

Test Report (PDF copy)
FCC Testing of the
M6040SC USA
Microwave Oven
FCC ID: APYDMR0172
For
Sharp Manufacturing Ltd

Document number 12120/TR/2

Project number C2368

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1 Introduction

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UKAS testing laboratory N° 91064

Name and address of client: Sharp Manufacturing UK Limited
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Clwyd
LL12 0PG

The test results contained in this test report relate only to the unit(s) tested.

Equipment under test	Microwave Oven - FCC ID: APYDMR0172		
EUT Model No.	M6040SC USA	Serial No.	UKM604
Noise filter board No.	FPWBFA397WRKZ	HV capacitor No.	RC-QZA331WRZZ
Transformer No.	RTRN-A037URE0	Magnetron No.	RV-MZA406WRZZ
Date of receipt	11 th April 2016	Number tested	One
Date(s) of test(s)	26 th & 27 th April 2016, 4 th , 5 th & 6 th May. 6 th June 2016 and 19 th July		
Date(s) when EUT was out of laboratory's control	None		
Personnel witnessing tests	The tests were carried out on an unwitnessed basis.		

Any other relevant information: The operating frequency of the EUT was declared as 2.45GHz; therefore, as per FCC MP-5, section 2.3(a), measurements were made to the tenth harmonic, which is 24.5GHz.

2 Test Specification

2.1 Environment

The equipment under test is a microwave oven intended for use in a household environment.

2.2 Relevant standards

2.2.1 Emissions

CFR 47 Part 18 (10-1-08 edition) Code of Federal Regulations Referencing: ANSI C63.4-2014	Conducted disturbance (AC mains port) 150kHz-30MHz limit as defined in 18.307 conduction limits Radiated disturbance (enclosure port) 30MHz-24.5GHz limit as defined in 18.305 Field strength limits Power Output measurement for microwave ovens as per Section 4.3 of MP-5 (1986) Frequency measurements as per Section 4.5 parts (a) and (b) of MP-5 (1986)
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Note 1: Testing was carried out according to the methods of measurement contained within FCC/OST MP-5 (1986)

Note 2: The operating frequency of the EUT was declared as 2.45GHz; therefore, measurements were made to the tenth harmonic i.e. 24.5GHz.

2.2.2 Immunity

No Immunity testing required by the customer

2.2.3 Operating modes

The EUT was operated in a total of 1 mode, the selection of which was test dependant.

Mode of operation	Description	Mode No.
	100% microwave power	1

Where the microwave function was being tested, the cavity was loaded with 1000 millilitres of tap water in a 190mm external diameter borosilicate glass container, with a height of 90mm, placed in the centre of the turntable unless otherwise specifically stated. Water was changed periodically to maintain the level and prevent the water boiling where required.

3 Test Results

3.1 Power Output measurements (Calorimetric direct method)

Mode of operation	Description	Mode No.
	100% microwave power	1

Test standard	Test description	Class/limit
MP-5 1986, section 4.3. Test method based upon EN60705:1999, Section 8.	Power output measurements for microwave ovens	N/A

Input Voltage (V)	Input Power (W)	Input Current (A)	Duration of run (sec)	Start Temp Water (°C)	Final Temp Water (°C)	ΔT (°C)	Output Power (W)
120	1644	15.06	60	20.9	34.1	13.1	921.1
120	1678	15.27	60	20.5	33.7	13.2	921.1
120	1646	15.42	60	20.5	33.7	13.2	921.1

Note 1: The test was performed using 1000g ± 5 g of tap water heated in a 150mm diameter cylindrical glass vessel placed in the centre of the oven. Start Temp is that of the water before it was poured into the glass vessel. Final temperature of the water was taken within 60sec of the microwave cycle finishing, after it had been stirred.

Note 2: The output power used to determine the value regarding out of band field strength limits, under the specified section of 18.305, was that of the measured value i.e. 921.1W this produced the limit line for electric field strength measurements see section 3.6 of this test report.

3.2 Frequency measurements

Mode of operation	Description	Mode No.
	100% microwave power	1

Test standard	Test description	Class/limit
MP-5 1986, section 4.5.	Frequency measurements for microwave magnetron fundamental frequency	As defined in CFR 18.301 2,450MHz $\pm$ 50MHz

3.2.1 Frequency variation over time MP-5 section 4.5 (a)

Time (Mins)	Measured Frequency (MHz)
Start of Test	2463
6	2462
12	2464
18	2470
24	2469
30	2470
36	2472
42	2475
48	2472
54	2466
60	2467
66	2467
72	2467

Note 1: The test was performed using 1000mililetres of tap water in a 150mm diameter cylindrical glass vessel placed in the centre of the oven. The test duration was defined by the length of time taken by the microwave to reduce the load by means of evaporation to approximately 20% of the start level. Frequency measurements are shown in figure 5.6.1. The frequency is plotted within the allowable band of variation for the ISM frequency of 2450MHz $\pm$ 50MHz i.e. 2400MHz to 2500MHz.

3.2.2 Frequency variation over supply voltage variation MP-5 section 4.5 (b)

Supply Voltage (V) at 60Hz	Frequency (MHz)
96	2476
150	2466

Note 1: The test was performed using 1000mililetres of tap water in a 150mm diameter cylindrical glass vessel placed in the centre of the oven. The microwave had been operating for 10mins prior to the test start and the load used was started at room temperature. The supply voltage was lowered to 80% of the nominal value and the EUT allowed enough time to respond to the voltage change prior to recording the frequency. The test was then repeated with the supply voltage at 125% of the nominal value.

3.3 Conducted emissions (150kHz to 30MHz)

Mode of operation	Description	Mode No.
	100% microwave power	1

Test standard	Test description	Class/limit
CFR 47 part 18 (10-1-08 edition)	Conducted emissions ac power	As defined in 18.307

Results	Figure	Result	Comments
	C01	Pass	Neutral Line
	C02	Pass	Live Line

Frequency	Peak	Average	Average Limit	Average Difference	Average Status	Quasi-Peak	Quasi-Peak Limit	Quasi-Peak Difference	Quasi-Peak Status	Overall Status
MHz	dBμV	dBμV	dBμV	dB	P/F	dBμV	dBμV	dB	P/F	P/F
0.275	58.6	29.6	51.0	-21.35	P	49.6	61.0	-11.38	P	P
0.410	57.0	26.2	47.6	-21.45	P	48.0	57.6	-9.64	P	P
0.545	52.9	20.1	46.0	-25.92	P	45.3	56	-10.66	P	P
13.580	55.1	41.5	50	-8.51	P	52.9	60	-7.11	P	P
17.125	52.2	35.8	50	-14.23	P	48.1	60	-11.87	P	P
19.965	56.8	39.6	50	-10.39	P	53.2	60	-6.75	P	P

Input Power 120V 60Hz C01 Neutral Peaks

Frequency	Peak	Average	Average Limit	Average Difference	Average Status	Quasi-Peak	Quasi-Peak Limit	Quasi-Peak Difference	Quasi-Peak Status	Overall Status
MHz	dBµV	dBµV	dBµV	dB	P/F	dBµV	dBµV	dB	P/F	P/F
0.270	55.9	28.7	51.1	-22.38	P	48.3	61.1	-12.85	P	P
0.405	52.6	24.5	47.8	-23.24	P	47.7	57.8	-10.03	P	P
0.530	54.8	20.7	46.0	-25.33	P	43.8	56.0	-12.16	P	P
13.575	55.7	42.6	50.0	-7.37	P	51.8	60.0	-8.16	P	P
17.100	52.9	38.6	50.0	-11.45	P	48.7	60.0	-11.33	P	P
19.990	56.8	40.8	50.0	-9.24	P	53.6	60.0	-6.44	P	P

Input Power 120V 60Hz C01 Live Peaks

Note 1: The graphical data for this test can be found in Appendix 4 of this report.

