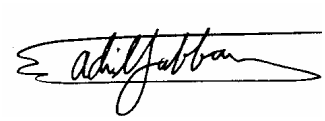
Test Report for Smart Controller

To CFR 47 Chapter 1 FCC Rules Part 15 Radio Frequency Devices

Radiated Spurious Emissions

Test Report Number: 619/1027

Approved	Adil Abbas International Compliance Manager		10/01/2005
Technical Check	Peter Bowen Senior EMC Test Engineer		05/01/2005
Administrative Check	Chris Bird Approvals Manager		05/01/2005
Report	Marc Paull EMC Test Engineer		05/01/2005
Report Date	05/01/2005	Test Date	23/11/2004 to 30/11/2004

Any reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor *k* = 2, providing a level of confidence of approximately 95%. Any uncertainty evaluation has been carried out with reference to CISPR16-4:2002

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1 Purpose of Tests

The purpose of the tests was to demonstrate that the EUT (Raymarine Smart Controller) meets the requirements of FCC rules 15.247 (d) & (i) with respect to radiated spurious emissions when operating within the 2400–2483.5 MHz band.

This report will form part of a grant application to be submitted to both FCC and Industry Canada.

2 Description of Equipment under Test (EUT)

(To include all equipment being tested)

Date of Receipt:	17 November 2004
Client:	Raymarine
Brand Name:	Raymarine
Product Range:	RF remote products
Country of Manufacture:	United Kingdom
Operational voltage range:	8 V – 16 V d.c. (12 V d.c. nominal)

Unit 1

Model Name or Number:	**Smart Controller**
Unique Type Identification:	A18105
Serial Number:	EMC171104d
Circuit Diagram Number(s) & Issue:	4593 001 issue N
PCB Assembly Number(s) & Issue:	3015 358 issue E
Software Version:	Ember Range test Software Version 1.0 September 1st 2004. 15:40:28
Modifications to Unit:	A Fair Rite ferrite type no. 2643167251 was added to the SeaTalk cable. This was in order to suppress spurious emissions within the marine VHF band caused by the battery charging circuit. This modification is specifically required to enable the EUT to meet the requirements of BS EN60945.

Other Information:	The EUT is normally supplied with a 2-metre SeaTalk cable. Raymarine part # 4001-136-A

3 Description of Auxiliary Equipment

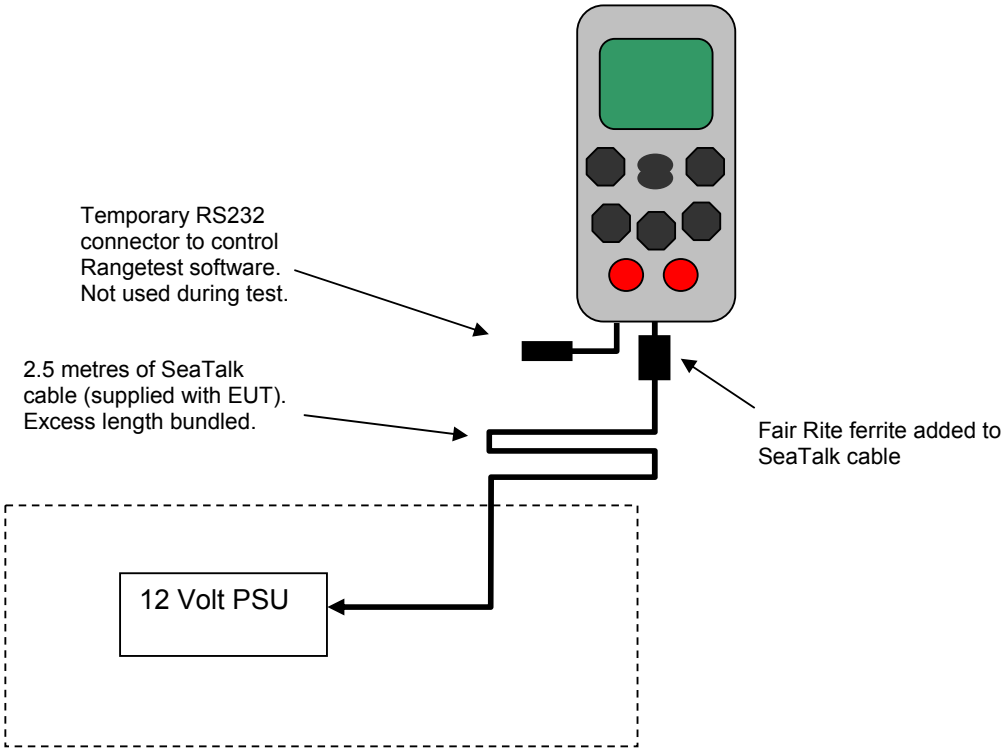
No auxiliary equipment was required during the tests.

4 General

Supply Voltage	Ambient Temperature	Relative Humidity
12V d.c.	20 - 22°C	30 - 33%

5 Test Configuration

(See Section 2 Description of Equipment under Test (EUT)and Section 5 Description of Auxiliary Equipment for Description of Equipment)



Title	Description
Test Set-up and Operating Mode	Set-up as per diagram Section 5 and photographs in section 7. The EUT was connected via 2m of SeaTalk cable to a 12-volt power supply. A depleted NM-Hi inside the EUT was used to activate the charging circuit; this condition is known to be the worst-case with respect to the generation of spurious emissions. Using special test software to enable efficient testing of the EUT the RF section was configured to continuous transmission or receiving mode as required during the course of the testing. Channels on which the RF module was operating were selected as required.

6 Description of Test Chamber

The test chamber used for the radiated emissions measurements is FCC listed (registration no. 970522) and registered with Industry Canada (registration no. IC 4069-1).

The test site is within a fully enclosed chamber on a ground plane of dimensions 9.3 x 6.3m. The walls, ceiling and door are completely lined with 6.7mm thickness Samwha ferrite tiles. Additional hybrid pyramidal absorber, type SLM500 and SLM850 is fitted to areas of the ceiling, sidewalls and the end wall nearest the turntable. The test volume is a cylinder 2m in height and 1.5m in diameter centred on the axis of the turntable.

The ground plane consists of galvanised steel sheets continuously bonded together with copper strip. The sheets at the edges of the ground plane are bonded, in a similar manner, to the walls of the chamber. To prevent flexing or warping, the edges of each individual steel sheet of the ground plane are secured to a wooden deck with screws at 10cm intervals.

The non-conductive turntable has the following characteristics:

a) mounted on the ground plane
b) fibre optic remote control
c) base diameter of 1.2m
d) base platform height 2cm above ground plane
e) hole in centre for EUT grounding and power source
f) power to centre via 20mm steel conduit bonded to ground plane
g) 360 degree rotation
h) the turntable, drive belt, drive shaft, couplings and turntable base are non-conductive.
i) A metallic shielded enclosure, located against the wall of the chamber, contains the motor and the electronics required to rotate the turntable.

The receiving antenna mast has the following characteristics:

a) fibre optic remote control
b) 1-4 metre search height
c) pneumatic antenna polarization change
d) the mast, carrier, boom, platform and drive belt are non-conductive.
e) A metallic shielded enclosure, located at the base of the tower, contains the motor and the electronics required to control the antenna carrier.

7 Photographs

Figure 1 View from within chamber showing turntable base and mast set-up.

