

Test Report (copy 1 of 1)
FCC Testing of the
13MHz RFID Device installed in
an Enduro Printer
for
Ultra Electronics

Document number 10208/TR/2

Project number 10984

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This test reports relates only to the unit(s) tested

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1 Introduction

Name and address of laboratory: York EMC Services Ltd
Three Lane Ends Business Centre
Methley Road
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WF10 1PN
UKAS testing laboratory N° 1574

Name and address of client: Mr Paul Conway
Ultra Electronics
Waverley House
Hampshire Road
The Granby Estate Weymouth
DT4 9XD

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

Equipment under test RFID device installed into a Security card-printing machine (Enduro, powered by 120Vac 60Hz).

Manufacturer Ultra Electronics

PCB number (RFID device) 3509-2500

Product name (Host) Magicard Enduro

Model (Host) Enduro

Serial number (Host) 47C8537

Firmware (Host) enduro-r1538-carrier-on.cfj

No. tested of each item One

FCC ID: XDW3633-0001

Customer supplied test plan ref. N/A

Date of receipt of EUT 28th September 2009

Method of receipt Brought by the customer

Date(s) of test(s) 28th, 29th, 30th, September 2009

5th October 2009

Date(s) when EUT was out of laboratory's control None

Method of disposal Awaiting disposal

Personnel witnessing tests The tests were partially witnessed by Mr Paul Conway of Ultra Electronics.

Any other relevant information: The RFID device normally only transmits for a fraction of a second when the printer is operated in order to detect the dye film cartridge inside the printer. For testing purposes the firmware of the host printer was modified such that the RFID continuously transmits while the printer is in an idle state.

2 Test Specification

2.1 Environment

The 13.56MHz RFID device is for incorporation into various products manufactured by Ultra Electronics. Typically these products will be printing devices and used in commercial and industrial environments.

2.2 Relevant standards

Test Standard	Relevant Section	Class/limit	Test Order
Title 47 of the CFR Part 15C:2008 & ANSI C63.4:2003	Section 15.225(a) Field strength within the band 13.553MHz-13.567MHz	As specified in Section 15.225(a)	3
	Section 15.225(d) Field Strength outside the band 13.110MHz-14.010MHz	As specified in Section 15.209	1
	Section 15.225(e) Frequency tolerance of the carrier signal	As specified in Section 15.225(e)	4 & 5
	Section 15.207 Mains conducted emissions	As specified in Section 15.207(a)	2

Note 1: Only the tests listed were required by the customer.

3 Test Results

3.1 Mains conducted emissions

Mode of operation	Description	Mode No.
	13.56MHz RFID device continuously transmitting inside host printer (printer in idle mode).	1

Test standard	Test description	Class/limit
CFR 47 Part 15C:2008 Section 15.207 & ANSI C63.4:2003	Conducted emissions on ac power of host printer	As specified in section 15.207(a)

Results	Mode	Figure	Result	Comments
	1	C01	Pass	None

QP Results	Mode	Freq (MHz)	QP level (dBuV)	Comments
	1			The peak results were greater than 10dB below the final average limit, therefore no final quasi peak measurements were performed.

Average Results	Mode	Freq (MHz)	Final AV level (dBuV)	Comments
	1	13.56	51.6	All other initial average measurements were greater than 10dB below the final average limit, therefore no further final average emissions measurements were performed.

Note 1: See Appendix 6 for the graphical data results.

Note 2: The Final average level was obtained by adding together the receiver reading and factors for the cables of the measuring system, the transient limiter and LISN:

$$\text{Final level (51.6) dBuV} = \text{Receiver reading (40.8)} + \text{cable and limiter losses (10.3) dB} + \text{LISN correction (0.5) dB}$$

Note 3: The graphical result shows the composite plot of both the live and neutral conductors.

Modifications	Required for this test	Modification state
	In order to pass this test the host printer was fitted with a 30uH common mode choke see Appendix 8 for details.	1

3.2 Field strength within the band 13.553MHz-13.567MHz

Mode of operation	Description	Mode No.
	13.56MHz RFID device continuously transmitting inside host printer (printer in idle mode)	1

Test standard	Test description	Class/limit
CFR 47 Part 15C:2008 Section 15.225(a) & ANSI C63.4:2003	Radiated emissions	As specified in section 15.225(a)

Results	Mode	Figure	Comments
	1	R01	Open Area Test Site result (parallel polarisation)
		R02	Open Area Test Site (OATS) (perpendicular polarisation)

Freq (MHz)	Rx dB μ V	CL (dB)	Antenna factor dB/m	Result at 10m (dB μ V/m)	Distance correction factor (40dB/decade)	Result at 30m (dB μ V/m)	Limit At 30m (dB μ V/m)	Margin (dB)	Result
13.56	22.21	0.59	19.3	42.1	19.0	23.1	84.0	60.9	Pass

Receiving antenna parallel position, receiving antenna at 1m measurement height, equipment under test at 263 degree angle.

Freq (MHz)	Rx dB μ V	CL (dB)	Antenna factor dB/m	Result at 10m (dB μ V/m)	Distance correction factor (40dB/decade)	Result at 30m (dB μ V/m)	Limit At 30m (dB μ V/m)	Margin (dB)	Result
13.56	27.41	0.59	19.3	47.3	19.0	28.3	84.0	55.7	Pass

Receiving antenna perpendicular polarisation, receiving antenna at 1m measurement height, equipment under test at 177 degree angle.

Rx = Test receiver reading (voltage dB μ V) before the addition of cable loss and antenna factor.

CL = total cable loss between antenna and test receiver (dB)

Result at 10m = Field strength (dB μ V/m) at a measurement distance of 10m, calculated as follows:

$$\text{Field strength (dB}\mu\text{V/m)} = \text{Rx (dBmV)} + \text{CL(dB)} + \text{Antenna factor (dB/m)}$$

$$\begin{aligned} \text{Example (using above data):} &= 27.41 (\text{dB}\mu\text{V}) + 0.59 (\text{dB}) + 19.3 \\ &= 47.3 \text{dB}\mu\text{V/m at a 10 m measurement distance} \\ &= 28.3 \text{dB}\mu\text{V/m at a 30 m measurement distance} \end{aligned}$$

Result at 30m : Section 15.225(a) of CFR 47 Part 15(c), States the limit to be 15,848uV/m at a test distance of 30m. The above measurement was performed at a test distance of 10m and hence the result at 10m was scaled using the extrapolation factor of **40dB/decade as stated in section 15.31(f)(2)**.

$$15,485\mu\text{V}/\text{m} \equiv 84\text{dBuV}/\text{m},$$

For the specified measurement distance of 30m the correction will be:

$$\text{Correction} = 40 * \log (10/30) = -19\text{dB}$$

Note 2: The graphical results can be found in Appendix 1, the crosses on the plot relate to the final quasi peak value.

Note 3: The above measurements were taken using a Quasi peak detector.

Modifications	Required for this test	Modification state
	None	0

3.3 Field strength within the bands 13.410-13.553MHz and 13.567-13.710MHz

Mode of operation	Description	Mode No.
	13.56MHz RFID device continuously transmitting inside host printer (printer in idle mode)	1

Test standard	Test description	Class/limit
CFR 47 Part 15C:2008 Section 15.225(b) & ANSI C63.4:2003	Radiated emissions	As specified in section 15.225(b)

Results	Mode	Figure	Comments
	1	R03	Chamber result within the band 13.410-13.553MHz (See Note 3)
		R04	Chamber result within the band 13.567-13.710MHz (See Note 3)

Result at 30m : Section 15.225(b) of CFR 47 Part 15(c), States the limit to be 334 μ V/m at a test distance of 30m. The above measurement was performed at a test distance of 3m and hence the result at 3m was scaled using the extrapolation factor of **40dB/decade as stated in section 15.31(f)(2)**.

