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A12.1

MetroLink Electromagnetic Radiation Baseline Survey Report

COMPLIANCE
ENGINEERING
IRELAND LTD

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SIGNATURE:

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ABBREVIATIONS

Abbreviation	Meaning
AC	Alternating Current
AIMD	Active Implantable Medical Devices
CEI	Compliance Engineering Ireland
CT	Computed Tomography
DAA	Dublin Airport Authority
DART	Dublin Area Rapid Transit
DC	Direct Current
DCU	Dublin City University
DFB	Dublin Fire Brigade
EIA(R)	Environmental Impact Assessment (Report)
EIS	Environmental Impact Statement
EM	Electromagnetic
EMC	Electromagnetic Compatibility
EMF	Electromagnetic Fields (comprising Electric and Magnetic Fields)
EMI	Electromagnetic interference
EMR	Electromagnetic Radiation
EPA	Environmental Protection Agency
ESB	Electricity Supply Board
EU	European Union
FWALA	Fixed Wireless Access Local Area
FWPMA	Fixed Wireless Point to Multi-Point Access
GSM	Global System for Mobile Communications
HV	High Voltage
ICNIRP	International Commission on Non-Ionising Radiation Protection
LTE	Long Term Evolution (standard for 4G wireless broadband communication)
MRI	Magnetic Resonance Imaging
µT	Magnetic Fields are measured in micro-Tesla, µT
MV	Medium Voltage
NMR	Nuclear Magnetic Resonance
OCS	Overhead Catenary System
OPW	Office of Public Works
OSI	Ordnance Survey Ireland
PBX	Private Branch Exchange
RED	Radio Equipment Directive
RF	Radiofrequency
SEM	Scanning Electron Microscope
SNIAM	Sami Nasr Institute for Advanced Materials
SQUID	Superconducting Quantum Interference Device
STM	Scanning Tunnelling Microscope
TCD	Trinity College Dublin
V/m or kV/m	Electric Fields are measured in Volts per metre, V/m or kiloVolts per metre, kV/m
WHO	World Health Organisation
XLPE	Cross-linked Polyethylene

1.0 Introduction

Between December 2018 and July 2022, Compliance Engineering Ireland Ltd. (CEI) was commissioned by Transport Infrastructure Ireland (TII) to carry out a baseline survey of the electromagnetic spectrum. The baseline survey locations were chosen following desktop review and stakeholder consultations as part of the MetroLink Environmental Impact Assessment Report (EIAR) compilation.

Specifically, the following locations were visited:

- Siemens (DC – 18 GHz)
- Dublin Airport
- DCU
- Irish Rail Crossing at Prospect Road
- Mater University Hospital
- Rotunda Campus (Rotunda Hospital and Gate Theatre)
- Irish Rail at Tara Street Station
- Trinity College Dublin
- The National Concert Hall
- Royal Victoria Eye and Ear Hospital
- New Substation Locations
    - Naul Road
    - Dardistown

Th following section contains a brief description of the types of EMR covered by the survey.

1.0.1 EMI – DC and Quasi-DC fields

Interference risks related to AC magnetic fields are relatively well known and documented in the literature. In part that is because the use of electricity and the fields that emanate from power sources are widespread. Less well known are interference issues related to DC or slowly varying (Quasi-DC) fields, although some of the principles are identical to AC magnetic field interference. DC fields are not fields, but rather, lines of flux. These lines of flux emanate from the earth and provide a compass with the ability to indicate "Magnetic

North". The "flux density" of the Earth's magnetic field varies from place to place on the globe, but can be thought of as around 50 µT.

In most circumstances, even equipment that is "sensitive" to elevated AC magnetic fields, is unaffected by elevated DC fields. Since they are, for most purposes, considered static – they do not move or increase/decrease in field strength – they do not induce changes in the electronics. However, under certain circumstances, these DC fields can be made to act like an AC field. Their ability to interfere with electronics is then correspondingly increased.

Since magnetic fields prefer to travel inside of iron or steel, a large mass of steel (a train, car or a truck) moving through a DC field will distort the lines of flux temporarily. When the mass of iron is outside of the influence of the flux lines, they will return to their original position. This movement will resemble, technically and in effect, a slowly oscillating AC field.

Although the Earth's DC fields are relatively stable, there are inherent slight variations in both field direction and strength, over time. These minor temporal instabilities are usually well below the sensitivity of most electronic instruments and can usually be ignored. However, some instruments like electron microscopes are sensitive to very small variations in field strength or changes in direction. The movement of a mass of ferromagnetic material through the Earth's field will alter both the field strength and the direction of the Earth's DC field. This influence can be measured at relatively large distances from the source of the perturbation and changes in the DC field environment caused by the external influences described above (moving vehicles, trains, elevators, etc.) can adversely impact the stability and accuracy of these instruments.

In DC railways, the power supplied by the local utility (AC electricity) is converted by rectifiers to DC. The magnetic fields from DC are identical with those from the earth, but, like AC fields, are the result of a complete electrical circuit. The field strength from these circuits is a function of the current (direct relationship) and the distance between the positive and negative currents (indirect relationship). In DC railways, maximum current will flow when trains are accelerating or braking and therefore the fields will increase when trains are either coming into or leaving the stations – particularly during peak traffic.

1.0.2 EMI – AC magnetic fields

AC magnetic fields are naturally emitted by alternating current-carrying electrical conductors and devices. The AC magnetic field strength emitted by electrical circuits is directly proportional to the magnitude of electrical current. However, multiple conductor cables carrying balanced currents have a low net emission; a consequence of natural cancellation of magnetic fields between opposing conductors. If electrical current from a circuit returns via an alternate path, then magnetic field levels emitted from such a circuit can increase significantly. This condition usually occurs if neutral circuits are “cross connected” or unintentional connections are made between a neutral and ground in an electrical distribution system. This is often referred to as “stray”, “ground” or “net-current” conditions.

AC magnetic fields decrease naturally in intensity as a function of distance (d) from the source. The rate of decrease however, can vary dramatically depending on the source. For example, magnetic fields from motors, transformers, etc. decrease very quickly ($1/d^3$) while circuits in a typical conduit decay slower ($1/d^2$). Magnetic fields from “stray” current on water pipes, building steel, etc. tend to decay much slower (1/d). Simply increasing the distance from the source(s) of an area with elevated magnetic field strengths can often reduce magnetic fields to an acceptable level.

Unlike electric fields that are relatively easily shielded by common materials used in commercial construction, magnetic fields are capable of penetrating all but a very few, specially manufactured and installed materials.AC magnetic fields will pass undiminished through earth, concrete and most metals, including lead. The actual AC magnetic flux densities (B) encountered within a given commercial building typically range from under 0.04µT in open areas to several hundred near electrical equipment, but for practical purposes, an ambient range of from 0.04 to 0.4µT can be considered typical.

AC magnetic fields at relatively low levels are capable of producing interference patterns on computer monitors and have been shown to otherwise interfere with electronic equipment. Equipment placed on the European Union (EU) market is required under EMC Directive 2014/30/EU to comply with AC magnetic field limits between 1.25 µT and 38 µT depending on the intended application.

1.0.3 EMI – Radio Frequency fields

Radio Frequency (RF) fields are normally caused by private mobile radio (two-way radios), mobile phones, broadcasting, and radar transmitters. Considering the rail environment these fields will be predominately caused by two-way radio or mobile phones and general EMI from the vehicle. Depending on the type of equipment, radio frequency fields are normally considered to present an EMI risk to electronic equipment when the field strength exceeds 1 to 3 V/m. Certain equipment, in particular medical and research equipment are more sensitive and consequently, have much lower interference thresholds.

Electronic equipment will produce low level narrow and broadband signals at frequencies up to and above 1 GHz. The EU EMC Directive limits the maximum amounts of Radio Frequency Interference (RFI) that equipment is permitted to generate. These limits are set in order to prevent electrical and electronic equipment from interfering with the operation of radio and television receivers. By way of example the emission limits for railways operating at 1,500 Vdc is given in the table below.

1.0.4 European Emission Limits for Railways

Table 1: Maximum Radiated Emissions at 10 meters EN 50121-2; 1,500 Vdc Systems

Frequency (MHz)	Limit
9 kHz to 150 kHz	60 dB(µA/m) to 35 dB(µA/m)
150 kHz to 30 MHz	70 dB(µV/m) to 20 dB(µA/m)
30 MHz to 1 GHz	95 dB (µV/m) to 70 dB(µV/m)

Transient electromagnetic fields are produced by the switching of inductive loads such as may be caused by the sliding contact on the catenary wire. A transient signal in a cable produces a radiated emission with a spectral content dependent on the amplitude, rise time and pulse width.

1.0.5 Guideline Limits for Public Exposure to Electromagnetic Fields

The guideline limits for public exposure to Electromagnetic Fields are published by ICNIRP and in the EU Recommendation 1999/519/EC.

Table 2: Guideline Limits for Public Exposure to Electromagnetic Fields

Frequency Range	E – Field Strength (Vm^{-1})	H – Field (Am^{-1})	B – Field (µT)	Equivalent plane wave power S (Wm-2)
up to 1Hz	-	3.2×10^4	4×10^4	-
1 – 8Hz	10,000	$3.2 \times 10^4/f^2$	$4 \times 104/f^2$	-
8 – 25Hz	10,000	$4{,}000/f$	$5000/f$	-
0.025 – 0.8kHZ	$250/f$	$4/f$	$5/f$	-
0.8 – 3kHZ	$250/f$	5	6.25	-
3 – 150kHZ	87	5	6.25	-
0.15 – 1MHz	87	$0.73/f$	$0.092/f$	-
1 – 10MHz	$87/f^2$	$0.73/f$	$0.092/f$	-
10 – 400MHz	28	0.16	0.092	2
400 – 2000MHz	$1.375f^{1/2}$	$0.0037f^{1/2}$	$0.0046f^{1/2}$	$f/200$
2 – 300GHz	61	0.16	0.20	10

1.0.6 Guideline Limits - Immunity

Immunity of non-radio electrical/electronic equipment is set by the EU EMC Directive 2014/30/EU. Limits or threshold values, used to analyse the measurement data are recognized industrial guidelines. 50 Hz AC fields are considered a risk above 1.26 µT or 38 µT depending on the equipment type. Radiated RF fields are compared to a limit of 3 V/m (129 dBµV) or 10 V/m (140 dBµV) depending on the classification of the equipment.

DC fields are not covered in current EU EMC standards. Traditionally, DC fields in excess of 200 µT or with temporal shifts greater than 7.5 µT are considered a risk to Cathode Ray Tube (CRT) based displays or analytical instruments.

It should be noted that these limits are “investigation” levels and are considered as guidance. There are instruments (Linear Accelerators, Computed Tomography (CT) Scanners, Magnetic Resonance Imaging, Scanning Electron Microscopes, etc.) that are more sensitive to elevated fields. In certain cases, further examination of the interference and threshold immunities may be necessary. The limits for these items of equipment can vary from 50 µT to 0.01 µT.

1.1 Field Surveys

The primary means of establishing the base data was via field surveys. The field surveys were performed using broadband radiation meters, spectrum analysers and appropriate antennas. The frequency range covered was from DC (0Hz) to 18 GHz.

1.2 Units of Measure

Magnetic flux densities (B) for AC and DC magnetic fields are reported using units of microtesla (µT); (1µT = 0.000001 Tesla) for magnetic flux densities. Many equipment manufacturers use the United States units of milliGauss. The conversion between these two units is 1 milliGauss = 0.1 µT.
RF data are presented in either the EMI international standard units Volts per meter (V/m) or microVolts per meter (µV/m) and in the logarithmic scale dB(µV/m). In the frequency range of 9kHz to 30MHz it is common to express the field strengths in the magnetic field units of dB(µA/m).

2.0 EMI SURVEY MEASUREMENT EQUIPMENT

A variety of instrumentation was utilized to measure DC and AC magnetic field, radiofrequency and microwave conditions at the sites. A discussion according to frequency class follows.

2.1 DC Magnetic Field Measurement Equipment

For DC field measurements, a Bartington Magnetometer (MAG 03MC) sensor was used. This sensor was monitored using Labview data acquisition and analysis software.

Measurements were taken at a standard elevation of 1-metre above grade, using a non-metallic support. The equipment was configured to record data in the three orthogonal planes (x, y and z) from which the resultant field was calculated. The resultant magnetic field is comparable to a maximum field value and is calculated as the square root of the sum of the squares for all three orthogonal axes $Br = \sqrt{(Bx^2 + By^2 + Bz^2)}$.

2.2 AC Measurement Equipment

AC electric and magnetic field measurements were taken using a Narda EHP50D Field probe connected to a data acquisition unit. The measurements were carried out at 1m above ground as required by international standards.

2.3 RF and Microwave Measurements Equipment

The survey equipment for these frequencies utilised the following equipment:

- Rohde and Schwarz ESCS EMI Testing Receiver
- Laptop
- Rohde and Schwarz FSH 20 Spectrum Analyser
- Selection of antenna
- Coaxial cables
- National Instruments Data Acquisition Unit

Unless otherwise stated, the RF measurements were carried out in peak detector mode.

3.0 MEASUREMENT RESULTS

Frequencies from DC up to 100 kHz were monitored in each of the five listed in section 1 above.

For the DC magnetic field measurements, the results are presented firstly as the static field recorded over the measurement interval and also the magnitude of the field fluctuations over that same period.

3.1 <u>Siemens EMR Survey</u>

Measurements were performed at the location depicted below -

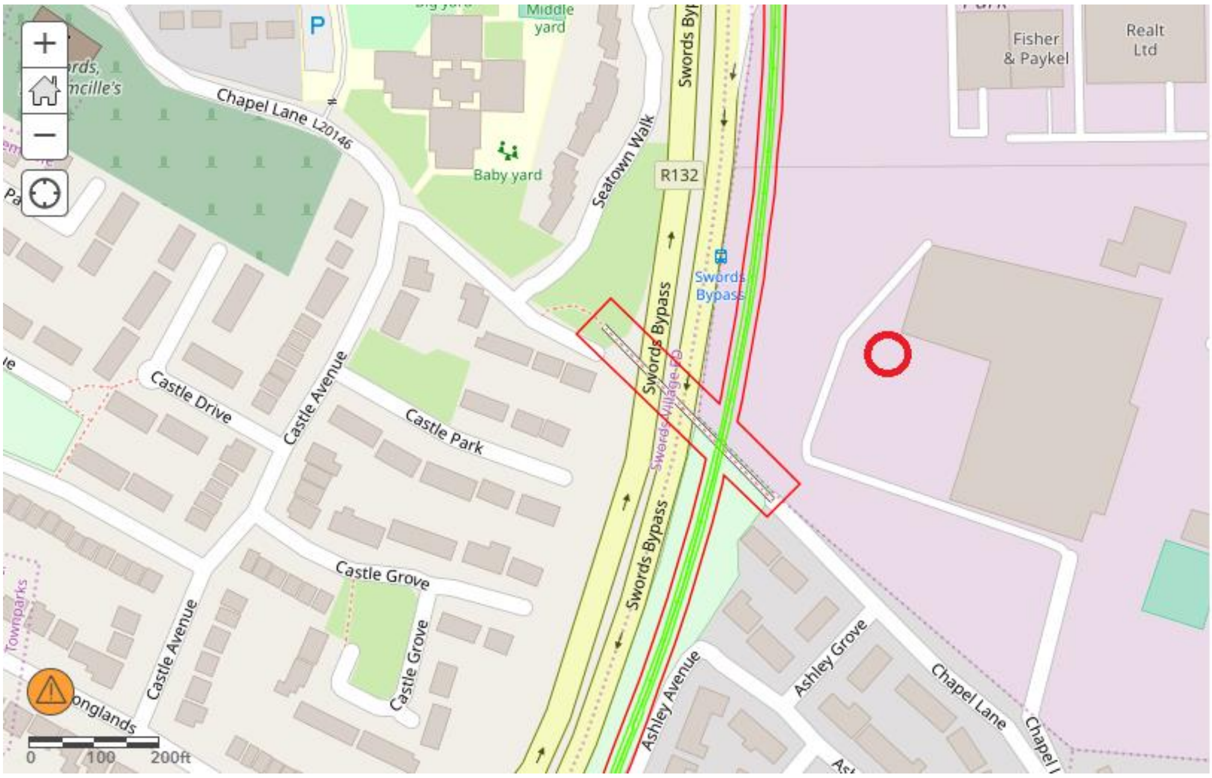

Figure 1: Measurement Location at Siemens

3.1.1 DC Magnetic Field, Siemens

The Earth's DC magnetic flux density (B) was measured for a period of 27 minutes. The average static field was approximately 47.3 µT with the maximum deviations seen to be 0.02 µT.

3.1.2 AC Electric and Magnetic Fields 1 Hz to 10 kHz, Siemens

Figure 4 gives a spectral plot of the magnetic field from DC to 100 Hz with figure 8 showing the equivalent electric field. The DC component can be seen to be much higher than any other frequency. A spike at 50 Hz is also evident, which is the transmission frequency for mains electricity. The magnetic field levels were also slightly elevated in the range 10 – 20 Hz, the cause of which is unknown.

No unusually elevated electromagnetic field levels were detected in the range between 100 Hz to 10 kHz.

3.1.3 Radiated Fields: 10 kHz to 18 GHz, Siemens

There was no evidence, during the measurement and observation time of this study of any transient or intermittent events.

The ambient spectrum comprised radio (digital and analog). The RF emissions profile in this frequency range was well below the typical risk levels of 3 V/m.

At this site the strongest emissions were caused by Analog radio broadcasts (80 – 110 MHz), Digital Radio (147-223 MHz), Maritime Communications (160 MHz), Tetra Radio (390 MHz), Digital Television Broadcasting (470 – 790 MHz) and WiFi (2.4 GHz). In terms of mobile technology, the following signals were present, mobile broadband, LTE (791-821 MHz and 925-960 MHz), GSM 900 and 1800 (900 MHz and 1.8 GHz) and 3G (2.1 GHz).

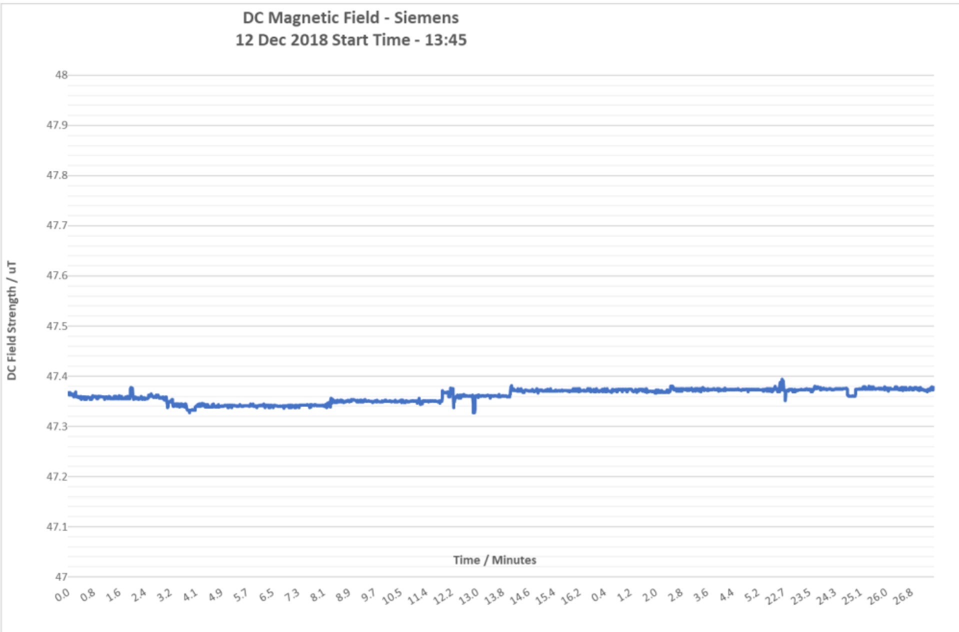

Figure 2: Siemens, DC Magnetic Field

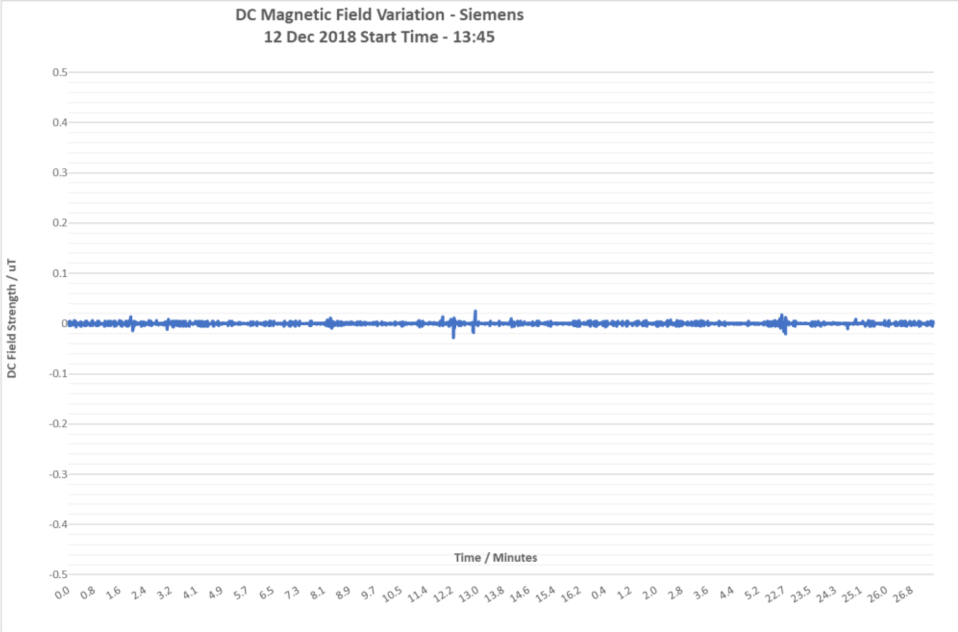

Figure 3: Siemens, DC Magnetic Field variations

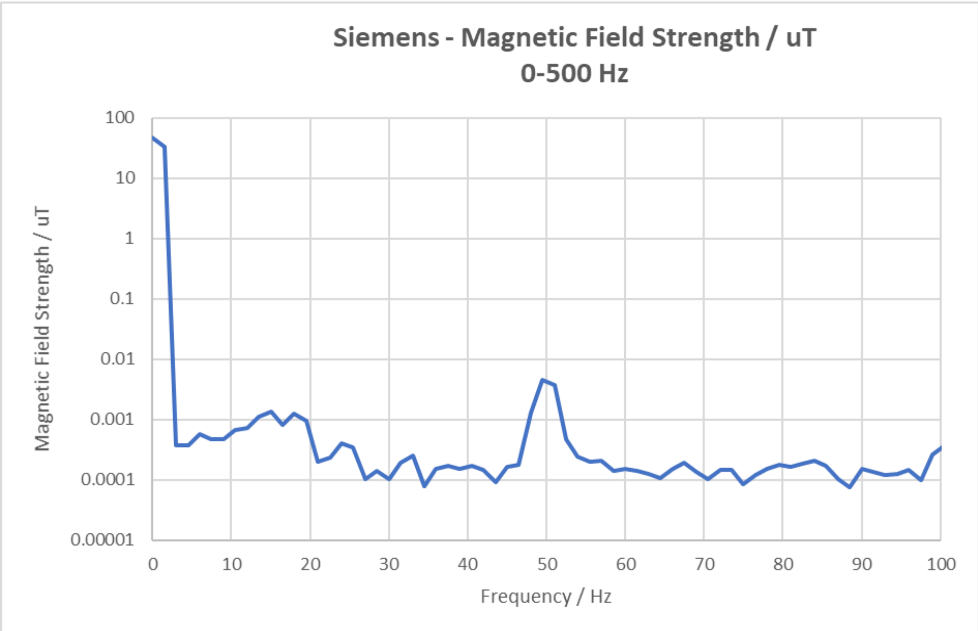

Figure 4: Siemens, 0 Hz to 100 Hz (Mag Field)

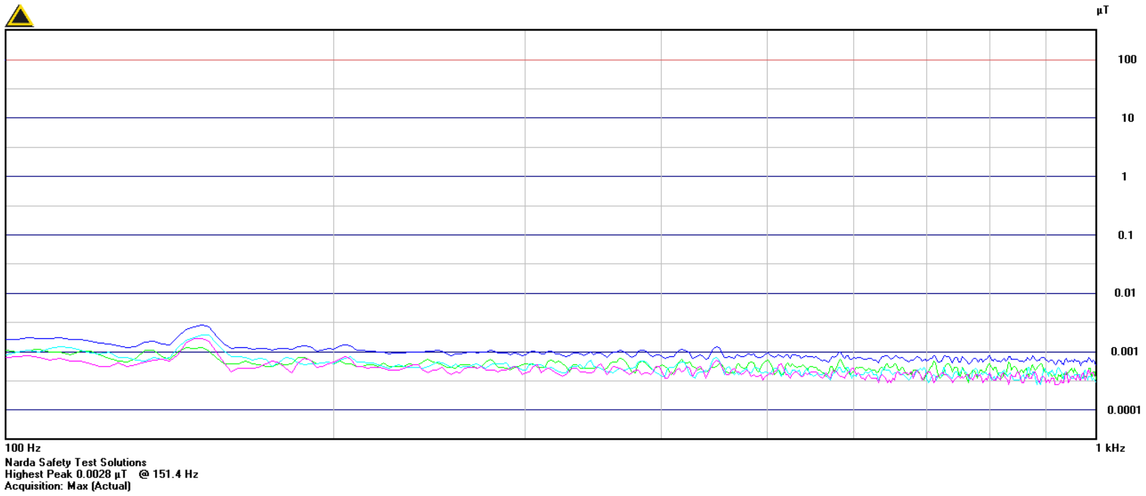

Figure 5: Siemens, 100 Hz to 1 kHz (Mag Field)

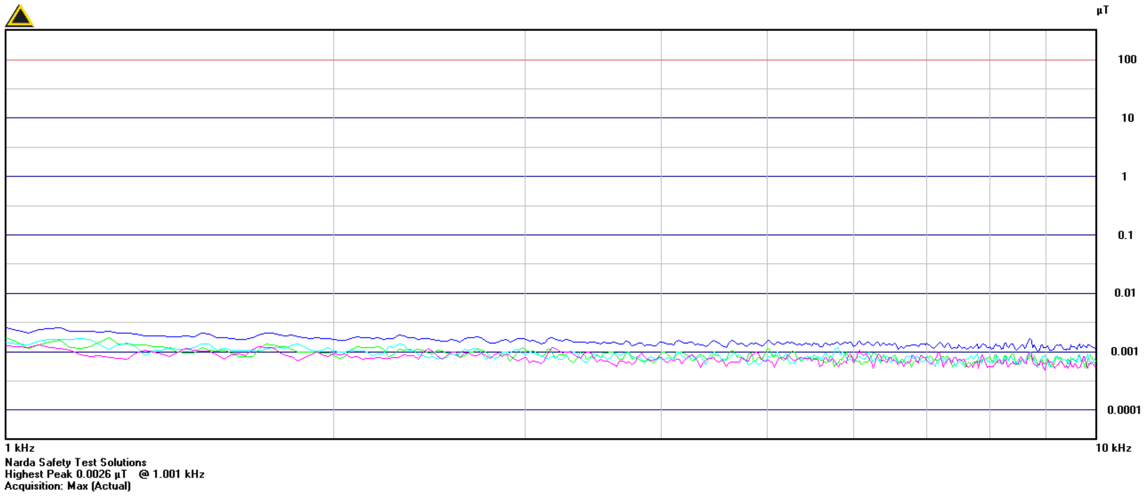

Figure 6: Siemens, 1 kHz to 10 kHz (Mag Field)

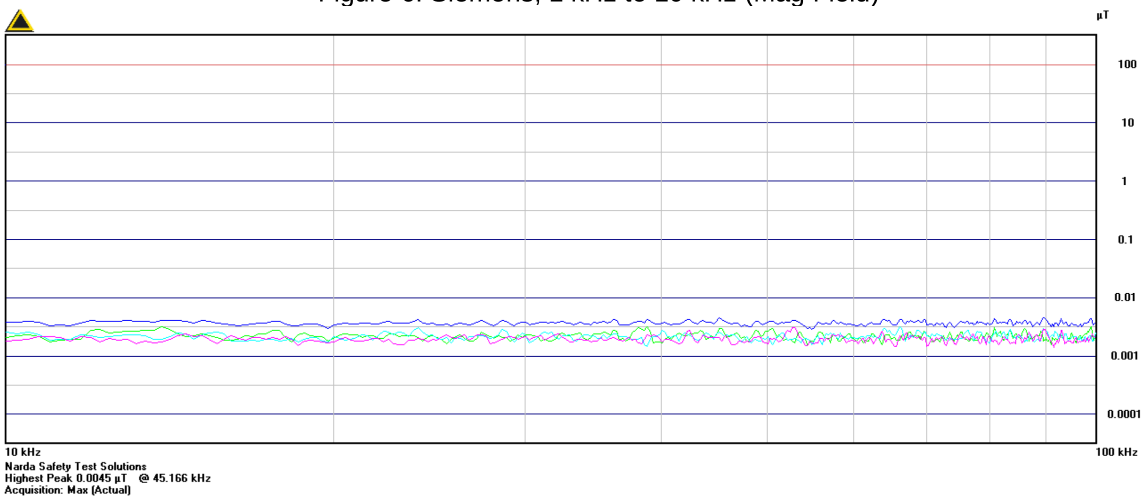

Figure 7: Siemens, 10 kHz to 100 kHz (Mag Field)

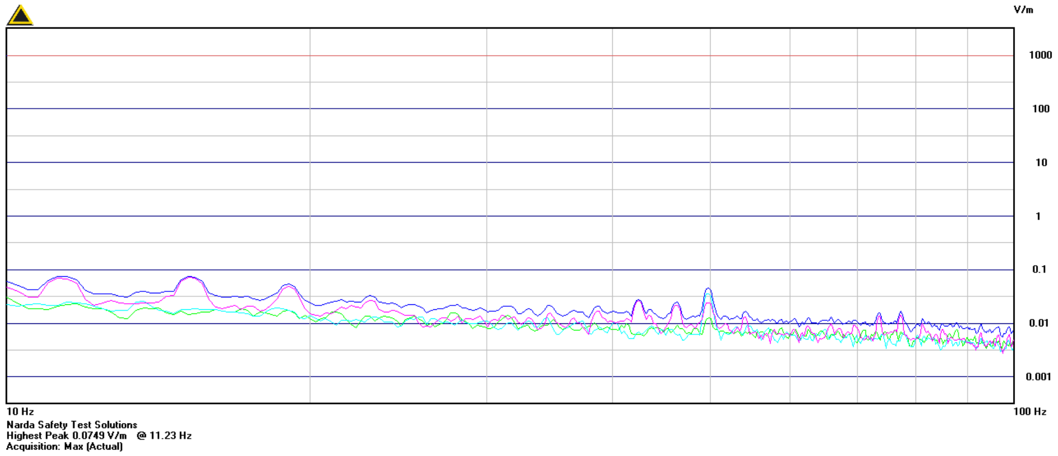

Figure 8: Siemens, 10 Hz to 100 Hz (E-Field)

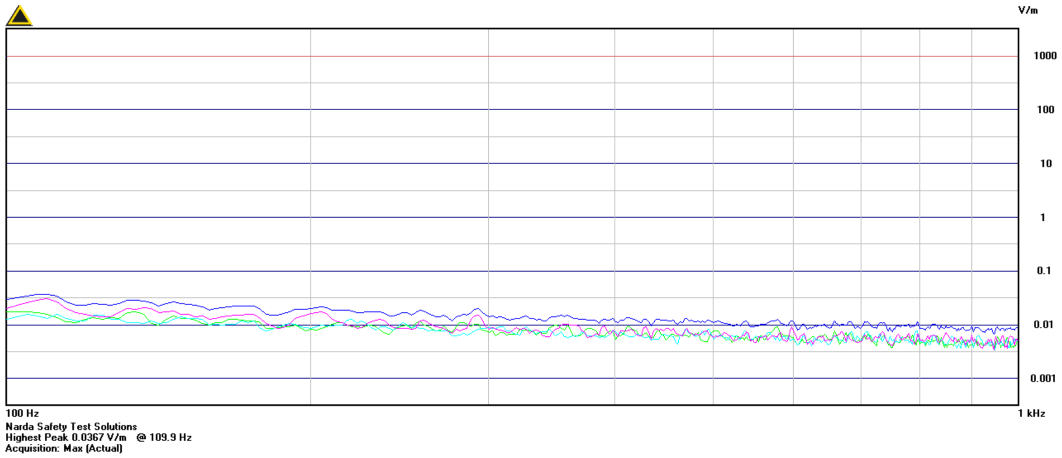

Figure 9: Siemens, 100 Hz to 1 kHz (E-Field)

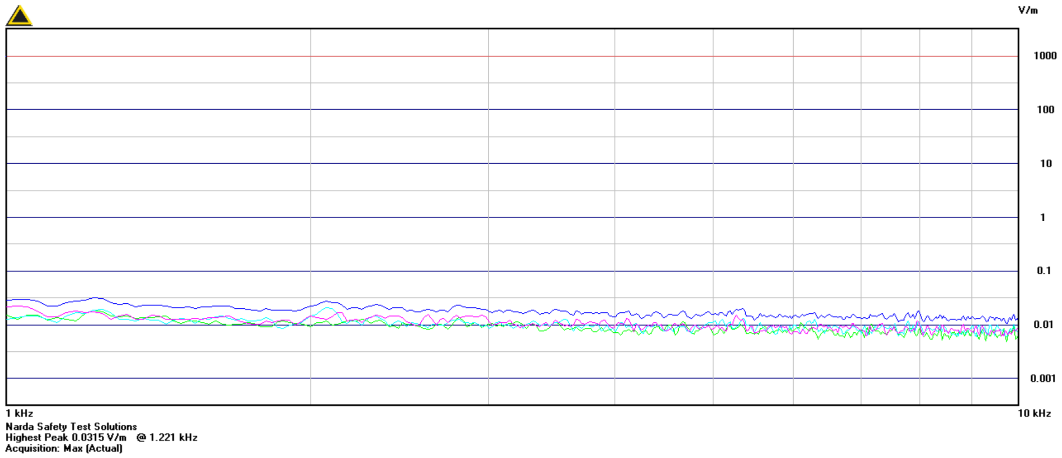

Figure 10: Siemens, 1 kHz to 10 kHz (E-Field)

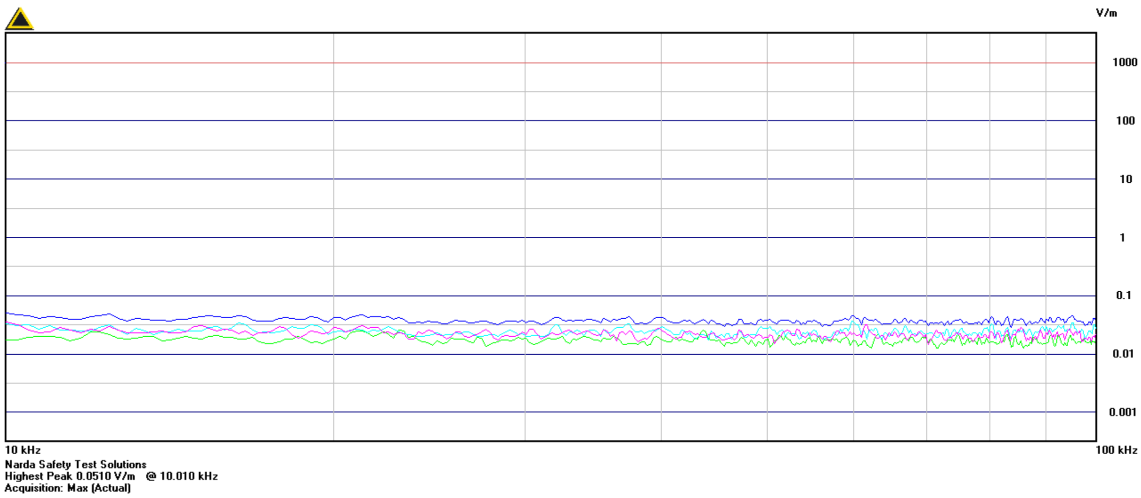

Figure 11: Siemens, 10 kHz to 100 kHz (E-Field)

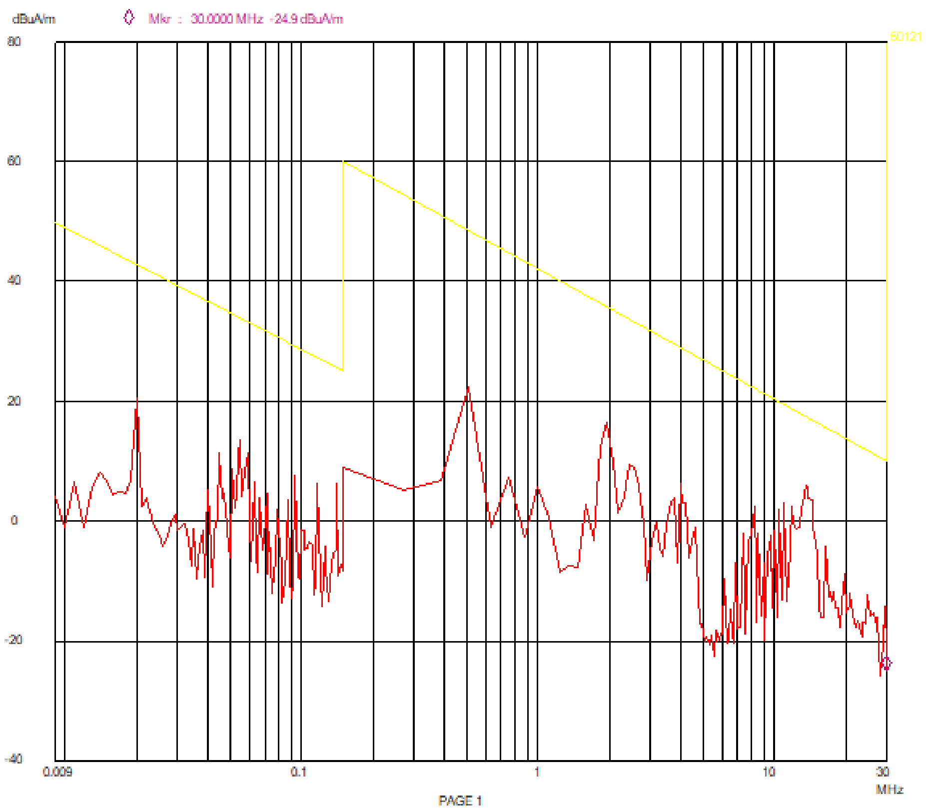

Figure 12: Siemens - 9 kHz to 30 MHz

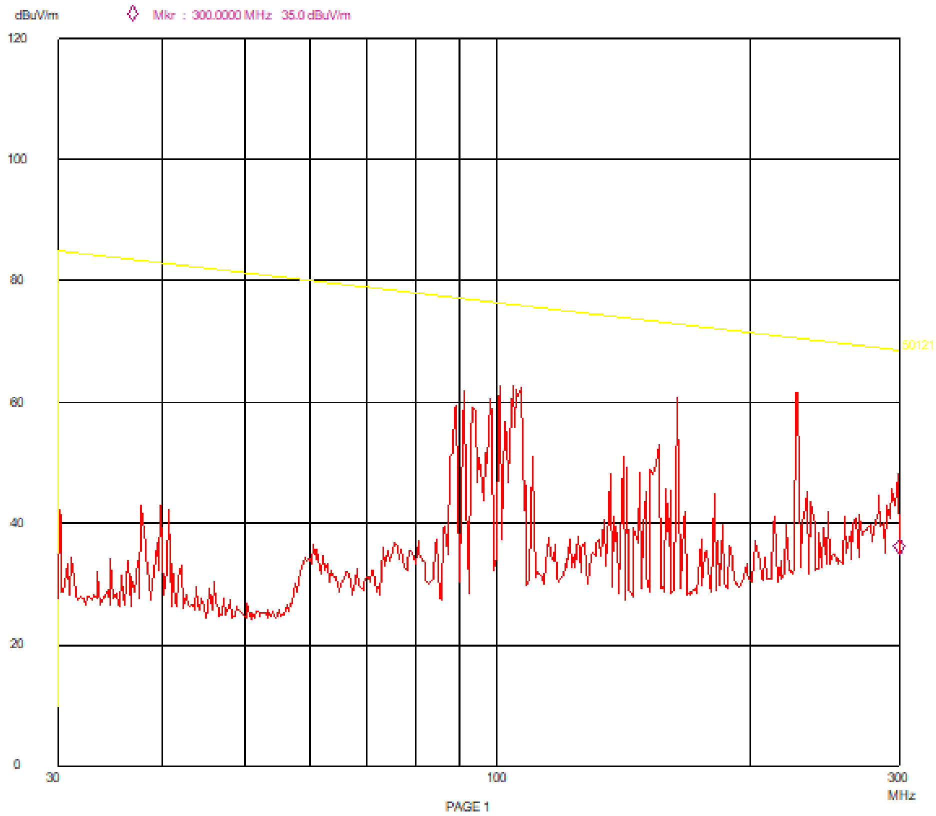

Figure 13: Siemens - 30 MHz to 300 MHz

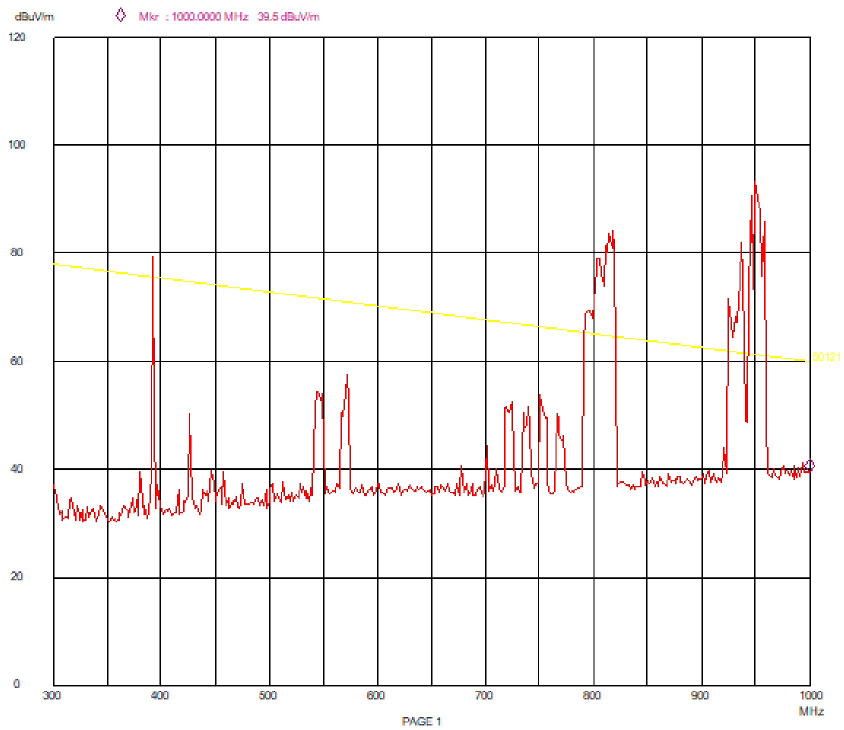

Figure 14: Siemens – 300 MHz - 1 GHz

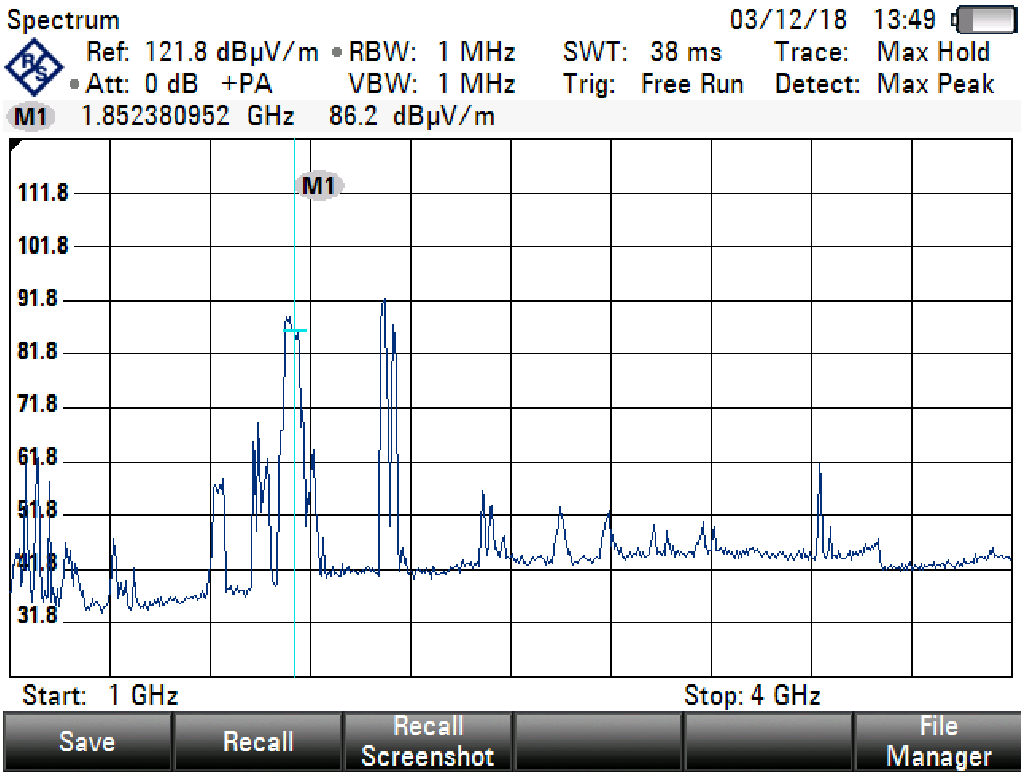

Figure 15: Siemens - 1 GHz to 4 GHz

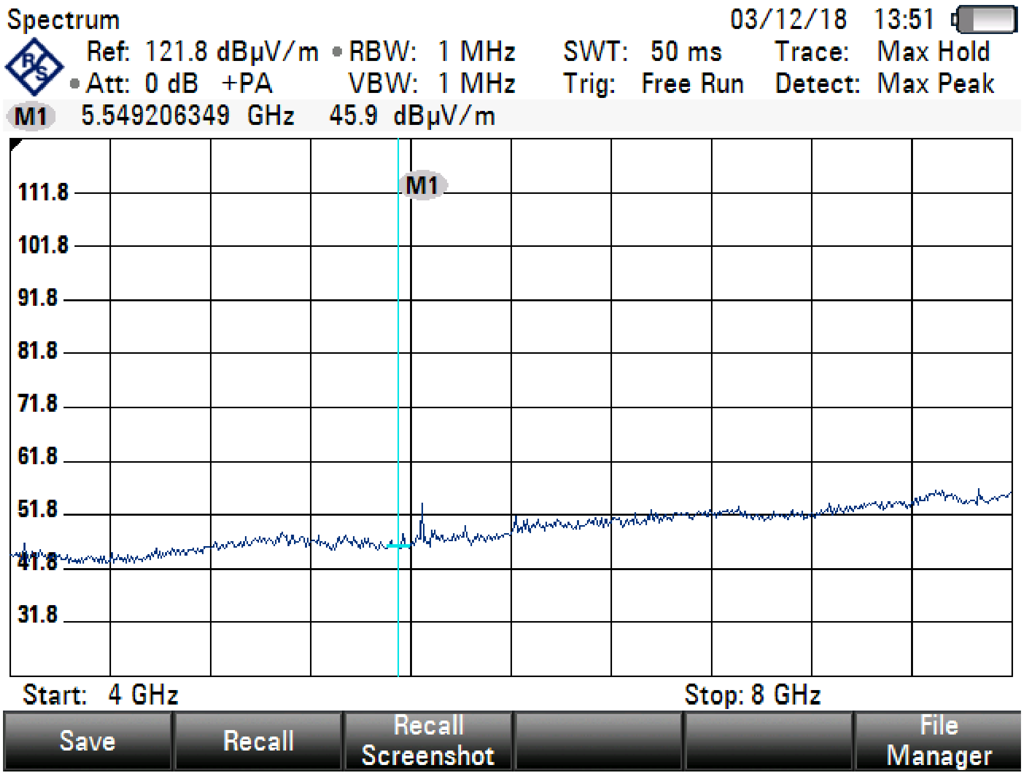

Figure 16: Siemens - 4 GHz to 8 GHz

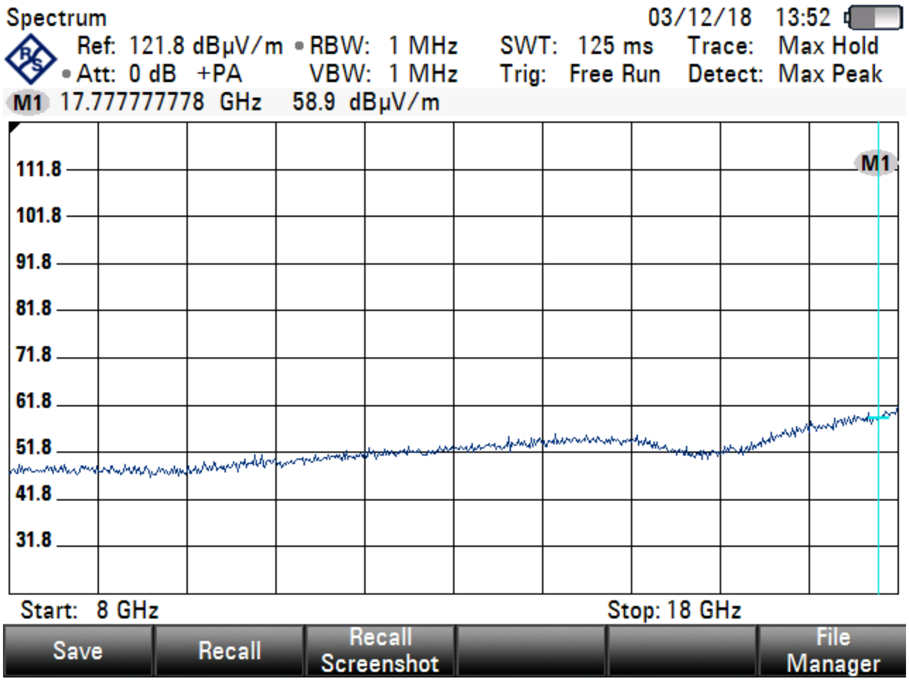

Figure 17: Siemens - 8 GHz to 18 GHz

3.2 Dublin Airport EMR Survey

Measurements were performed at the location depicted below -

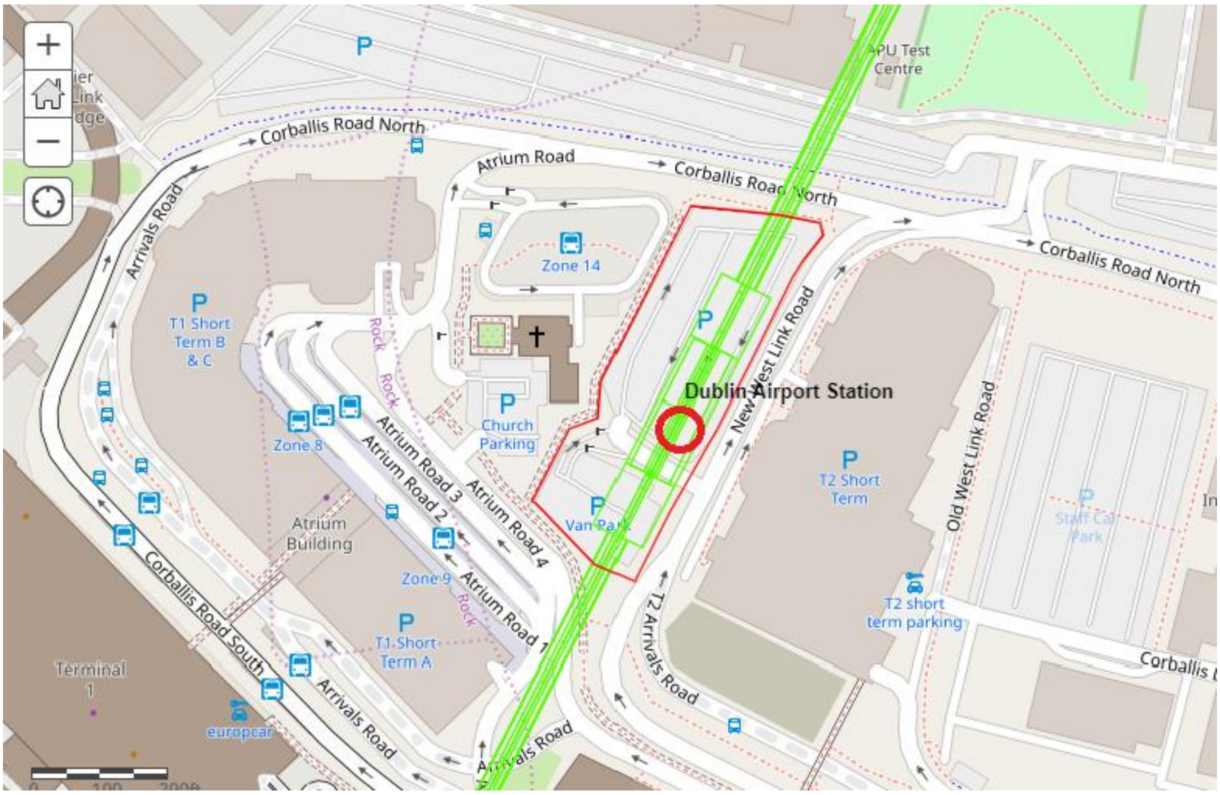

Figure 18: Measurement Location at Dublin Airport

3.2.1 DC Magnetic Field, Dublin Airport

The Earth's DC magnetic flux density (B) was measured for a period of 30 minutes. The average static field was approximately 47.3 µT with the maximum deviations seen to be 0.15 µT.

3.2.2 AC Electric and Magnetic Fields 1 Hz to 10 kHz, Dublin Airport

Figure 21 gives a spectral plot of the magnetic field from DC to 100 Hz with Figure 25 showing the equivalent electric field. The DC component can be seen to be much higher than any other frequency. A spike at 50 Hz is also evident, which is the transmission frequency for mains electricity.

No unusually elevated electromagnetic field levels were detected in the range between 100 Hz to 10 kHz.

3.2.3 Radiated Fields: 10 kHz to 18 GHz, Dublin Airport

There was no evidence, during the measurement and observation time of this study of any transient or intermittent events.

The ambient spectrum comprised radio (digital and analog). The RF emissions profile in this frequency range was well below the typical risk levels of 3 V/m.

At this site the strongest emissions were caused by Analog radio broadcasts (80 – 110 MHz), Digital Radio (147-223 MHz), Maritime Communications (160 MHz), Tetra Radio (390 MHz), Personal Mobile Radio (450 MHz), Digital Television Broadcasting (470 – 790 MHz), WiFi (2.4 GHz, 5 GHz), RADAR (5.6 GHz) and FWALA (10.4 GHz). In terms of mobile technology, the following signals were present, mobile broadband, LTE (791-821 MHz and 925-960 MHz), GSM 900 and 1800 (900 MHz and 1.8 GHz) and 3G (2.1 GHz).

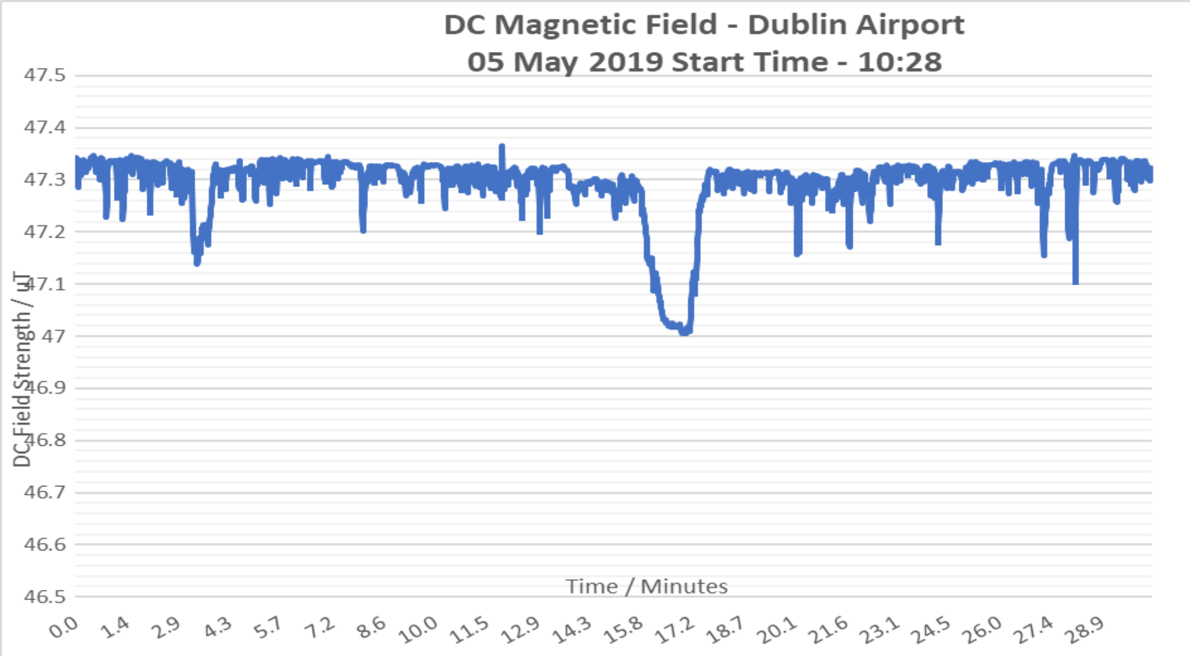

Figure 19: Dublin Airport, DC Magnetic Field

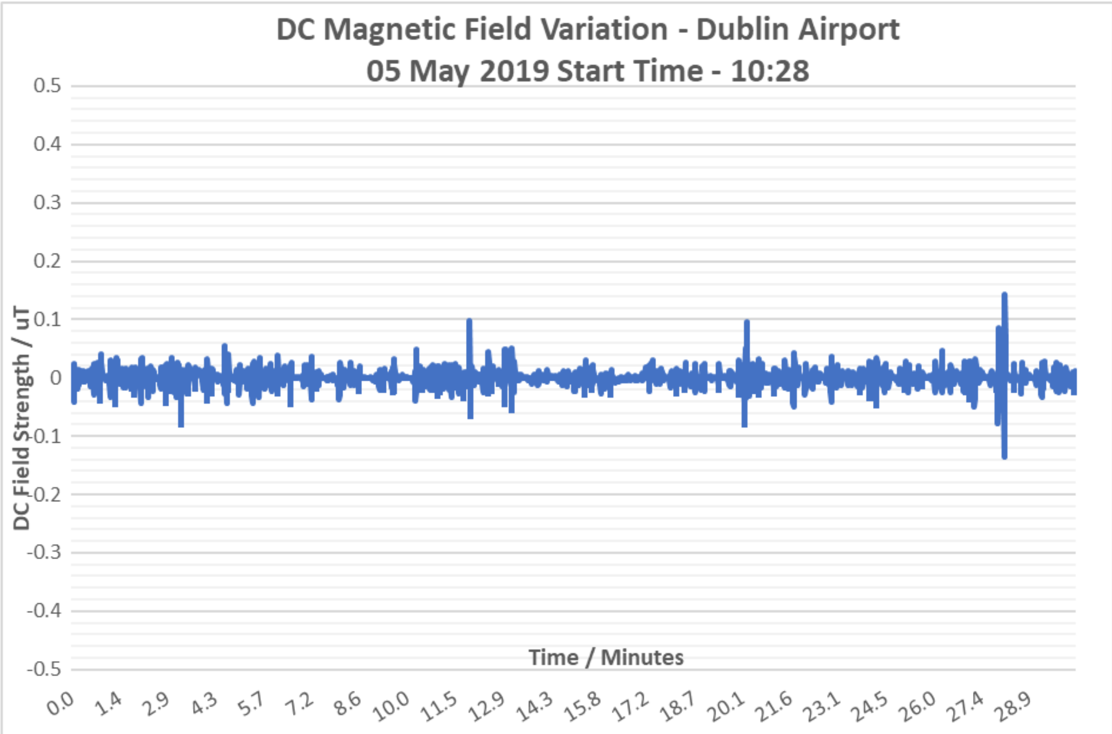

Figure 20: Dublin Airport, DC Magnetic Field variations

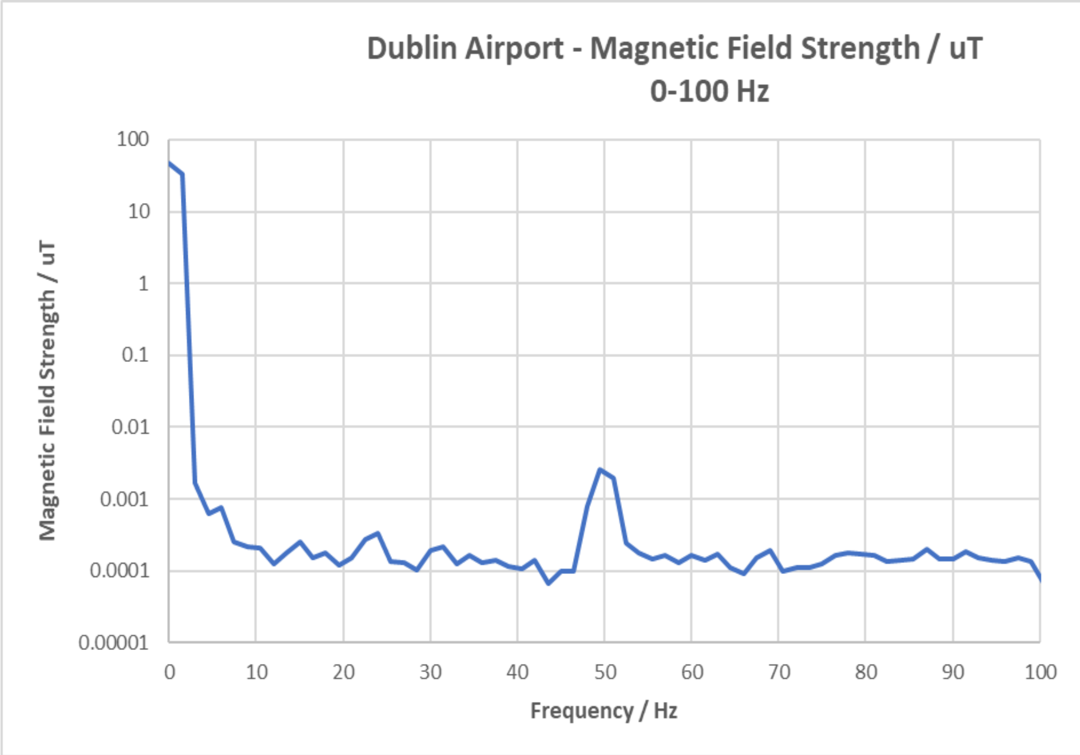

Figure 21: Dublin Airport, 0 Hz to 100 Hz (Mag Field)

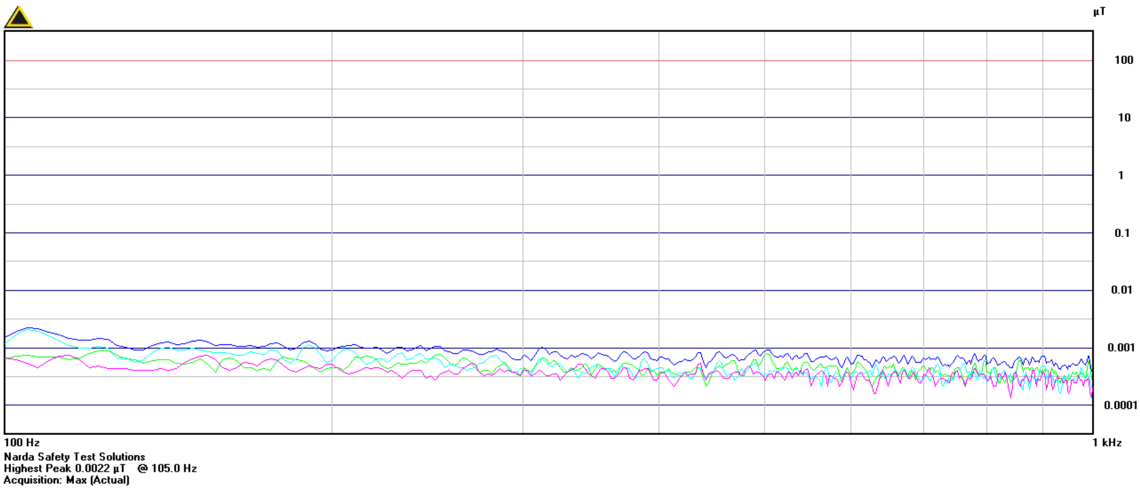

Figure 22: Dublin Airport, 100 Hz to 1 kHz (Mag Field)

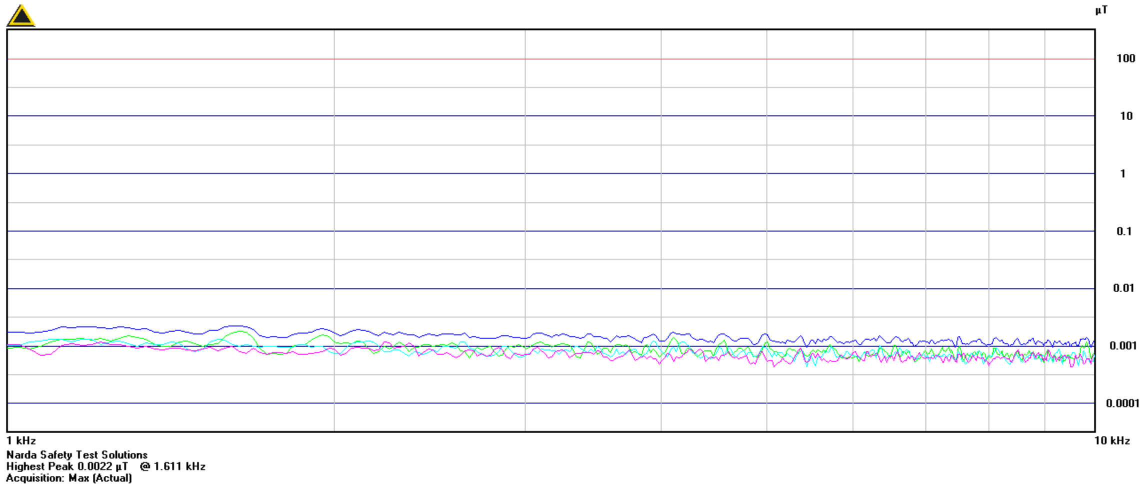

Figure 23: Dublin Airport, 1 kHz to 10 kHz (Mag Field)

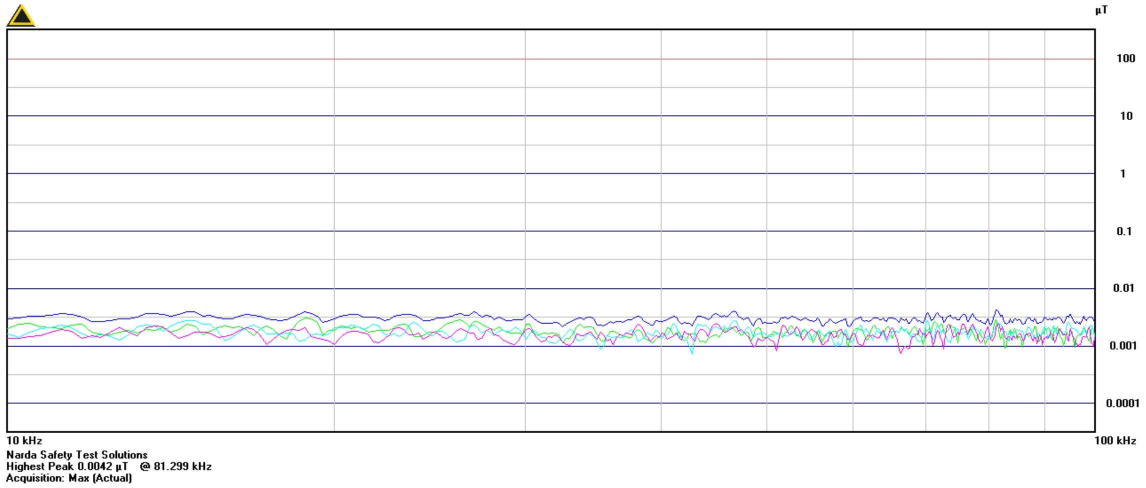

Figure 24: Dublin Airport, 10 kHz to 100 kHz (Mag Field)