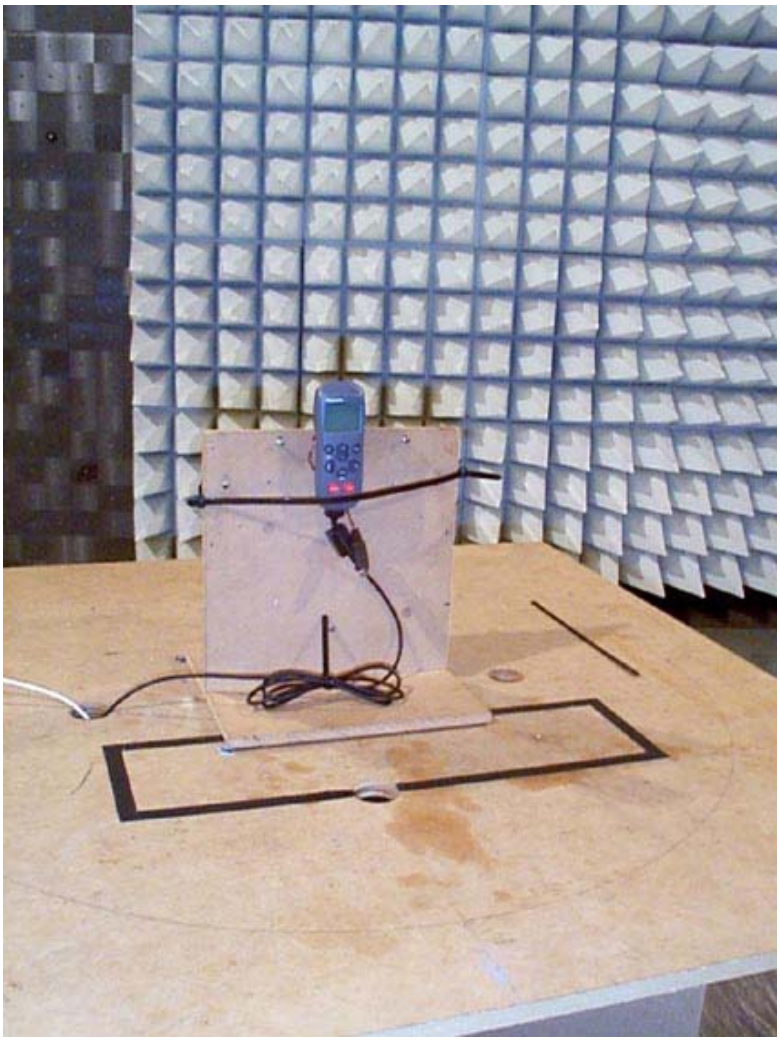


Figure 2 EUT mounted on supporting bracket on turntable in test chamber.

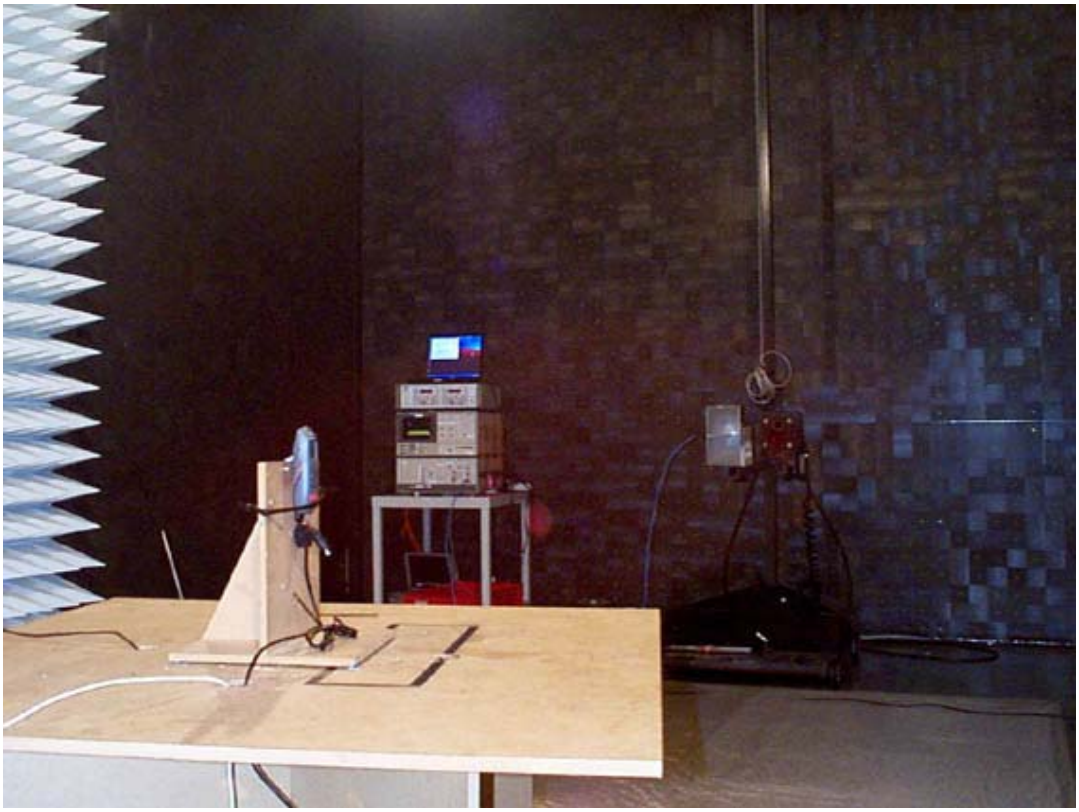


Figure 3 Set up in chamber for 2GHz-7GHz measurements at 3m.

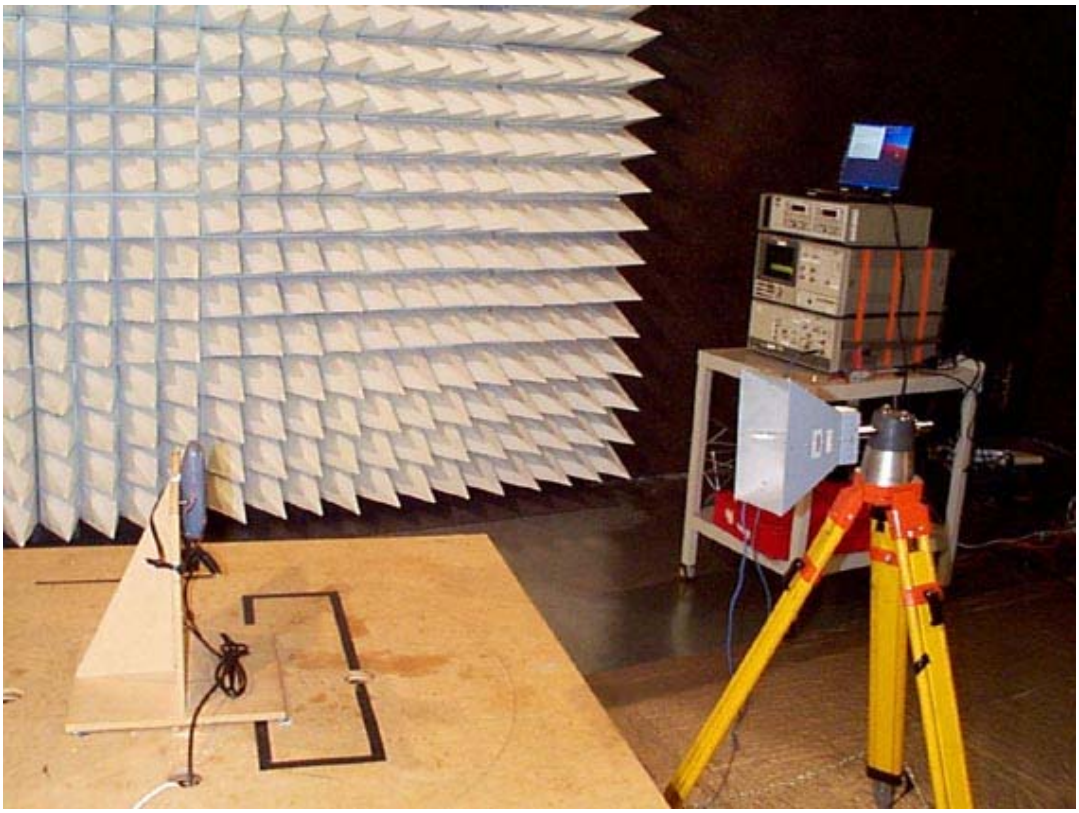


Figure 4 Set up showing measurements above 7GHz at 1m.

8 Method of test

The EUT was placed on the turntable and powered from a 12V PSU. In normal use the EUT only transmits for short durations in order to send a request for data, an autopilot command, or to maintain a link with a Raymarine RF device registered to it (i.e. an S1000 autopilot or Raymarine RF Base Station). Therefore the normal application code was substituted with alternative software (Rangetest) to enable control of the EUT transceiver module with a PC via an RS232 connection. The EUT could then be operated on any of the 15 available channels and configured to function in either a continuous receive mode or to transmit continuously.

An investigative sweep to identify any spurious emissions for detailed investigation was carried out in continuous transmit mode and then repeated in continuous receive mode, each sweep being conducted on channel 7. The results of these tests have been presented separately in this report (see sections 9 and 10). The method used was to conduct the measurements within each test band on four orthogonally opposed faces of the EUT in order to identify any spurious emissions that would require further, detailed examination. Composite plots from these investigative sweeps are presented below in sections 9 and 10.

In the bands below 2 GHz any frequencies identified for further investigation were measured with the EUT transmitting/receiving on channel 7 only. Radiated spurious emissions within these bands are not likely to be affected by the channel of operation of the EUT transceiver.

At frequencies above 2GHz any emissions identified during the investigative sweeps were then re-measured on channels 0, 7 and 15 (i.e. lower, middle and upper channels) as the channel of operation was more likely to have a significant impact on the emission level. The levels recorded are presented in tables and HP70000 screenshots of the worst-case measurements are presented below in sections 9 and 10.