At a measurement distance of 30m:

$$334\mu\text{V}/\text{m} = 50.47\text{dB}\mu\text{V}/\text{m}$$

For the measurement distance of 3m the correction will be:

$$\text{Correction} = 40 * \log (30/3) = 40\text{dB}$$

Therefore the limit at 3m will be :

$$50.47\text{dB}\mu\text{V}/\text{m} + 40 = 90.47\text{dB}\mu\text{V}/\text{m}$$

Note 2: The graphical results can be found in Appendix 2.

Note 3: The above measurements were taken using a peak detector.

No emissions were detected within the specified bands of 15.225(b) that were within 30dB of the specification limit.

Modifications	Required for this test	Modification state
	None	0

3.4 Field strength within the bands 13.110-13.410MHz and 13.710-134.010MHz

Mode of operation	Description	Mode No.
	13.56MHz RFID device continuously transmitting inside host printer (printer in idle mode)	1

Test standard	Test description	Class/limit
CFR 47 Part 15C:2008 Section 15.225(c) & ANSI C63.4:2003	Radiated emissions	As specified in section 15.225(c)

Results	Mode	Figure	Comments
	1	R05	Chamber result within the band 13.410-13.553MHz (See Note 3)
		R06	Chamber result within the band 13.567-13.710MHz (See Note 3)

Result at 30m : Section 15.225(c) of CFR 47 Part 15(c), States the limit to be 106 μ V/m at a test distance of 30m. The above measurement was performed at a test distance of 3m and hence the result at 3m was scaled using the extrapolation factor of **40dB/decade as stated in section 15.31(f)(2)**.

At a measurement distance of 30m:

$$106\mu\text{V}/\text{m} = 40.5\text{dB}\mu\text{V}/\text{m},$$

For the measurement distance of 3m the correction will be:

$$\text{Correction} = 40 * \log (30/3) = 40\text{dB}$$

Therefore the limit at 3m will be :

$$40.5\text{dB}\mu\text{V}/\text{m} + 40 = 80.47\text{dB}\mu\text{V}/\text{m}$$

Note 2: The graphical results can be found in Appendix 3.

Note 3: The above measurements were taken using a peak detector.

No emissions were detected within the specified bands of 15.225(b) that were within 30dB of the specification limit.

Modifications	Required for this test	Modification state
	None	0

3.5 Field Strength outside the band 13.110MHz-14.010MHz

Mode of operation	Description	Mode No.
	13.56MHz RFID device continuously transmitting inside host printer (printer in idle mode)	1

Test standard	Test description	Class/limit
CFR 47 Part 15C:2008 Section 15.225(d) & ANSI C63.4:2003	Radiated emissions	As specified in Section 15.209

Results	Mode	Figure	Frequency Range	Comments
	1	R07	9kHz to 30MHz	Chamber result (See Note 2)
		R08	30MHz to 1GHz	Chamber result (See Note 2)
		R09	9kHz to 30MHz	Open Area Test Site Result
		R10	30MHz to 1GHz	Open Area Test Site Result

Freq (MHz)	Rx* (dBuV)	Cable loss (dB)	Antenna factor (dB/m)	Final level (dBuV/m)	Antenna height (m)	Turntable angle (°)	Pol	Det	Limit*** (dBuV/m)	Margin (dB)	Result
0.0375	-18.93	0.027	19.71	0.8	1.0	0	Perp	AV	36.12	35.32	Pass
0.0500	-3.94	0.02	19.62	15.7	1.0	0	Perp	AV	33.62	17.92	Pass
0.0700	-40.28	0.02	19.56	-20.7	1.0	0	Perp	AV	30.70	51.4	Pass
0.0980	-32.47	0.03	19.54	-12.9	1.0	0	Perp	QP	27.78	40.68	Pass
0.1125	-27.75	0.03	19.52	-8.2	1.0	0	Perp	AV	26.58	34.78	Pass

Freq (MHz)	Rx** (dBuV)	Cable loss (dB)	Antenn a factor (dB/m)	Final QP level (dBuV/m)	Antenna height (m)	Pol	Turntable angle (°)	Det.	Limit (dBuV/m)	Margin (dB)	Result
195.24	20.99	2.41	7.8	31.2	1.00	V	182	QP	43.52	12.32	Pass
144.0	18.44	2.06	11.2	31.7	1.00	V	184	QP	43.52	11.82	Pass
133.86	20.82	2.01	11.37	34.2	1.00	V	189	QP	43.52	9.32	Pass
130.2	18.4	2	11.3	31.7	1.00	V	0	QP	43.52	11.82	Pass
217.02	20.9	2.6	8.8	32.3	1.00	V	169	QP	46.02	13.72	Pass
230.58	20.88	2.69	9.43	33.0	1.97	V	222	QP	46.02	13.02	Pass
240.0	16.72	2.88	10.3	29.9	1.00	V	0	QP	46.02	16.12	Pass
312.48	15.41	3.17	13.42	32	1.45	V	215	QP	46.02	14.02	Pass
401.7	16.65	3.68	16.17	36.5	1.00	V	0	QP	46.02	9.52	Pass
455.52	14.35	4.04	17.11	35.5	1.00	V	0	QP	46.02	10.52	Pass

Det = detector, QP = Quasi-Peak, AV = Average

Pol = position of receive antenna, below 30MHz perp = loop antenna plane perpendicular to equipment under test. Above 30MHz, V = Vertical, H = horizontal

*Test receiver reading (voltage dB μ V) before the addition of cable loss and antenna factors at 300m as stated in section 15.20

Measurements were made at 10m and the data extrapolated to a 300m distance.

For the specified measurement distance of 300m the correction will be:

$$\text{Correction} = 40 \times \log(10/300) = -59 \text{dB}$$

**Test receiver reading (voltage dB μ V) before the addition of cable loss and antenna factors at 3m as stated in section 15.209.

***According to section 15.209 of Part 15, in the frequency range 0.009MHz to 0.490MHz the limit is calculated as:

Limit (μ V/m) = 2400 / F(kHz):

At 0.0375MHz the limit at 300m is: $2400/37.5 = 64 = 36.12 \text{dB}\mu\text{V/m}$

At 0.0500 MHz the limit at 300m is: $2400/50.0 = 48 = 33.62 \text{ dB}\mu\text{V/m}$

At 0.0700 MHz the limit at 300m is: $2400/70.0 = 34.29 = 30.70 \text{ dB}\mu\text{V/m}$

At 0.0980 MHz the limit at 300m is: $2400/98 = 24.49 = 27.78 \text{ dB}\mu\text{V/m}$

At 0.1125 MHz the limit at 300m is: $2400/112.5 = 21.33 = 26.58 \text{ dB}\mu\text{V/m}$

Note 1: The graphical data can be found in Appendix 4, the crosses on the plot relate to the final quasi peak value.

Note 2: Chamber measurements (scans) were first performed to obtain the radiated frequency data. The worse case frequencies were then measured on an Open Area Test Site (OATS).

Note 3: All emissions outside the RFID band were found to be due to the printer and not the RFID device.

