
REPORT ON

Limited FCC Part 80 testing in support of the Application for Grant of Equipment
Authorisation of the Raymarine RAY54 VHF Marine Radio

COMMERCIAL-IN-CONFIDENCE

FCC ID: PJ5RAY54

Report No OR612408/01 Issue 2

May 2004



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Marine Radio

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DATED

14th May 2004

DISTRIBUTION

Raymarine Inc

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BABT

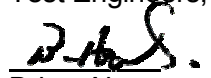
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ENGINEERING STATEMENT

The measurements shown in this report were made in accordance with the procedures described on test pages. All reported testing was carried out on a sample equipment to demonstrate limited compliance with FCC Part 80. The sample tested was found to comply with the requirements defined in the applied rules.

Test Engineers;


Brian Airs
Radio Engineer


J Holcombe
EMC Engineer


A Hubbard
EMC Engineer





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SECTION 1

REPORT SUMMARY

Limited FCC Part 80 testing in support of the Application for Grant of Equipment
Authorisation of the Raymarine RAY54 VHF Marine Radio

**1.1 STATUS**

EQUIPMENT UNDER TEST	VHF Marine Radio
OBJECTIVE	To undertake measurements to determine the Equipment Under Test's (EUT's) compliance with the specification.
NAME AND ADDRESS OF CLIENT	Raymarine Inc. 1800 NW 49 th Street, Suite 130 Fort Lauderdale Florida 3309, USA
TYPE NUMBER	RAY54
SERIAL NUMBER	SR - 024104
TEST SPECIFICATION / ISSUE / DATE	FCC Part 80
NUMBER OF ITEMS TESTED	One
SECURITY CLASSIFICATION OF EUT	Commercial In Confidence
DISPOSAL	Held pending disposal
REFERENCE NUMBER	Not Applicable
DATE	Not Applicable
ORDER NUMBER	FTL659
DATE	18/02/04
START OF TEST	5 th April 2004
FINISH OF TEST	17 th April 2004
RELATED DOCUMENTS	ANSI C63.4 2001. Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz. FCC Public Notice document (DA 00-705 released 30 March 2000)



1.2 INTRODUCTION

The information contained within this report is intended to show limited verification of compliance of the Raymarine RAY54 VHF Marine Radio to the requirements of FCC Specification Part 80.

Testing was carried out in support of an application for Grant of Equipment Authorisation in the name of Raymarine Inc.

1.3 BRIEF SUMMARY OF RESULTS

A brief summary of the tests carried out is shown below.

Test	Spec Clause	Test Description	Result	Comments
2.1	2.1049/80.205	Bandwidths	Pass	-
2.2	2.1055/80.209	Transmitter Frequency Tolerance	Pass	-
2.3	2.1051/80.211	Emission Limitations (Conducted)	Pass	-
2.4	2.1053/80.211	Emission Limitations (Radiated)	Pass	-
2.5	2.1047/80.213	Modulation Requirements	Pass	-
2.6	2.1046/80.215	Transmitter Power	Pass	-
2.7	80.217	Suppression of Interface Aboard Ships	Pass	-
2.8	1.1307(b)/80.227	MPE	Pass	
-	80.225	Requirements for Selective Calling Equipment	N/A	Manufacturer's Declaration
-	80.203(b)(c)(n)	Authorisation of Transmitters for Licensing	N/A	Manufacturer's Declaration
-	80.207	Classes of Emissions	N/A	Manufacturer's Declaration



1.4 OPINIONS AND INTERPRETATIONS

Our UKAS Accreditation does not cover opinions and interpretations and any expressed are outside the scope of our UKAS Accreditation.



1.5 PRODUCT INFORMATION

1.5.1 Technical Description

The RAYMARINE RAY54 operates from a 13.6 Volt DC Supply, operating with a maximum output power of 25 Watts.

1.5.2 Modes of Operation

Applicable testing was carried out with the EUT transmitting at maximum power.

1.6 TEST CONDITIONS

The EUT was set-up simulating a typical user installation on the Alternative Open Field Test Site identified in Appendix A, and tested in accordance with the applicable specification.

For all tests, the EUT was powered by a 13.6V DC supply.

