

# TEST REPORT FROM RFI GLOBAL SERVICES LTD

Test of: Lo-Q Plc  
Q-bot

To: FCC Part 15.247: 2006 (Subpart C)

**Test Report Serial No:**  
RFI/RPTE1/RP49207JD03A

This Test Report Is Issued Under The Authority  
Of Michael Derby, Wireless Radio Performance Group Leader:



Tested By: Petr Hajek	Checked By: Tony Henriques
	
Report Copy No: PDF01	
Issue Date: 25 May 2007	Test Dates: 02 May to 25 May 2007

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This report may be copied in full. The results in this report apply only to the sample(s) tested.

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## **Executive Summary**

RFI Global Services Ltd (RFI) was commissioned to perform an independent series on conformance tests to assess compliance with the FCC Part 15.247: 2006 (Subpart C)

### **Summary of Results**

Range of Measurements	Clause Reference	Port Type	Compliance Status	
Idle Mode Radiated Spurious Emissions	Section 15.109	Antenna	Compliant	
Transmitter Minimum 6 dB Bandwidth	Section 15.247(a)(2)	Antenna	Compliant	
Transmitter 20 dB Bandwidth	Section 2.1049	Antenna	Compliant	
Transmitter Peak Power Spectral Density	Section 15.247(e)	Antenna	Compliant	
Transmitter Maximum Peak Output Power	Section 15.247(b)(3)	Antenna	Compliant	
Transmitter Radiated Emissions	Sections 15.247(d) & 15.209(a)	Antenna	Compliant	
Transmitter Band Edge Radiated Emissions	Sections 15.247(d) & 15.209(a)	Antenna	Compliant	

Key to Compliance Colours used in this report:

Colour	Definition
Green	Compliant
Red	Not compliant

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## 1. Client Information

Company Name:	Lo-Q Plc
Address:	The Smith Centre The Fairmile Henley-on-Thames Oxfordshire RG9 6AB
Contact Name:	Mr C Butler

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## 2. Equipment Under Test (EUT)

The following information (with the exception of the date of receipt) has been supplied by the customer:

### 2.1. Description of EUT

The equipment under test is a hand-held device that holds the users place in a virtual queue

### 2.2. Identification of Equipment Under Test (EUT)

<b>Brand Name:</b>	Lo-Q
<b>Model Name or Number:</b>	Q-bot
<b>Serial Number:</b>	07799 150 407 000
<b>FCC ID Number:</b>	QCX-QB916-200
<b>Country of Manufacture:</b>	UK
<b>Date of Receipt:</b>	02 May 2007

### 2.3. Modifications Incorporated in the EUT

During the course of testing the EUT was not modified.

### 2.4. Support Equipment

No support equipment was used to exercise the EUT during testing.

### 2.5. Additional Information Related to Testing

<b>Type of Unit:</b>	Portable Transceiver		
<b>Power Supply Requirement:</b>	Internal Battery Supply of 12 V		
<b>Maximum Power Output (ERP)</b>	0 dBm (rated)		
<b>Transmit Frequency Range:</b>	2405 MHz to 2480 MHz		
<b>Transmit Channels Tested:</b>	Channel ID	Channel Number	Channel Frequency (MHz)
	Bottom	11	2405
	Middle	19	2445
	Top	25	2475
<b>Receive Frequency Range:</b>	2405 MHz to 2480 MHz		
<b>Receive Channels Tested:</b>	Channel ID	Channel Number	Channel Frequency (MHz)
	Bottom	11	2405
	Middle	19	2445
	Top	25	2475

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### **3. Test Specification, Methods and Procedures**

#### **3.1. Test Specification**

Reference:	FCC Part 15.247: 2006 Subpart C
Title:	Code of Federal Regulations, Part 15.247 (47CFR15) (Intentional Radiators operating within the band 2400 MHz to 2483.5 MHz)

#### **3.2. Methods and Procedures**

The methods and procedures used were as detailed in:

ANSI C63.2 (1987)

Title: American National Standard for Instrumentation - Electromagnetic noise and field strength.

ANSI C63.4 (2003)

Title: American National Standard Methods of Measurement of Electromagnetic Emissions from Low Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.

ANSI C63.5 (1988)

Title: American National Standard for the Calibration of antennas used for Radiated Emission measurements in Electromagnetic Interference (EMI) control.

ANSI C63.7 (1988)

Title: American National Standard Guide for Construction of Open Area Test Sites for performing Radiated Emission Measurements.

CISPR 16-1: (1999)

Title: Specification For Radio Disturbance and Immunity Measuring Apparatus and Methods. Part 1: Radio Disturbance and Immunity Measuring Apparatus.

DA00-705 (2000)

Title: Filing and Frequency Measurement Guidelines for Frequency Hopping Spread Spectrum Systems.

#### **3.3. Definition of Measurement Equipment**

The measurement equipment used complied with the requirements of the standards referenced in the methods & procedures section above. Appendix 1 contains a list of the test equipment used.

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#### **4. Deviations from the Test Specification**

There were no deviations from the test specification.

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## **5. Operation and Configuration of the EUT during Testing**

### **5.1. Operating Modes**

The EUT was tested in the following operating modes, unless otherwise stated.

Receive mode

Continuous transmit mode (EUT continuously transmitting random code)

### **5.2. Configuration and Peripherals**

The EUT was tested in the following configuration:

Stand-alone.

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## **6. Measurements, Examinations and Derived Results**

### **6.1. General Comments**

This section contains test results only.

Measurement uncertainties are evaluated in accordance with current best practice. Our reported expanded uncertainties are based on standard uncertainties, which are multiplied by an appropriate coverage factor to provide a statistical confidence level of approximately 95%. Please refer to section 8 for details of measurement uncertainties.

### **6.2. Location of Tests**

All the measurements described in this report were performed at the premises of  
RFI Global Services Ltd, Ewhurst Park, Ramsdell, Basingstoke, Hampshire, RG26 5RQ

FCC Site Registration Number: 90895

IC Site Registration Number: 3485

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### **6.3. Test Results**

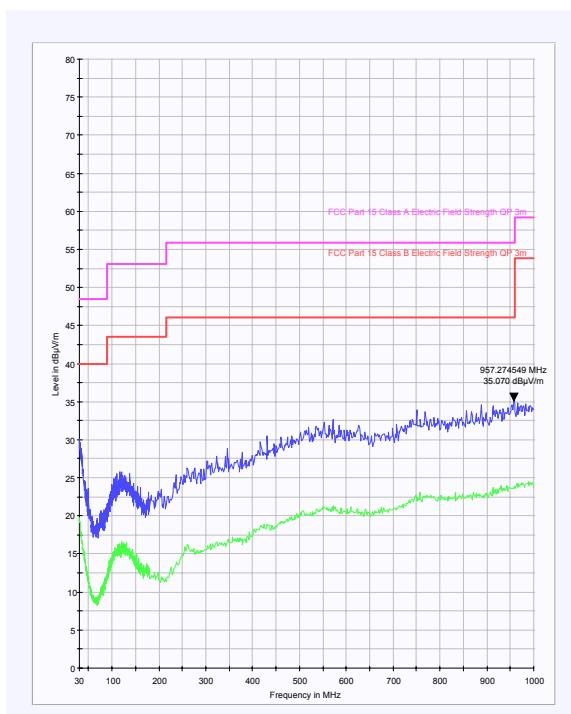
#### **Idle Mode Radiated Spurious Emissions: Section 15.109**

##### **Results:**

##### **Electric Field Strength Measurements (Frequency Range: 30 to 1000 MHz)**

Frequency (MHz)	Antenna Polarity	Peak Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Note(s)
957.274	Vertical	35.1	54.0	18.9	1

##### **Graph(s):**



##### **Note(s):**

1. No emissions were detected therefore the highest peak noise floor level of the measuring receiver was recorded.

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**Idle Mode Radiated Spurious Emissions: Section 15.109 (Continued)**