Modifications	Required for this test	Modification state
	None	0

3.6 Frequency tolerance of the carrier signal

Mode of operation	Description	Mode No.
	13.56MHz RFID device continuously transmitting inside host printer (printer in idle mode)	1

Test standard	Test description	Class/limit
CFR 47 Part 15C:2008 Section 15.225(e) & ANSI C63.4:2003	Frequency tolerance of the carrier signal	As specified in Section 15.225(e)

Results	Mode	Figure	Result	Comments
1	R01	Pass	The frequency tolerance as specified in section 15.225(e) is +/-0.01	

Carrier frequency: 13.56258MHz

0.01% = 0.001356258MHz

Lower limit = 13.56258 – 0.001356258 = 13.56122374MHz

Upper limit = 13.56258 + 0.001356258 = 13.56393626MHz

Table 3.6.1 Frequency tolerance of carrier frequency for variations in temperature – measurements taken

Temp	minus 20 degrees				minus 10 degrees				0 degrees				10 degrees			
	0	2mins	5mins	10mins	0	2mins	5mins	10mins	0	2mins	5mins	10mins	0	2mins	5mins	10mins
Time	0	63.75	63.42	63.40	61.23	61.04	60.94	61.20	64.76	64.66	64.62	64.48	59.22	59.10	58.83	58.33
Max amplitude of carrier	63.82															
Temp	20 degrees				30 degrees				40 degrees				50 degrees			
	0	2mins	5mins	10mins	0	2mins	5mins	10mins	0	2mins	5mins	10mins	0	2mins	5mins	10mins
Time	0	63.75	63.42	63.40	61.23	61.04	60.94	61.20	64.76	64.66	64.62	64.48	59.22	59.10	58.83	58.33
Max amplitude of carrier	63.82															
Freq at max amplitude	13.56233	13.56233	13.56234	13.56233	13.56236	13.56235	13.56226	13.56235	13.56233	13.56233	13.56233	13.56233	13.5625	13.5625	13.56248	13.56233

Max Freq of scans 1 to 32	Upper limit	Min Freq of scans 1 to 32	Lower limit
13.56284000MHz	13.56393626MHz	13.56210000MHz	13.56122374MHz

Table 3.6.1 Frequency tolerance of carrier frequency for variations in temperature – Result summary

Scan Number	102V(85%)				114V(95%)				126V(105%)				138V(115%)			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Max amplitude of carrier	77.23	76.90	76.46	75.92	75.82	75.68	75.38	74.91	84.74	84.71	84.71	84.69	84.67	84.67	84.64	84.62
Freq at max amplitude	13.5628	13.56258	13.56254	13.56254	13.56254	13.56226	13.56252	13.56255	13.56252	13.56252	13.56252	13.56251	13.56209	13.56222	13.56224	13.56251

Table 3.6.3 Frequency tolerance of carrier frequency for variations in supply voltage – measurements taken

Max Freq of scans 1 to 16	Upper limit	Min Freq of scans 1 to 16	Lower limit
13.56280000MHz	13.56393626MHz	13.56209000MHz	13.56122370MHz

Table 3.6.4 Frequency tolerance of carrier frequency for variations in supply voltage result summary

Note 1: The graphical data can be found in Appendix 5.

4 Summary

4.1 Emissions

Test Standard	CFR 47 Part 15C:2008 &ANSI C63.4:2003
---------------	---------------------------------------

Basic Standard	Class/limit	Result
Section 15.225(a) Field strength within the band 13.553MHz-13.567MHz	As specified in Section 15.225(a)	Pass
Section 15.225(d) Field Strength outside the band 13.110MHz-14.010MHz	As specified in Section 15.209	Pass
Section 15.225(e) Frequency tolerance of the carrier signal	As specified in Section 15.225(e)	Pass
Section 15.207 Mains conducted emissions	As specified in Section 15.207(a)	Pass

Note 1: Only the tests listed were required by the customer.

4.2 Compliance statement

The 13.56MHz RFID Device installed in an 'Enduro' printer, as tested and modified, was shown to meet the requirements of the standards listed in 4.1 of this report.

5 Appendices

5.1 Appendix 1 Field strength within the band 13.553MHz-13.567MHz

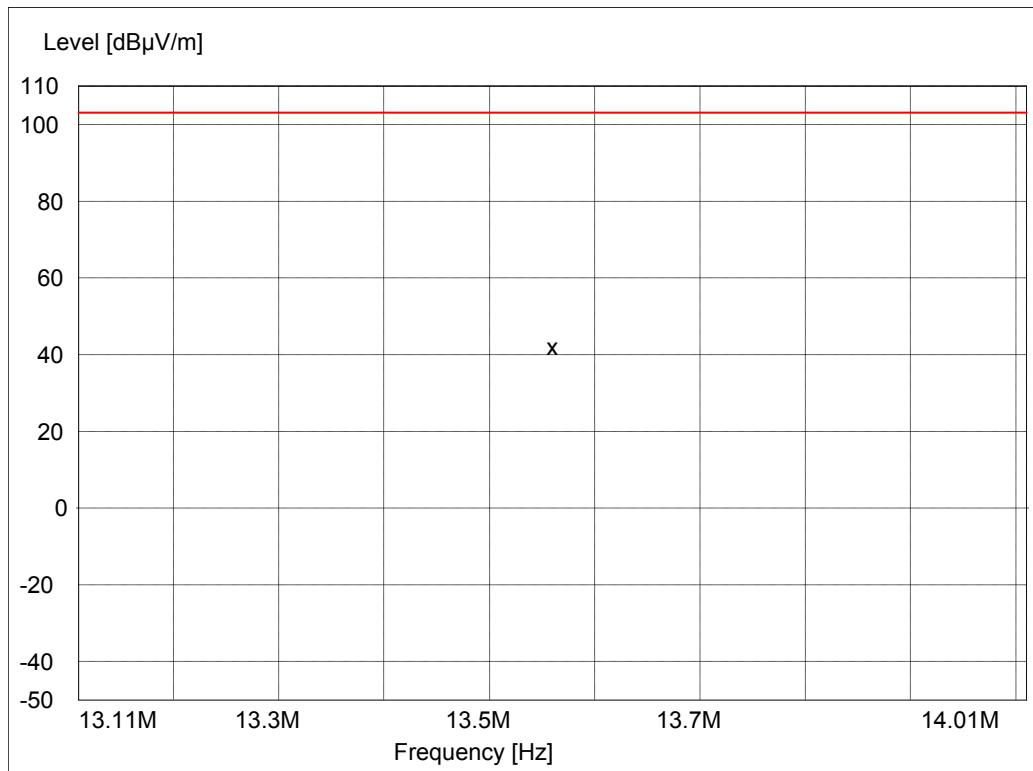


Fig 5.1.1 Radiated emission at 13.56MHz spot frequency (R01), Open Area Test Site result, 10m measurement distance, perpendicular polarisation