1.7 DEVIATIONS FROM THE STANDARD

Not Applicable

1.8 MODIFICATION RECORD

Not Applicable



SECTION 2

TEST DETAILS

Limited FCC Part 80 testing in support of the Application for Grant of Equipment
Authorisation of the Raymarine RAY54 VHF Marine Radio



2.1 BANDWIDTHS

2.1.1 FCC Part 80, Section 2.1049(c)(1)/80.205

2.1.2 Equipment Under Test RAY54

2.1.3 Date of Test 15th April 2004

2.1.4 Test Equipment Used (See Section 3.1 for details) 1, 2, 3, 4, 11

2.1.5 Test Procedure

The EUT is declared as having a class of emission:- G3E, which dictates an emission designator of 16K0G3E, which from 80.205(a) equates to an authorised bandwidth of 20kHz.

Initially, the EUT was connected via a 30dB Attenuator to a Modulation Analyser, which was set to measure deviation. From the results in 80.213, the audio frequency for a set input level, which produces the highest level of deviation, was 2.5kHz. Thus, the Audio Analyser was set to supply the EUT with an audio tone of 2.5kHz at an amplitude which produced a deviation corresponding to 50% of the maximum permissible frequency deviation, (2.5kHz). The level was then increased on the Audio Analyser by 16dB.

The Modulation Analyser was then replaced with a Spectrum Analyser and the 99% Bandwidth was measured. The measurements were performed on channel 70 (DSC), bottom and top channels on both maximum and minimum power levels.

2.1.6 Test Results

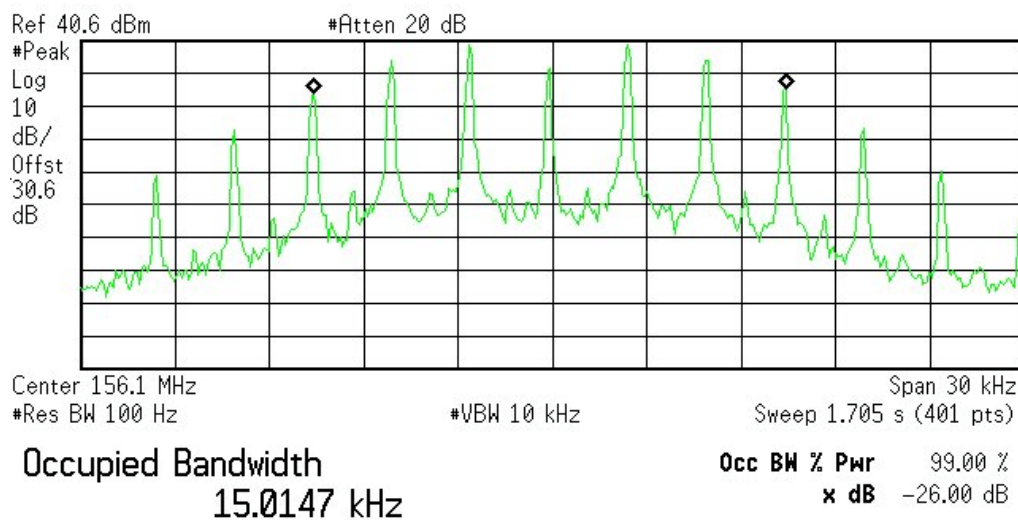
Channel Number/Frequency	Power Level (W)	Result (kHz)	Authorised Bandwidth (kHz)
1 / 156.050MHz	25	15.0147	20
1 / 156.050MHz	1	14.9686	20
88 / 157.425MHz	25	15.0561	20
88 / 157.425MHz	1	15.0443	20
70 / 156.525MHz	25	11.8519	20
70 / 156.525MHz	1	12.4021	20

The test result plots are shown in the following pages.