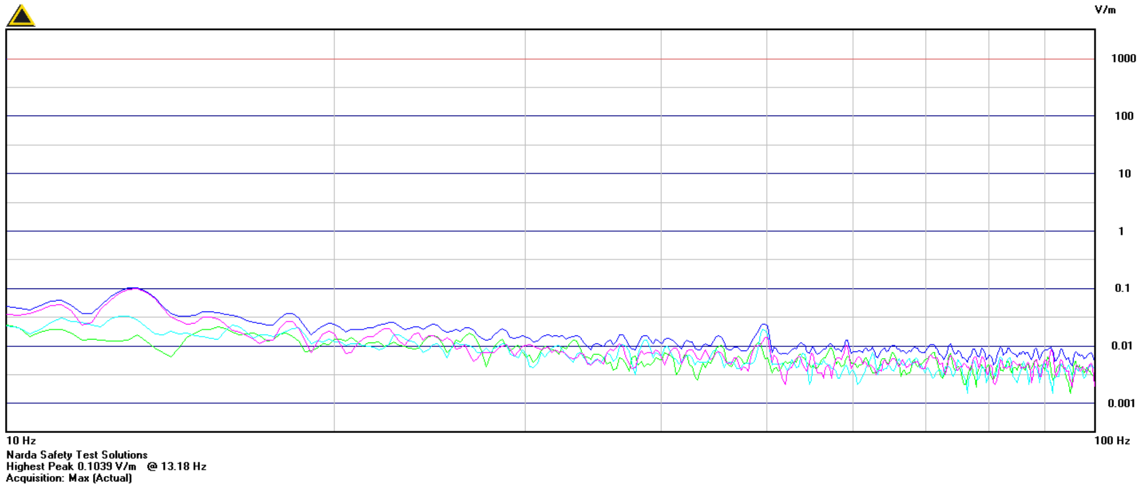

Figure 25: Dublin Airport, 10Hz to 100 Hz (E-Field)

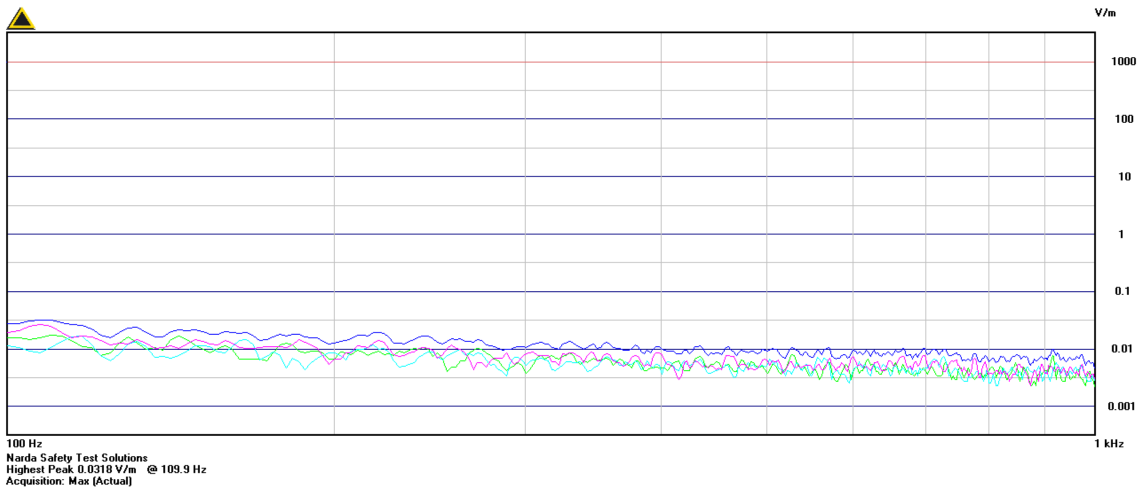

Figure 26: Dublin Airport, 100 Hz to 1 kHz (E-Field)

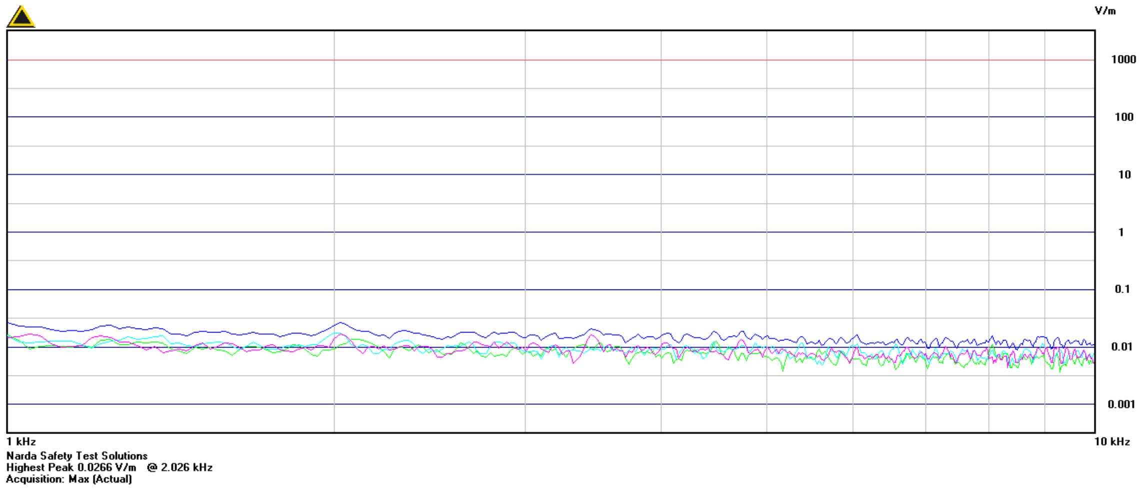

Figure 27: Dublin Airport, 1 kHz to 10 kHz (E-Field)

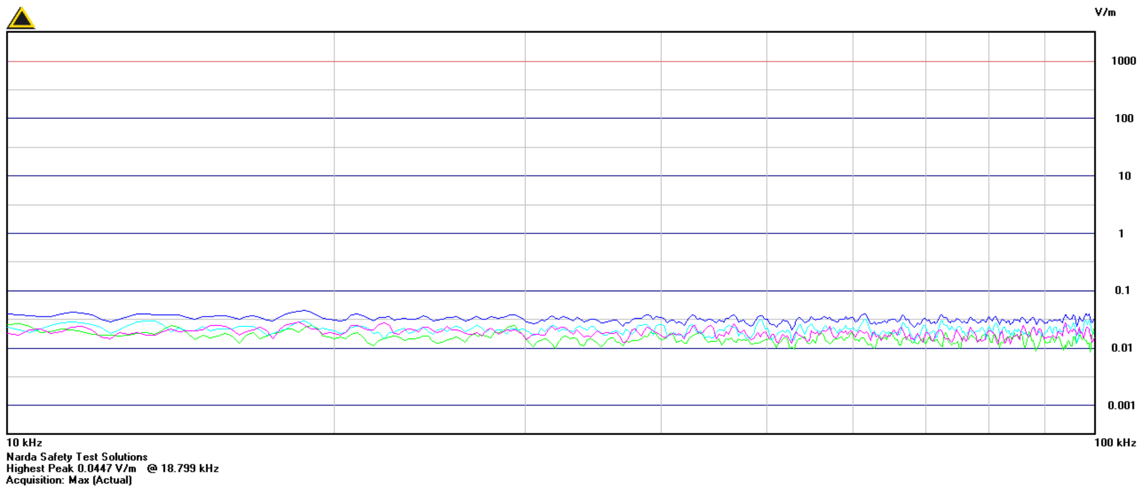

Figure 28: Dublin Airport, 10 kHz to 100 kHz (E-Field)

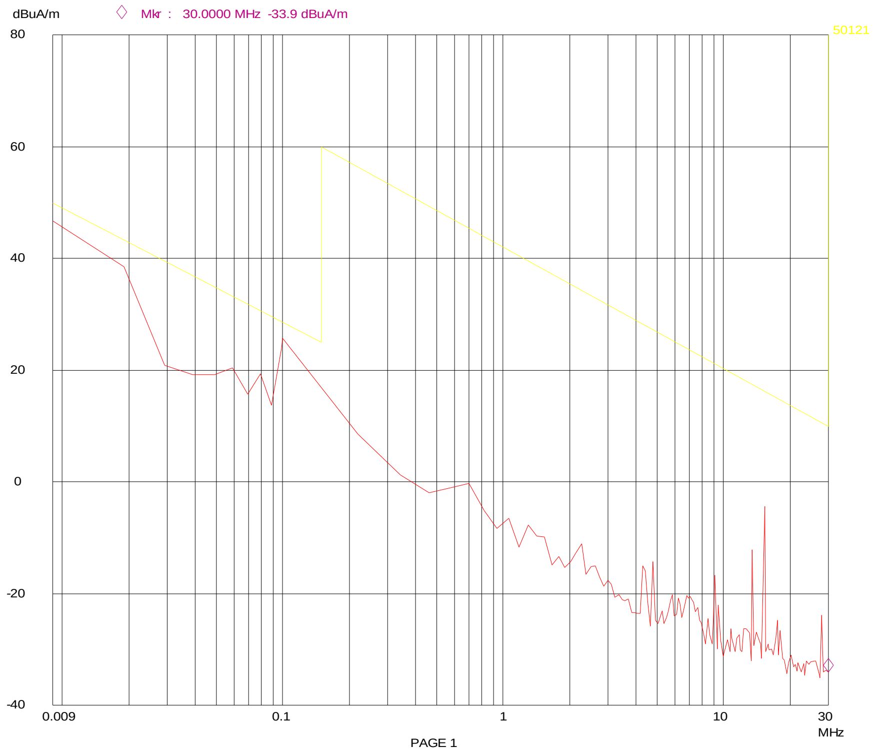

Figure 29: Dublin Airport - 9 kHz to 30 MHz

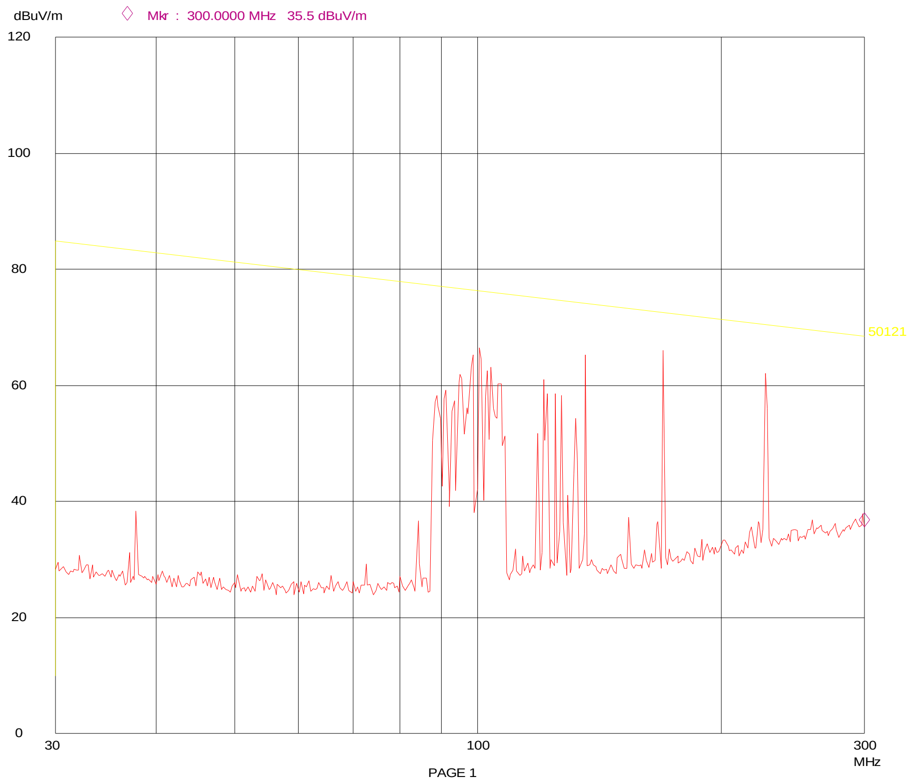

Figure 30: Dublin Airport - 30 MHz to 300 MHz

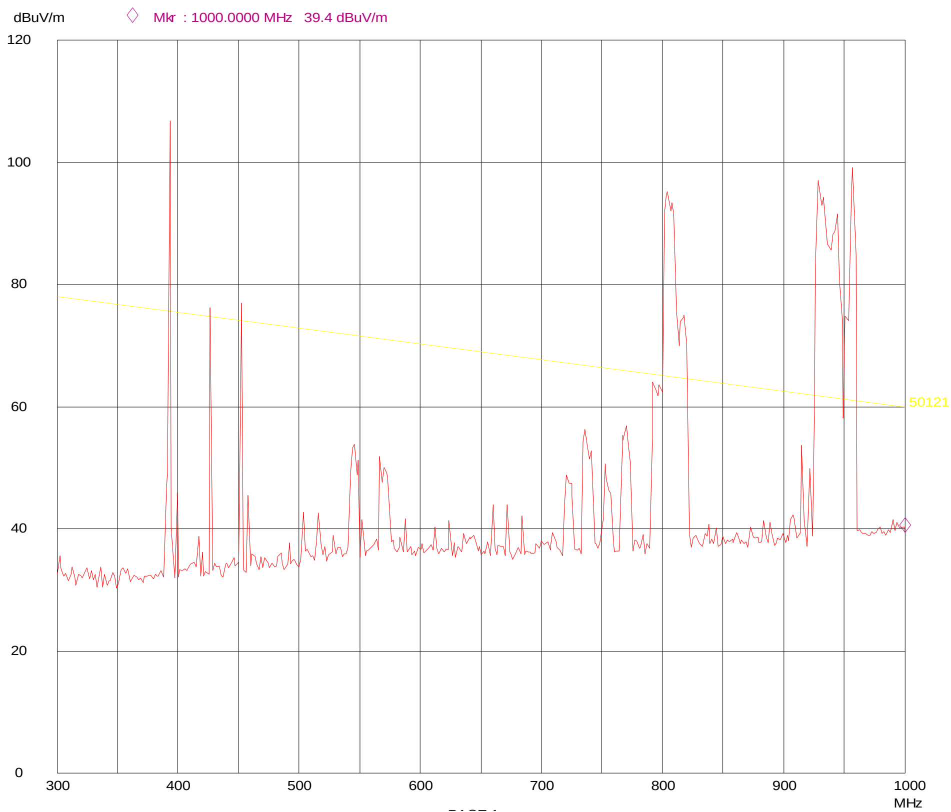

Figure 31: Dublin Airport – 300 MHz - 1 GHz

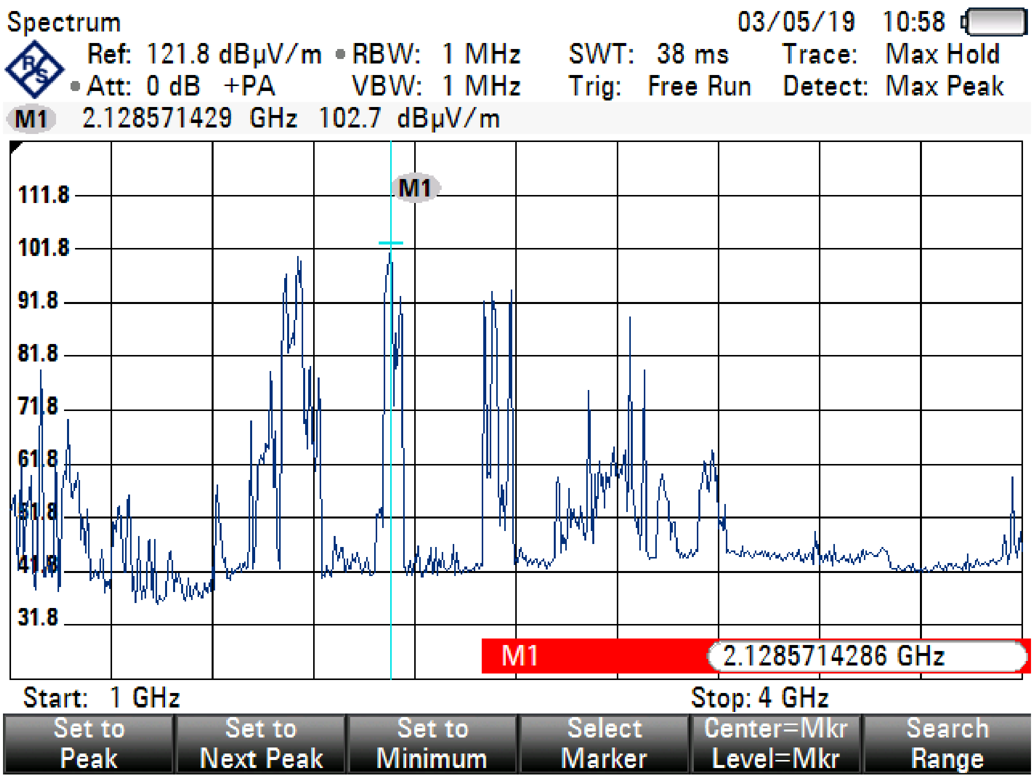

Figure 32: Dublin Airport - 1 GHz to 4 GHz

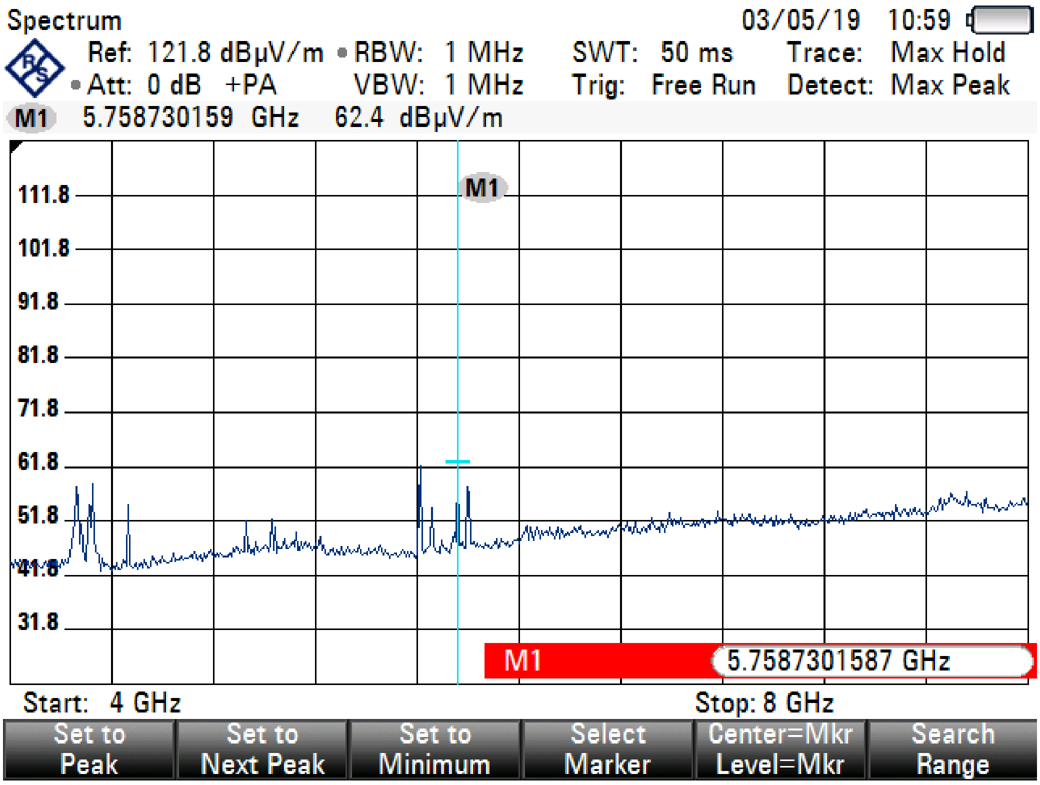

Figure 33: Dublin Airport - 4 GHz to 8 GHz

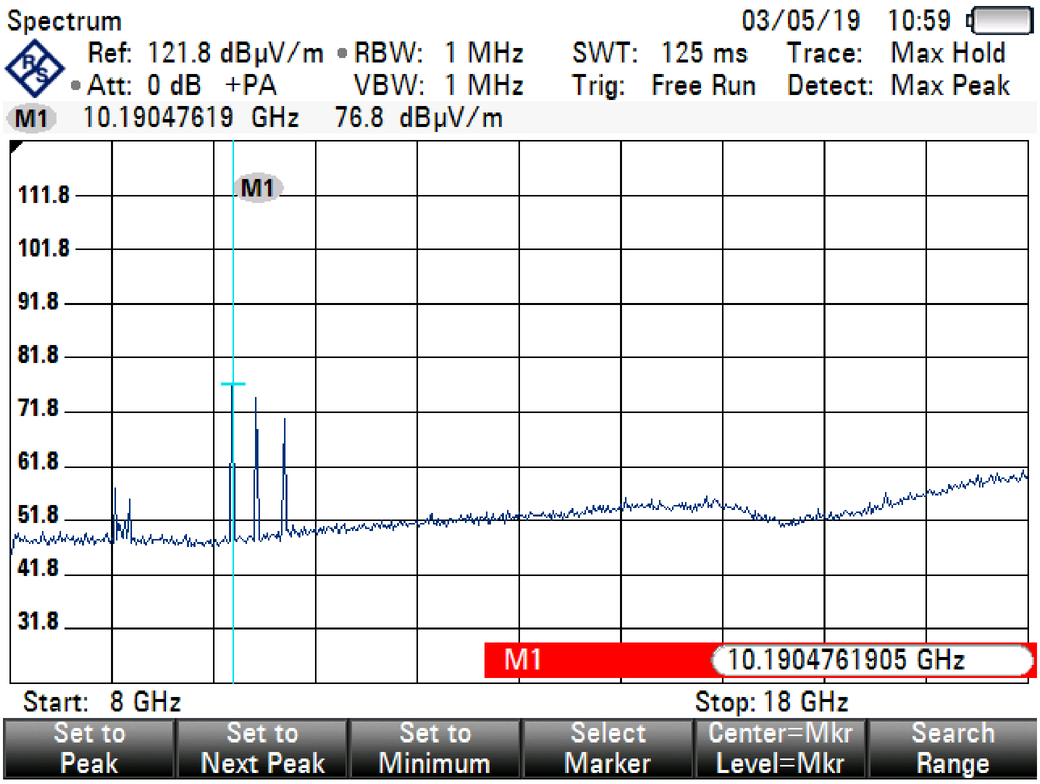

Figure 34: Dublin Airport - 8 GHz to 18 GHz

3.3 DCU EMR Survey

Measurements were performed at the location depicted below -

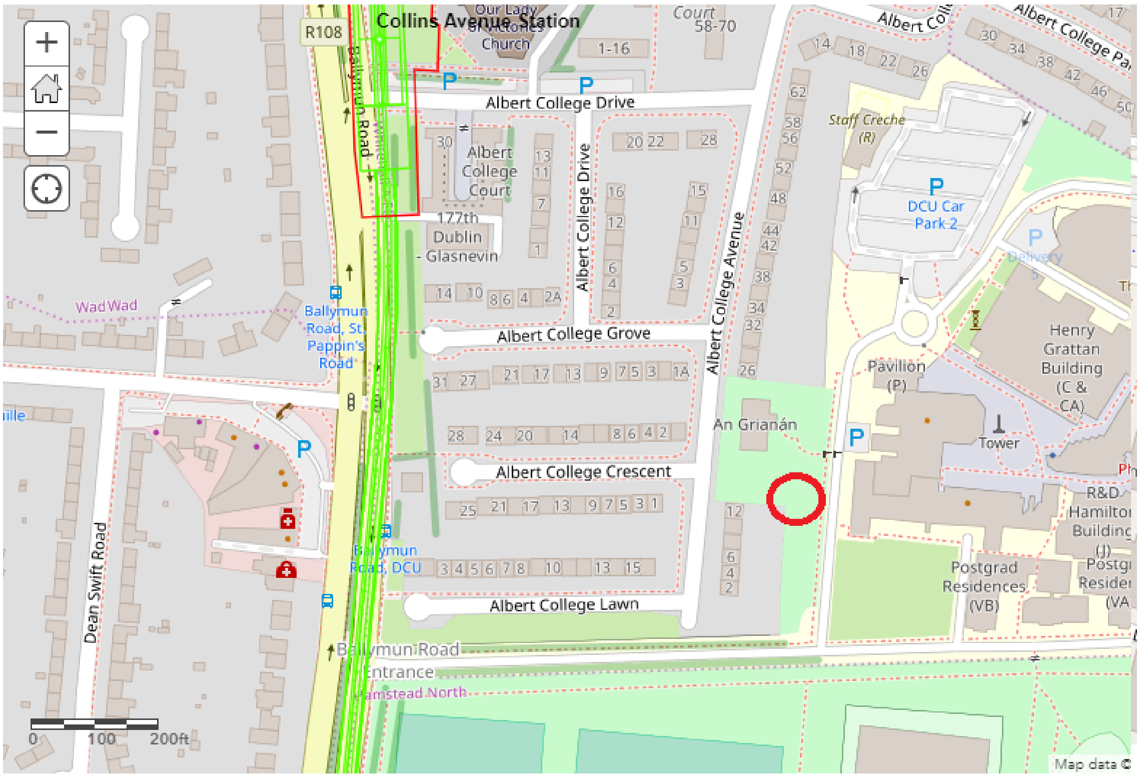

Figure 35: Measurement Location at DCU

3.3.1 DC Magnetic Field, DCU

The Earth's DC magnetic flux density (B) was measured for a period of 26 minutes. The average static field was approximately 48.2 µT with the maximum deviations seen to be 0.01 µT.

3.3.2 AC Electric and Magnetic Fields 1 Hz to 10 kHz, DCU

Figure 38: DCU, 0 Hz to 100 Hz (Mag Field) gives a spectral plot of the magnetic field from DC to 100 Hz. The DC component can be seen to be much higher than any other frequency. A spike at 50 Hz is also evident, which is the transmission frequency for mains electricity.

No unusually elevated electromagnetic field levels were detected in the range between 1 Hz to 10 kHz.

3.3.3 Radiated Fields: 10 kHz to 18 GHz, DCU

There was no evidence, during the measurement and observation time of this study of any transient or intermittent events.

The RF emissions profile in this frequency range was well below the typical risk levels of 3 V/m.

At this site the strongest emissions were caused by Aeronautical mobile services (3.1 MHz) Analog radio broadcasts (80 – 110 MHz), Digital Radio (147-223 MHz), Aeronautical navigation systems and mobile communications (108 to 137 MHz), Tetra Radio (390 MHz), Digital Television Broadcasting (470 – 790 MHz) and WiFi (2.4 GHz). In terms of mobile technology, the following signals were present, mobile broadband, LTE (791-821 MHz and 925-960 MHz), GSM 900 and 1800 (900 MHz and 1.8 GHz) and 3 G (2.1 GHz).

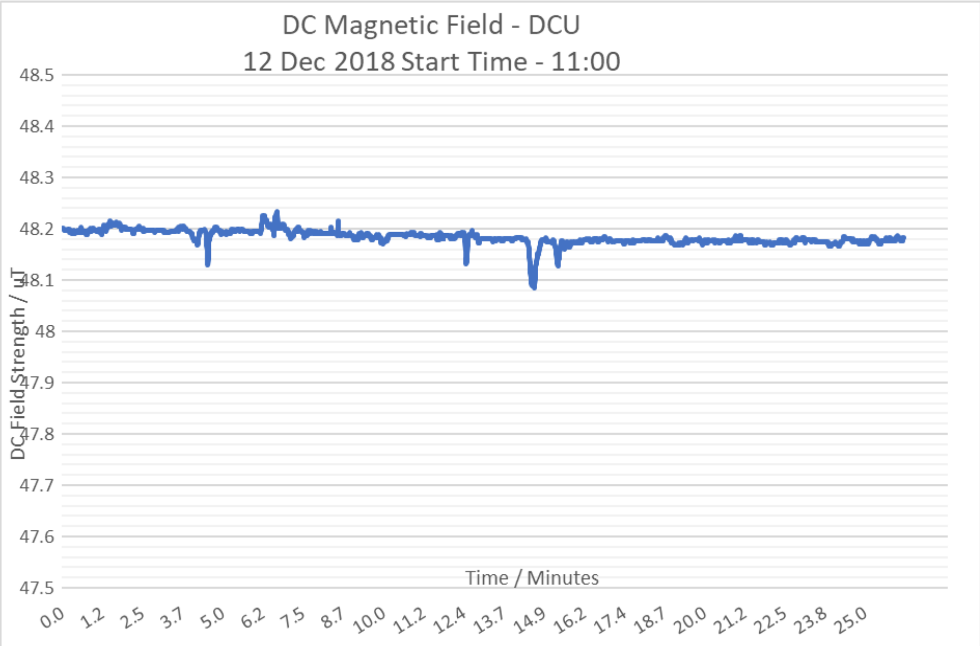

Figure 36: DCU, DC Magnetic Field

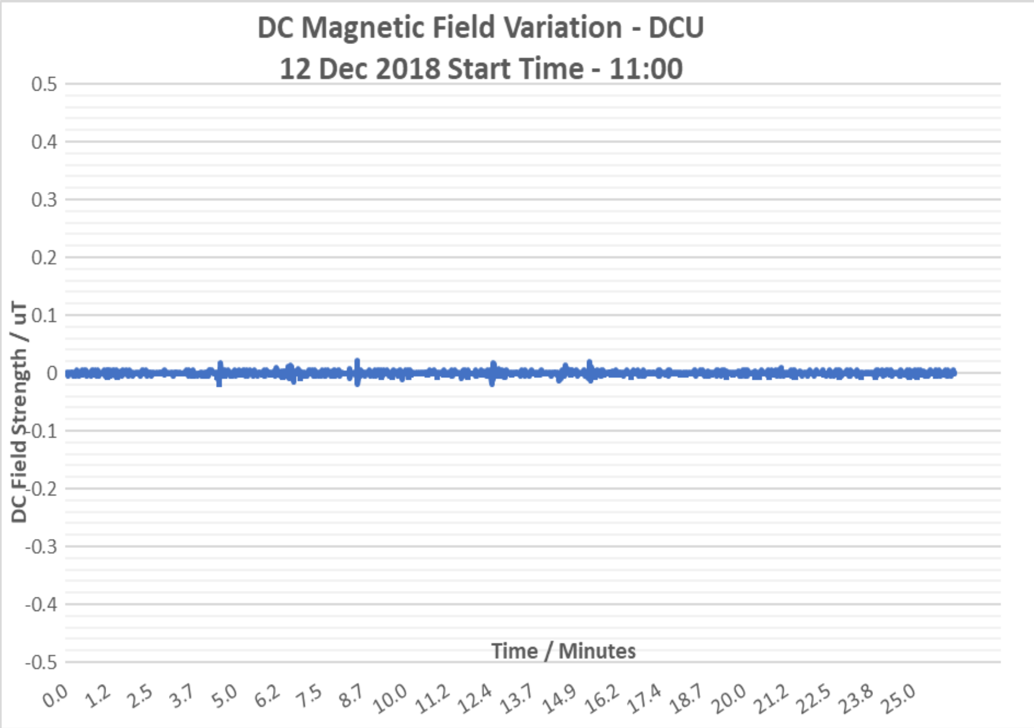

Figure 37: DCU, DC Magnetic Field variations

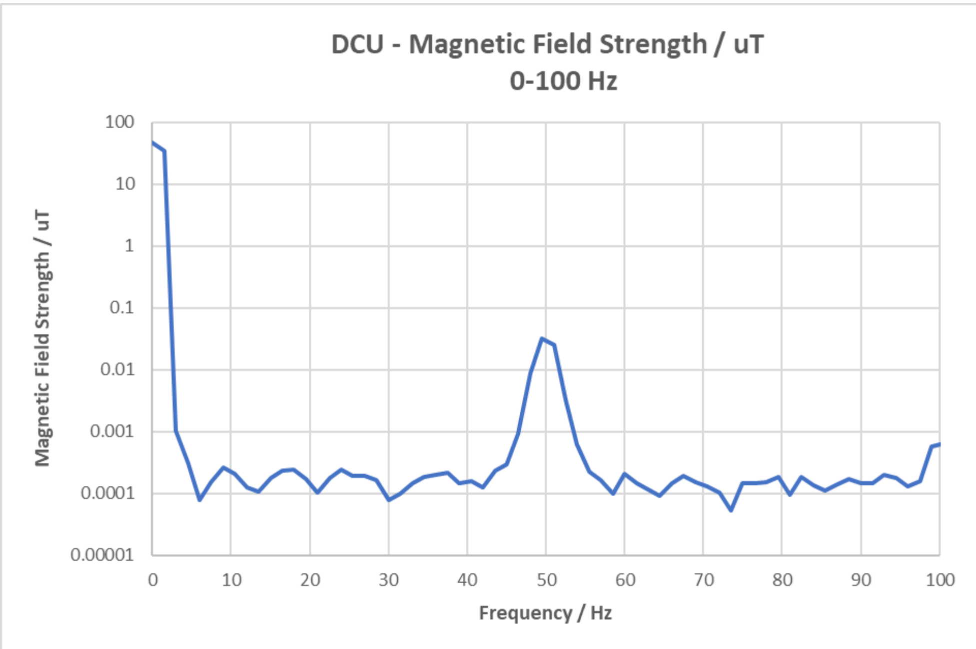

Figure 38: DCU, 0 Hz to 100 Hz (Mag Field)

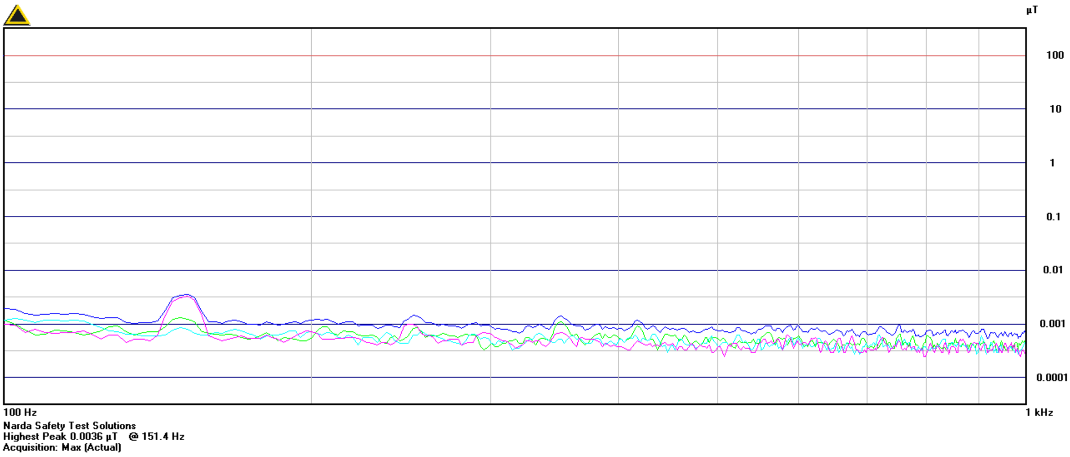

Figure 39: DCU, 100 Hz to 1 kHz (Mag Field)

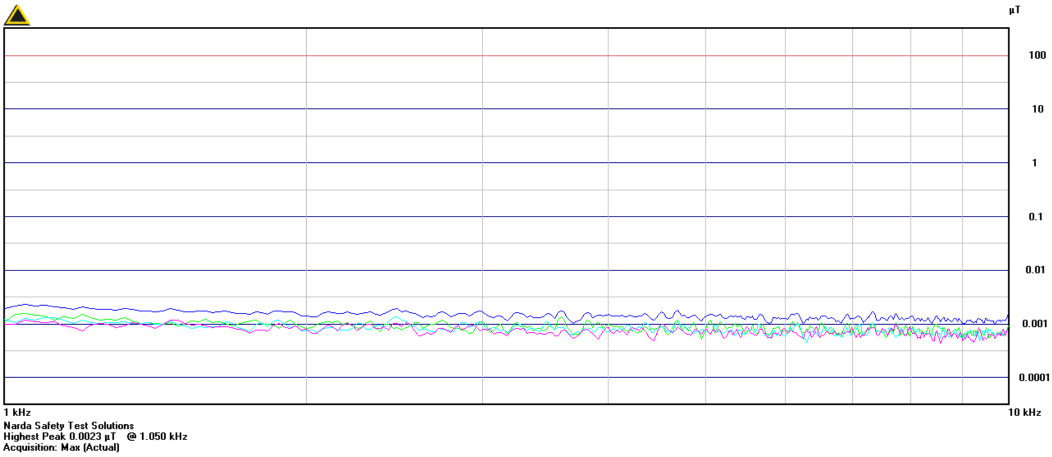

Figure 40: DCU, 1 kHz to 10 kHz (Mag Field)

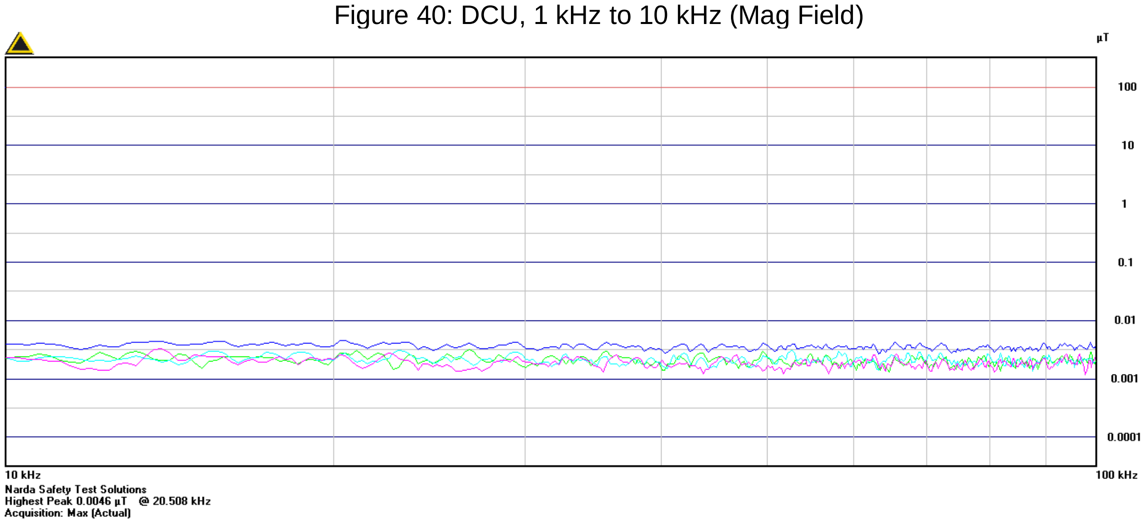

Figure 41: DCU, 10 kHz to 100 kHz (Mag Field)

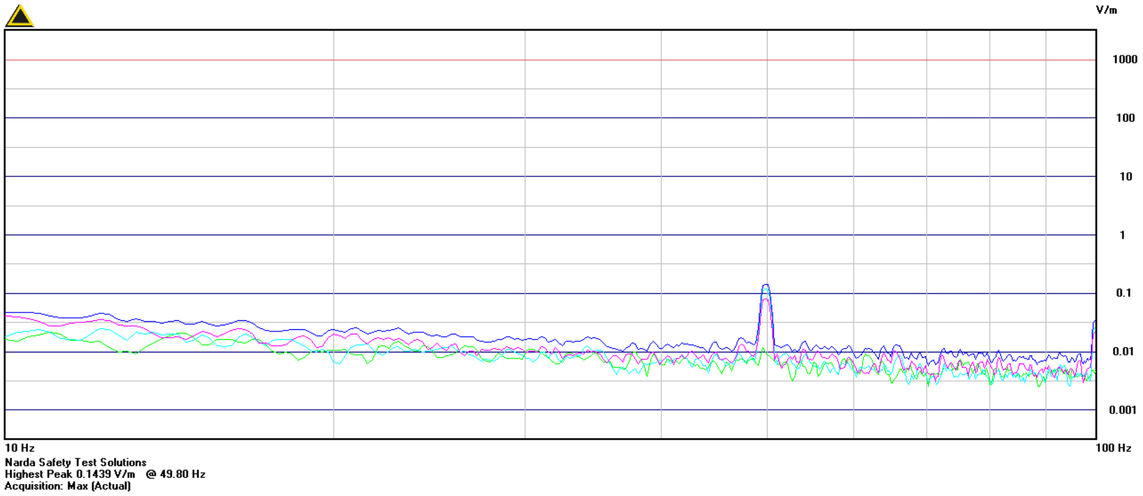

Figure 42: DCU, 10Hz to 100 Hz (E-Field)

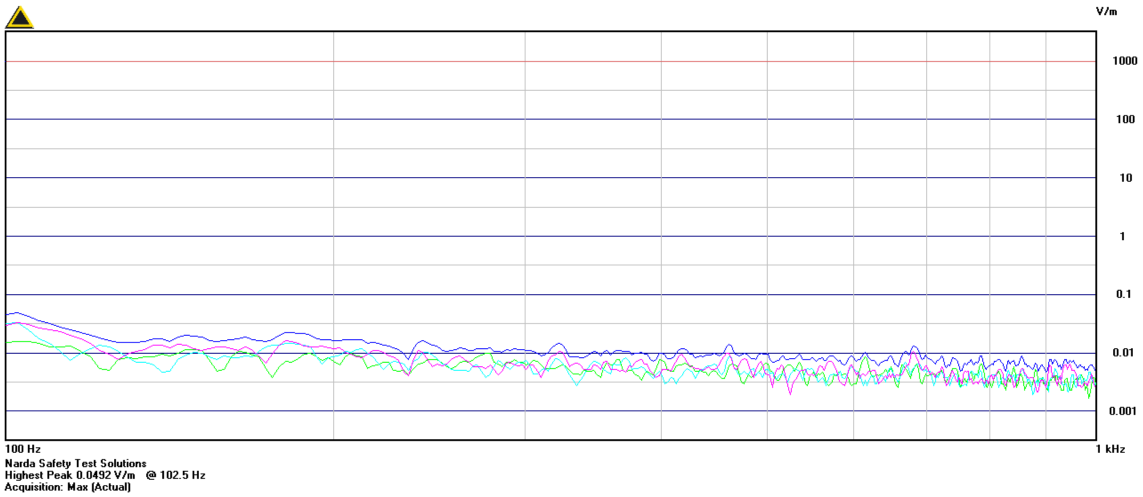

Figure 43: DCU, 100 Hz to 1 kHz (E-Field)

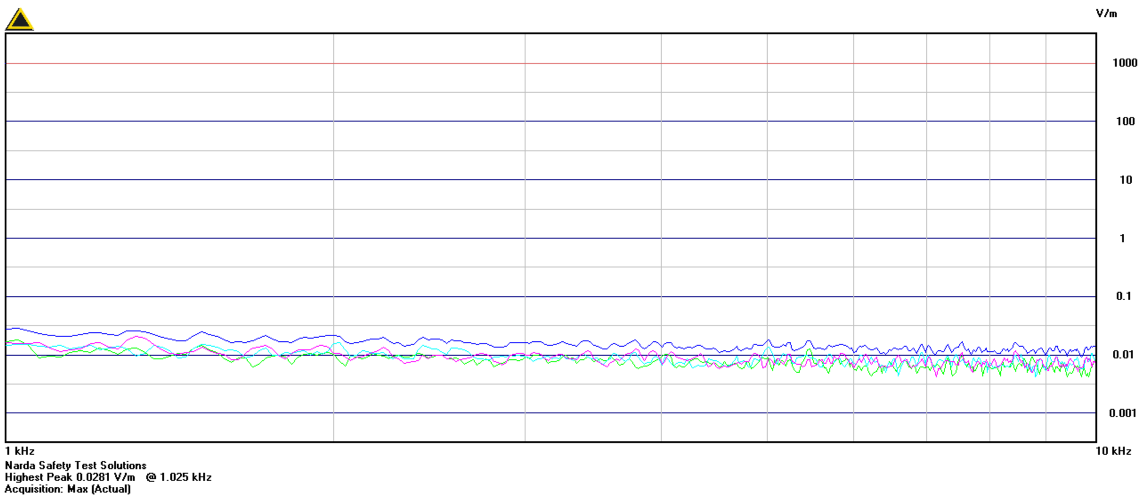

Figure 44: DCU, 1 kHz to 10 kHz (E-Field)

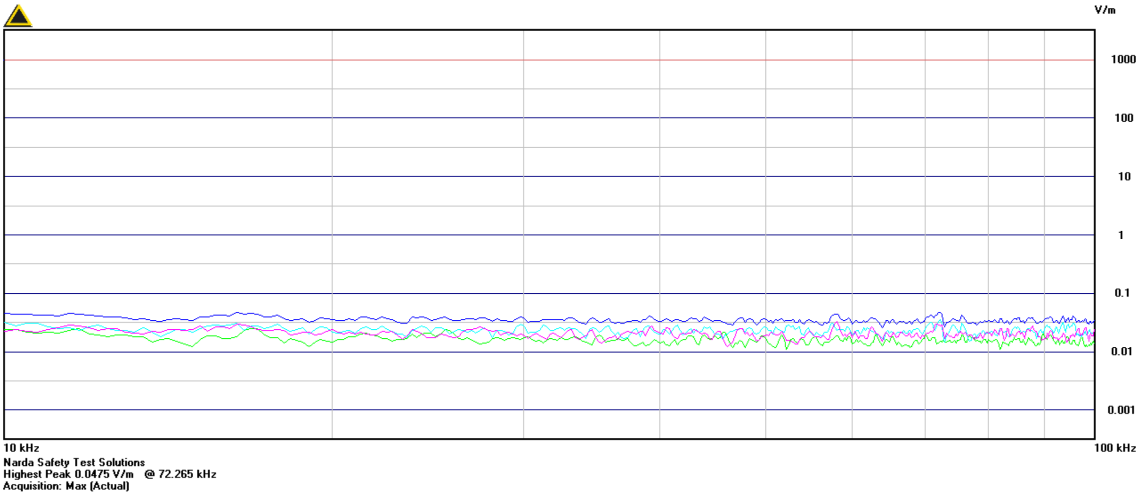

Figure 45: DCU, 10 kHz to 100 kHz (E-Field)

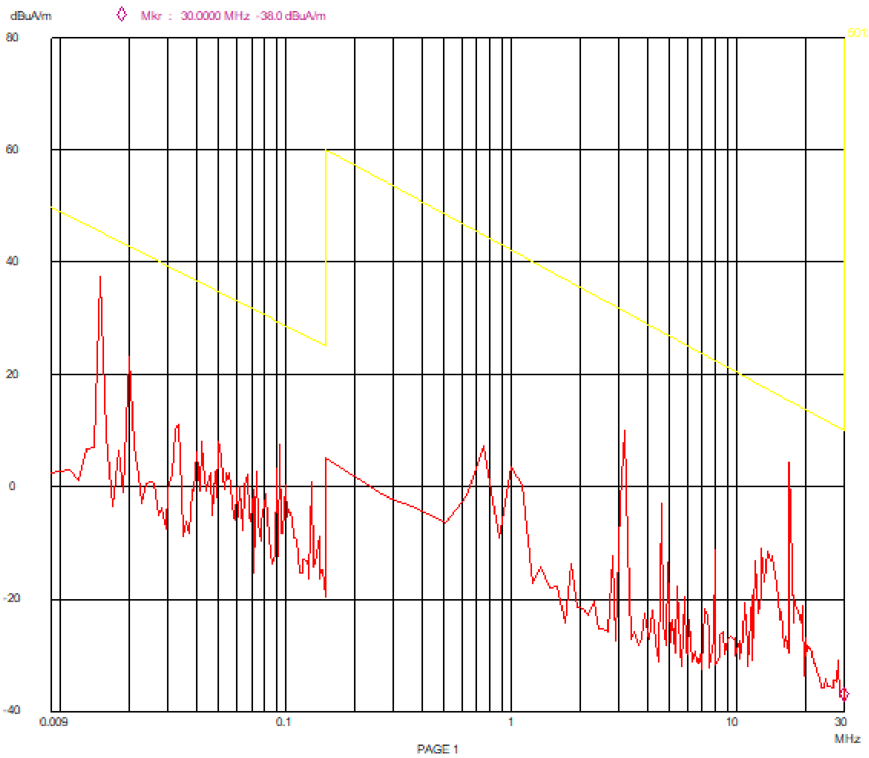

Figure 46: DCU – 9 kHz to 30 MHz

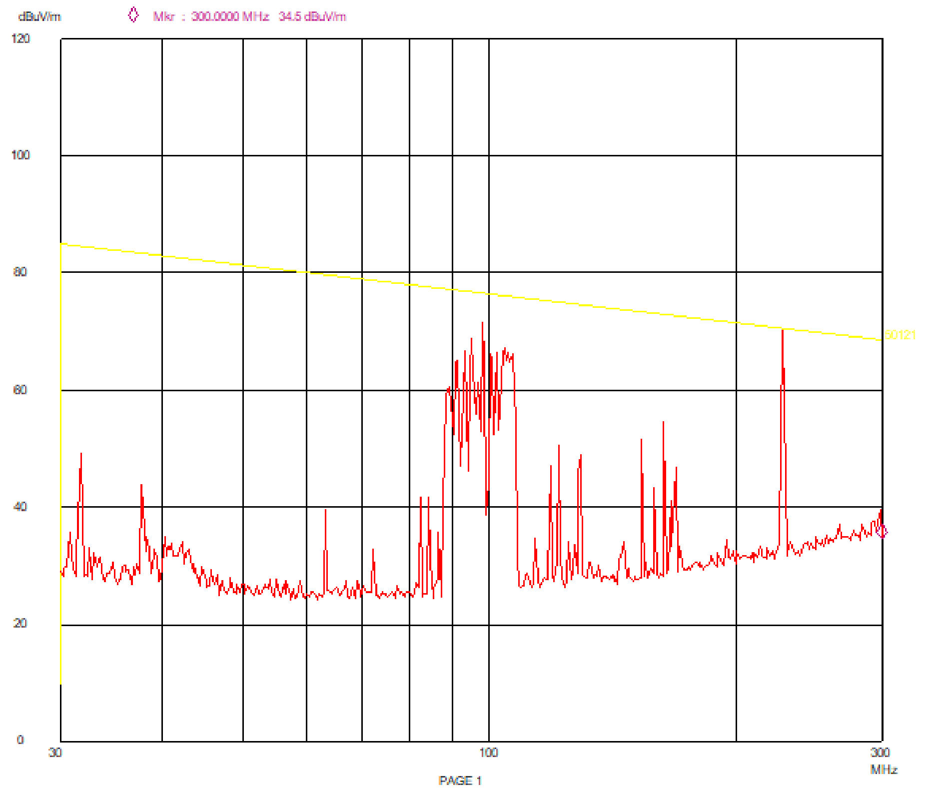

Figure 47: DCU – 30 MHz to 300 MHz

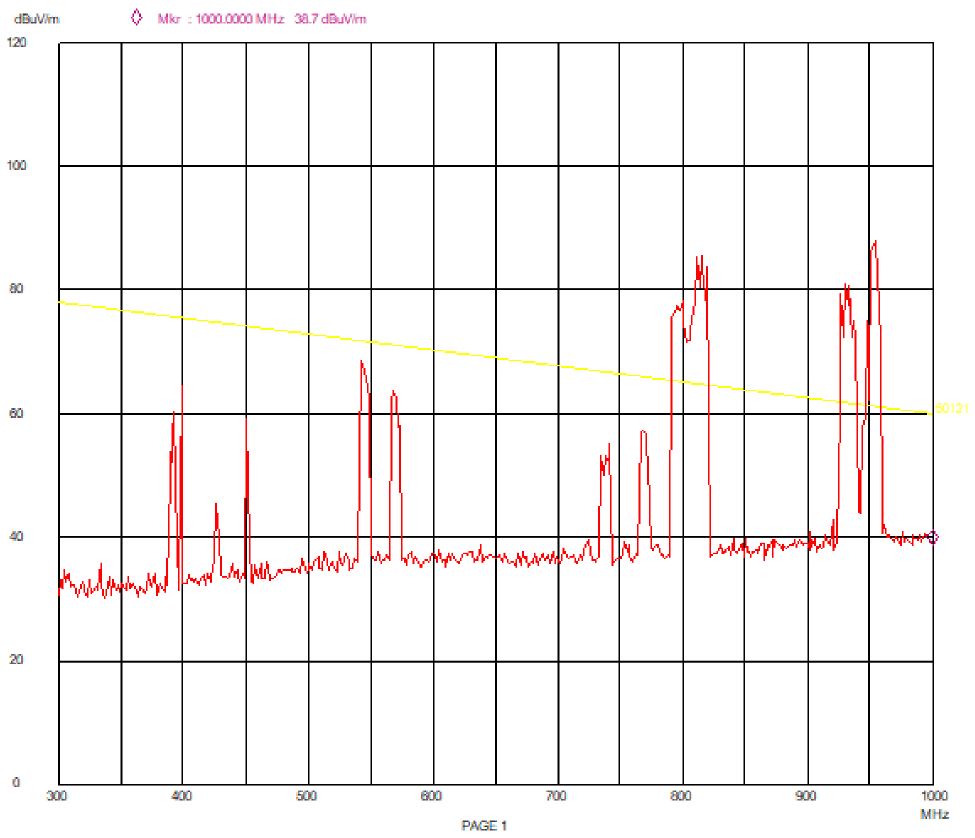

Figure 48: DCU – 300 MHz to 1 GHz

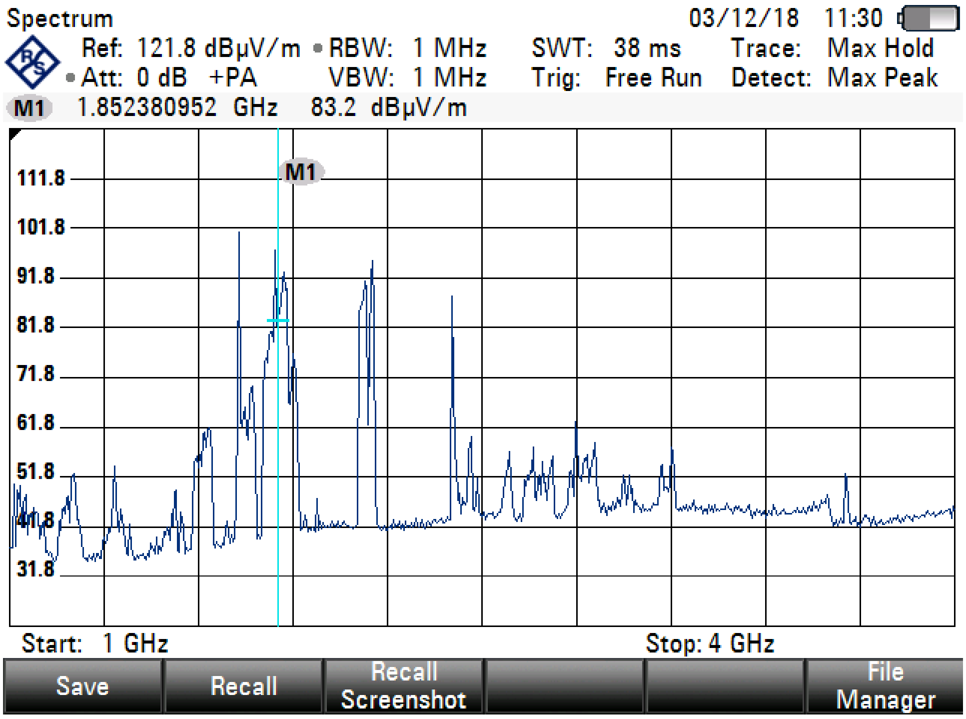

Figure 49: DCU - 1 GHz to 4 GHz

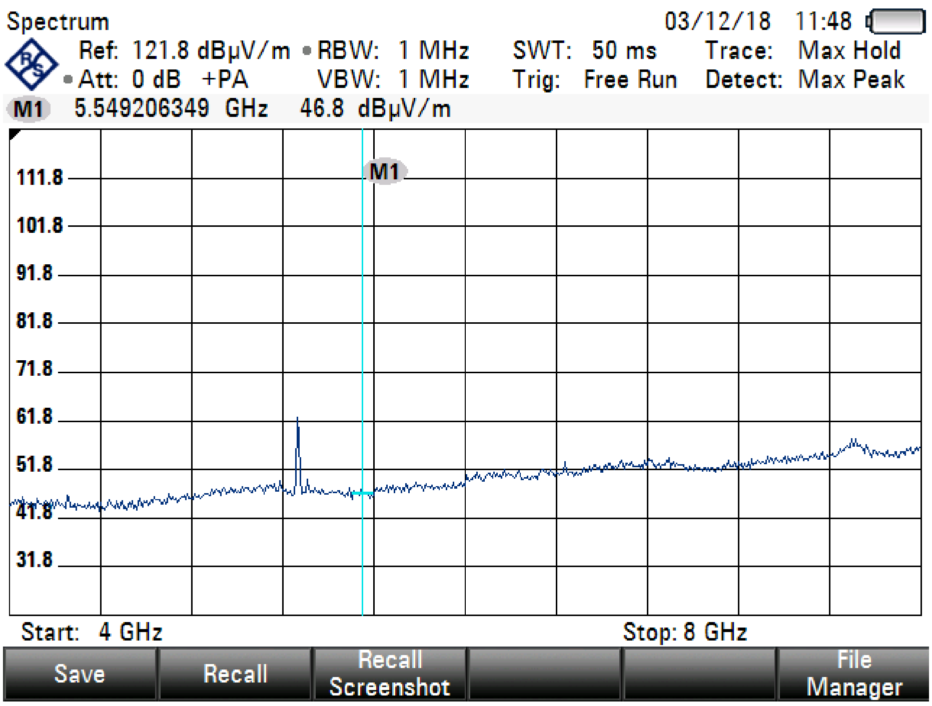

Figure 50: DCU - 4 GHz to 8 GHz

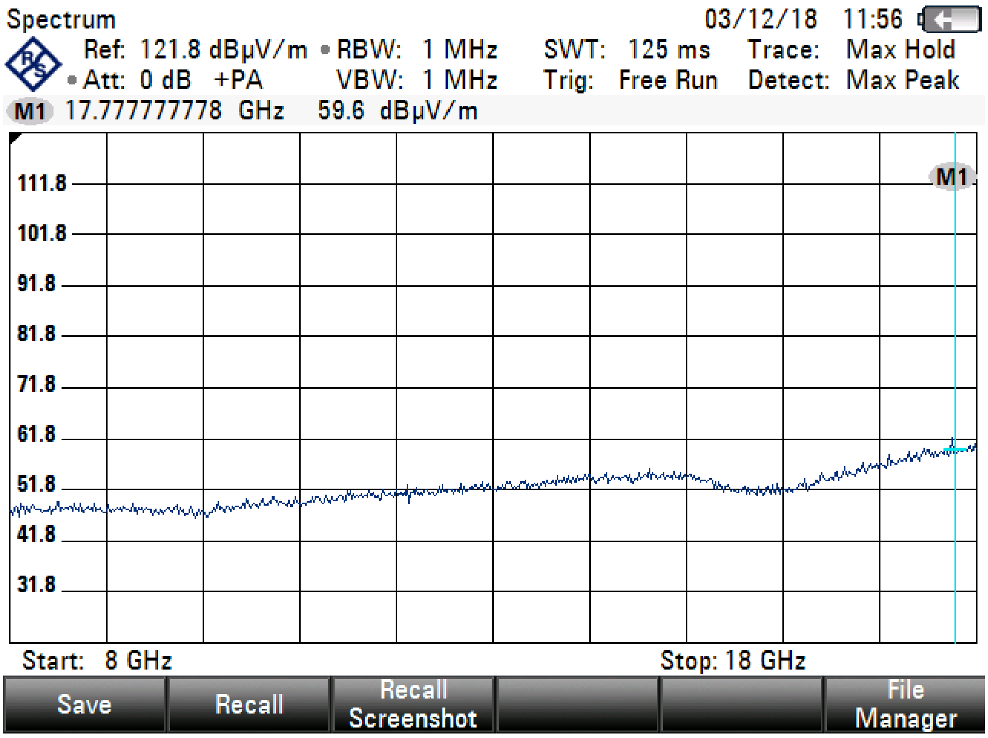

Figure 51: DCU - 8 GHz to 18 GHz

3.4 Irish Rail at Prospect Road EMR Survey

Measurements were performed at the location depicted below -

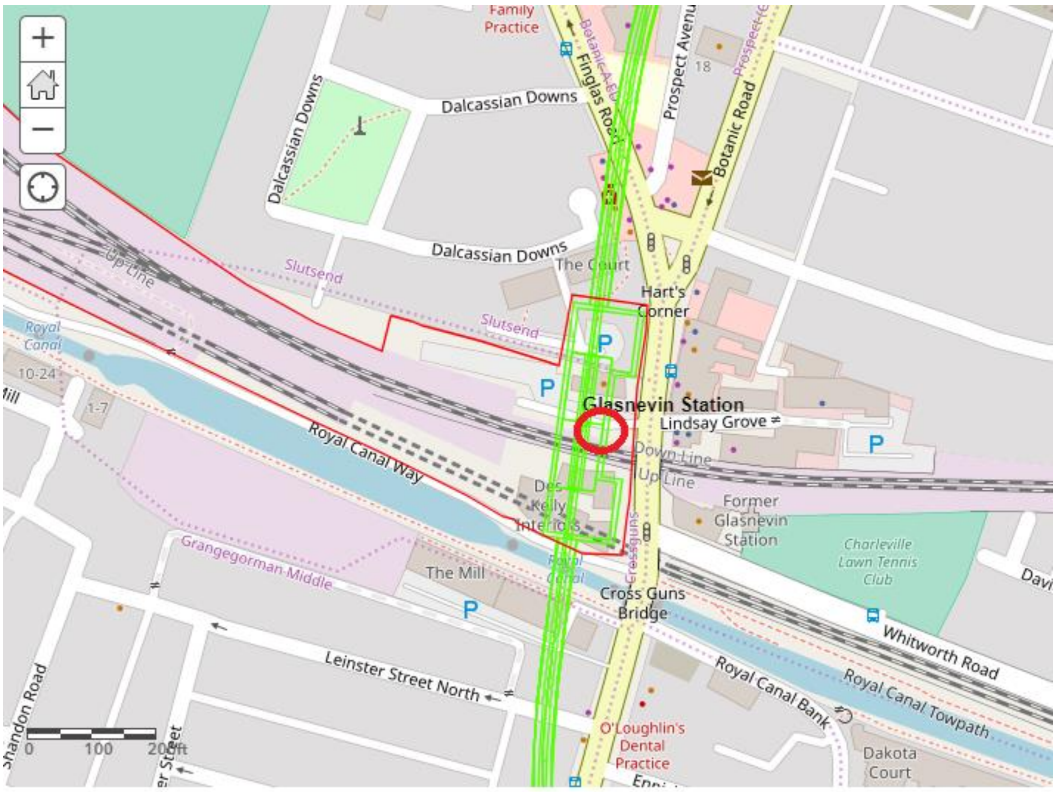

Figure 52: Measurement Location at Irish Rail crossing at Prospect Road

3.4.1 DC Magnetic Field, Irish Rail at Prospect Road

The Earth's DC magnetic flux density (B) was measured for a period of 20 minutes. The average static field was approximately 44.5 µT with the maximum deviations seen to be 6 µT with the high fluctuation attributed to vehicular traffic passing quite close to our measurement location.

3.4.2 AC Electric and Magnetic Fields 1 Hz to 10 kHz, Irish Rail at Prospect Road

Figure 55 gives a spectral plot of the magnetic field from DC to 100 Hz. The DC component can be seen to be much higher than any other frequency. A spike at 50 Hz is also evident, which is the transmission frequency for mains electricity.

No unusually elevated electromagnetic field levels were detected in the range between 1 Hz to 10 kHz.

3.4.3 Radiated Fields: 10 kHz to 18 GHz, Irish Rail at Prospect Road

There was no evidence, during the measurement and observation time of this study of any transient or intermittent events.

The RF emissions profile in this frequency range was well below the typical risk levels of 3 V/m.

At this site the strongest emissions were caused by Aeronautical mobile services (3.1 MHz) Analog radio broadcasts (80 – 110 MHz), Digital Radio (147-223 MHz), Aeronautical navigation systems and mobile communications (108 to 137 MHz), Tetra Radio (390 MHz), Digital Television Broadcasting (470 – 790 MHz), WiFi (2.4 GHz) and FWALA (4.2 GHz). In terms of mobile technology, the following signals were present, mobile broadband, LTE (791-821 MHz and 925-960 MHz), GSM 900 and 1800 (900 MHz and 1.8 GHz) and 3 G (2.1 GHz).

There was no evidence, during the measurement and observation time of this study of any transient or intermittent events.