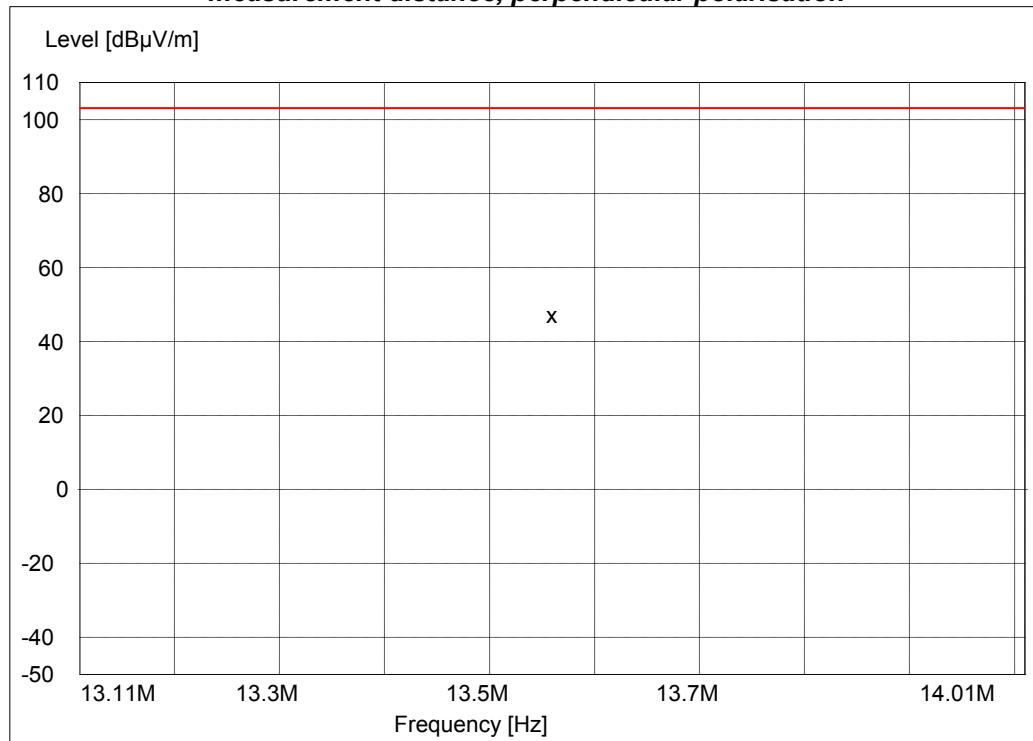


Fig 5.1.2 Radiated emission at 13.56MHz spot frequency (R02), Open Area Test Site result, 10m measurement distance, parallel polarisation

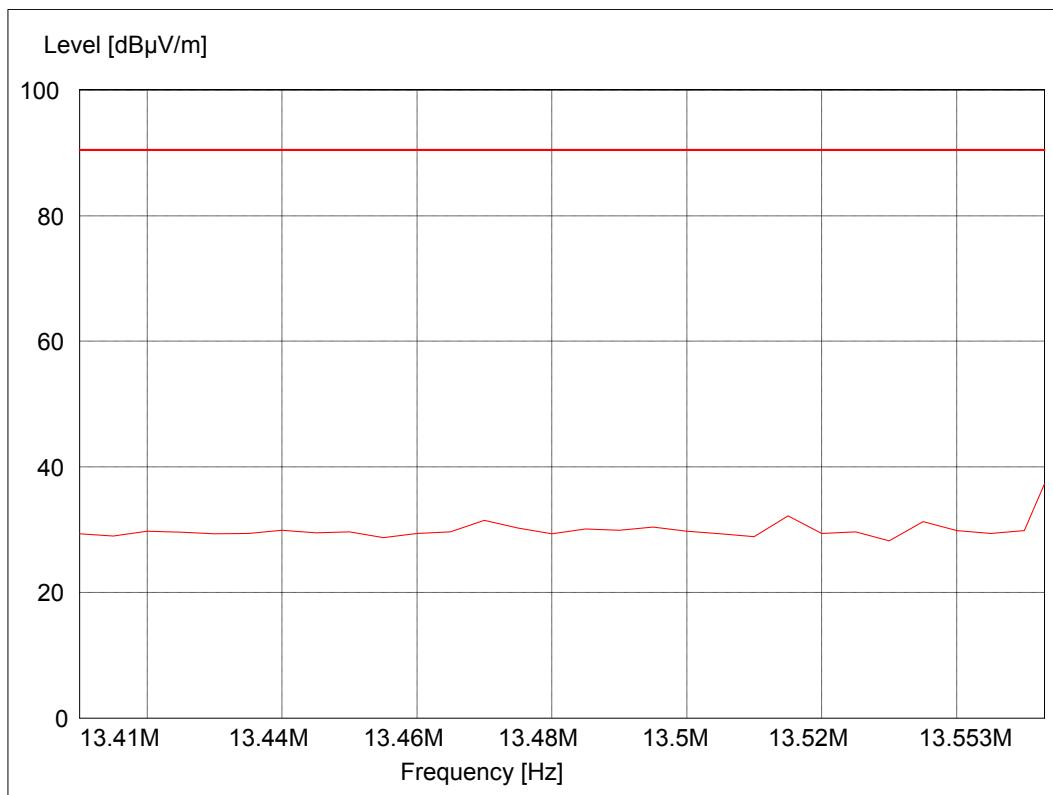
5.2 Appendix 2 Field strength within the bands 13.410-13.553MHz and 13.567-13.710MHz

Fig 5.2.1 Radiated emissions, within the band 13.410-13.553MHz (Chamber R03), 3m measurement distance.

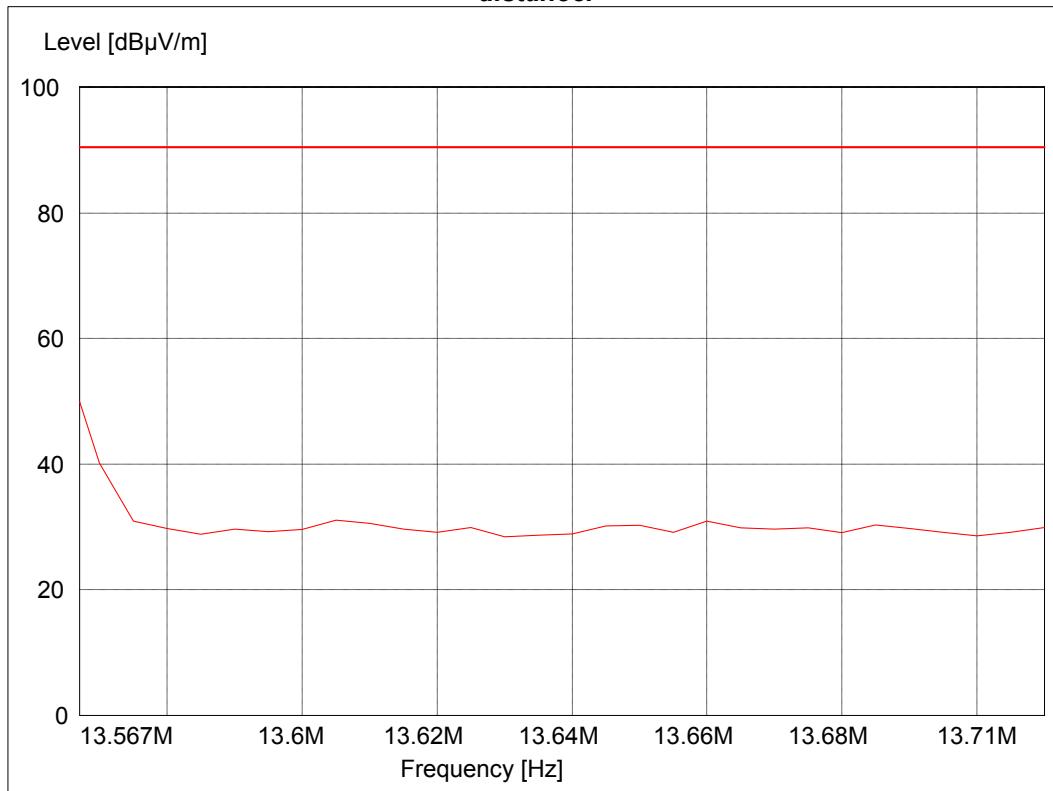


Fig 5.2.2 Radiated emissions, within the band 13.567-13.710MHz (Chamber R04), 3m measurement distance.