2.1 BANDWIDTHS - Continued

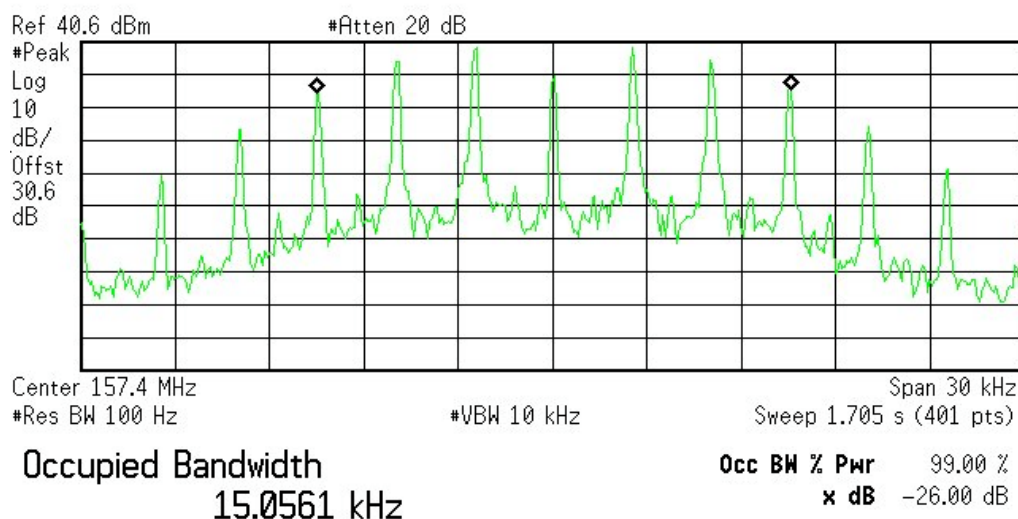
Agilent 12:13:52 Apr 14, 2004



Transmit Freq Error -100.288 Hz
x dB Bandwidth 20.042 kHz

99% Bandwidth – Channel 1 - 25W

Agilent 12:32:44 Apr 14, 2004



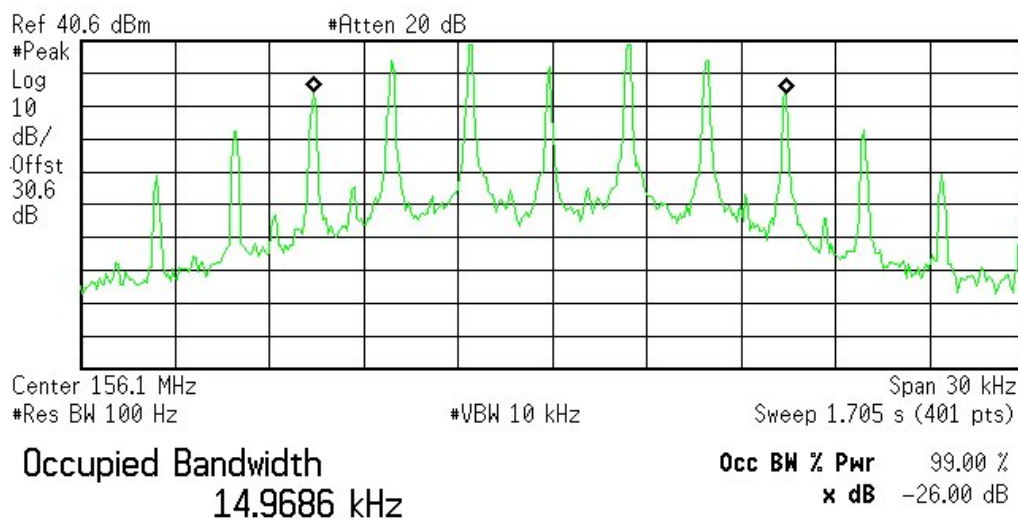
Transmit Freq Error 49.268 Hz
x dB Bandwidth 20.082 kHz