<u>9kHz-30MHz</u>
These measurements were carried out within the test chamber at a distance of 3m. The limits against which the emissions were measured have been extrapolated using a factor of 40dB/decade as per FCC rule 15.31 (f)(2). Frequency scans and any spurious emissions investigations were carried out using a Chase automated EMC measurement system to control the measuring receiver, antenna height and turntable angle. The automated measurement system was operated from outside the test chamber. There is no requirement to test below 30MHz with the EUT in receive/standby mode therefore data from these bands relates only to the EUT in transmit mode.

30MHz-2GHz

Measurements between 30MHz and 2GHz were carried out in accordance with the recommendations of ANSI C63.4-2000 section 8. The separation distance between the periphery of the EUT and the test receive antenna was 3 metres as defined by FCC rule 15.209. Frequency scans and spurious emissions investigations were carried out using an EMC measurement system utilising Chase software to control the measuring receiver, antenna height and turntable angle. The automated measurement system was operated from outside the test chamber.

Above 2GHz sweeps

These measurements were carried out manually from within the EMC chamber using an HP70000 spectrum analyser. This was done to reduce cable losses by shortening the length of the receive cable and therefore enabling noise floor levels to be kept to a minimum. The antenna height and turntable angle were also controlled manually via an EMCO 2090 multi device controller.

The spurious emissions from these frequency sweeps were captured with an HP70000 peak detector in max hold mode. During these sweeps the EUT was set to transmit continuously on channel 7. For each frequency sweep the receive antenna was maintained at 1.0m while the turntable was rotated through 360˚. This process was repeated with the spectrum analyser remaining in max hold mode and using the opposite antenna polarisation so that a trace was obtained comprising the worst case emissions obtained for both antenna polarities on all radials from the EUT.

The frequency and level data from the HP70000 traces was extracted to an excel file using SoftPlot measurement presentation software. All the data obtained from the individual sweeps was then combined into a single spreadsheet and corrected for cable loss and antenna factors. Graphs were then produced from the final corrected figures to show the spurious emissions in the 2GHz to 25GHz band (see figures 13 and 21 below).

Any emissions observed to be above the noise floor were then investigated more thoroughly on channels 0, 7 and 15 to determine the worst-case frequency, level, antenna height (where possible) and turntable angle. This was then captured using SoftPlot. These investigations were carried out at the frequencies of interest with the HP70000 amplitude offset to account for cable losses and antenna correction factors. The plots are presented below (see figures 14 to 16 and figure 22)

The frequency sweeps were as follows:

2GHz-7GHz
The separation distance between the EUT and the test receive antenna was kept to 3 metres. HP70000 resolution bandwidth was 1MHz

7GHz-12GHz
In order to maintain the noise floor sufficiently below the specification limit it was necessary to reduce the separation distance between the EUT and the test receive antenna to 1m. The limits against which the emissions were measured have been extrapolated using a factor of 20dB/decade as per FCC rule 15.31 (f)(1). The extrapolated limit was calculated to be 63.5dBµV/m. The near field / far field transition at 7 GHz is:

λ at 7GHz = 0.042m

$$d > \frac{2l^2}{\lambda} \qquad \text{(l=2.5cm)}$$

$$d > \frac{2(0.025)^2}{0.042} = 0.0298 \text{ m}$$

$$= 30 \text{ mm}$$

Therefore all measurements made above 7GHz at 1m are within the far field. The HP70000 resolution bandwidth was 1MHz

12GHz-16.5GHz
Measured at 1m-separation distance, resolution bandwidth was 1MHz.

16.5GHz-20GHz
Measured at a 1m-separation distance, resolution bandwidth was 1MHz.

20GHz-25GHz
Measured at a 1m-separation distance. The resolution bandwidth was reduced to 215kHz in order to allow enough margin between the noise floor and the specification limit to identify any spurious emissions that may be present.

Frequency band	Resolution bandwidth	Remarks
9kHz – 150 kHz	200 Hz	
150 kHz – 30 MHz	9 kHz	
30 MHz – 1 GHz	120 kHz	
1 GHz – 20GHz	1 MHz	
20 GHz – 25 GHz	215 kHz	Resolution bandwidth reduced to lower system noise floor.

Table 1 Summary of resolution bandwidths used during emissions measurements.

9 Radiated emissions results – intentional radiator

9.1 Test measurement limits.

The EUT was tested for spurious emissions between 9kHz and 25GHz (i.e. above 10th harmonic) against the following limits:

- -20dBc as defined in FCC rule 15.247(d)
- Within restricted bands (see table under rule 15.205) the limits of table 15.209 were applied.
- Additionally a peak limit of 74dBµV/m was applied as defined in FCC rule 15.35(b)

For measurements above 2GHz, radiated spurious emissions were recorded using an HP70000 spectrum analyser with a peak detector in max hold mode. The tests were carried out with the EUT transmitting continuously, however in normal use the transmission duration during any 100ms period is 40ms. An equivalent average value of each emission has therefore been derived from the peak measurement by application of the following conversion factor (ref rule 15.35(c)):

$$20\log\left(\frac{40ms}{100ms}\right) = -7.96 \text{ dB}$$

9.2 Test results

9.2.1 9KHz – 150kHz

There were no emissions detected that were within 20dB of the requirement limit. The noise floor was greater than 40dB below the specification limit. A composite graph combining 6 sweeps taken at 120˚ angles and with the loop antenna orientation rotated by 90˚ is presented in figure 7 below.

9.2.2 150kHz - 30MHz

There were no emissions detected that were within 20dB of the requirement limit. The noise floor was more than 30dB lower than the specification limit. A composite graph combining 6 sweeps taken at 120˚ intervals around the EUT and with the loop antenna orientation rotated by 90˚ is presented in figure 8 below.

9.2.3 30MHz – 50MHz

A composite graph combining sweeps taken at 90˚ intervals around the EUT in both vertical and horizontal polarisations is presented in figure 9 below.

The following frequencies were investigated using a quasi-peak detector:

Freq (MHz)	QP level (dBµV/m)	Antenna polarity	Antenna height (m)	Turntable angle (Degrees)	Limit (dBµV/m)	Δ Limit (dB)
30.66	20.5	Vertical	1.7	001	40	-19.5
33.54	26.7	Vertical	1.7	145	40	-13.5
34.08	27.5	Vertical	2.5	341	40	-12.5
37.14	26.1	Vertical	1.0	154	40	-13.9

Table 2 Quasi peak results for emissions in 30MHz – 50 MHz band.

All emissions within this band were below –20dBc.

9.2.4 50MHz – 300MHz

All emissions occurring within restricted bands in this sweep were greater than 10dB below the specification limits and therefore did not warrant further measurements using a quasi-peak detector. All other emissions outside of the restricted bands were below –20dBc. A composite graph combining sweeps taken at 90˚ intervals around the EUT in both vertical and horizontal polarisations is presented in figure 10 below.

9.2.5 300MHz – 1GHz

There were no emissions detected above the measurement system noise floor. The noise floor was greater than 8dB below specification limits. A composite graph combining sweeps taken at 90˚ intervals around the EUT in both vertical and horizontal polarisations is presented in figure 11 below.

9.2.6 1GHz – 2GHz

There were no emissions detected above the measurement system noise floor. The noise floor was greater than 8dB below the specification limits. A composite graph combining sweeps taken at 90˚ intervals around the EUT in both vertical and horizontal polarisations is presented in figure 12 below.

9.2.7 2GHz – 25GHz

Measurements were carried out in the 2.4 GHz – 2.4835 GHz band on channel 0, 7 and 15 in order to determine the maximum peak level of the fundamental emission. The maximum level may then be referenced back to emissions that are outside the restricted bands to ensure they meet the –20dBc requirement of FCC rule 15.247(4)(d). A table summarising the results is presented below and a plot of the highest level recorded is presented in figure 14.

Channel No.	Freq (GHz)	Peak level (dBµV/m)	Antenna polarity	Antenna height (m)	Turntable angle (Degrees)
0	2.405288	99.2	Vertical	1.3	29.6
0	2.405288	95.9	Horizontal	1.5	31.5
7	2.440438	99.2	Vertical	1.2	27.5
7	2.440438	94.2	Horizontal	1.4	155.7
15	2.480413	96.6	Vertical	1.1	59.2
15	2.480413	90.7	Horizontal	1.1	294.2

Table 3 Summary of results of fundamental frequency levels for channels 0, 7, 15.

The frequency sweeps above 2GHz clearly indicated an emission at the 2nd harmonic frequency of the EUT (see figure 13 below). This was investigated in more detail on channels 0, 7 and 15. The results from these measurements have been presented in table 4 below and a plot of the highest recorded emission presented in figure 15.