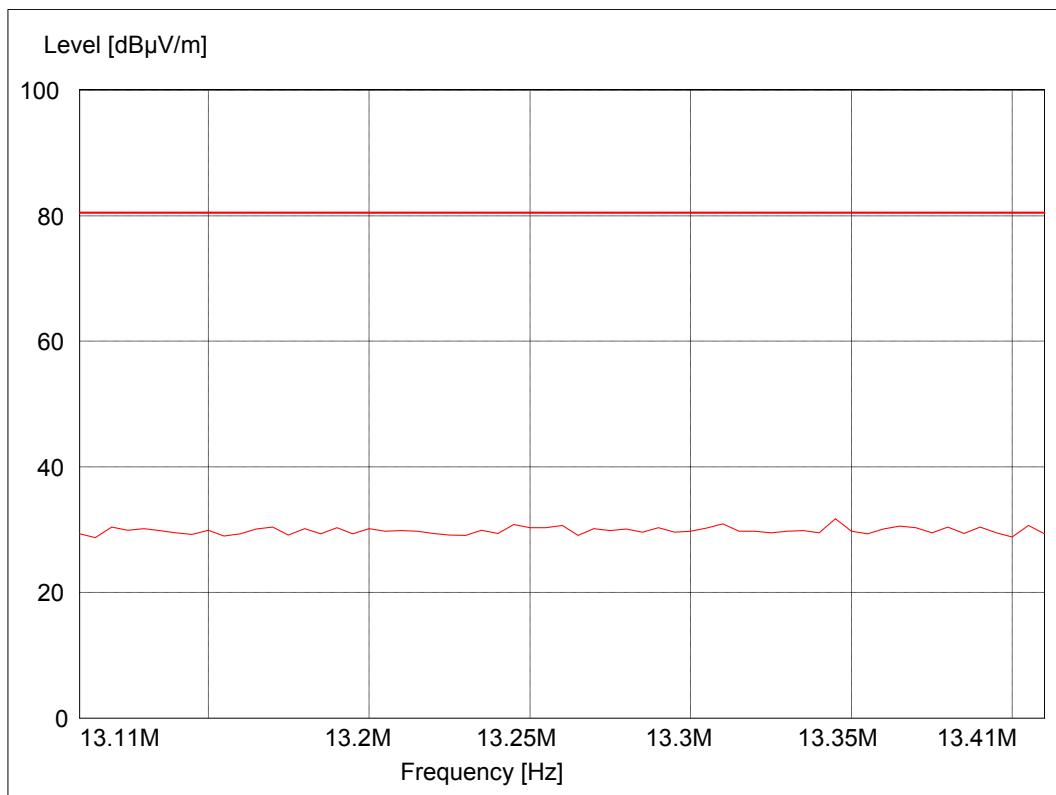
5.3 Appendix 3 Field strength within the bands 13.110-13.410MHz and 13.710-14.010MHz

Fig 5.3.1 Radiated emissions (Chamber R05), within the band 13.110-13.410MHz, 3m measurement distance.

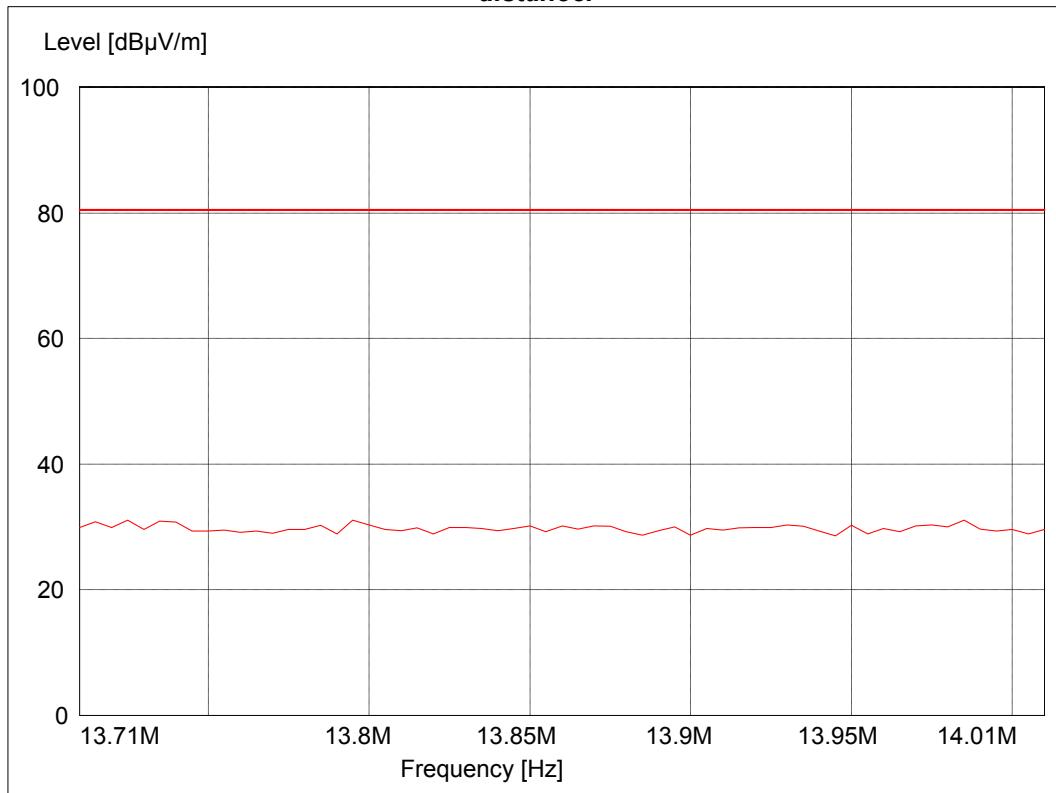


Fig 5.3.2 Radiated emissions (Chamber R06), within the band 13.710-14.010MHz, 3m measurement distance.

