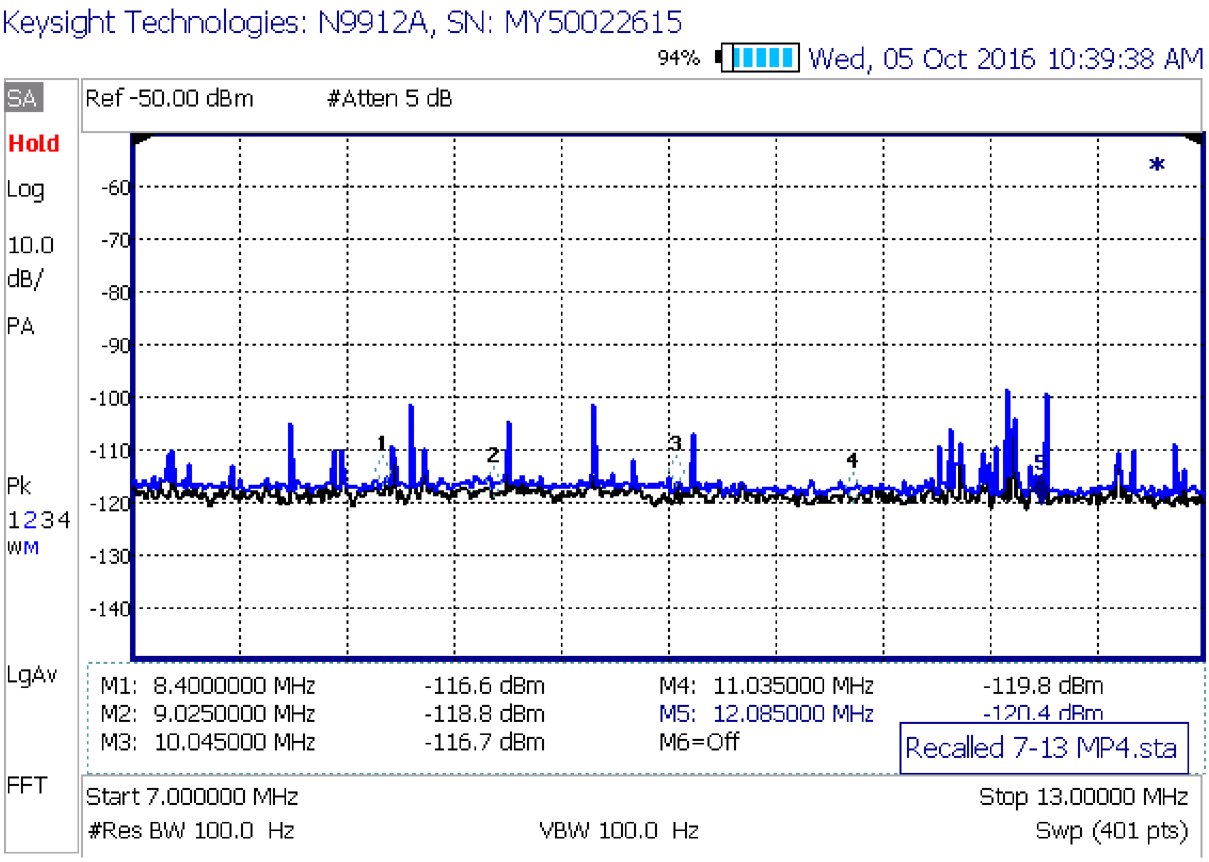
Marker 2 = -116.6 dBm + 107 + 28.1= 18.5 dBµV/m