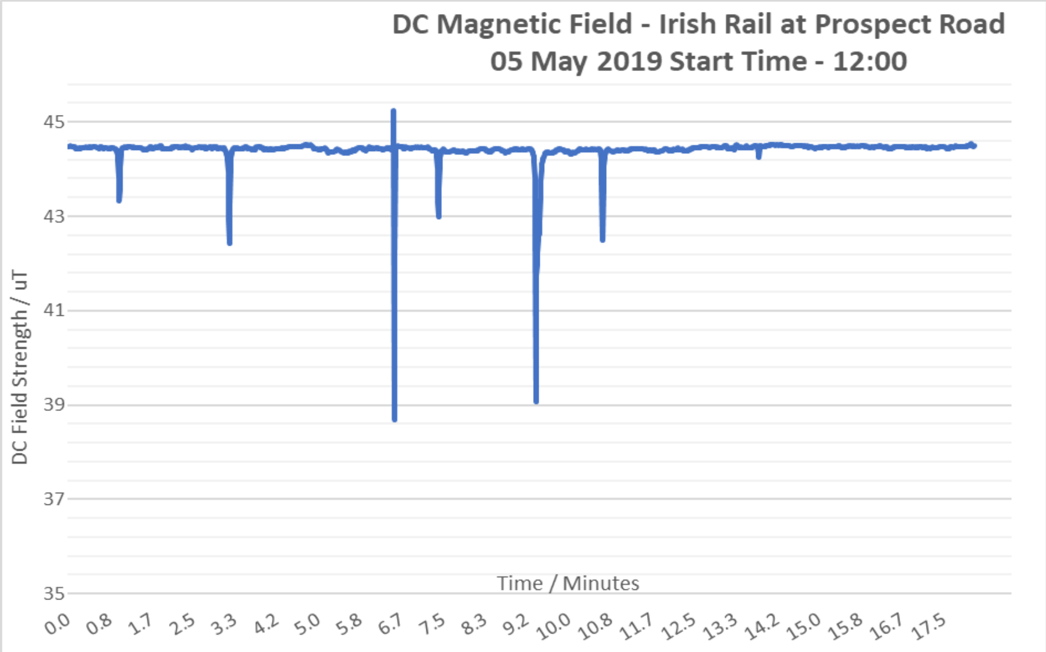

Figure 53: Irish Rail crossing at Prospect Road, DC Magnetic Field

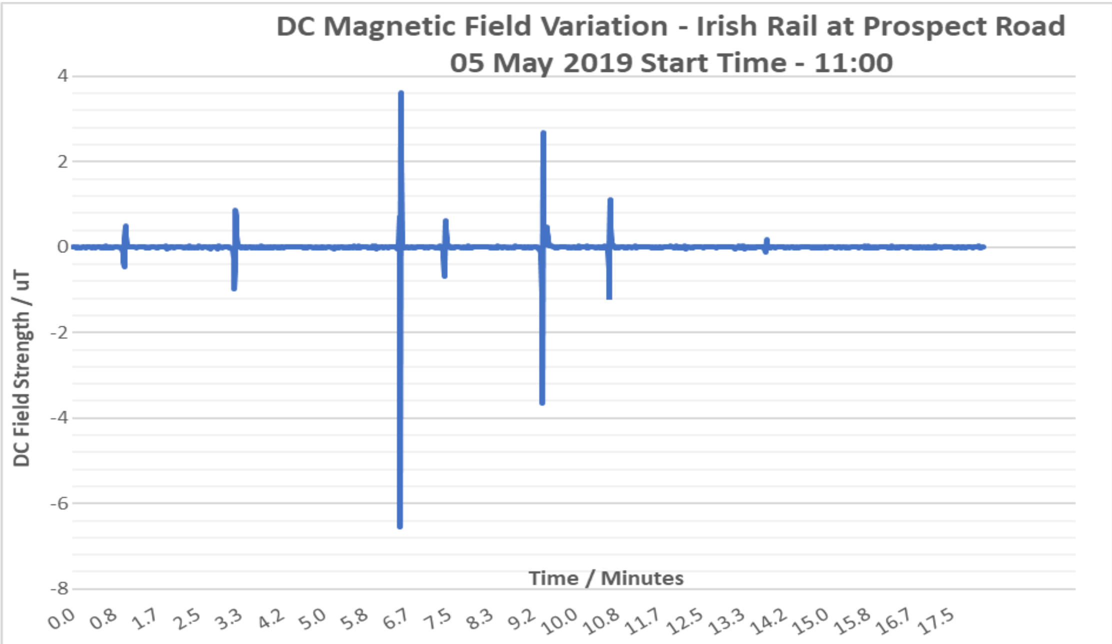

Figure 54: Irish Rail at crossing Prospect Road, DC Magnetic Field variations

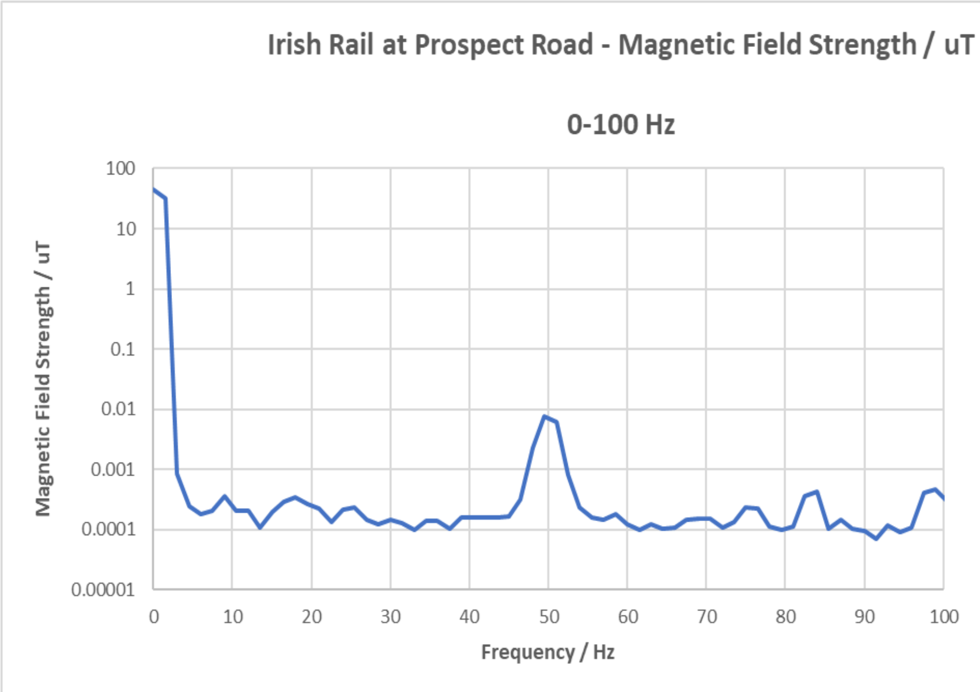

Figure 55: Irish Rail crossing at Prospect Road, 0 Hz to 100 Hz (Mag Field)

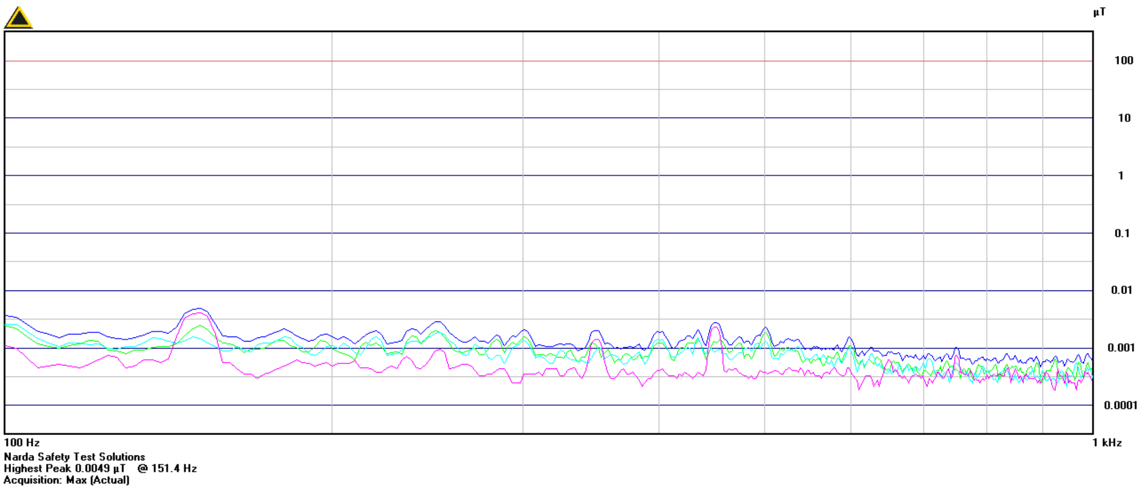

Figure 56: Irish Rail crossing at Prospect Road, 100 Hz to 1 kHz (Mag Field)

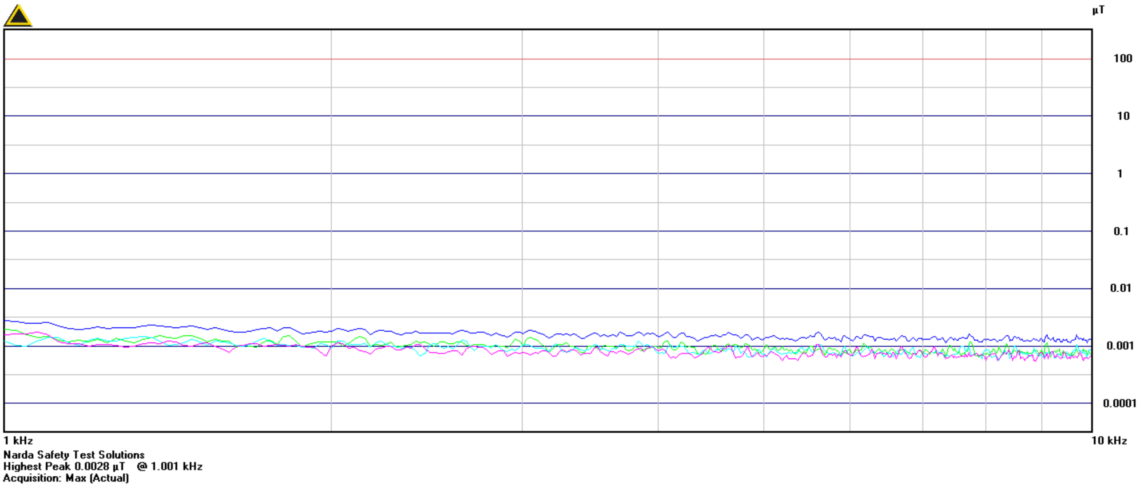

Figure 57: Irish Rail crossing at Prospect Road, 1 kHz to 10 kHz (Mag Field)

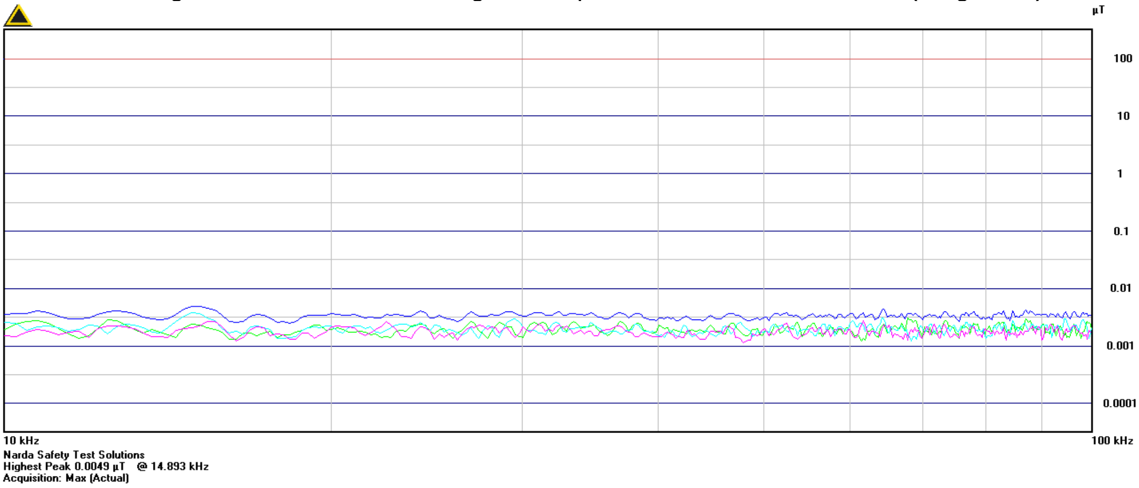

Figure 58: Irish Rail crossing at Prospect Road, 10 kHz to 100 kHz (Mag Field)

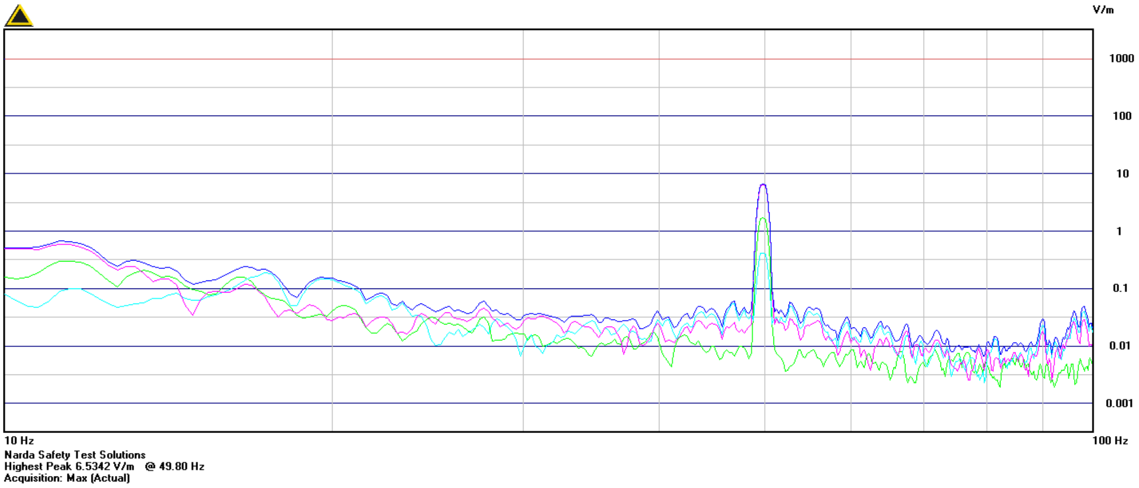

Figure 59: Irish Rail crossing at Prospect Road, 10Hz to 100 Hz (E-Field)

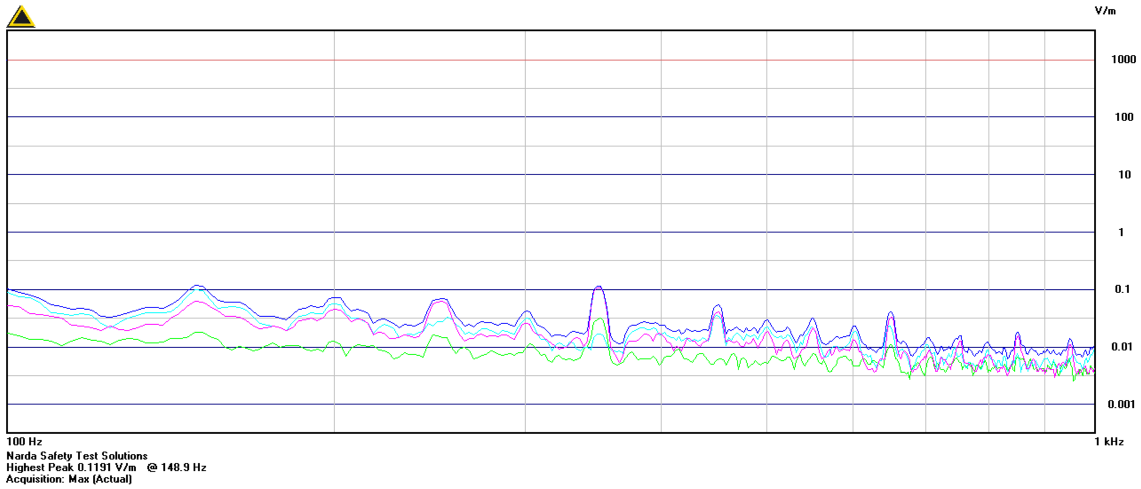

Figure 60: Irish Rail crossing at Prospect Road, 100 Hz to 1 kHz (E-Field)

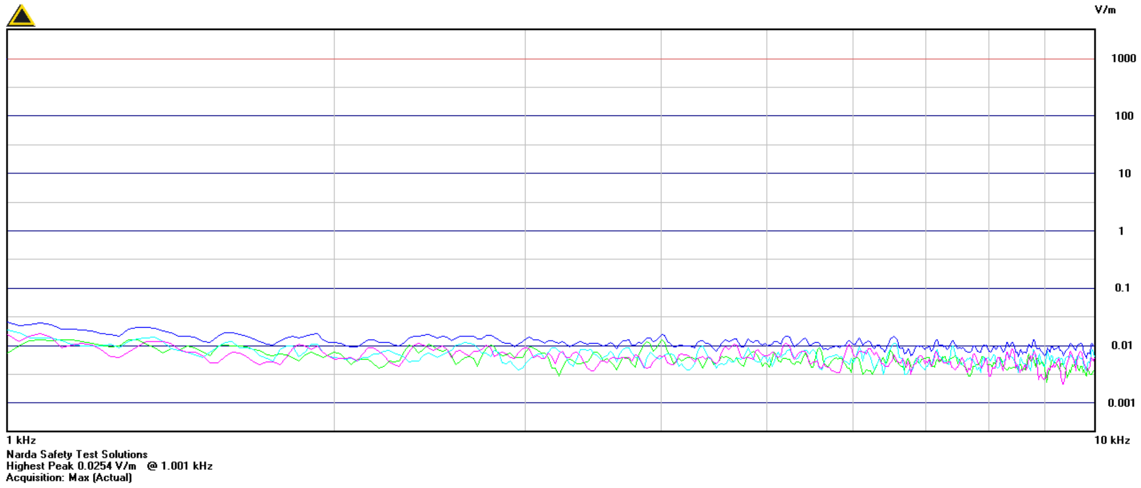

Figure 61: Irish Rail crossing at Prospect Road, 1 kHz to 10 kHz (E-Field)

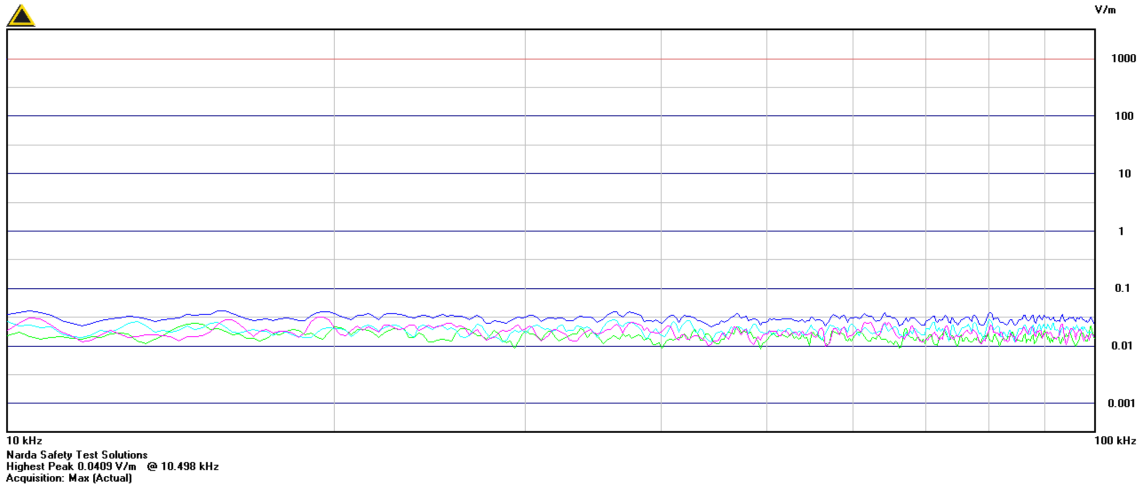

Figure 62: Irish Rail crossing at Prospect Road, 10 kHz to 100 kHz (E-Field)

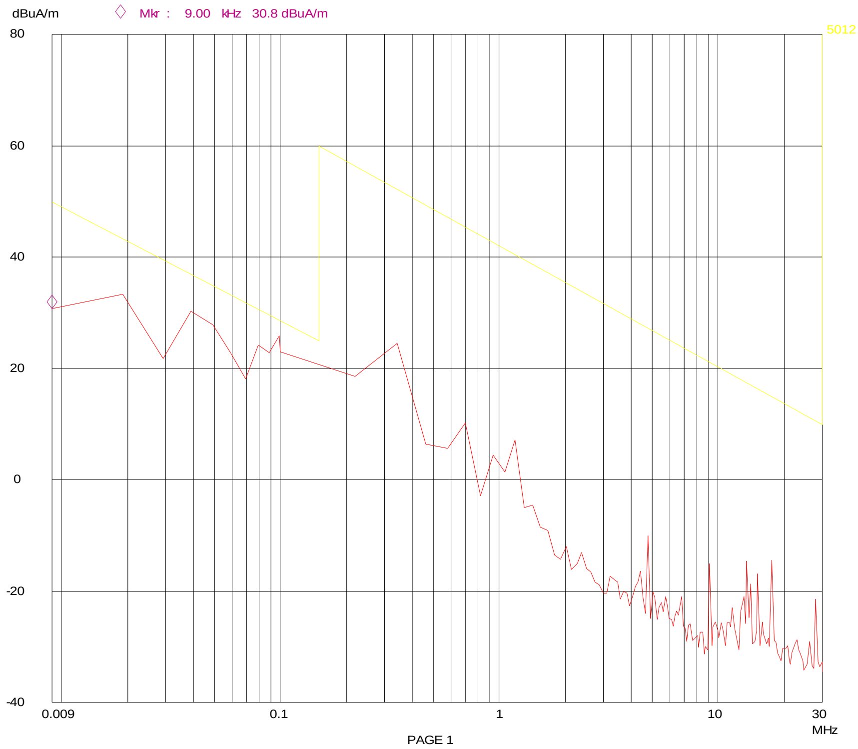

Figure 63: Irish Rail crossing at Prospect Road – 9 kHz to 30 MHz

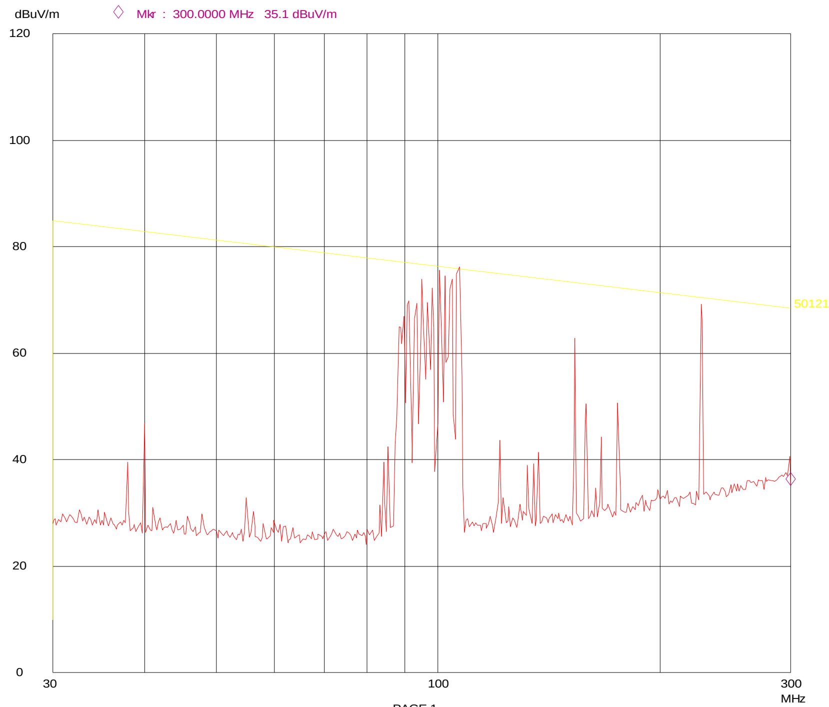

Figure 64: Irish Rail crossing at Prospect Road – 30 MHz to 300 MHz

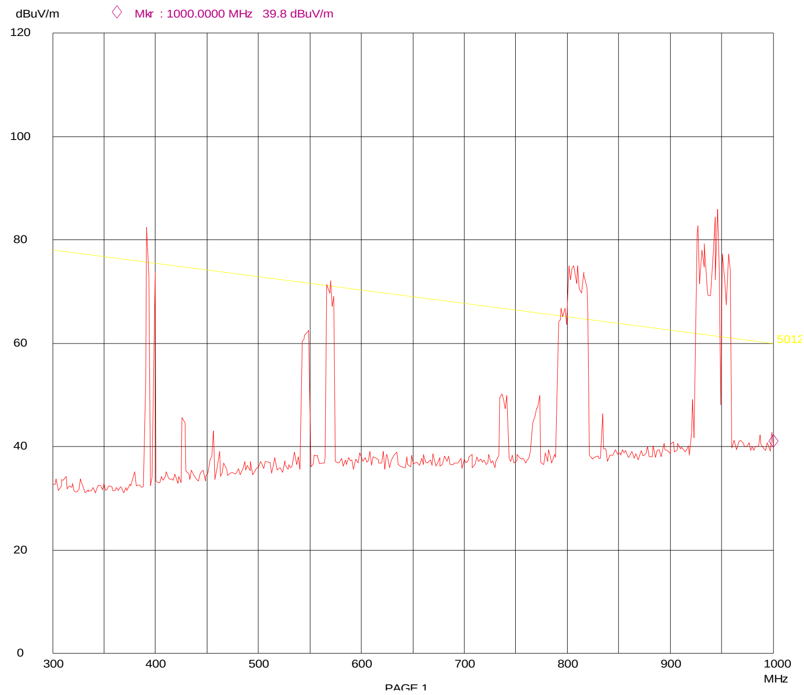

Figure 65: Irish Rail crossing at Prospect Road – 300 MHz to 1 GHz

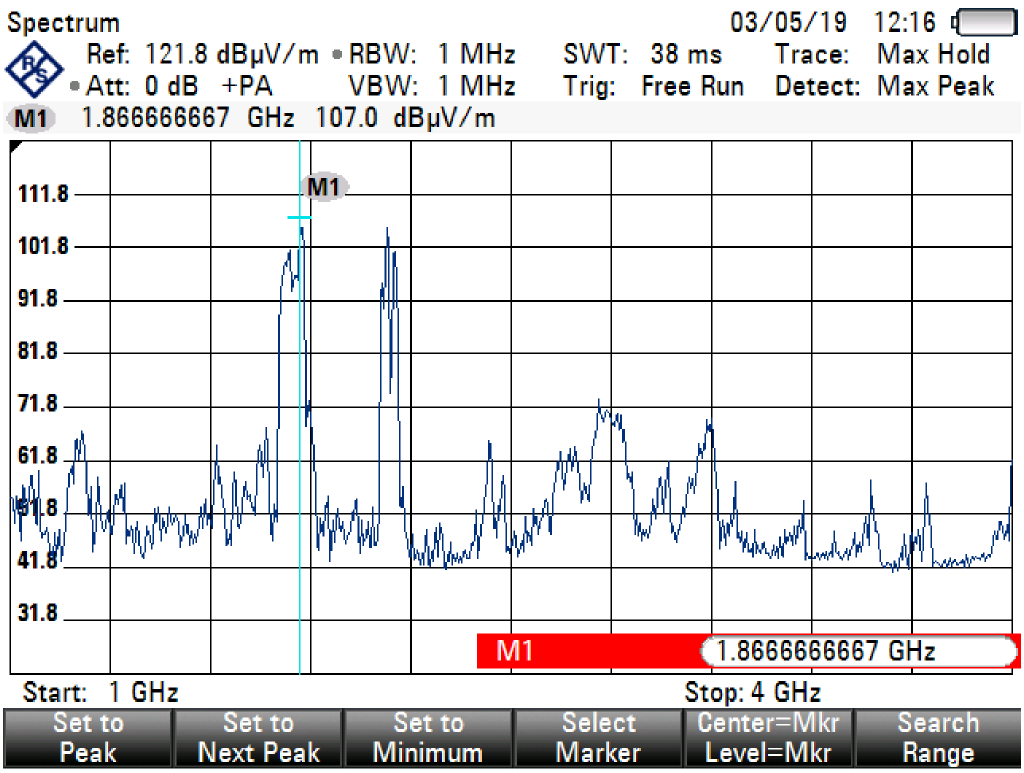

Figure 66: Irish Rail crossing at Prospect Road - 1 GHz to 4 GHz

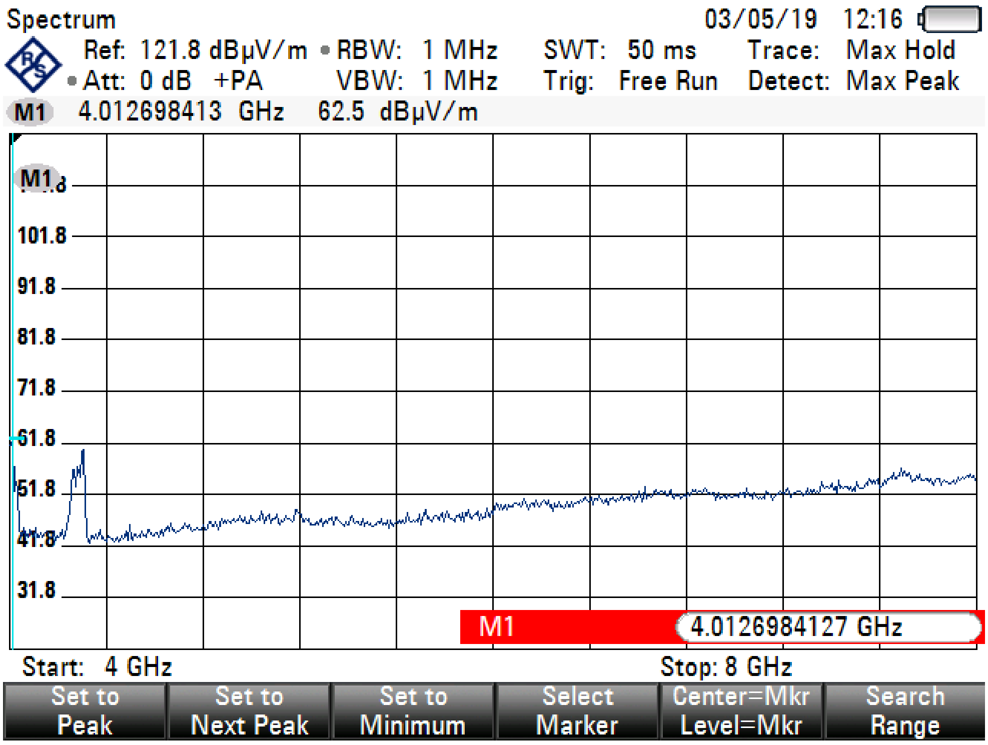

Figure 67: Irish Rail crossing at Prospect Road - 4 GHz to 8 GHz

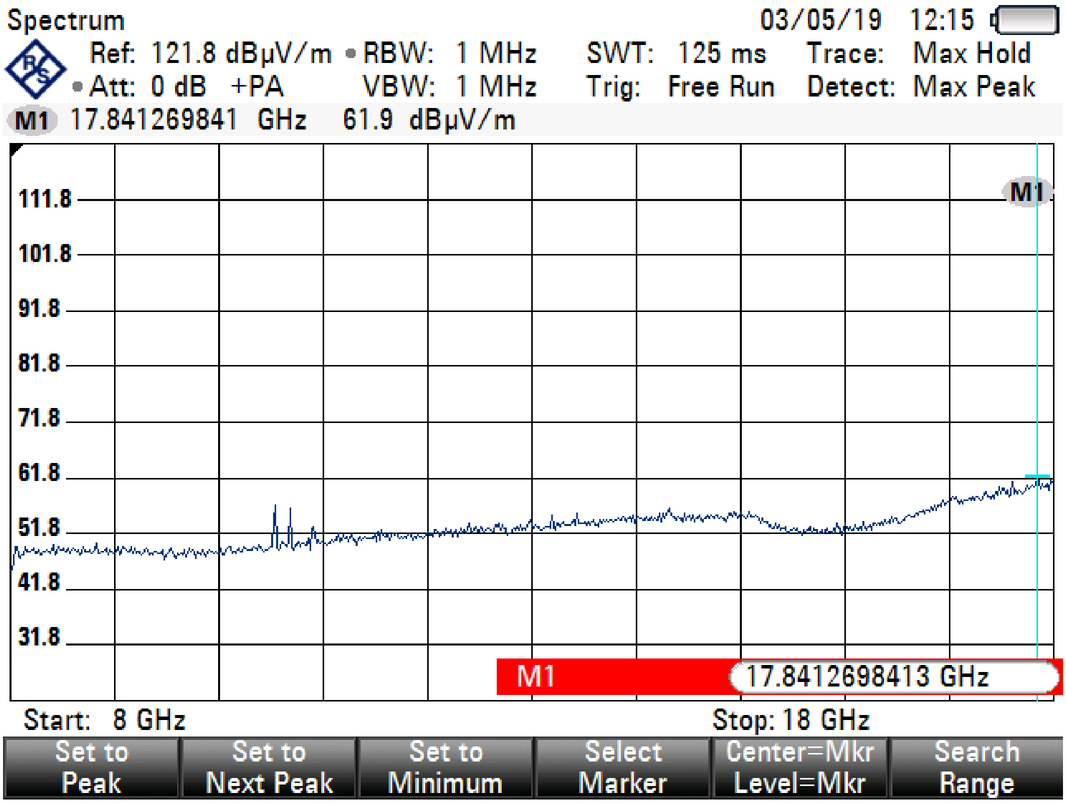

Figure 68: Irish Rail crossing at Prospect Road - 8 GHz to 18 GHz

3.5 Mater University Hospital EMR Survey

Measurements were performed at the location depicted below -

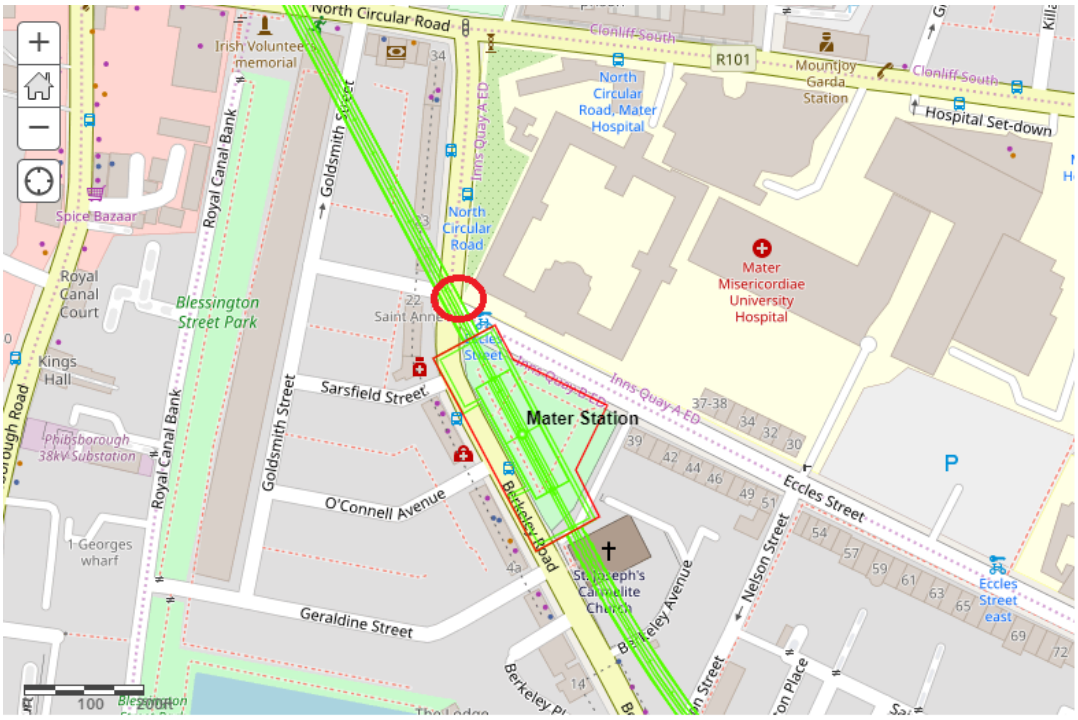

Figure 69: Measurement Location at Mater University Hospital

3.5.1 DC Magnetic Field, Mater Hospital

The Earth's DC magnetic flux density (B) was measured for a period of 22 minutes. The average static field was approximately 47.5 µT with a maximum deviation measured during this time period of 2.25 µT. This deviation was likely caused by a passing truck or bus since the measurement location was roadside.

3.5.2 AC Electric and Magnetic Fields 1 Hz to 10 kHz, Mater Hospital

Figure 72: Mater University Hospital, 0 Hz to 100 Hz (Mag Field) gives a spectral plot of the magnetic field from DC to 100 Hz. The DC component can be seen to be much higher than any other frequency. A spike at 50 Hz is also evident, which is the transmission frequency for mains electricity. Figure 76: Mater University Hospital, 10Hz to 100 Hz (E-Field) shows the equivalent electric field in this frequency range. Harmonics of the fundamental 50 Hz mains frequency are evident in both the E-Field and M-Field plots from 100 Hz to 1 kHz, occurring at frequencies such as 100 Hz, 150 Hz, 200 Hz etc. There was likely a mains transmission line in the vicinity of this measurement location.

3.5.3 Radiated Fields: 10 kHz to 18 GHz, Mater Hospital

There was no evidence, during the measurement and observation time of this study of any transient or intermittent events. The RF emissions profile in this frequency range was well below the typical risk levels of 3 V/m.

At this site the strongest emissions were caused by Analog radio broadcasts (80 – 110 MHz), Digital Radio (147-223 MHz), Tetra Radio (390 MHz), Digital Television Broadcasting (470 – 790 MHz) and WiFi (2.4 GHz). In terms of mobile technology, the following signals were present, mobile broadband, LTE (791-821 MHz and 925-960 MHz), GSM 900 and 1800 (900 MHz and 1.8 GHz) and 3 G (2.1 GHz).

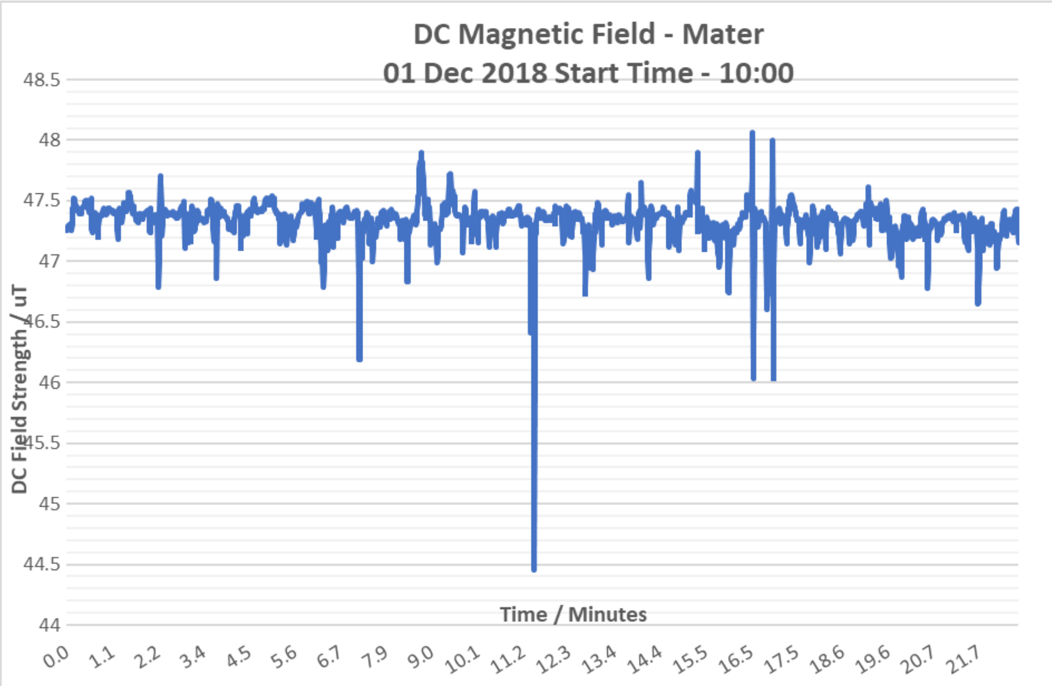

Figure 70: Mater University Hospital, DC Magnetic Field

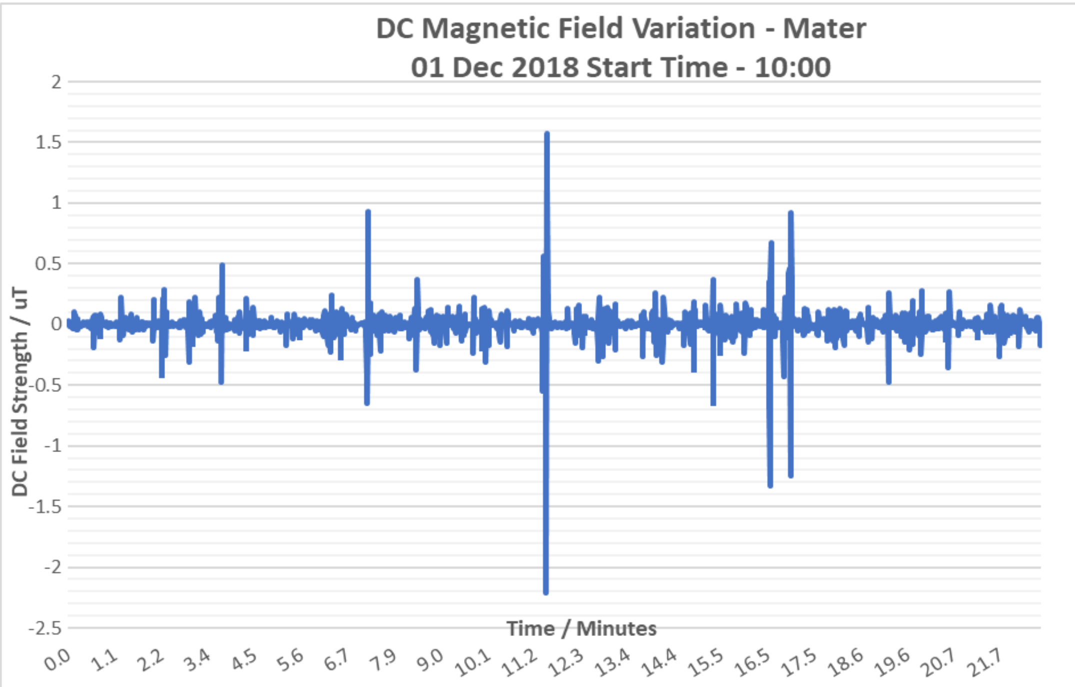

Figure 71: Mater University Hospital, DC Magnetic Field variations

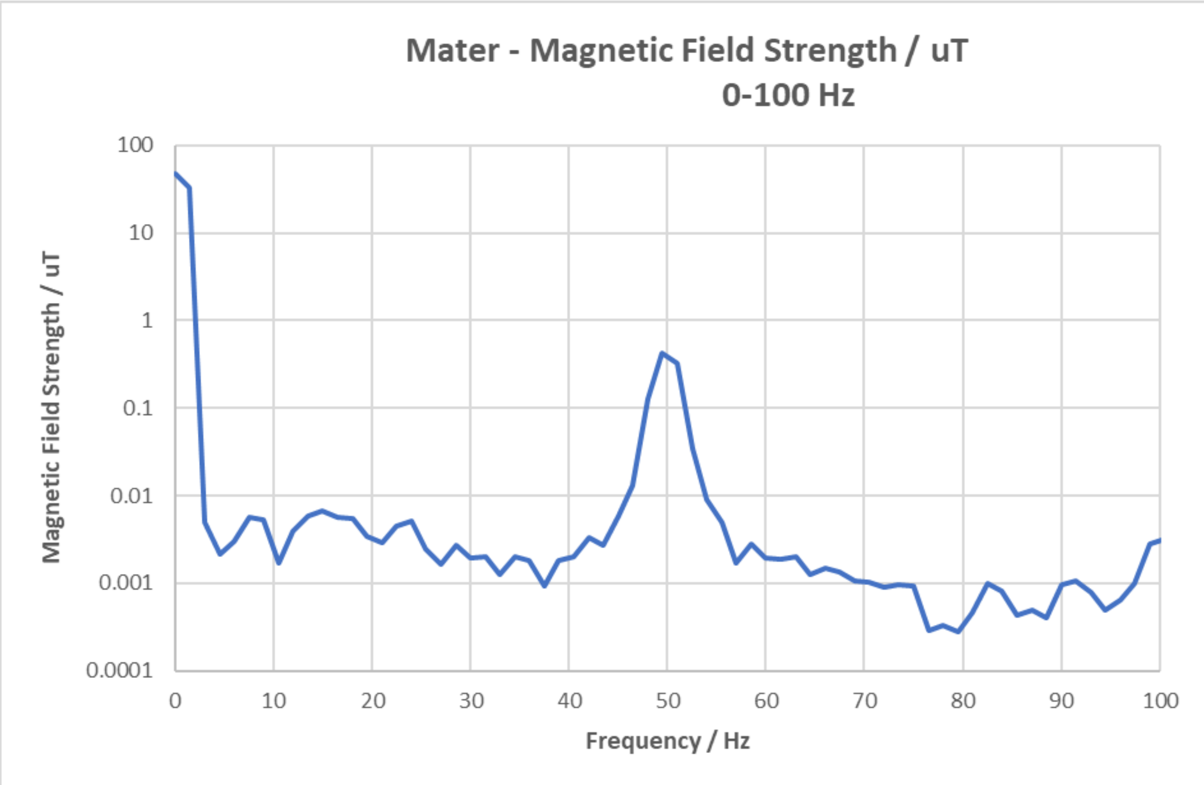

Figure 72: Mater University Hospital, 0 Hz to 100 Hz (Mag Field)

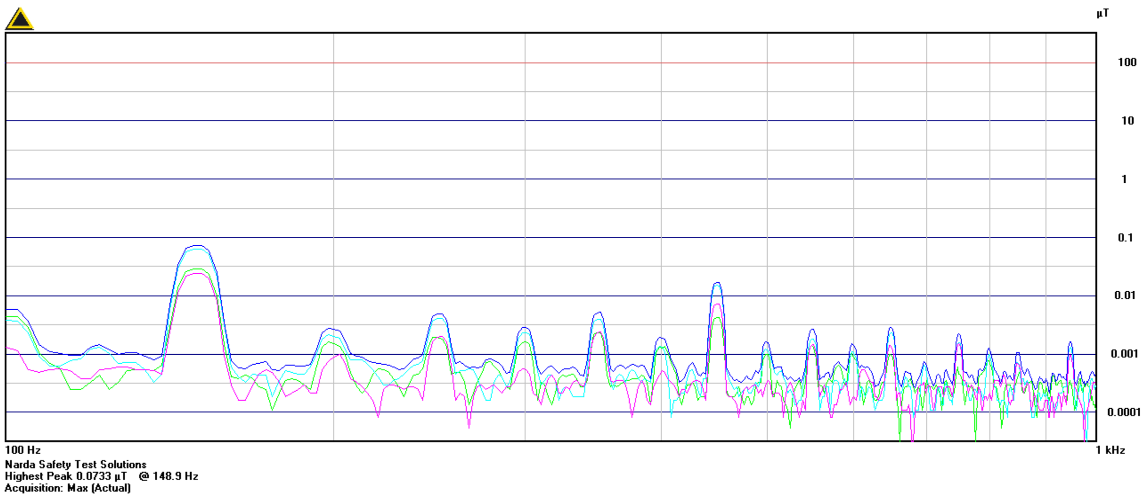

Figure 73: Mater University Hospital, 100 Hz to 1 kHz (Mag Field)

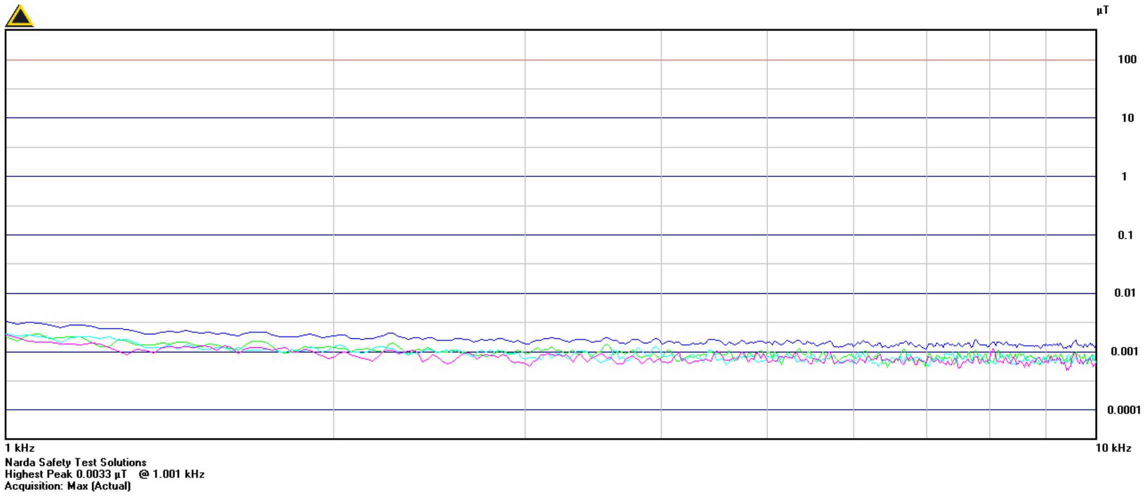

Figure 74: Mater University Hospital, 1 kHz to 10 kHz (Mag Field)

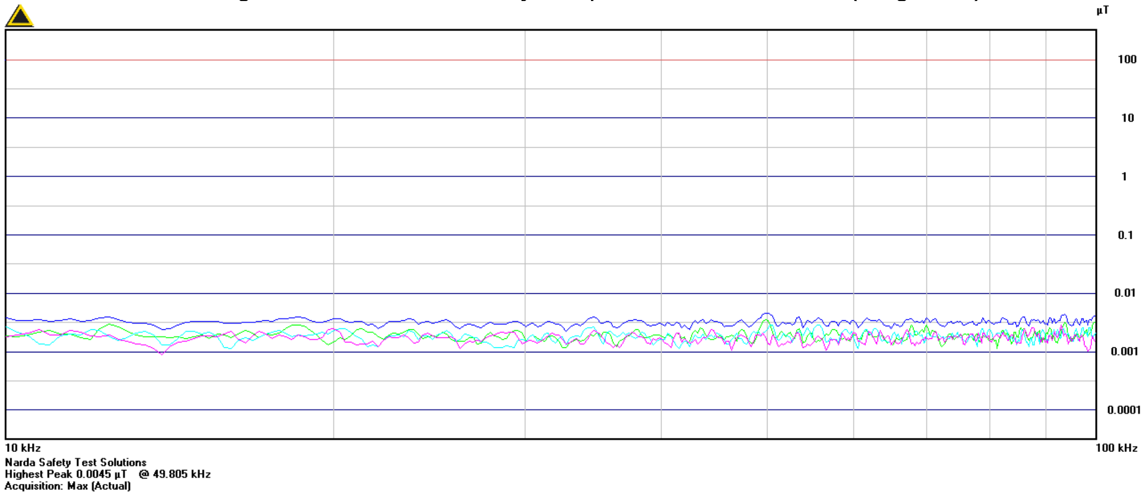

Figure 75: Mater University Hospital, 10 kHz to 100 kHz (Mag Field)

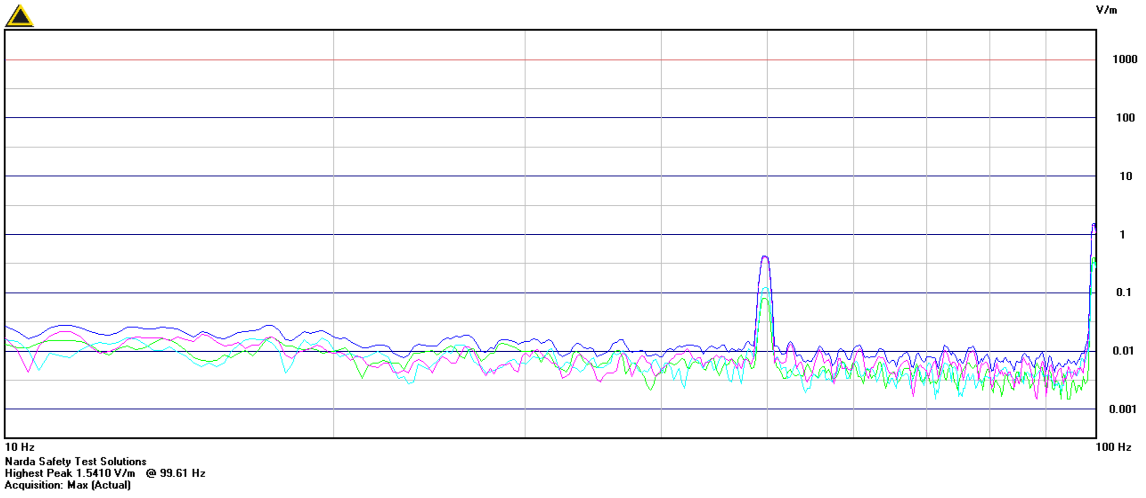

Figure 76: Mater University Hospital, 10Hz to 100 Hz (E-Field)

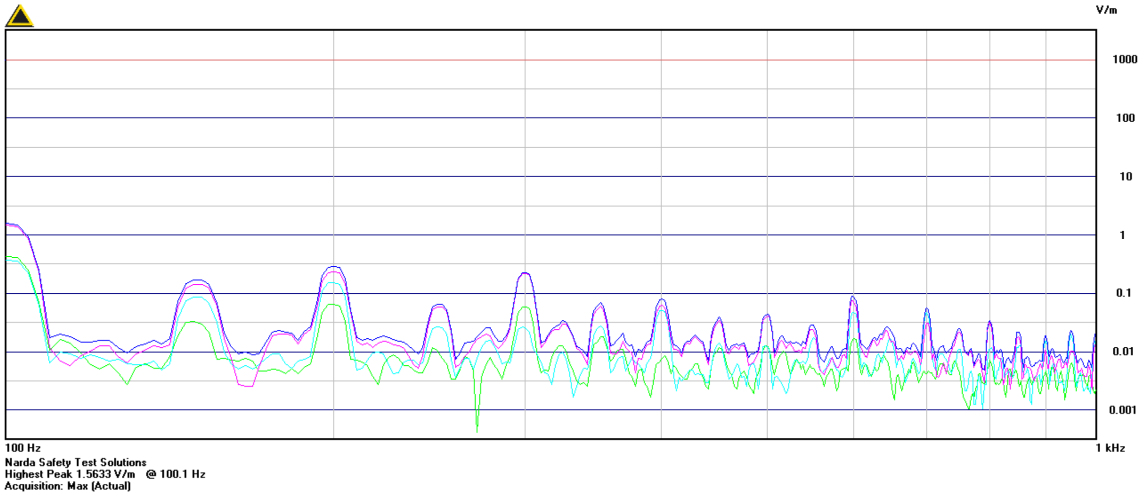

Figure 77: Mater University Hospital, 100 Hz to 1 kHz (E-Field)

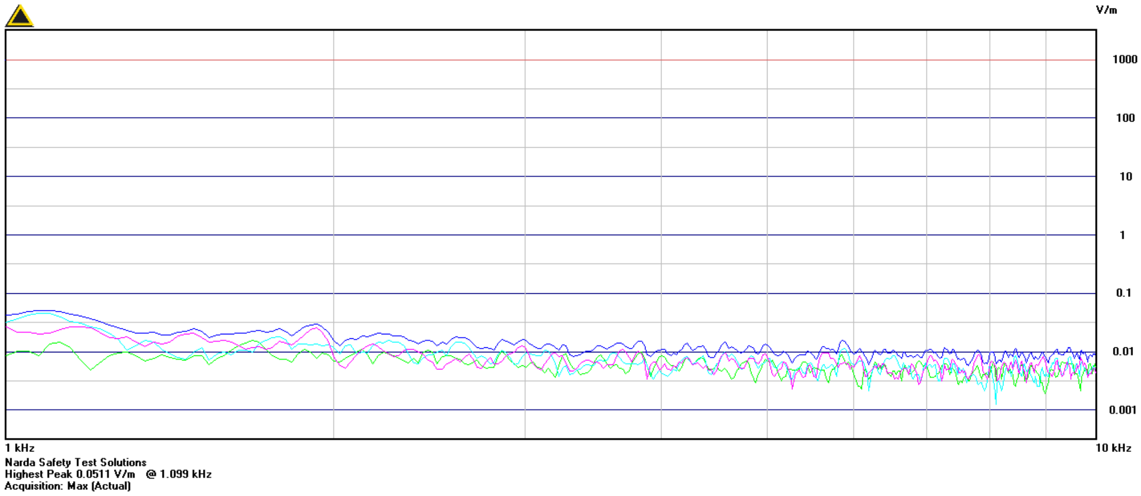

Figure 78: Mater University Hospital, 1 kHz to 10 kHz (E-Field)

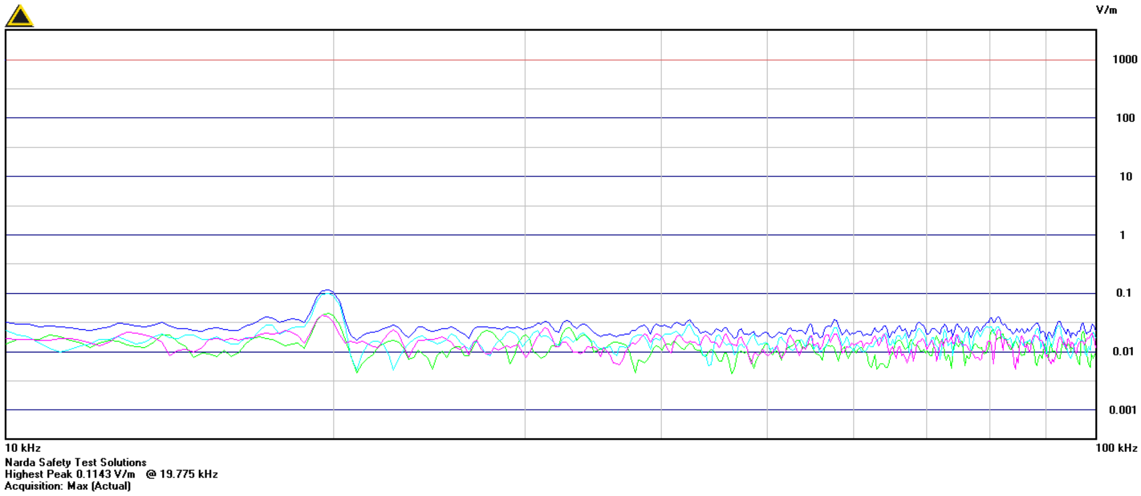

Figure 79: Mater University Hospital, 10 kHz to 100 kHz (E-Field)

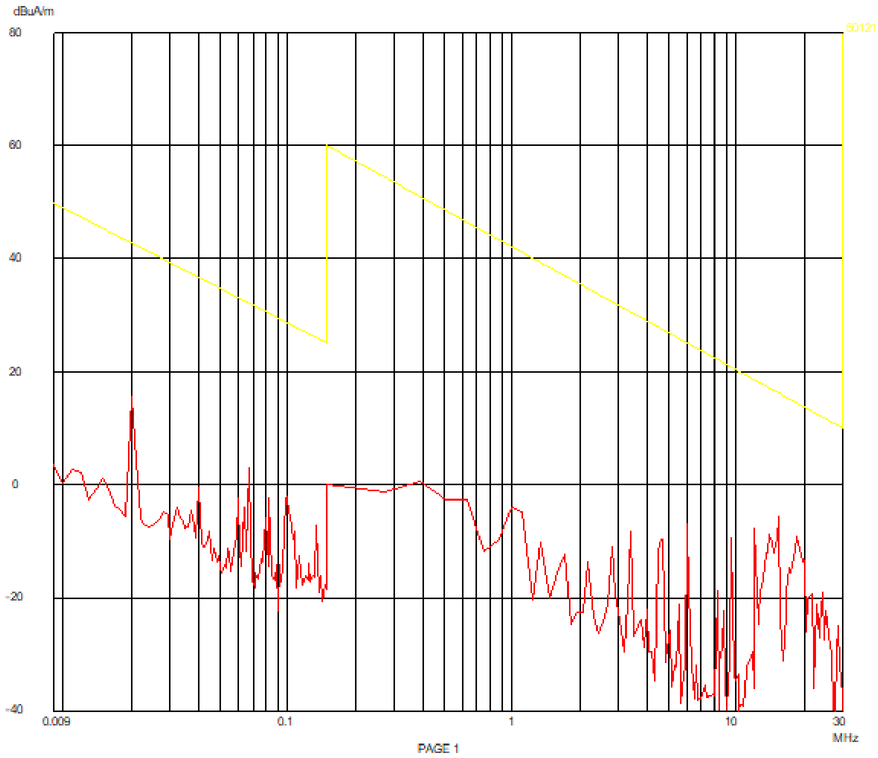

Figure 80: Mater University Hospital – 9 kHz to 30 MHz

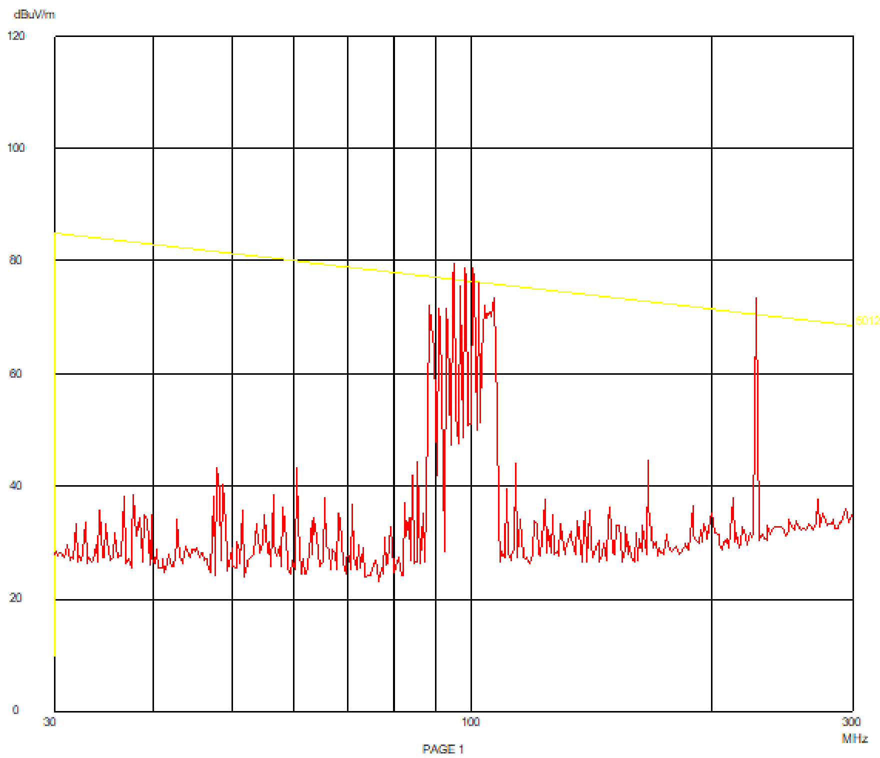

Figure 81: Mater University Hospital – 30 MHz to 300 MHz

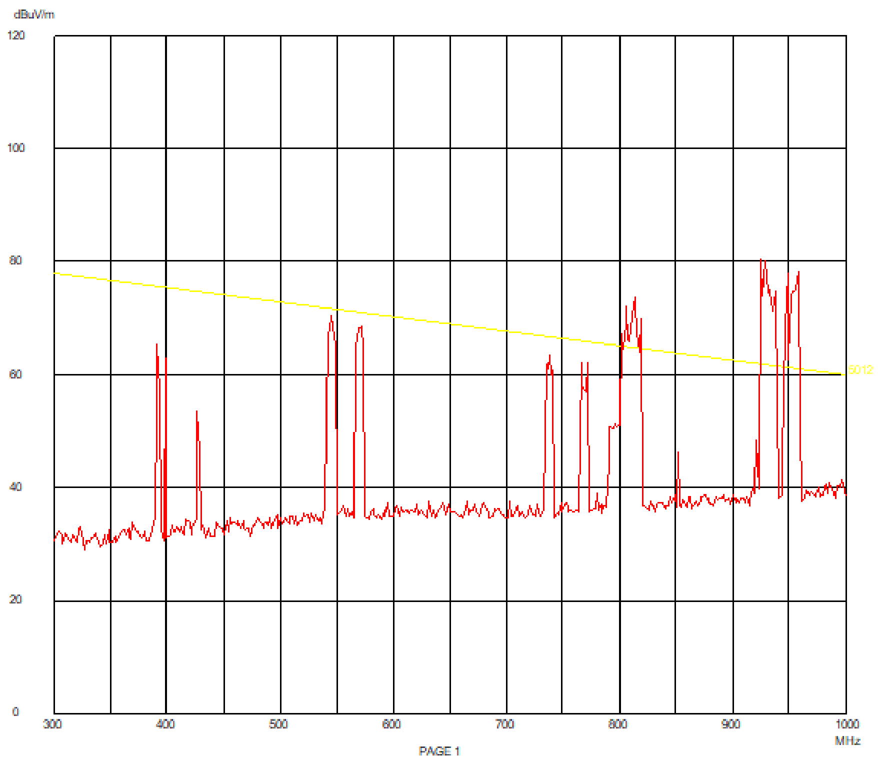

Figure 82: Mater University Hospital – 300 MHz to 1 GHz

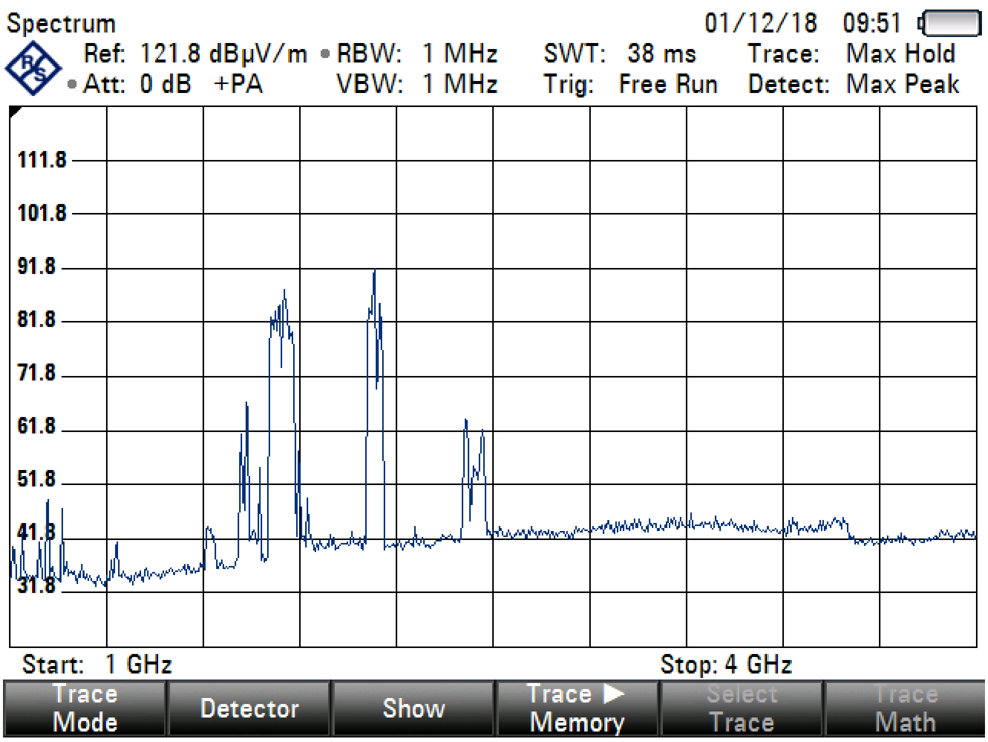

Figure 83: Mater University Hospital - 1 GHz to 4 GHz

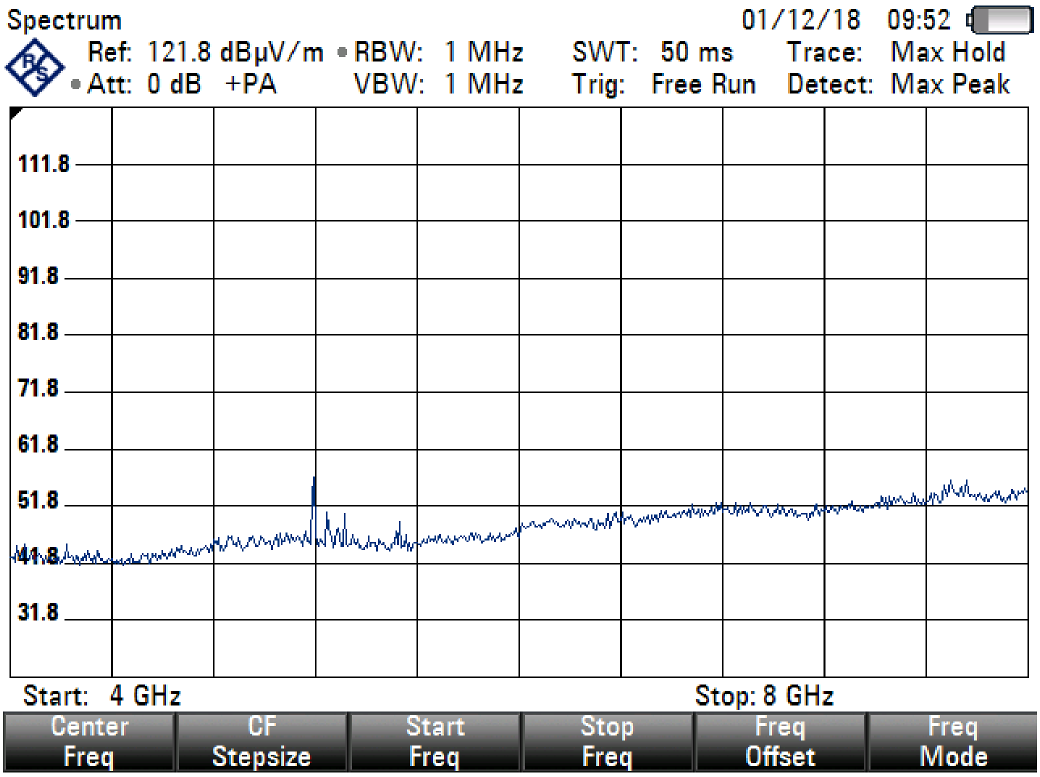

Figure 84: Mater University Hospital - 4 GHz to 8 GHz

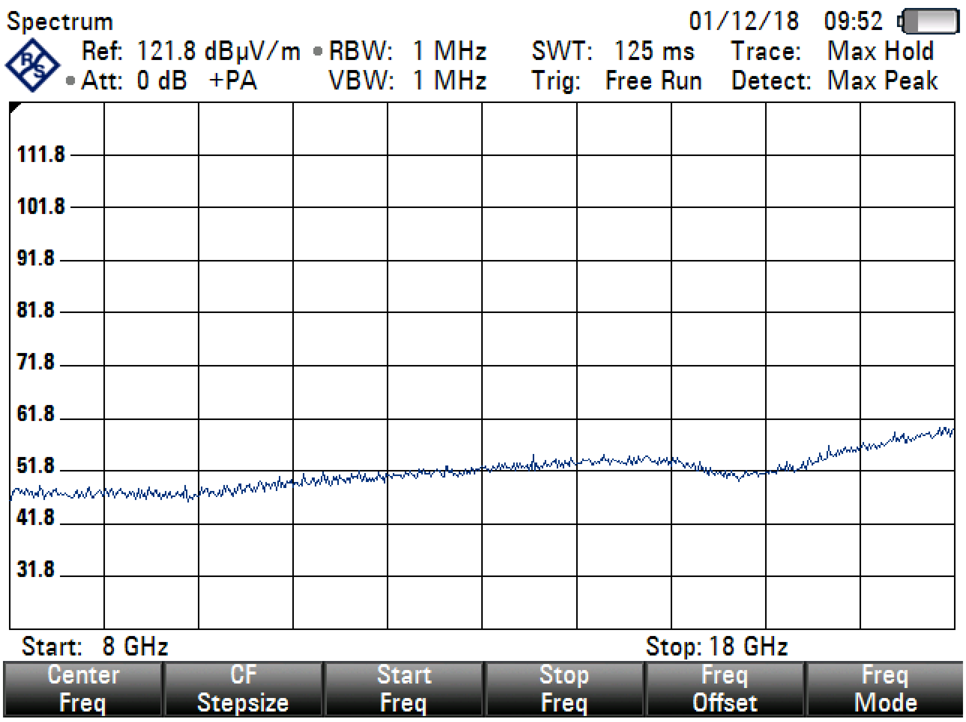

Figure 85: Mater University Hospital - 8 GHz to 18 GHz

3.6 <u>Rotunda Campus (Rotunda Hospital, Gate and Ambassador Theatre) EMR Survey</u>

Measurements were performed at the locations depicted below. The first site, A, was within the grounds of the rotunda hospital while the second site, B, was inside the Gate Theatre with C on the stage of the Ambassador Theatre. Only AC field measurements were performed within the Gate and Ambassador Theatres -

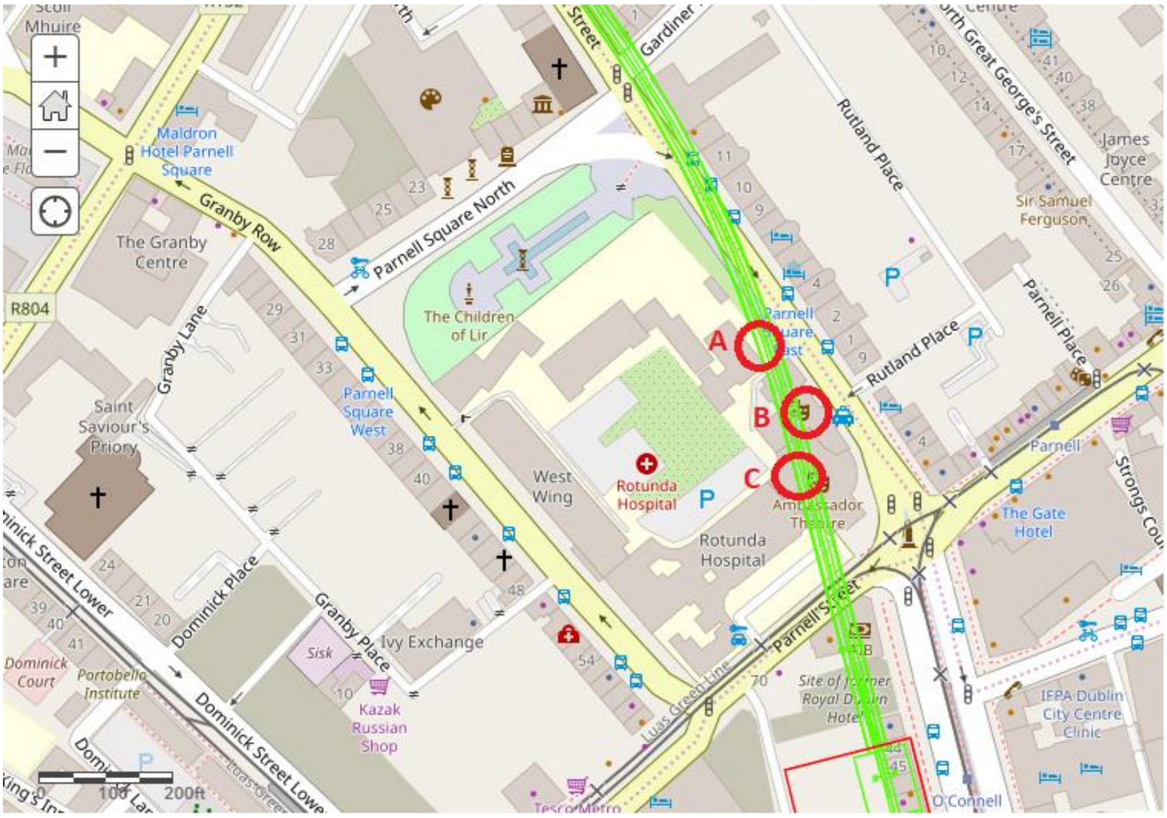

Figure 86: Measurement Locations on Rotunda Campus

3.6.1 DC Magnetic Field, Rotunda Hospital

The Earth's DC magnetic flux density (B) was measured for a period of 25 minutes. The average static field was approximately 41.9 µT with a maximum deviation measured during this time period of 0.03 µT demonstrating that the DC magnetic field environment at that location was relatively quiescent.