**Test Equipment Used:**

RFI No.	Instrument	Manufacturer	Type No.	Serial No.	Date Last Calibrated	Cal. Interval
A1037	Bilog Antenna	Chase EMC	CBL6112B	2413	20 Sep 2006	12
M1263	EMI Test Receiver	Rohde & Schwarz	ESIB7	100265	25 Jan 2007	12
S212	Screened Room	RFI	12		N/A	N/A

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**Idle Mode Radiated Spurious Emissions: Section 15.109 (Continued)**

**Results:**

**Electric Field Strength Measurements (Frequency Range: 1 to 12.5 GHz)**

**Highest Peak Level:**

Frequency (GHz)	Antenna Polarity	Detector Level (dB $\mu$ V)	Transducer Factor (dB)	Actual Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Note(s)
4.805921	Horizontal	51.9	-3.3	48.6	74.0	25.4	-
4.955861	Horizontal	51.2	-3.8	47.4	74.0	26.6	-

**Highest Average Level:**

Frequency (GHz)	Antenna Polarity	Detector Level (dB $\mu$ V)	Transducer Factor (dB)	Actual Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Note(s)
4.805921	Horizontal	50.1	-3.3	46.8	54.0	7.2	-
4.955861	Horizontal	49.7	-3.8	45.9	54.0	8.1	-

**Note(s):**

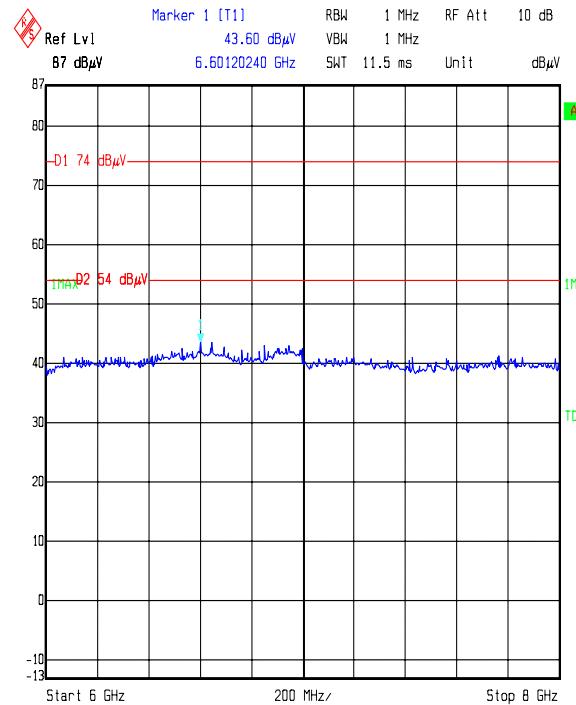
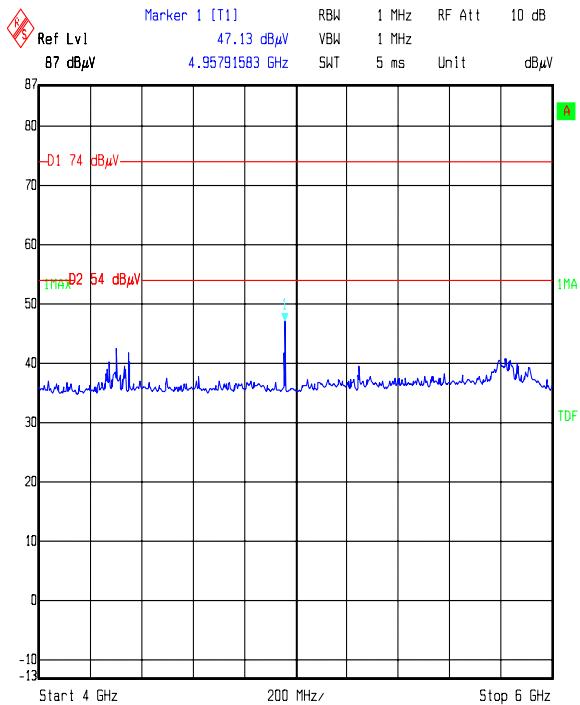
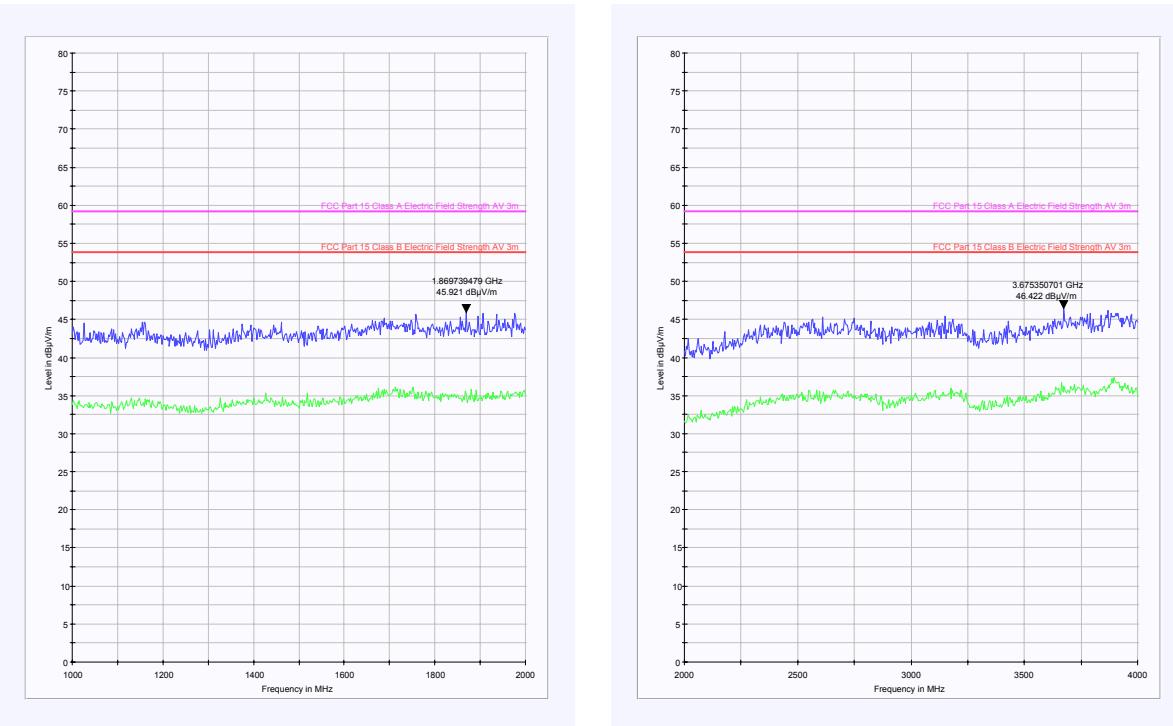
1. The emission at 10.687 GHz is an ambient unrelated to the EUT and therefore was not measured.

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***Idle Mode Radiated Spurious Emissions: Section 15.109 (Continued)***

**Graph(s):**



Date: 08.MAY.2007 14:12:17

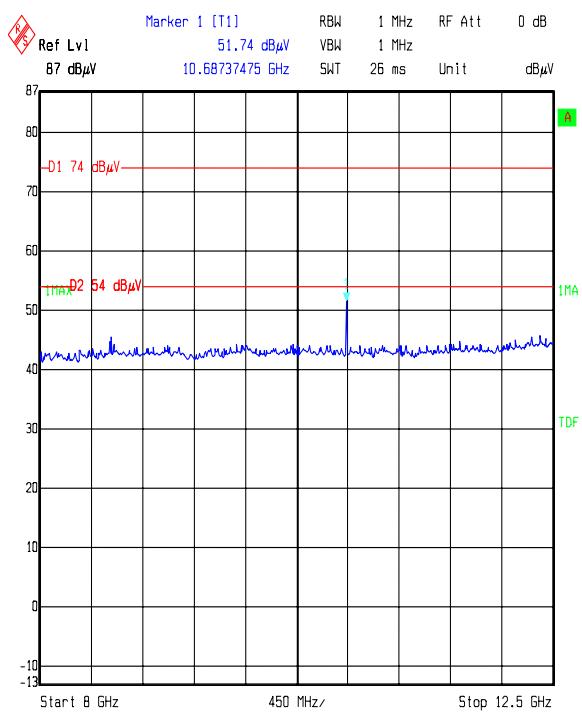
Date: 08.MAY.2007 14:34:02

These plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.