Marker 3 = -109.5 dBm + 107 + 28 = 25.5 dBµV/m

Marker 4 = -118.6 dBm + 107 + 28 = 16.4 dBµV/m



Plot 28 3-12.5MHz



Plot 29 7-13MHz

Marker 1 = -116.6 dBm + 107 + 28.2 = 18.6 dBµV/m

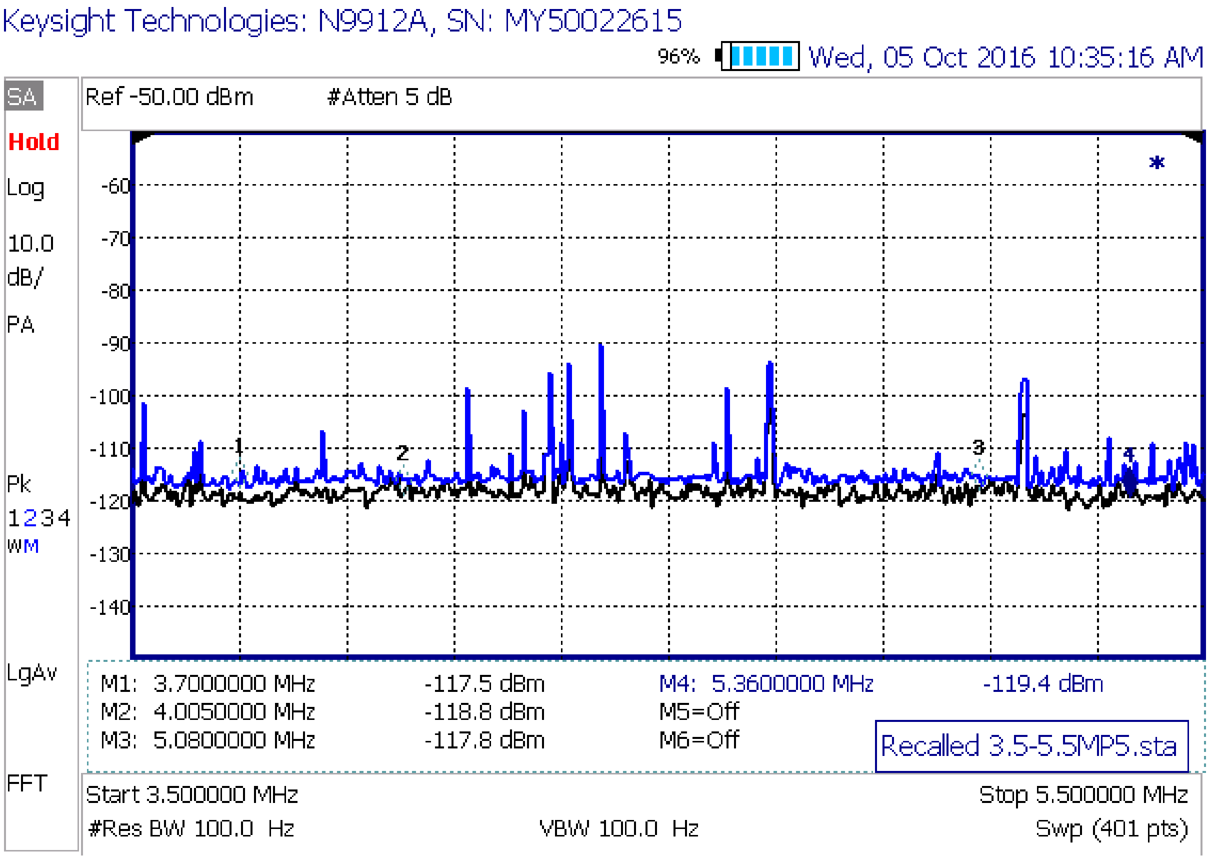
Marker 2 = -118.8 dBm + 107 + 28.1= 16.3 dBµV/m

Marker 3 = -116.7 dBm + 107 + 28.1= 18.4 dBµV/m

Marker 4 = -119.8 dBm + 107 + 28.2 = 15.4 dBµV/m

Marker 5 = -120.4 dBm + 107 + 28.2 = 14.8 dBµV/m

Measurement Point 5 – Outside the gate/drive entrance to Dr [✂] property 12.2m from Dr [✂] house and 13.5m from the overhead cable running over MP 4. The measuring antenna was at a height of 1.8m above the ground.