3.6.2 AC Electric and Magnetic Fields 1 Hz to 10 kHz, Rotunda Campus

Figure 89 shows a spectral plot of the magnetic field from DC to 100 Hz. The DC component can be seen to be much higher than any other frequency. A spike at 50 Hz is also evident, which is the transmission frequency for mains electricity. Figure 93 shows the equivalent electric field in this frequency range. Harmonics of the fundamental 50 Hz mains frequency are evident in both the E-Field and M-Field plots from 100 Hz to 1 kHz, occurring at frequencies such as 100 Hz, 150 Hz, 200 Hz etc indicating the presence of electricity power lines in the vicinity.

Within the Gate Theatre measurements were taken within the main theatre with the stage lights and amplification systems switched on across the frequency range 10 Hz – 100 kHz. These plots are seen in Figure 97 to Figure 104. Again harmonics of the fundamental 50 Hz frequency are seen but not at significant levels of magnitude.

Measurements were taken on the stage inside the Ambassador Theatre across the range 10 Hz – 100 kHz. No audio visual equipment was present or operating at the time of the survey. These plots are seen in Figure 105 to Figure 112. Harmonics of the fundamental 50 Hz frequency are seen but not at significant levels of magnitude.

3.6.3 Radiated Fields: 10 kHz to 18 GHz, Rotunda Hospital

There was no evidence, during the measurement and observation time of this study of any transient or intermittent events. The RF emissions profile in this frequency range was well below the typical risk levels of 3 V/m.

At this site the strongest emissions were caused by Analog radio broadcasts (80 – 110 MHz), Digital Radio (147-223 MHz), Tetra Radio (390 MHz), Digital Television Broadcasting (470 – 790 MHz), WiFi (2.4 GHz and 5 GHz) and RADAR (2.7-2.9 GHz). In terms of mobile technology, the following signals were present, mobile broadband, LTE (791-821 MHz and 925-960 MHz), GSM 900 and 1800 (900 MHz and 1.8 GHz) and 3 G (2.1 GHz).

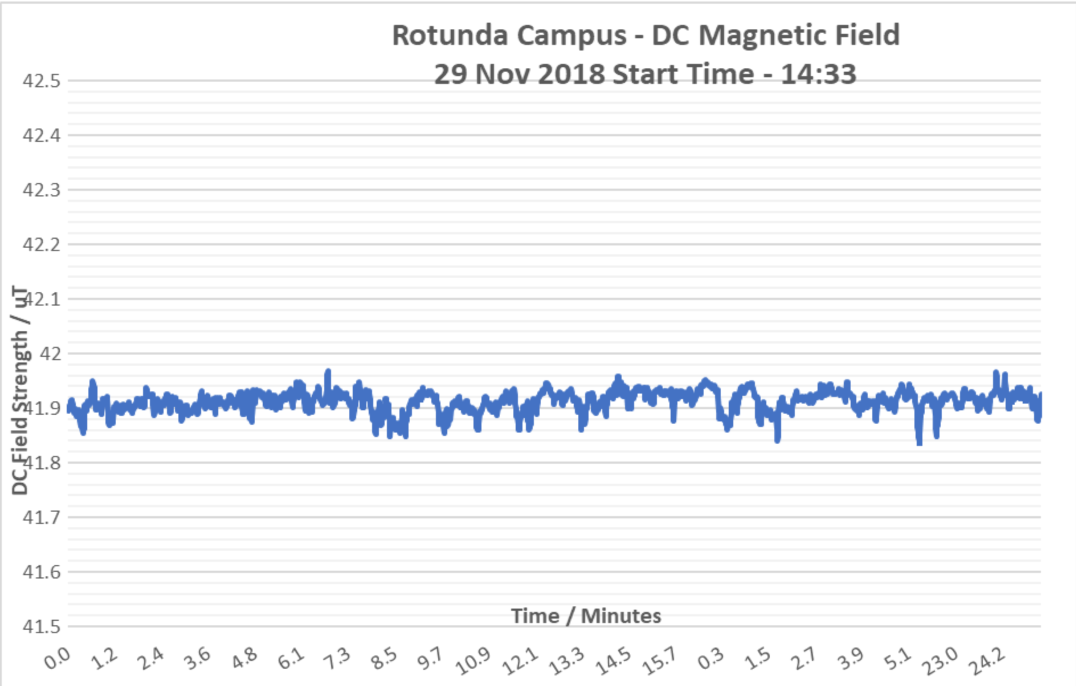

Figure 87: Rotunda Campus, DC Magnetic Field

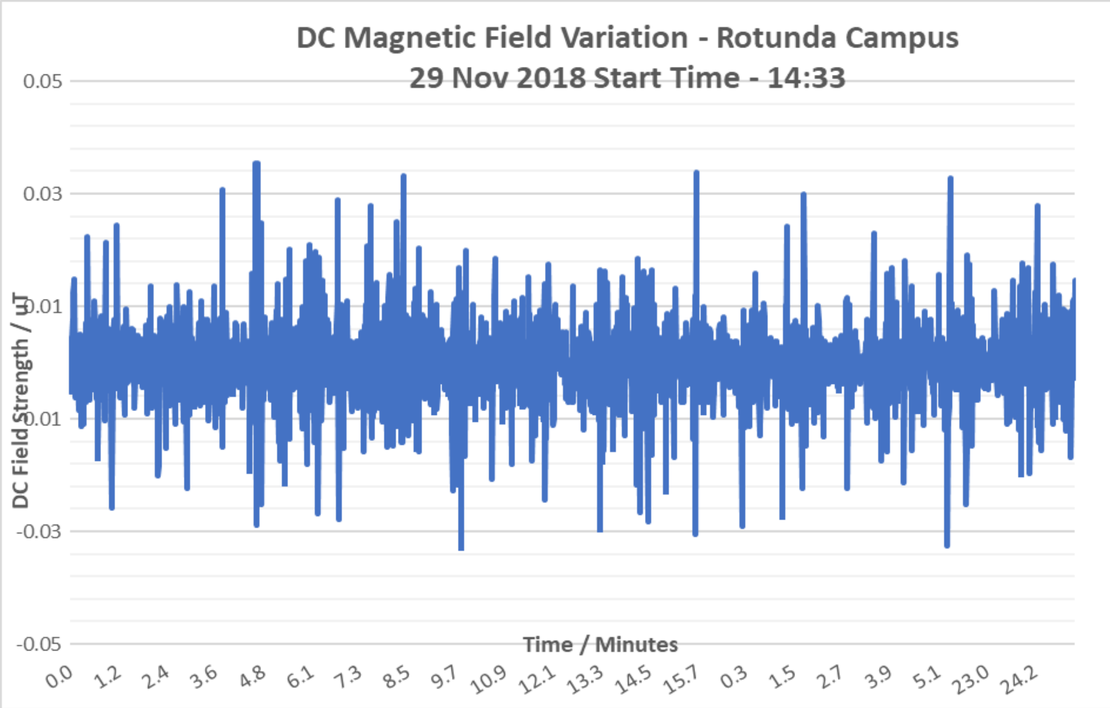

Figure 88: Rotunda Campus, DC Magnetic Field variations

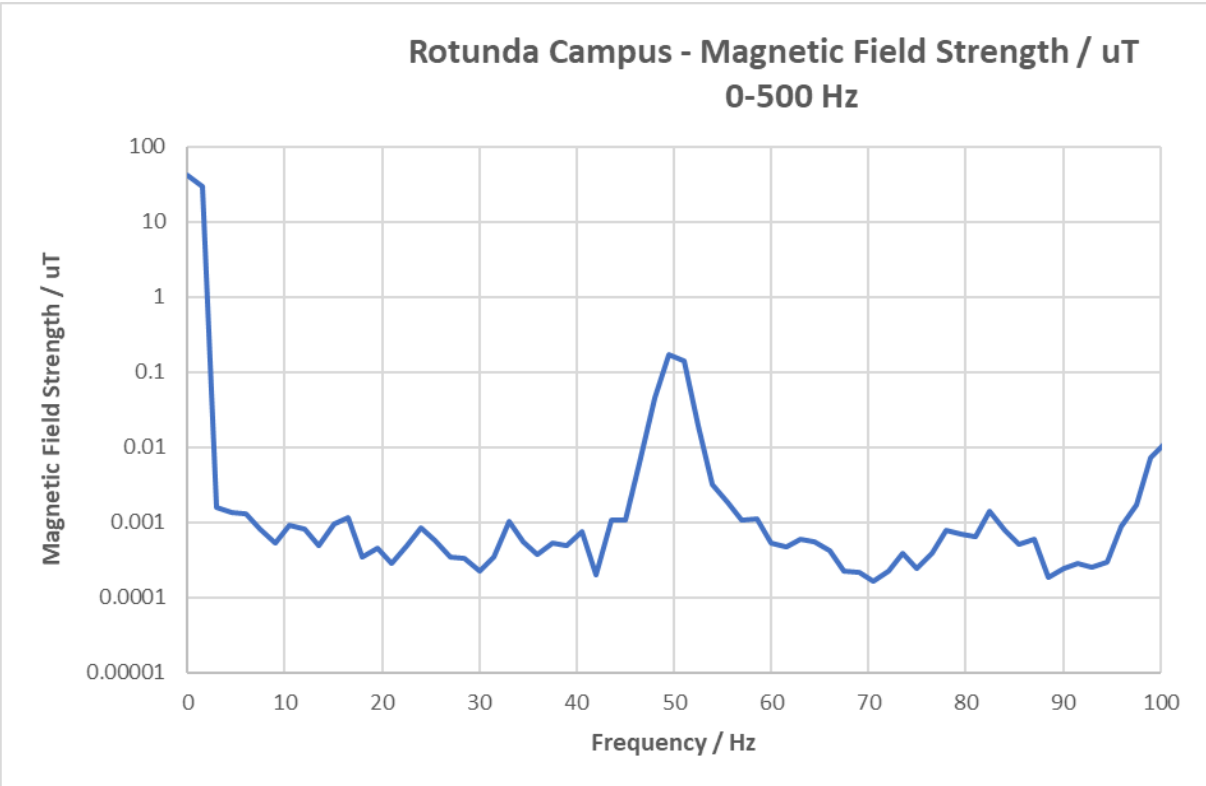

Figure 89: Rotunda Campus, 0 Hz to 100 Hz (Mag Field)

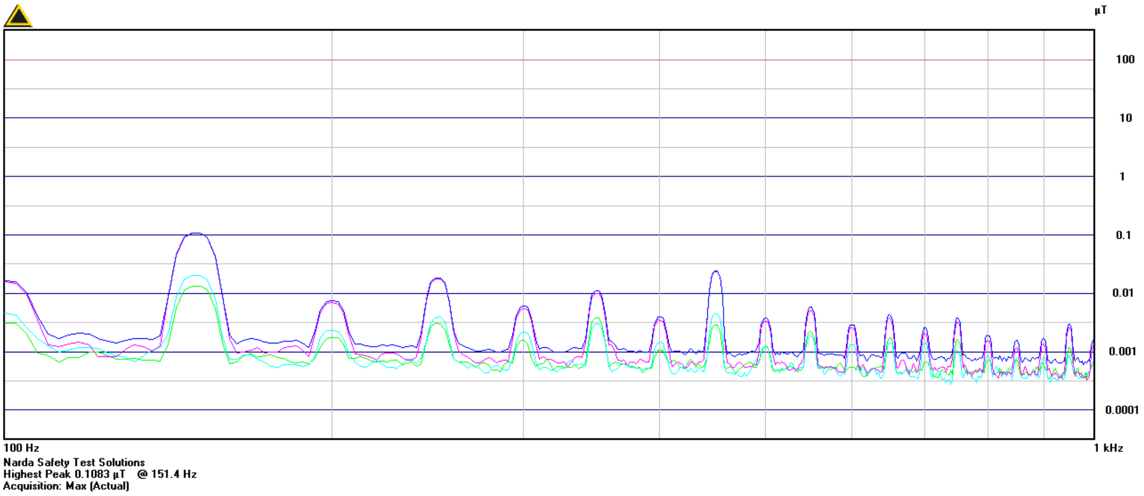

Figure 90: Rotunda Campus, 100 Hz to 1 kHz (Mag Field)

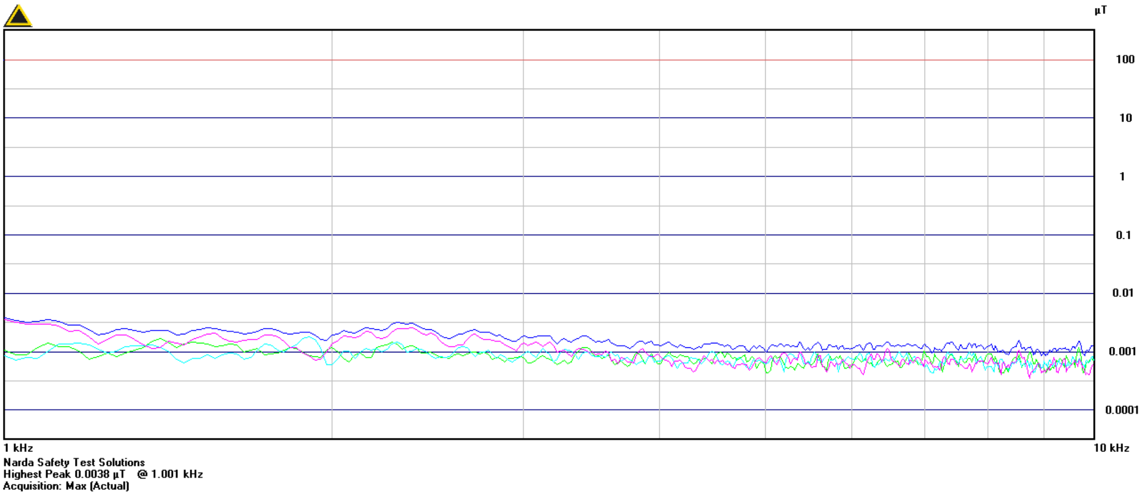

Figure 91: Rotunda Campus, 1 kHz to 10 kHz (Mag Field)

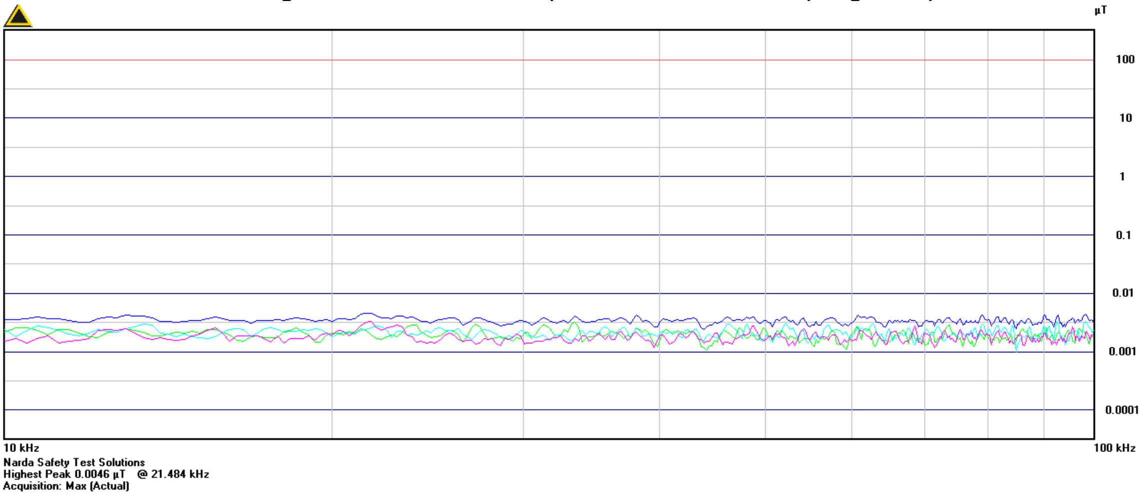

Figure 92: Rotunda Campus, 10 kHz to 100 kHz (Mag Field)

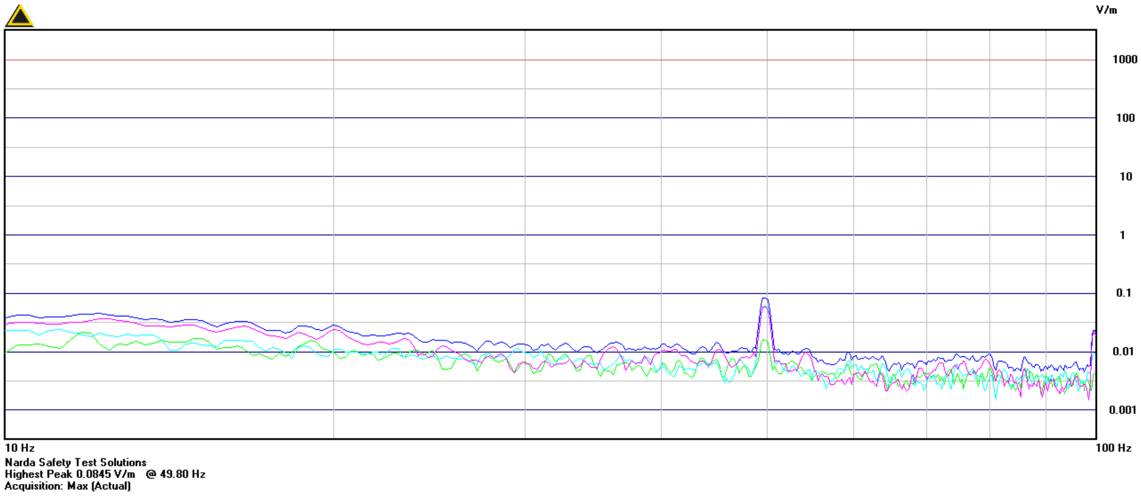

Figure 93: Rotunda Campus, 10Hz to 100 Hz (E-Field)

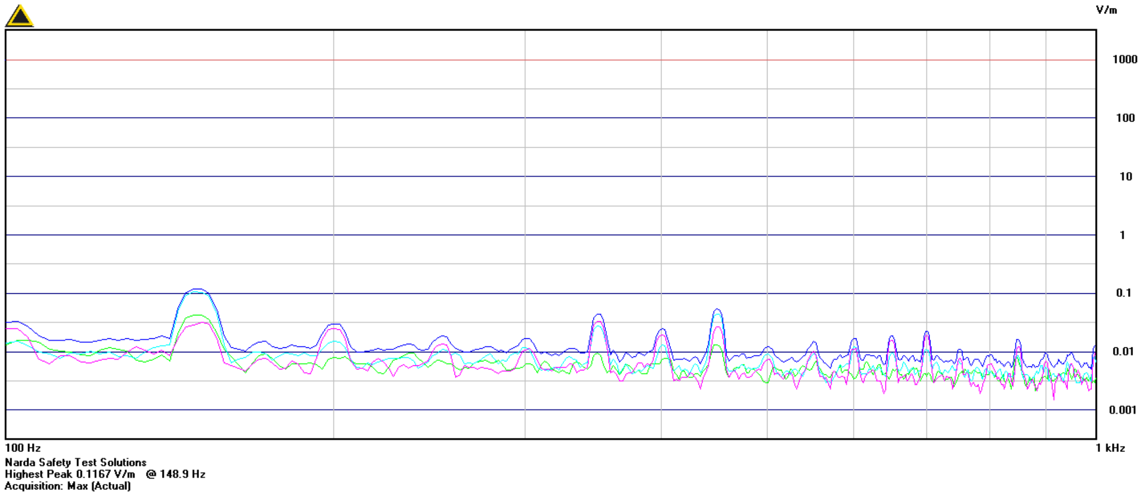

Figure 94: Rotunda Campus, 100 Hz to 1 kHz (E-Field)

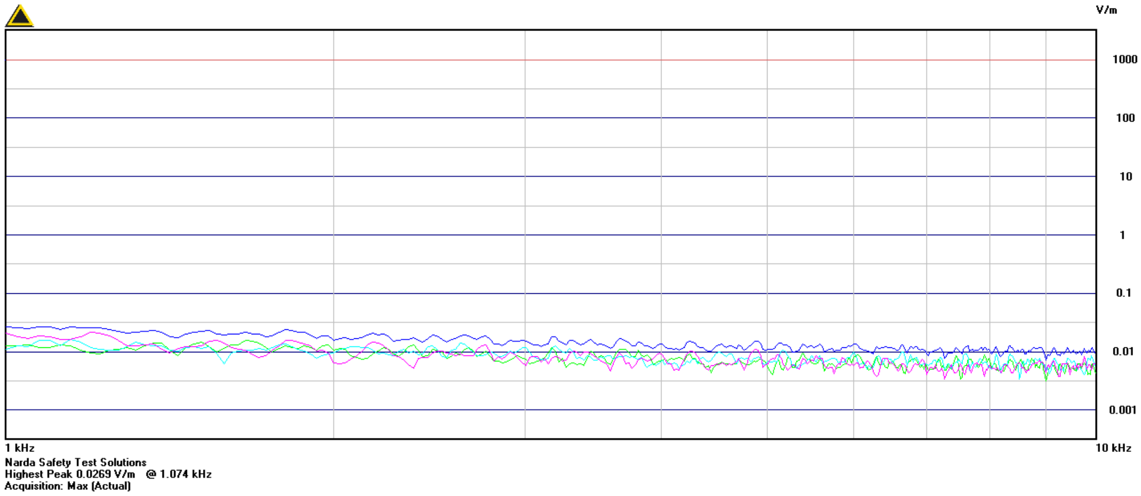

Figure 95: Rotunda Campus, 1 kHz to 10 kHz (E-Field)

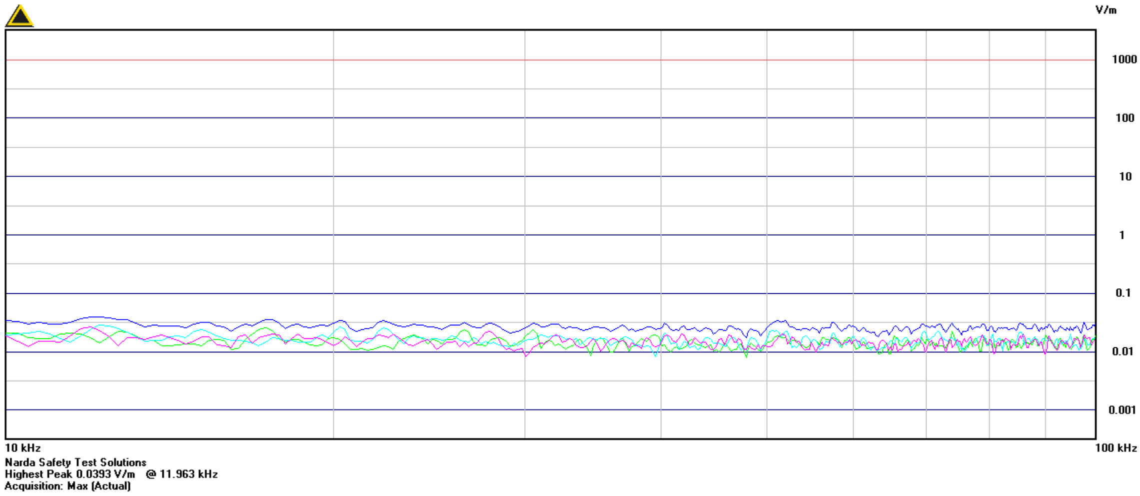

Figure 96: Rotunda Campus, 10 kHz to 100 kHz (E-Field)

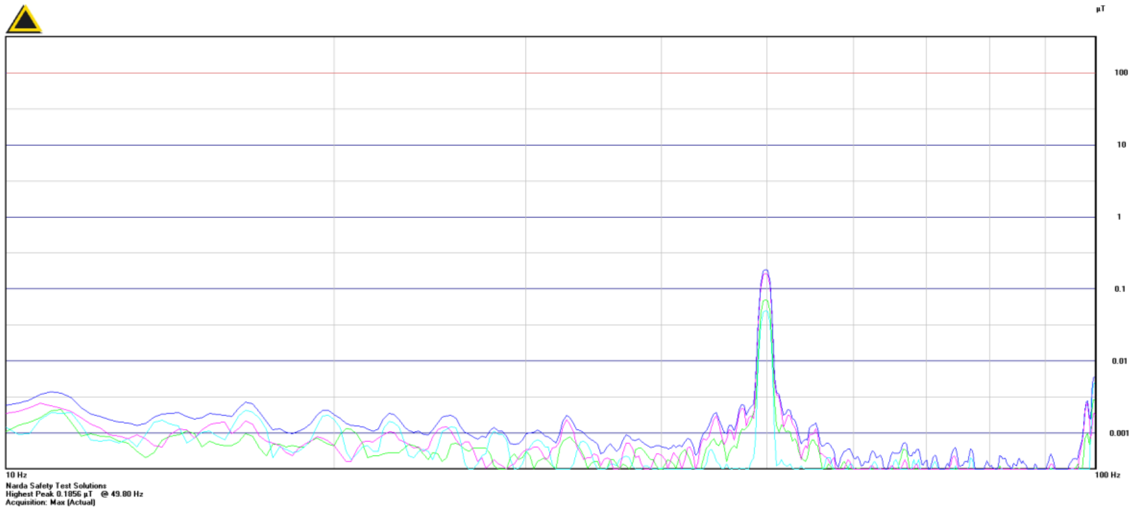

Figure 97: Gate Theatre, 10 Hz to 100 Hz (Mag Field)

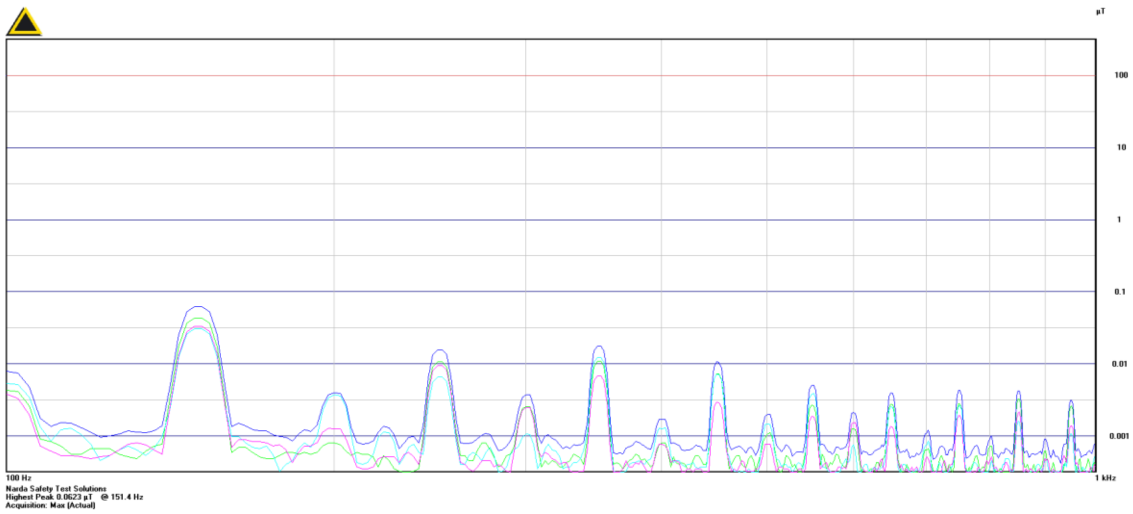

Figure 98: Gate Theatre, 100 Hz to 1 kHz (Mag Field)

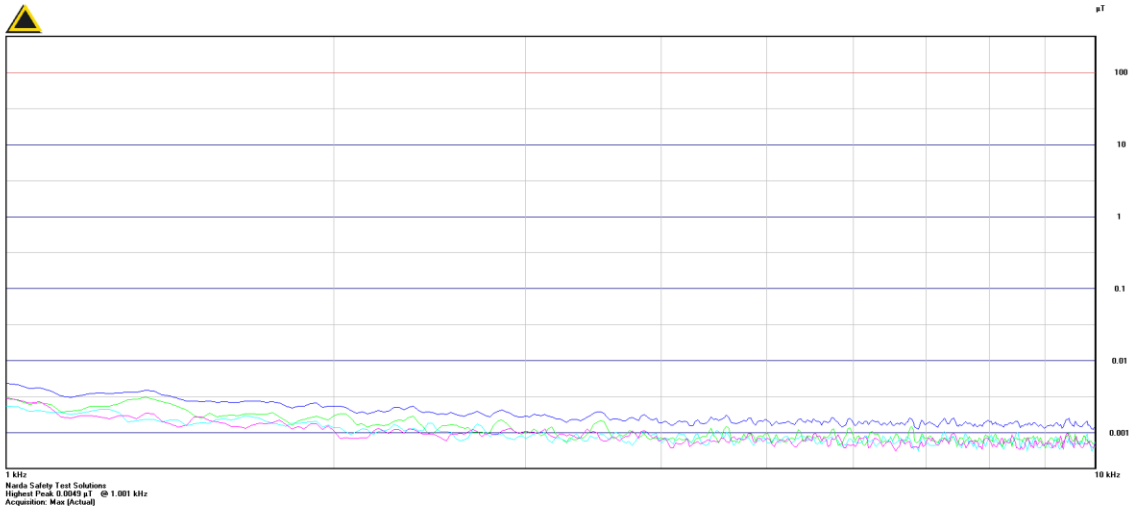

Figure 99: Gate Theatre, 1 kHz to 10 kHz (Mag Field)

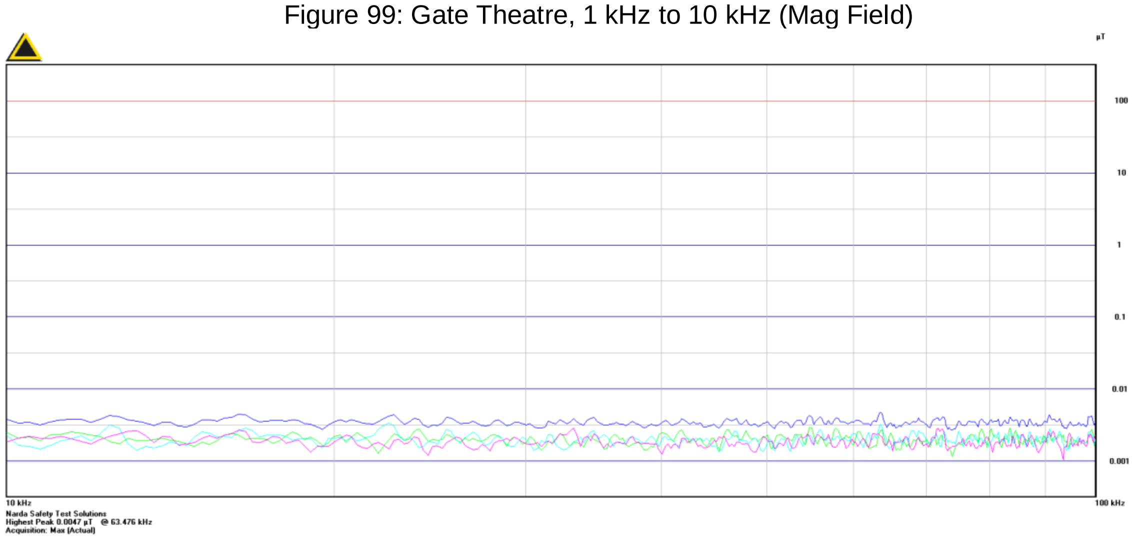

Figure 100: Gate Theatre, 10 kHz to 100 kHz (Mag Field)

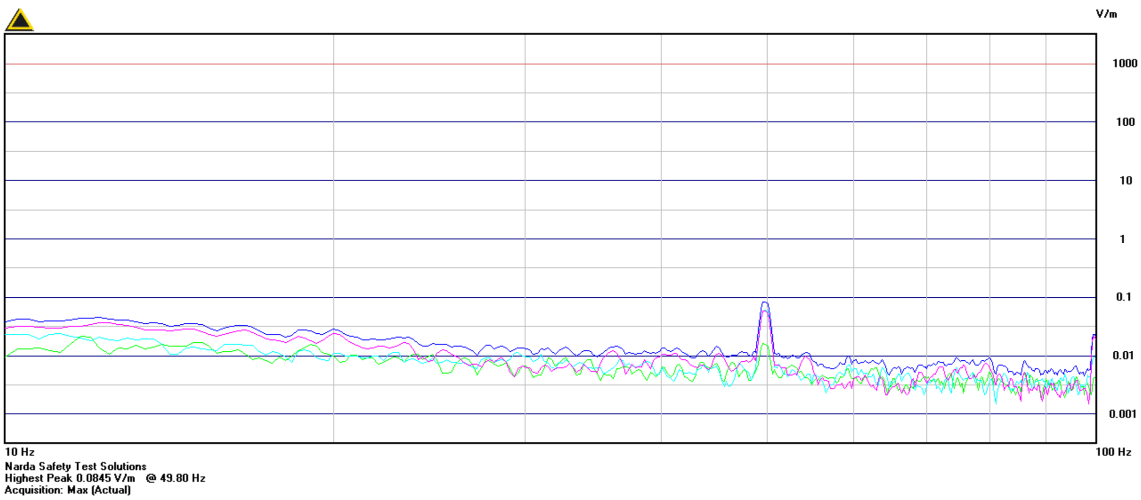

Figure 101: Gate Theatre, 10Hz to 100 Hz (E-Field)

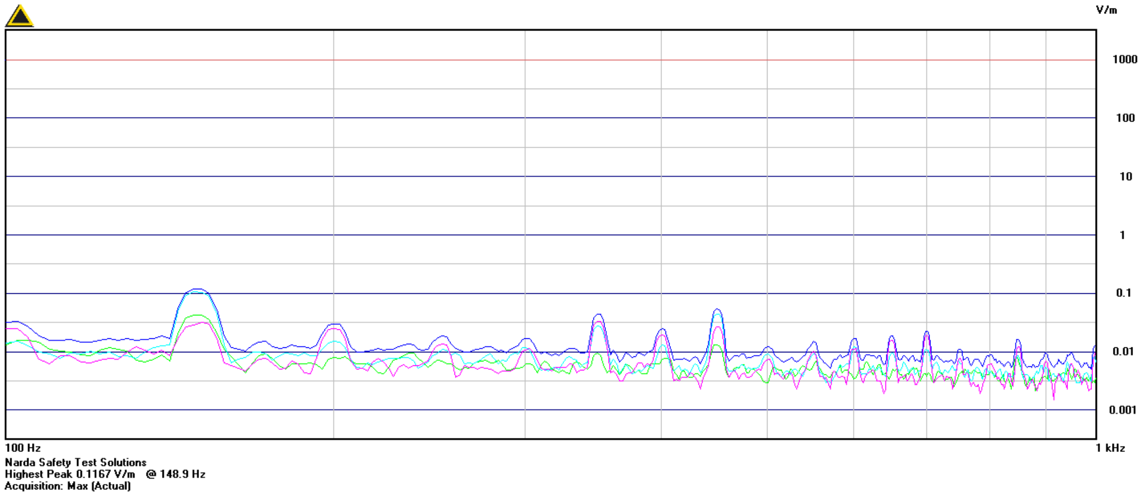

Figure 102: Gate Theatre, 100 Hz to 1 kHz (E-Field)

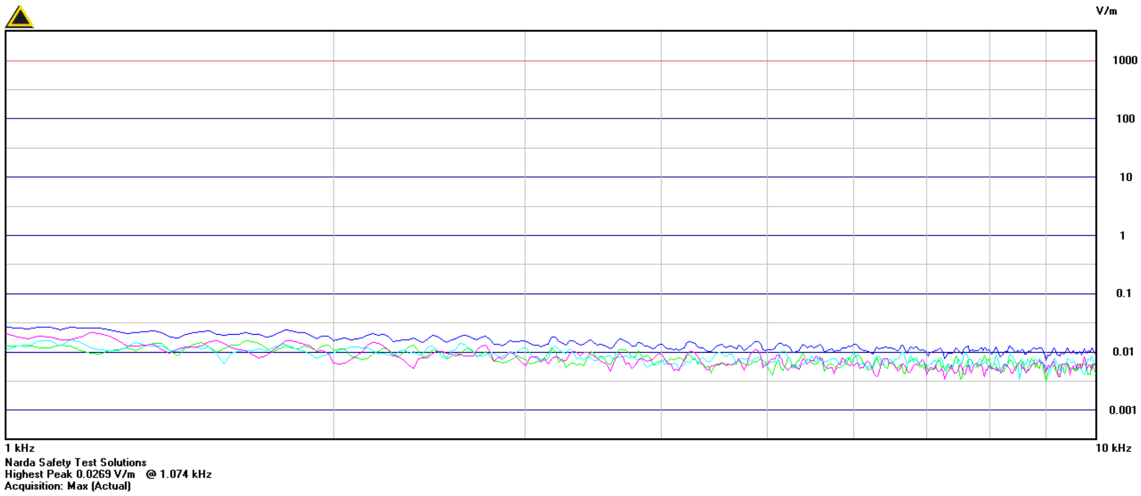

Figure 103: Gate Theatre, 1 kHz to 10 kHz (E-Field)

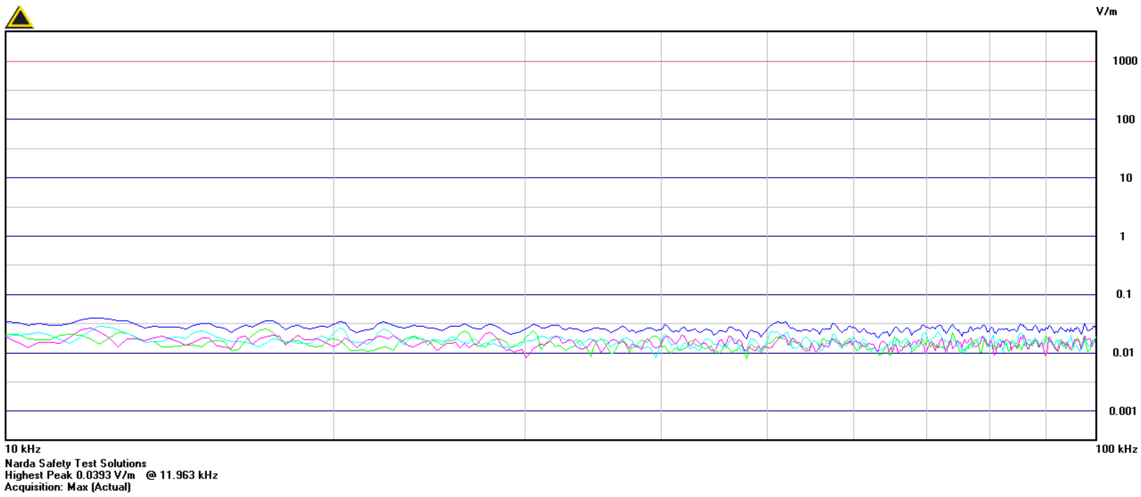

Figure 104: Gate Theatre, 10 kHz to 100 kHz (E-Field)

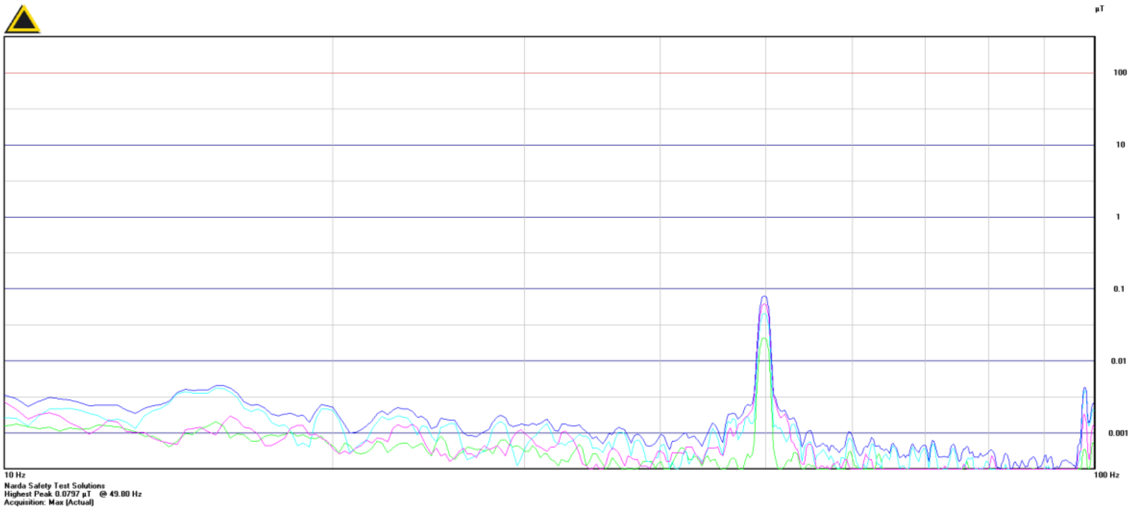

Figure 105: Ambassador Theatre, 10 Hz to 100 Hz (Mag Field)

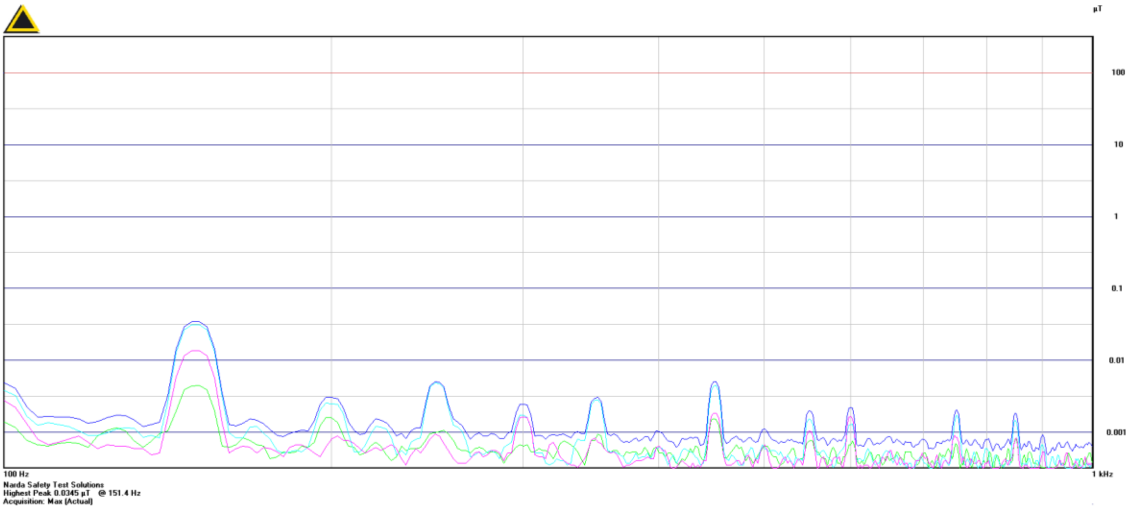

Figure 106: Ambassador Theatre, 100 Hz to 1 kHz (Mag Field)

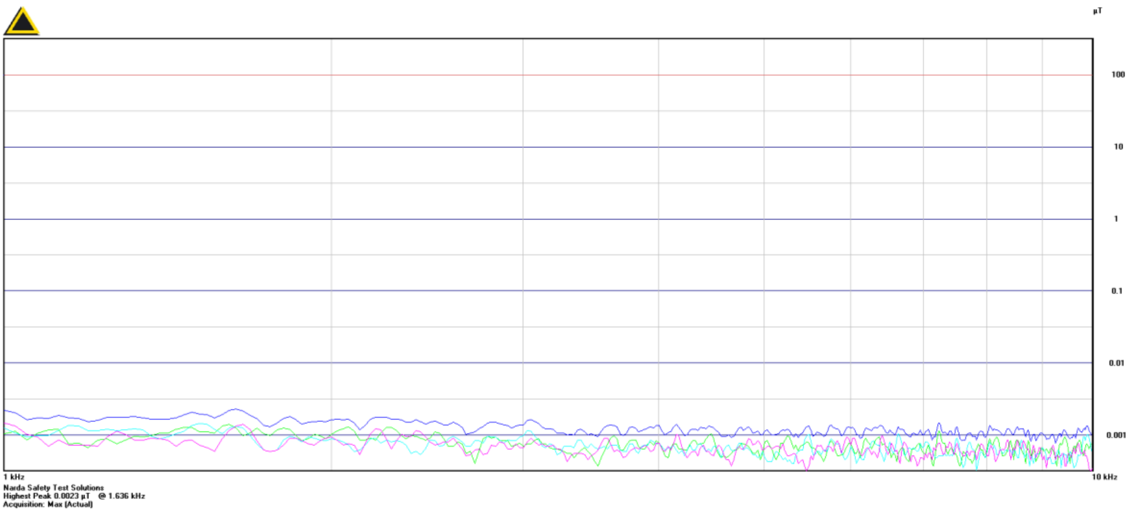

Figure 107: Ambassador Theatre, 1 kHz to 10 kHz (Mag Field)

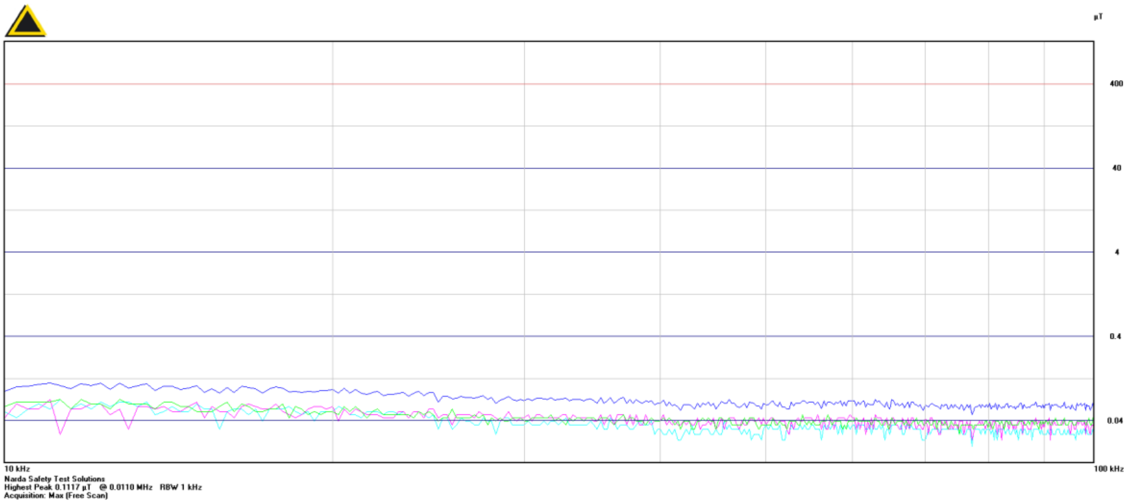

Figure 108: Ambassador Theatre, 10 kHz to 100 kHz (Mag Field)

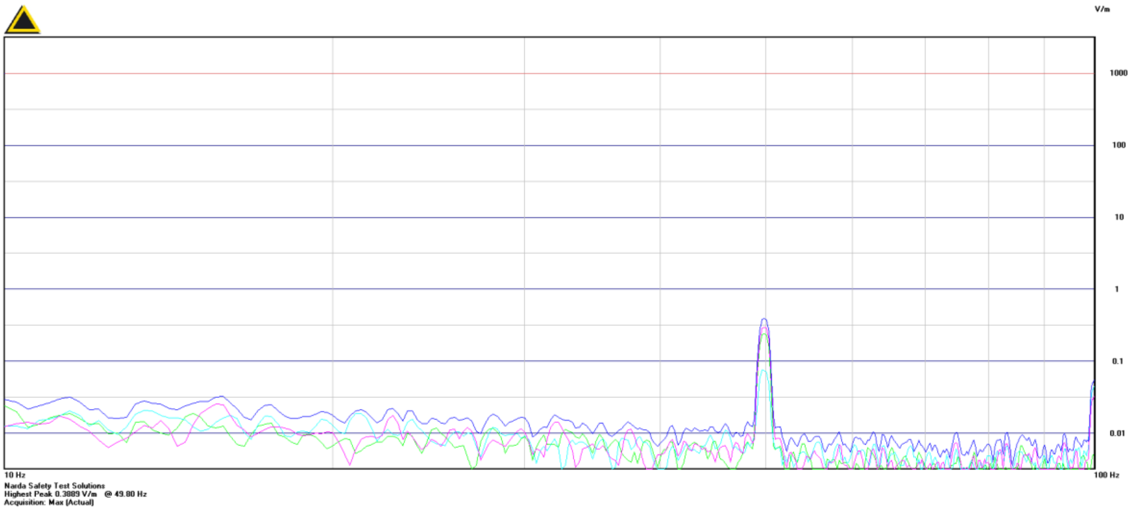

Figure 109: Ambassador Theatre, 10Hz to 100 Hz (E-Field)

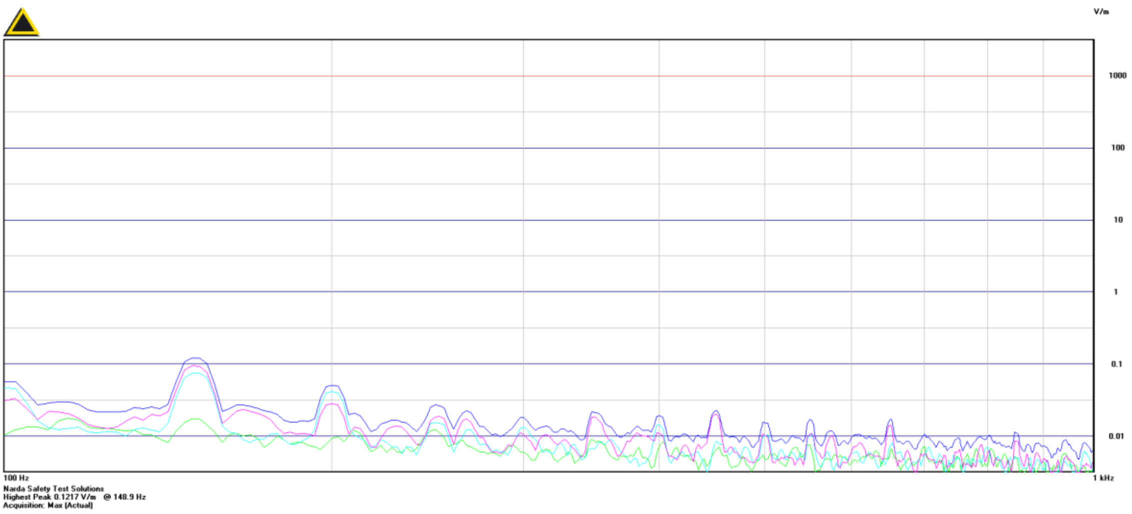

Figure 110: Ambassador Theatre, 100 Hz to 1 kHz (E-Field)

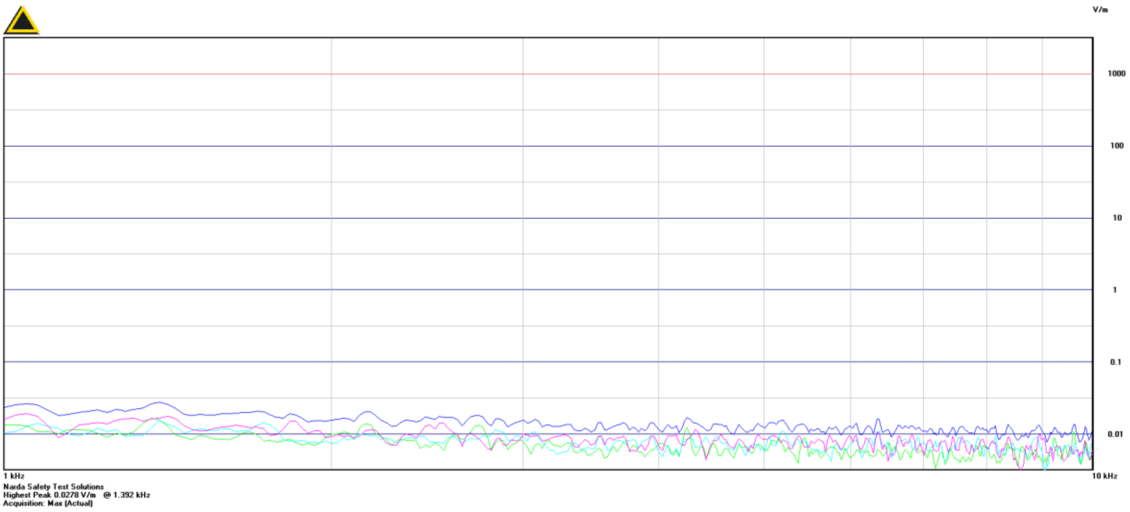

Figure 111: Ambassador Theatre, 1 kHz to 10 kHz (E-Field)

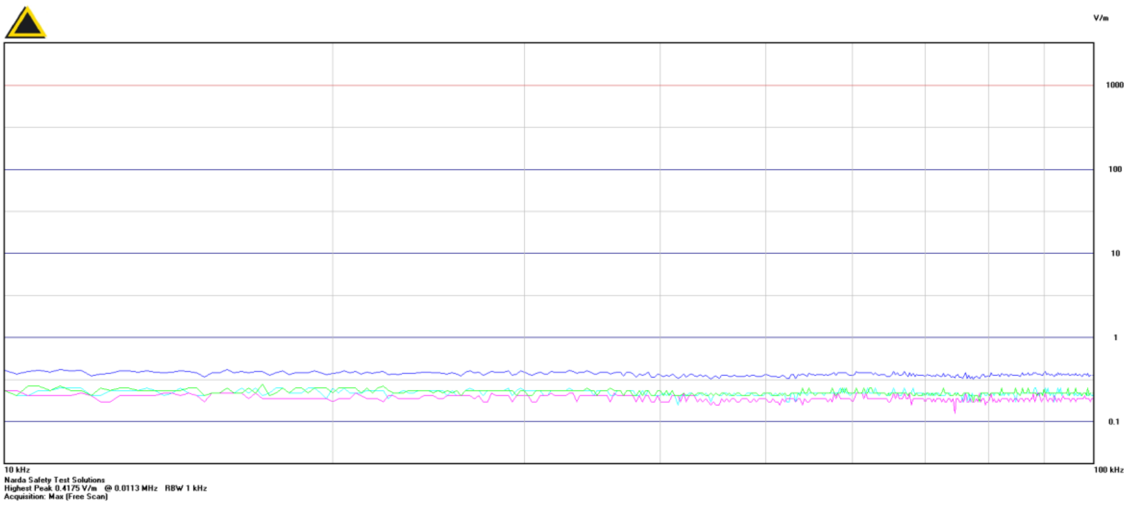

Figure 112: Ambassador Theatre, 10 kHz to 100 kHz (E-Field)

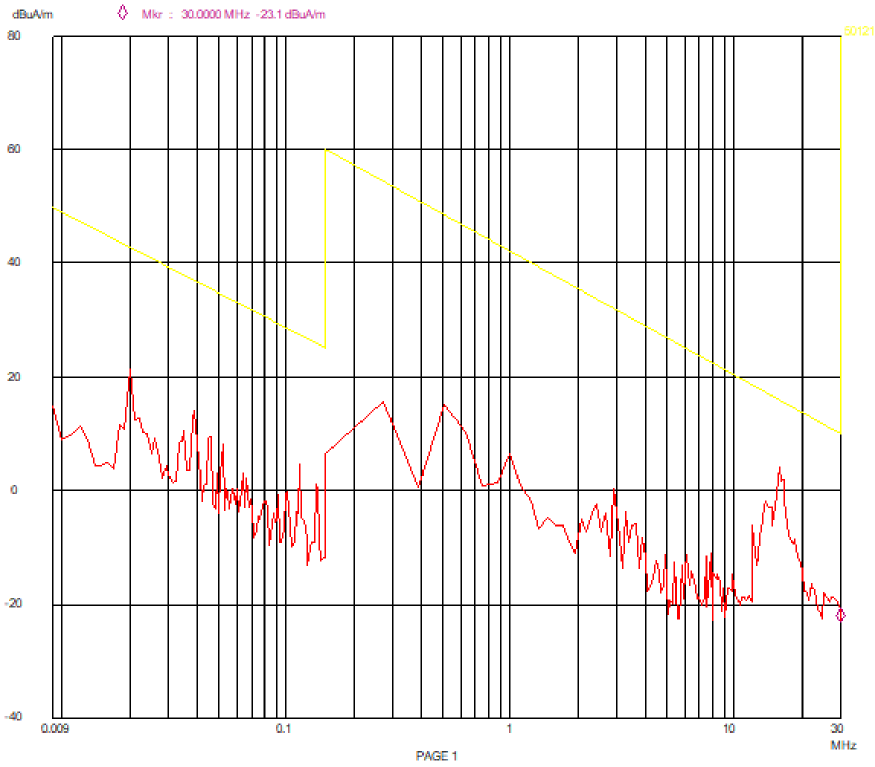

Figure 113: Rotunda Campus – 9 kHz to 30 MHz

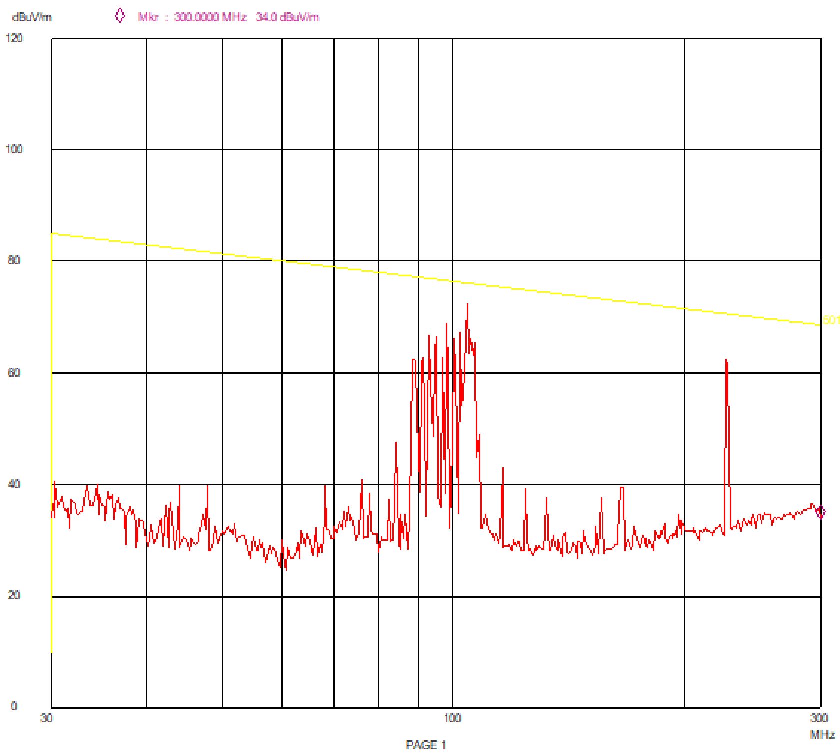

Figure 114: Rotunda Campus – 30 MHz to 300 MHz

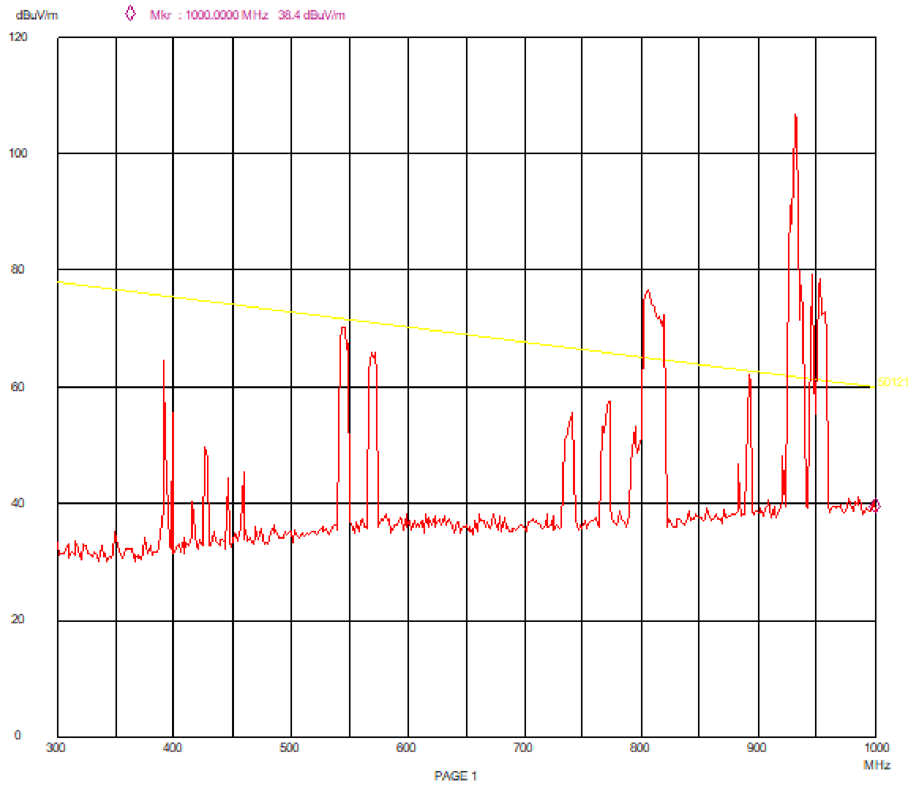

Figure 115: Rotunda Campus – 300 MHz to 1 GHz

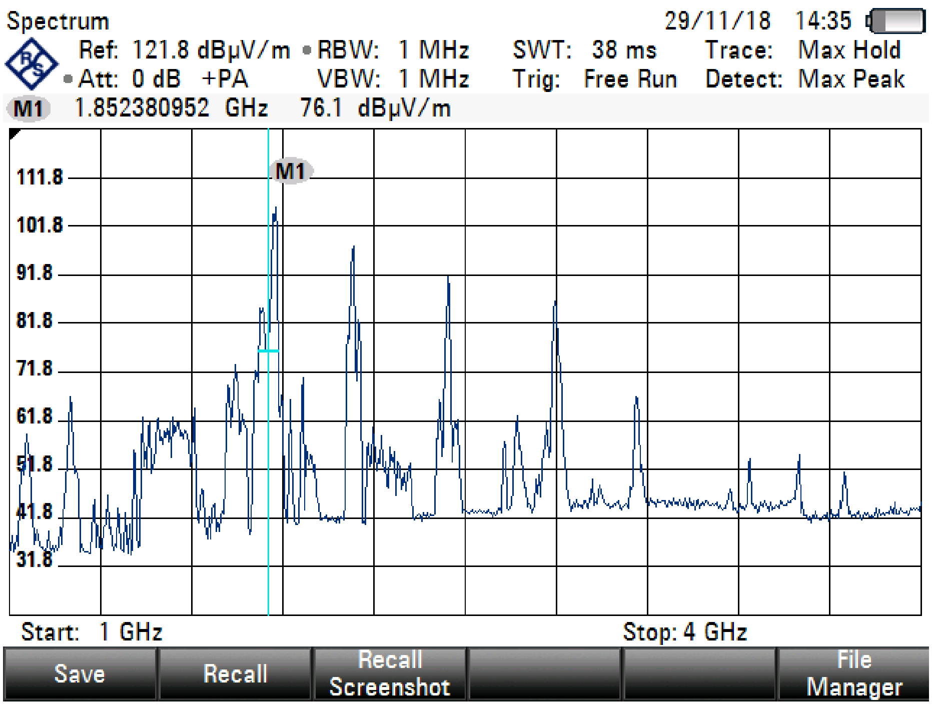

Figure 116: Rotunda Campus - 1 GHz to 4 GHz

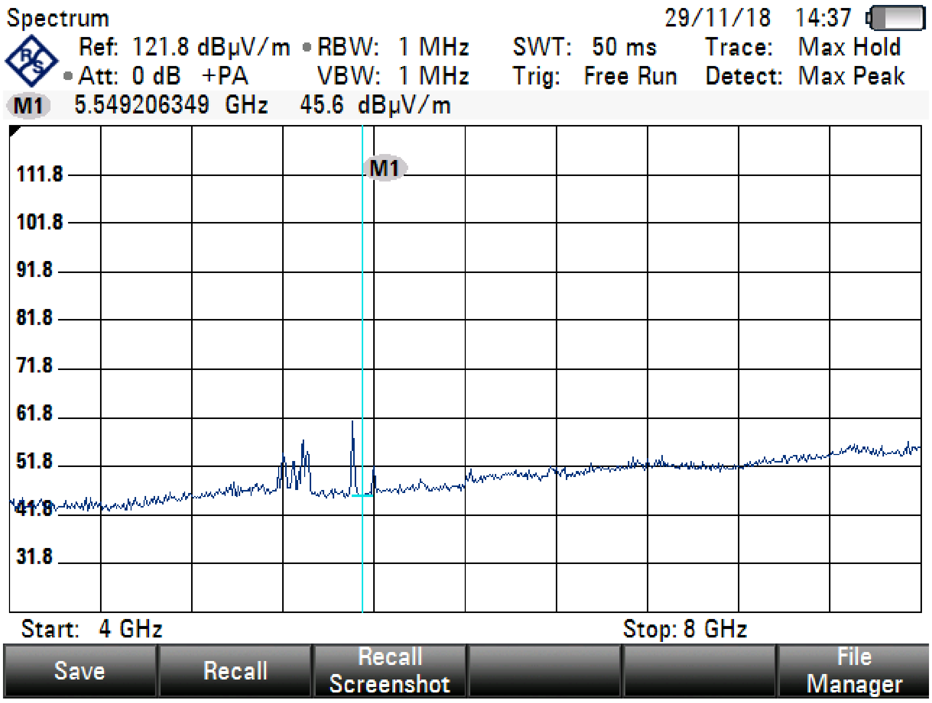

Figure 117: Rotunda Campus - 4 GHz to 8 GHz

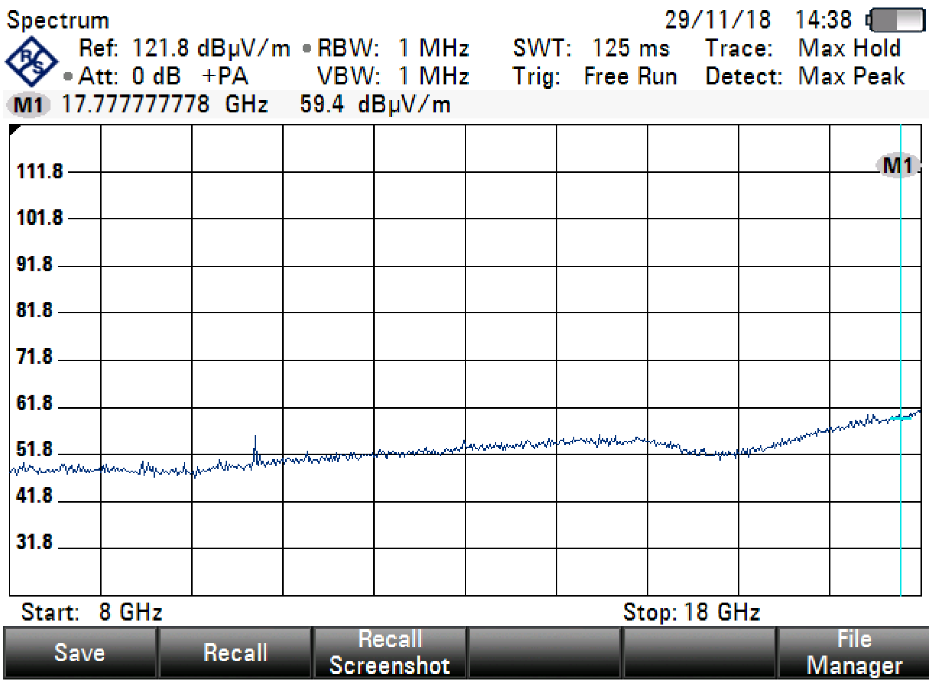

Figure 118: Rotunda Campus - 8 GHz to 18 GHz

3.7 Irish Rail at Tara Street EMR Survey

Measurements were performed at the location depicted below -

Figure 119: Measurement Location near Irish Rail line at Tara Street Station

3.7.1 DC Magnetic Field, Irish Rail at Tara Street

The Earth's DC magnetic flux density (B) was measured for a period of 24 minutes. The average static field was approximately 55 µT with maximum fluctuations measured during this time period of up to 3.5 µT. Deviations of this magnitude and slightly higher would be expected near an electrified rail system such as the DART.