Test of: Lo-Q Plc  
Q-bot

To: FCC Part 15.247: 2006 (Subpart C)

***Idle Mode Radiated Spurious Emissions: Section 15.109 (Continued)***



Date: 08.MAY.2007 14:54:18

*This plot is a pre-scan and for indication purposes only. For final measurements, see accompanying tables.*

Test of: Lo-Q Plc  
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To: FCC Part 15.247: 2006 (Subpart C)

**Idle Mode Radiated Spurious Emissions: Section 15.109 (Continued)**

**Test Equipment Used:**

RFI No.	Instrument	Manufacturer	Type No.	Serial No.	Date Last Calibrated	Cal. Interval
A028	Horn Antenna	Eaton	91888-2	304	08 Jun 2006	36
A031	Horn Antenna	Eaton	91889-2	557	08 Jun 2006	36
A1534	Preamplifier	Hewlett Packard	8449B	3008A00405	Cal Before Use	12
A253	Horn Antenna	Flann Microwave	12240-20	128	17 Nov 2006	36
A254	Horn Antenna	Flann Microwave	14240-20	139	17 Nov 2006	36
A255	Horn Antenna	Flann Microwave	16240-20	519	17 Nov 2006	36
A256	Horn Antenna	Flann Microwave	18240-20	400	17 Nov 2006	36
A436	Horn Antenna	Flann Microwave	20240-20	330	24 Apr 2006	36
M1242	Spectrum Analyser	Rohde & Schwarz	FSEM30	845986_022	08 Sep 2006	12
M1263	EMI Test Receiver	Rohde & Schwarz	ESIB7	100265	25 Jan 2007	12
S202	3m OATS	RFI	2		17 Nov 2006	12
S212	Screened Room	RFI	12		N/A	N/A

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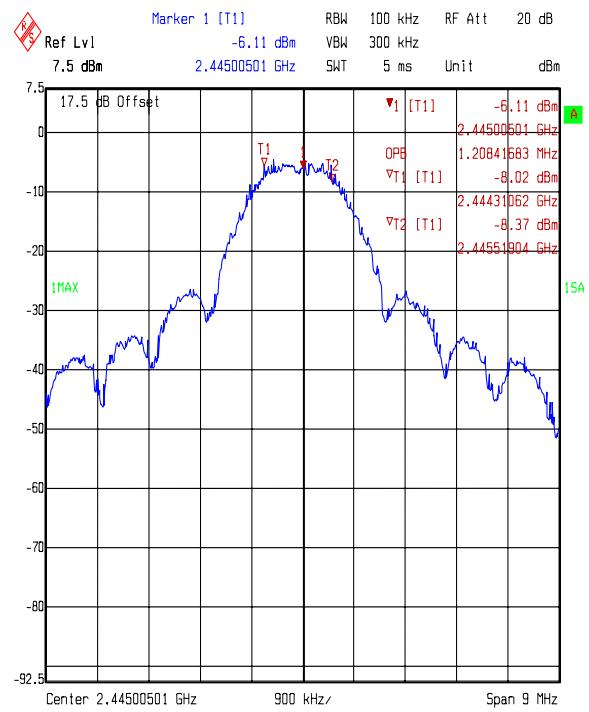
To: FCC Part 15.247: 2006 (Subpart C)

**Transmitter Minimum 6 dB Bandwidth: Section 15.247(a)(2)**

**Results:**

Channel	Transmitter 6 dB Bandwidth (MHz)	Limit (MHz)	Margin (MHz)	Notes
Bottom	1.298597	≥ 0.5	0.798	-
Middle	1.208416	≥ 0.5	0.708	-
Top	1.244488	≥ 0.5	0.744	-

**Graph(s):**



Date: 24.MAY.2007 15:15:32

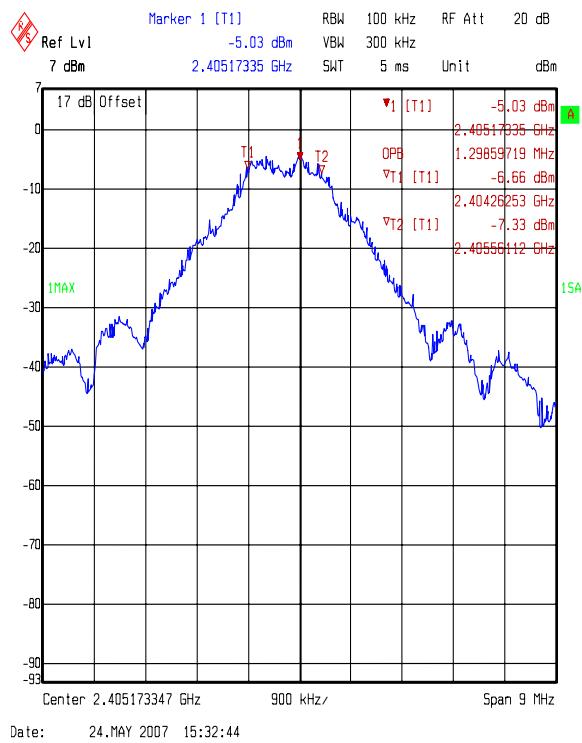
Date: 24.MAY.2007 15:27:34

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### Graph(s):



Test of: Lo-Q Plc  
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**Test Equipment Used:**

RFI No.	Instrument	Manufacturer	Type No.	Serial No.	Date Last Calibrated	Cal. Interval
A1818	Horn Antenna	EMCO	3115	00075692	17 Nov 2006	12
M127	Spectrum Analyser	Rohde & Schwarz	FSEB 30	842 659/016	07 Aug 2006	12

Test of: Lo-Q Plc  
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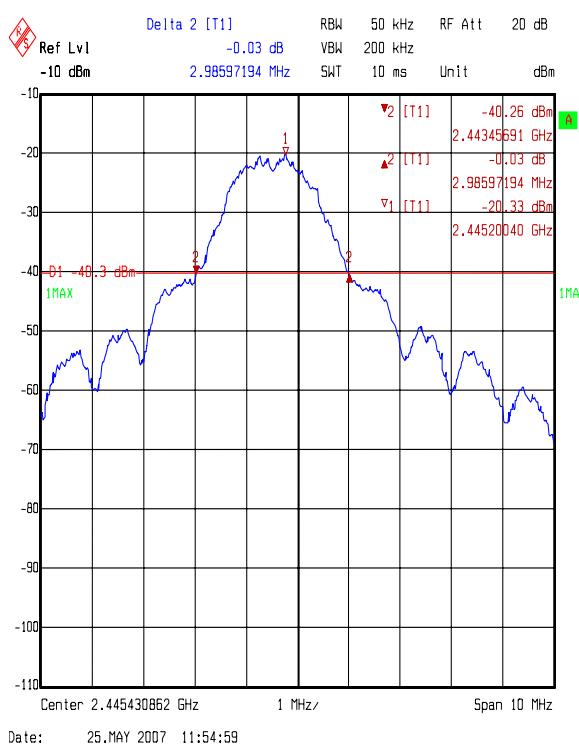
To: FCC Part 15.247: 2006 (Subpart C)

### Transmitter 20 dB Bandwidth: Section 2.1049

#### Results:

Transmitter 20 dB Bandwidth (MHz)	Limit (kHz)
2.985979	None specified

#### Graph(s):



#### Note(s):

1. This measurement was performed for the purposes of Industry Canada certification.

#### Test Equipment Used:

RFI No.	Instrument	Manufacturer	Type No.	Serial No.	Date Last Calibrated	Cal. Interval
M127	Spectrum Analyser	Rohde & Schwarz	FSEB 30	842 659/016	07 Aug 2006	12