During the investigative frequency sweeps in the 7GHz – 12GHz band there was no emission recorded at the 3rd harmonic frequency on channel 7. A detailed measurement was carried out on channels 0 and 15 at the 3rd harmonic frequency, however no emissions were detected.

There were no other emissions identified or investigated in the 2GHz to 25GHz band.

Channel No.	Freq (GHz)	Max peak level (dBµV/m)	Peak limit (dBµV/m)	Average level (dBµV/m) Note 1	Average Limit (dBµV/m)	Ae polarity	Ae height (m)	Turntable angle (Degrees)	Δ Limit (dB)
0	4.809955	60.3	74	52.3	54	Ver	1.2	30.6	-1.7
0	4.809955	56.1	74	48.1	54	Hor	1.0	361.3	-5.9
7	4.879955	61.2	74	53.2	54	Ver	1.3	299.1	-0.8
7	4.879955	56.9	74	48.9	54	Hor	1.4	354.0	-5.1
15	4.959987	61.3	74	53.3	54	Ver	1.3	301.0	-0.7
15	4.959987	56.5	74	48.5	54	Hor	1.5	35.0	-5.5

Note 1: Average level is maximum-recorded peak level with applied relaxation factor as described in section 9.1 above.

Table 4 Summary of results for radiated spurious emissions in 2GHz – 25GHz band.