3.4 Radiated emissions (100MHz to 1000MHz)

Mode of operation	Description	Mode No.
	100% microwave power	1

Test standard	Test description	Class/limit
CFR 47 Part 18 (10-1-08 edition)	Radiated emissions	As defined in 18.305

Results	Figure	Result	Comments
	R01	Pass	None

QP Results	Freq (MHz)	Antenna height (m)	Turntable angle (°)	QP level (dBμV/m)	Limit (dBμV/m)	Comments
(Max 10)	100.020	1	270	40.3	66.49	None
	100.080	1	0	39.3	66.49	None
	100.260	1	90	40.4	66.49	None
	101.220	1	180	40.2	66.49	None
	101.350	1	180	40.4	66.49	None
	101.460	1	180	42.1	66.49	None
	101.640	1	180	42.5	66.49	None
	103.320	1	180	41.6	66.49	None
	104.280	1	180	39.3	66.49	None
	430.920	1	90	40.0	66.49	None

Note 1: The graphical data of this test can be found in Appendix 5 of this report.

3.5 Radiated emissions (1GHz to 18GHz)

Mode of operation	Description	Mode No.
	100% microwave power	1

Test standard	Test description	Class/limit
CFR 47 Part 18:2004	Radiated emissions	As defined in 18.305

Results	Figure	Result	Comments
	R02	N/A	Measurements were performed in an anechoic chamber.
	R03	Pass	These tests were performed on the open area test site.

Frequency (GHz)	1 Analyser Level (dBµV)	2 AF (dB/m)	3 Cable loss (dB)	4 Pre Amplifier Gain (dB)	(1+2+3-4) Average detector Result @3m dBµV/m	Limit@3m dBµV/m
3.156	43.67	30.7	5.7	-52.25	27.79	66.49
3.168	44.44	30.7	5.8	-52.51	28.64	66.49
4.230	43.33	32.1	7.05	-52.51	29.91	66.49
4.872	43.62	33.1	6.52	-52.71	30.52	66.49
4.908	47.19	33.25	7.78	-52.72	35.50	66.49
4.920	44.47	33.28	7.85	-52.73	32.87	66.49
4.932	43.21	33.31	7.78	-52.74	31.56	66.49
7.362	24.37	36.57	9.08	-53.73	16.29	66.49
7.368	47.17	36.58	9.23	-53.74	39.23	66.49
9.858	42.89	38.33	11.58	-54.17	38.63	66.49
9.876	43.05	38.36	11.58	-54.16	38.83	66.49
14.796	41.35	41.67	14.48	-51.74	45.76	66.49
17.136	40.89	41.07	17.33	-50.92	48.38	66.49

Frequency (GHz)	1 Analyser Level (dBμV)	2 AF (dB/m)	3 Cable loss (dB)	4 Pre Amplifier Gain (dB)	(1+2+3-4) Average detector Result @3m dBμV/m	Limit@3m dBμV/m
17.142	40.88	41.09	17.38	-50.92	48.44	66.49
17.232	40.90	45.91	17.17	-50.85	48.76	66.49
17.250	40.87	41.66	17.16	-50.84	48.85	66.49
17.892	41.03	45.87	17.10	-50.40	50.36	66.49
17.910	40.95	45.91	16.84	-50.39	53.31	66.49

Fundamental Frequency Peak measurements 2,450 MHz ±50MHz OATS (Information purposes)

Frequency (GHz)	1 Analyser Level (dBμV)	2 AF (dB/m)	3 Cable loss (dB)	4 Pre Amplifier Gain (dB)	(1+2+3-4) Peak Result @3m dBμV/m	Limit@3m dBμV/m
2.462	119.73	28.29	5.16	-52.05	101.13	Unlimited
2.468	121.60	28.29	5.12	-52.06	102.95	Unlimited

Note 1: The tests in the above table carried out between 1GHz to 2GHz and 3GHz to 18GHz were performed with a 2.4GHz notch filter connected, this was to avoid spurious harmonics from the magnetron fundamental frequency of 2.45GHz appearing in the measuring instrumentation. The bands between 2GHz and 3GHz were performed without the filter. Testing was performed over the frequency ranges 1000MHz to 18000MHz. Results were compared with the limit line as defined in 18.305 and scaled for a measurement distance of 3m.

Note 2: The above results >1GHz were recorded using an average detector.

Note 3: Loads and locations of beaker during these tests as defined within FCC/OST MP-5 (1986) in section 4.1 Load for microwave ovens

3.6 Radiated emissions (18GHz to 24.5GHz)

Mode of operation	Description	Mode No.
	100% microwave power	1

Test standard	Test description	Class/limit
CFR 47 Part 18:2004	Radiated emissions	As defined in 18.305

Results	Figure	Result	Comments
	R04	Pass	None

Note 1: The EUT was rotated from 0° to 360° and back to 0° whilst the peak emissions were recorded, with the antenna first in horizontal polarisation. This was then repeated with the antenna in vertical polarisation.

Note 2: **No emissions were detected above the noise floor of the anechoic chamber when investigated at a distance of 3m.**

Note 3: The graphical data can be found in Appendix 5 of this test report.

Note 4: The test was performed using 1000millilitres of tap water in a 150mm diameter cylindrical borosilicate glass vessel placed in the centre of the oven.

3.7 Calculation of Electric Field Strength Limit

ISM equipment operating on a frequency specified in Section 18.301 of the FCC Rules is permitted unlimited radiated energy in the band specified for that frequency.

The limit of field strength levels of emissions that lie outside the ISM bands is specified in Section 18.305 of the FCC rules as follows:

Where the operating frequency is within an ISM frequency band and where the output power is greater than 500W at a measurement distance of 300m the limit for radiated field strength outside of the ISM bands is:

$$\text{Limit } (\mu\text{V/m}) \text{ at } 300\text{m} = 25\sqrt{\frac{P}{500}}$$

Where P is the measured output power of the oven in w (refer to section 3.1 of this test report).

In units of dB μ V/m, and at a measurement distance of 3m the limit is calculated as:

$$\text{Limit (dB}\mu\text{V/m) at 3m} = 20\log_{10}\left(25\sqrt{\frac{P}{500}}\right) + 20\log_{10}\left(\frac{300}{3}\right)$$

The measured oven power P , was 921.1W (refer to section 3.1 of this test report). Using this measured value of P in above formula this gives a field strength limit of 66.49dB μ V/m at a measurement distance of 3m.

The electric field strength between 100MHz and 24.5GHz was measured at 3m and compared to this limit calculated at 3m.

Note: Section 4.6.1 of FCC Document MP5 dated 1986 states that a conservative value of the field strength limit at closer distances than 300m may be calculated using inverse linear variation of field with distance.

3.8 Conversion of measurements to Electric Field Strength

Field strength is the calculation from the measurement of an emission taking into account the associated losses of the cables used, the antenna factor and the gain of the pre-amplifier.

The measurements of field strength in this test report were derived using the following calculation;

$$\text{Measured analyser voltage in dB}\mu\text{V} + \text{Antenna Factor} + \text{Cable loss} - \text{Pre amplifier gain}^* = \text{Field Strength in dB}\mu\text{V/m}$$

*External pre-amplifier gain above 1GHz. In the frequency range 30MHz to 1GHz the receiver internal preamplifier was used.