3.7.2 AC Electric and Magnetic Fields 1 Hz to 10 kHz, Irish Rail at Tara Street

Figure 122 shows a spectral plot of the magnetic field from DC to 100 Hz. The DC component can be seen to be much higher than any other frequency. The near DC fields (less than 10 Hz) were typically of a magnitude of less than 0.01 µT with variations of current drawn by the nearby DART line due to traffic passing the near DC fields were seen to increase to in excess of 0.01 µT. A spike at 50 Hz is also evident, which is the transmission frequency for mains electricity. Figure 127 shows the equivalent electric field in this frequency range. Harmonics of the fundamental 50 Hz mains frequency are evident in both the E-Field and M-Field plots from 100 Hz to 1 kHz, occurring at frequencies such as 100 Hz, 150 Hz, 200 Hz with the 3rd and 5th harmonics exceeding 0.01 µT.

3.7.3 Radiated Fields: 10 kHz to 18 GHz, Irish Rail at Tara Street

There was no evidence, during the measurement and observation time of this study of any transient or intermittent events. The RF emissions profile in this frequency range was well below the typical risk levels of 3 V/m.

At this site the strongest emissions were caused by Analog radio broadcasts (80 – 110 MHz), Digital Radio (147-223 MHz), Tetra Radio (390 MHz), Digital Television Broadcasting (470 – 790 MHz), WiFi (2.4 GHz and 5 GHz), RADAR (2.7-2.9 GHz) and FWPMA (3.4-3.6 GHz). In terms of mobile technology, the following signals were present, mobile broadband, LTE (791-821 MHz and 925-960 MHz), GSM 900 and 1800 (900 MHz and 1.8 GHz) and 3 G (2.1 GHz).

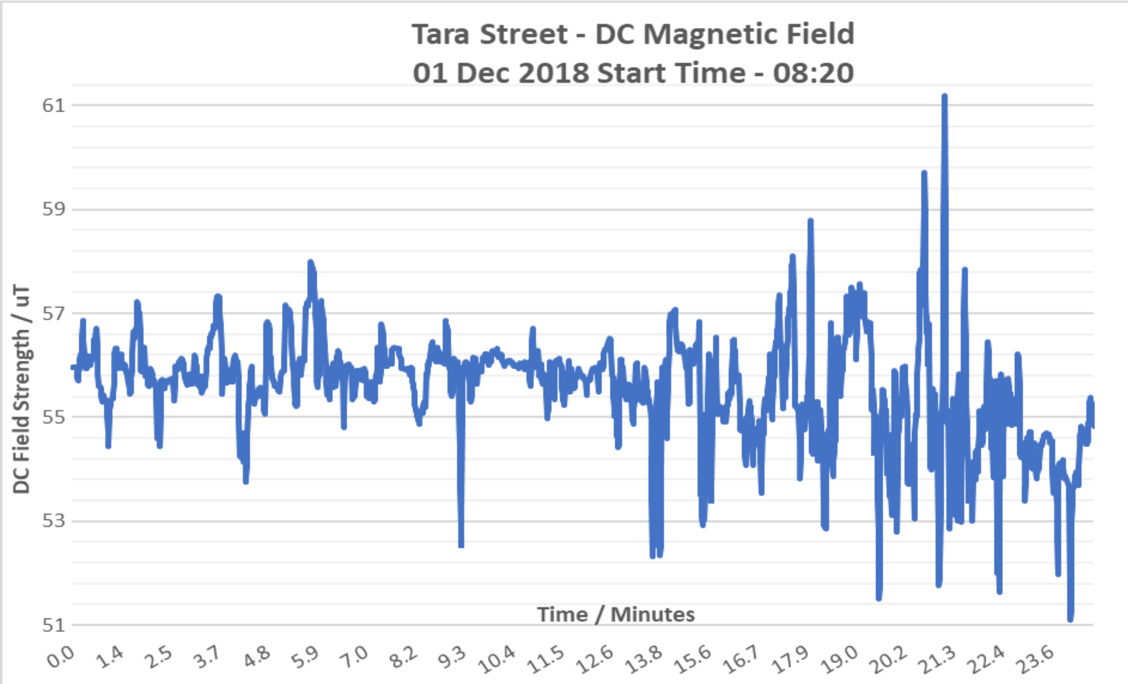

Figure 120: Irish Rail at Tara Street, DC Magnetic Field

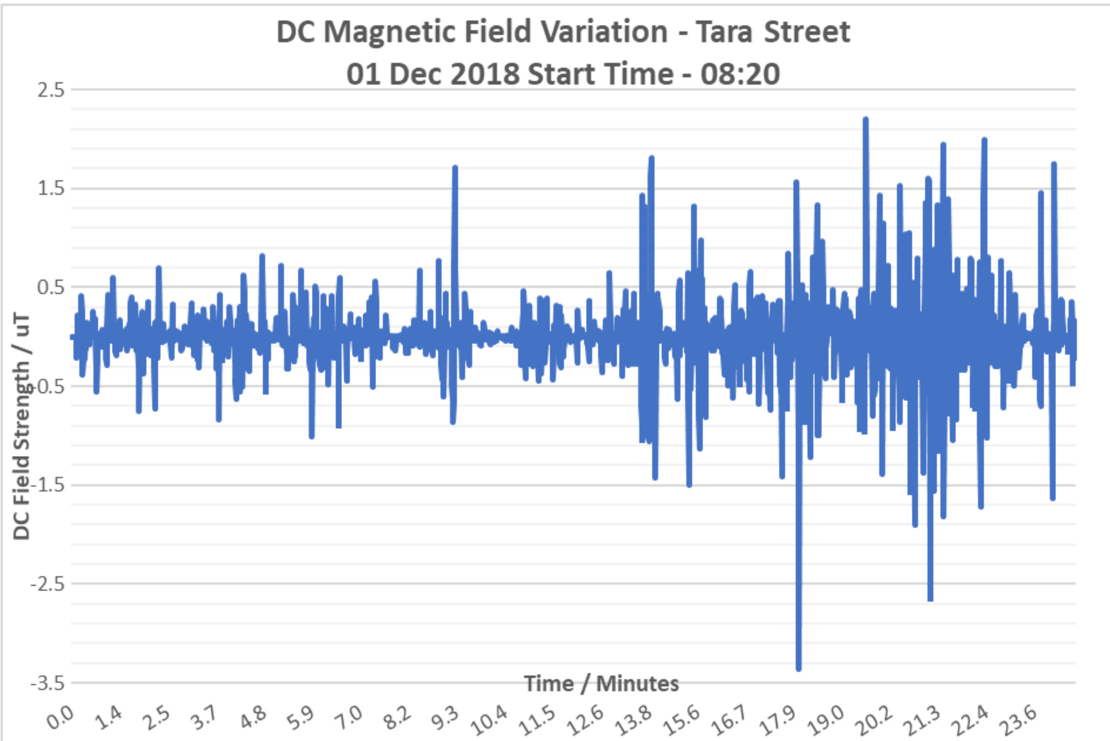

Figure 121: Irish Rail at Tara Street, DC Magnetic Field variations

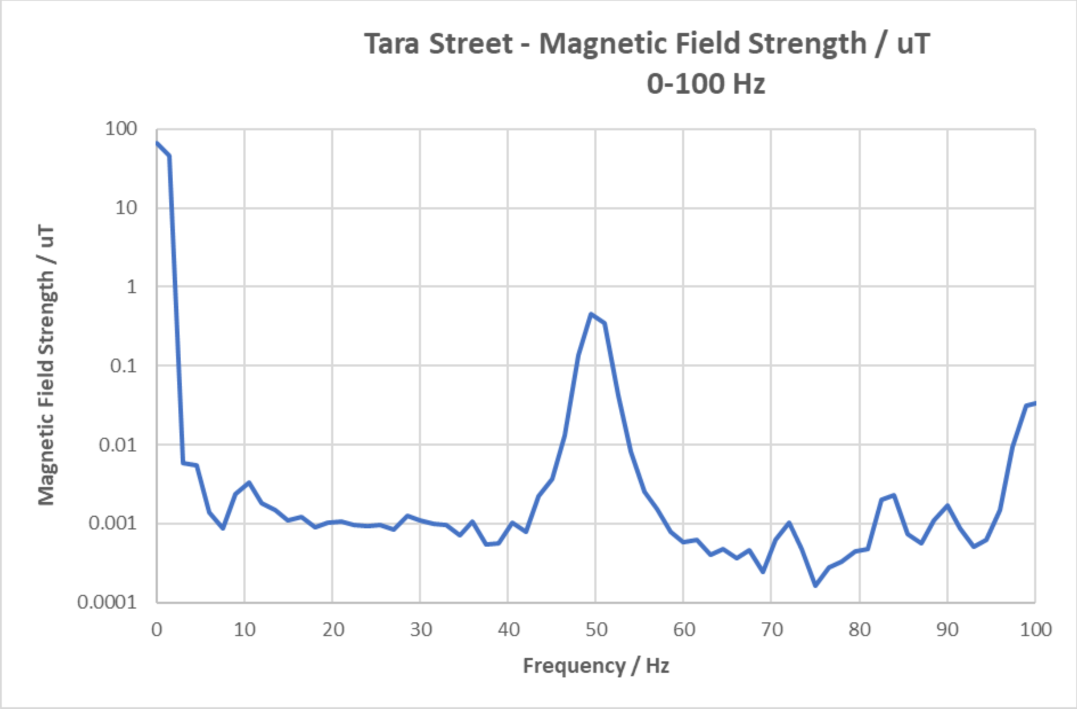

Figure 122: Irish Rail at Tara Street, 0 Hz to 100 Hz (Mag Field)

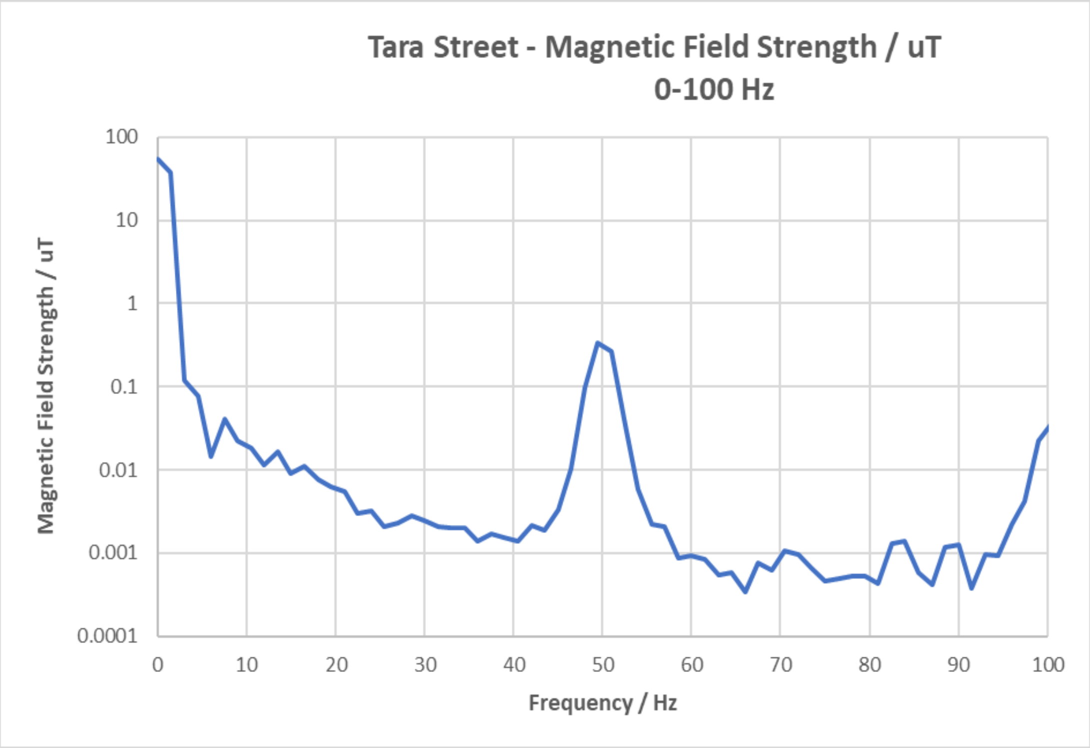

Figure 123: Irish Rail at Tara Street, 0 Hz to 100 Hz (Mag Field) – with train passing

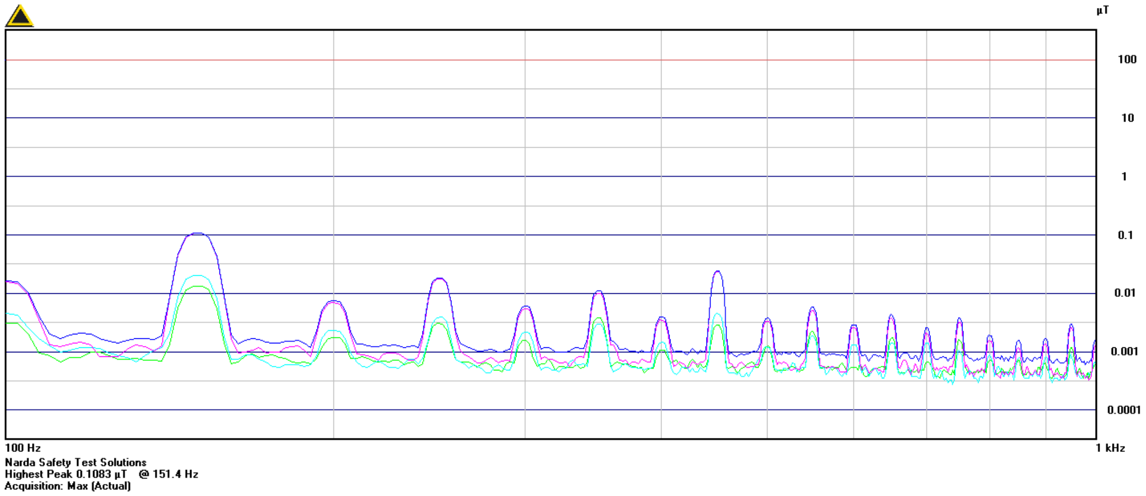

Figure 124: Irish Rail at Tara Street, 100 Hz to 1 kHz (Mag Field)

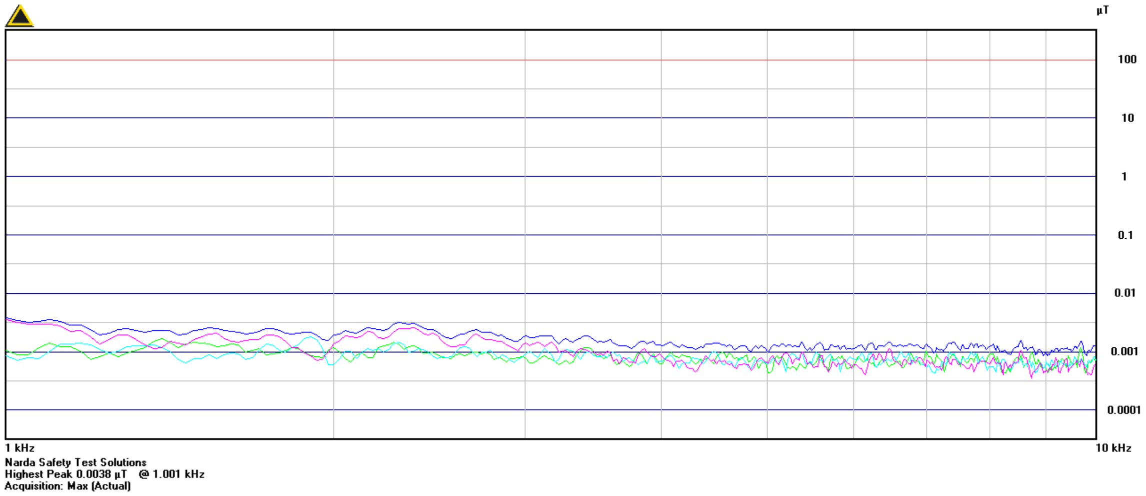

Figure 125: Irish Rail at Tara Street, 1 kHz to 10 kHz (Mag Field)

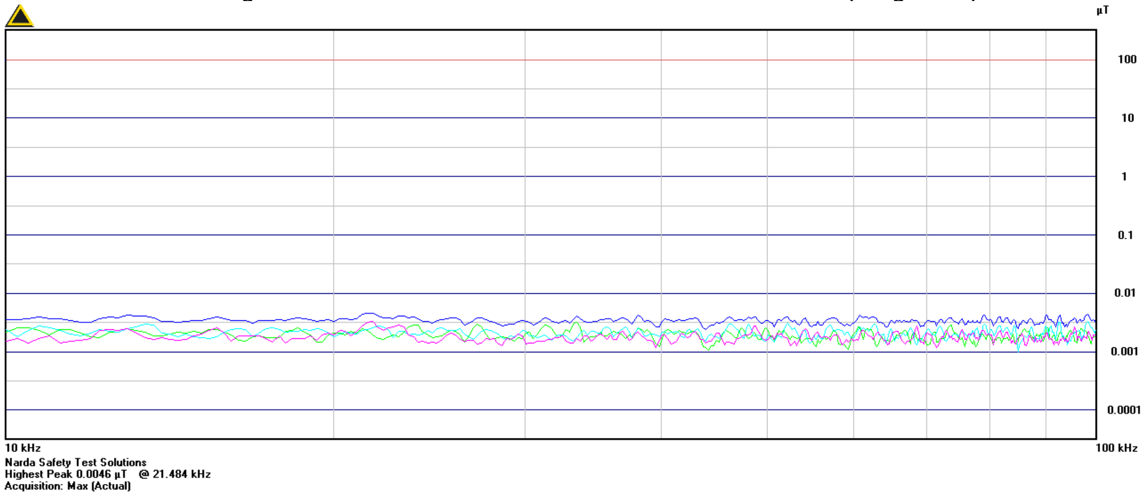

Figure 126: Irish Rail at Tara Street, 10 kHz to 100 kHz (Mag Field)

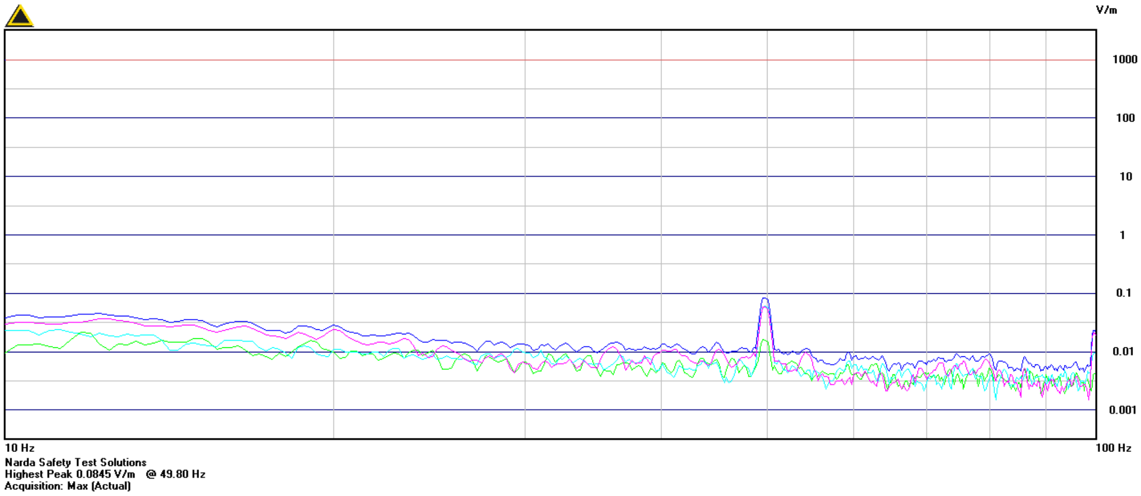

Figure 127: Irish Rail at Tara Street, 10Hz to 100 Hz (E-Field)

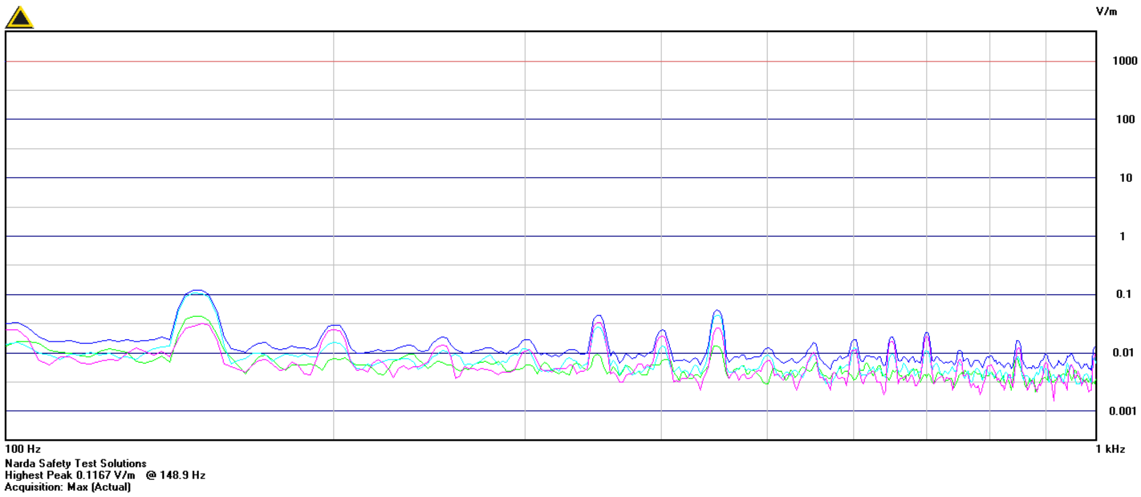

Figure 128: Irish Rail at Tara Street, 100 Hz to 1 kHz (E-Field)

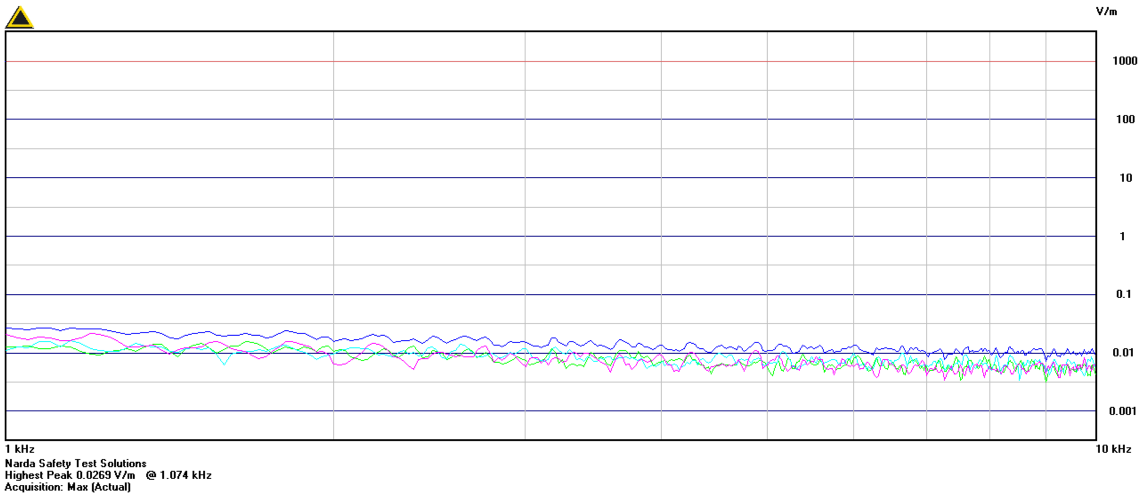

Figure 129: Irish Rail at Tara Street, 1 kHz to 10 kHz (E-Field)

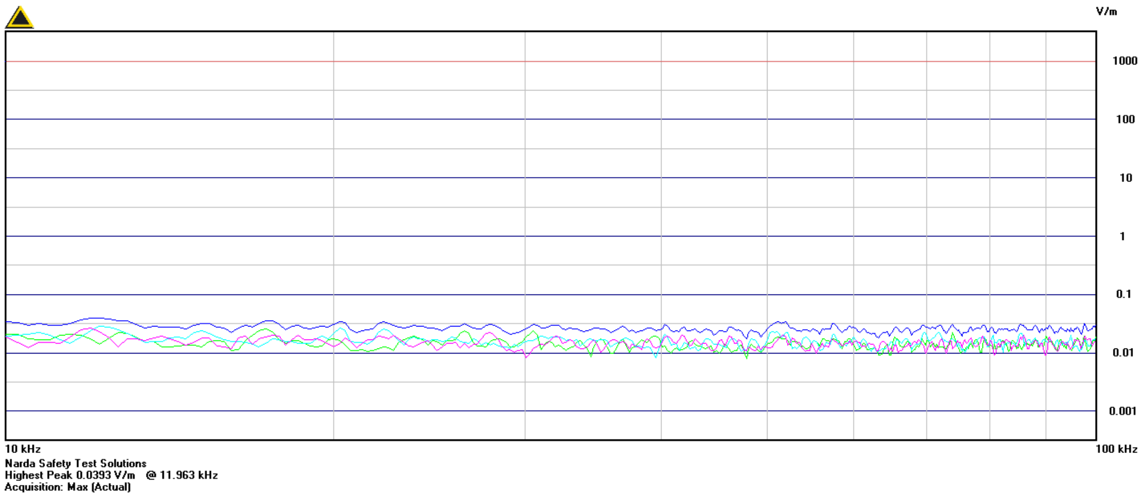

Figure 130: Irish Rail at Tara Street, 10 kHz to 100 kHz (E-Field)

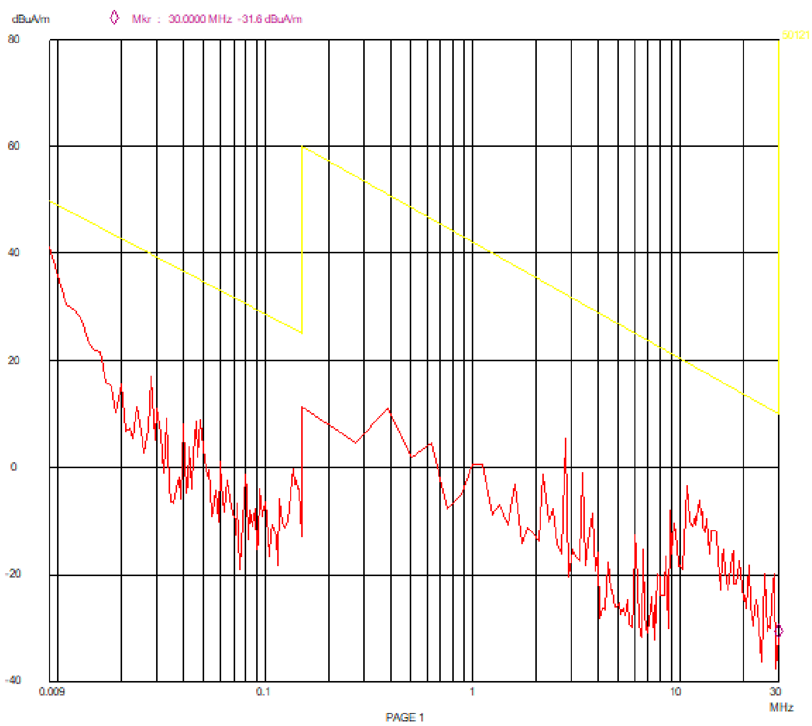

Figure 131: Irish Rail at Tara Street Station – 9 kHz to 30 MHz

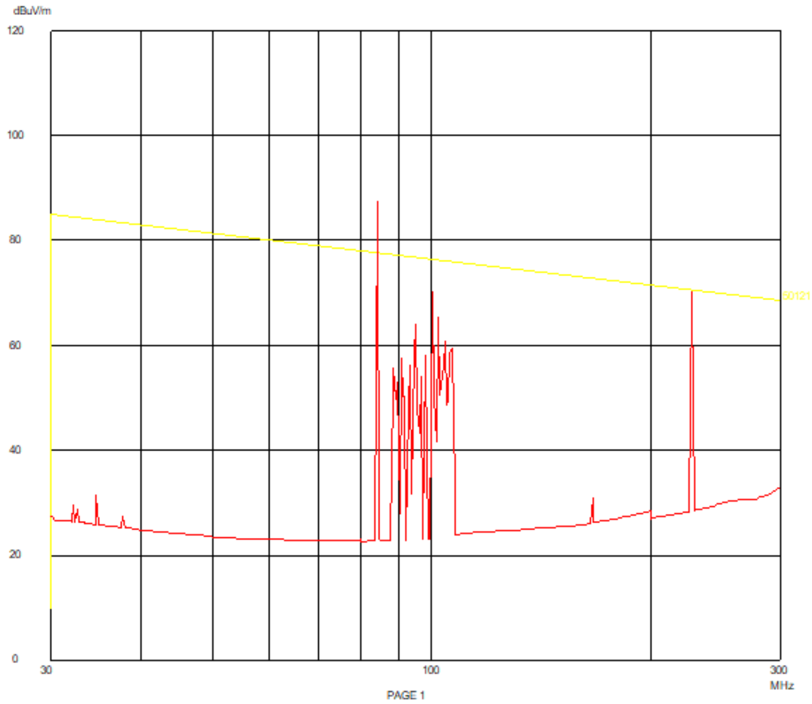

Figure 132: Irish Rail at Tara Street – 30 MHz to 300 MHz

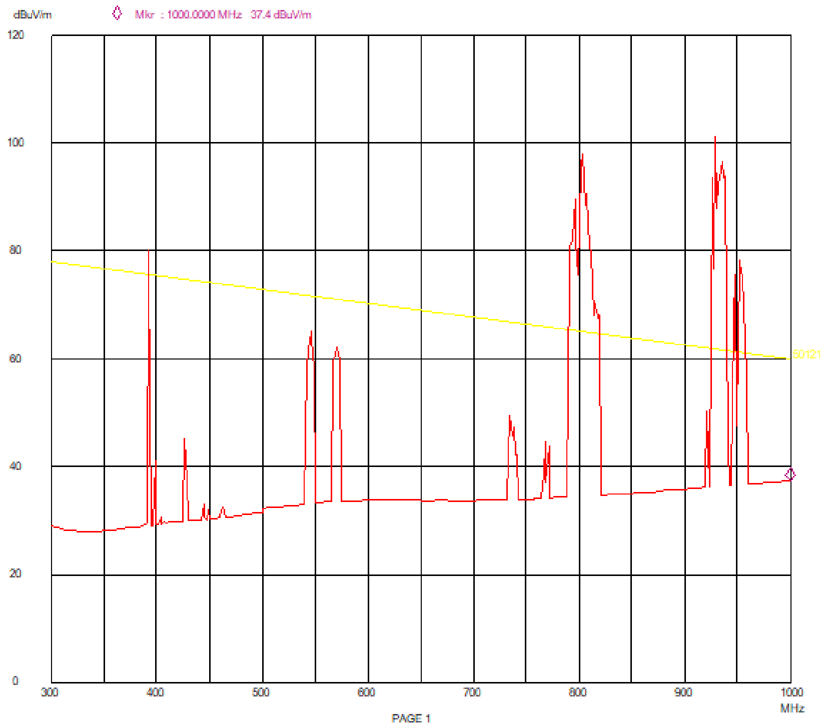

Figure 133: Irish Rail at Tara Street – 300 MHz to 1 GHz

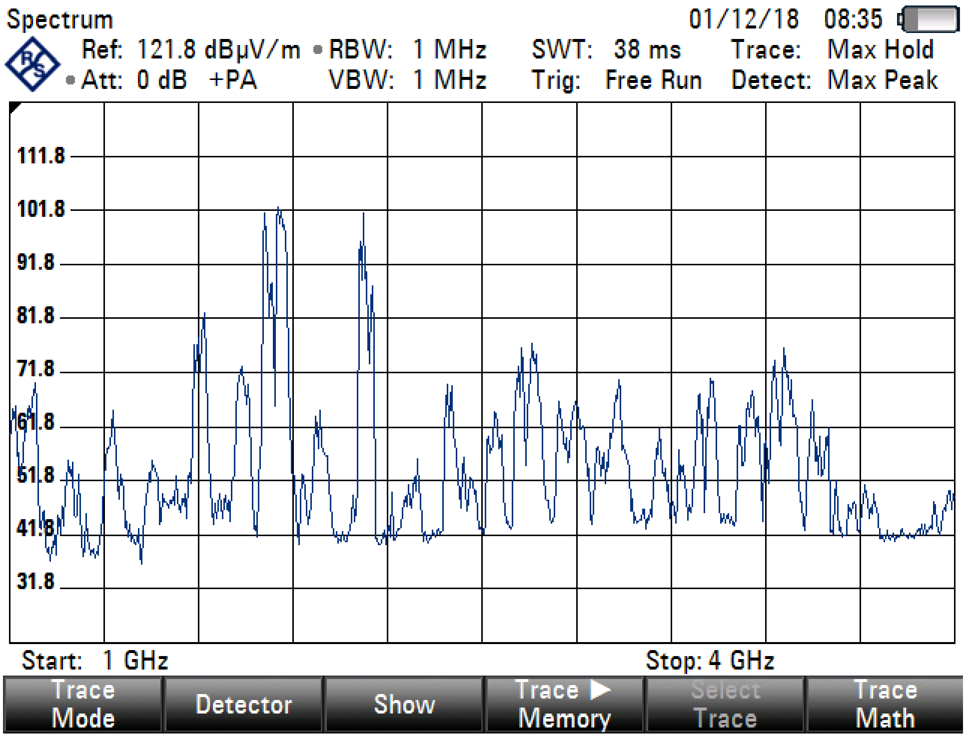

Figure 134: Irish Rail at Tara Street - 1 GHz to 4 GHz

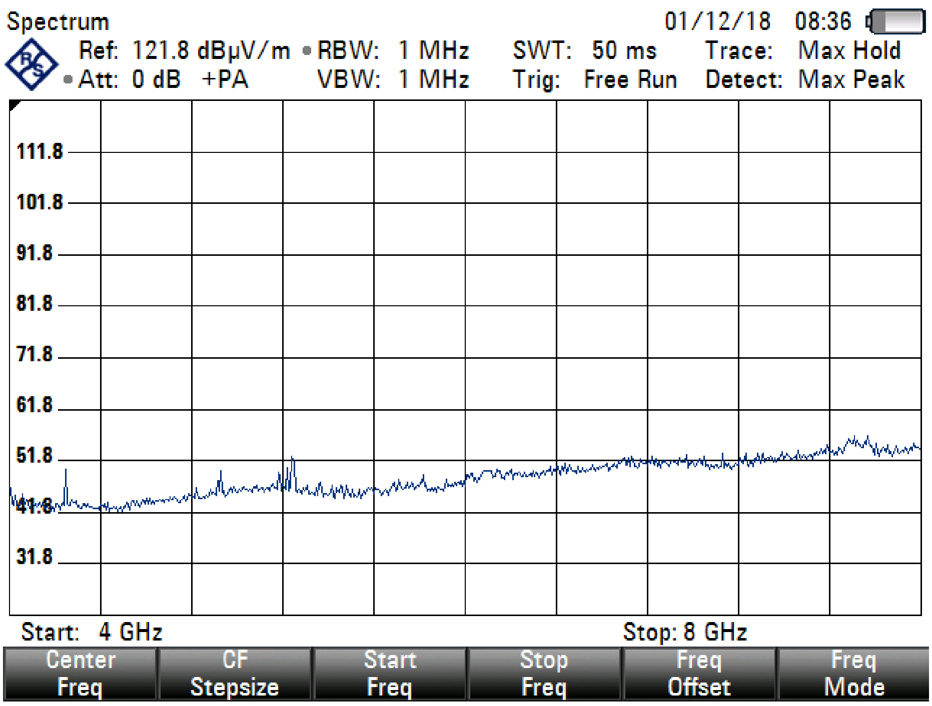

Figure 135: Irish Rail at Tara Street - 4 GHz to 8 GHz

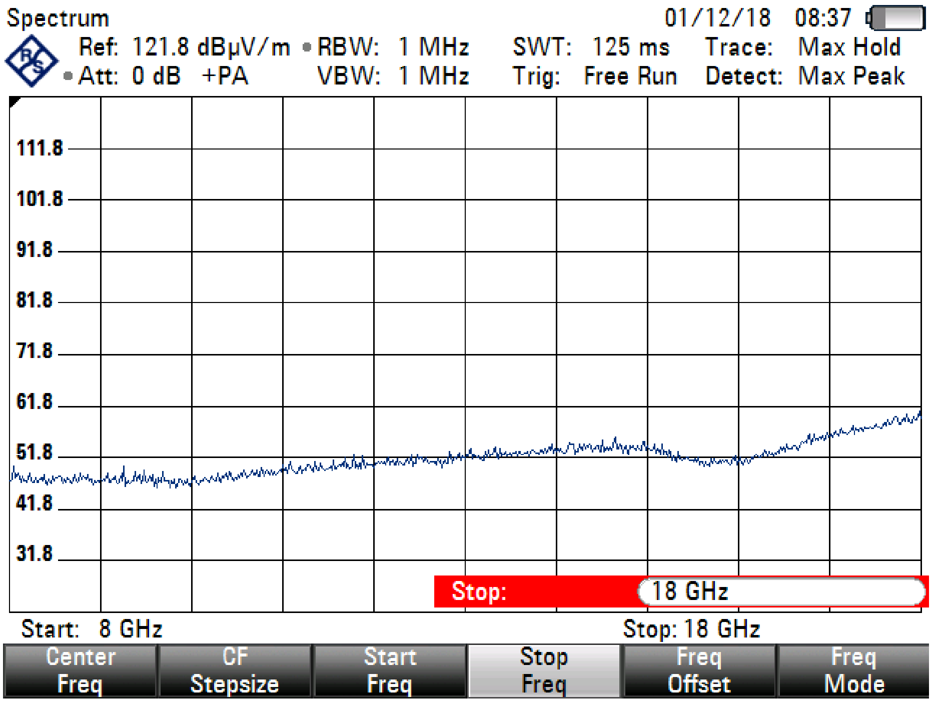

Figure 136: Irish Rail at Tara Street - 8 GHz to 18 GHz

3.8 <u>Trinity College Dublin EMR Survey</u>

Measurements were performed at the locations depicted below -

Figure 137: Measurement Location within Trinity College Dublin

Location A was an outdoor survey at ground level located directly above the proposed alignment outside the Zoology Department on the Trinity campus.

Location B was an indoor location, specifically the basement SNIAM building. On the day of the day of the survey (29th November) this was thought to be one of the closest locations to the proposed development vertically location. The measurement location was in the hallway outside room -1.02 at a distance of approximately 3 metres below ground level.

3.8.1 DC Magnetic Field, Trinity College

At location A, the Earth's DC magnetic flux density (B) was measured for a period of 24 minutes. The average static field was approximately 45.2 µT with maximum fluctuations measured during this time period of up to 0.2 µT reflecting that the location was relatively quiescent with regards to DC magnetic field deviations. The measurement location was accessible by car however and fluctuations of up to 0.5 µT could be typically expected although these would be very localised to the moving ferromagnetic body.

At location B, the magnetic flux density was measured for a period of 29 minutes. The average static field was approximately 52.5 µT with maximum fluctuations measured during this time period of up to 0.4 µT.

3.8.2 AC Electric and Magnetic Fields 1 Hz to 10 kHz, Trinity College

Figure 140 and Figure 156 show the spectral plots of the magnetic field from DC to 100 Hz. The DC component can be seen to be much higher than any other frequency with the power frequency of 50 Hz also evident. Figure 144 and Figure 160 show the equivalent electric field levels in the same range.

No other significant fields were measured up to 10 kHz at location A. In location B however, due to its indoor location and the prevalence of building wiring harmonics of 50 Hz power frequency can be seen between 100 – 1 kHz.

3.8.3 Radiated Fields: 10 kHz to 18 GHz, Trinity College

There was no evidence, during the measurement and observation time of this study of any transient or intermittent events. The RF emissions profile in this frequency range was well below the typical risk levels of 3 V/m.

At this site the strongest emissions were caused by Analog radio broadcasts (80 – 110 MHz), Digital Radio (147-223 MHz), Tetra Radio (390 MHz), Digital Television Broadcasting (470 – 790 MHz), Aeronautical navigation signals (960 MHz – 1.16 GHz), WiFi (2.4 GHz and 5 GHz), RADAR (2.7-2.9 GHz) and FWPMA (3.4-3.6 GHz). In terms of mobile technology, the following signals were present, mobile broadband, LTE (791-821 MHz and 925-960 MHz), GSM 900 and 1800 (900 MHz and 1.8 GHz) and 3 G (2.1 GHz).

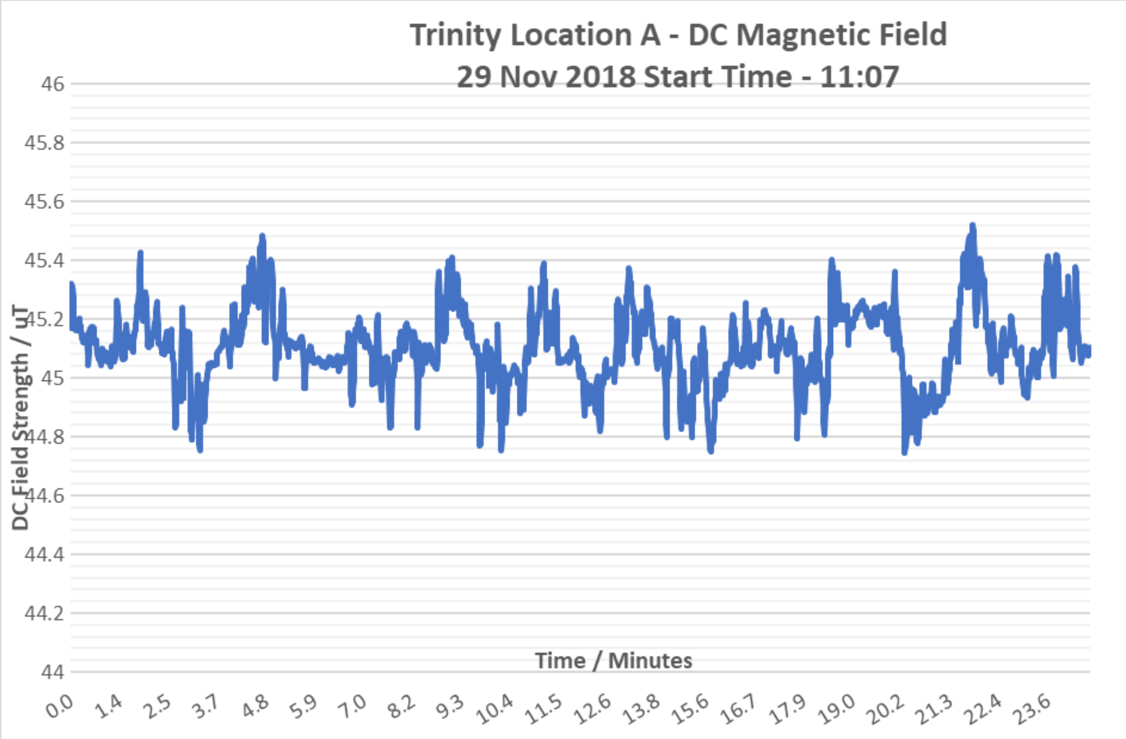

Figure 138: Trinity College Dublin Location A, DC Magnetic Field

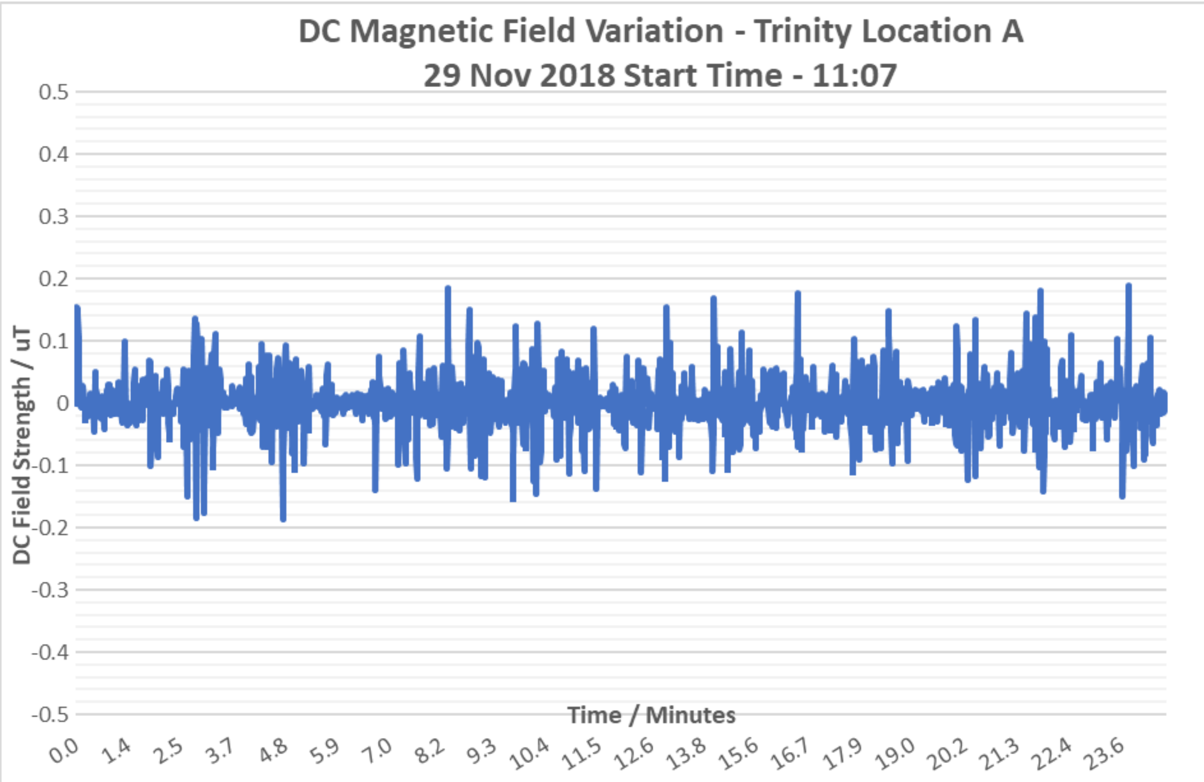

Figure 139: Trinity College Dublin Location A, DC Magnetic Field variations

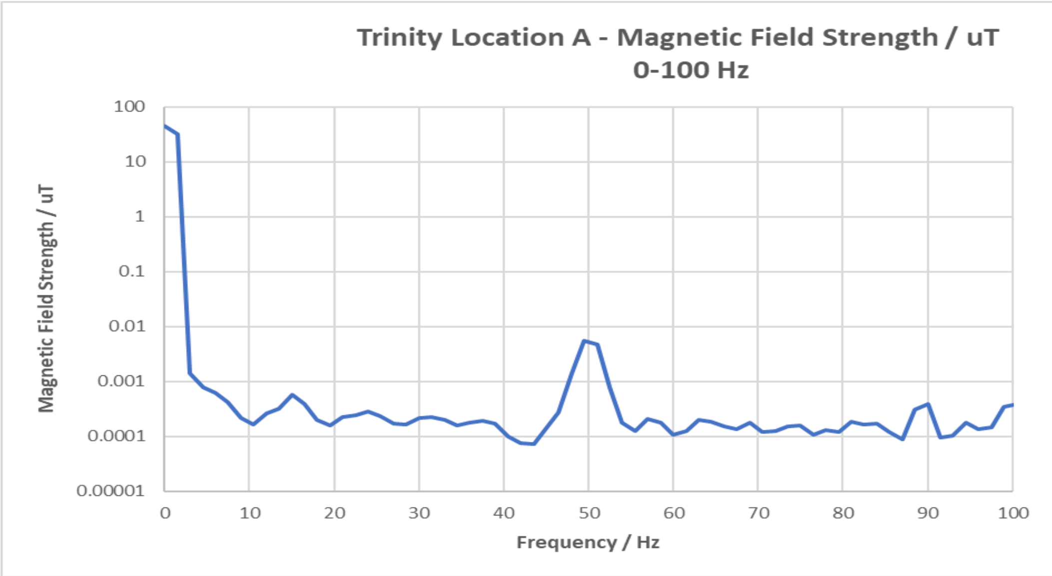

Figure 140: Trinity College Dublin Location A, 0 Hz to 100 Hz (Mag Field)

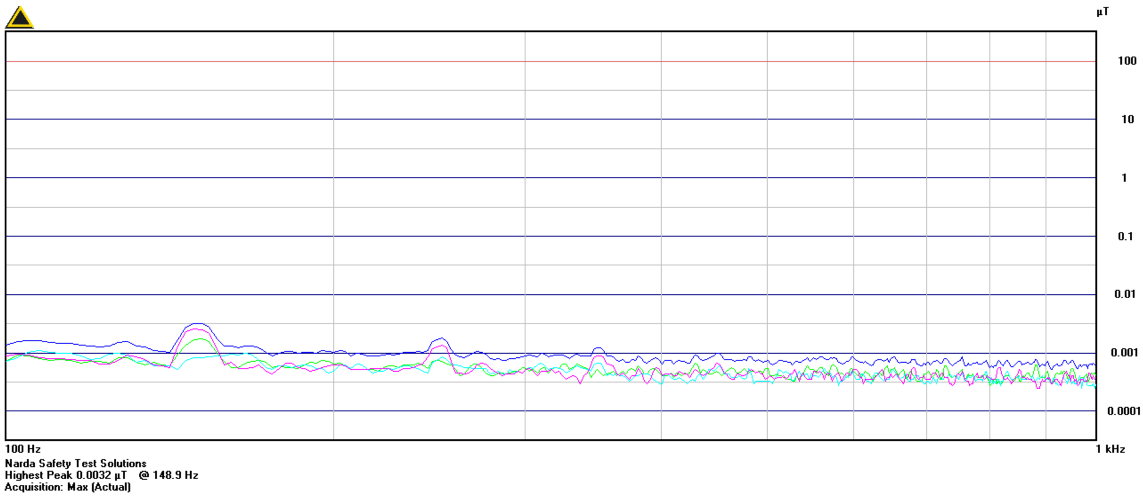

Figure 141: Trinity College Dublin Location A, 100 Hz to 1 kHz (Mag Field)

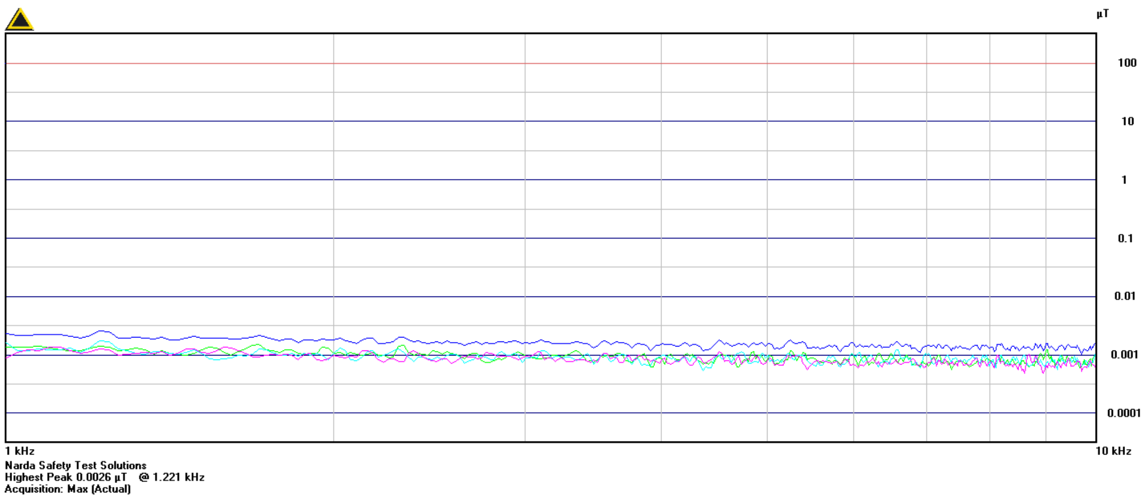

Figure 142: Trinity College Dublin Location A, 1 kHz to 10 kHz (Mag Field)

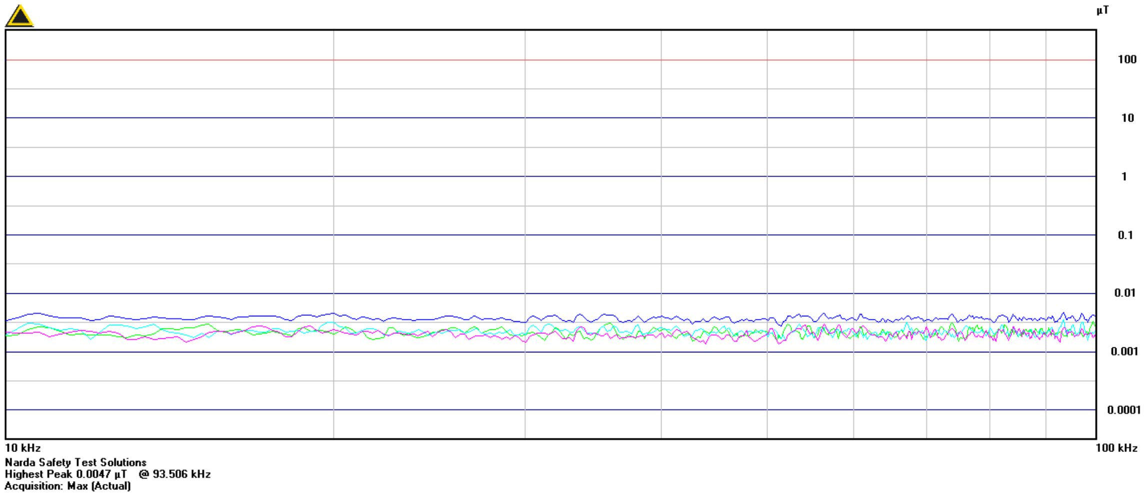

Figure 143: Trinity College Dublin Location A, 10 kHz to 100 kHz (Mag Field)

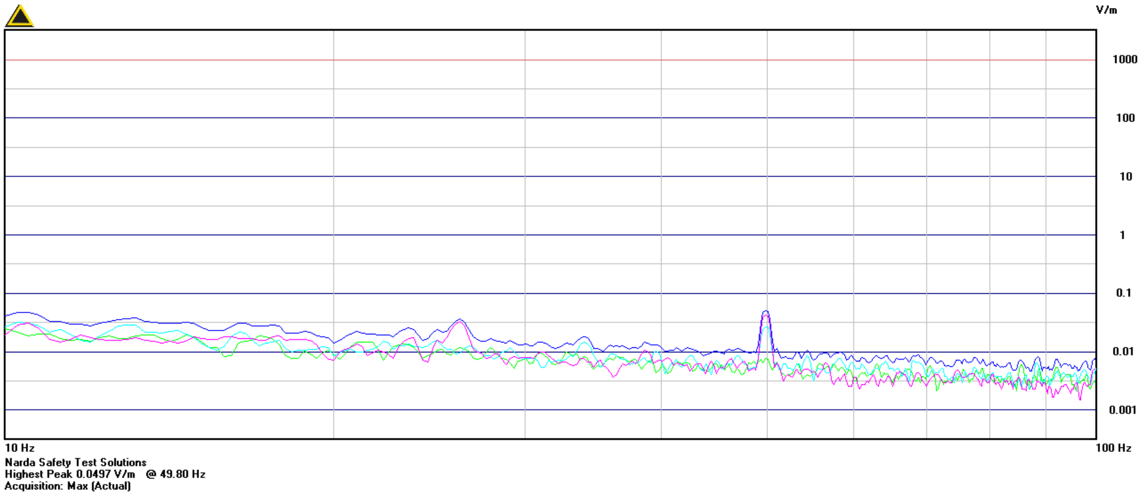

Figure 144: Trinity College Dublin Location A, 10Hz to 100 Hz (E-Field)

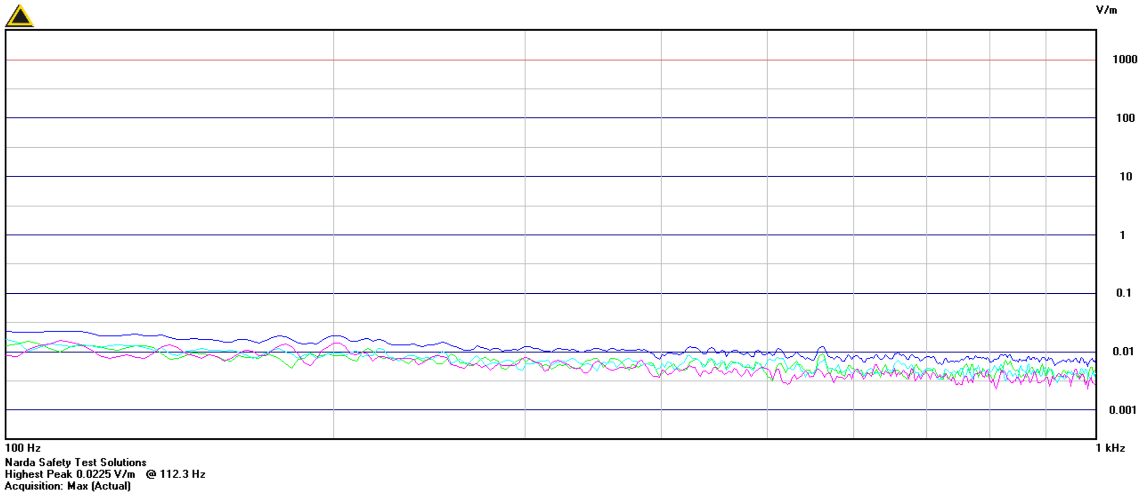

Figure 145: Trinity College Dublin Location A, 100 Hz to 1 kHz (E-Field)

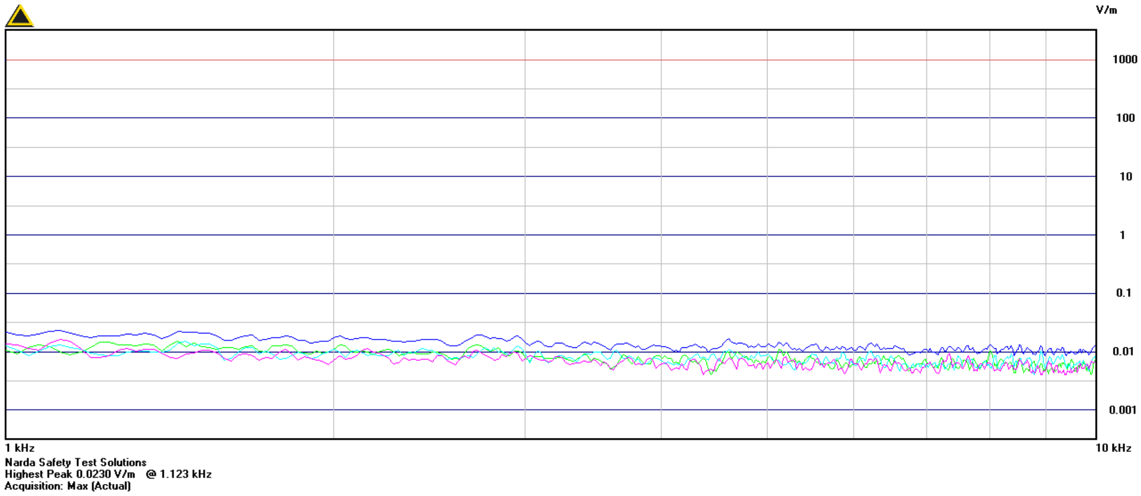

Figure 146: Trinity College Dublin Location A, 1 kHz to 10 kHz (E-Field)

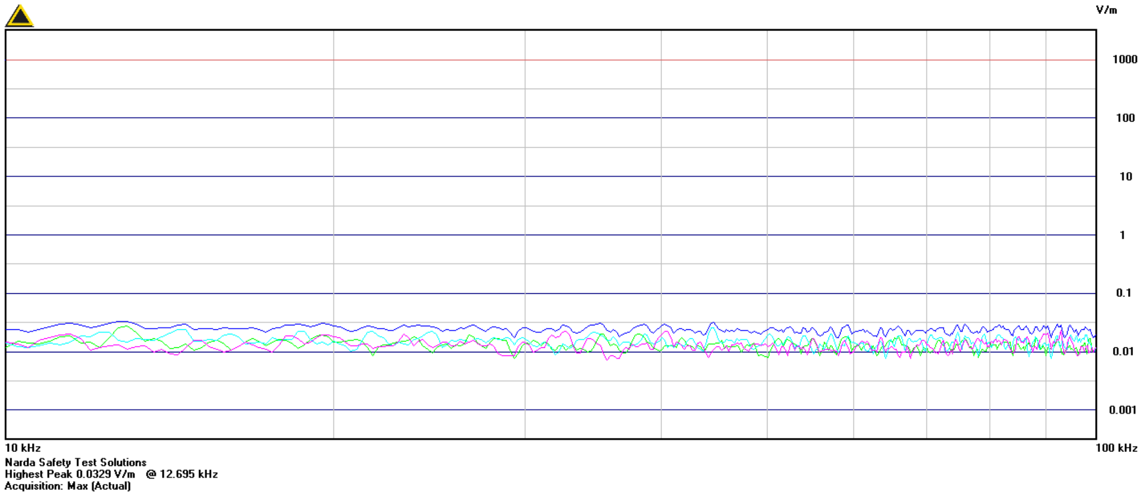

Figure 147: Trinity College Dublin Location A, 10 kHz to 100 kHz (E-Field)