5.4 Appendix 4 Field Strength outside the band 13.110MHz-14.010MHz

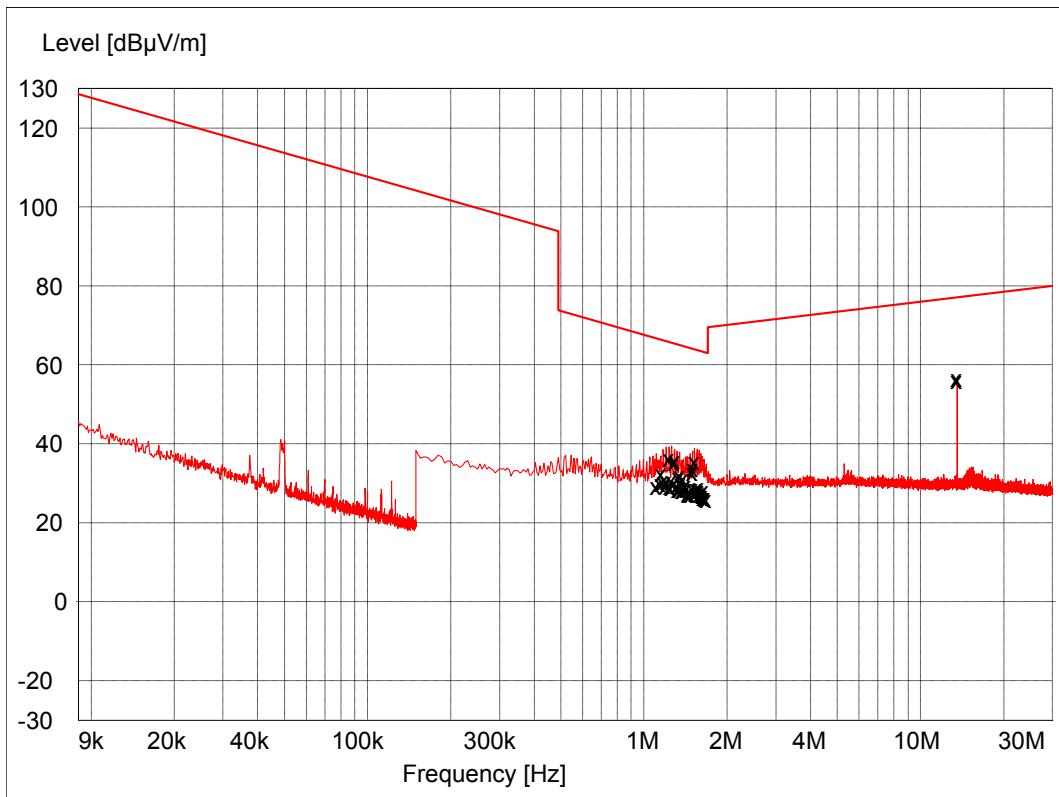


Fig 5.4.1 Radiated emissions result (Chamber R07), 9kHz to 30MHz parallel and perpendicular polarisation combined plot, 3m measurement distance

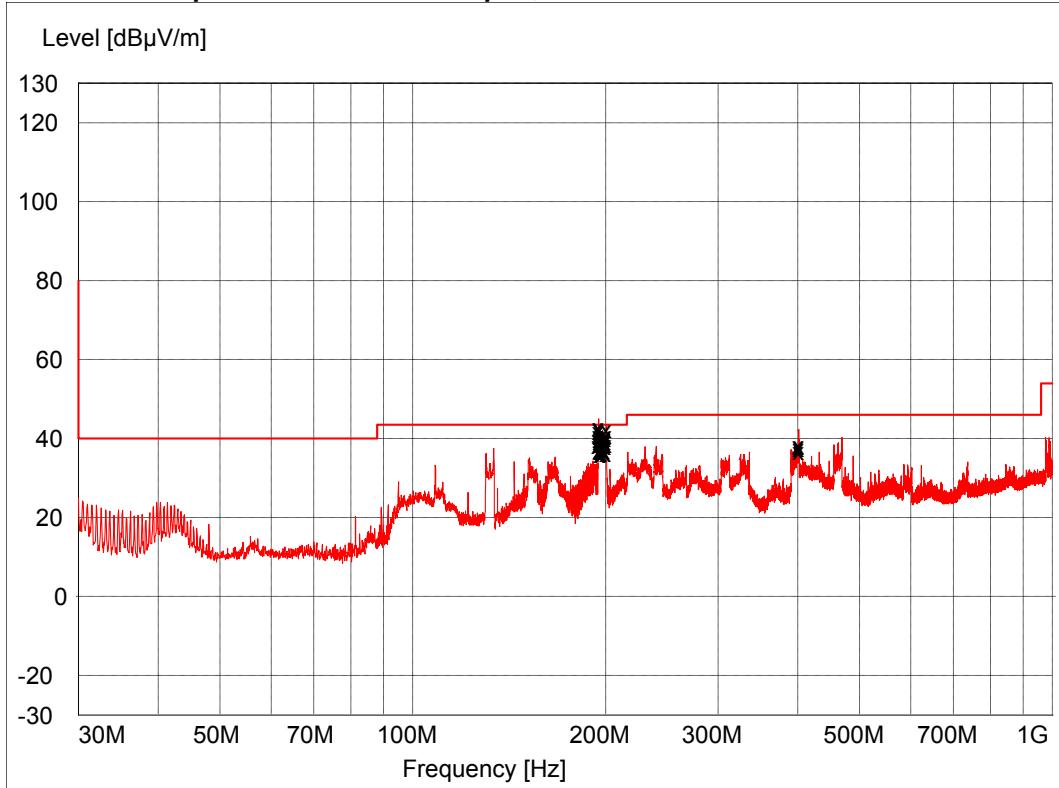


Fig 5.4.2 Radiated emissions result (Chamber R08), 30MHz to 1GHz vertical and horizontal polarisation combined plot, 3m measurement distance

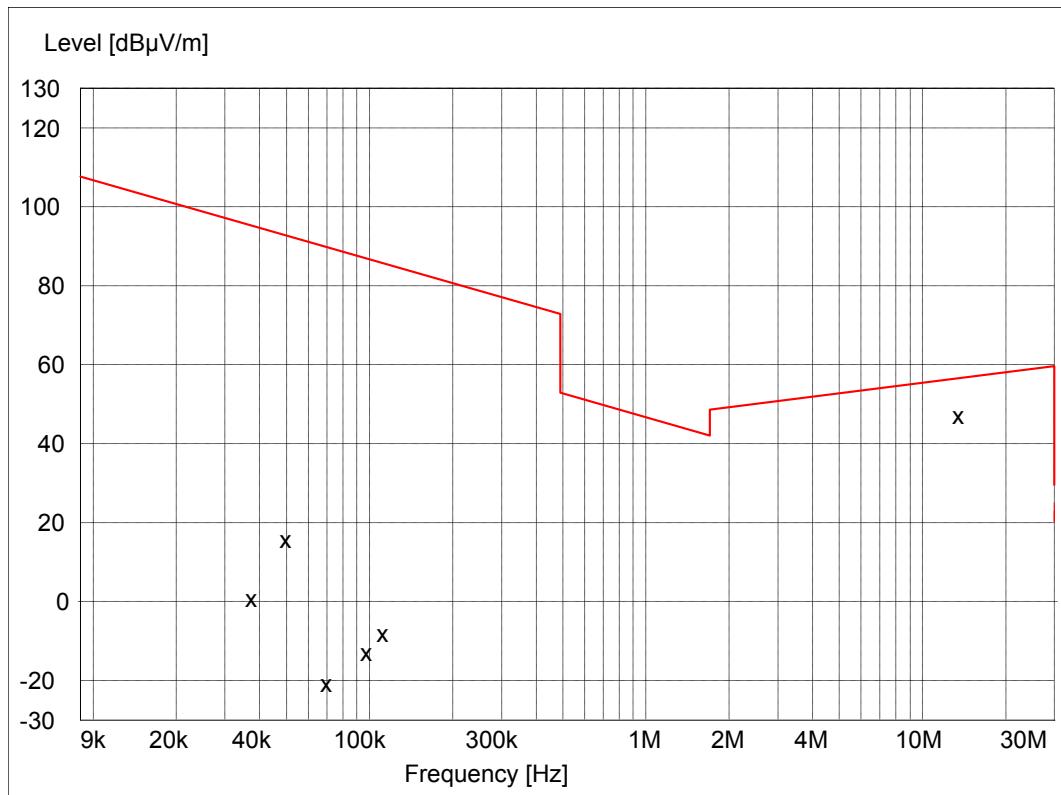


Fig 5.4.3 Radiated emissions (Open Area Test Site result R09), 9kHz to 30MHz parallel and perpendicular polarisation combined plot, 10m measurement distance