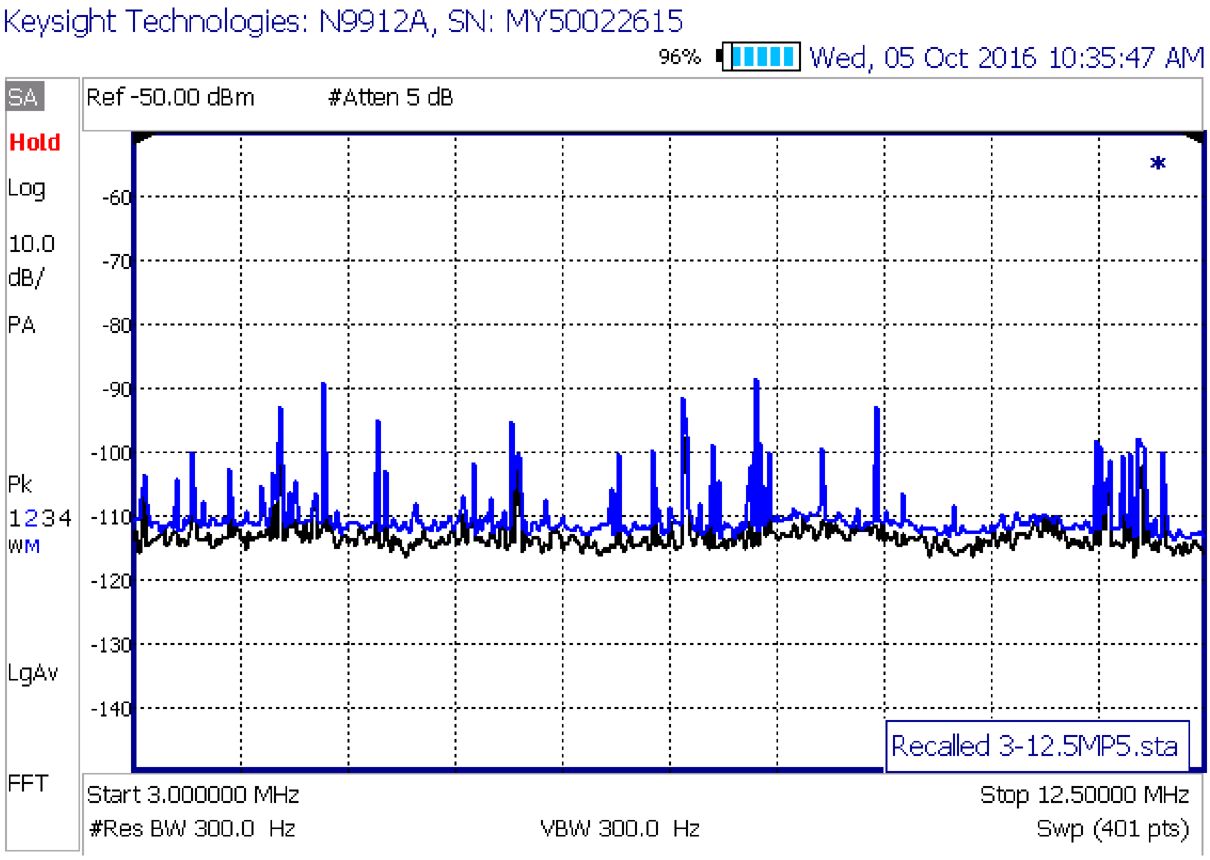
Plot 30 3.5-5.5MHz

Marker 1 = -117.5 dBm + 107 + 28 = 17.5 dBµV/m

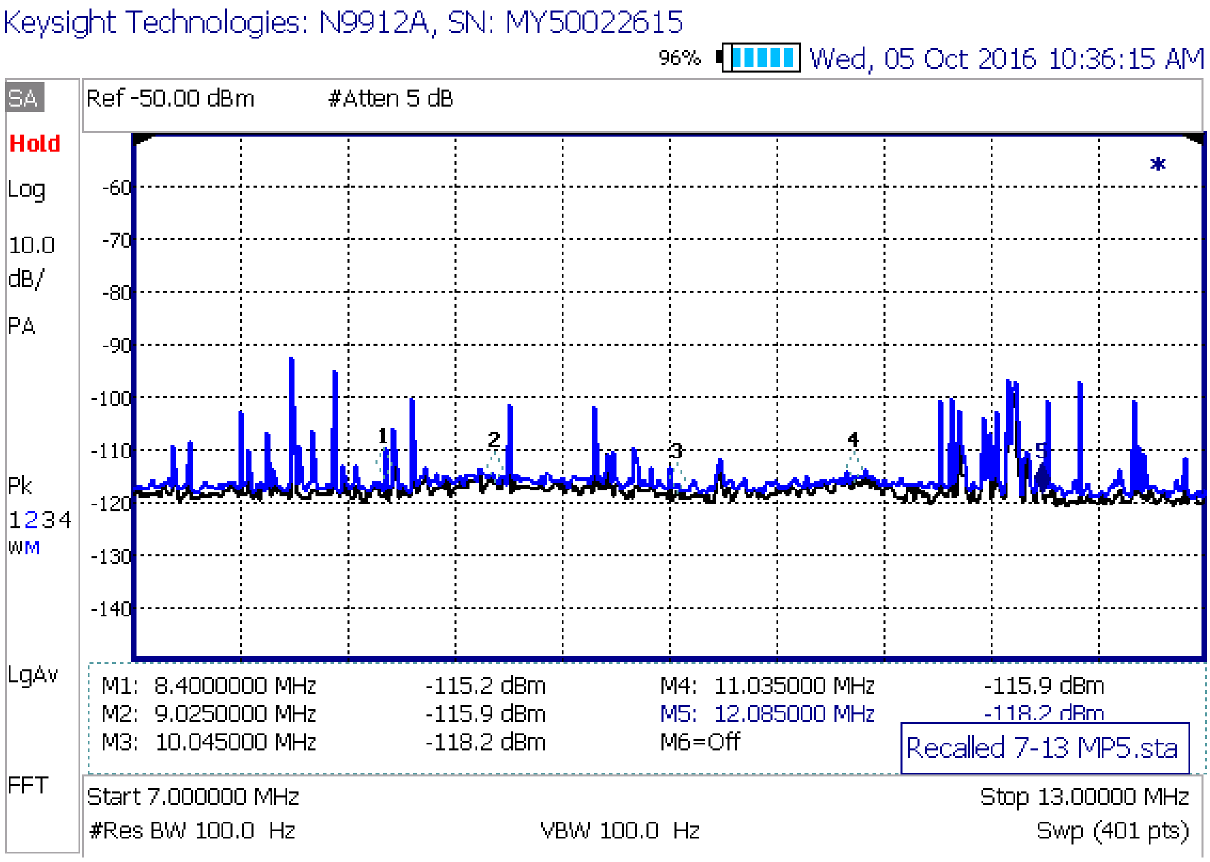
Marker 2 = -118.8 dBm + 107 + 28 = 16.2 dBµV/m