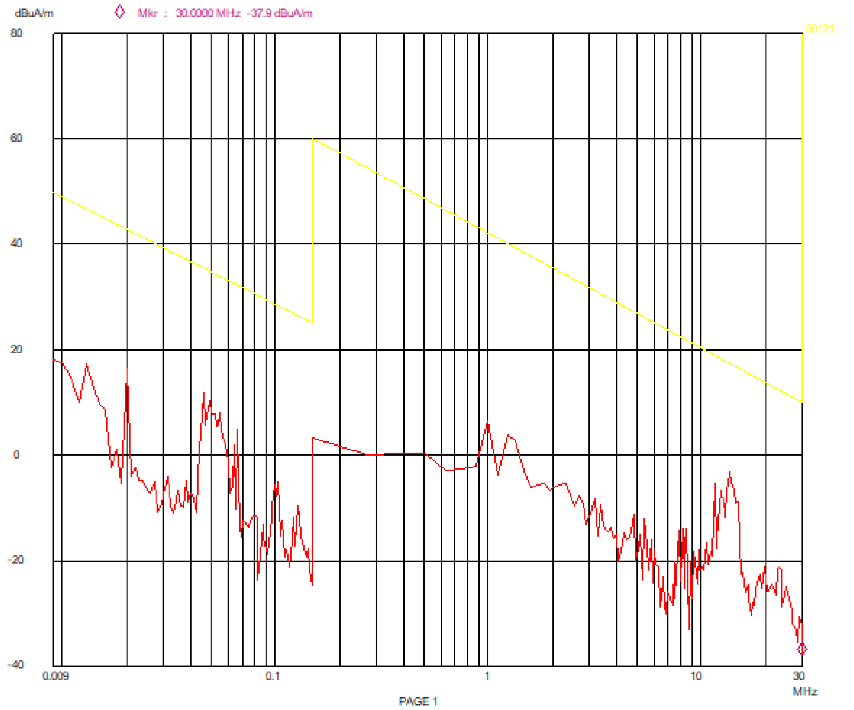

Figure 148: Trinity College Dublin Location A – 9 kHz to 30 MHz

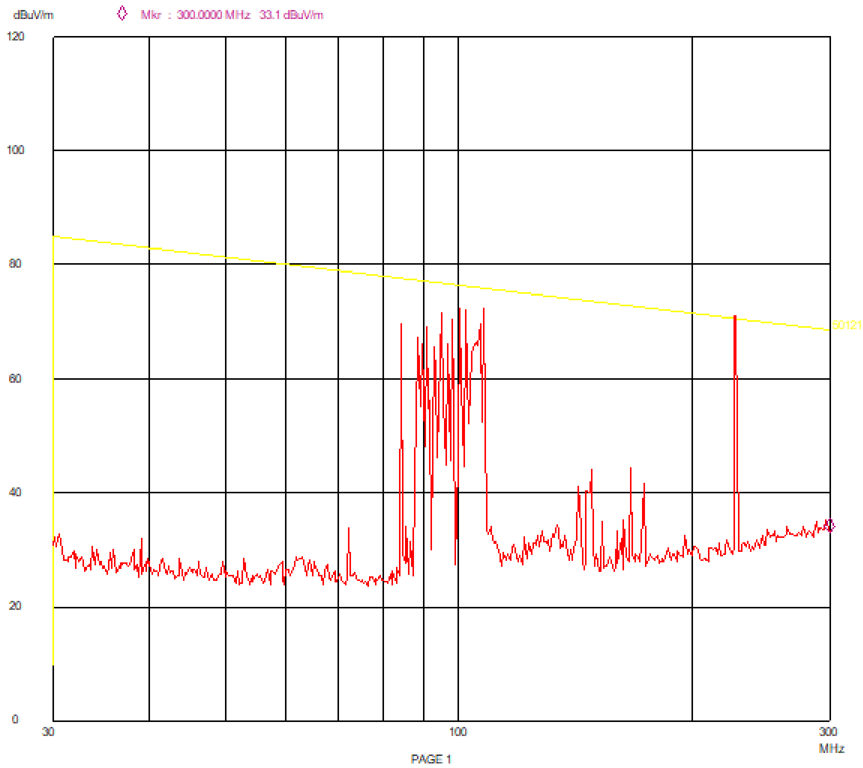

Figure 149: Trinity College Dublin Location A – 30 MHz to 300 MHz

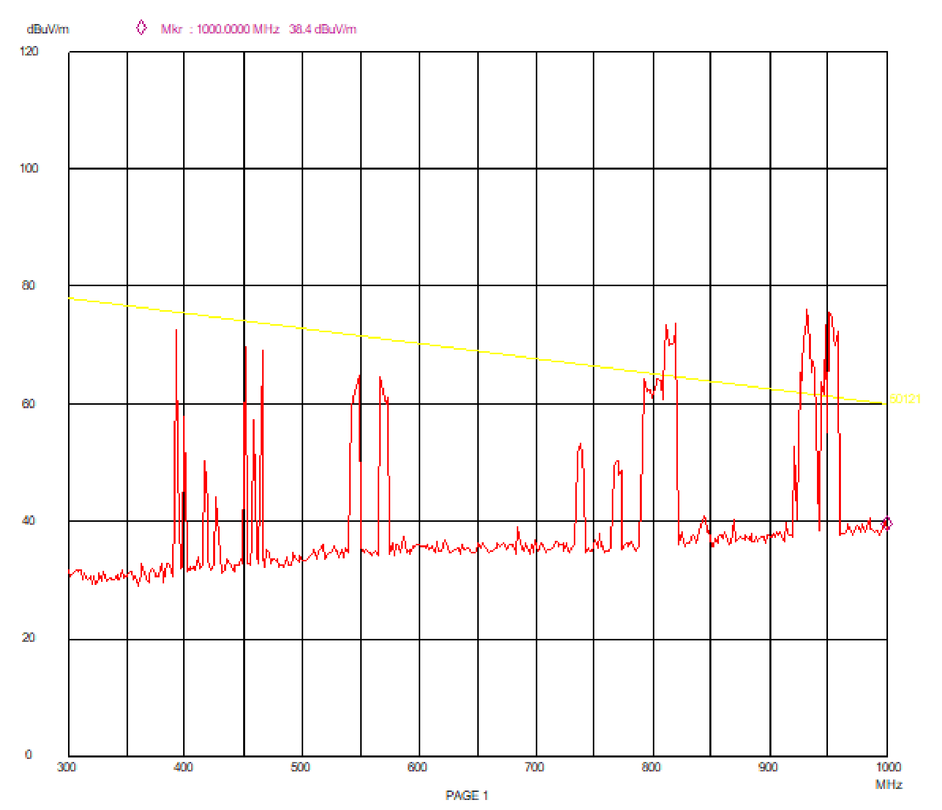

Figure 150: Trinity College Dublin Location A – 300 MHz to 1 GHz

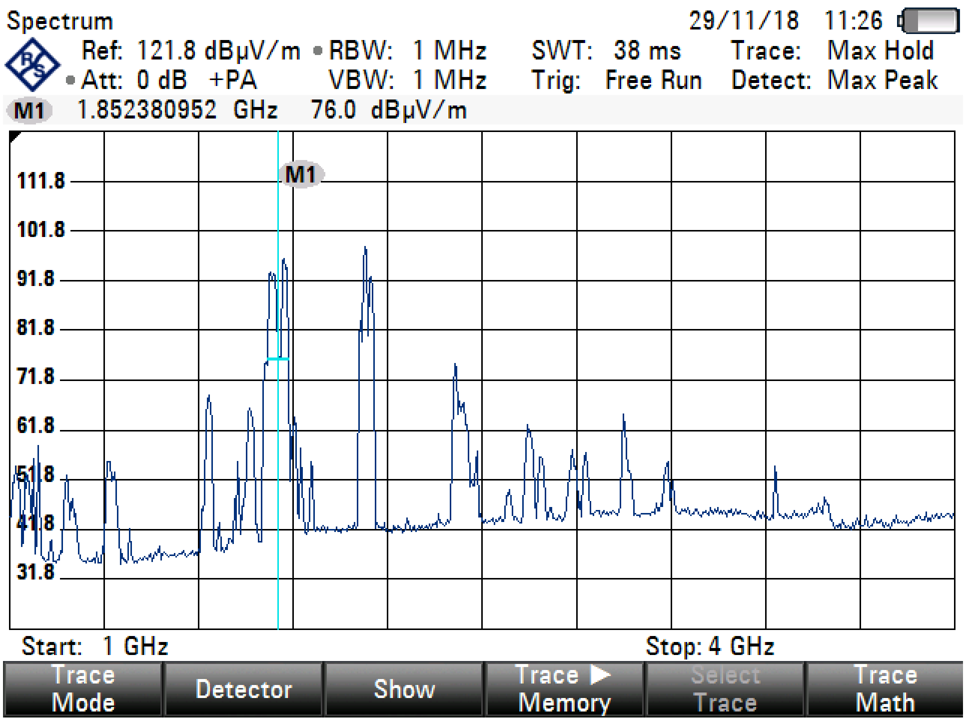

Figure 151: Trinity College Dublin Location A - 1 GHz to 4 GHz

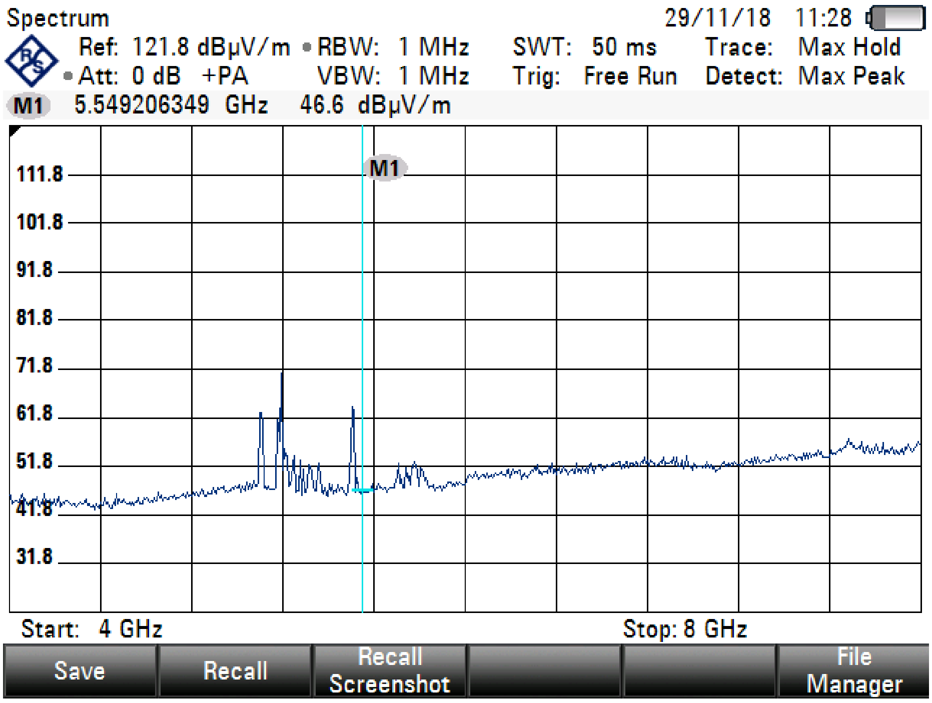

Figure 152: Trinity College Dublin Location A - 4 GHz to 8 GHz

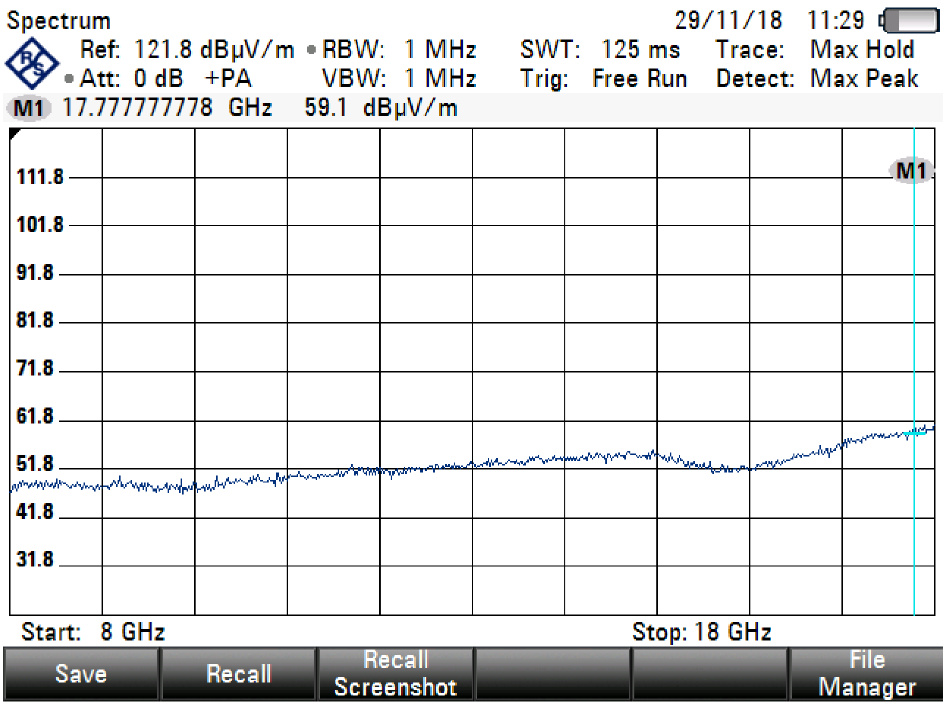

Figure 153: Trinity College Dublin Location A - 8 GHz to 18 GHz

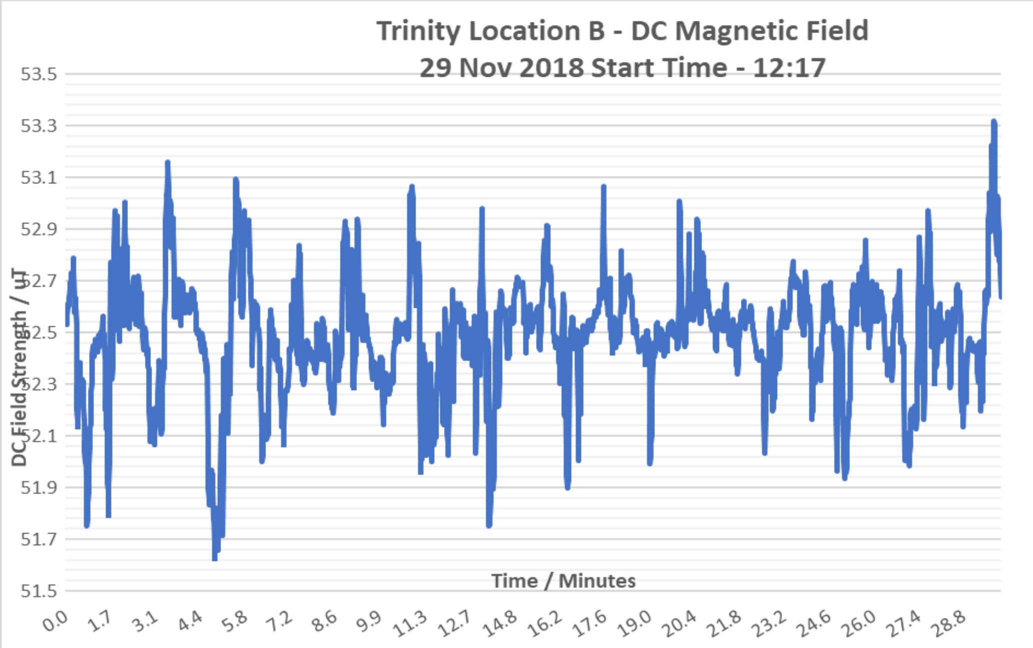

Figure 154: Trinity College Dublin Location B, DC Magnetic Field

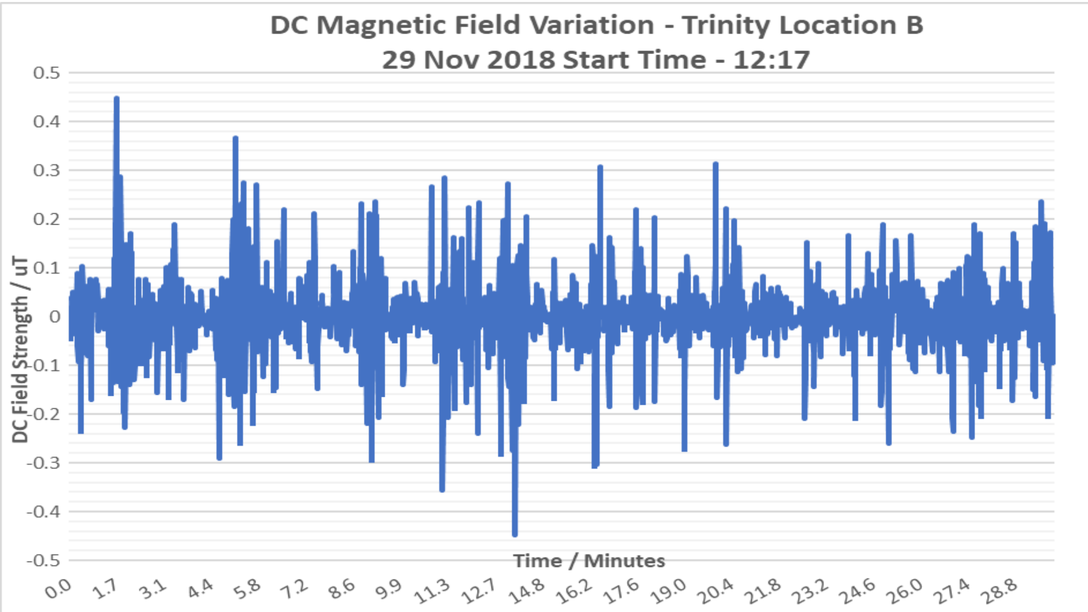

Figure 155: Trinity College Dublin Location B, DC Magnetic Field variations

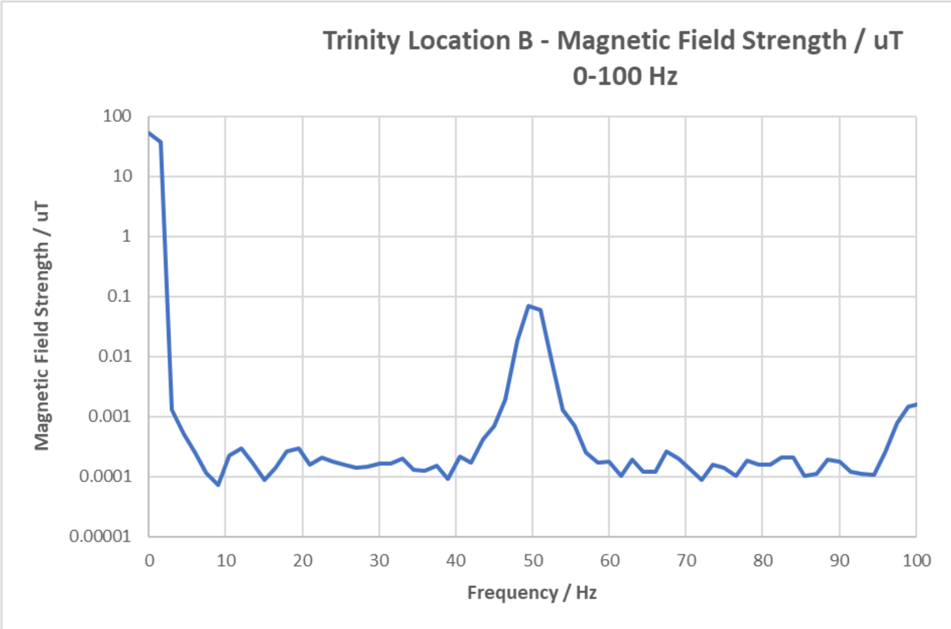

Figure 156: Trinity College Dublin Location B, 0 Hz to 100 Hz (Mag Field)

Figure 157: Trinity College Dublin Location B, 100 Hz to 1 kHz (Mag Field)

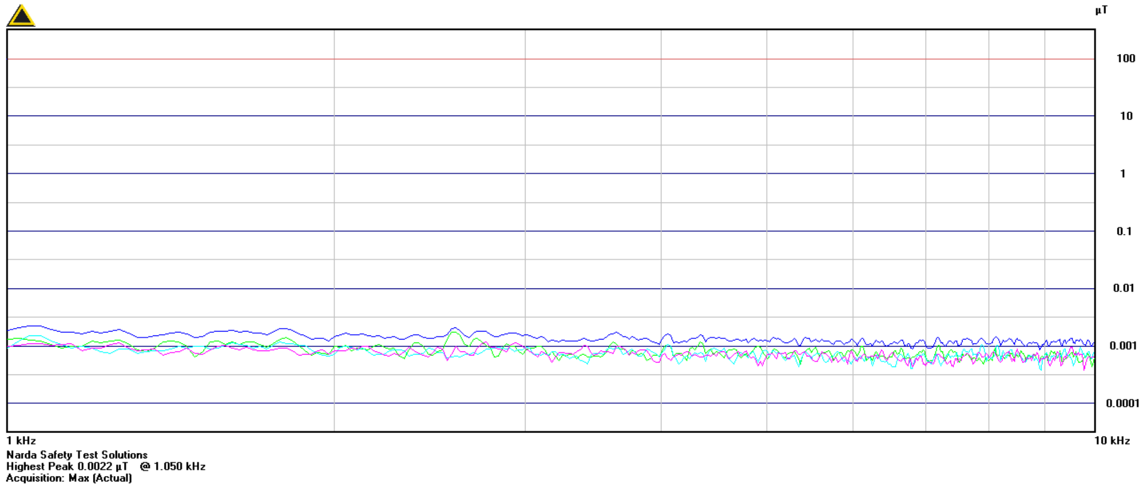

Figure 158: Trinity College Dublin Location B, 1 kHz to 10 kHz (Mag Field)

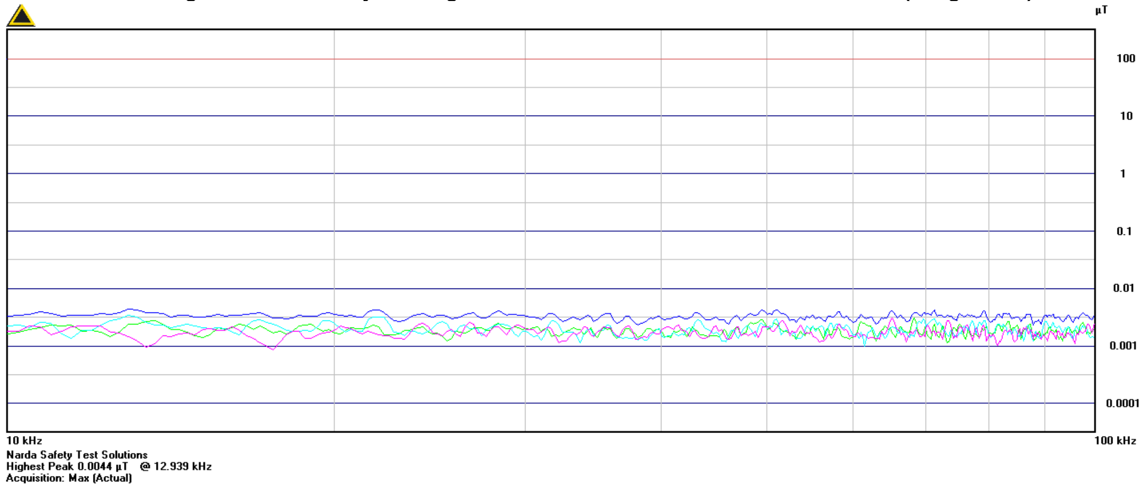

Figure 159: Trinity College Dublin Location B, 10 kHz to 100 kHz (Mag Field)

Figure 160: Trinity College Dublin Location B, 10Hz to 100 Hz (E-Field)

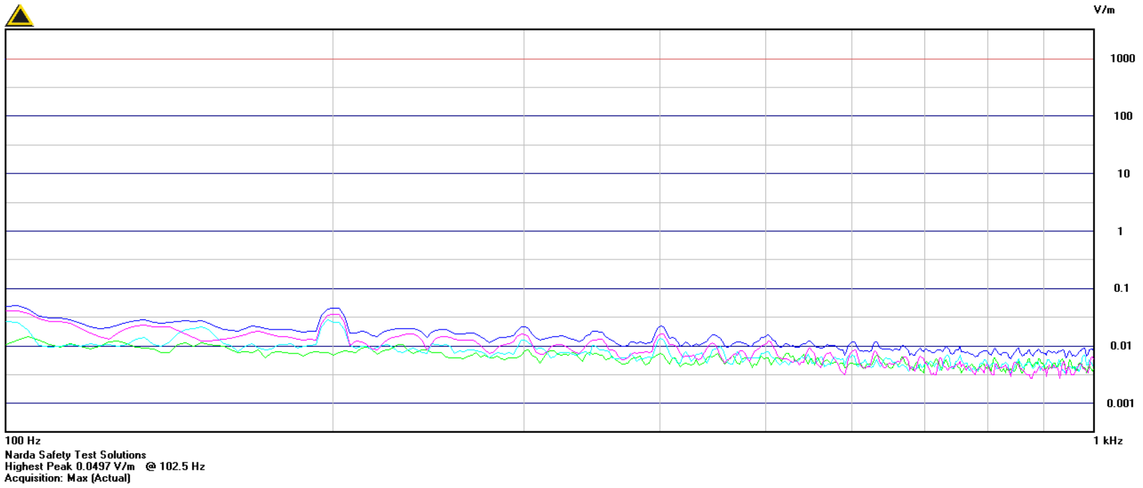

Figure 161: Trinity College Dublin Location B, 100 Hz to 1 kHz (E-Field)

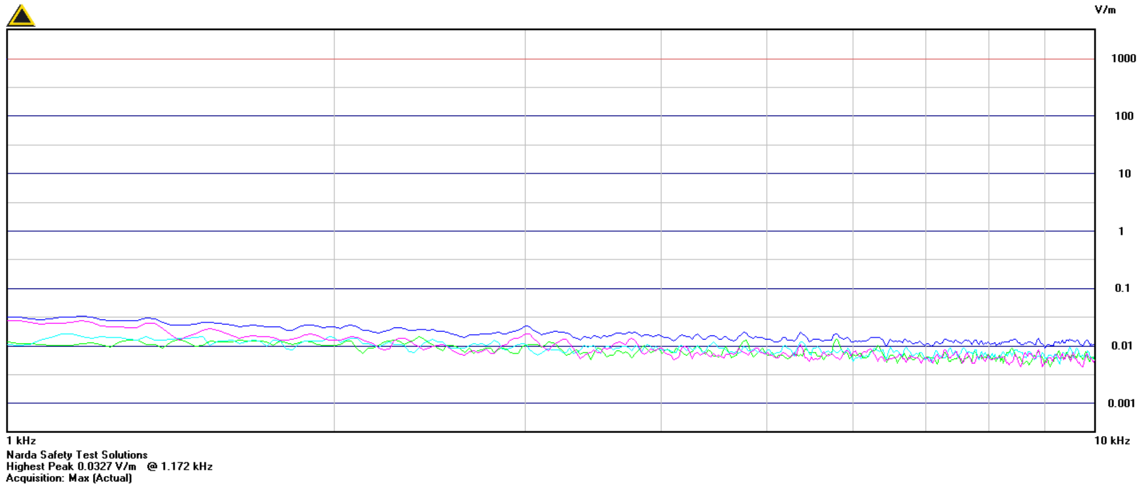

Figure 162: Trinity College Dublin Location B, 1 kHz to 10 kHz (E-Field)

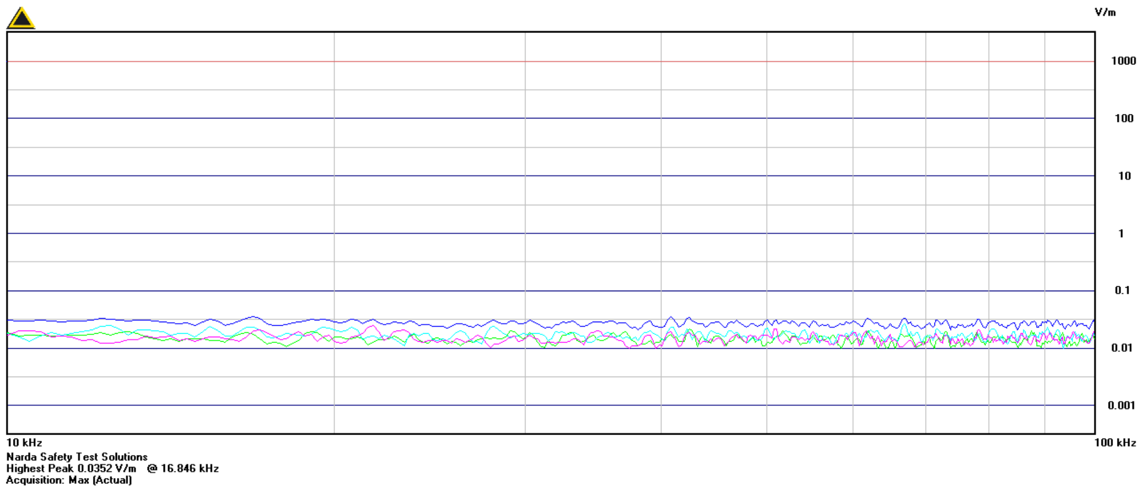

Figure 163: Trinity College Dublin Location B, 10 kHz to 100 kHz (E-Field)

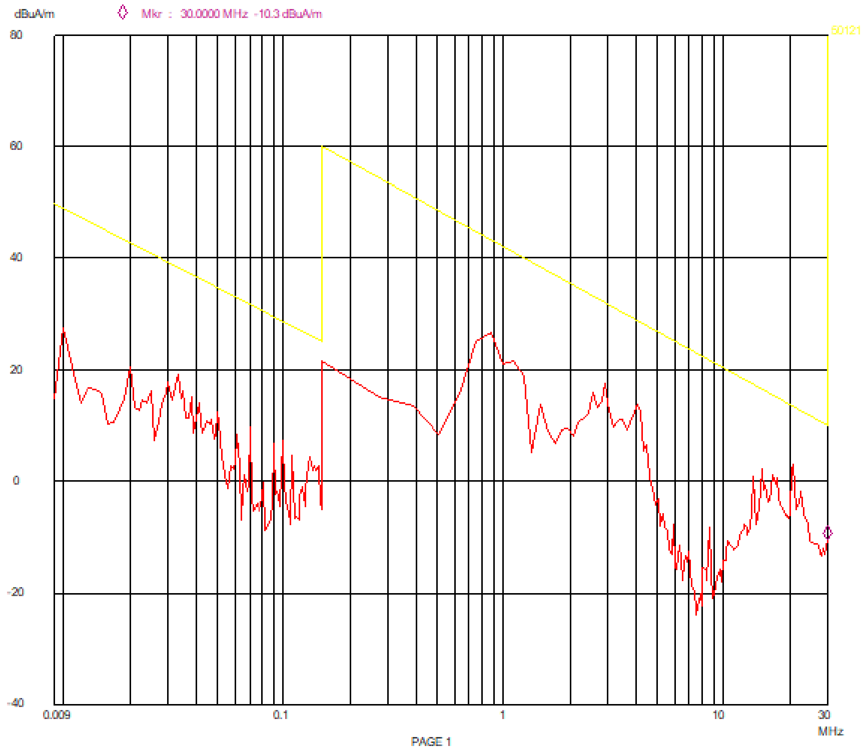

Figure 164: Trinity College Dublin Location B – 9 kHz to 30 MHz

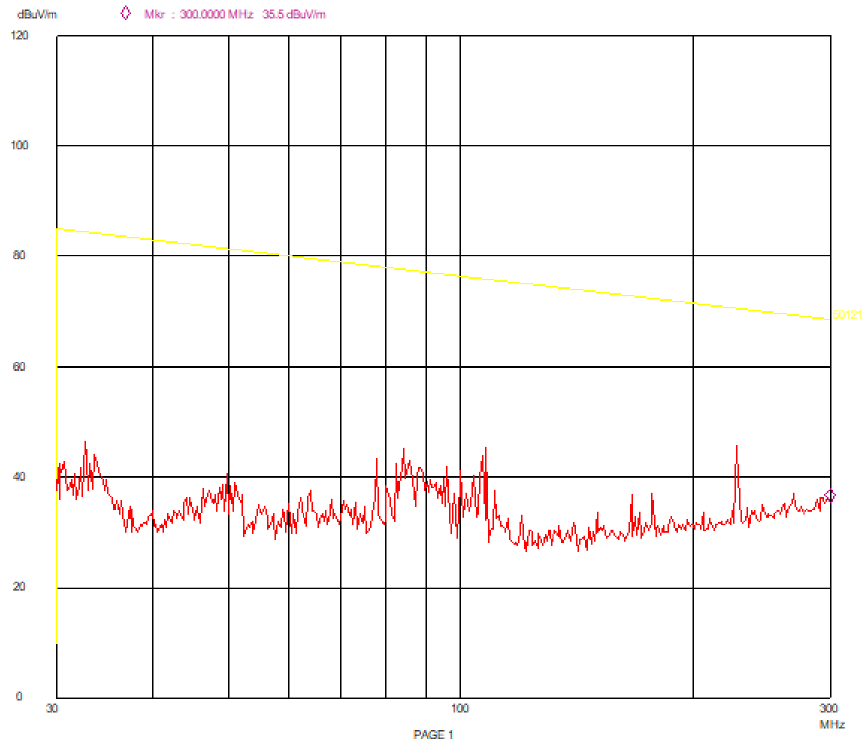

Figure 165: Trinity College Dublin Location B – 30 MHz to 300 MHz

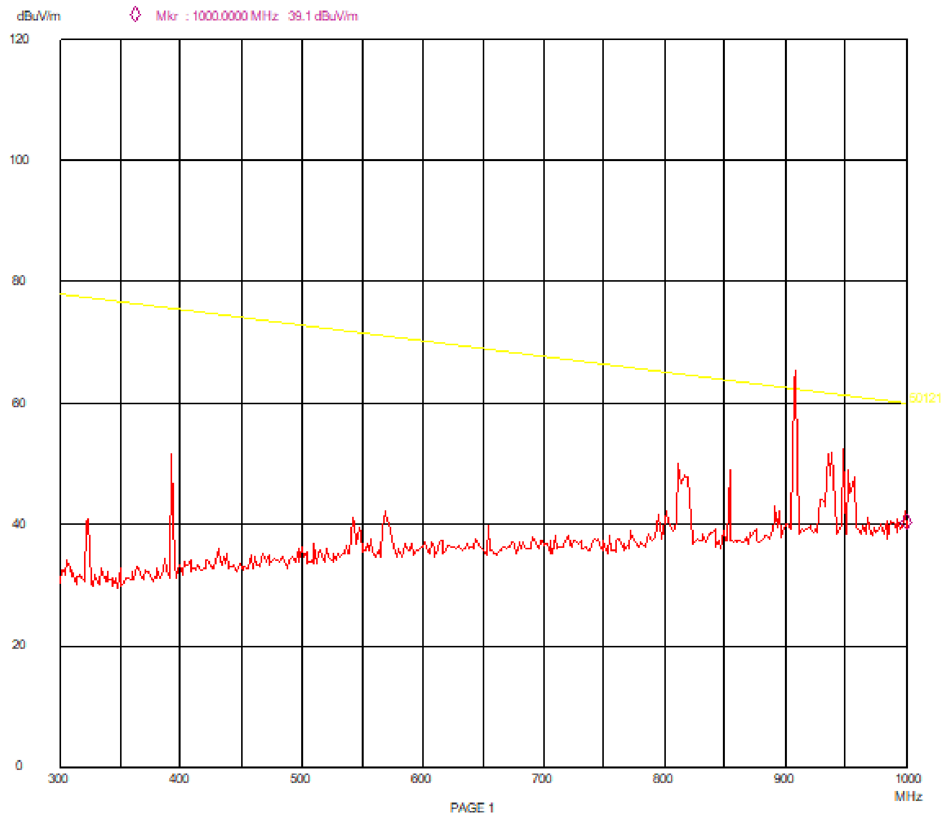

Figure 166: Trinity College Dublin Location B – 300 MHz to 1 GHz

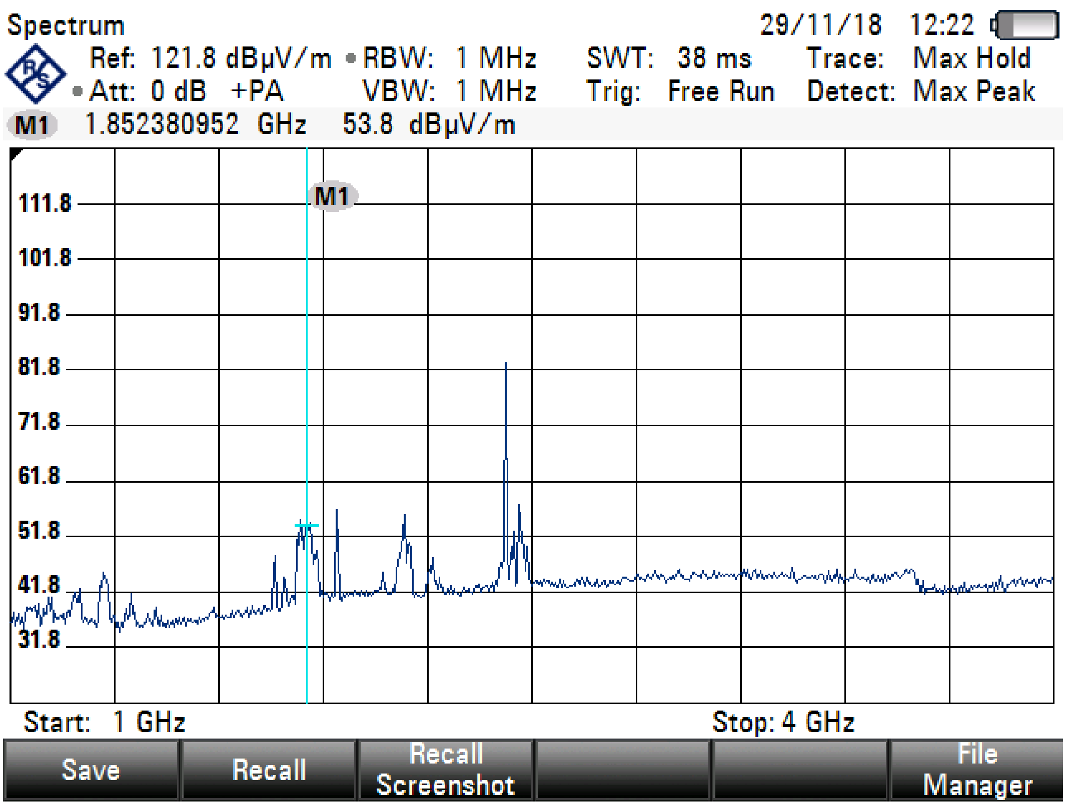

Figure 167: Trinity College Dublin Location B - 1 GHz to 4 GHz

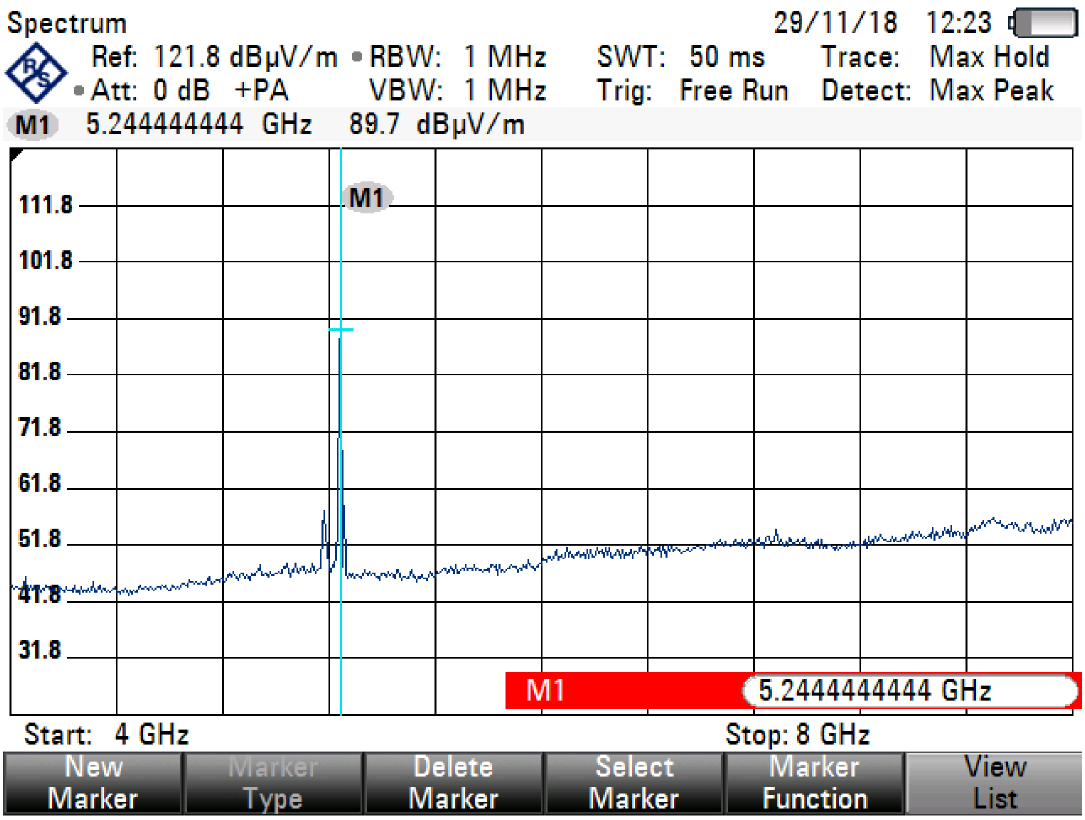

Figure 168: Trinity College Dublin Location B - 4 GHz to 8 GHz

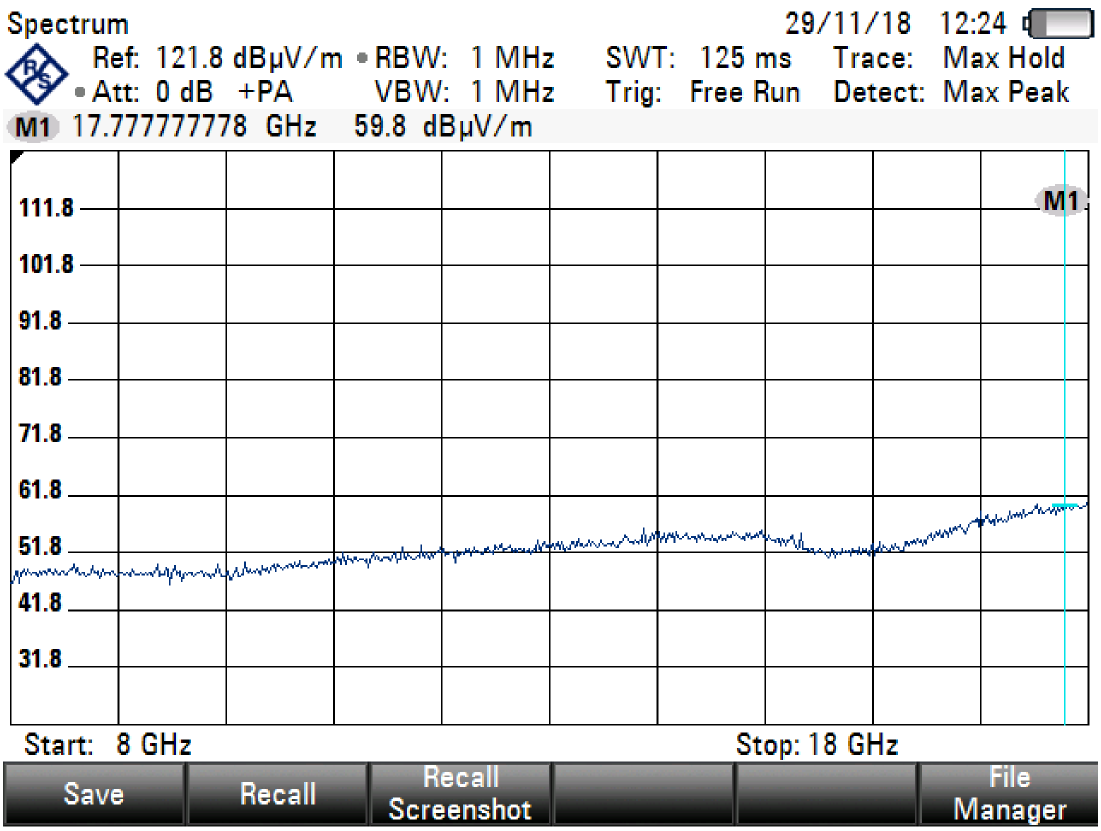

Figure 169: Trinity College Dublin Location B - 8 GHz to 18 GHz

3.9 National Concert Hall EMR Survey

Measurements were performed at the location depicted below -

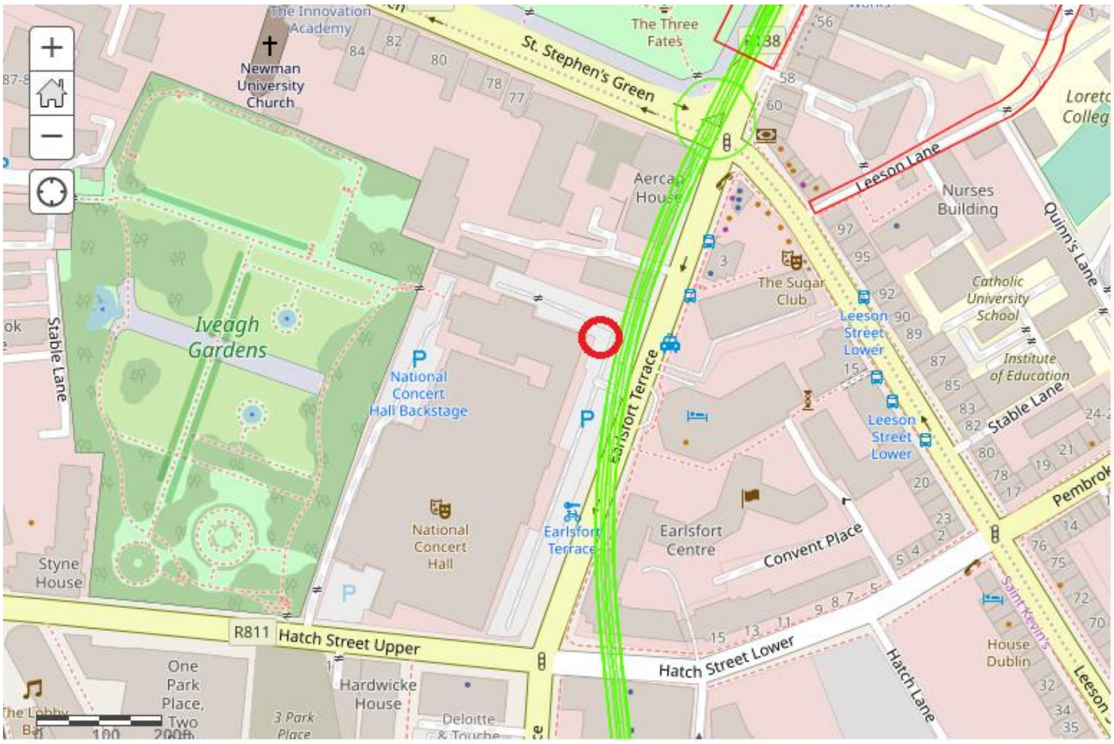

Figure 170: Measurement Location at the National Concert Hall

3.9.1 DC Magnetic Field, National Concert Hall

The Earth's DC magnetic flux density (B) was measured for a period of 22 minutes. The average static field was approximately 44 µT (Figure 171) with maximum fluctuations measured during this time period of up to 0.15 µT.

3.9.2 AC Electric and Magnetic Fields 1 Hz to 10 kHz, National Concert Hall

Figure 173 shows a spectral plot of the magnetic field from DC to 100 Hz. The DC component can be seen to be much higher than any other frequency. The near DC fields (less than 10 Hz) were typically of a magnitude of less than 0.01 µT. A spike at 50 Hz is also evident, which is the transmission frequency for mains electricity. Figure 177 shows the equivalent electric field in this frequency range. Harmonics of the fundamental 50 Hz mains frequency are evident in both the E-Field and M-Field plots from 100 Hz to 1 kHz, occurring at frequencies such as 100 Hz, 150 Hz, 200 Hz with the 3rd and 5th harmonics exceeding 0.01 µT.

3.9.3 Radiated Fields: 10 kHz to 18 GHz, National Concert Hall

There was no evidence, during the measurement and observation time of this study of any transient or intermittent events. The RF emissions profile in this frequency range was well below the typical risk levels of 3 V/m.

At this site the strongest emissions were caused by Analog radio broadcasts (80 – 110 MHz), Digital Radio (147-223 MHz), Tetra Radio (390 MHz), Digital Television Broadcasting (470 – 790 MHz), WiFi (2.4 GHz and 5 GHz), RADAR (2.7-2.9 GHz), FWPMA (3.4-3.6 GHz) and FWALA (10.5 GHz). In terms of mobile technology, the following signals were present, mobile broadband, LTE (791-821 MHz and 925-960 MHz), GSM 900 and 1800 (900 MHz and 1.8 GHz) and 3G (2.1 GHz).

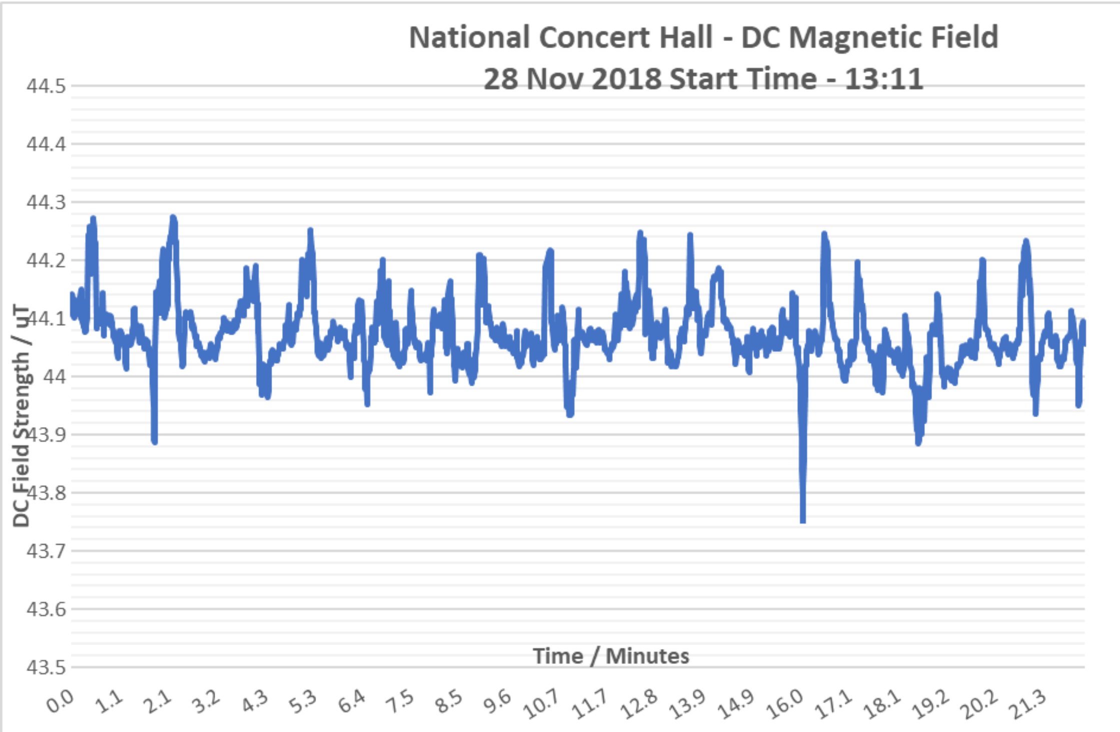

Figure 171: National Concert Hall, DC Magnetic Field

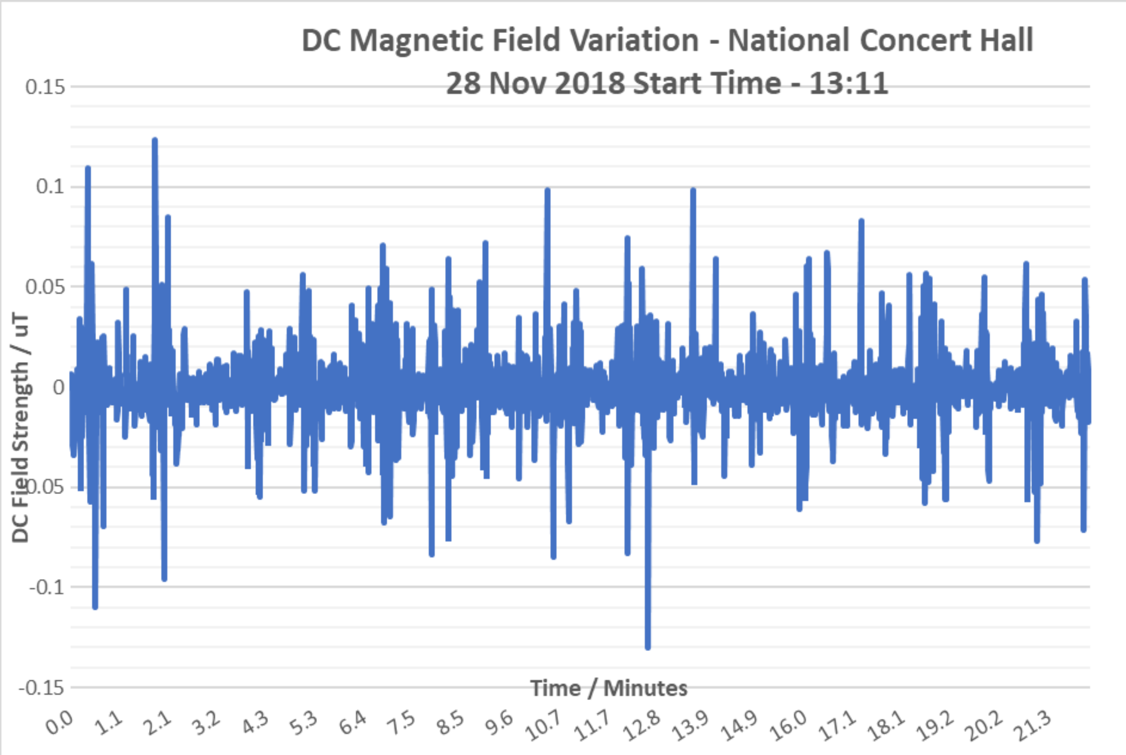

Figure 172: National Concert Hall, DC Magnetic Field variations

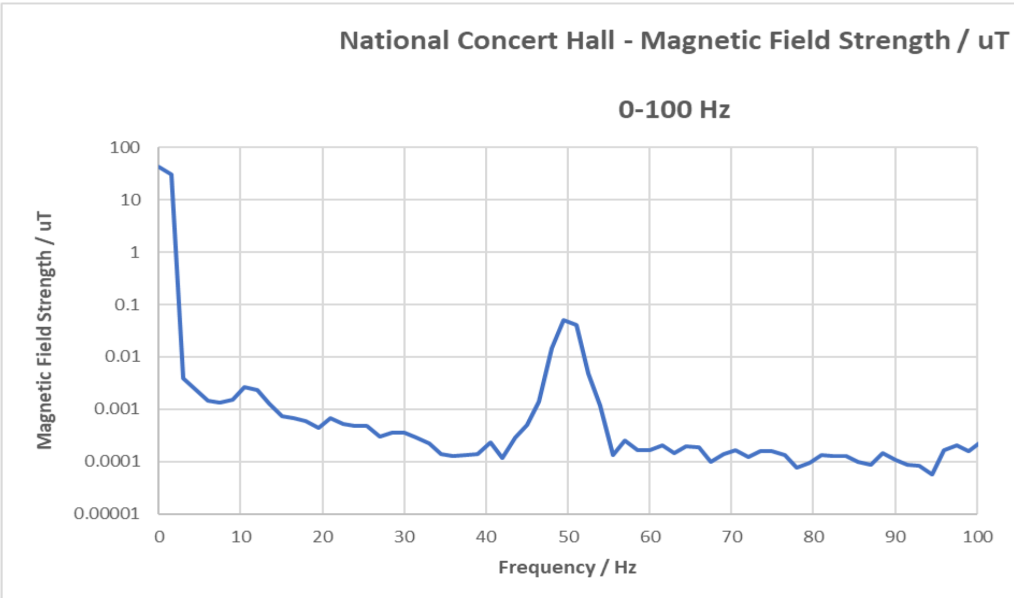

Figure 173: National Concert Hall, 0 Hz to 100 Hz (Mag Field)

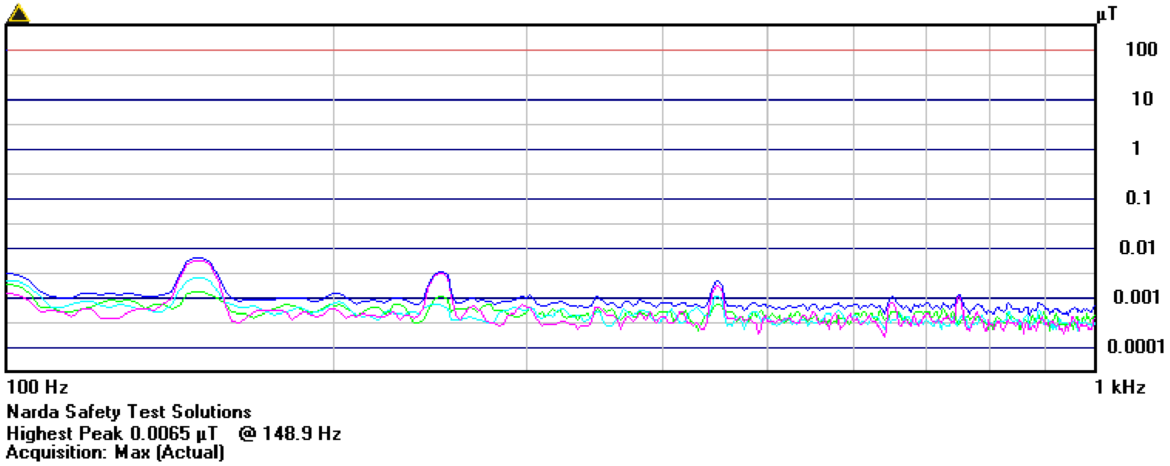

Figure 174: National Concert Hall, 100 Hz to 1 kHz (Mag Field)

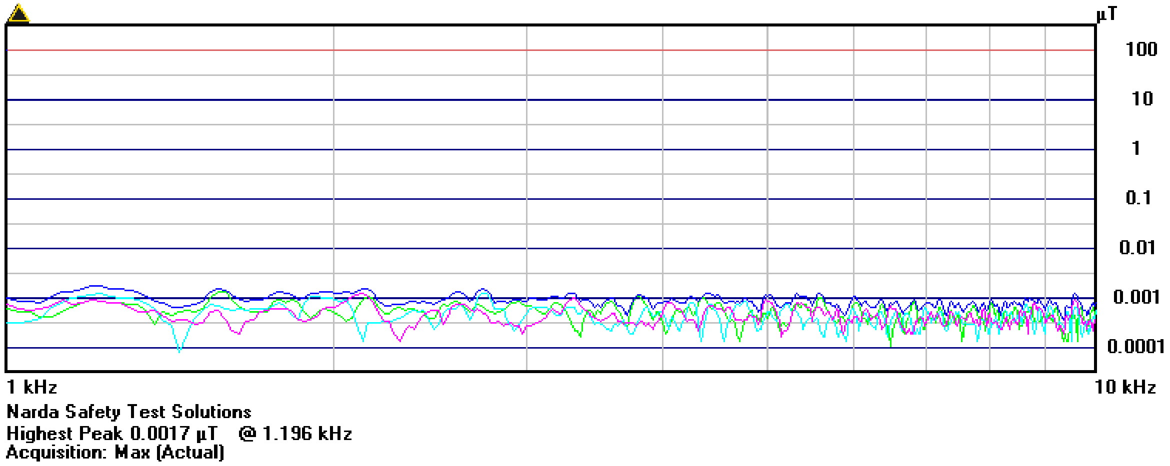

Figure 175: National Concert Hall, 1 kHz to 10 kHz (Mag Field)

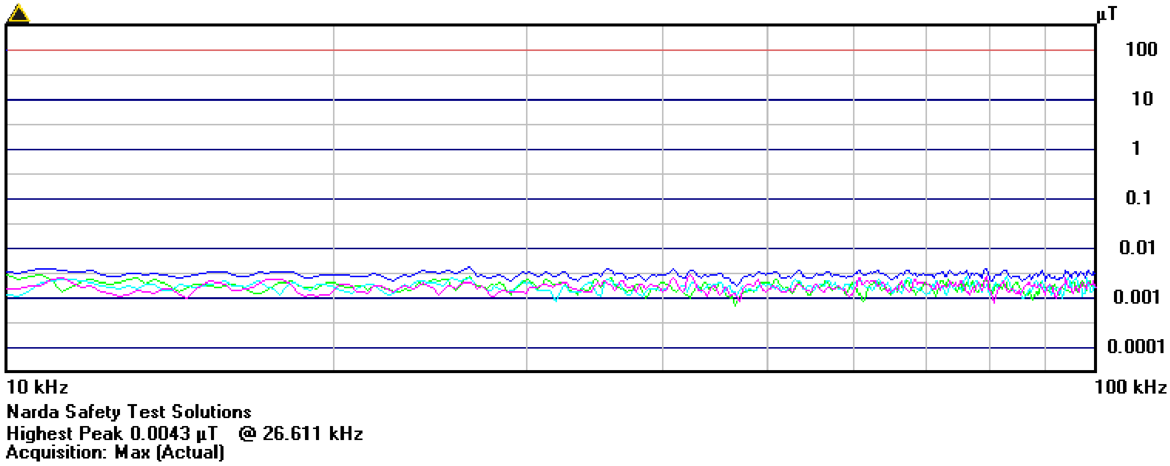

Figure 176: National Concert Hall, 10 kHz to 100 kHz (Mag Field)

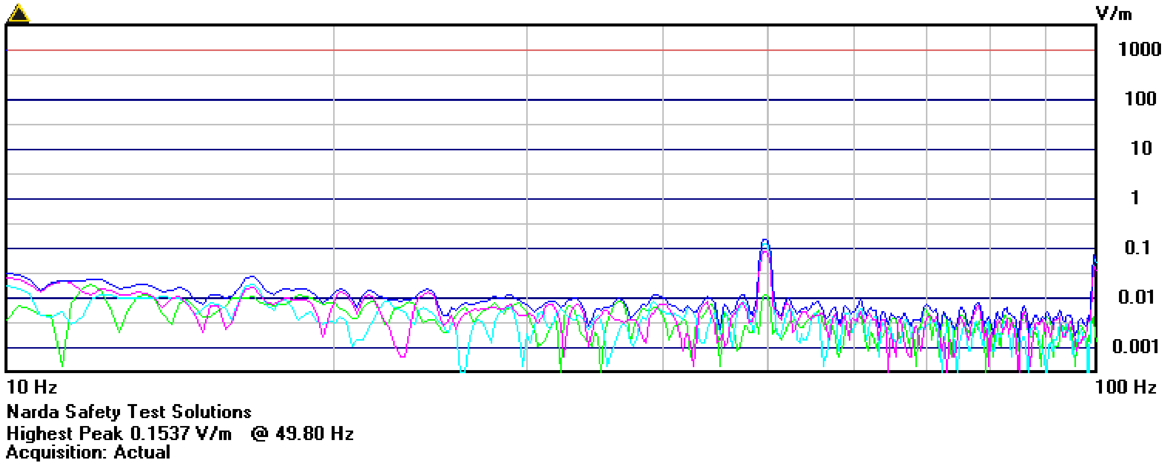

Figure 177: National Concert Hall, 10Hz to 100 Hz (E-Field)

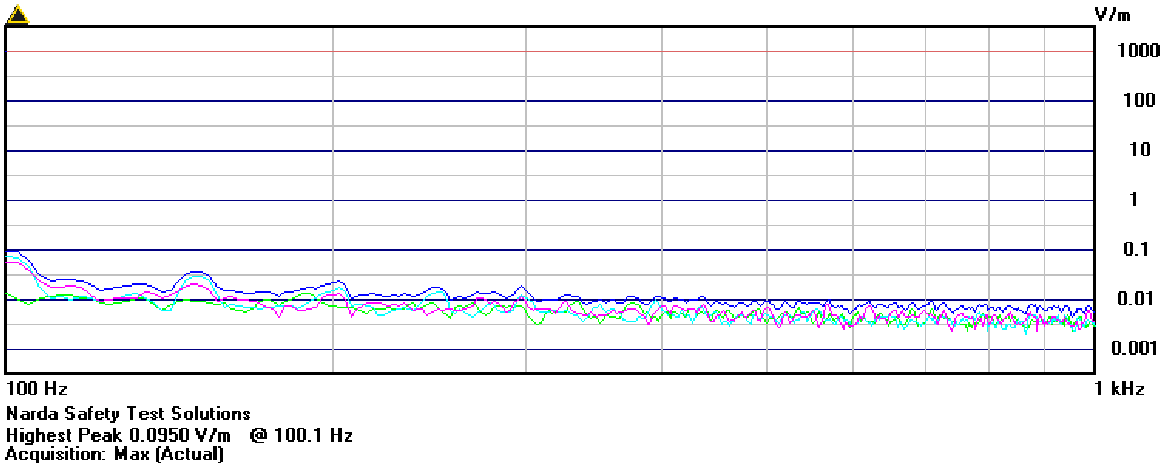

Figure 178: National Concert Hall, 100 Hz to 1 kHz (E-Field)

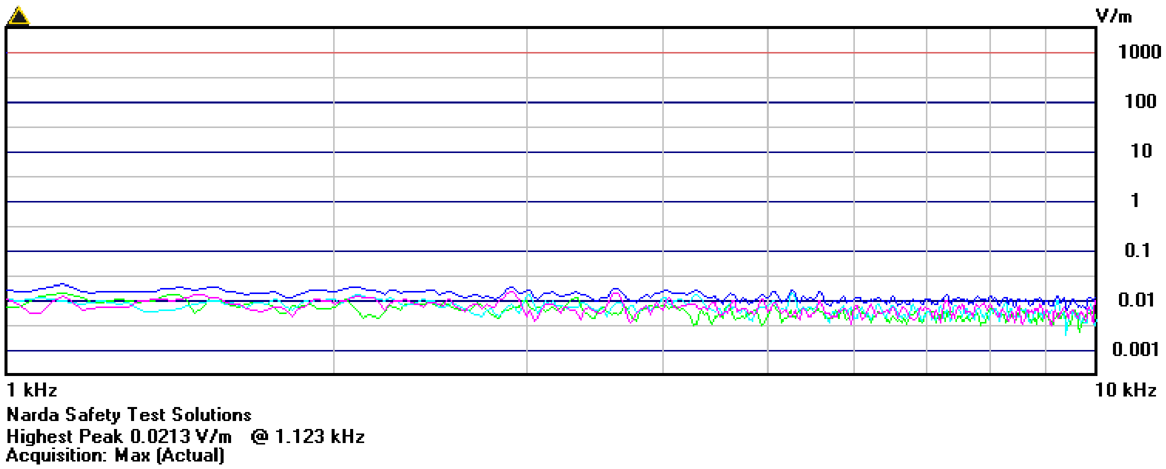

Figure 179: National Concert Hall, 1 kHz to 10 kHz (E-Field)

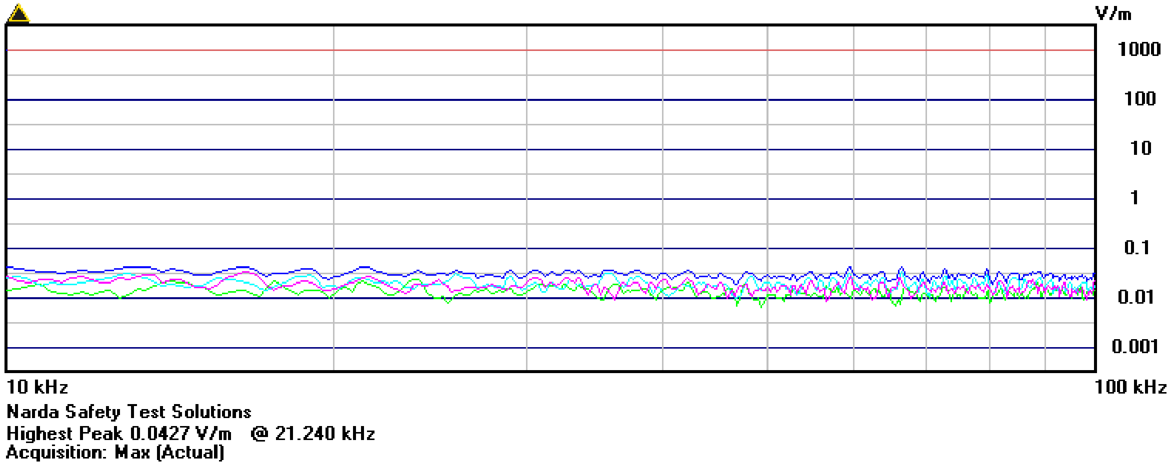

Figure 180: National Concert Hall, 10 kHz to 100 kHz (E-Field)