4 Summary

4.1 Emissions

Standard	Test Description	Result
CFR 47 Part 18 (10-1-08 edition)	Conducted disturbance (AC mains port) 150kHz-30MHz, Limit as defined in 18.307	Pass
	Radiated disturbance (enclosure port) 30MHz-24.5GHz, Limit as defined in 18.305	Pass
	Power Output measurement for microwave ovens as per Section 4.3 of MP-5 (1986)	See note 1
	Frequency measurements as per Section 4.5 parts (a) and (b) of MP-5 (1986)	Pass

Note 1: Power Output measurements were made using the calorimetric method; the outcome of this test is to determine the allowable out of band field strength under the terms specified within section 18.305 of the rules (see section 3.6 of this test report). Therefore, the resultant level of this test is not governed within a Pass/Fail criterion.

4.2 Compliance statement

The M6040SC USA microwave oven, as tested was shown to meet the requirements of the tests listed in 4.1 of this report.

5 Appendices

5.1 Appendix 1 Conducted emission test method

5.1.1 Test information

Standard	CFR 47 Part 18 (10-1-08 edition)
YES Test Method	Based upon CEP19
Measurement uncertainty	+/- 2.38dB
Equipment Used	Rohde & Schwarz ESHS10 receiver Rohde & Schwarz ESH3-Z5 LISN Chase 9206 transient limiter

The conducted emissions from the ac power port were assessed from both the live and neutral lines with respect to earth.

For this test the EUT was placed in a screened room and the test carried out using equipment compliant to CISPR 16.

Following an initial measurement made with a peak detector, any disturbances within 10dB of the limit line were measured with a quasi-peak and average detector respectively.

5.2 Appendix 2 Radiated emission test method (30MHz to 1000MHz)

5.2.1 Test information

Standards	CFR 47 Part 18 (10-1-08 edition)
YES Test Method	CEP23
Measurement uncertainty	±3.48dB with 10dB of attenuation
Equipment Used	Rohde & Schwarz receiver Bilog antenna Rohde & Schwarz positioning mast and controller EMCO 2m diameter turntable and controller 80cm non conducting test table

Pre-compliance measurement in an anechoic chamber

The radiated emissions from the enclosure port of the EUT were initially assessed in an anechoic chamber at a test distance of 3m, using an X Wing Bilog antenna at a fixed height of 1.5m. The measurement was made using a peak detector and the emissions were assessed with the antenna in both horizontal and vertical polarisation on the four faces of the EUT i.e. 0°, 90°, 180° and 270°. The purpose of these preliminary investigations is to highlight any frequencies within 15dB of the applied limit line. Any identified frequencies inside the anechoic chamber are then maximised on the open area test site.

Compliance measurement on the Open Area Test Site (OATS)

Any disturbances within 10dB of the limit line, or as a minimum the 10 highest values found during the anechoic chamber scans, were measured with a quasi-peak detector on the OATS using equipment compliant with CISPR16. The EUT was rotated 360°, the antenna was orientated in both horizontal and vertical polarisation with the mast scanned from 1m to 4m to maximise the Quasi-Peak values at the identified frequencies.

5.3 Appendix 3 Radiated emission test method (1GHz to 24.5GHz)

5.3.1 Test information

Standards	CFR 47 Part 18 (10-1-08 edition)
YES Test Method	CEP27
Measurement uncertainty	±4.86dB with 0dB of attenuation
Equipment Used	Anritsu spectrum analyser HP Pre-amplifier Horn antenna EMCO turntable and controller 80cm non conducting (plastic) table

Pre-compliance measurement in an anechoic chamber

The radiated emissions from the enclosure port of the EUT were initially assessed in an anechoic chamber at a test distance of 3m, using a horn antenna at a fixed height, directed towards the radiation centre of the EUT. The measurement was made using a peak detector and the emissions were assessed with the antenna in both horizontal and vertical polarisation with the EUT rotated 360° in 20° Steps.

Compliance measurement on the Open Area Test Site (OATS)

The highest values found during the anechoic chamber scans, were measured with an average detector on the OATS. The EUT was set at the angles which produced the highest levels during the pre-scan phase, the antenna was orientated in both horizontal and vertical polarisation with the mast scanned from 1m to 4m to maximise the values at the identified frequencies.

5.4 Appendix 4 Conducted emission test results

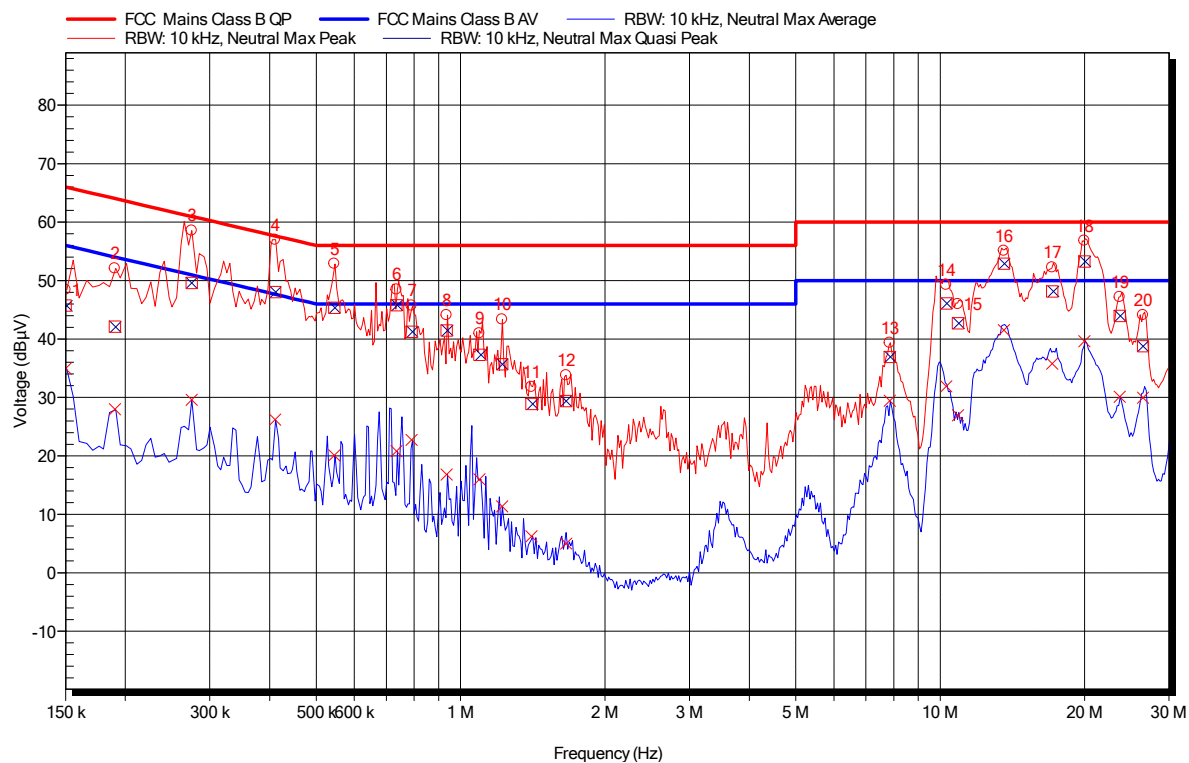


Figure 5.4.1 Conducted emissions results, (C01).