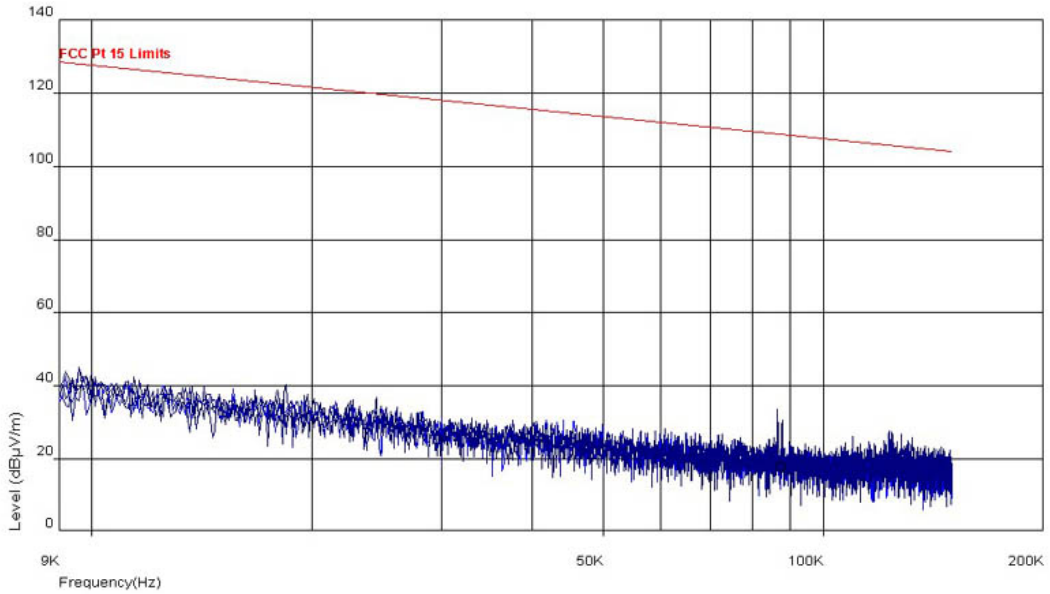


Figure 5 Composite graph of radiated emissions (9kHz – 150 kHz) from EUT

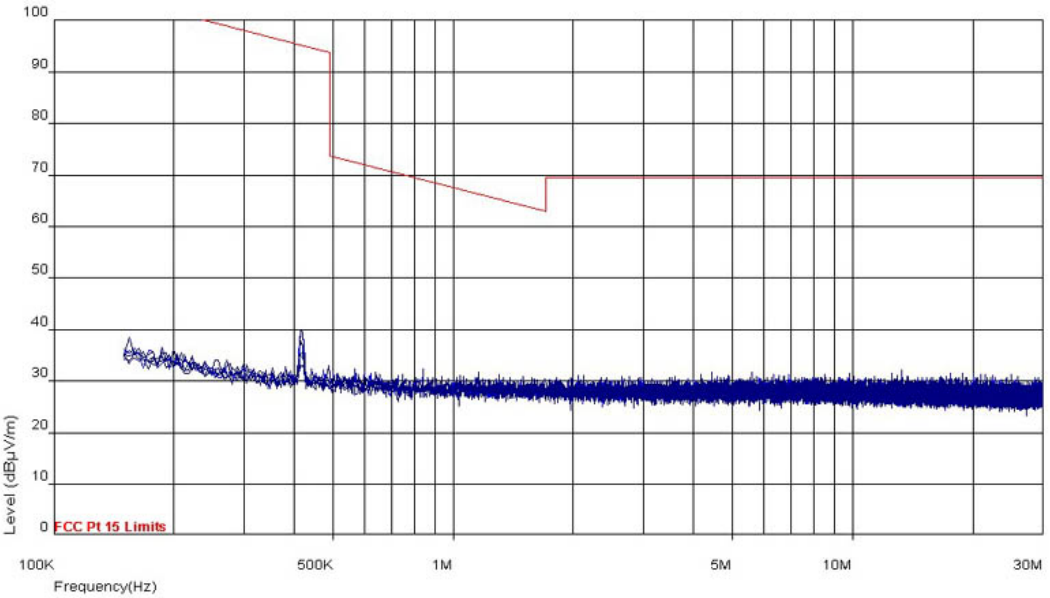


Figure 6 Composite graph of radiated emissions (150kHz–30MHz) from EUT

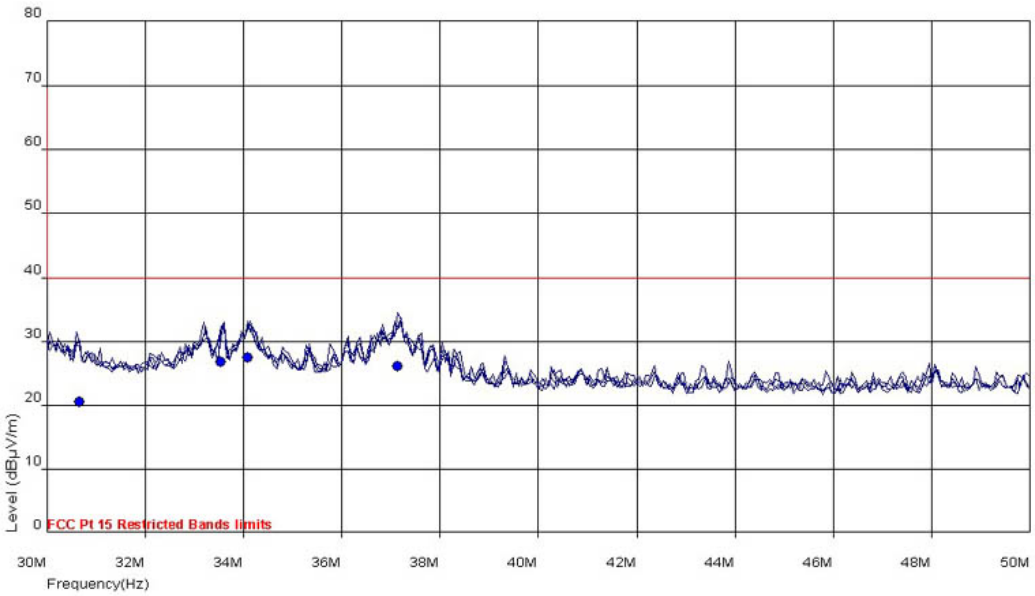


Figure 7 Composite graph of radiated emissions (30MHz–50 MHz) from EUT

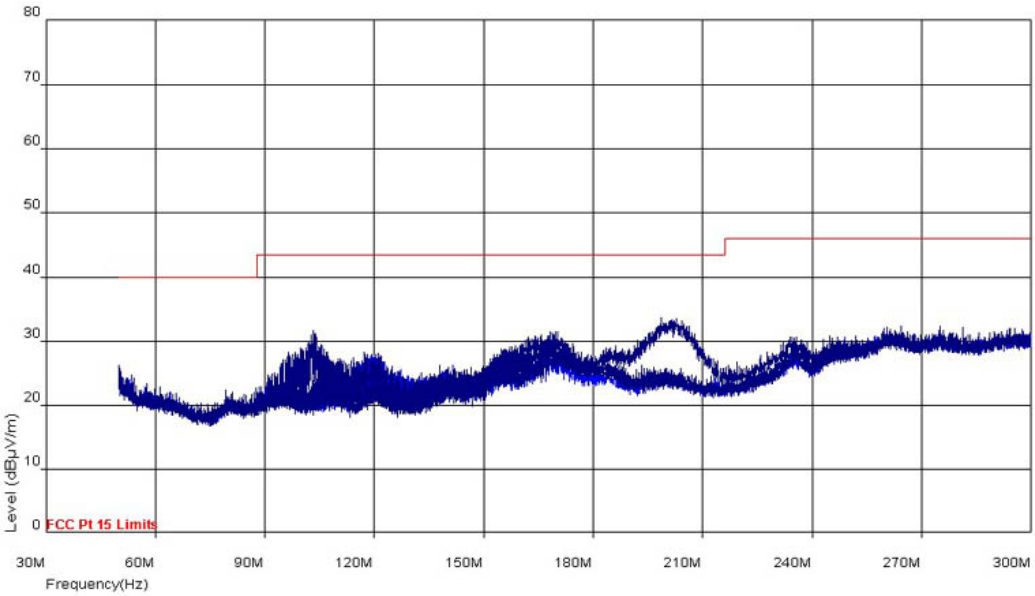


Figure 8 Composite graph of radiated emissions (50MHz-300MHz) from EUT

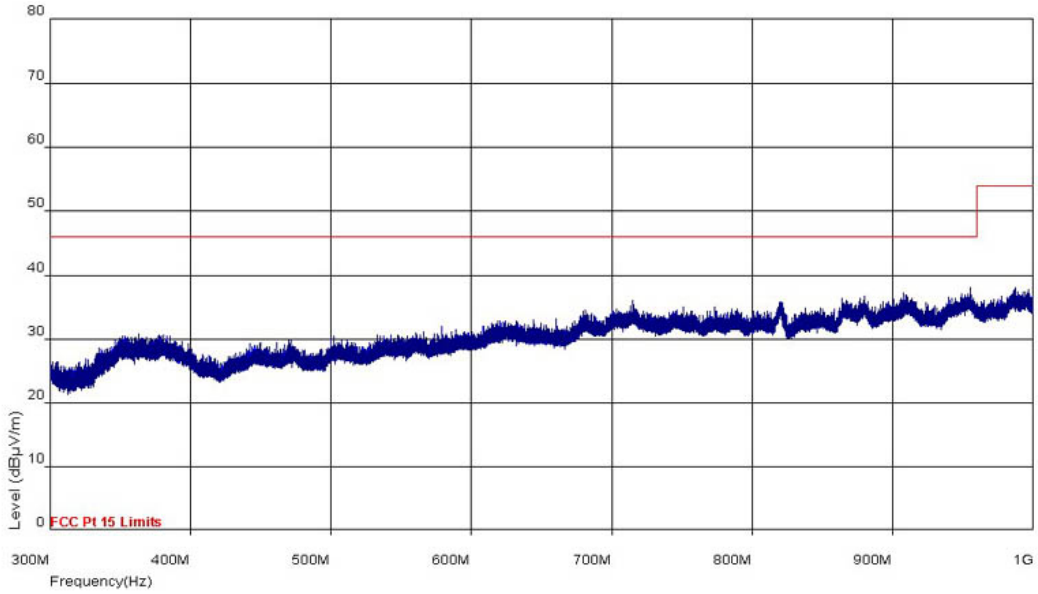


Figure 9 Composite graph of radiated emissions (300 MHz–1GHz) from EUT

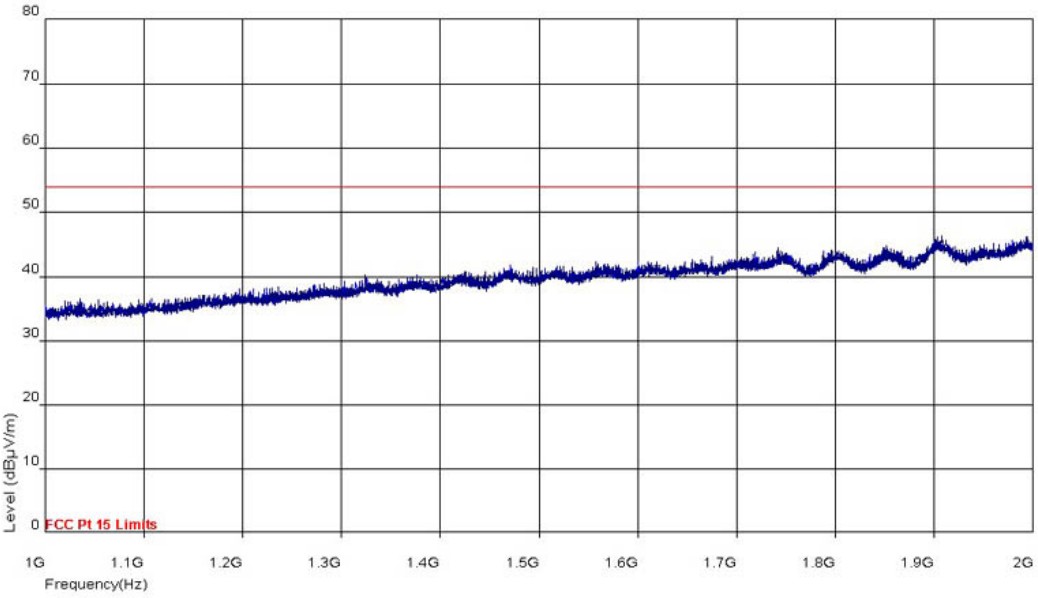


Figure 10 Composite graph of radiated emissions (1GHz-2GHz) from EUT

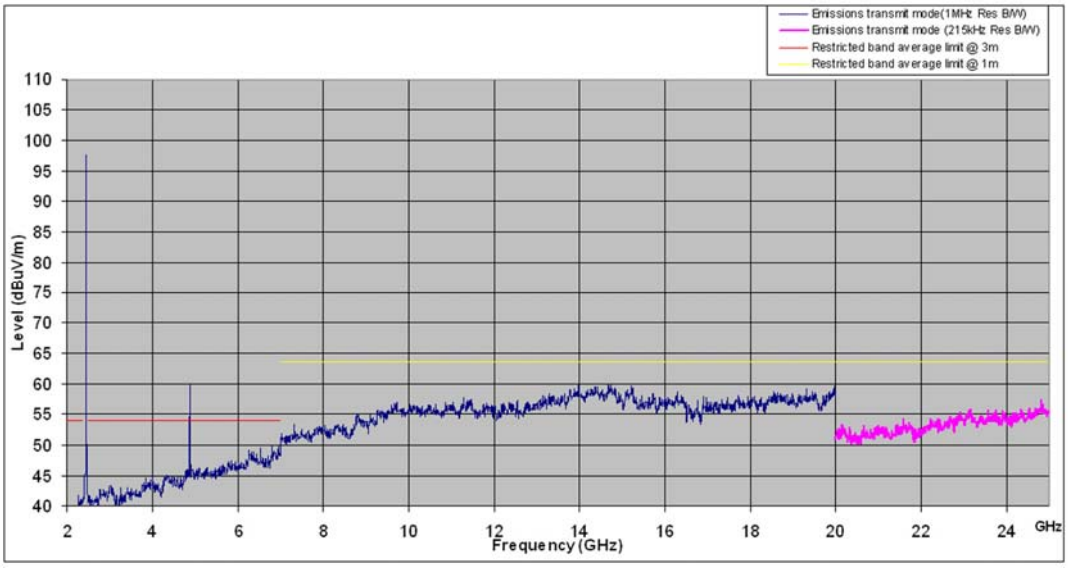


Figure 11 Composite graph of radiated emissions (2GHz-25GHz). EUT Tx on Ch7.