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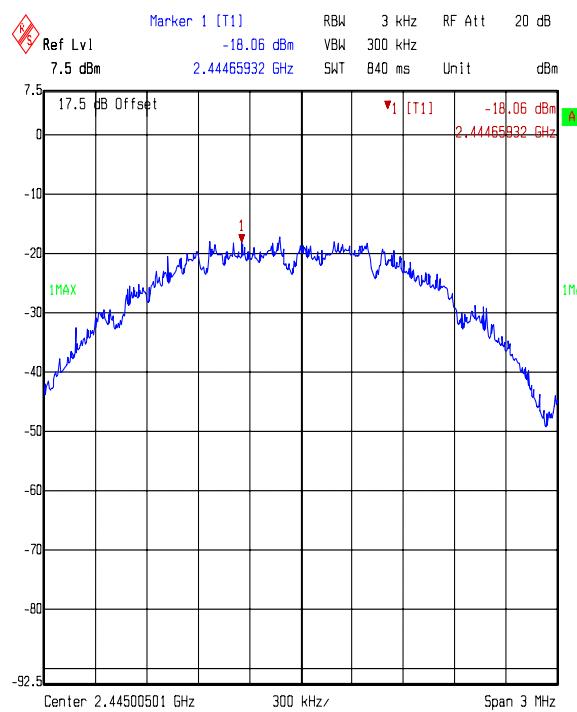
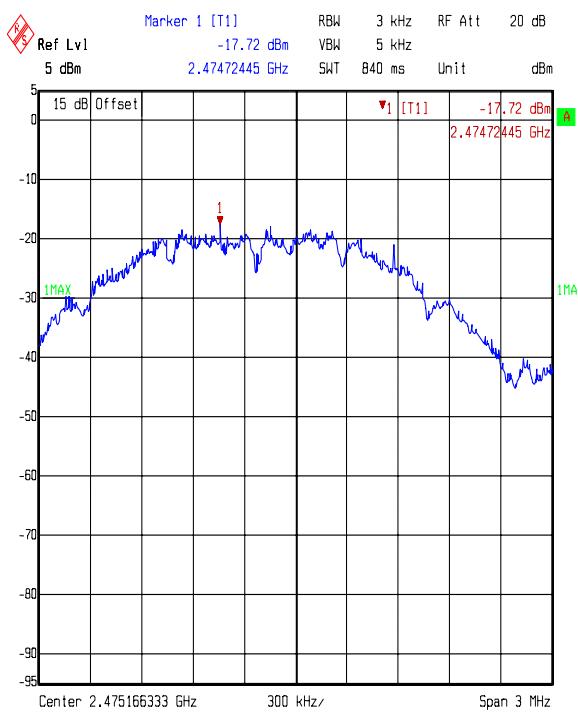
To: FCC Part 15.247: 2006 (Subpart C)

**Transmitter Peak Power Spectral Density: Section 15.247(e)**

**Results:**

Channel	Output Power (dBm/3 kHz)	Limit (dBm/3 kHz)	Margin (dB)	Notes
Bottom	-16.9	8.0	24.9	-
Middle	-18.1	8.0	26.1	-
Top	-17.7	8.0	25.7	-

**Graph(s):**

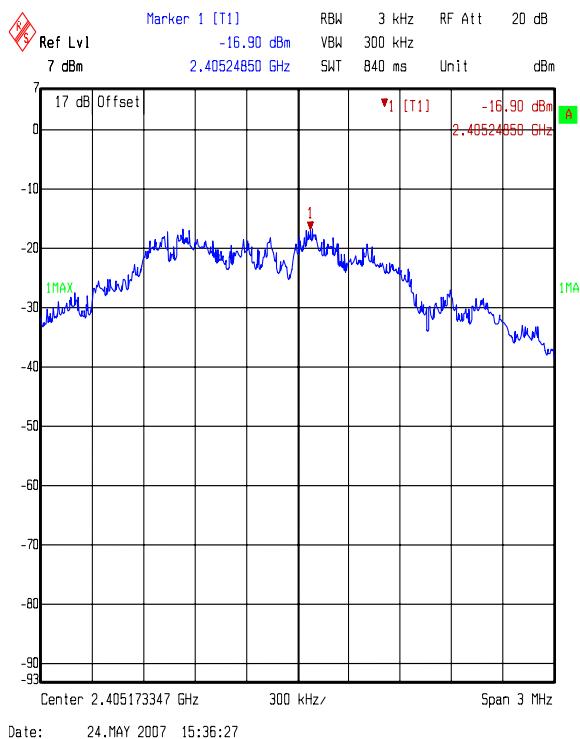


These plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.

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### Graph(s):



*This plot is a pre-scan and for indication purposes only. For final measurements, see accompanying tables*

### Test Equipment Used:

RFI No.	Instrument	Manufacturer	Type No.	Serial No.	Date Last Calibrated	Cal. Interval
A1818	Horn Antenna	EMCO	3115	00075692	No Details	12
M127	Spectrum Analyser	Rohde & Schwarz	FSEB 30	842 659/016	07 Aug 2006	12

Test of: Lo-Q Plc  
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**Transmitter Maximum Peak Output Power: (EIRP) Section 15.247(b)(3)**

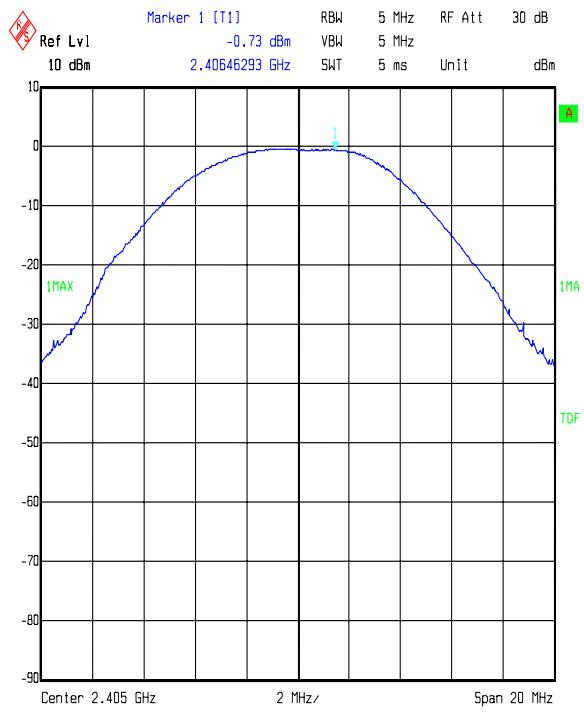
**Results:**

Channel	EIRP (dBm)	Limit (dBm)	Margin (dB)	Note(s)
Bottom	-0.7	30.0	30.7	-
Middle	-0.9	30.0	30.9	-
Top	-1.2	30.0	31.2	-

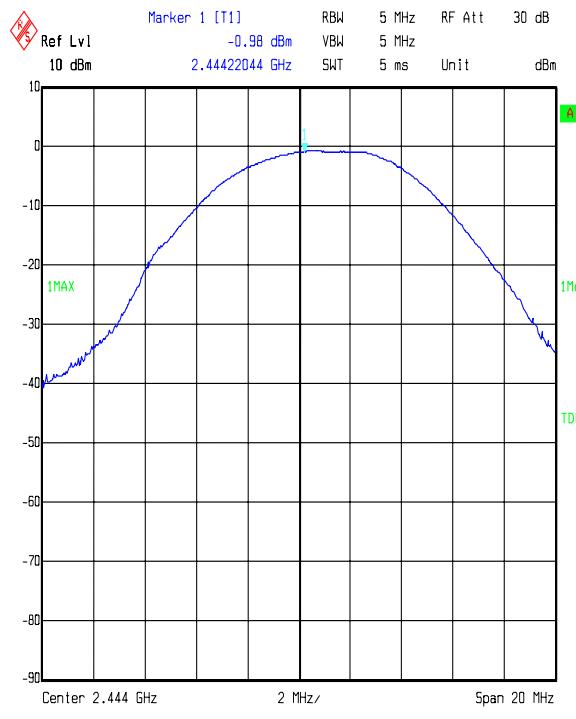
**Note(s):**

1. These tests were performed radiated; therefore the EUT antenna gain is encompassed in the final result and not measurable.