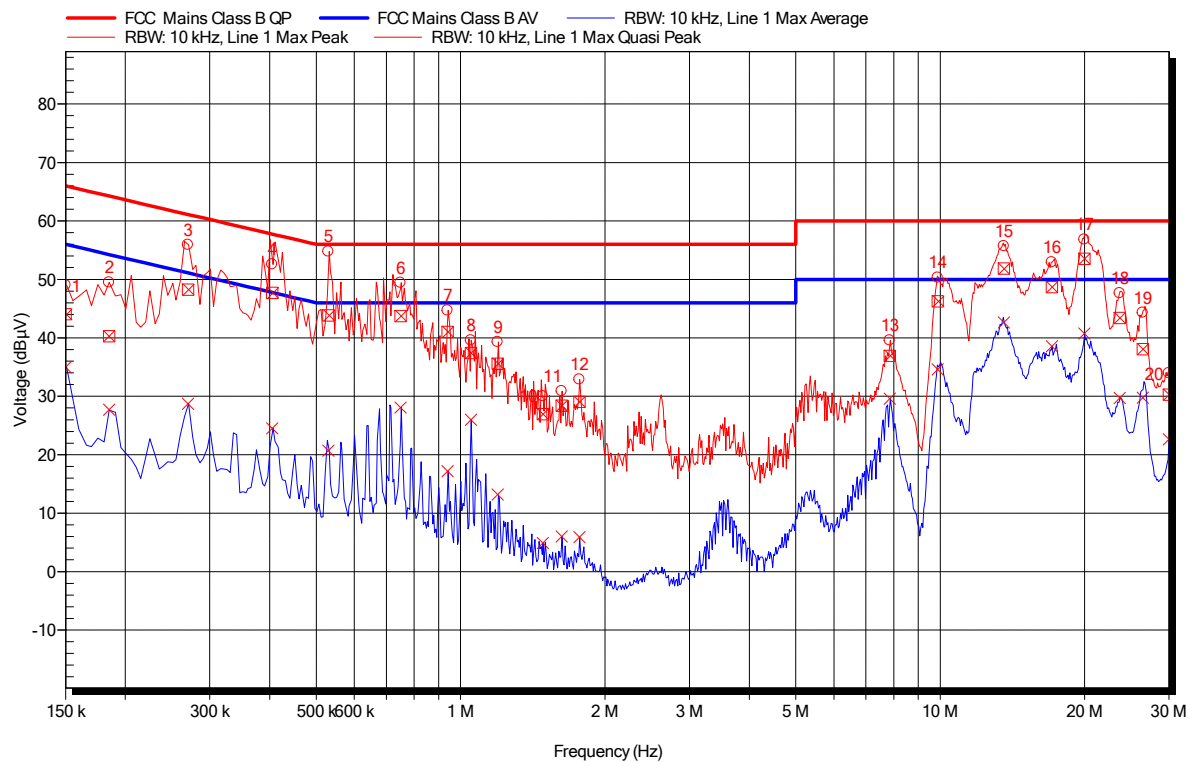


Figure 5.4.2 Conducted emissions results, (C02).

5.5 Appendix 5 Radiated emission test results

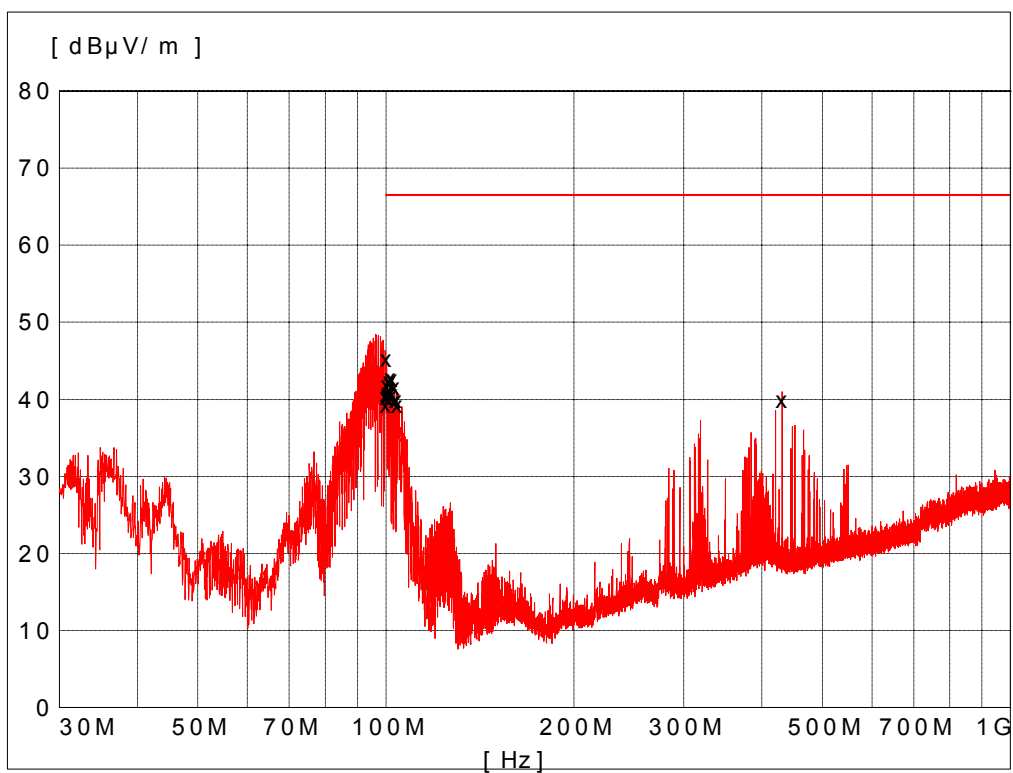


Figure 5.5.1 Radiated emissions results (R01, Peak Detector Chamber – information only).

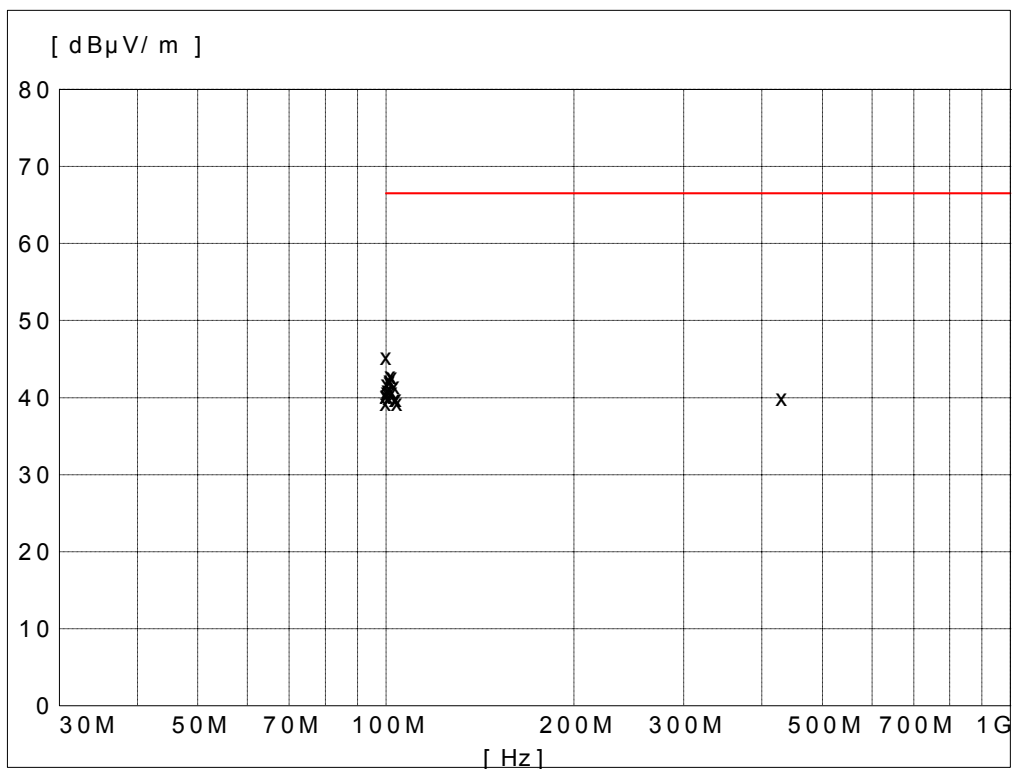


Figure 5.5.2 Radiated emissions results (R02, OATS) – Maximised Quasi Peak data.