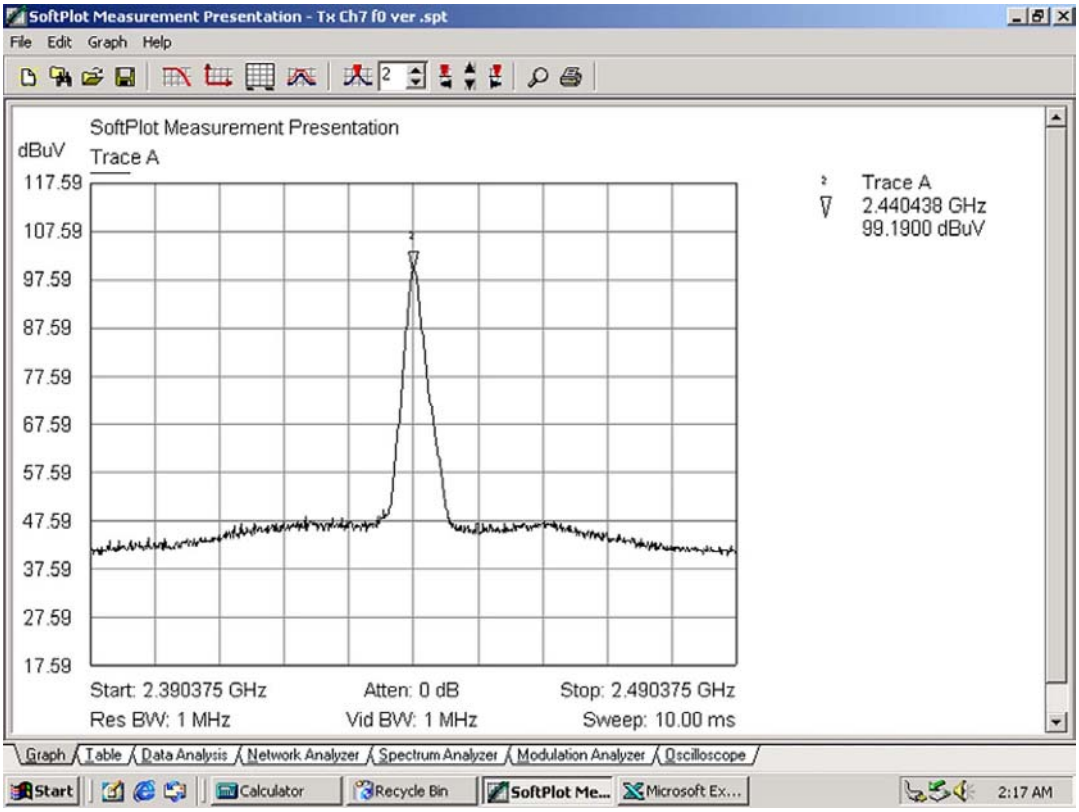


Figure 12 Channel 7 vertical (Highest recorded fundamental frequency)

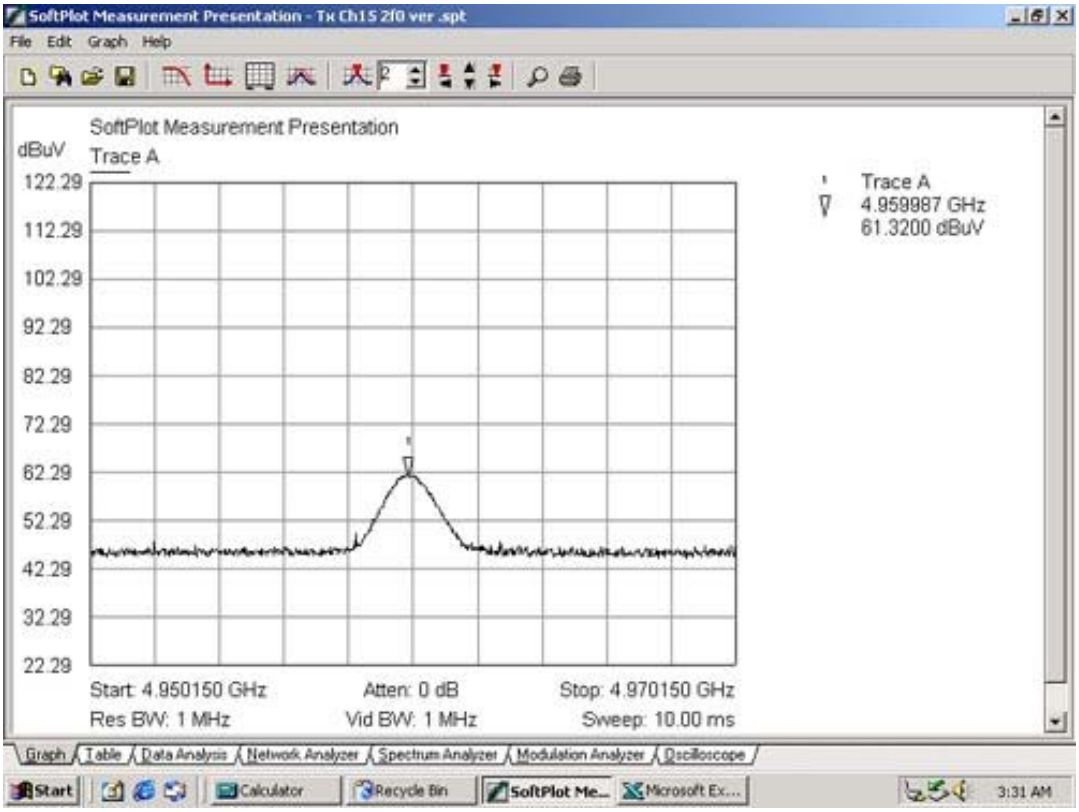


Figure 13 Channel 15 vertical (Highest recorded 2nd harmonic)

10 Radiated emissions results – unintentional radiator

10.1 Test measurement limits.

The EUT was tested for spurious emissions between 30MHz and 25GHz (i.e. above 10th harmonic) against the following limits:

- Table of rule 15.109 (a)

10.2 Test results

10.2.1 30MHz – 50MHz

A composite graph combining sweeps taken at 90˚ intervals around the EUT in both vertical and horizontal polarisations is presented in figure 17 below.

The following frequencies were investigated:

Freq (MHz)	QP level (dBµV/m)	Antenna polarity	Antenna height (m)	Turntable angle (Degrees)	Limit (dBµV/m)	Δ Limit (dB)
30.66	20.7	Vertical	1.48	87	40	-19.3
33.54	27.1	Vertical	1.01	207	40	-12.9
34.08	27.3	Horizontal	3.88	119	40	-12.7
37.14	28.3	Vertical	1.25	154	40	-11.7

Table 5 Quasi peak results for emissions in 30MHz – 50 MHz band.

10.2.2 50MHz – 300MHz

A composite graph combining sweeps taken at 90˚ intervals around the EUT in both vertical and horizontal polarisations is presented in figure 18 below.

The following frequency was investigated with a quasi-peak detector:

Freq (MHz)	QP level (dBµV/m)	Antenna polarity	Antenna height (m)	Turntable angle (Degrees)	Limit (dBµV/m)	Δ Limit (dB)
90.8	31.8	Vertical	1.01	289.0	40	-8.2

Table 6 Quasi peak results for emissions in 50 – 300MHz band

The other identified peaks within this band were all greater than10dB below the limit.

10.2.3 300MHz – 1GHz

There were some peak emissions observed, however these were greater than 10dB below the specification limit and were therefore not investigated further. The noise floor was greater than 8dB below specification limits (worst case). A composite graph combining sweeps taken at 90˚ intervals around the EUT in both vertical and horizontal polarisations is presented in figure 19 below.

10.2.4 1GHz – 2GHz

There were no emissions detected above the measurement system noise floor. The noise floor was greater than 8dB below the specification limits (worse case). A composite graph combining sweeps taken at 90° intervals around the EUT in both vertical and horizontal polarisations is presented in figure 20 below.

10.2.5 2GHz – 25GHz

The frequency sweeps above 2GHz clearly indicated a spurious emission radiating from the EUT (see figure 21 below). This was investigated in more detail on channels 0, 7 and 15. On channel 0 there was no emission above the noise floor. With respect to channels 7 and 15 the worst-case peak emission in max hold mode was measured on channel 15 at 4.956038 GHz. A plot of this measurement is shown in figure 22 below.

There were no other emissions identified or investigated in the 2GHz to 25GHz band.

Channel No.	Freq (GHz)	Max peak level (dBµV/m)	Average Limit (dBµV/m)	Ae polarity	Ae height (m)	Turntable angle (Degrees)	Δ Limit (dB)
0	-	-	-	-	-	-	-
0	-	-	-	-	-	-	-
7	4.876	50.4	54	Ver	1.3	305.7	-3.6
7	4.876	47.6	54	Hor	1.3	0.0	-6.4
15	4.956	51.3	54	Ver	1.2	63.3	-2.7
15	4.956	48.9	54	Hor	1.2	301.8	-5.1

Table 7 Summary of results for radiated spurious emissions in 2GHz – 25GHz band.