**Graph(s):**



Date: 06.MAY 2007 15:48:02



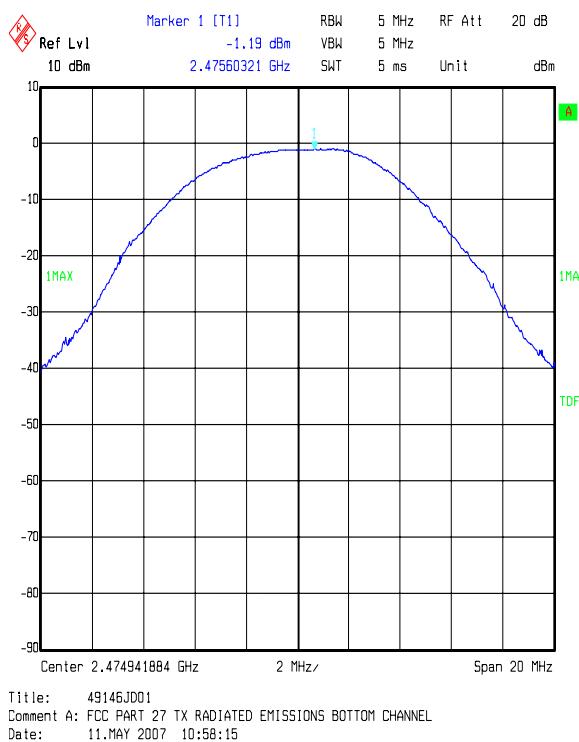
Date: 06.MAY 2007 15:51:02

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To: FCC Part 15.247: 2006 (Subpart C)

**Transmitter Maximum Peak Output Power: (EIRP) Section 15.247(b)(3)**

**Graph(s):**



**Test Equipment Used:**

RFI No.	Instrument	Manufacturer	Type No.	Serial No.	Date Last Calibrated	Cal. Interval
A031	Horn Antenna	Eaton	91889-2	557	08 Jun 2006	36
A1534	Preamplifier	Hewlett Packard	8449B OPT H02	3008A00405	Cal Before Use	12
M1242	Spectrum Analyser	Rohde & Schwarz	FSEM30	845986_022	08 Sep 2006	12
S202	3m OATS	RFI	2	-	17 Nov 2006	12

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**Transmitter Radiated Emissions: Section 15.247(d) and 15.209(a)**

**Results:**

**Electric Field Strength Measurements: 30 to 1000 MHz**

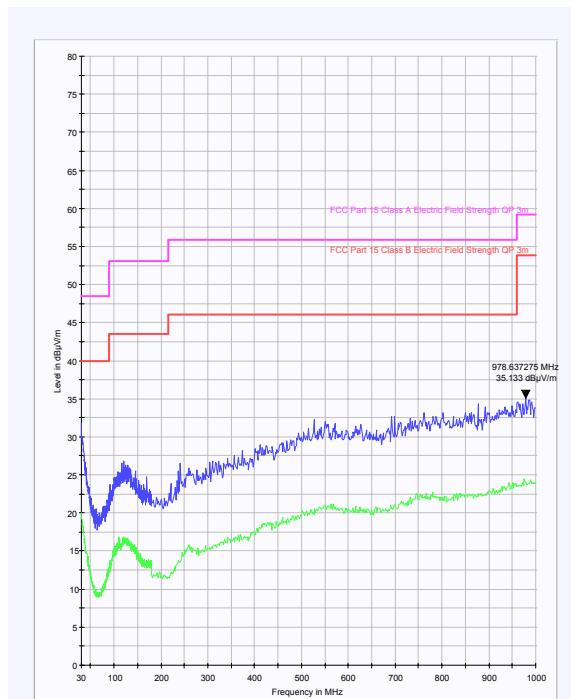
**Top Channel**

Frequency (MHz)	Antenna Polarity	Peak Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Note(s)
978.637	Vertical	35.1	54.0	18.9	1, 2

**Note(s):**

1. No emissions were detected therefore the highest peak noise floor level of the measuring receiver was recorded.
2. The preliminary scans showed similar emission levels below 1 GHz, for each channel of operation. Therefore final radiated emissions measurements were performed with the EUT set to the top channel only.

**Graph(s):**



This plot is a pre-scan and for indication purposes only. For final measurements, see accompanying tables.

**Test Equipment Used:**

RFI No.	Instrument	Manufacturer	Type No.	Serial No.	Date Last Calibrated	Cal. Interval
A1037	Bilog Antenna	Chase EMC Ltd	CBL6112 B	2413	20 Sep 2006	12
M1263	EMI Test Receiver	Rohde & Schwarz	ESIB7	100265	25 Jan 2007	12
S212	Screened Room	RFI	12	-	N/A	N/A

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**Transmitter Radiated Emissions: Section 15.247(d) and 15.209(a) (Continued)**

**Results:**

**Electric Field Strength Measurements (Frequency Range: 1 to 25GHz)  
(emissions occurring in the restricted bands)**

**Highest Peak Level: Bottom Channel**

Frequency (MHz)	Antenna Polarity	Detector Level (dB $\mu$ V)	Transducer Factor (dB)	Actual Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Note(s)
4810.931	Horizontal	57.3	-3.3	54.0	74.0	20.0	-

**Highest Average Level: Bottom Channel**

Frequency (MHz)	Antenna Polarity	Detector Level (dB $\mu$ V)	Transducer Factor (dB)	Actual Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Note(s)
4810.931	Horizontal	50.8	-3.3	47.5	54.0	6.5	-

**Highest Peak Level: Middle Channel**

Frequency (MHz)	Antenna Polarity	Detector Level (dB $\mu$ V)	Transducer Factor (dB)	Actual Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Note(s)
4890.010	Horizontal	51.5	-3.5	48.0	74.0	26.0	-

**Highest Average Level: Middle Channel**

Frequency (MHz)	Antenna Polarity	Detector Level (dB $\mu$ V)	Transducer Factor (dB)	Actual Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Note(s)
4890.010	Horizontal	46.4	-3.5	42.9	54.0	11.1	-

**Highest Peak Level: Top Channel**

Frequency (GHz)	Antenna Polarity	Detector Level (dB $\mu$ V)	Transducer Factor (dB)	Actual Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Note(s)
4.948770	Horizontal	54.5	-3.5	51.0	74.0	23.0	-

**Highest Average Level: Top Channel**

Frequency (GHz)	Antenna Polarity	Detector Level (dB $\mu$ V)	Transducer Factor (dB)	Actual Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Note(s)
4.948770	Horizontal	47.7	-3.5	44.2	54.0	9.8	-