Marker 3 = -117.8 dBm + 107 + 28.1 = 17.3 dBµV/m

Marker 4 = -119.4 dBm + 107 + 28 = 15.6 dBµV/m



Plot 31 3-12.5MHz



Plot 32 7-13MHz

Marker 1 = -115.2 dBm + 107 + 28.2 = 19 dBµV/m

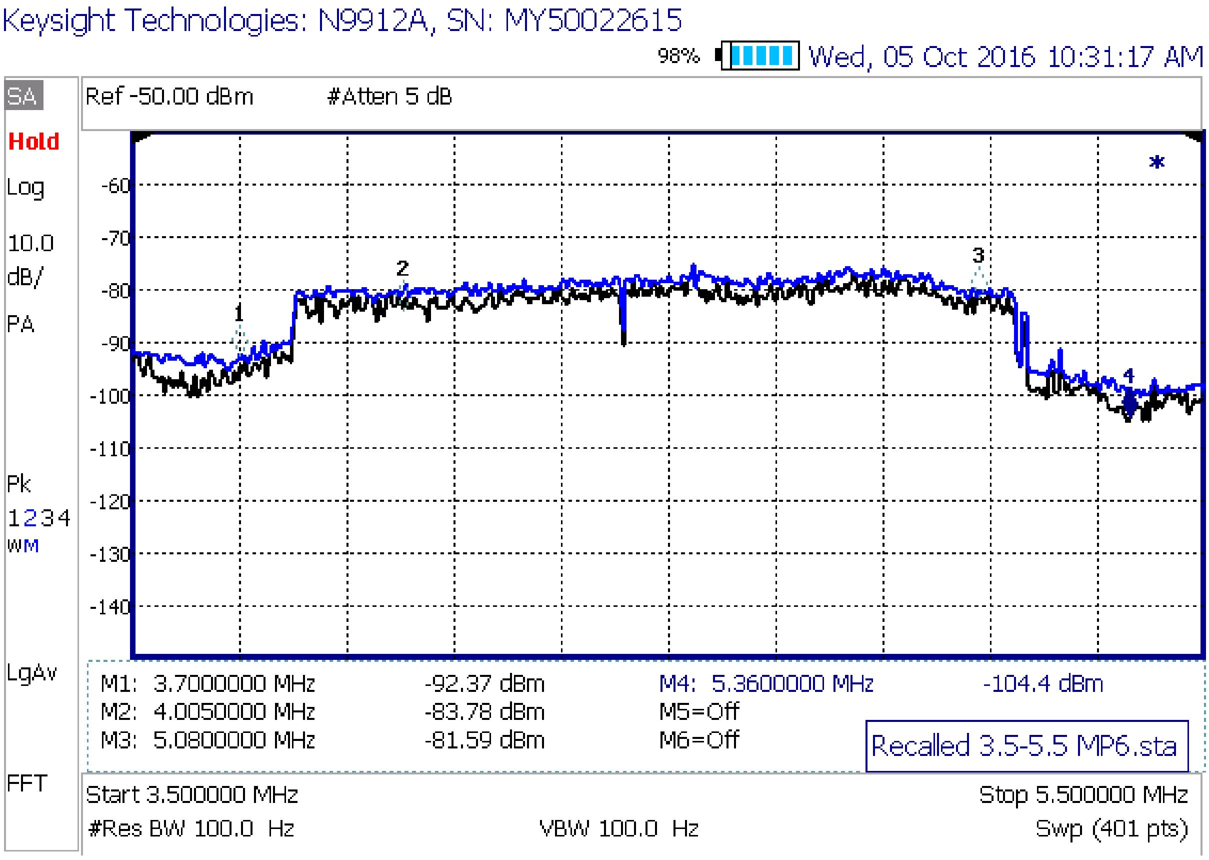
Marker 2 = -115.9 dBm + 107 + 28.1 = 19.2 dBµV/m

Marker 3 = -118.2 dBm + 107 + 28.1 = 16.9 dBµV/m

Marker 4 = -115.9 dBm + 107 + 28.2 = 19.3 dBµV/m

Marker 5 = -118.2 dBm + 107 + 28.2 = 17 dBµV/m

Measurement Point 6 – Telegraph pole to the North (N – N/W) of Dr [✂] on the opposite side of [✂]. The pole was approximately 9m tall and the measuring antenna was held against the cable (coupled) running from underground up the pole. The height of the antenna was approximately 1m from the base of the pole.