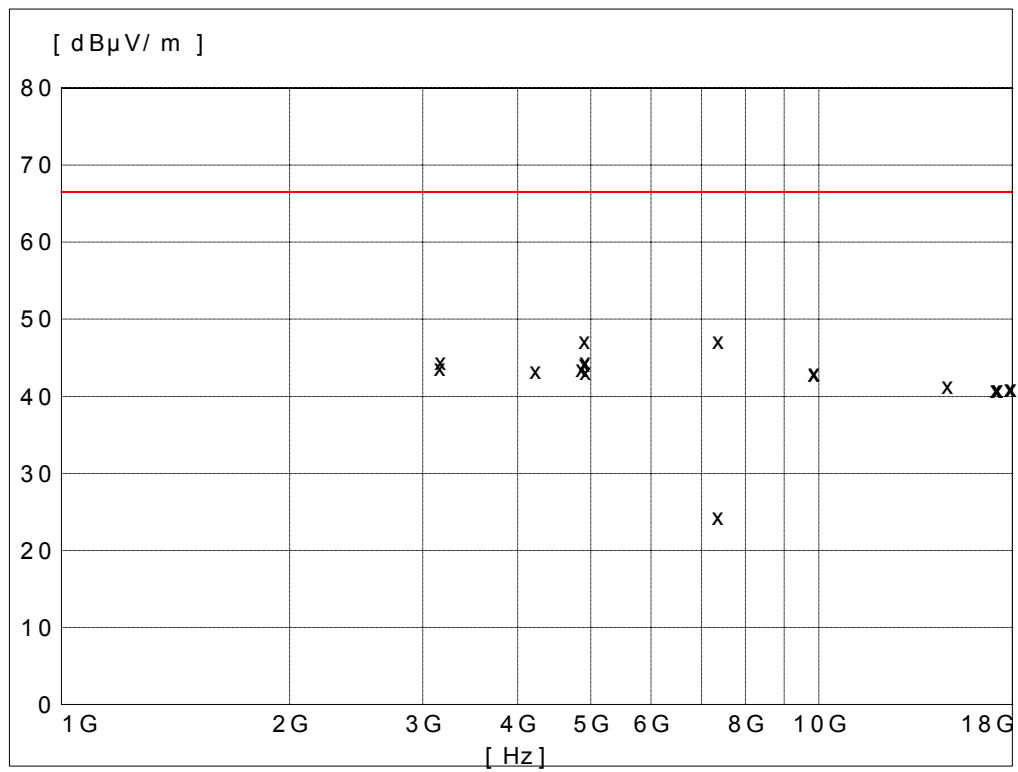


Figure 5.5.3 Radiated emissions >1GHz results (R03, OATS) – Maximised Average data.

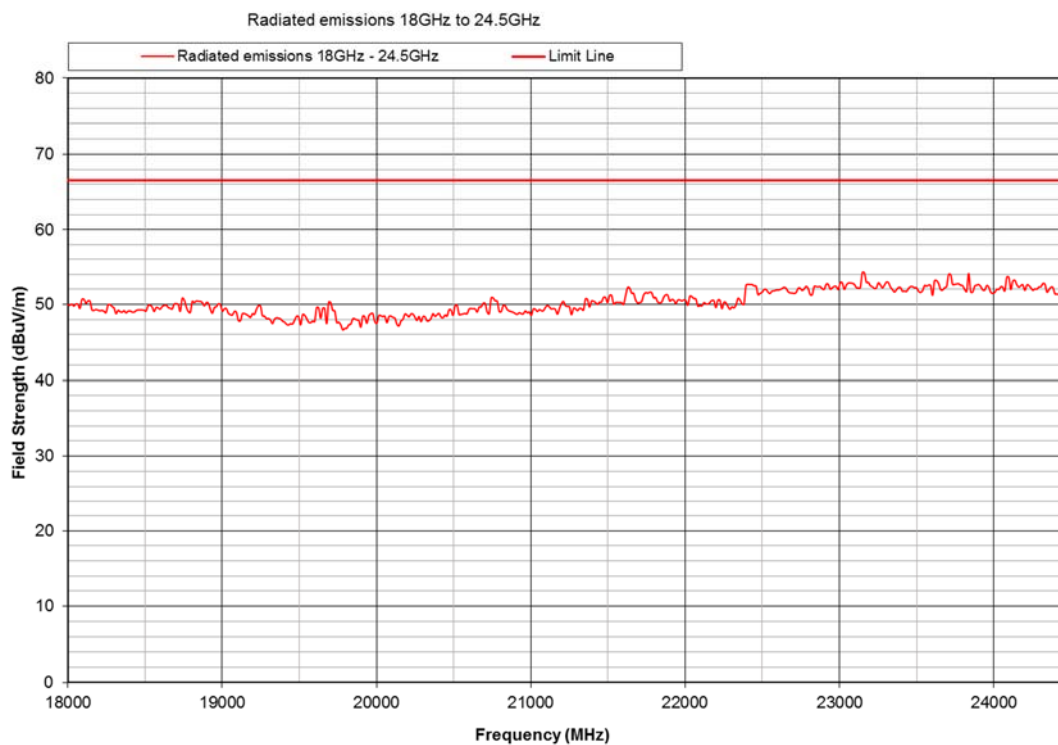


Figure 5.5.4 Radiated emissions results Antenna Horizontal
(Chamber measurement at 3m, 18GHz to 24.5GHz Peak data-Information only)