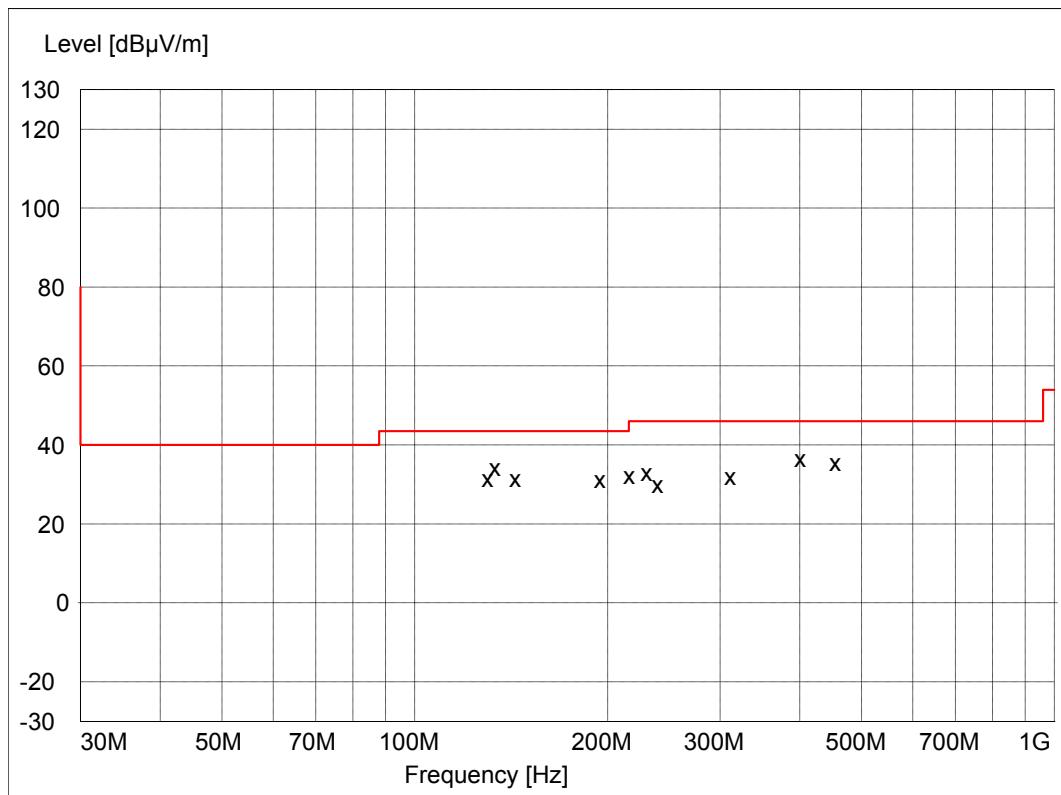


Fig 5.4.4 Radiated emissions (Open Area Test Site result R10), 30MHz to 1GHz vertical and horizontal polarisation combined plot, 3m measurement distance

5.5 Appendix 5 Frequency tolerance of the carrier signal

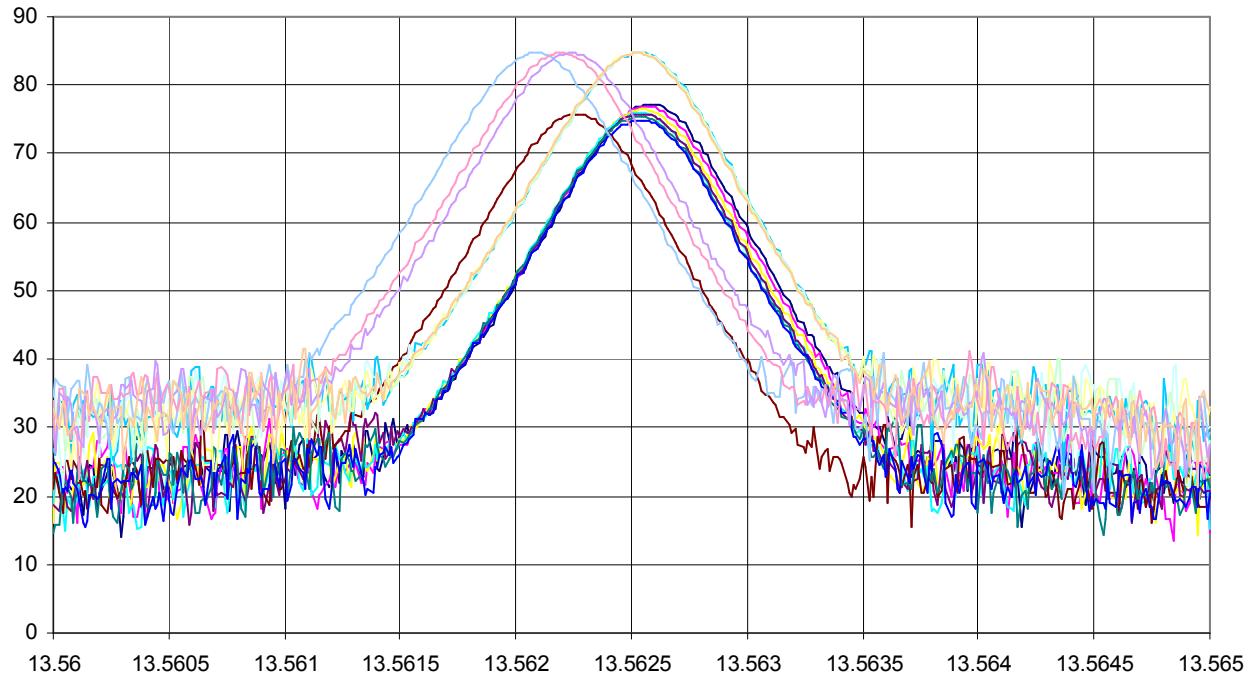


Fig 5.5.1, Frequency stability of carrier for variation of supply voltage, composite plot of all scans.

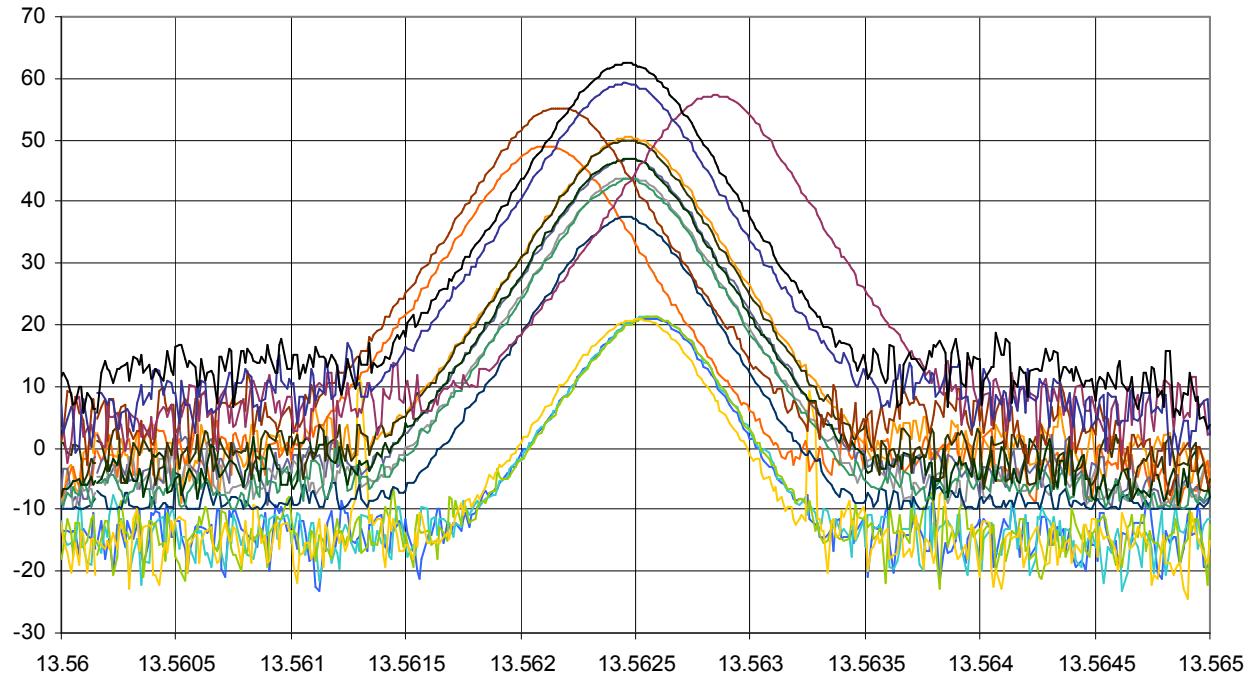


Fig 5.5.2, Frequency stability of carrier for variation of temperature, composite plot of all scans.