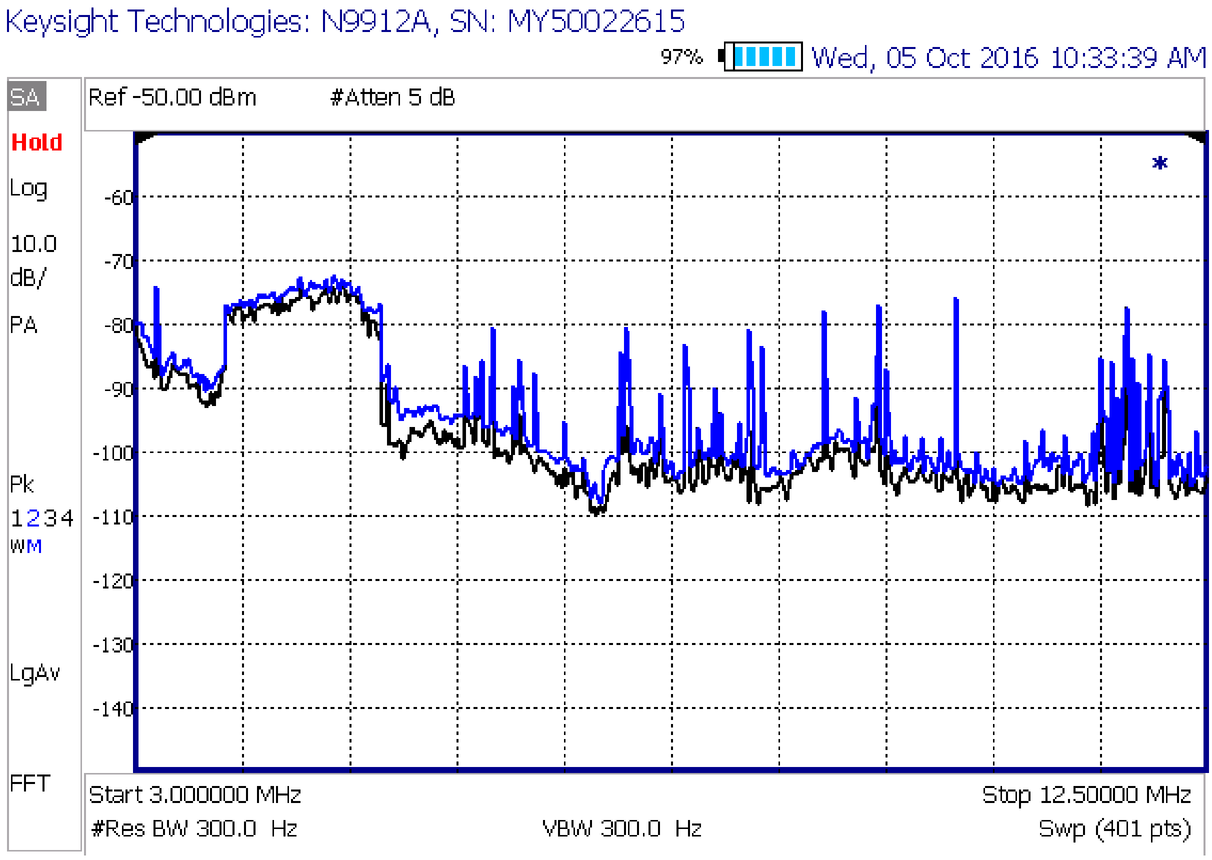
Plot 33 3.5-5.5MHz

Marker 1 = -92.37 dBm + 107 + 28 = 42.63 dBµV/m

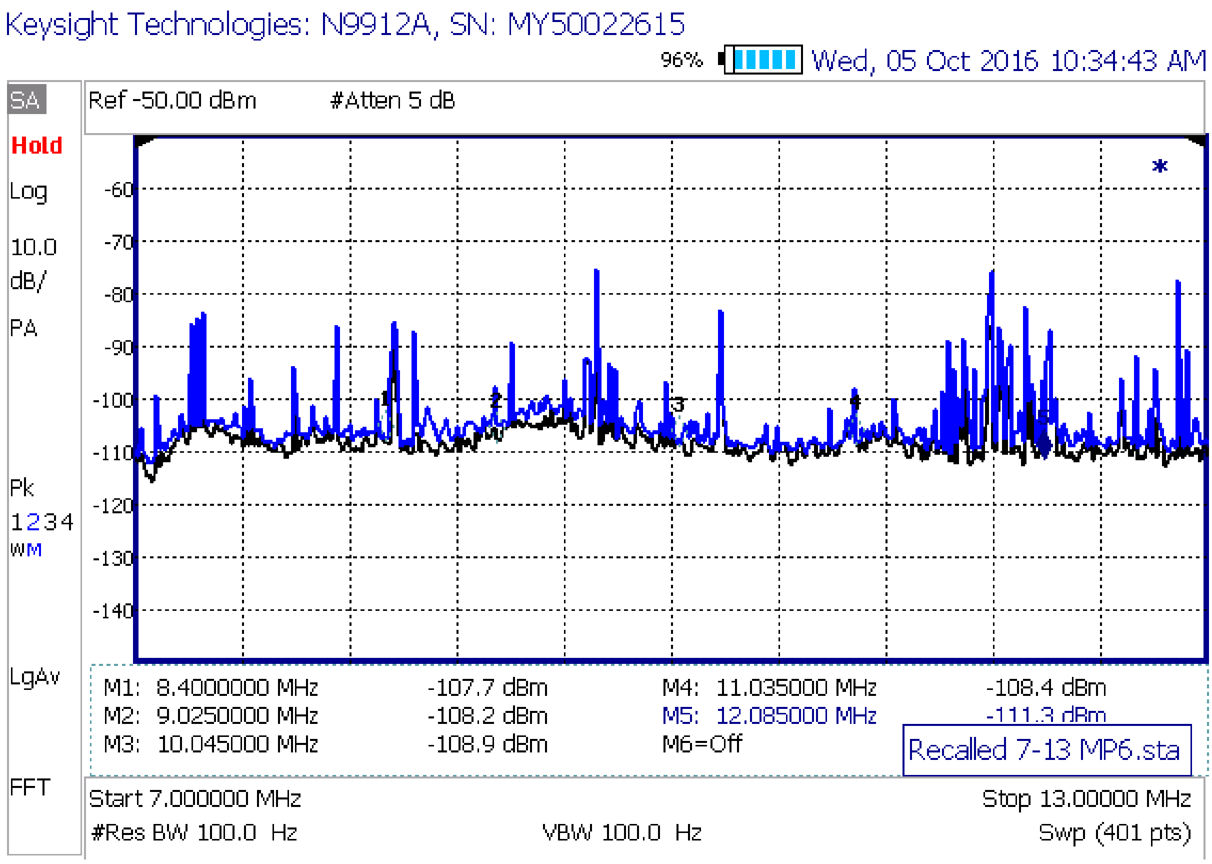
Marker 2 = -83.78 dBm + 107 + 28 = 51.22 dBµV/m