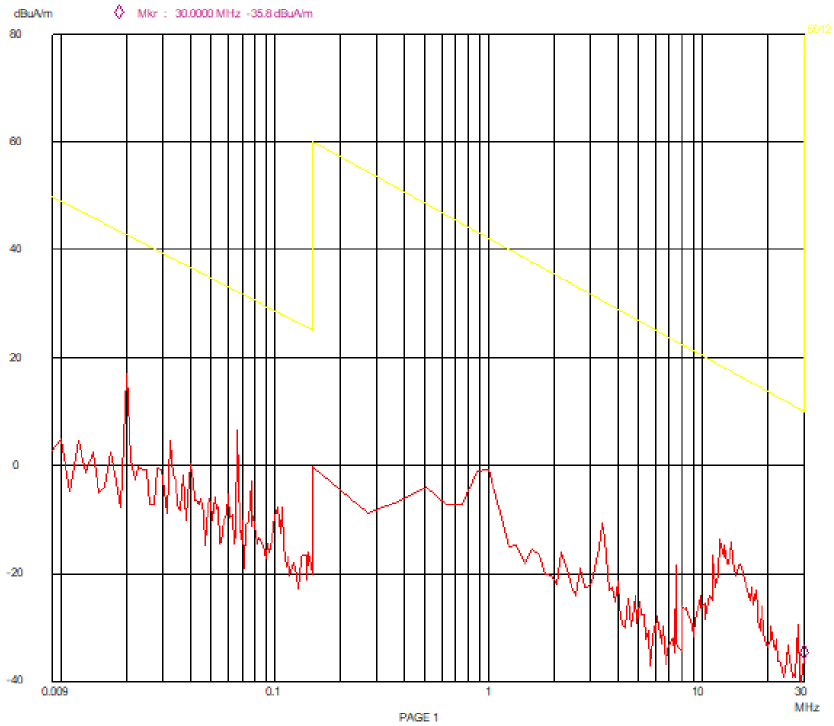

Figure 181: National Concert Hall – 9 kHz to 30 MHz

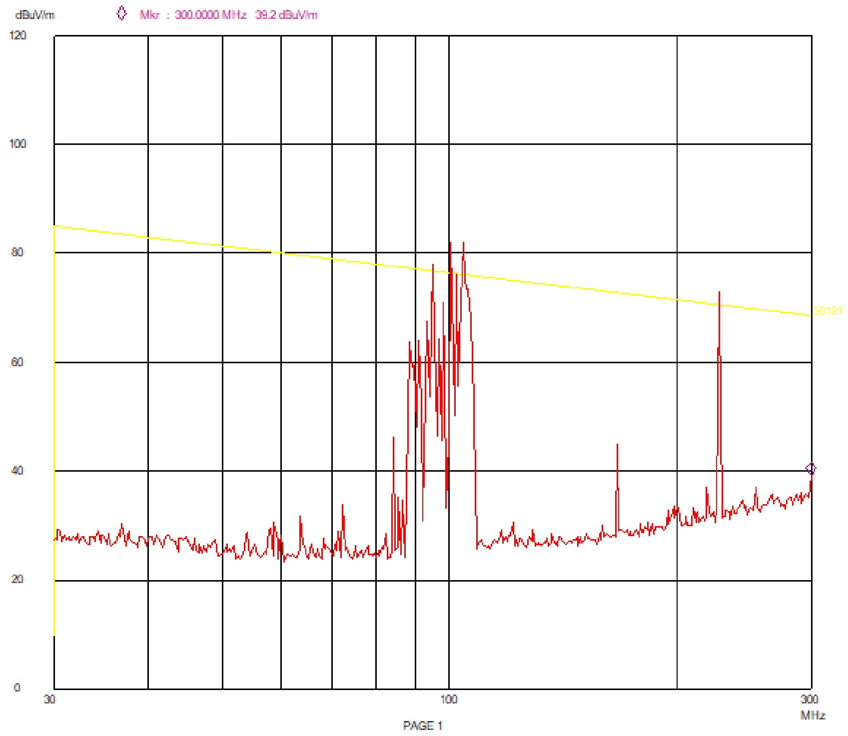

Figure 182: National Concert Hall – 30 MHz to 300 MHz

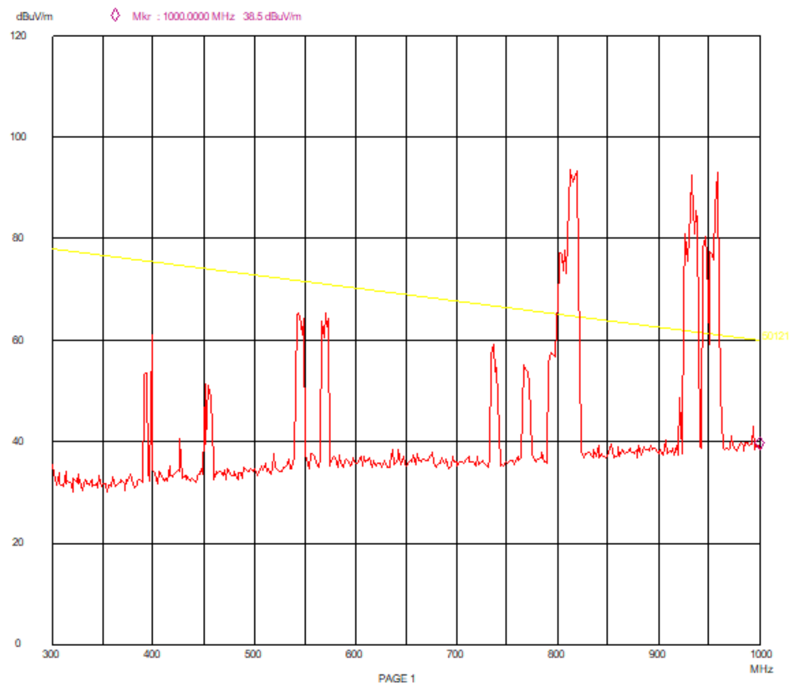

Figure 183: National Concert Hall – 300 MHz to 1 GHz

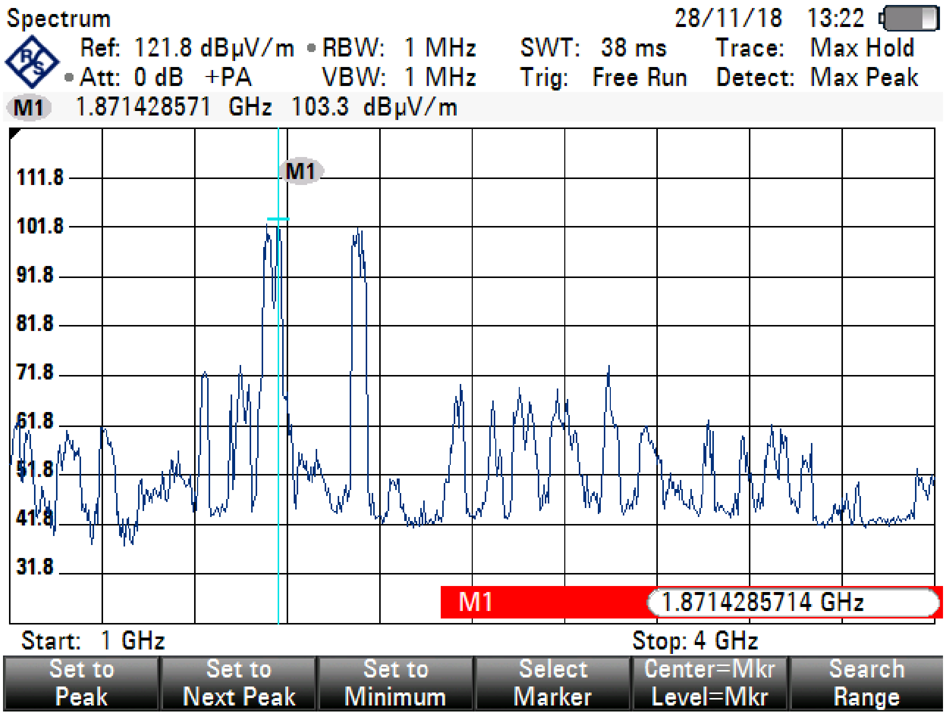

Figure 184: National Concert Hall - 1 GHz to 4 GHz

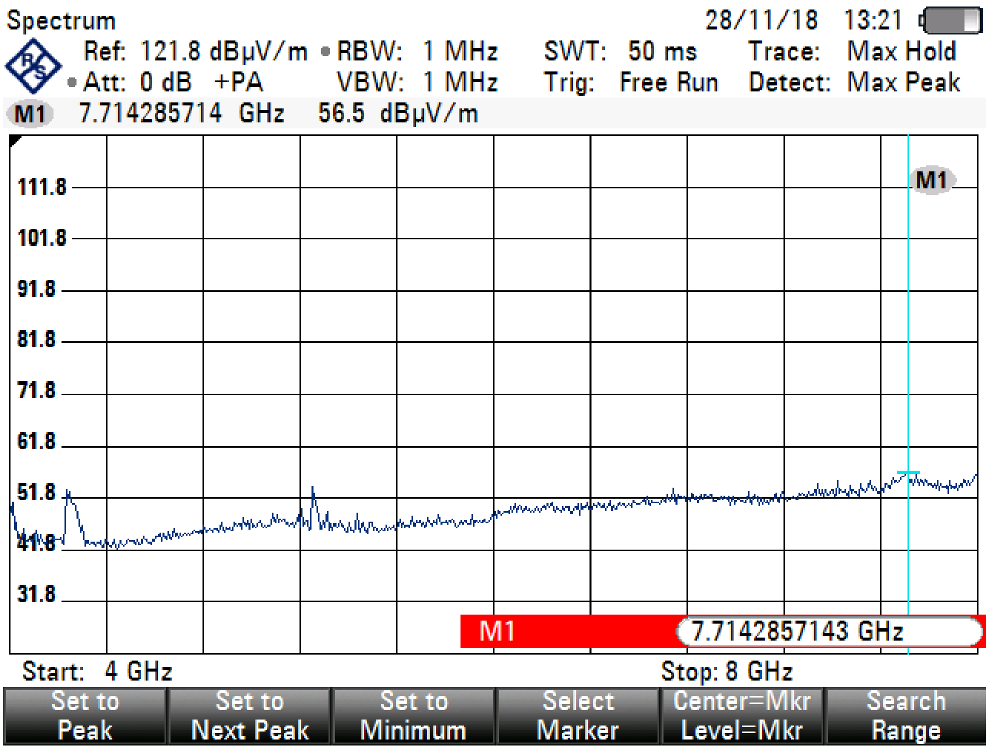

Figure 185: National Concert Hall - 4 GHz to 8 GHz

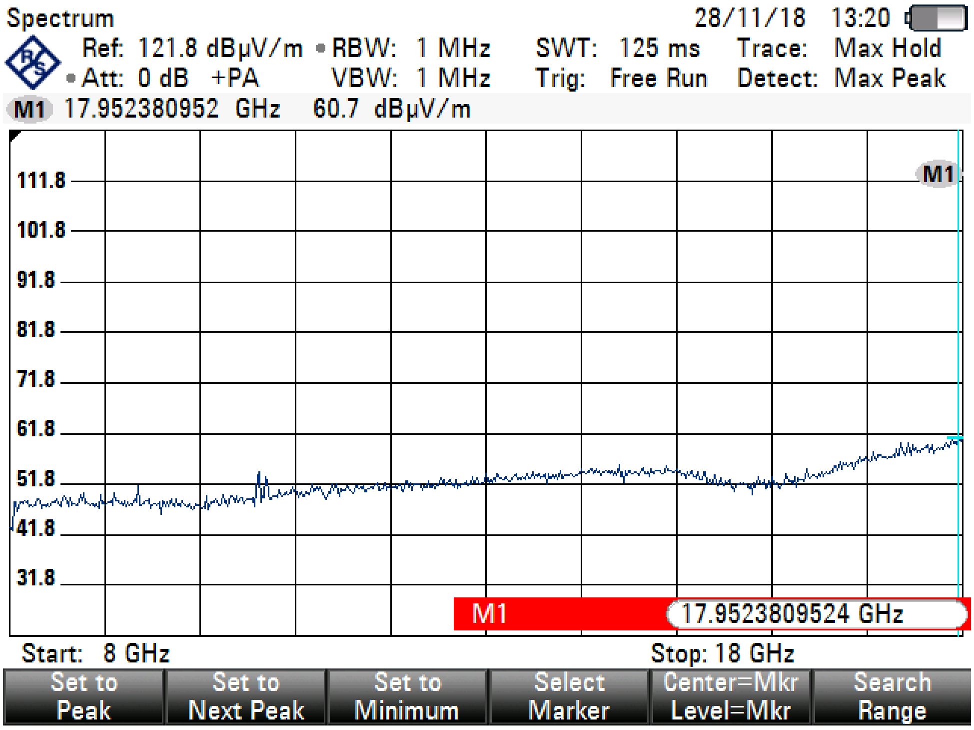

Figure 186: National Concert Hall - 8 GHz to 18 GHz

3.10 Royal Victoria Eye and Ear Hospital EMR Survey

Measurements were performed at the location depicted below -

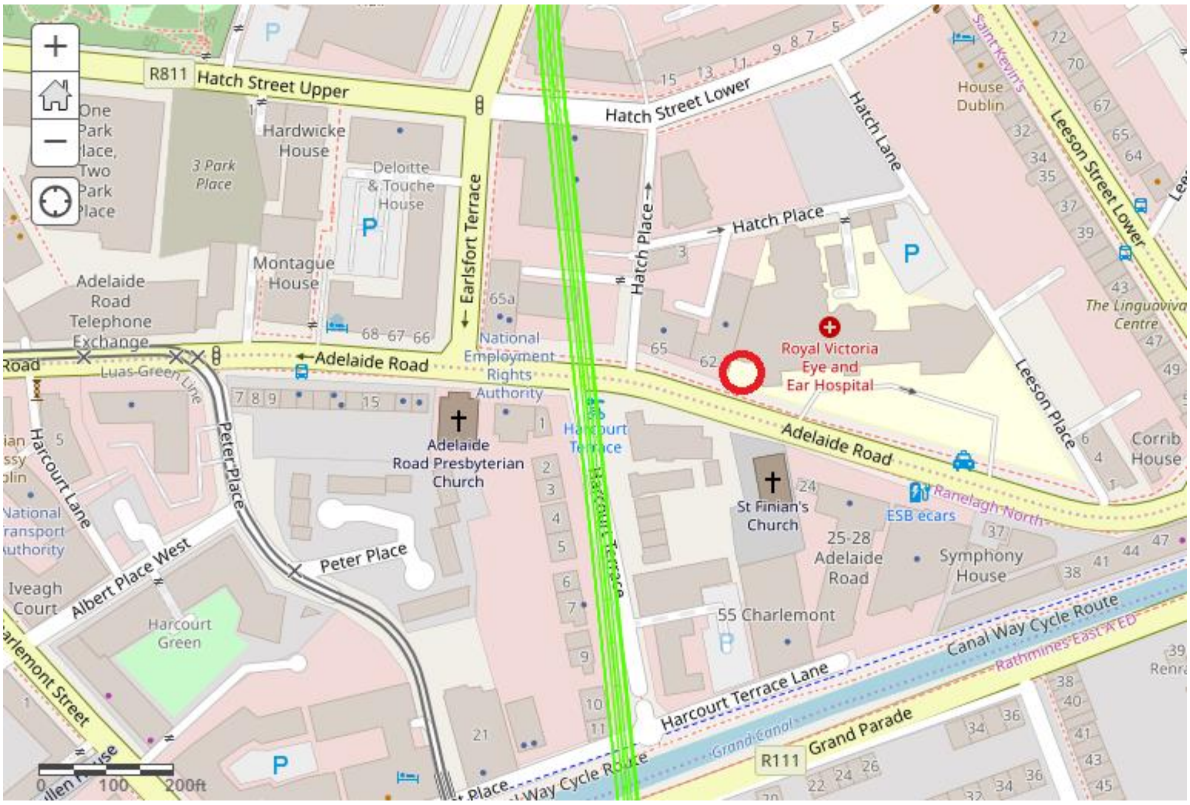

Figure 187: Measurement Location at Royal Victoria Eye and Ear Hospital

3.10.1 DC Magnetic Field, Royal Victoria Eye and Ear Hospital

The Earth's DC magnetic flux density (B) was measured for a period of 24 minutes. The average static field was approximately 47 µT (Figure 188) with maximum fluctuations measured during this time period of up to 0.1 µT.

3.10.2 AC Electric and Magnetic Fields 1 Hz to 10 kHz, Royal Victoria Eye and Ear Hospital

Figure 190 shows a spectral plot of the magnetic field from DC to 100 Hz. The DC component can be seen to be much higher than any other frequency. The near DC fields (less than 10 Hz) were typically of a magnitude of less than 0.01 µT. A spike at 50 Hz is also evident, which is the transmission frequency for mains electricity. Figure 194 shows the equivalent electric field in this frequency range. Harmonics of the fundamental 50 Hz mains frequency are evident in both the E-Field and M-Field plots from 100 Hz to 1 kHz, occurring at frequencies such as 100 Hz, 150 Hz, 200 Hz.

3.10.3 Radiated Fields: 10 kHz to 18 GHz, Royal Victoria Eye and Ear Hospital

There was no evidence, during the measurement and observation time of this study of any transient or intermittent events. The RF emissions profile in this frequency range was well below the typical risk levels of 3 V/m.

At this site the strongest emissions were caused by Analog radio broadcasts (80 – 110 MHz), Digital Radio (147-223 MHz), Tetra Radio (390 MHz), Digital Television Broadcasting (470 – 790 MHz), WiFi (2.4 GHz and 5 GHz), RADAR (2.7-2.9 GHz) and FWPMA (3.4-3.6 GHz). In terms of mobile technology, the following signals were present, mobile broadband, LTE (791-821 MHz and 925-960 MHz), GSM 900 and 1800 (900 MHz and 1.8 GHz) and 3G (2.1 GHz).

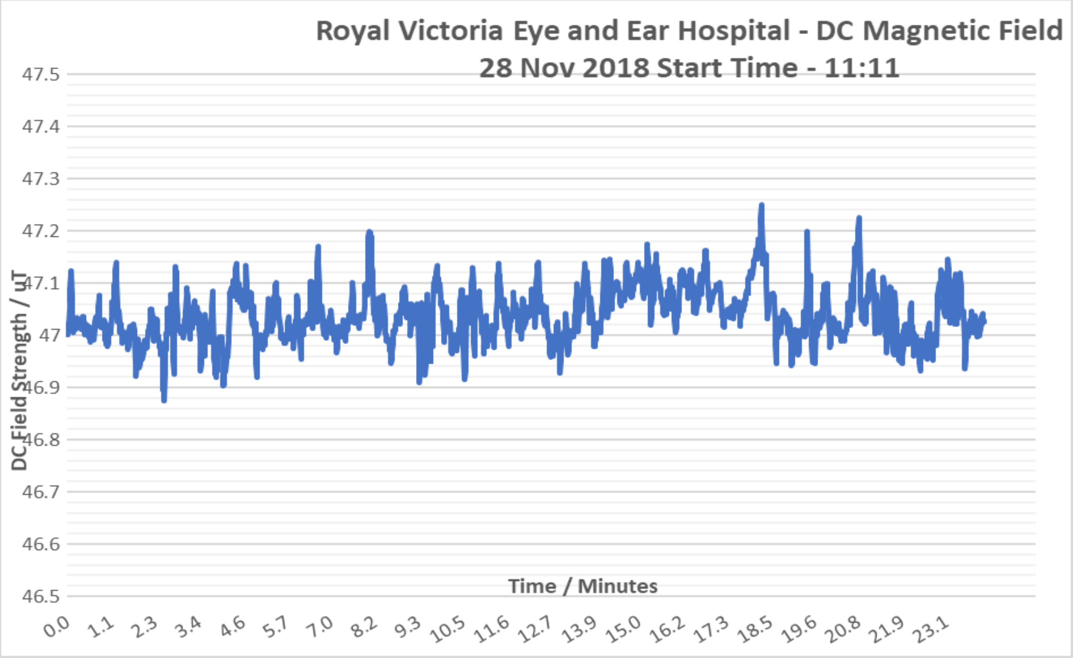

Figure 188: Royal Victoria Eye and Ear Hospital, DC Magnetic Field

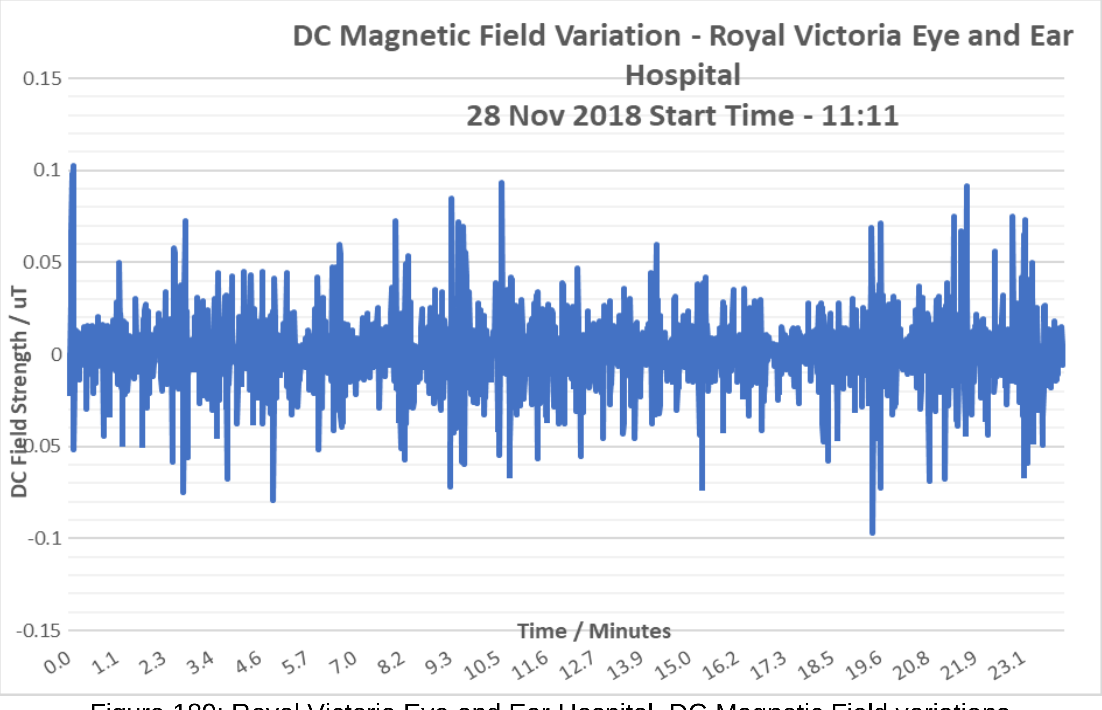

Figure 189: Royal Victoria Eye and Ear Hospital, DC Magnetic Field variations

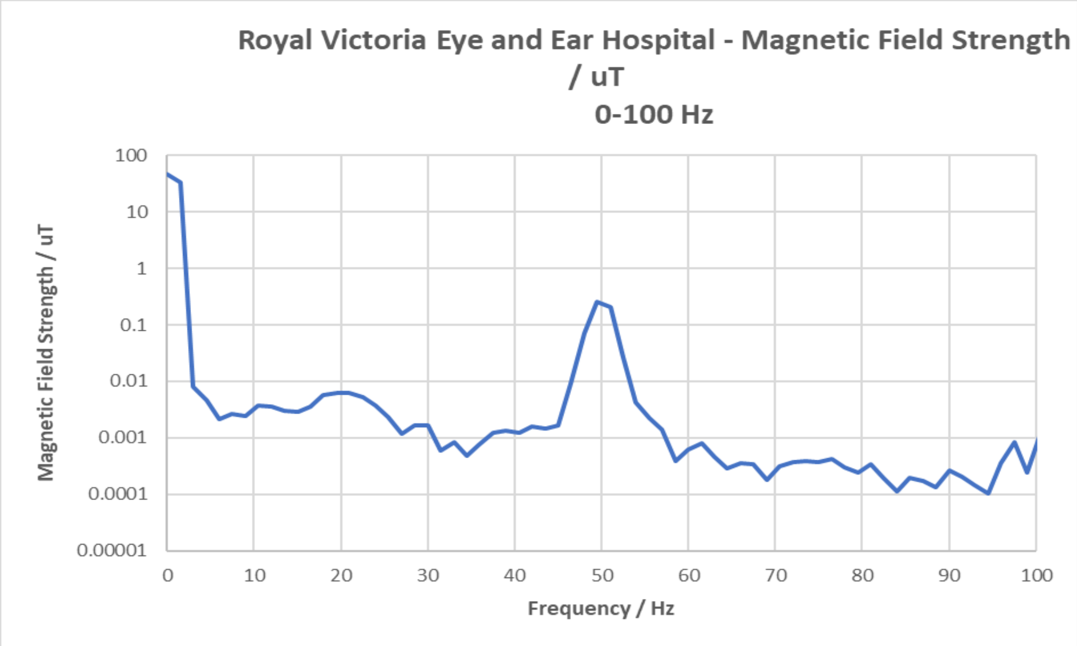

Figure 190: Royal Victoria Eye and Ear Hospital, 0 Hz to 100 Hz (Mag Field)

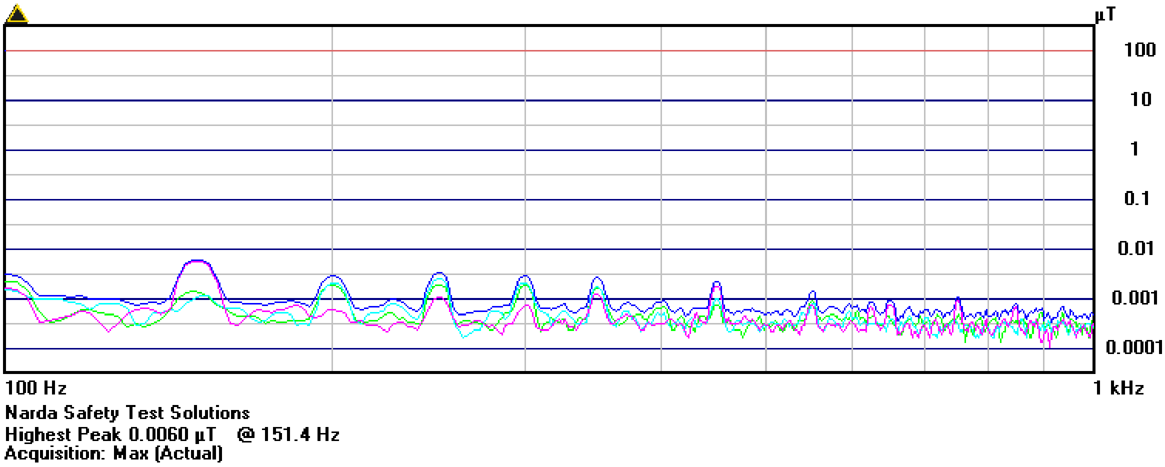

Figure 191: Royal Victoria Eye and Ear Hospital, 100 Hz to 1 kHz (Mag Field)

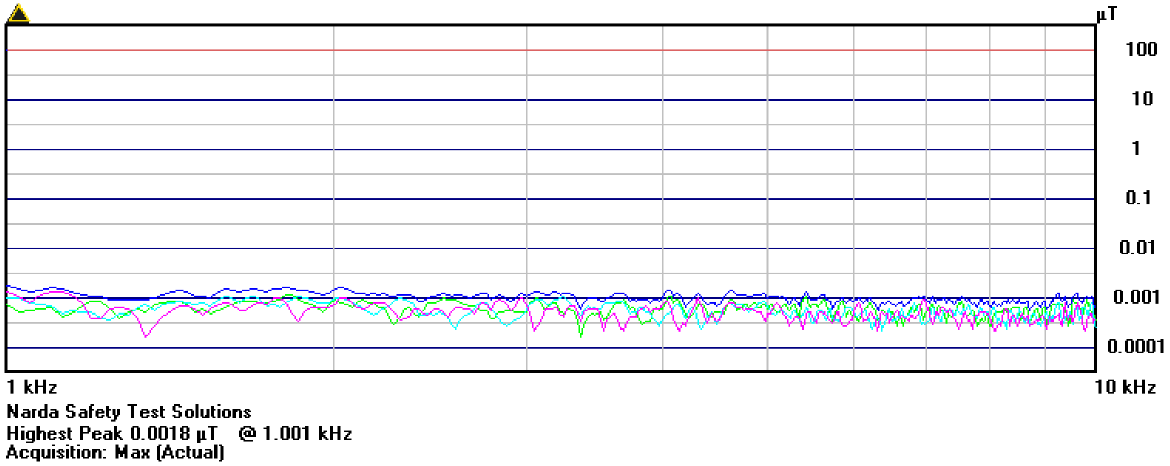

Figure 192: Royal Victoria Eye and Ear Hospital, 1 kHz to 10 kHz (Mag Field)

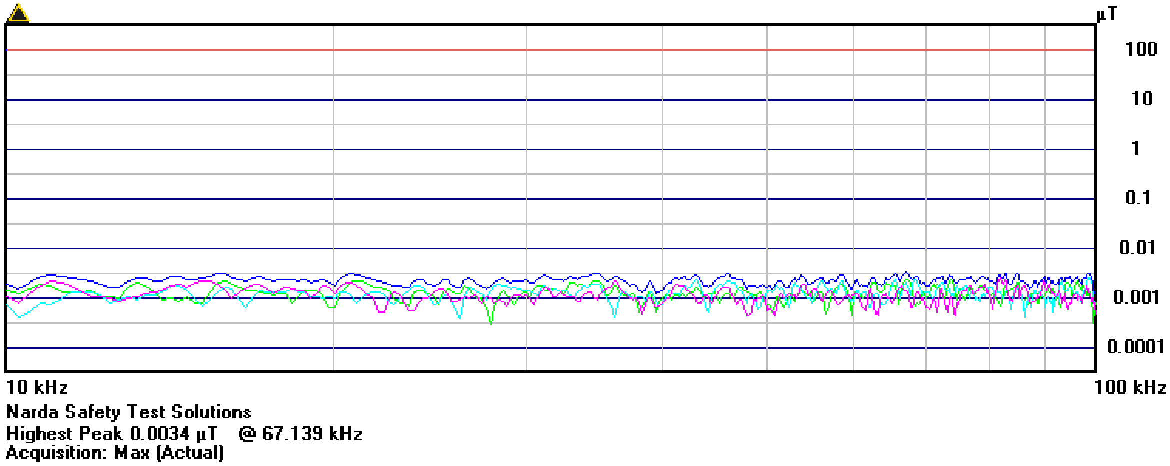

Figure 193: Royal Victoria Eye and Ear Hospital, 10 kHz to 100 kHz (Mag Field)

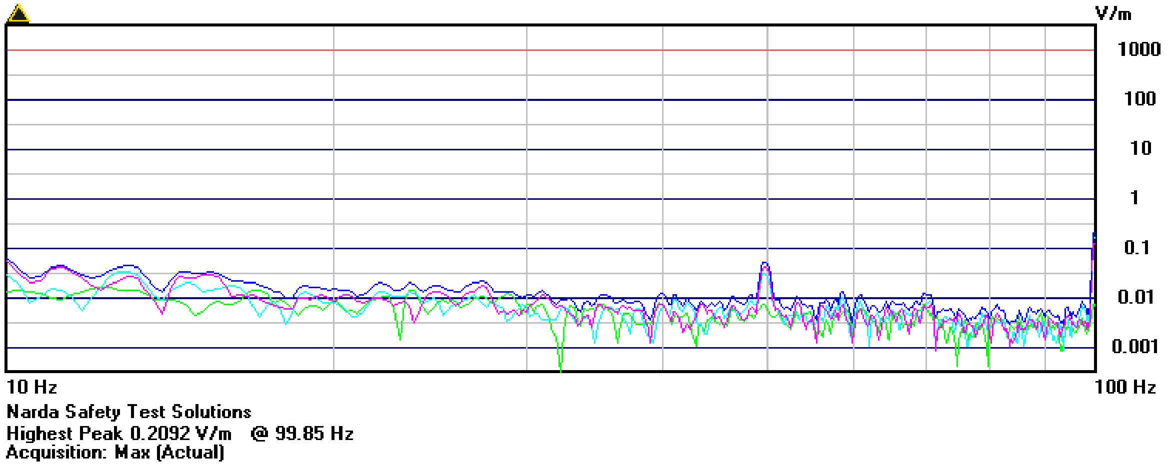

Figure 194: Royal Victoria Eye and Ear Hospital, 10Hz to 100 Hz (E-Field)

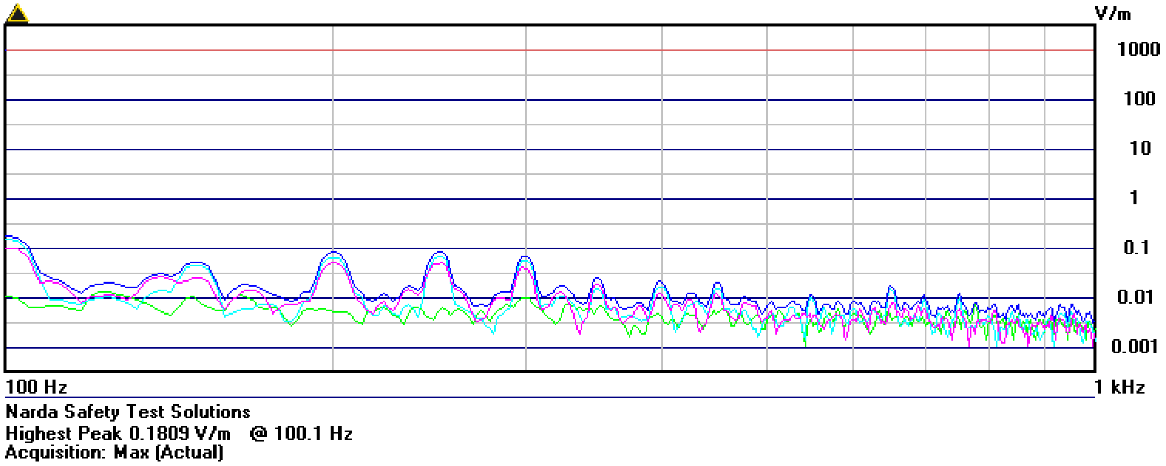

Figure 195: Royal Victoria Eye and Ear Hospital, 100 Hz to 1 kHz (E-Field)

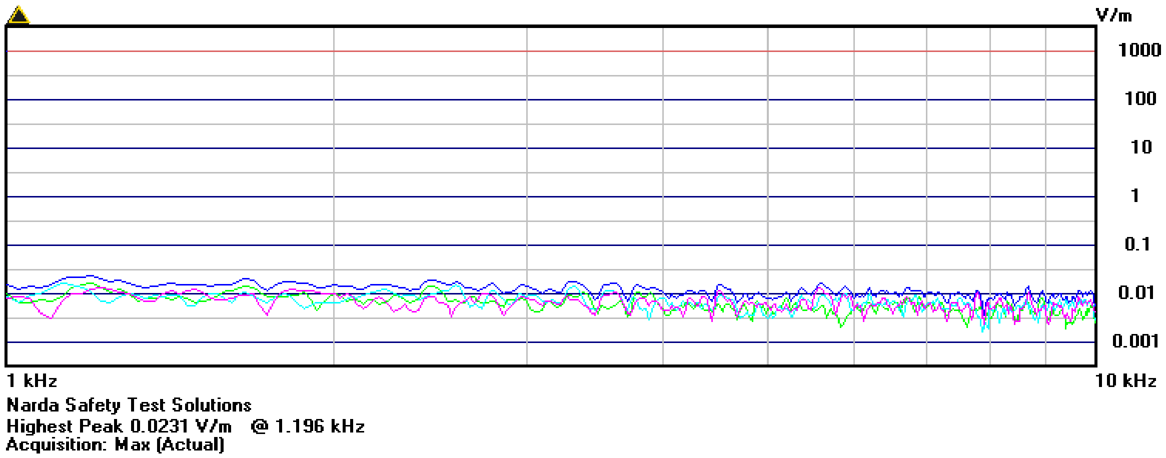

Figure 196: Royal Victoria Eye and Ear Hospital, 1 kHz to 10 kHz (E-Field)

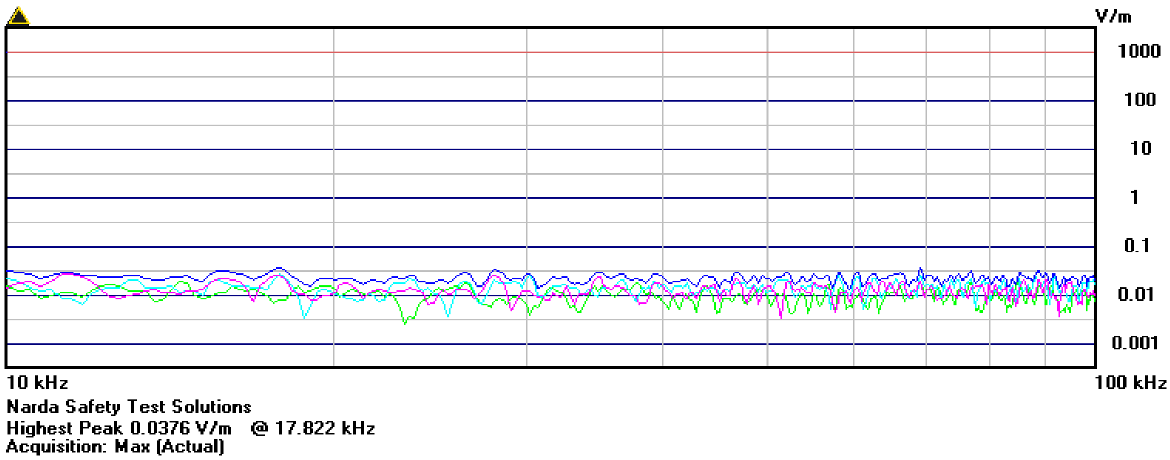

Figure 197: Royal Victoria Eye and Ear Hospital, 10 kHz to 100 kHz (E-Field)

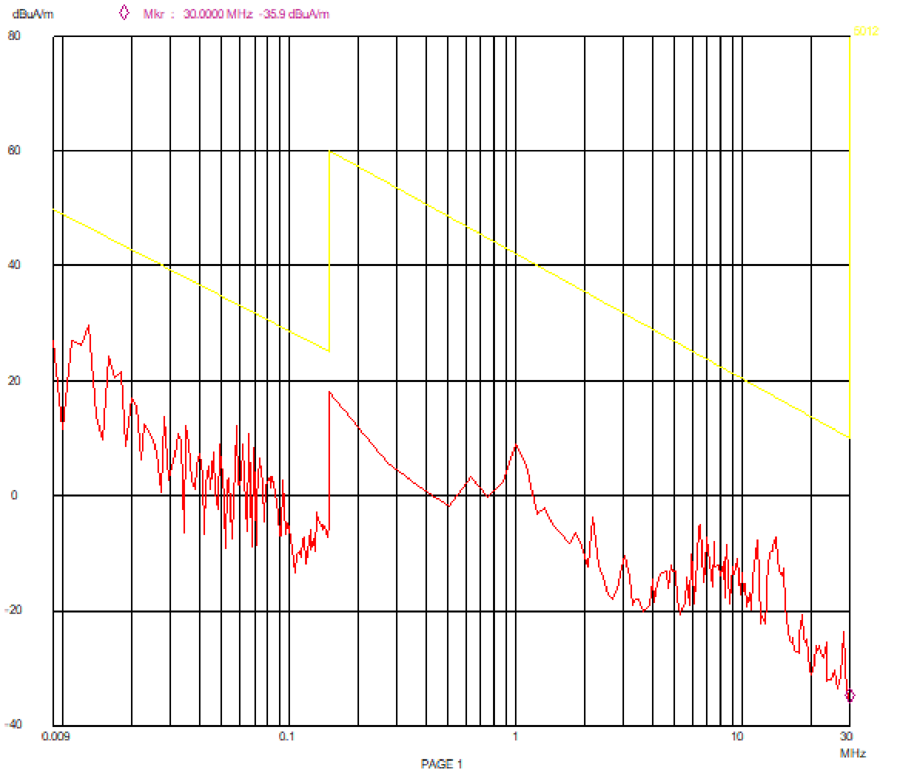

Figure 198: Royal Victoria Eye and Ear Hospital – 9 kHz to 30 MHz

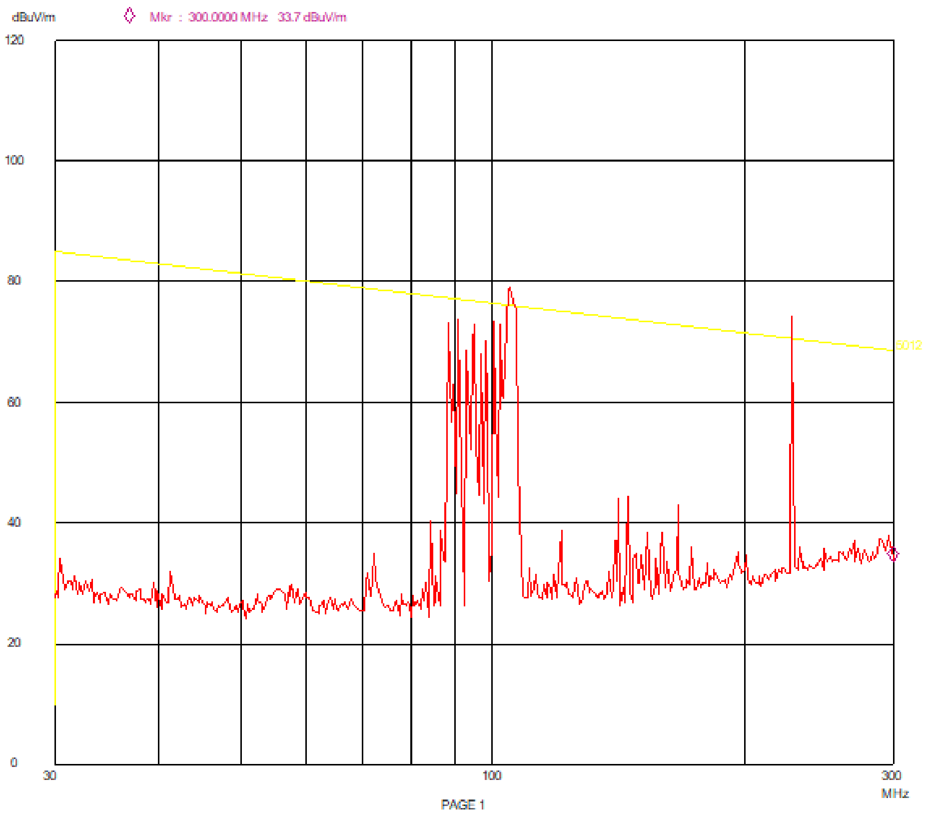

Figure 199: Royal Victoria Eye and Ear Hospital – 30 MHz to 300 MHz

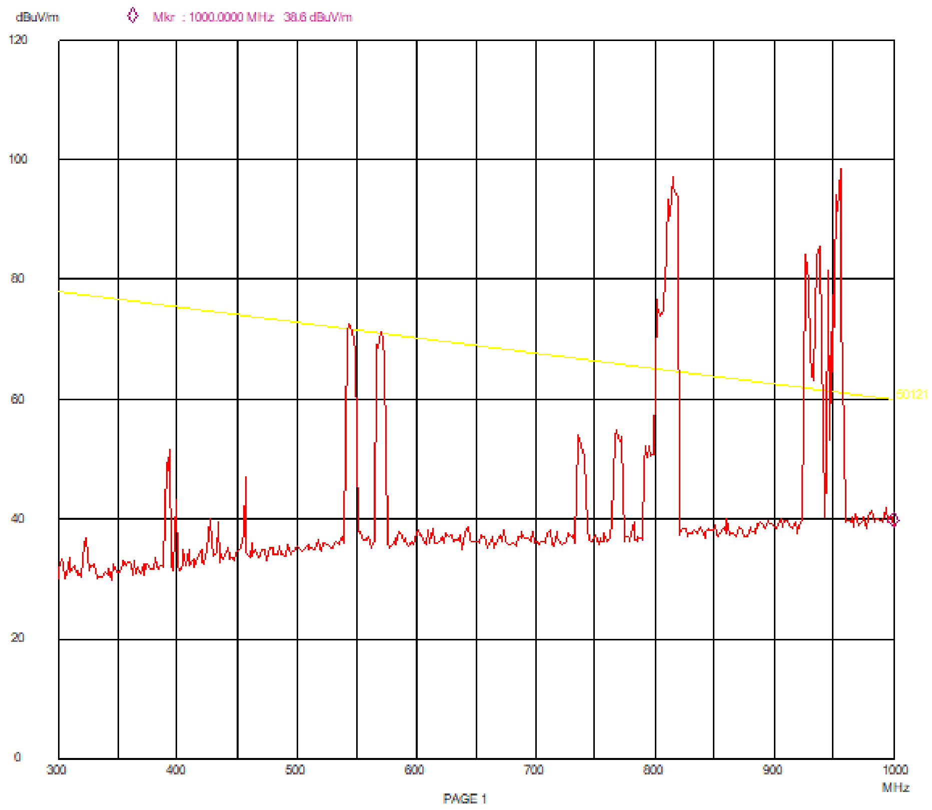

Figure 200: Royal Victoria Eye and Ear Hospital – 300 MHz to 1 GHz

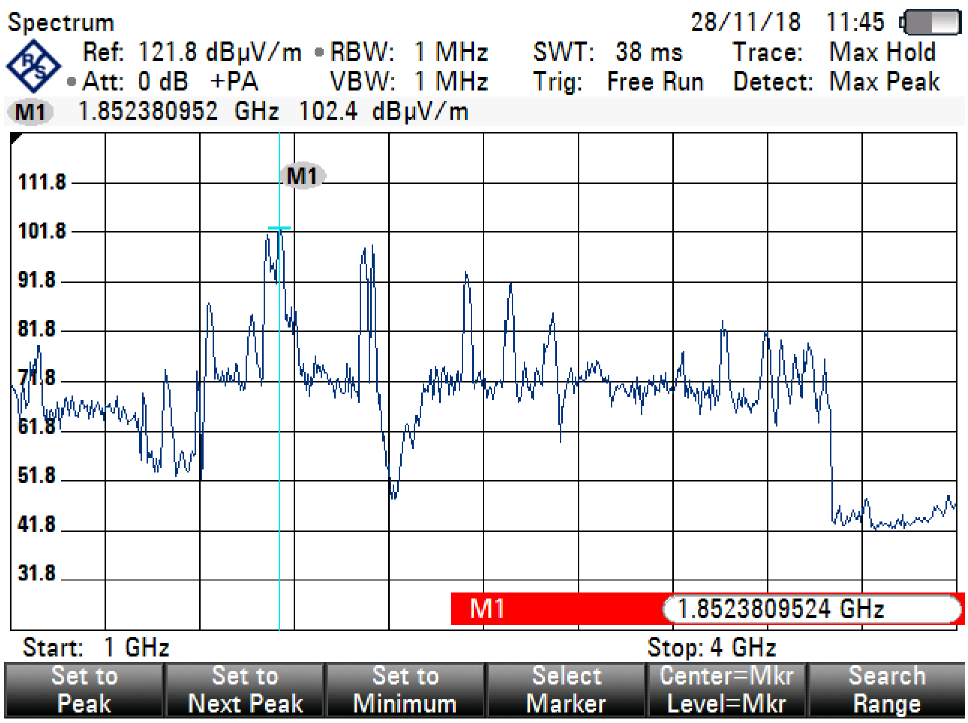

Figure 201: Royal Victoria Eye and Ear Hospital - 1 GHz to 4 GHz

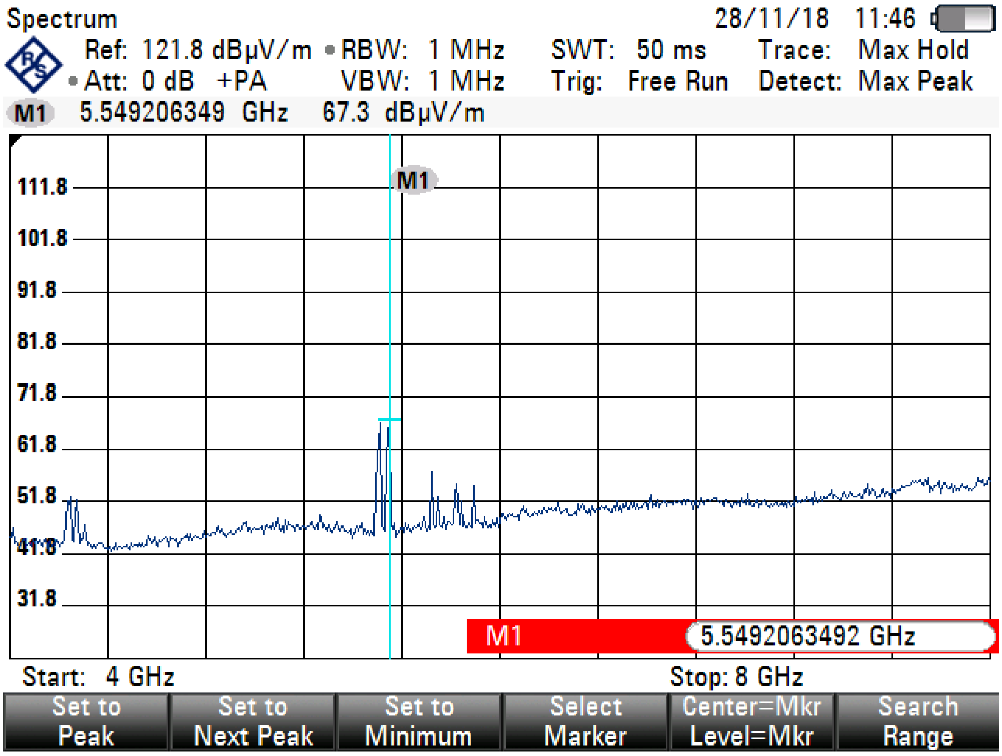

Figure 202: Royal Victoria Eye and Ear Hospital - 4 GHz to 8 GHz

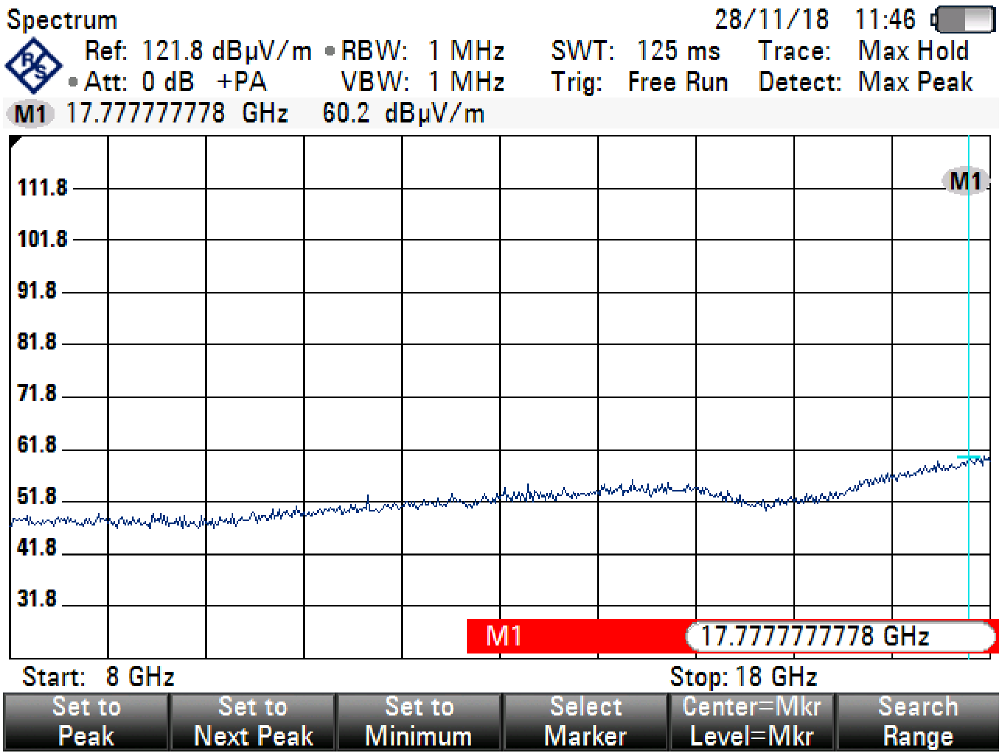

Figure 203: Royal Victoria Eye and Ear Hospital - 8 GHz to 18 GHz

3.11 Naul Road (Substation 1 location) EMR Survey

Measurements were performed at the location depicted below -

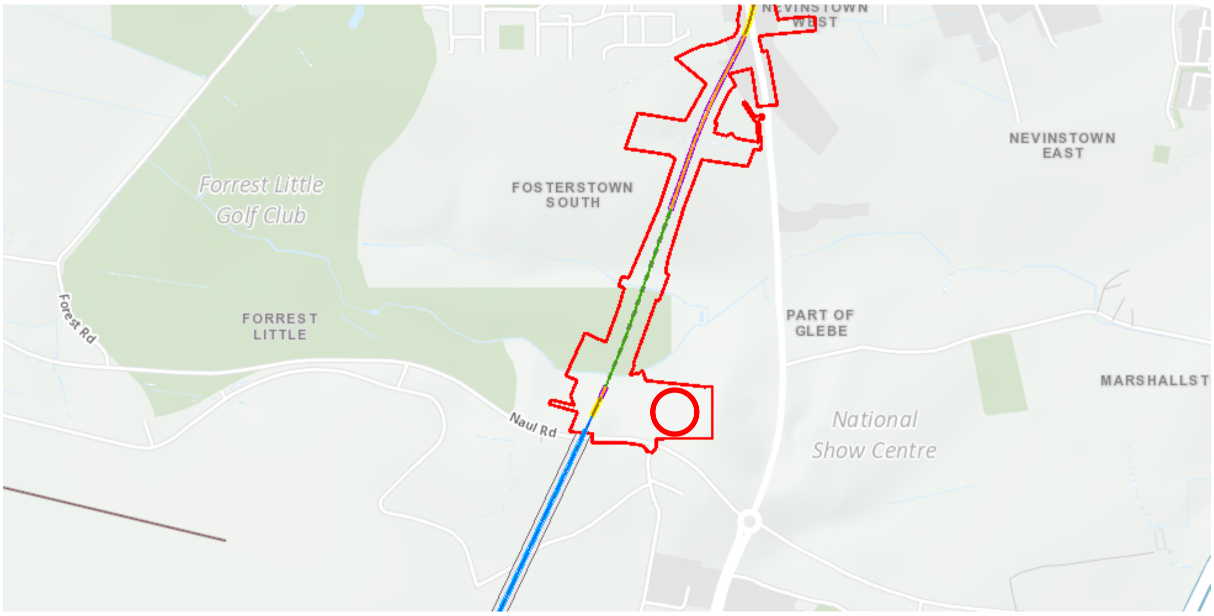

Figure 204: Measurement Location for Substation 1 – Naul Road

3.11.1 DC Magnetic Field, Naul Road

The Earth's DC magnetic flux density (B) was measured for a period of 30 minutes. The average static field was approximately 49.9 µT (Figure 205) with maximum fluctuations of 0.03 µT.

3.11.2 AC Electric and Magnetic Fields 1 Hz to 10 kHz, Naul Road

Figure 207 shows a spectral plot of the magnetic field from DC to 100 Hz. The DC component can be seen to be much higher than any other frequency. The near DC fields (less than 10 Hz) were typically of a magnitude of less than 0.001 µT. The 50 Hz field was notable in this range due to the close proximity of an overhead power line passing near the measurement location (10 metres approximately). Figure 211 shows the equivalent electric field at 50 Hz with harmonics associated with the transmission line evident at higher frequencies (100 Hz and above) .

3.11.3 Radiated Fields: 10 kHz to 18 GHz, Naul Road

There was no evidence, during the measurement and observation time of this study of any transient or intermittent events. The RF emissions profile in this frequency range was well below the typical risk levels of 3 V/m.

At this site the strongest emissions were caused by Analog radio broadcasts (80 – 110 MHz), Digital Radio (147-223 MHz), Tetra Radio (390 MHz), Digital Television Broadcasting (470 – 790 MHz), RADAR (2.7-2.9 GHz and 5.6 GHz) and FWPMA (3.4-3.6 GHz), with the detection of RADAR signifying the proximity of the site to Dublin Airport In terms of mobile technology, the following signals were present, mobile broadband, LTE (791-821 MHz and 925-960 MHz), GSM 900 and 1800 (900 MHz and 1.8 GHz) and 3G (2.1 GHz).

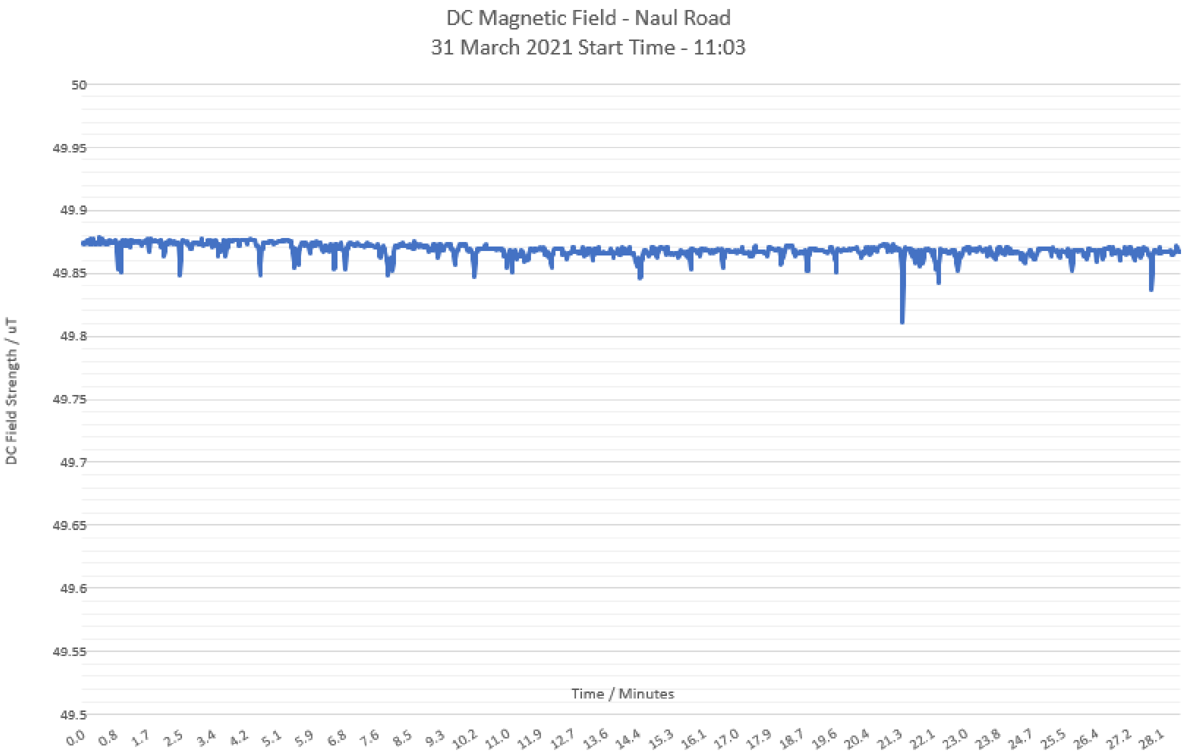

Figure 205: Naul Road (Substation 1 location), DC Magnetic Field

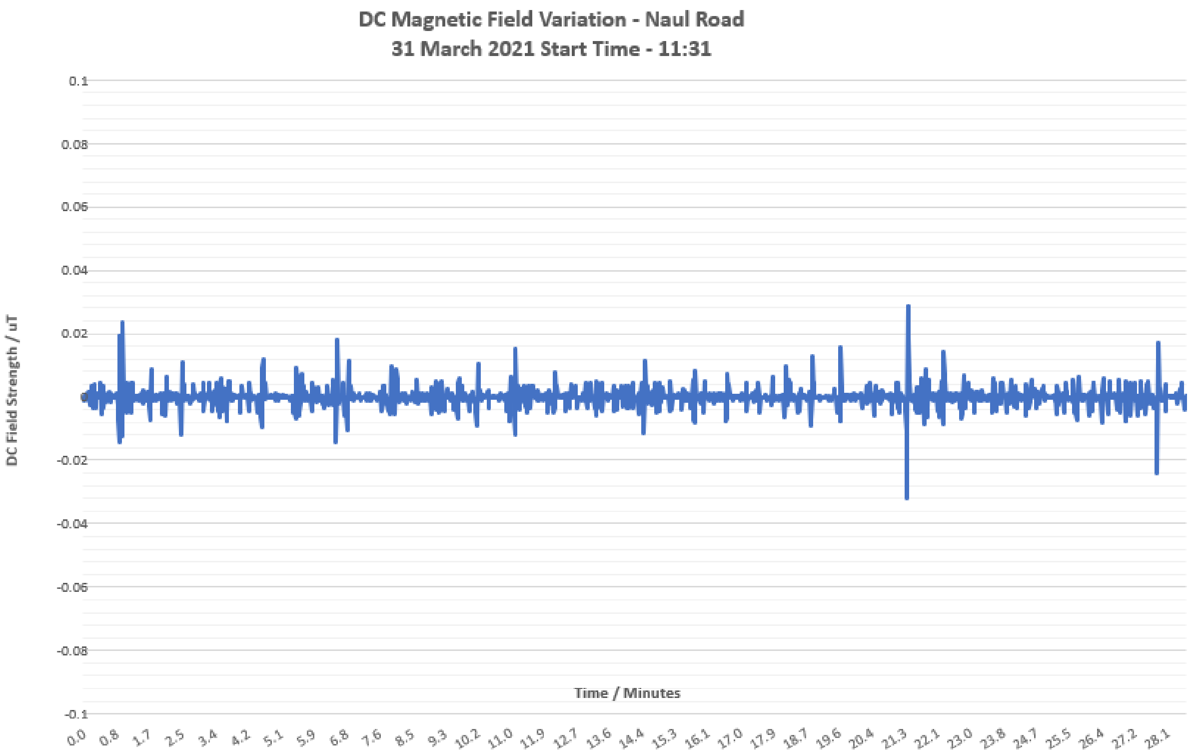

Figure 206: Naul Road (Substation 1 location), DC Magnetic Field variations

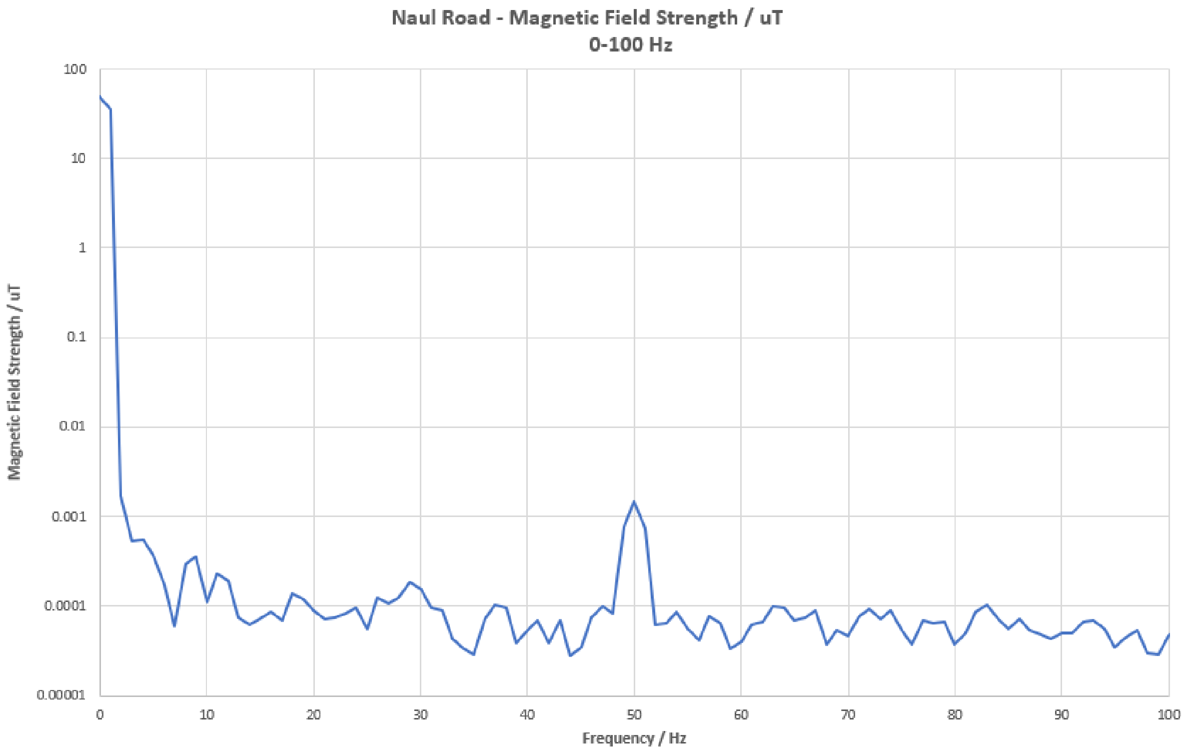

Figure 207: Naul Road (Substation 1 location), 0 Hz to 100 Hz (Mag Field)

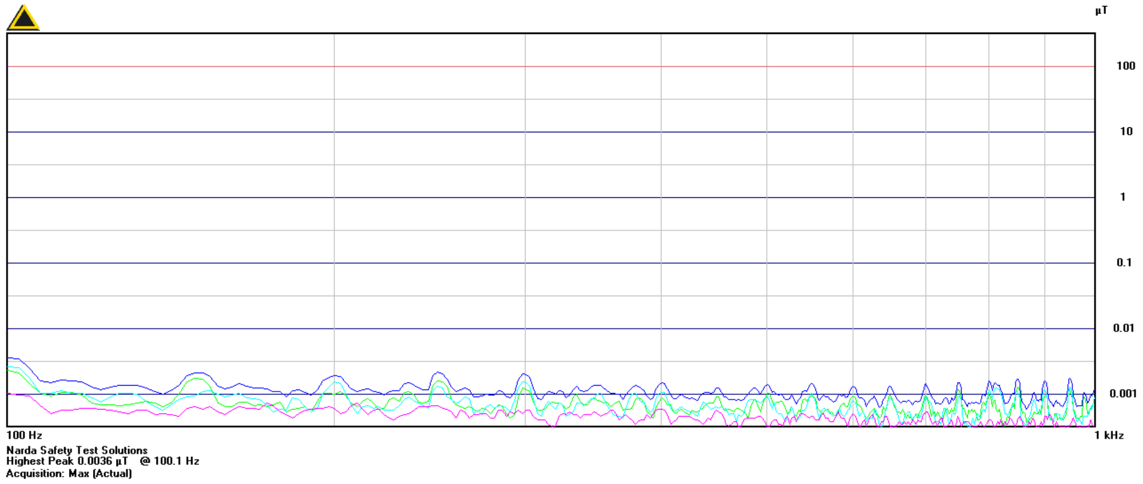

Figure 208: Naul Road (Substation 1 location), 100 Hz to 1 kHz (Mag Field)

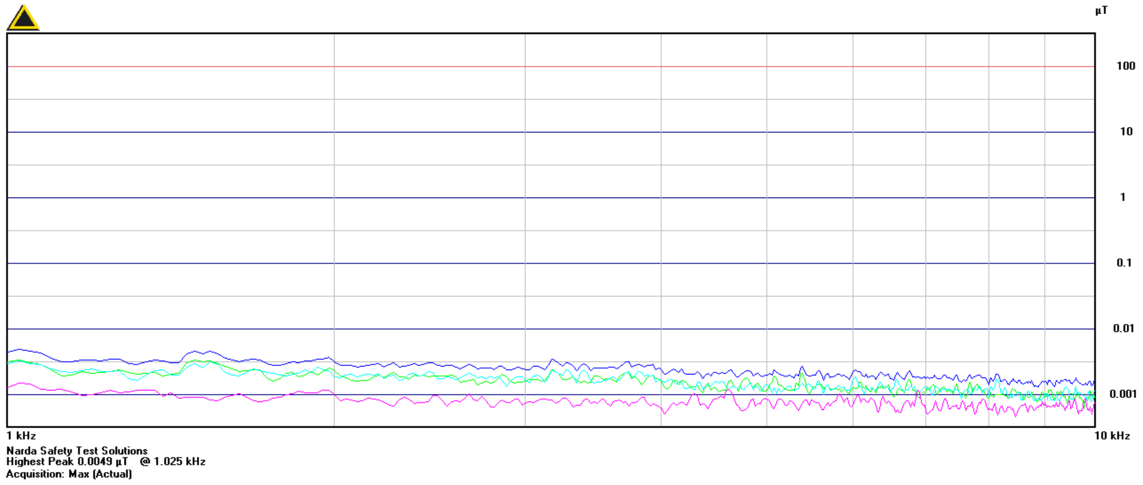

Figure 209: Naul Road (Substation 1 location), 1 kHz to 10 kHz (Mag Field)

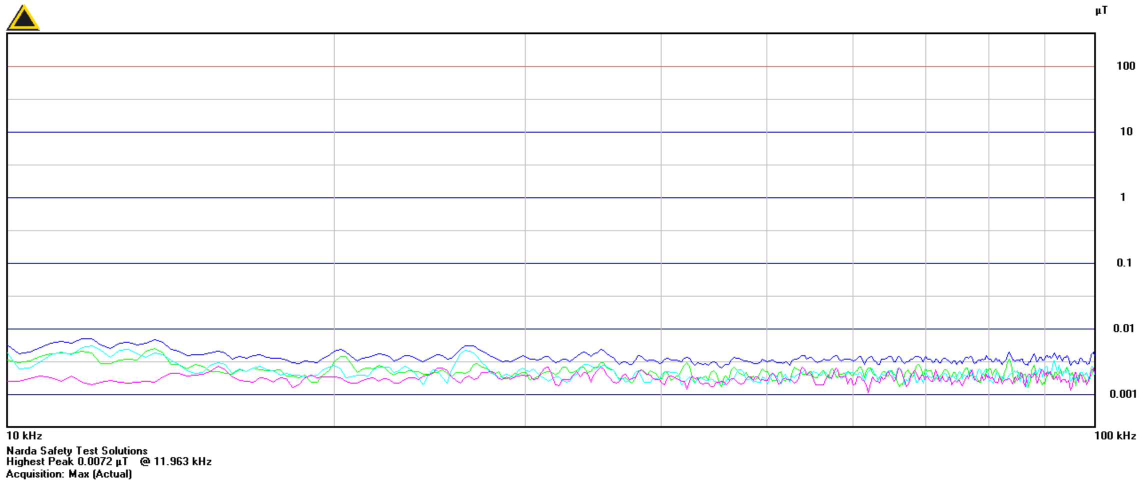

Figure 210: Naul Road (Substation 1 location), 10 kHz to 100 kHz (Mag Field)

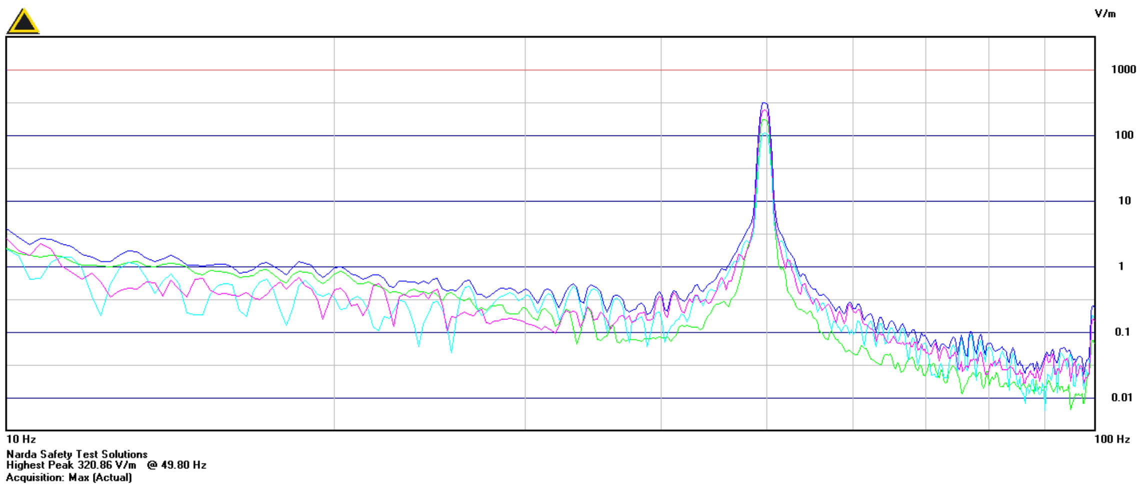

Figure 211: Naul Road (Substation 1 location), 10Hz to 100 Hz (E-Field)