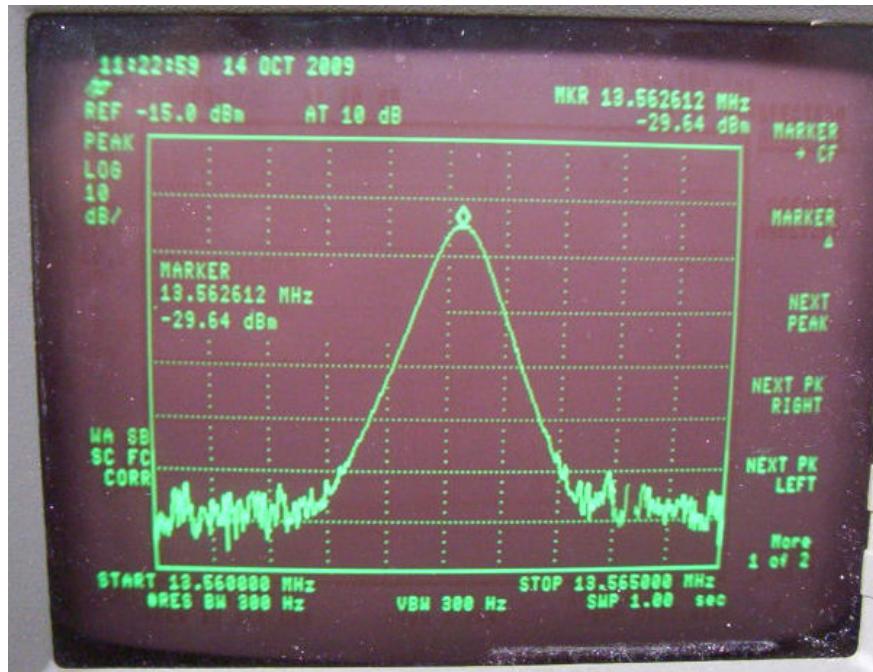


Fig 5.5.2, Frequency stability of carrier, oscilloscope screen shot of one particular scan.

5.6 Appendix 6 Conducted emissions

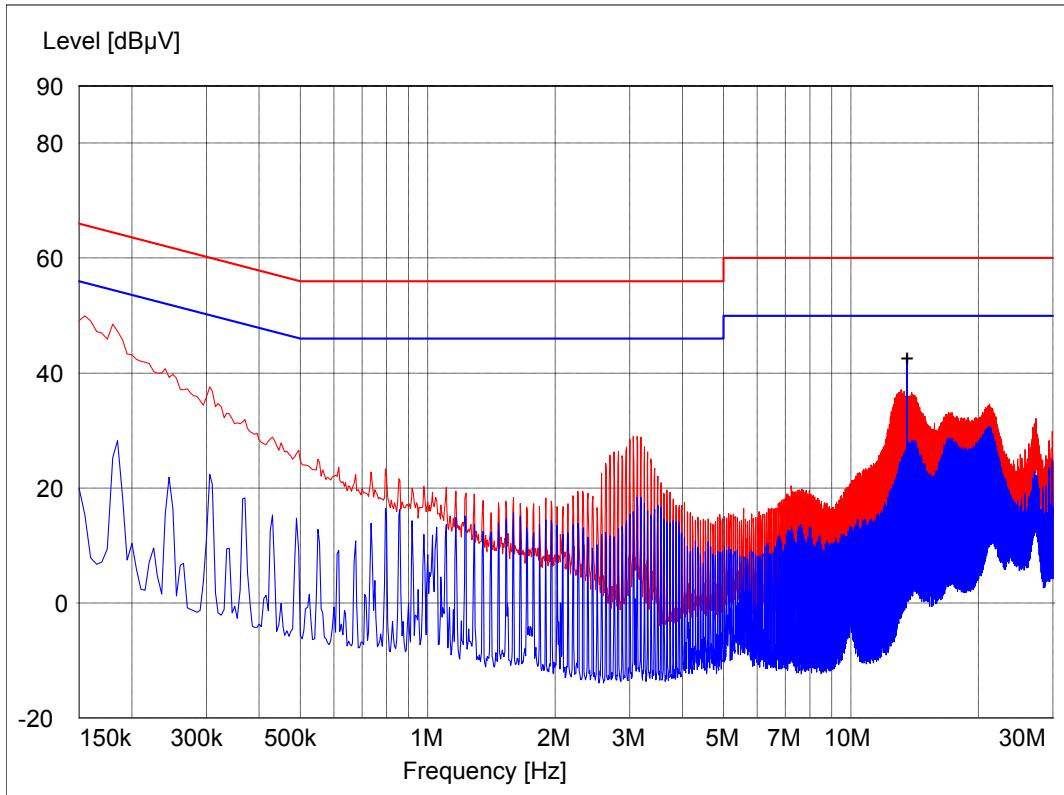


Fig 5.6.1 Conducted emissions result, C01.

Note: The blue trace relates to the initial average measurements, the red trace relates to the initial peak measurements and the cross shows the final average measurement.

5.7 Appendix 7 EUT test configurations



Photograph 5.7.1 Conducted emissions testing



Photograph 5.7.3 Radiated emissions testing (9kHz to 30MHz), Open Area Test Site



Photograph 5.7.3 Radiated emissions testing (30MHz to 1GHz), Open Area Test Site



Photograph 5.7.4 Frequency stability testing

5.8 Appendix 8 Equipment used

Equipment	York EMC Asset No.	Cal Type	Cal date	Cal Period (Months)
Chase CBL 6111A BiLog Antenna	78167	UKAS	16th December 2008	12
Chase HLA6120 Loop Antenna	78128	NPL	5th January 2009	12
R&S ESHS 10 Receiver	78035	UKAS	29th December 2008	12
R&S ESVS 30 Receiver	78107	UKAS	23rd December 2008	12
HP 8594E Spectrum analyser	78663	UKAS	18th September 2008	24
Chase CFL 9206 Transient Limiter	78101	In-house	11 th February 2009	12
R&S ESH3 Z5 LISN	78119	UKAS	5 th January 2009	12
RS 1313 -Thermometer	79242	UKAS	23 rd September 2009	12
JTS FMHZ/343/-20/+150/P environment chamber	C0108	UKAS	29 th September 2009	12
California instruments PACS-1 analyser	79135	UKAS	29 th October 2007	24
California instruments 5001ix power supply	7915	UKAS	29 th October 2007	24

5.9 Appendix 9 Customers test equipment used

Equipment	Serial number	Cal status
None	N/A	N/A

5.10 Appendix 10 Modification States

Modification state	Modification
0	As supplied by the customer.
1	In order to pass the conducted emissions test the host printer was fitted with a 30uH common mode choke on the supply lead shown below. In practice this choke will be fitted on the main PCB at the point of entry of the mains cable.



Fig 5.10.1, 30uH common mode choke fitted to mains supply lead

5.11 Appendix 11 Test Report History

Issue	Modification details
1	Original issue of the test report
2	Added sections 3.3 and 3.4