**Note(s):**

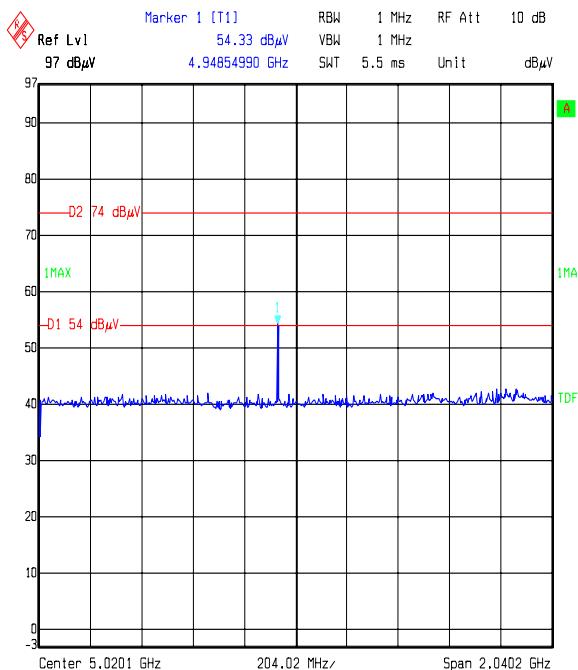
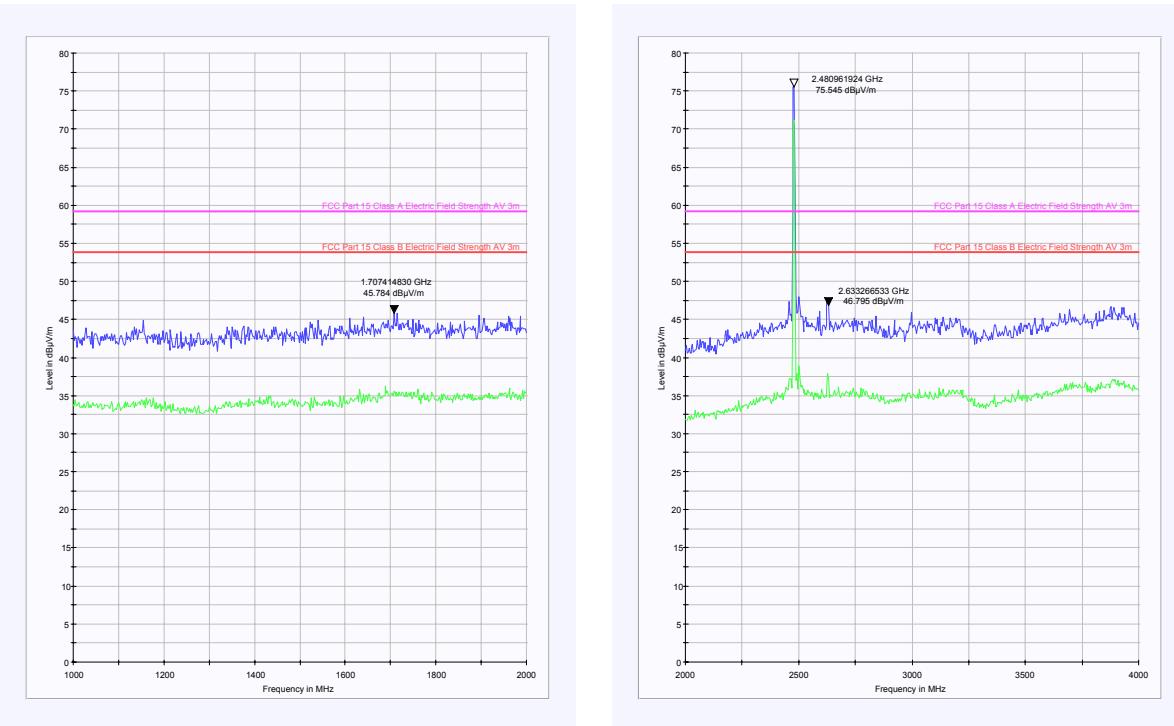
1. The 2 to 4 GHz plot shows the fundamental frequency which is ignored as it is the wanted emission.
2. The emission at 10.687 GHz is an ambient unrelated to the EUT and therefore was not measured.

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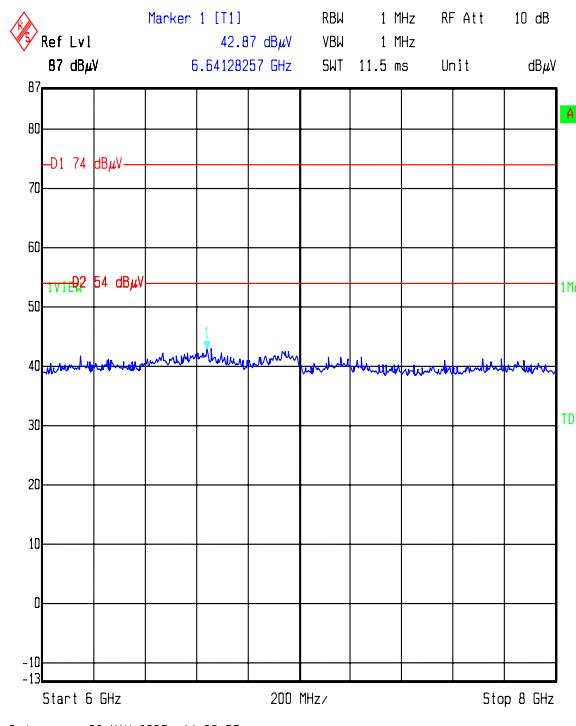
To: FCC Part 15.247: 2006 (Subpart C)

**Transmitter Radiated Emissions: Section 15.247(d) and 15.209(a) (Continued)**

**Graph(s):**



Title: 49146J001  
Comment A: FCC PART 27 TX RADIATED EMISSIONS BOTTOM CHANNEL  
Date: 11.MAY.2007 10:16:38

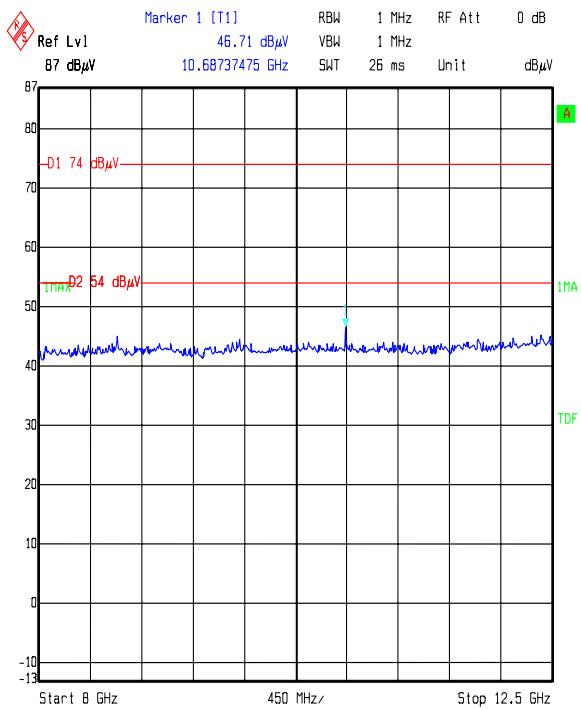


These plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.

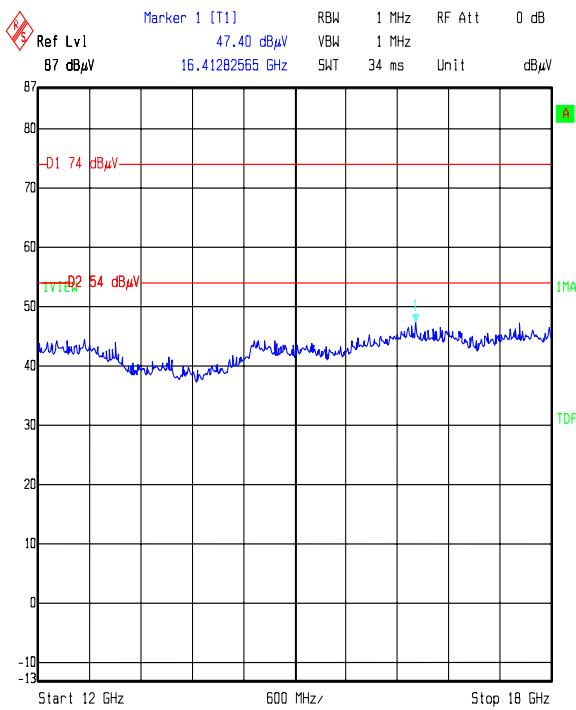
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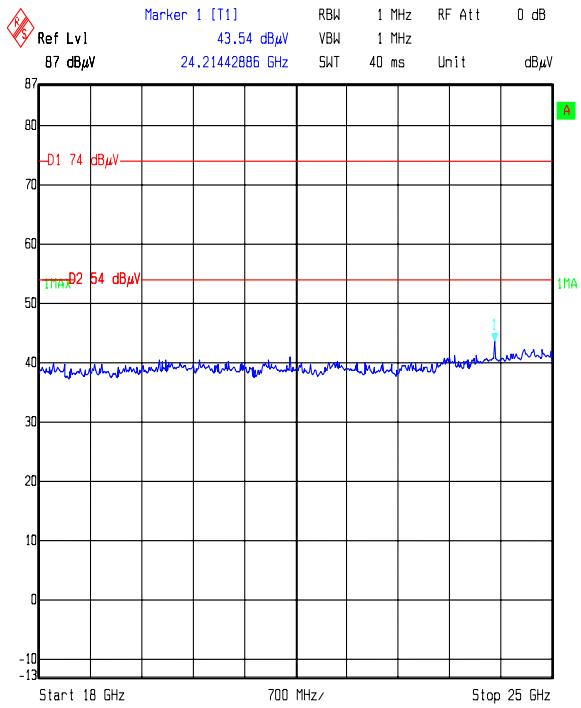
***Transmitter Radiated Emissions: Section 15.247(d) and 15.209(a) (Continued)***



Date: 08.MAY.2007 14:49:26



Date: 08.MAY.2007 15:06:01



Date: 08.MAY.2007 15:27:04

These plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.