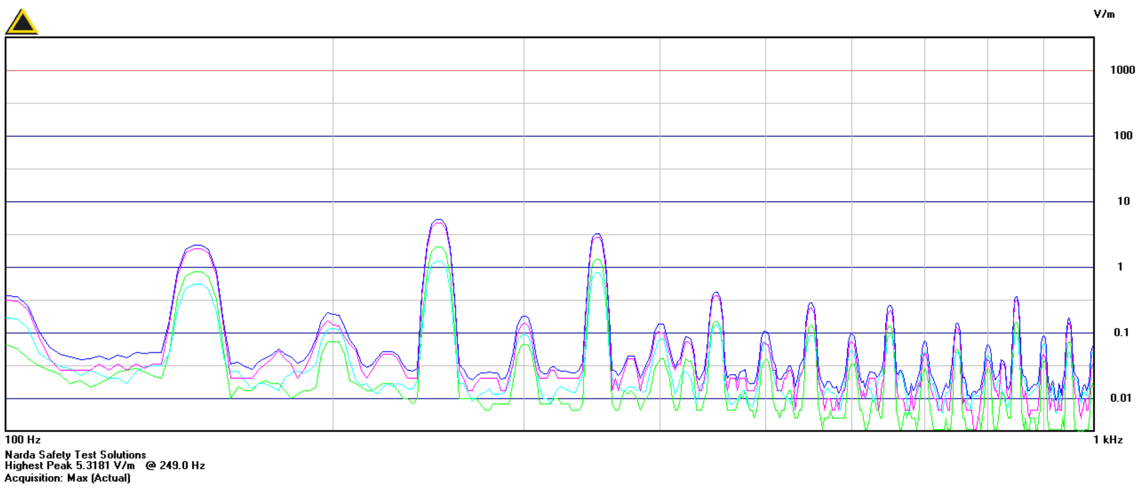

Figure 212: Naul Road (Substation 1 location), 100 Hz to 1 kHz (E-Field)

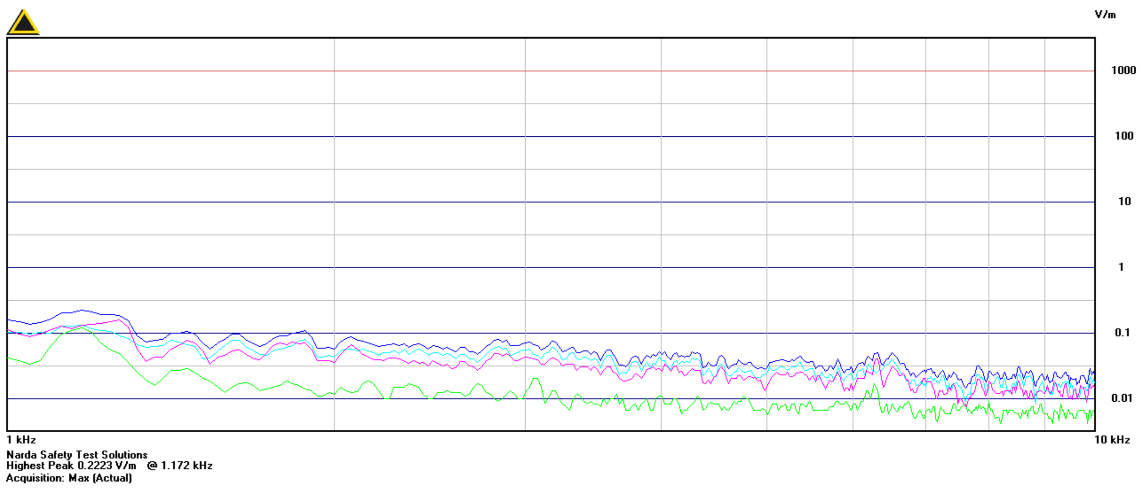

Figure 213: Naul Road (Substation 1 location), 1 kHz to 10 kHz (E-Field)

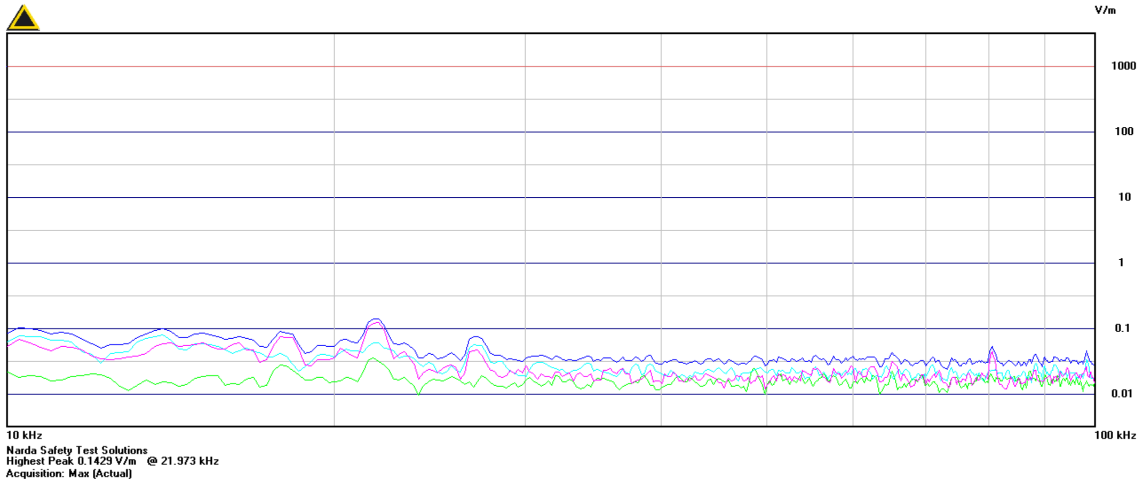

Figure 214: Naul Road (Substation 1 location), 10 kHz to 100 kHz (E-Field)

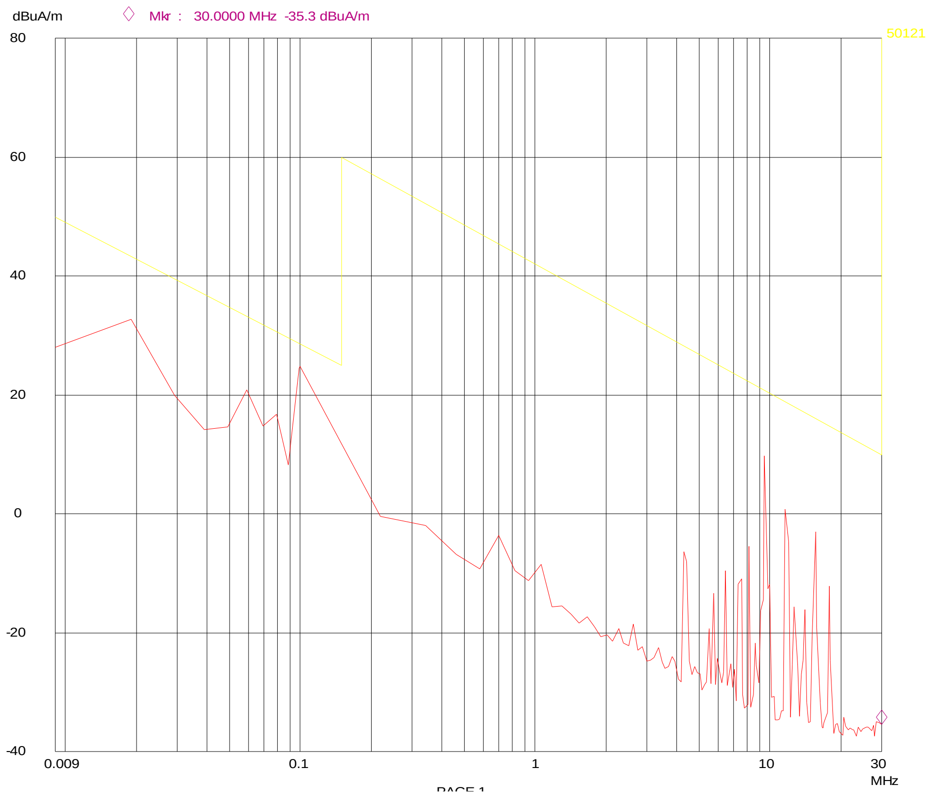

Figure 215: Naul Road (Substation 1 location) – 9 kHz to 30 MHz

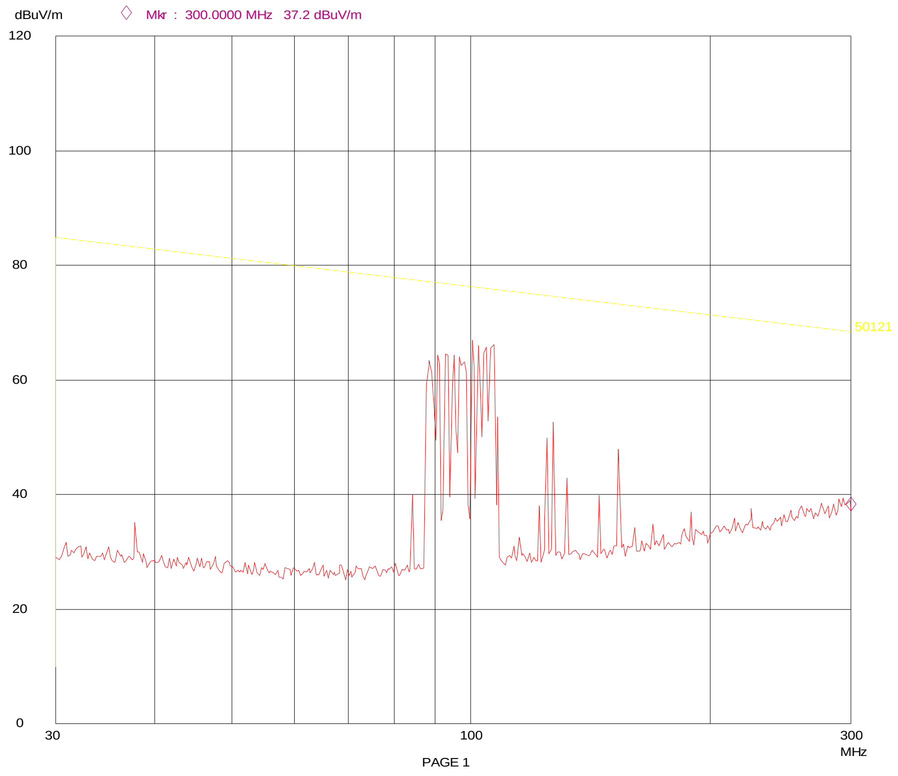

Figure 216: Naul Road (Substation 1 location) – 30 MHz to 300 MHz

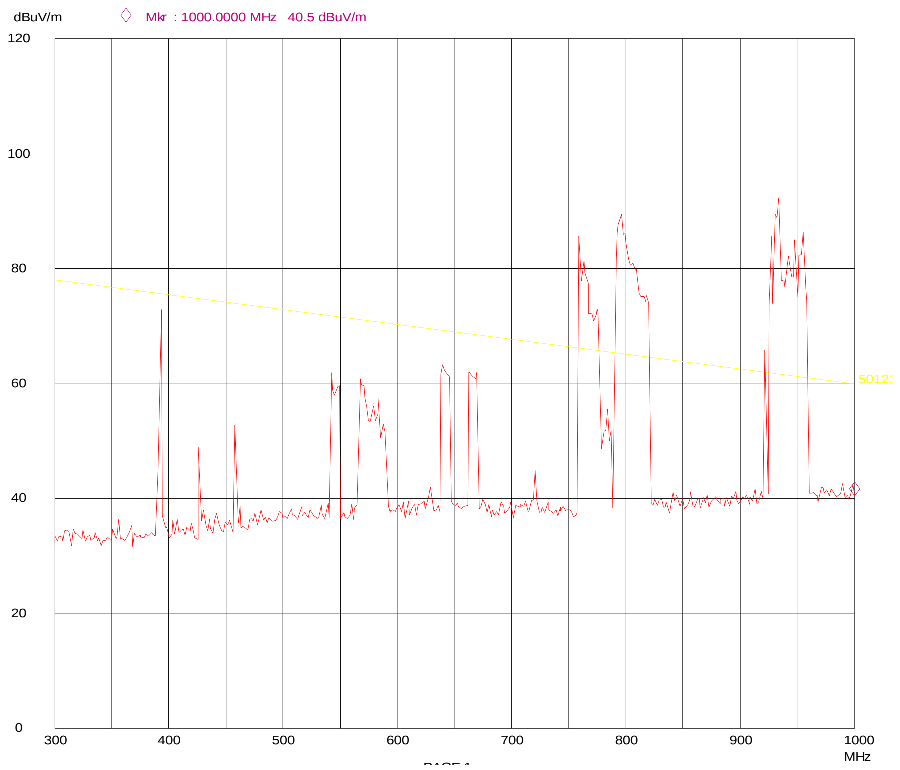

Figure 217: Naul Road (Substation 1 location) – 300 MHz to 1 GHz

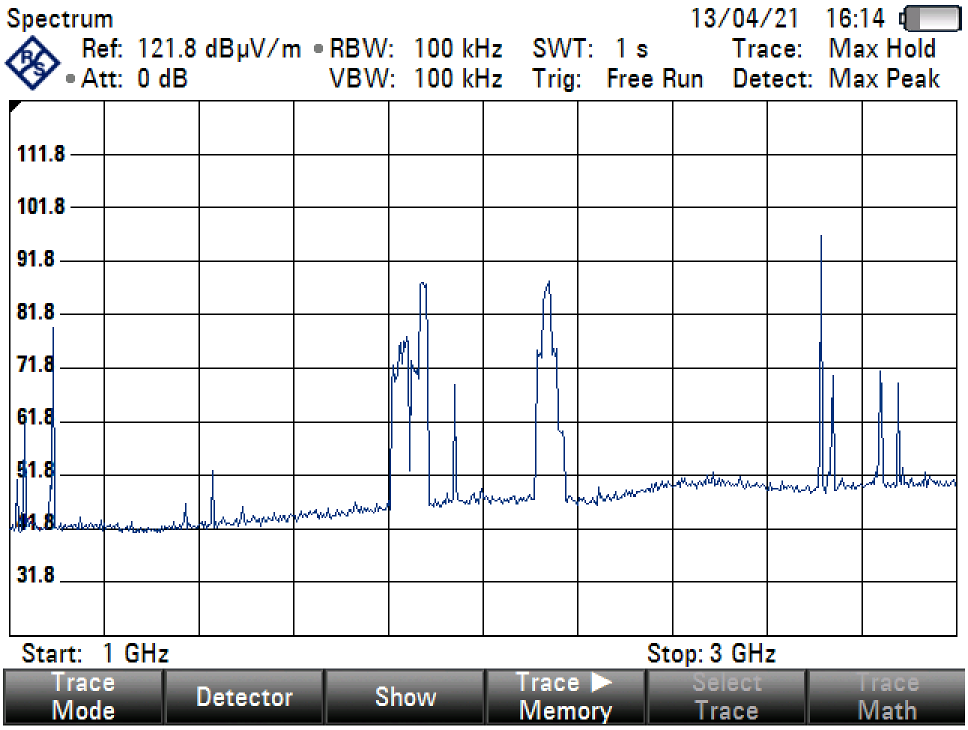

Figure 218: Naul Road (Substation 1 location) - 1 GHz to 3 GHz

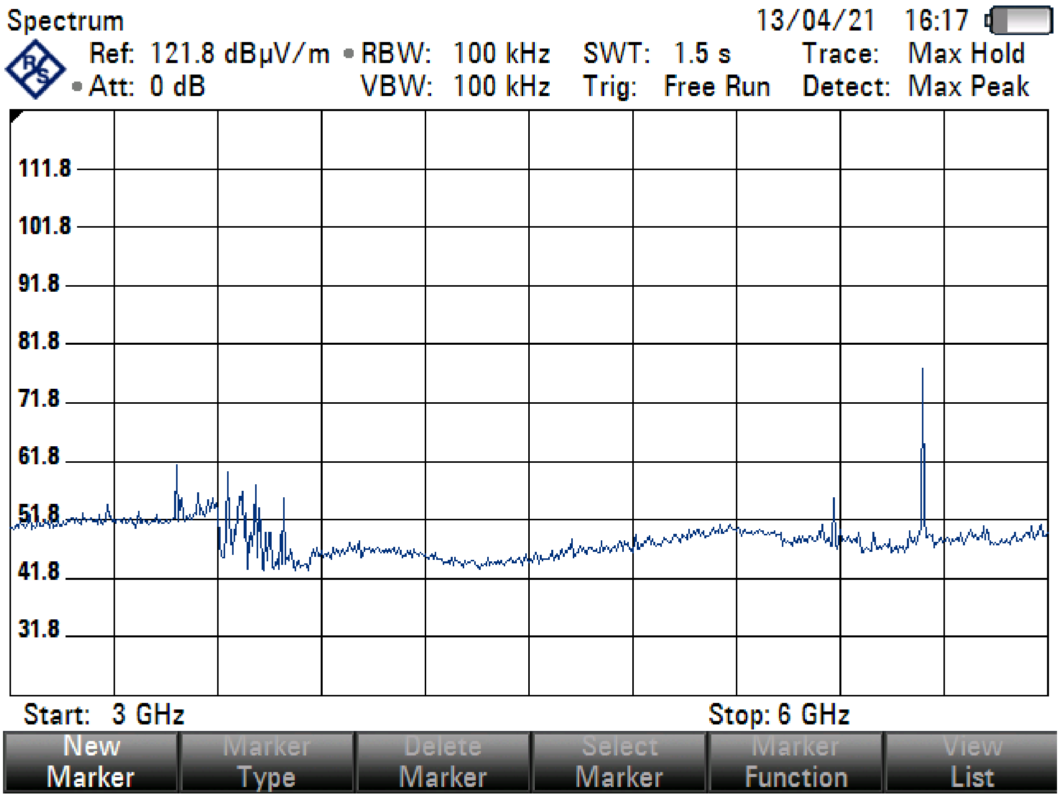

Figure 219: Naul Road (Substation 1 location) - 3 GHz to 6 GHz

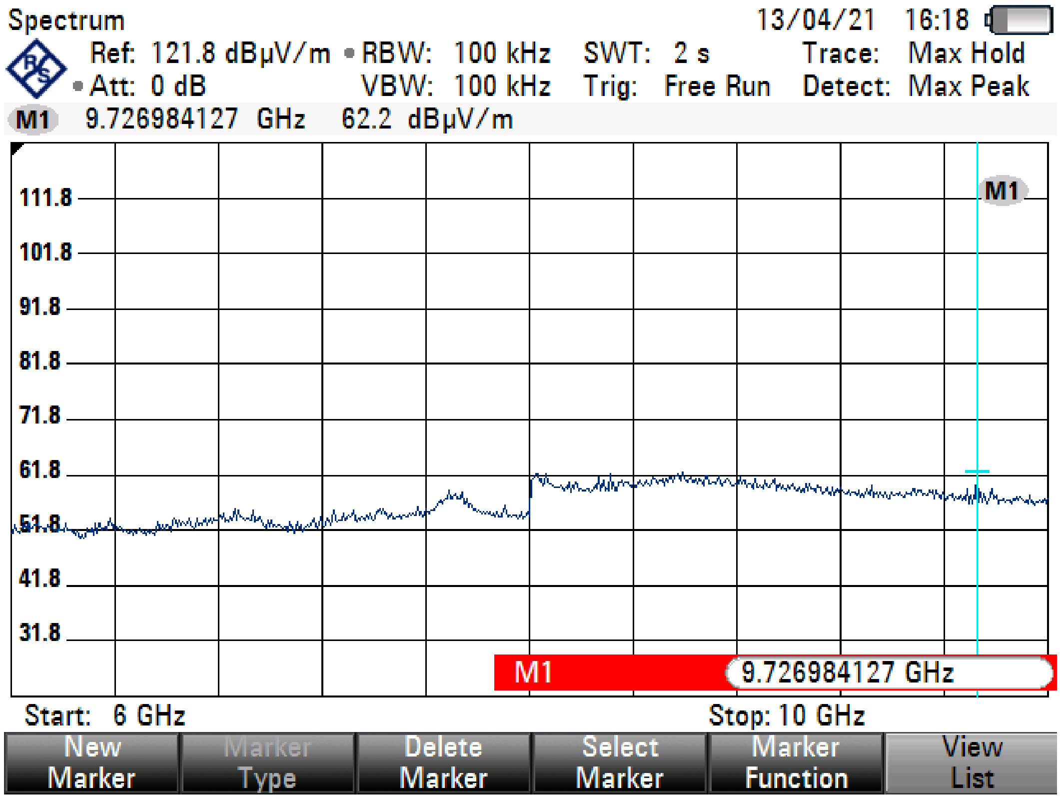

Figure 220: Naul Road (Substation 1 location) - 6 GHz to 10 GHz

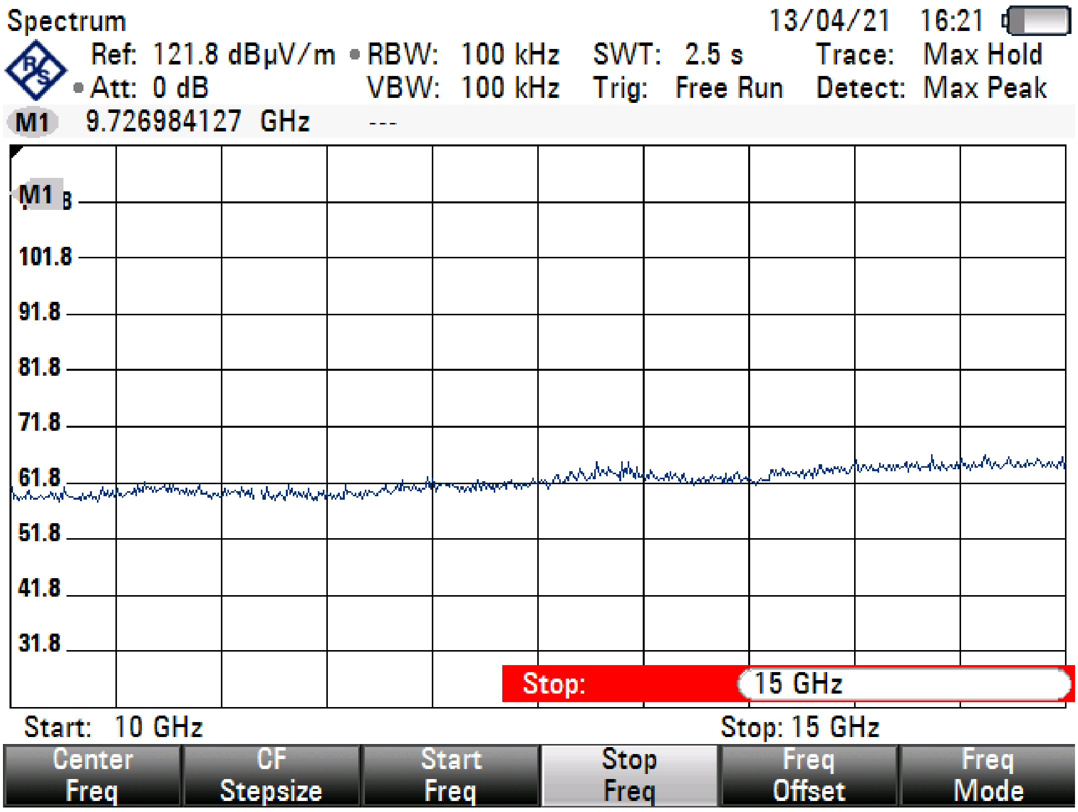

Figure 221: Naul Road (Substation 1 location) - 10 GHz to 15 GHz

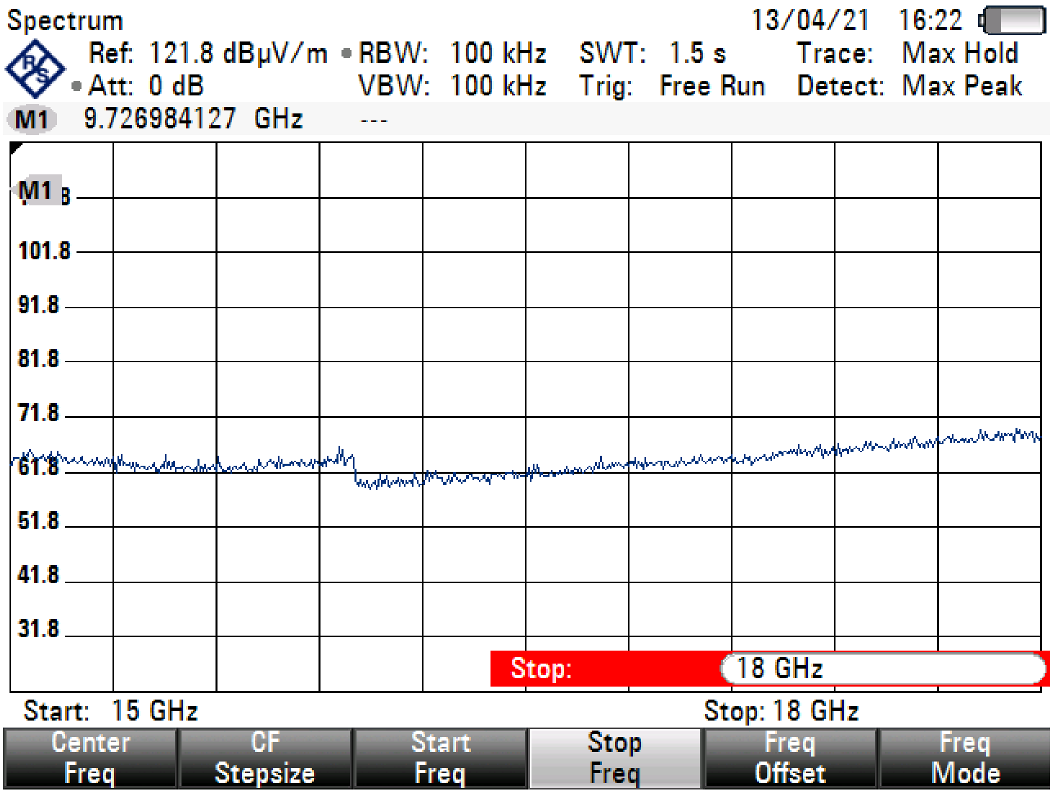

Figure 222: Naul Road (Substation 1 location) - 15 GHz to 18 GHz

3.12 Dardistown (Substation 2 Location) EMR Survey

Measurements were performed at the location depicted below -

Figure 223: Measurement Location for Substation 2

3.12.1 DC Magnetic Field, Dardistown

The Earth's DC magnetic flux density (B) was measured for a period of 28 minutes. The average static field was approximately 47.5 µT (Figure 224) with maximum fluctuations measured during this period of less than 0.01 µT.

3.12.2 AC Electric and Magnetic Fields 1 Hz to 10 kHz, Dardistown

Figure 226 shows a spectral plot of the magnetic field from DC to 100 Hz. The DC component can be seen to be much higher than any other frequency. The near DC fields (less than 10 Hz) were typically of a magnitude of less than 0.01 µT. An elevated 50 Hz magnetic field was measured at 0.3 µT, understandably as the measurement location was approximately 5 m away from an overhead electricity line. From 100 Hz to 1 kHz harmonics of the mains frequency were evident as illustrated in Figure 227. Figure 230 and Figure 231 shows the fields in this frequency range 10 Hz to 1 kHz with the fundamental frequency of 50 Hz again present along with its harmonics, occurring at frequencies such as 100 Hz, 150 Hz, 200 Hz etc.

3.12.3 Radiated Fields: 10 kHz to 18 GHz, Dardistown

There was no evidence, during the measurement and observation time of this study of any transient or intermittent events. The RF emissions profile in this frequency range was well below the typical risk levels of 3 V/m.

At this site the strongest emissions were caused by Analog radio broadcasts (80 – 110 MHz), Digital Radio (147-223 MHz), Tetra Radio (390 MHz), Digital Television Broadcasting (470 – 790 MHz), WiFi (2.4 GHz and 5 GHz), RADAR (2.7-2.9 GHz and 5.9 GHz) and FWPMA (3.4-3.6 GHz). In terms of mobile technology, the following signals were present, mobile broadband, LTE (791-821 MHz and 925-960 MHz), GSM 900 and 1800 (900 MHz and 1.8 GHz) and 3G (2.1 GHz). Due to the proximity of the measurement location to the airport 9 GHz radionavigation transmissions sere also detected.

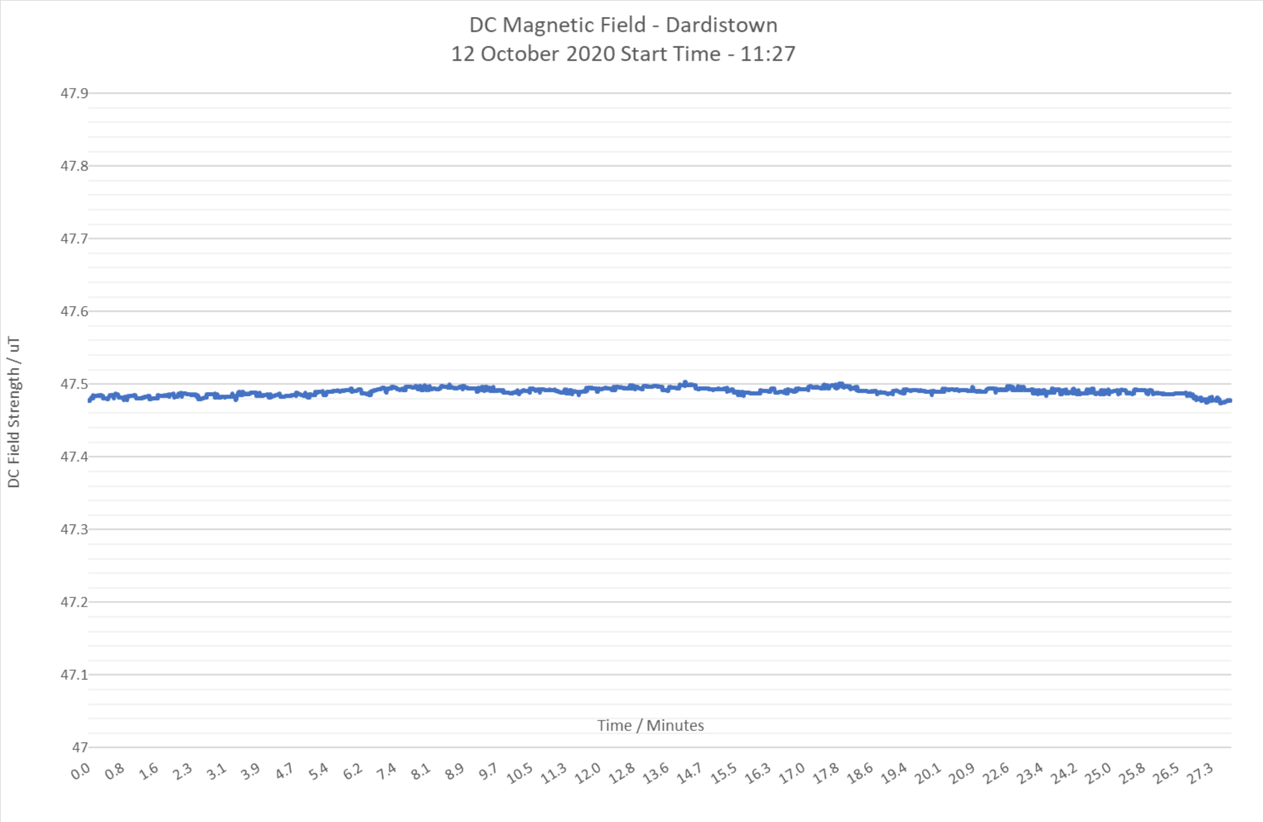

Figure 224: Dardistown (Substation 2 location), DC Magnetic Field

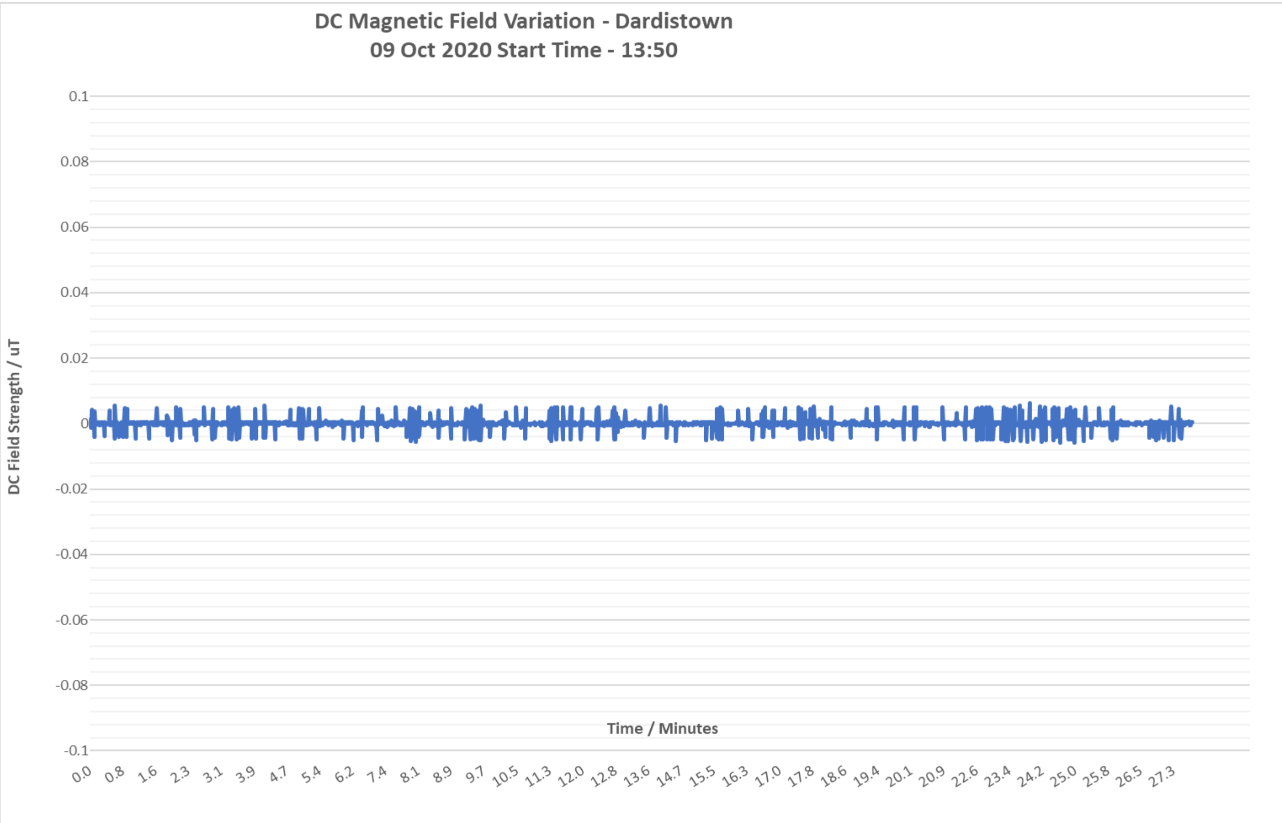

Figure 225: Dardistown (Substation 2 location), DC Magnetic Field variations

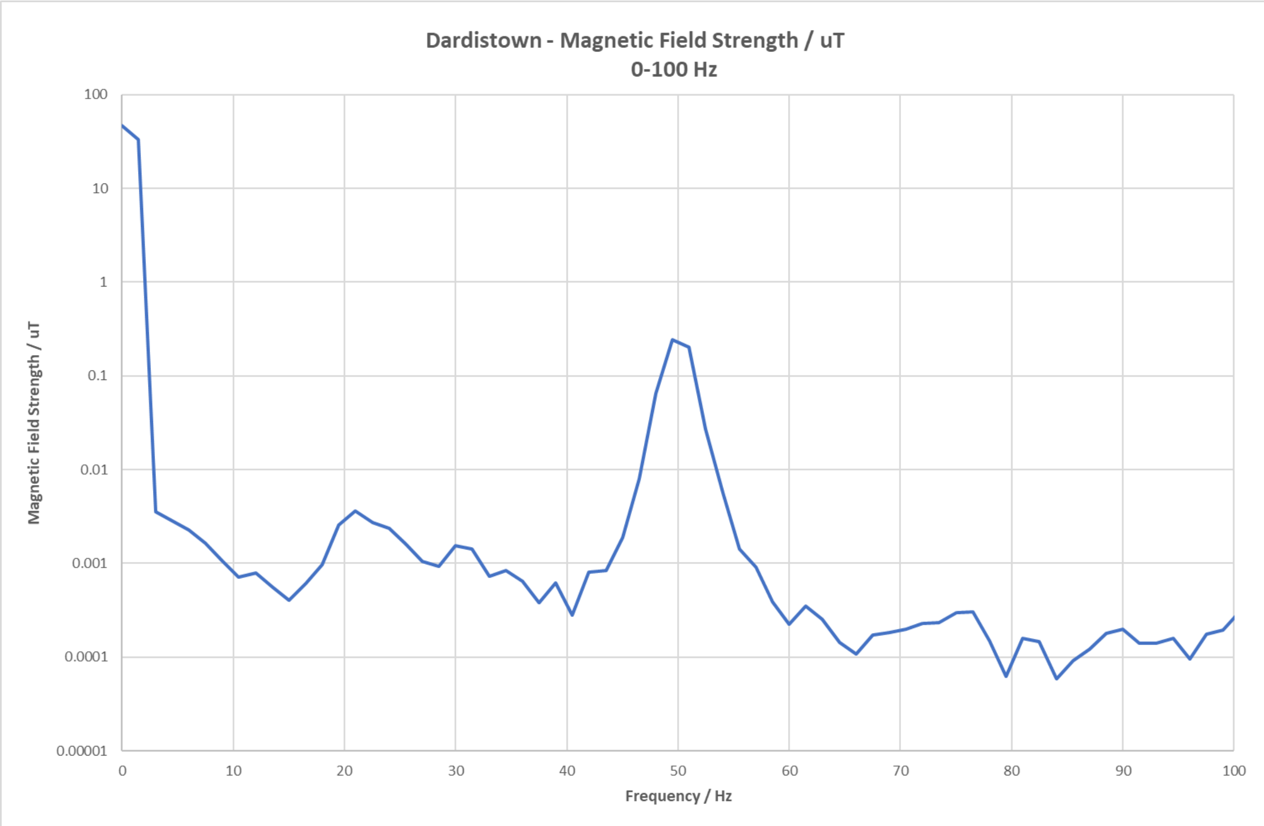

Figure 226: Dardistown (Substation 2 location), 0 Hz to 100 Hz (Mag Field)

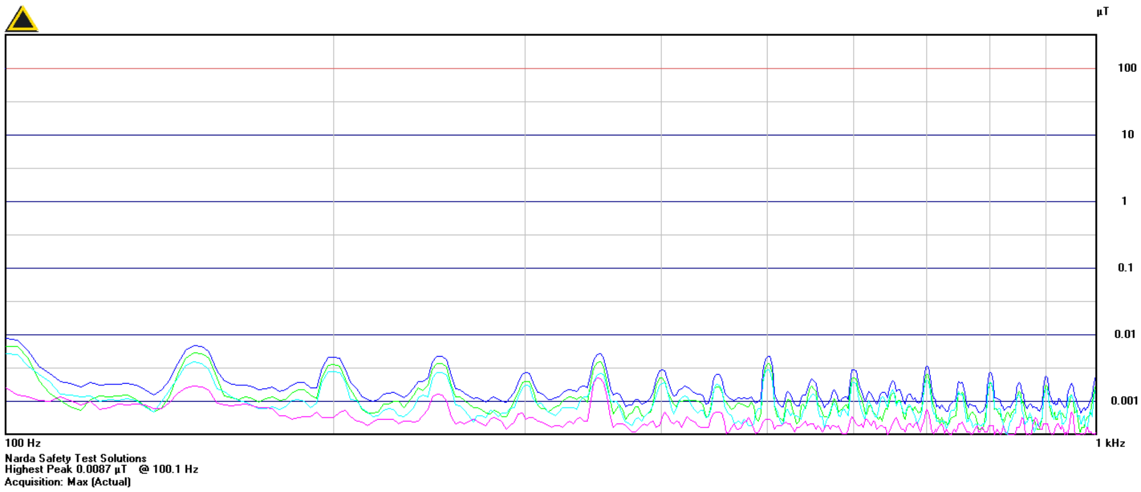

Figure 227: Dardistown (Substation 2 location), 100 Hz to 1 kHz (Mag Field)

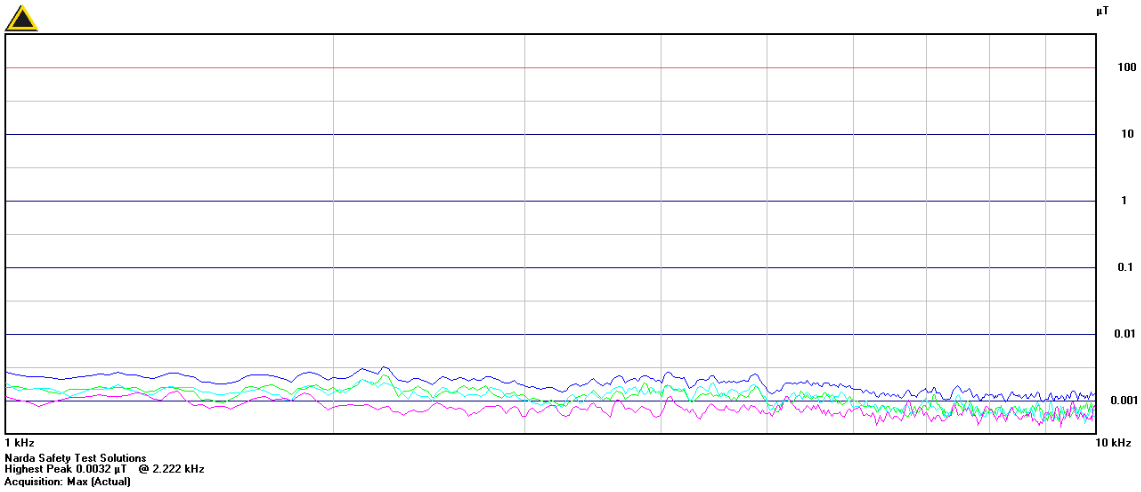

Figure 228: Dardistown (Substation 2 location), 1 kHz to 10 kHz (Mag Field)

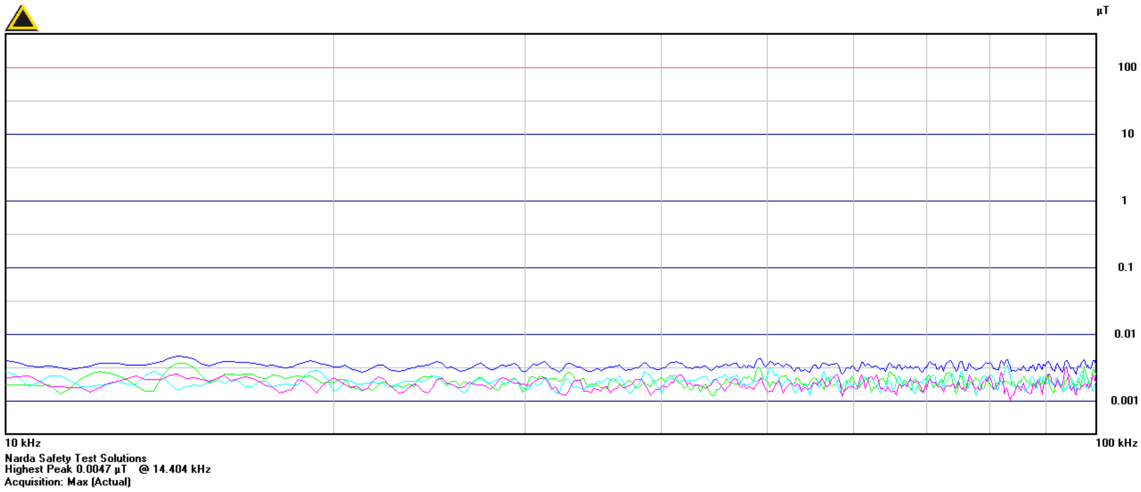

Figure 229: Dardistown (Substation 2 location), 10 kHz to 100 kHz (Mag Field)

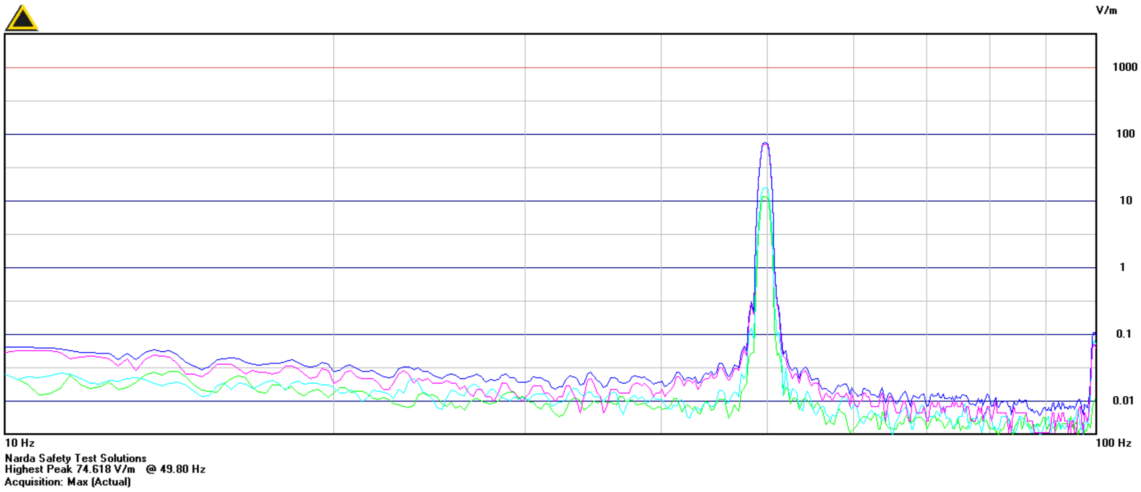

Figure 230: Dardistown (Substation 2 location), 10Hz to 100 Hz (E-Field)

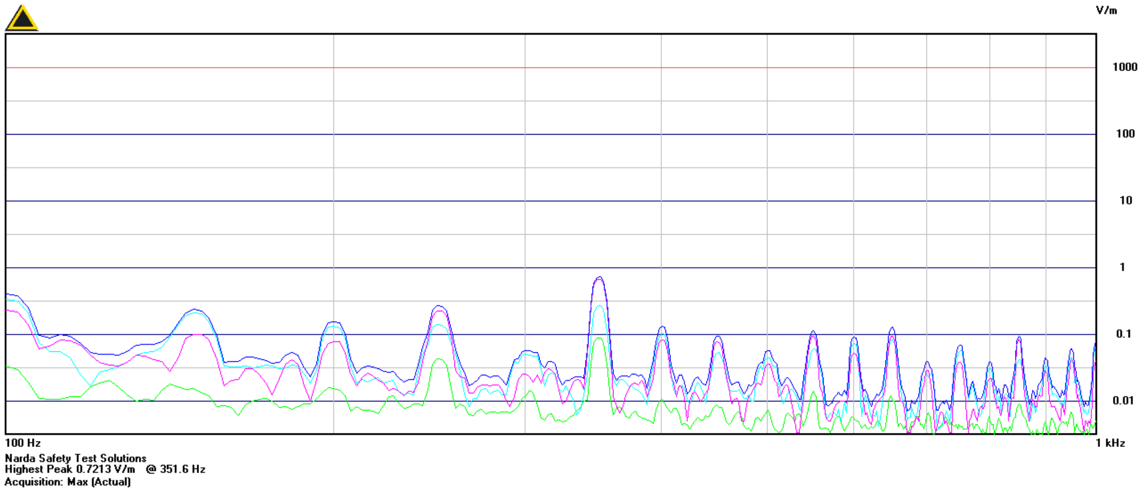

Figure 231: Dardistown (Substation 2 location), 100 Hz to 1 kHz (E-Field)

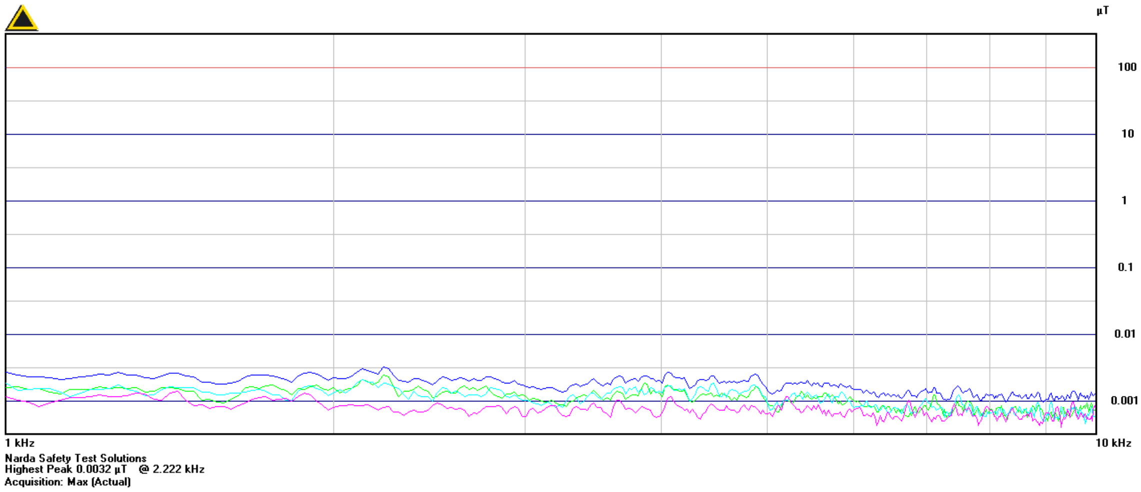

Figure 232: Dardistown (Substation 2 location), 1 kHz to 10 kHz (E-Field)

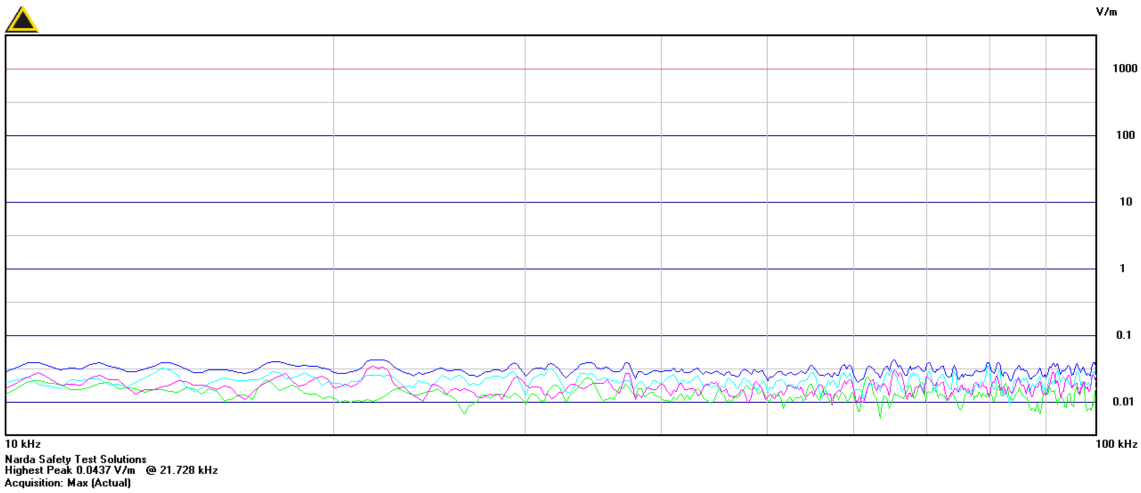

Figure 233: Dardistown (Substation 2 location), 10 kHz to 100 kHz (E-Field)

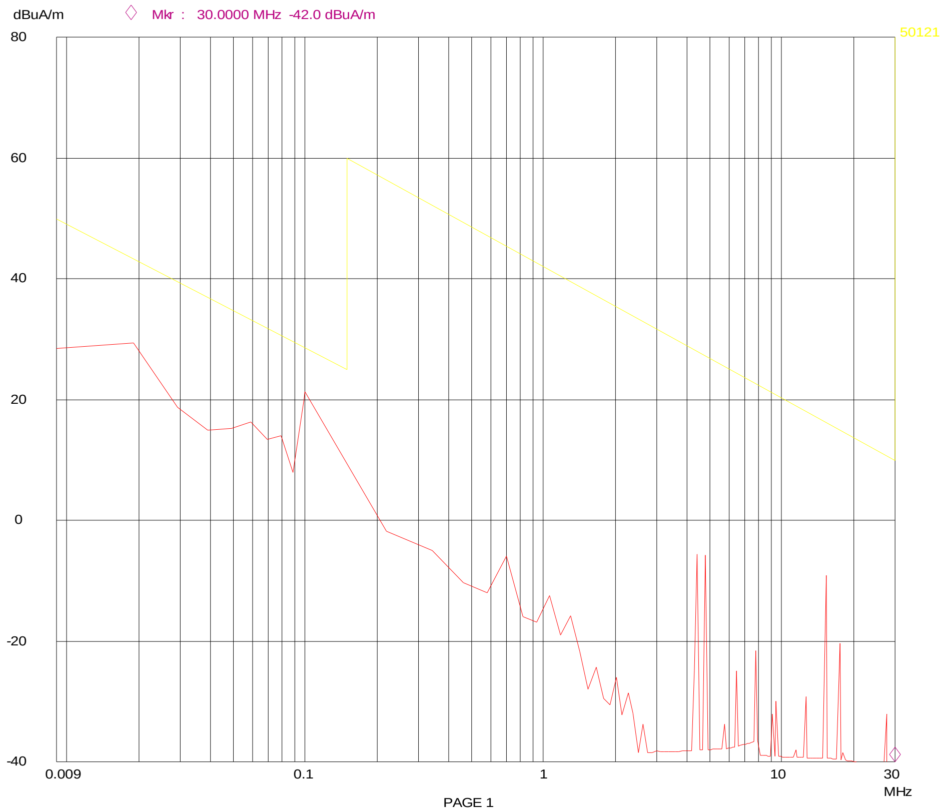

Figure 234: Dardistown (Substation 2 location) – 9 kHz to 30 MHz

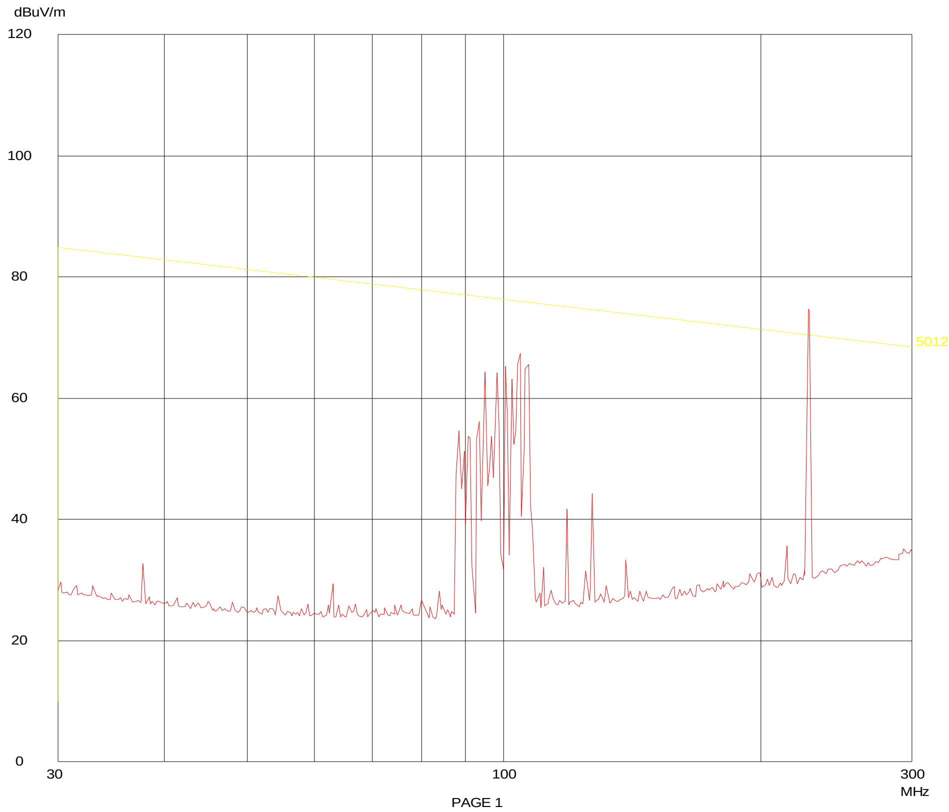

Figure 235: Dardistown (Substation 2 location) – 30 MHz to 300 MHz

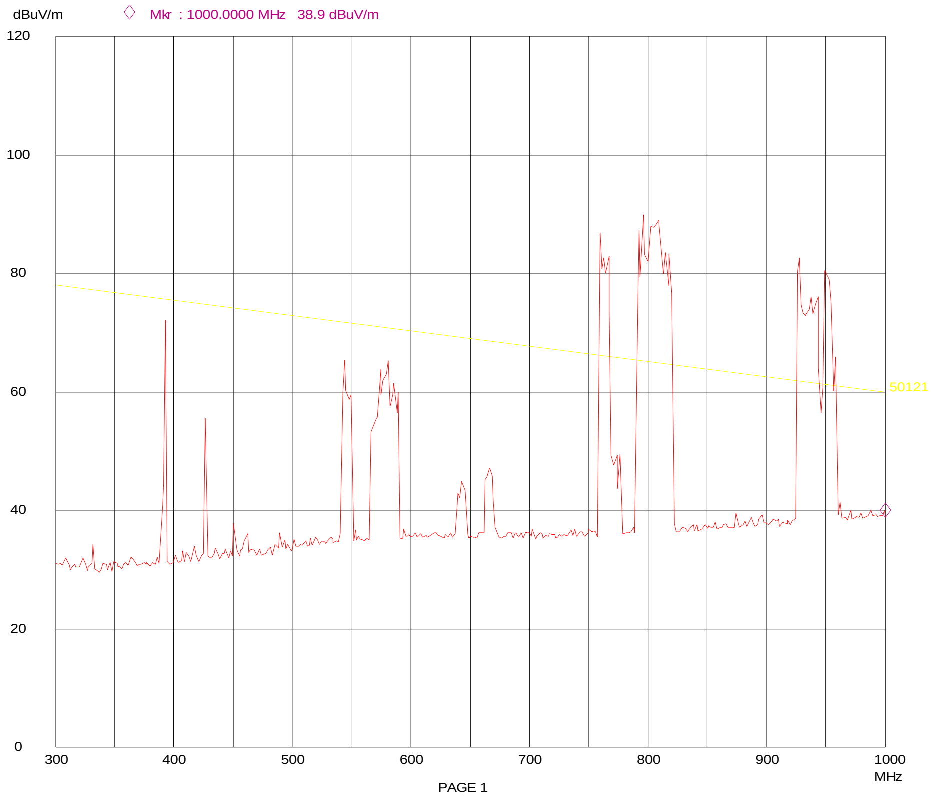

Figure 236: Dardistown (Substation 2 location) – 300 MHz to 1 GHz

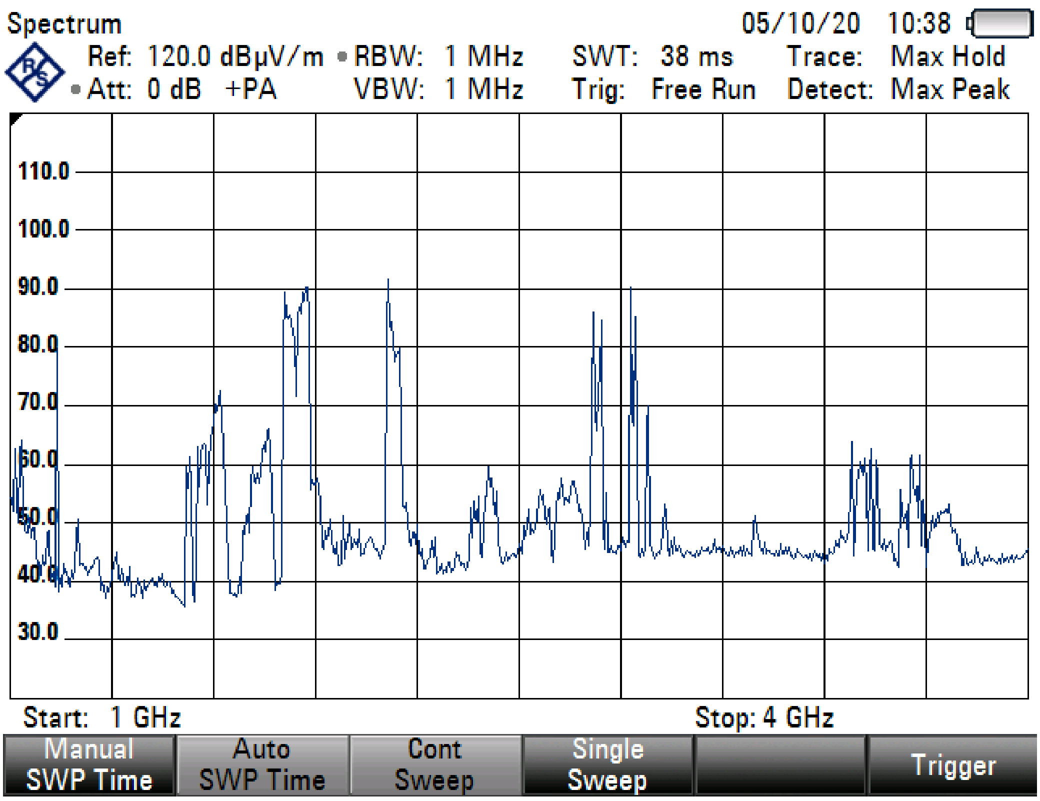

Figure 237: Dardistown (Substation 2 location) - 1 GHz to 4 GHz

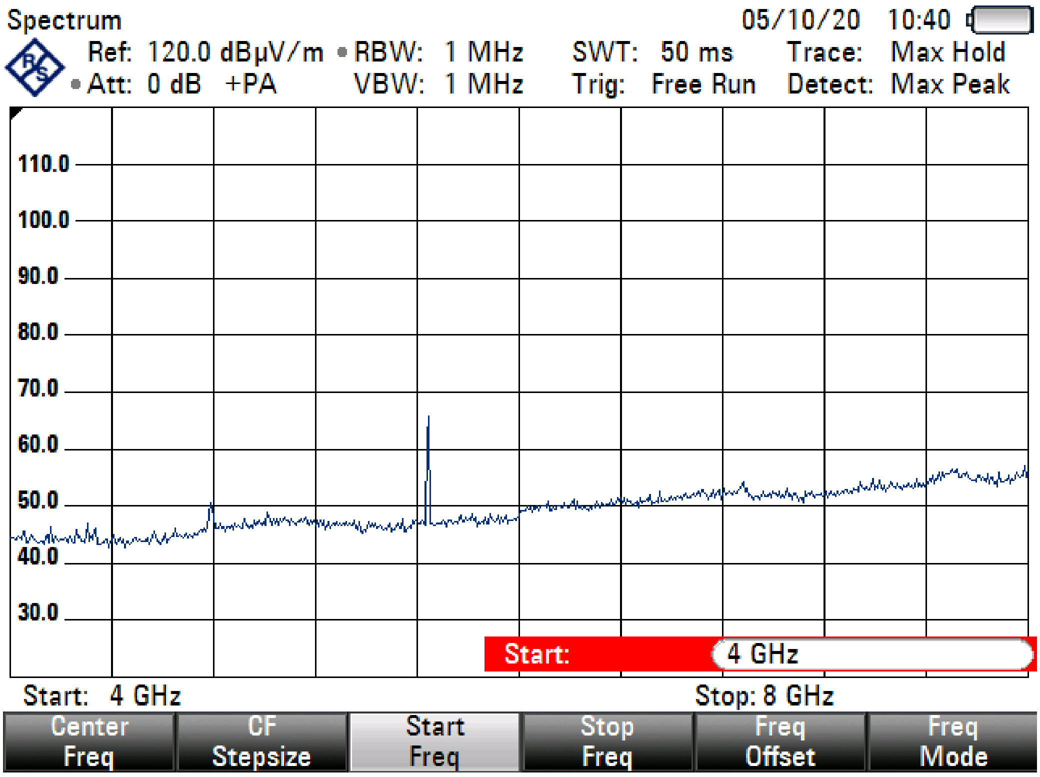

Figure 238: Dardistown (Substation 2 location) - 4 GHz to 8 GHz

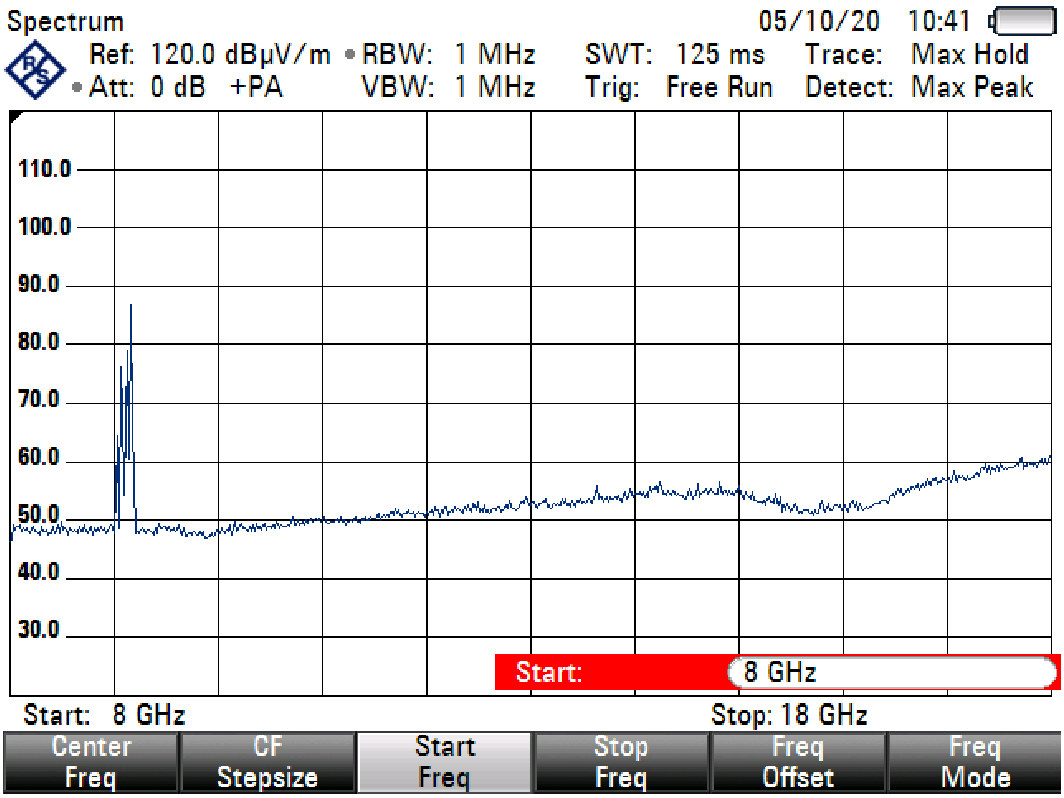

Figure 239: Dardistown (Substation 2 location) - 8 GHz to 18 GHz

4.0 CONCLUSIONS

4.1 DC fields

DC magnetic field fluctuations measured throughout the surveys were, in general, low. The levels measured at each site were equal to the earth's magnetic flux density at that location with time varying deviations typically less than 3 µT often much lower in areas with no DART and little street level traffic.

The DC Magnetic fields measured at each site are a snapshot of the levels at a given time.

4.2 AC fields

The pre-existing 50 Hz electric and magnetic levels were elevated in areas where mains transmission lines were in proximity including the electricity supply to the DART. No non-mains derived fields were noted at in the AC domain at any of the survey with the exception of the measurements performed close to the DART line where near-DC field levels (1-10 Hz) were elevated slightly at times due to the varying current draw on the lines.

4.3 RF fields

No unusual signals were noted to be present during the RF surveys carried out.

4.4 Electromagnetic fields and human health

The field strengths measured during these surveys also indicate that the existing environment was benign from a human health standpoint.