Marker 3 = -81.59 dBm + 107 + 28.1= 53.51 dBµV/m

Marker 4 = -104.4 dBm + 107 + 28 = 30.6 dBµV/m



Plot 34 3-12.5MHz



Plot 35 7-13MHz

Marker 1 = -107.7 dBm + 107 + 28.2 = 27.5 dBµV/m

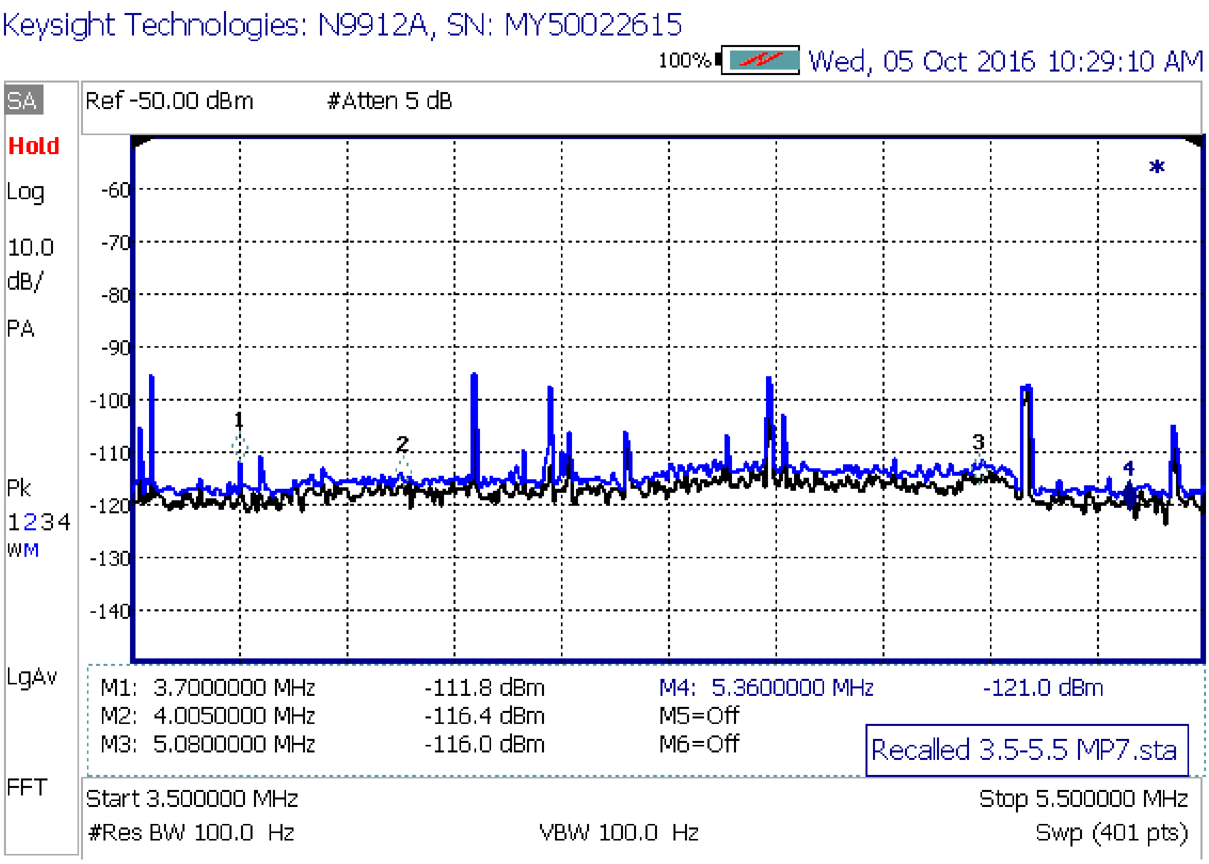
Marker 2 = -108.2 dBm + 107 + 28.1 = 26.9 dBµV/m

Marker 3 = -108.9 dBm + 107 + 28.1 = 26.2 dBµV/m

Marker 4 = -108.4 dBm + 107 + 28.2 = 26.8 dBµV/m

Marker 5 = -111.3 dBm + 107 + 28.2 = 23.9 dBµV/m

Measurement Point 7 – Telegraph pole to South (S – S/E) of the curtilage of Dr [✂] property approximately 85m from the telegraph pole in his back garden (MP. The pole was marked as a 9m pole and the measuring antenna was at a height of 1.8m above the ground. The measuring antenna was approximately 1m away from being directly below the overhead twisted pairs.