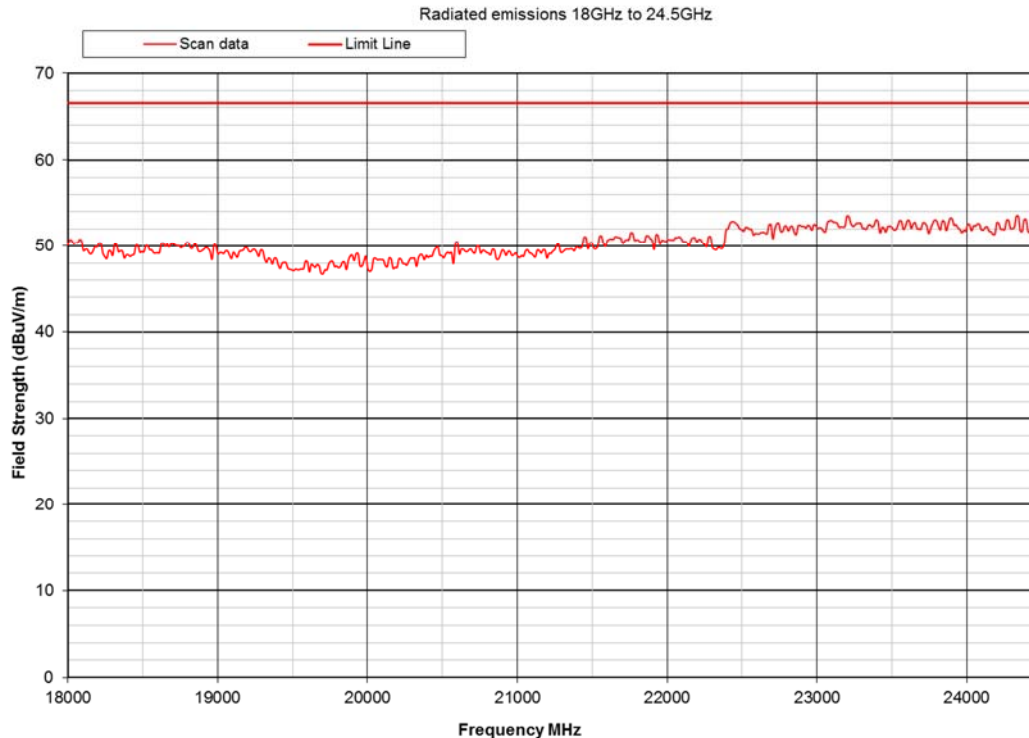


Figure 5.5.5 Radiated emissions results Antenna Vertical
(Chamber measurement at 3m, 18GHz to 24.5GHz Peak data-Information only)

5.6 Appendix 6 Frequency variation measurements

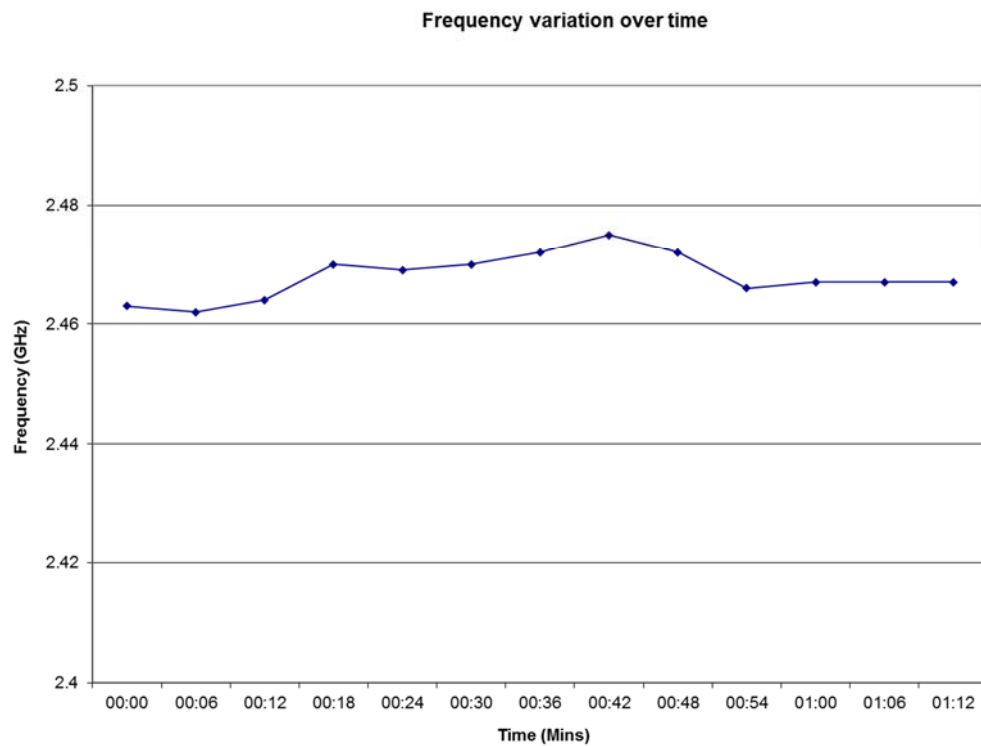


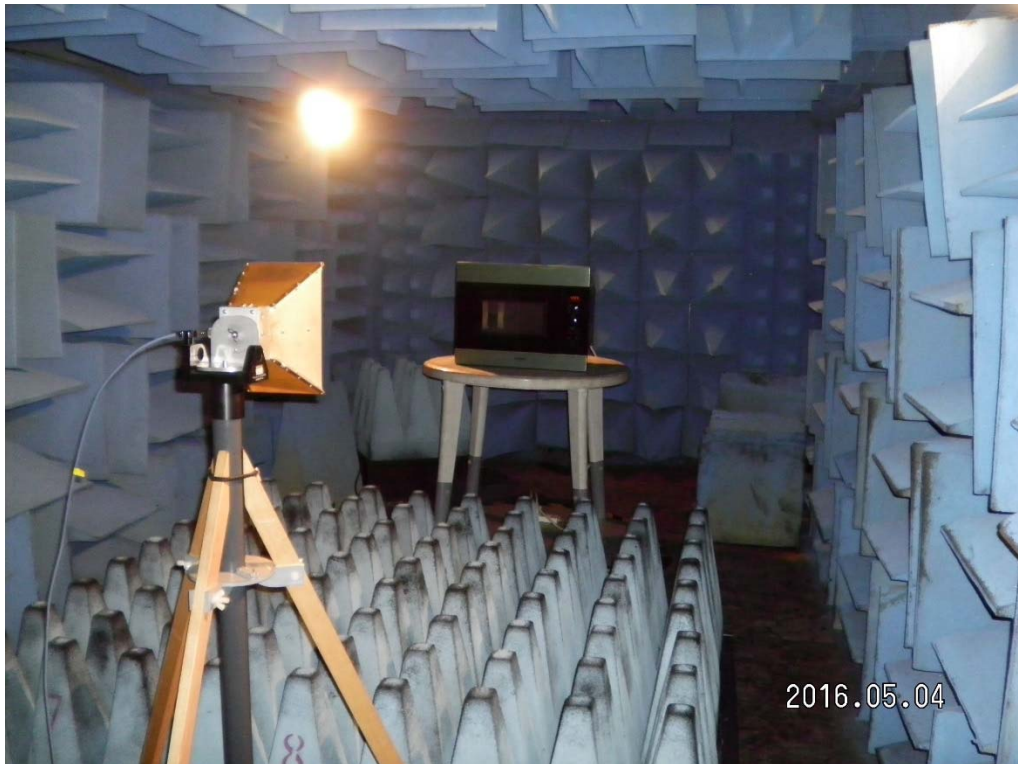
Figure 5.6.1 Frequency variation over time.