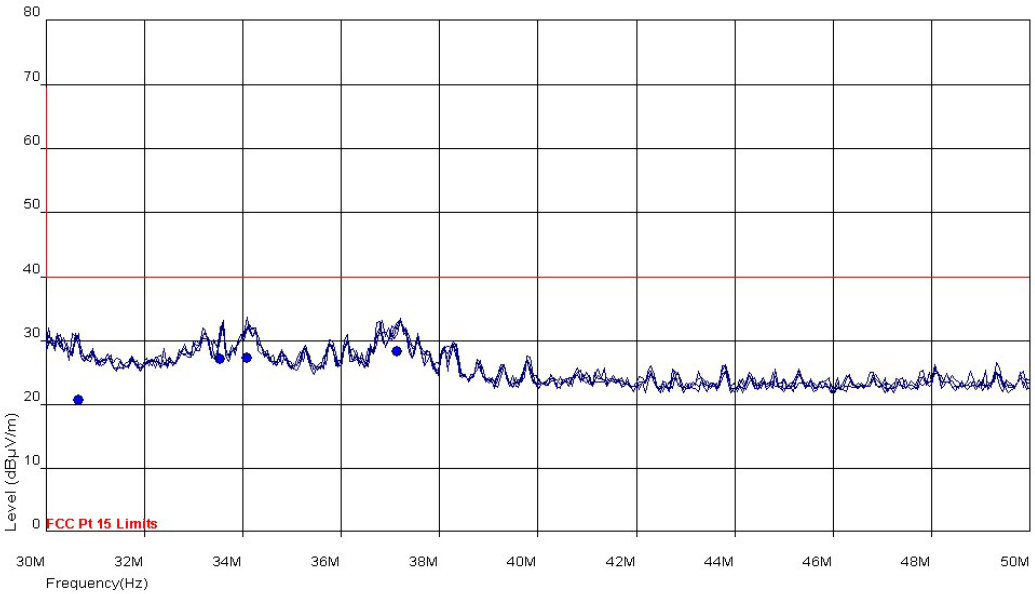


Figure 14 Composite graph of radiated emissions (30MHz–50 MHz) from EUT

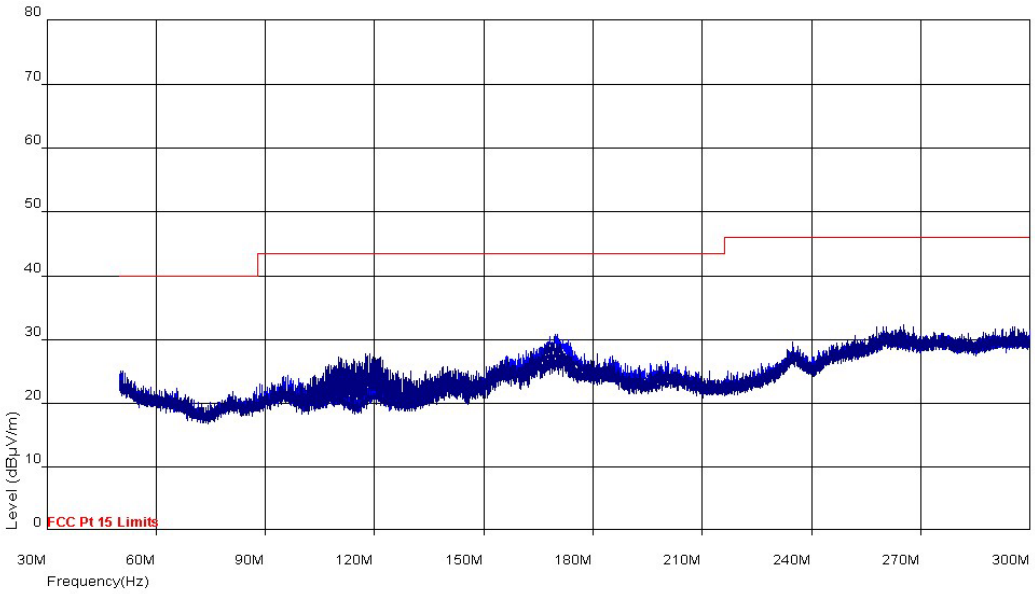


Figure 15 Composite graph of radiated emissions (50MHz-300MHz) from EUT

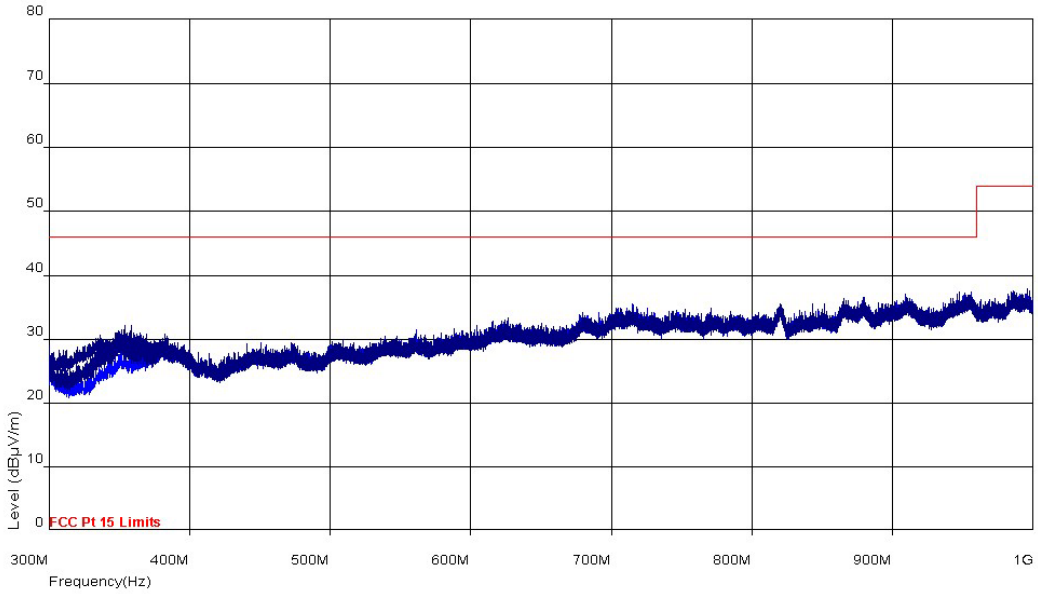


Figure 16 Composite graph of radiated emissions (300MHz-1GHz) from EUT

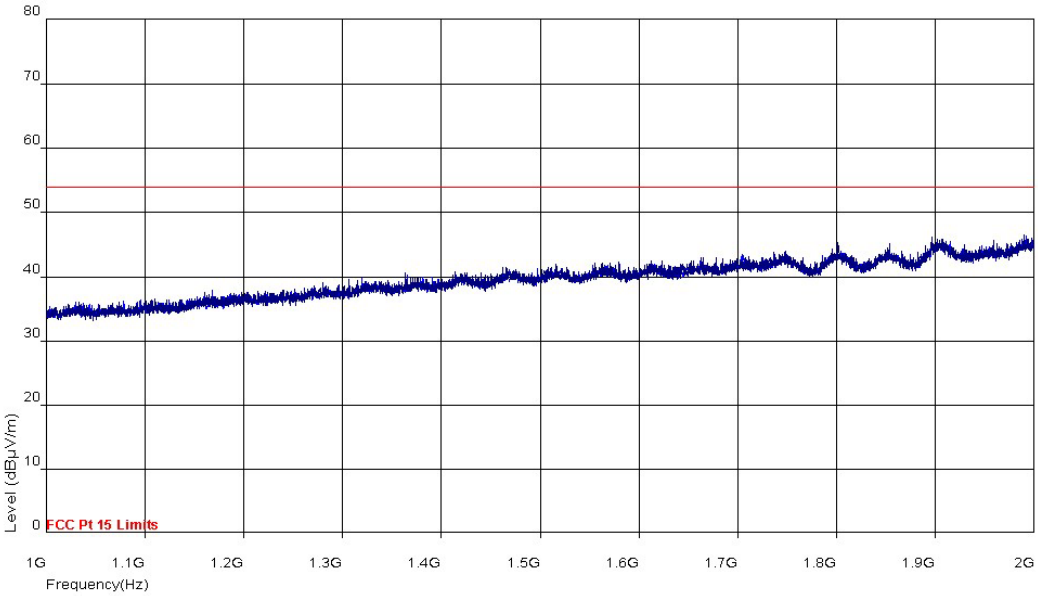


Figure 17 Composite graph of radiated emissions (1GHz-2GHz) from EUT

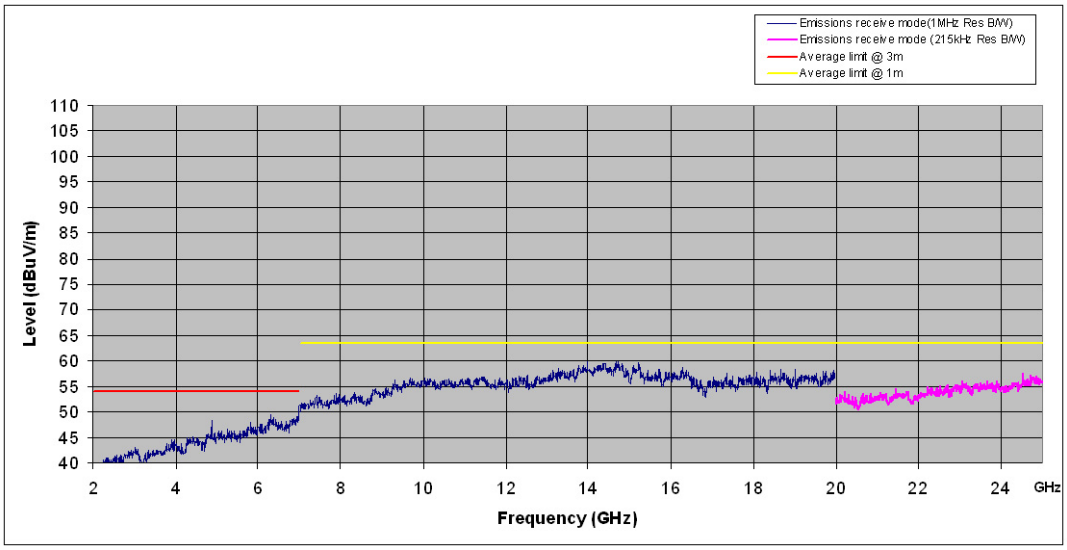


Figure 18 Composite graph of radiated emissions (2GHz-25GHz). EUT Rx on Ch 7

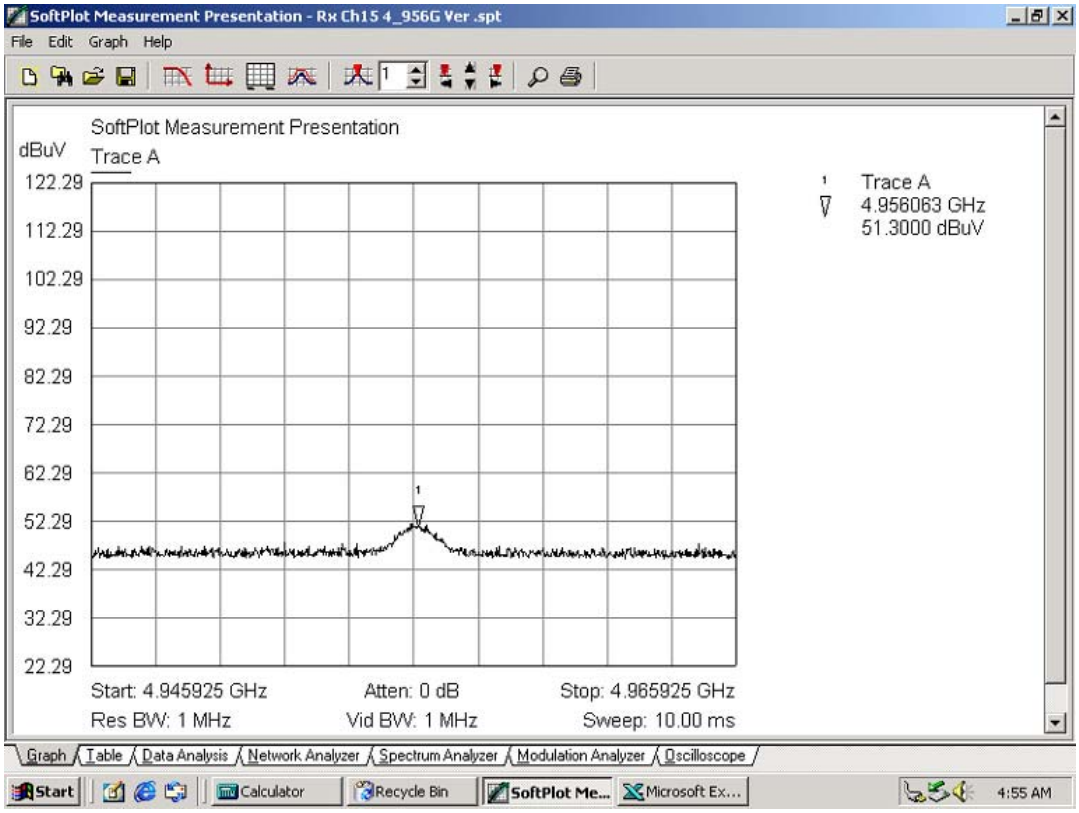


Figure 19 Channel 15 @ 4.956 GHz; horizontal (Highest recorded measurement)

11 Test equipment list

Test Equipment Type	Manufacturer and Type Number	Serial Number	TE No.	In Use
G-TEM Cell	Rayproof 1250	1356	**1416**	
G-Strip Cell	Comtest G320	GS112-1006	**1516**	
Semi-Anechoic Chamber, Site 2	Global EMC	GE001	**1429**	
Semi-Anechoic Chamber, Site 3	Global EMC	GE002		✓
Biconical Antenna, 30-300MHz	Schwarzbeck VHBB9124/BBAK9137	285	**0968**	✓
Log-Periodic Antenna, 0.3-3.0GHz	Emco EM6946	112	**0969**	✓
Broadband Antenna 200-1000MHz	Raven Engineering Type 96005	94020704	**1506**	
Broadband Antenna 20-200MHz	Raven Engineering Type 94455-1	93072404	**1507**	
Broadband Antenna 200-1300MHz	Rohde & Schwarz HL223	840110/14	**1426**	
Broadband Antenna 20-2000MHz	Chase EMC CBL6141	4038	**1427**	
Antenna Horn 1-18GHz	Chase BBHA9120D	128	**1446**	✓
Antenna Horn 18-26GHz	Credowan 20-R-2843-0007	36755	**1448**	✓
Active Loop Antenna 9kHz - 30MHz	Chase EMC HLA6120	1122	**0904**	✓
RF receive cable 2GHz – 26GHz	Amp Inc. Testline 18	1087200-4		✓
Loop Antenna PSU/Charger	Chase EMC CBP9720	1076	**1424**	✓
Antenna Mast (Site 3)	EMCO 2075 4m Mini-Mast		**1526**	✓
Turntable (Site 3)	EMCO Lo-Pro Turntable		**1527**	✓