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Q-bot

To: FCC Part 15.247: 2006 (Subpart C)

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**Transmitter Radiated Emissions: Section 15.247(d) and 15.209(a) (Continued)**

**Test Equipment Used:**

RFI No.	Instrument	Manufacturer	Type No.	Serial No.	Date Last Calibrated	Cal. Interval
A028	Horn Antenna	Eaton	91888-2	304	08 Jun 2006	36
A031	Horn Antenna	Eaton	91889-2	557	08 Jun 2006	36
A1534	Preamplifier	Hewlett Packard	8449B OPT H02	3008A00405	Cal Before Use	12
A253	Horn Antenna	Flann Microwave	12240-20	128	17 Nov 2006	36
A254	Horn Antenna	Flann Microwave	14240-20	139	17 Nov 2006	36
A255	Horn Antenna	Flann Microwave	16240-20	519	17 Nov 2006	36
A256	Horn Antenna	Flann Microwave	18240-20	400	17 Nov 2006	36
A436	Horn Antenna	Flann	20240-20	330	24 Apr 2006	36
M1242	Spectrum Analyser	Rohde & Schwarz	FSEM30	845986_022	08 Sep 2006	12
M1263	EMI Test Receiver	Rohde & Schwarz	ESIB7	100265	25 Jan 2007	12
S202	3m OATS	RFI	2		17 Nov 2006	12
S212	Screened Room	RFI	12		N/A	N/A

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### Transmitter Band Edge Radiated Emissions: Section 15.247(d) & 15.209(a)

#### Results:

##### Peak Power Level:

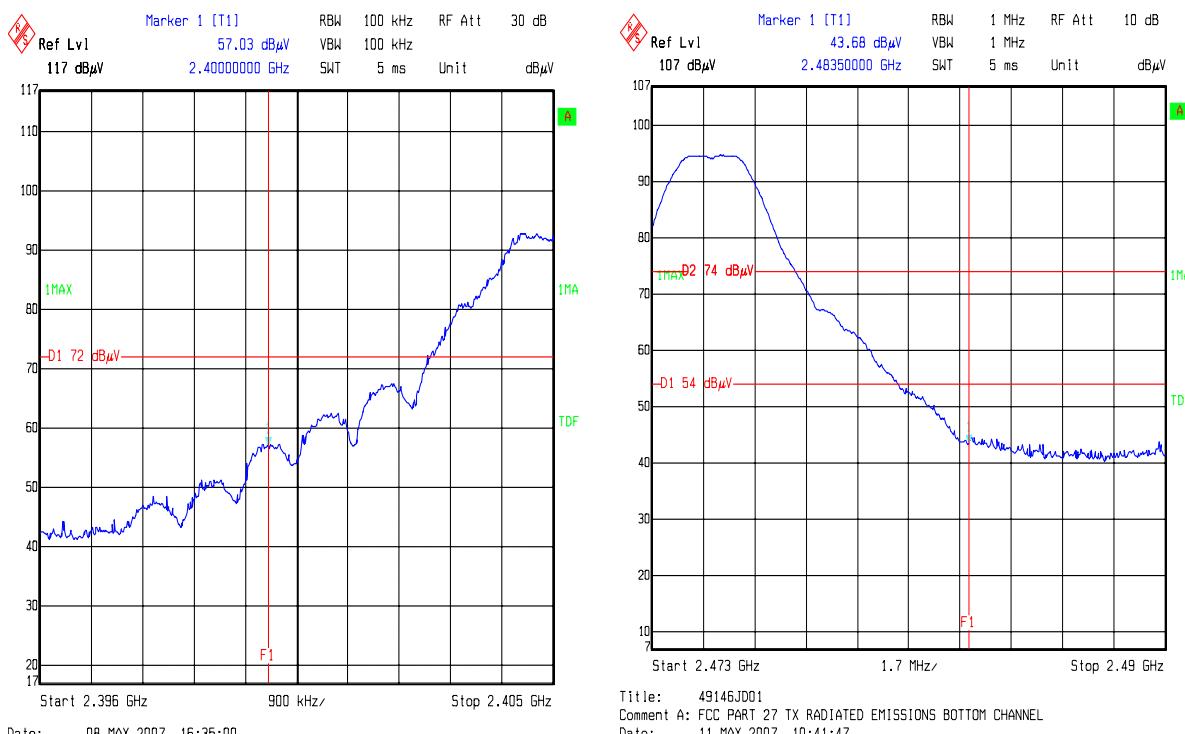
Frequency (GHz)	Antenna Polarity	Detector Level (dB $\mu$ V)	Transducer Factor (dB)	Actual Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Note(s)
2.4000	Horizontal	63.5	-6.5	57.0	72.0*	15	-
2.4835	Horizontal	51.9	-8.2	43.7	74.0	30.3	-

\*Note: -20 dBc limit

##### Average Power Level:

Frequency (GHz)	Antenna Polarity	Detector Level (dB $\mu$ V)	Transducer Factor (dB)	Actual Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Note(s)
2.4835	Horizontal	42.3	-8.2	34.1	54.0	19.9	-

#### Graph(s):



#### Test Equipment Used:

RFI No.	Instrument	Manufacturer	Type No.	Serial No.	Date Last Calibrated	Cal. Interval
A031	Horn Antenna	Eaton	91889-2	557	08 Jun 2006	36
A1534	Preamplifier	Hewlett Packard	8449B OPT H02	3008A00405	Cal Before Use	12
M1242	Spectrum Analyser	Rohde & Schwarz	FSEM30	845986_022	08 Sep 2006	12
S202	3m OATS	RFI	2		17 Nov 2006	12

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## **7. Measurement Uncertainty**

No measurement or test can ever be perfect and the imperfections give rise to error of measurement in the results. Consequently, the result of a measurement is only an approximation to the value of the measurand (the specific quantity subject to measurement) and is only complete when accompanied by a statement of the uncertainty of the approximation.

The expression of uncertainty of a measurement result allows realistic comparison of results with reference values and limits given in specifications and standards.

The uncertainty of the result may need to be taken into account when interpreting the measurement results.

The reported expanded uncertainties below are based on a standard uncertainty multiplied by an appropriate coverage factor, such that a confidence level of approximately 95% is maintained. For the purposes of this document “approximately” is interpreted as meaning “effectively” or “for most practical purposes”.

Measurement Type	Range	Confidence Level (%)	Calculated Uncertainty
AC Conducted Spurious Emissions	0.15 MHz to 30 MHz	95%	±3.72 dB
Transmitter Maximum Peak Output Power	Not applicable	95%	±2.94 dB
Spectral Power Density	Not applicable	95%	±0.27 dB
6 dB/20 dB Bandwidth	Not applicable	95%	±11.4 ppm
Radiated Spurious Emissions	30 MHz to 1000 MHz	95%	±4.64 dB
Radiated Spurious Emissions	1 GHz to 40 GHz	95%	±2.94 dB

The methods used to calculate the above uncertainties are in line with those recommended within the various measurement specifications. Where measurement specifications do not include guidelines for the evaluation of measurement uncertainty, the published guidance of the appropriate accreditation body is followed.

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## **8. Measurement Methods**

### **8.1. Radiated Emissions**

Radiated emissions measurements were performed in accordance with the standard, against appropriate limits for each detector function.

Initial measurements covering the entire measurement band in the form of swept scans in a shielded enclosure were performed in order to identify frequencies on which the EUT was generating interference. This determined the frequencies on which the EUT should be re-measured in full on the open area test site. In order to minimise the time taken for the swept measurements, a peak detector was used in conjunction with the appropriate detector IF measuring bandwidth (see table below). Repetitive scans were performed to allow for emissions with low repetition rates.