5.7 Appendix 7 EUT test configurations

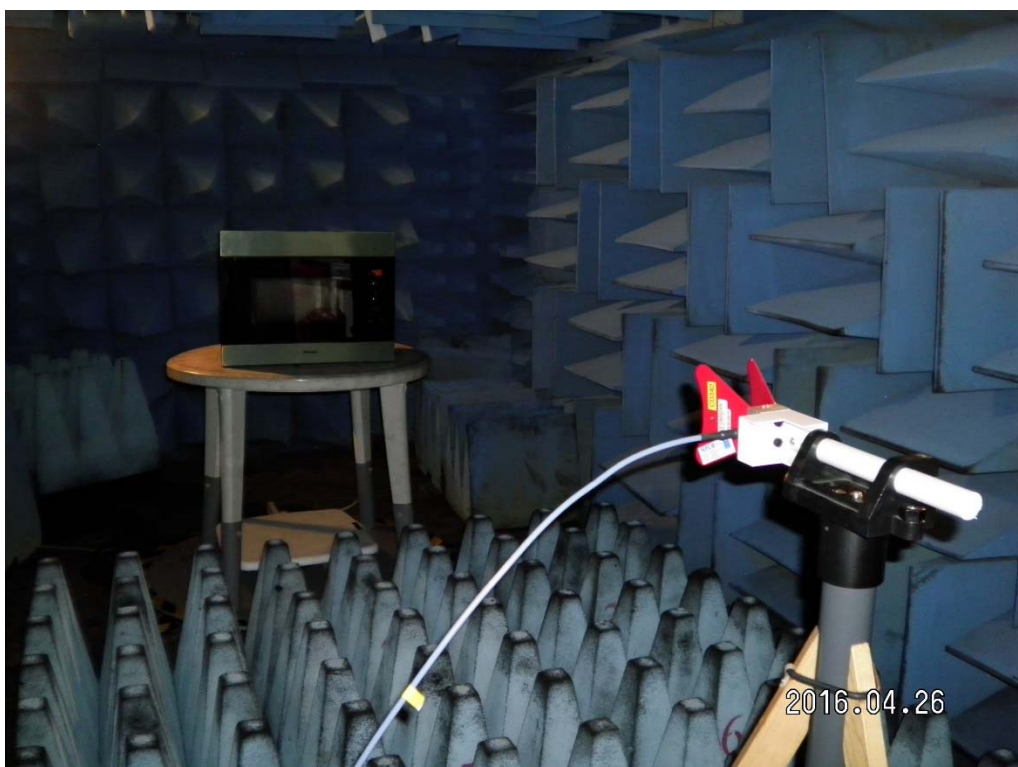
Photograph 5.7.1 Conducted emissions testing.



Photograph 5.7.2 Radiated emissions testing 30MHz-1GHz (Anechoic chamber)



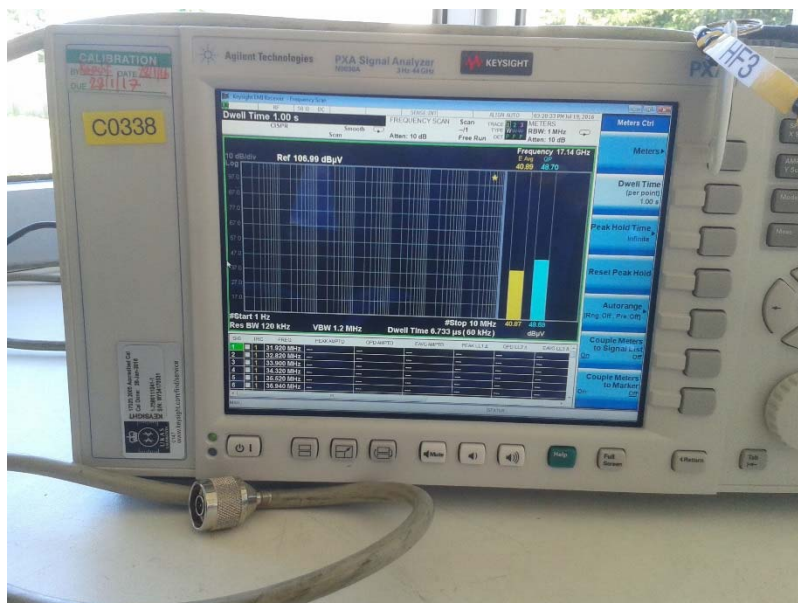
Photograph 5.7.3 Radiated emissions testing 1GHz-18GHz (Anechoic chamber)



Photograph 5.7.4 Radiated emissions testing 18GHz-24.5GHz (Anechoic chamber)



Photograph 5.7.6 Radiated emissions testing (OATS)



Photograph 5.7.7 Radiated emissions testing (OATS)