Mast/Turntable/Antenna Controller (Site 3)	EMCO 2090 Multi-Device Controller	9712-1278	**1525**	✓
Antenna Mast (Site 2)	EMCO 2075 Mini-Mast		**1526**	
Turntable (Site 2)	EMCO Lo-Pro Turntable		**1527**	
Mast/Turntable/Antenna Controller (Site 2)	EMCO 2090 Multi-Device Controller	9712-1278	**1525**	
EMI Test Receiver 20Hz to 26.5GHz	Rohde & Schwarz ESI26	832692/006	**886**	✓
EMI Test Receiver 9kHz-6.5GHz	Hewlett-Packard 8546A	3625A00329/344 8A00219	**1432/33**	✓
Spectrum Analyser 20Hz - 26.5GHz	HP70000 series	3230A05180	**1605**	✓
EMI Test Receiver 9kHz - 30MHz	Rohde & Schwarz ESHS-10	840046/014	**1411**	
EMI Test Receiver 20-1000MHz	Rohde & Schwarz ESVS-10	840241/002	**1412**	
Spectrum Analyser 9kHz - 1.8GHz	Hewlett-Packard 8591E	3402V00990	**1020**	
R.F. Preamplifier 9kHz-1.3GHz	Hewlett-Packard 8477F	3113A05581	**1822**	✓
R.F. Preamplifier 30-2000MHz	Comtest GPA304	1002		
Reference Comb Generator	RN Electronics RN5102	215	**1423**	
DVM	Fluke Model 83	63550394	**1420**	
Power Supply Unit	Powerline LAB7244D	13077244DX07	**1503**	
Power Supply Unit	Thurlby-Thandar CPX200	112718	**00013**	
Power Supply Unit	Powerline LAB505	1603505X06	**1009**	
Power Supply Unit	Palstar PS30M	92534722	**1454A**	✓
Power Supply Unit	Palstar PS30M	92534727	**1454B**	
Computer	Dell Optiplex Pentium Gs+ 166	T601	**N/A**	
Computer	Dell Optiplex Pentium GX1 400	T742	**N/A**	✓
Computer	Dell Optiplex Pentium GX1 400	T743	**N/A**	
Computer	Toshiba Tecra 520CDT	T672	**N/A**	
Computer (Site 3)	Compaq EVO	LT1052	**N/A**	
Computer (Site 2)	Compaq EVO	LT1051	**N/A**	
Emissions Software	Rohde & Schwarz ESxS-K1 v.203	840.913/153	**N/A**	
Emissions Software	Schaffner-Chase CES9985 v1.11	VCQZPC	**N/A**	✓

In accordance with UKAS requirements, all measuring equipment is on a calibration cycle.