99% Bandwidth – Channel 88 - 25W



2.1 BANDWIDTHS - Continued

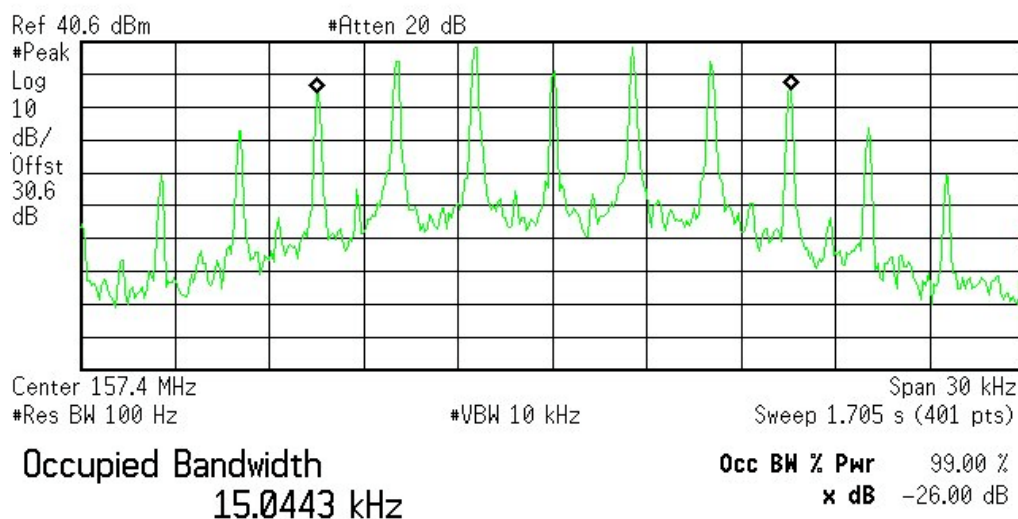
Agilent 12:15:09 Apr 14, 2004



Transmit Freq Error -88.273 Hz
x dB Bandwidth 17.625 kHz

99% Bandwidth – Channel 1 - 1W

Agilent 12:31:01 Apr 14, 2004



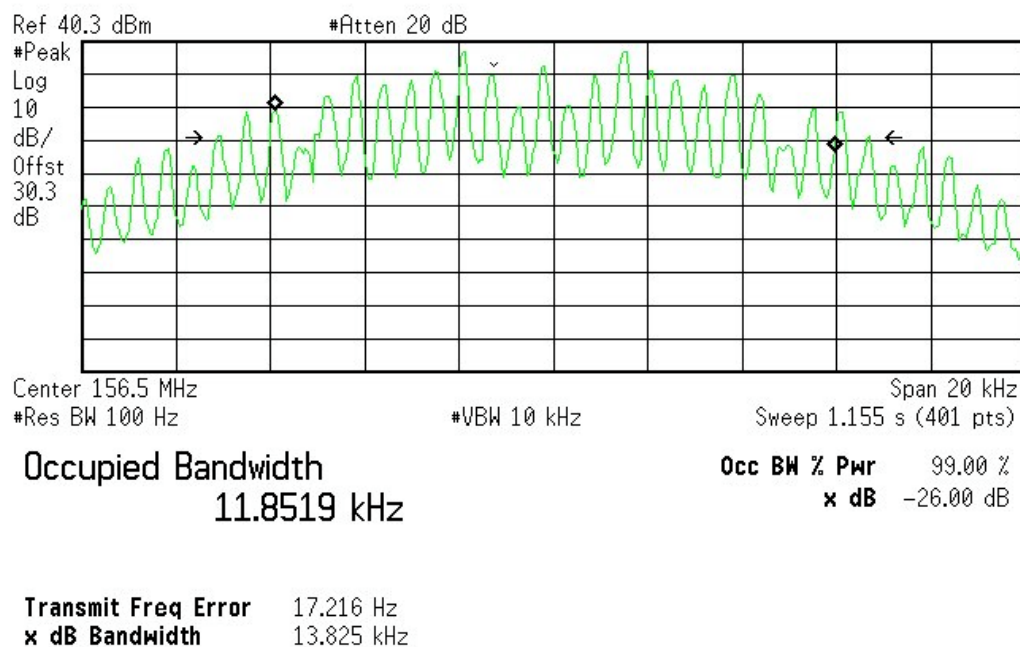
Transmit Freq Error 48.275 Hz
x dB Bandwidth 20.058 kHz