The initial scans were performed using an antenna height of 1.5 m and a measurement distance of 3 m. Following the initial scans, graphs were produced giving an overview of the emissions from the EUT plotted against the appropriate specification limit. Any emission within 20 dB of the limit were then measured on the open area test site, except in cases where the noise floor was within 20 dB of the limit, in these cases the highest point of the noise floor was measured.

Where an emission fell inside a restricted band, measurements were made at the appropriate test distance using a measuring receiver with a quasi peak detector for measurements below 1000 MHz and an average and peak detector for measurements above 1000 MHz. A peak detector was used for all other measurements.

For the final measurements the EUT was arranged on a non-conducting turn table on a standard test site compliant with ANSI C63.4 – 2003 Clause 5.4.

All measurements on the open area test site were performed using broadband antennas in both vertical and horizontal polarisations.

On the open area test site, at each frequency where a signal was to be measured, the trace was maximised by rotating a turntable through 360°. The angle at which the maximum signal was observed was locked out. For frequencies below 1000 MHz the test antenna was varied in height between 1 m and 4 m in order to further maximise the target emission.

For frequencies above 1000 MHz where a horn antenna was used, height searching was performed to locate the optimal height of the horn with respect to the EUT. At this point the horn was locked off and the turntable was again rotated through 360° to maximise the target signal. It should be noted that the received signal from the EUT would diminish very quickly after it exits the beam width of the horn antenna, for this reason it may not be necessary to fully height search with the horns.

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### Radiated Emissions (Continued)

At this point, any signals found to be between the limit and a level 6 dB below it were further maximised by changing the configuration of the EUT, e.g. re-routing cables to peripherals and moving peripherals with respect to the EUT.

Scans were performed to the upper frequency limits as stated in section 15.33

The final field strength was determined as the indicated level in dB $\mu$ V plus cable loss and antenna factor.

The test equipment settings for radiated emissions measurements were as follows:

Receiver Function	Initial Scan	Final Measurements <1 GHz	Final Measurements $\geq$ 1 GHz
Detector Type:	Peak	Quasi-Peak (CISPR)	Peak / Average
Mode:	Max Hold	Not applicable	Max Hold
Bandwidth:	(120 kHz <1 GHz) (1 MHz $\geq$ 1 GHz)	120 kHz	1 MHz
Amplitude Range:	100 dB	100 dB	100 dB
Step Size:	Continuous sweep	Not applicable	Not applicable
Sweep Time:	Coupled	Not applicable	Not applicable

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### **Minimum 6 dB Bandwidth**

The EUT and spectrum analyser were configured as for radiated measurements.

To determine the 6 dB bandwidth, a resolution bandwidth of 100 kHz was used, which is approximates to 10% of the 6 dB bandwidth. A video bandwidth of 300 kHz was used. The analyser was set to a span of greater than twice the 6 dB bandwidth and for a maximum hold scan to capture the profile of the signal. The peak level was then determined, and a reference established 6 dB below the peak level. The bandwidth was determined at the points where the 6 dB reference crossed the profile of the emission.

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## **8.2. Transmitter 20 dB Bandwidth**

The EUT and spectrum analyser was configured as for transmitter radiated measurements.

To determine the occupied bandwidth, a resolution bandwidth of 50 kHz was used, which is greater than 1% of the 20 dB bandwidth. A video bandwidth of at least the same value was used. The analyser was set for a maximum hold scan to capture the profile of the signal. The peak level was then determined, and a reference line was drawn 20 dB below the peak level. The bandwidth was determined at the points where the 20 dB reference crossed the profile of the emission.

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### **8.3. Spectral Power Density**

The EUT and spectrum analyser were configured as for radiated emissions measurements.

Prior to testing being performed a suitable RF attenuator and cables were calibrated for the required frequencies. For each frequency the calibrated level of the attenuator and cable were entered as an offset into the spectrum analyser to compensate for the losses in the measurement set up.

Prior to the measurement being taken the spectrum analyser was tuned to the fundamental frequency of the EUT.

A resolution bandwidth of 3 kHz was selected and the analyser was set to a span greater than twice the 6 dB bandwidth. The trace was max held and a reading was taken at the peak point of the trace.

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#### **8.4. Band Edge Compliance of RF Radiated Emissions**

The EUT and spectrum analyser were configured as for radiated measurements.

To determine band edge compliance, the analyser resolution bandwidth was set to  $\geq$  1% of the analyser span. The video bandwidth was set to be  $\geq$  the resolution bandwidth. The sweep was set to auto and the detector to peak. The trace was set to max hold and a trace was produced.

Plots of the lower and upper band edge of the allocated frequency band were produced. A marker was set to the level of the highest in band emission with a limit line set to 20 dB below this. The marker was then placed on the highest out of band emission (the specification states that either the band edge level must be measured or the highest out of band emission, whichever is the greater). The plots show that the highest out of band emission complies with the -20 dBc Limit.

The above procedure was then repeated for the upper band edge except that, as the upper band edge fell on a restricted band edge (as defined in section 15.205(a)), the limit for the restricted band was applied instead of the 20 dBc limit i.e. the general limits defined in section 15.209(a).

Final measurements were performed on the worst-case configuration as described in part 15.31(i).

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### **8.5. Effective Radiated Power (ERP)**

ERP measurements were performed in accordance with the standard, against appropriate limits.

The ERP was measured with the EUT arranged on a non-conducting turn table on a standard test site compliant with ANSI C63.4 – 2003 Clause 5.4. The transmitter was fitted with an integral antenna; as such all radiated tests were performed with the unit operating into the integral antenna.

The level of the ERP was measured using a spectrum analyser.

The test antenna was positioned in the horizontal plane. The EUT was oriented in the X plane. The test antenna was then raised and lowered until a maximum peak was observed. The turntable was then rotated through 360 degrees and the maximum peak reading obtained. The height search was then repeated to take into consideration the new angular position of the turntable. The maximum reading observed was then recorded. This procedure was then repeated with the EUT oriented in the Y and Z planes. The highest reading taken in all 3 planes was recorded. The entire procedure was then repeated with the test antenna set in the vertical polarity.

Once the final amplitude (maximised) had been obtained, the EUT was substituted with a substitution antenna. For ERP measurements a dipole antenna was used. The centre of the substitution antenna was set to approximately the same centre location as the EUT. The substitution antenna was set to the horizontal polarity. The substitution antenna was matched into a signal generator using a 6 dB or greater PAD. The signal generator was tuned to the EUT's frequency under test.

The test antenna was then raised and lowered to obtain a maximum reading on the spectrum analyser. The level of the signal generator output was then adjusted until the maximum recorded EUT level was observed. The signal generator level was noted. This procedure was repeated with both test antenna and substitution antenna vertically polarised. The ERP was calculated as:-

$$\text{ERP} = \text{Signal Generator Level} - \text{Cable Loss} + \text{Antenna Gain}$$

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**Effective Radiated Power (ERP) (Continued)**

Circumstances where the signal generator could not produce the desired power substitution was performed with the signal generator set to 0 dBm. The radiated signal was maximised as previously described. The level indicated on the measuring receiver was noted. The delta between this level and the maximum level for the EUT was calculated and also noted. The ERP of the signal generator was calculated using the above formulae. The recorded delta was added to the calculated ERP to obtain the substituted EUT ERP.

Delta (dB) = EUT – SG

Where :

EUT = spectrum analyser indicated EUT raw level

SG = spectrum analyser indicated signal generator raw level

The signal generator actual ERP is calculated as:

ERP SG= Signal Generator Level - Cable Loss + Antenna Gain

The EUT ERP is calculated as:

ERP EUT = ERP SG + Delta.

The test equipment settings for ERP measurements were as follows:

Receiver Function	Setting
Detector Type:	Peak
Mode:	Not applicable
Bandwidth:	$\geq$ Emission Bandwidth
Amplitude Range:	100 dB
Sweep Time:	Coupled

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## **Appendix 1. Test Configuration Drawings**

This appendix contains the following drawings:

Drawing Reference Number	Title
DRG\49207JD03A\EMIRAD	Test configuration for measurement of radiated emissions.

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