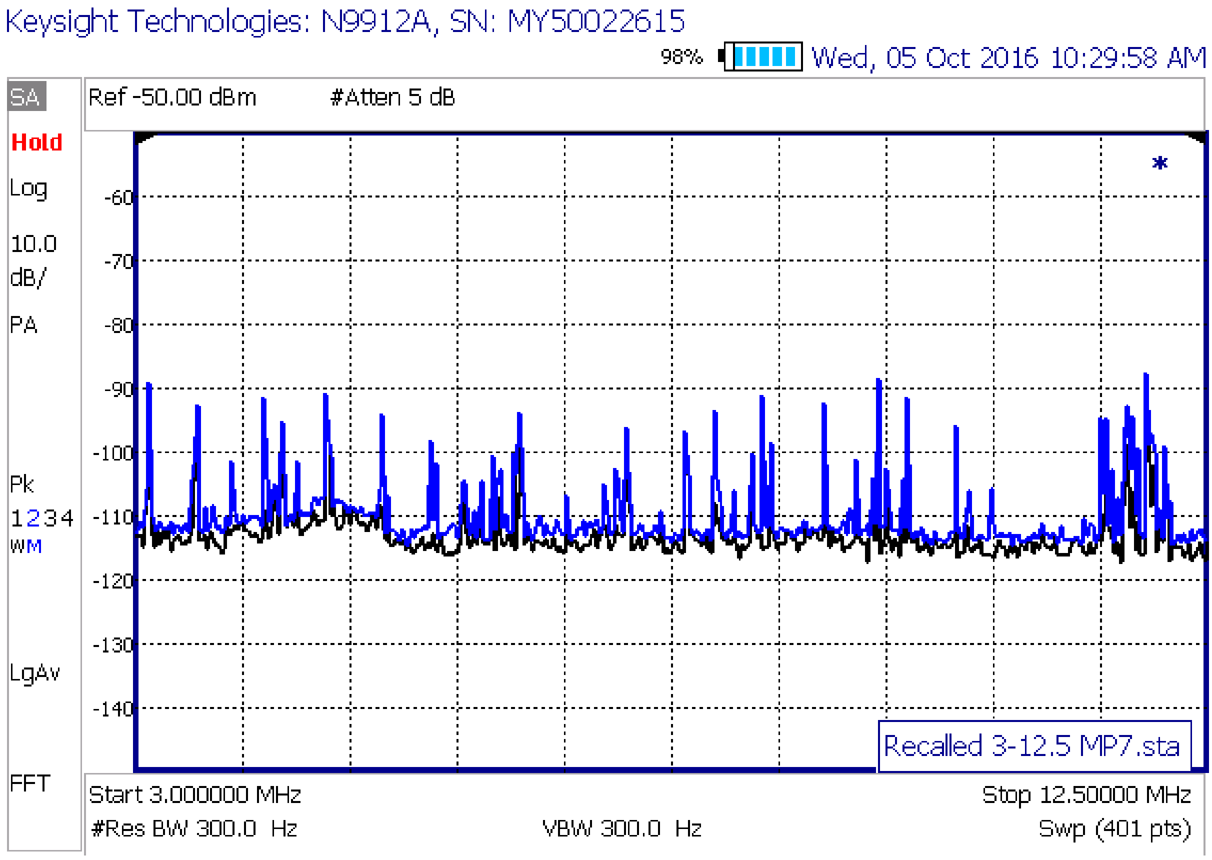
Plot 36 3.5-5.5MHz

Marker 1 = -111.8 dBm + 107 + 28 = 23.2 dBµV/m

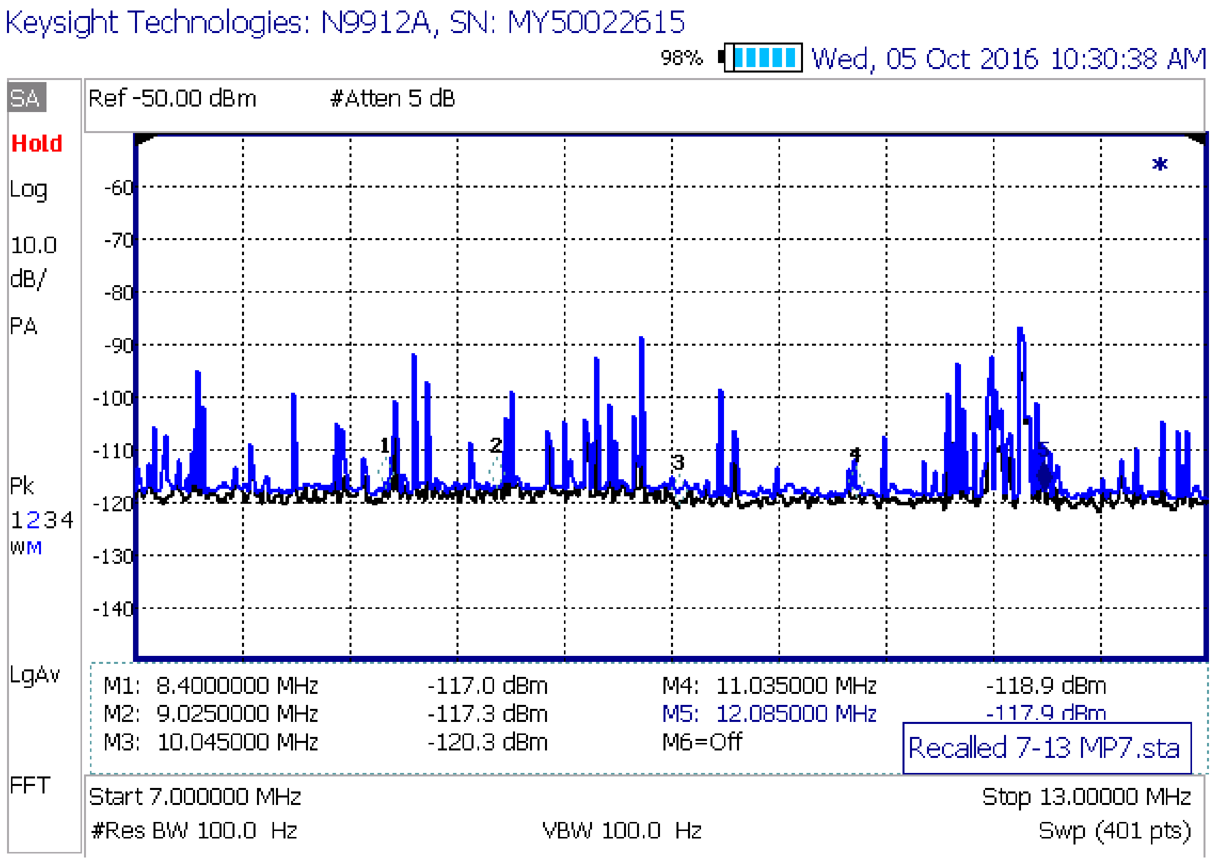
Marker 2 = -116.4 dBm + 107 + 28 = 18.6 dBµV/m