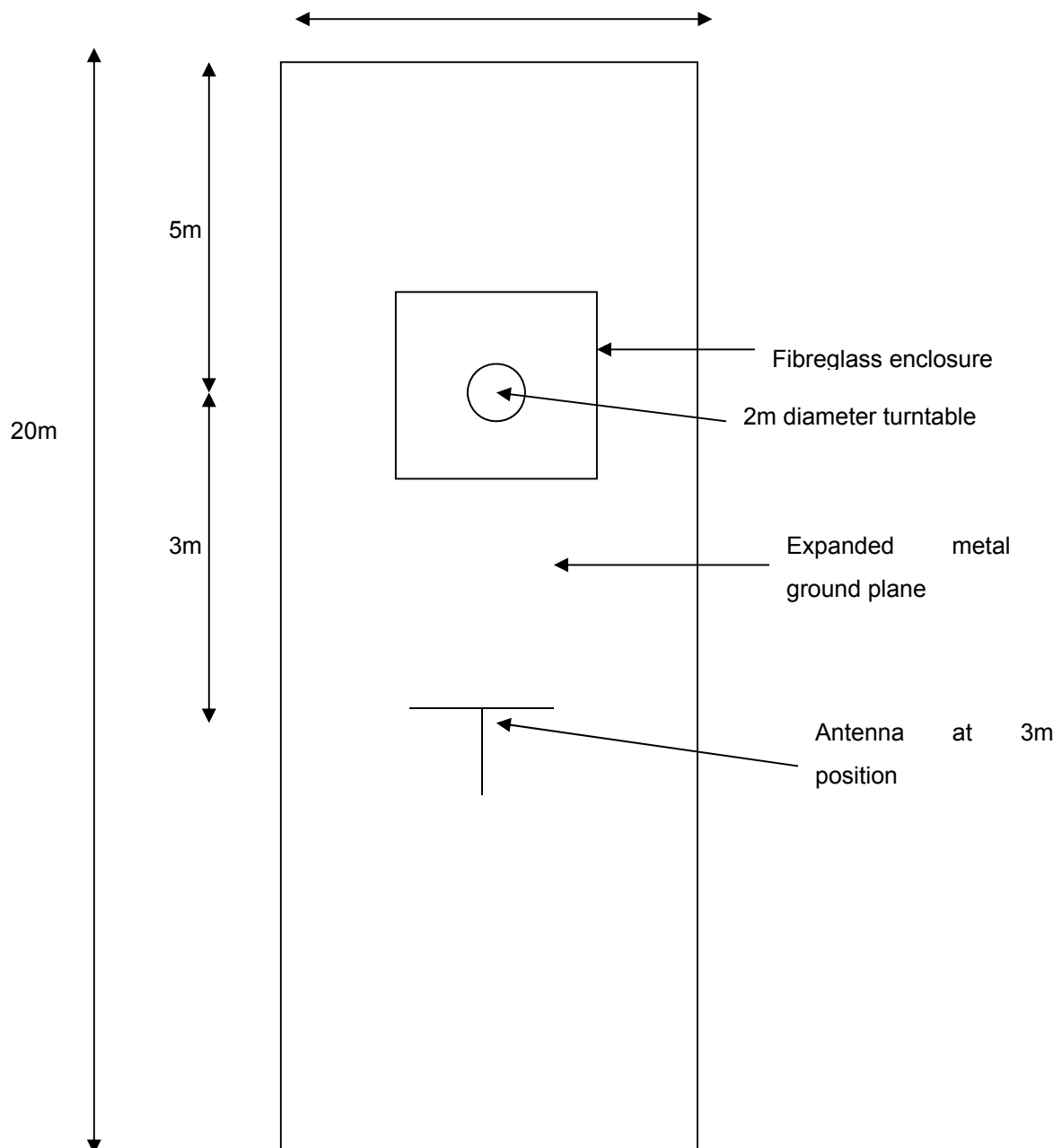
5.8 Appendix 8 Equipment used

Equipment	No.	Cal Type	Used
Chase CBL 6111A Bilog Antenna	78167	UKAS	
Chase CBL 6111C Bilog Antenna	78707	UKAS	✓
Chase CBL 6140 X-Wing Antenna	78309	In-house	✓
Chase CFL 9206 Transient Limiter	78101	In-house	
Chase CFL 9206 Transient Limiter	78087	In-house	✓
Emco 3115 Horn Antenna	78347	UKAS	✓
3116 40GHz Horn Antenna	C0342	UKAS	✓
HP 8449B Pre-amplifier	C0221	UKAS	✓
Anritsu MS2667C Analyser	78490	UKAS	✓
2.4GHz notch filter	79178	UKAS	✓
Rolfe Heine NNB 32A LISN	79739	UKAS	✓
R&S ESH3-Z5 LISN	78119	UKAS	
R&S ESHS 10 Receiver	78035	UKAS	✓
R&S ESHS10 Receiver	79182	UKAS	
R&S ESVS 30 Receiver	79183	UKAS	✓
R&S ESVS 10 Receiver	78036	UKAS	
R&S ESVS 30 Receiver	78107	UKAS	
Bonn Pre-amplifier	Y0145	UKAS	✓
Agilent PXA analyser	C0338	UKAS	✓
Thermometer and K-Type Thermocouple	79242	UKAS	✓
California Inst PACS-1 analyser	79135	UKAS	
California Inst 5000 iX Power supply	79136	UKAS	✓

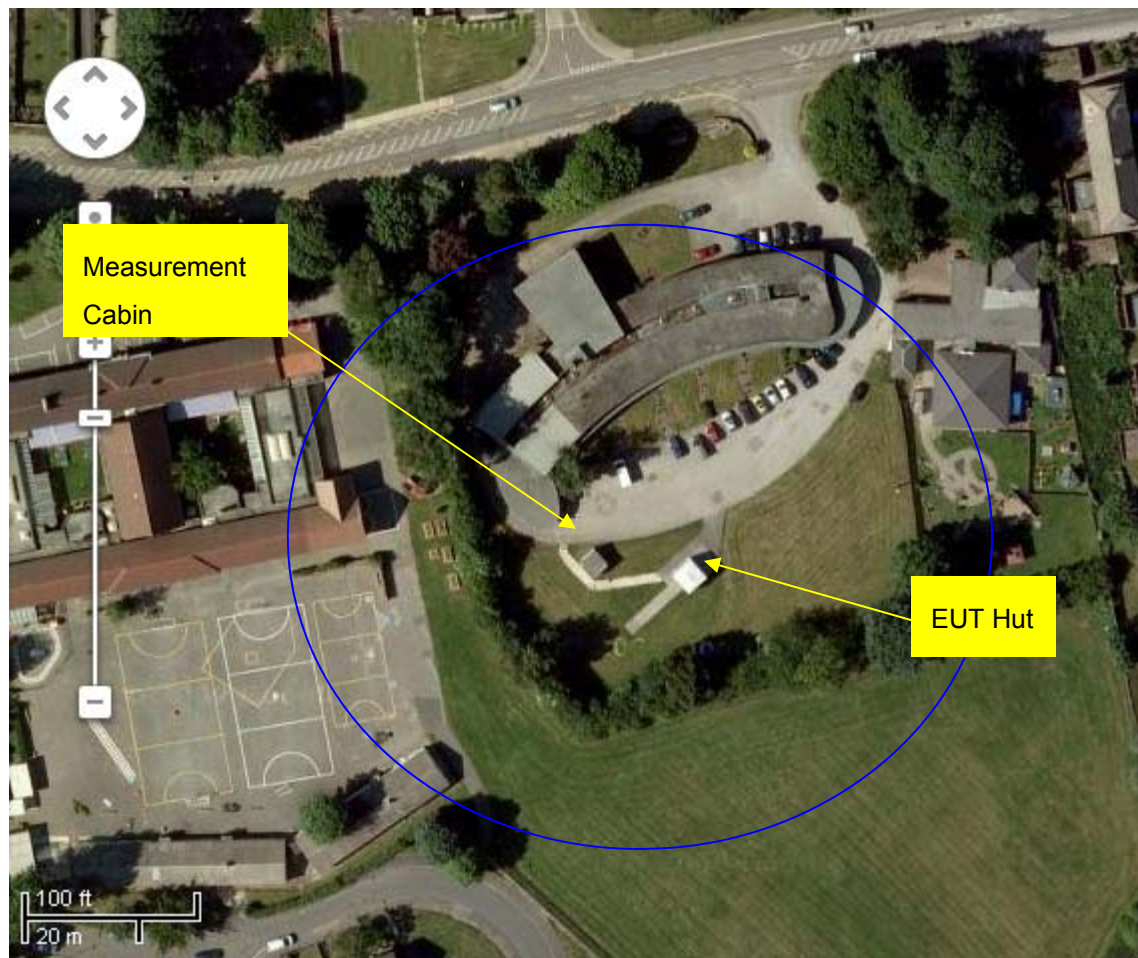
NCS-Not on calibration schedule

5.9 Appendix 9 Open Area Test Site Description

The Open Area Test Site (OATS) is constructed of welded expanded galvanised steel “Expamet” with major aperture size of approximately 28mm. The ground plane was approximately 20mx5m fitted with a 2m diameter flush mounted turntable, covered with a fibreglass enclosure approximately 4.3m x 4.3m x 3.5m high. This enclosure is fitted with double doors at both the front and rear, and has an apex height of approximately 3.5m. The site was fitted with a Rohde and Schwarz antenna mast, which was bolted to the ground plane at a 3m measurement position. No other objects were located within the CISPR ellipse. A “portacabin” type building (approximately 3.9mx3.3m) was located to one side of the site, approximately 8.6m from the edge of the ground plane and containing the measuring equipment.



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Open Area Test Site Dimensions

Open area test site, via Google, showing all structures within the estimated 5 times the distance between the measuring set and the EUT.

5.10 Appendix 10 Calibration data

Yes No.	Equipment description	Calibration Date	Calibration Frequency
78035	9kHz-30MHz R&S ESHS 10 Receiver	09/02/2016	12 Months
79739	Rolfe Heine 32A LISN	22/03/2016	12 Months
78087	CFL9206 Transient limiter	01/11/2015	12 Months
79183	30MHz-1000MHz R&S ESVS 30 Receiver	07/01/2015	18 Months
78309	Chase Xwing antenna 1053	21/12/2015	12 Months
78707	CBL6111C Blue Bilog antenna – used for OATS	30/10/2015	12 Months
78347	EMCO 3115 horn antenna	04/05/2016	24 Months
C0342	EMCO 3116C 18 to 40GHz horn antenna	26/11/2014	24 Months
78490	Anritsu MS2667C Spectrum analyser	17/05/2016	12 Months
78459	HP 8449B Pre-amplifier	25/09/2014	24 Months
Y0145	Bonn Pre-amplifier	04/05/2016	12 Months
79178	Microtronics BRM13134 2.4GHz Notch filter	23/12/2013	36 Months
79242	Digital Thermometer and K-Type Thermocouple	15/10/2015	12 Months
C0338	Agilent PXA Signal Analyser	29/01/2016	12 Months

5.11 Appendix 11 Test Report History

Issue	Modification details
1	Original issue of the test report
2	Second issue addressing comments made by FCC assessor. • Addition of section regarding calculation of field strength. • Addition of reference to ANSI C63.4:2014. • Addition of the FCC ID number