Marker 3 = -116.0 dBm + 107 + 28.1 = 19.1 dBµV/m

Marker 4 = -121.0 dBm + 107 + 28 = 14 dBµV/m



Plot 37 3-12.5MHz



Plot 38 7-13MHz

Marker 1 = -117.0 dBm + 107 + 28.2 = 18.2 dBμV/m

Marker 2 = -117.3 dBm + 107 + 28.1 = 17.8 dBμV/m

Marker 3 = -120.3 dBm + 107 + 28.1= 14.8 dBμV/m

Marker 4 = -118.9 dBm + 107 + 28.2 = 16.3 dBμV/m

Marker 5 = -117.9 dBm + 107 + 28.2 = 17.3 dBμV/m

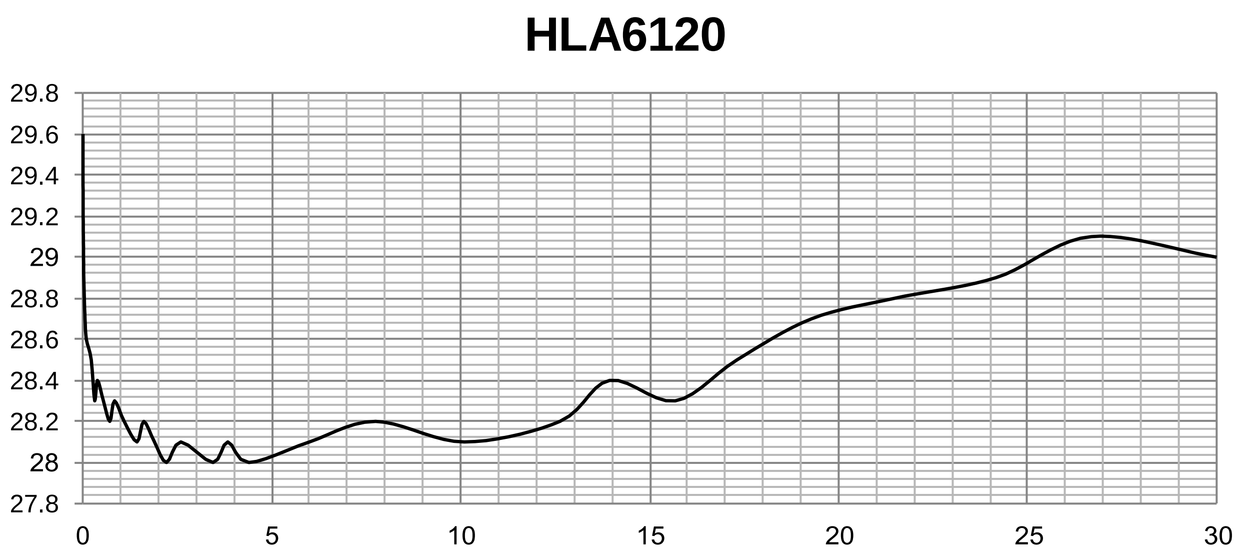
Annex 2

Field Strength Correction Factors, Measurement Equipment, and Glossary

2.1 Field Strength Correction Factors

Field Strength below VDSL lines (vertical polarisation)					
Plot number	Centre Frequency (MHz)	Maximum signal (dBm)	Maximum signal (dBμV)	Correction factors (dB/m)	Maximum FS (dBμV/m)
Mr [redacted]					
2 Upper	3740	-105	2	28.0	30.0
2 Lower	3660	-115	-8	28.0	20.0
6	14.1	-105	2	28.4	30.4
Mr [redacted]					
9	3.71	-102	5	28.0	33.0
12	10.1	-106	1	28.1	29.1

Table 1: Corrected field strength results



Plot 13: Magnetic Loop Antenna Factors & Table 1 Below

Freq MHz	Mag AF	E AF
0.009	-21.9	29.6
0.01	-22	29.5
0.011	-22.1	29.4
0.013	-22.2	29.3
0.015	-22.3	29.2
0.02	-22.4	29.1
0.026	-22.5	29
0.032	-22.6	28.9
0.046	-22.7	28.8
0.065	-22.8	28.7
0.1	-22.9	28.6
0.23	-23	28.5
0.319	-23.2	28.3
0.393	-23.1	28.4
0.55	-23.2	28.3
0.72	-23.3	28.2
0.845	-23.2	28.3
1.1	-23.3	28.2
1.439	-23.4	28.1
1.618	-23.3	28.2
1.9	-23.4	28.1
2.218	-23.5	28
2.6	-23.4	28.1
3.449	-23.5	28
3.843	-23.4	28.1
4.4	-23.5	28
6	-23.4	28.1

7.75	-23.3	28.2
10.1	-23.4	28.1
12.628	-23.3	28.2
13.944	-23.1	28.4
15.678	-23.2	28.3
17.313	-23	28.5
19.289	-22.8	28.7
21.493	-22.7	28.8
24.165	-22.6	28.9
26.683	-22.4	29.1
30	-22.5	29
	dB(S/m)	dB(Vu/m)

Table 1 Correction factor

2.2 Measurement Equipment

Equipment	**Model**	**Serial No.**	**Cal due**	**Certificate No.**
Comms Receiver	R&S EB200	838228/017	N/A	
Spectrum Analyser	Field Fox	MY50022601	28/10/2016	
Active Magnetic loop	HLA6120	1172	16/05/2017	2016050007-1
10m cable	Chase	-	-	-

Table 2: Equipment details (including calibration status).

2.3 Glossary

Conversions from dBm to dBµV were completed (dBm value + 107) and then the relevant antenna factor was added to provide field strength values (dBµV value plus antenna factor = xxx dBµV/m).

ADSL	Asymmetric Digital Subscriber Line
a.g.l.	above ground level

ANFP	Access Network Frequency Plan
BW	Bandwidth
EMC or emc	Electromagnetic Compatibility
EMI	Electromagnetic Interference
EUT	Equipment Under Test
FS	Field Strength measured in dBµV/m
FTTC	Fibre to The Cabinet
FTTdp	Fibre to The distribution point
FTTP	Fibre to The Premises
Ofcom	Office of Communications
RBW	Resolution Bandwidth
RF	Radio Frequency
VDSL	Very high bit rate DSL
λ	Wavelength
kHz	kilohertz
MHz	Megahertz
GHz	Gigahertz
µv	microvolt
mV	millivolt
mV/m	millivolts per metre
dB	decibel
dBµV/m	decibels above 1 microvolt per metre (see FS above)
dBm	decibels relative to 1 milliwatt
dBW	decibels relative to 1 Watt
m	metres
cm	centimetres
C	Centigrade

F	Fahrenheit
s	seconds