99% Bandwidth – Channel 88 - 1W



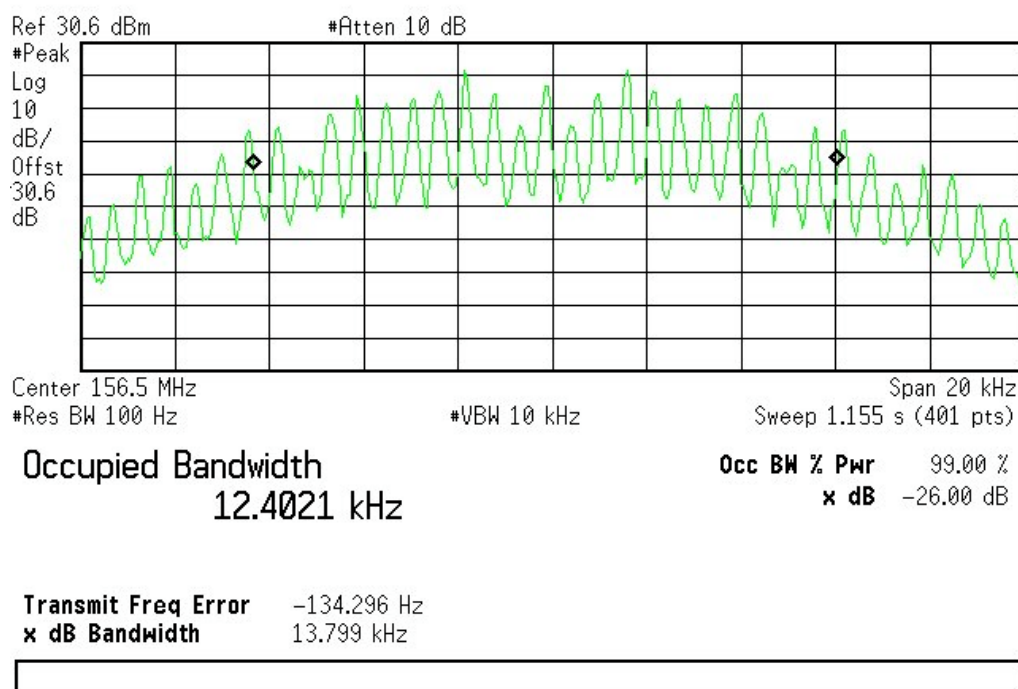
2.1 BANDWIDTHS – Continued

Agilent 15:27:21 11 May 2004



99% Bandwidth – Channel 70 - 25W – DSC

Agilent 11:51:42 Apr 14, 2004



99% Bandwidth – Channel 70 - 1W – DSC

**2.1 BANDWIDTHS - Continued****2.1.7 LIMITS**

Limit	<20kHz
-------	--------

Remarks

EUT complies with CFR 47 2.1049(c)(1) and 80.205(a) for G3E Class of Emission. The Authorised Bandwidth is less than 20kHz in all states of modulation.



2.2 TRANSMITTER FREQUENCY TOLERANCE

2.2.1 FCC Part 80, Section 2.1055/80.209

2.2.2 Equipment Under Test RAY54

2.2.3 Date of Test 16th April 2004

2.2.4 Test Equipment Used (See Section 3.1 for details) 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

2.2.5 Test Procedure

The EUT was set to transmit on maximum power with no modulation. A Modulation Analyser was used to measure the Frequency Error. The results were recorded at each temperature and Voltage interval.

2.2.6 Test Results

Temperature Variation

Channel 1 – 156.050MHz

Temperature Interval(°C)	Test Frequency (MHz)	Deviation (Hz)	Limit (kHz)
- 20	156.050	443	± 1.56
- 10	156.050	355	± 1.56
0	156.050	143	± 1.56
+ 10	156.050	-144	± 1.56
+ 20	156.050	-151	± 1.56
+ 30	156.050	-201	± 1.56
+ 40	156.050	-201	± 1.56
+ 50	156.050	-128	± 1.56

Channel 88 – 157.425MHz

Temperature Interval(°C)	Test Frequency (GHz)	Deviation (Hz)	Limit (kHz)
- 20	157.425	443	± 1.57
- 10	157.425	358	± 1.57
0	157.425	143	± 1.57
+ 10	157.425	-144	± 1.57
+ 20	157.425	-185	± 1.57
+ 30	157.425	-206	± 1.57
+ 40	157.425	-203	± 1.57
+ 50	157.425	-119	± 1.57



2.2 TRANSMITTER FREQUENCY TOLERANCE - Continued

Voltage Variation

Channel 1 – 156.050MHz

DC Voltage (V)	Test Frequency (MHz)	Deviation (Hz)	Deviation Limit (kHz)
11.73	156.050	-156	± 1.56
13.80	156.050	-151	± 1.56
15.87	156.050	-159	± 1.56

Channel 88 – 157.425MHz

DC Voltage (V)	Test Frequency (MHz)	Deviation (Hz)	Deviation Limit (kHz)
11.73	157.425	-175	± 1.57
13.80	157.425	-185	± 1.57
15.87	157.425	-168	± 1.57

2.2.7 LIMITS

Limit	±1.56kHz or 10ppm
-------	-------------------

Remarks

EUT complies with CFR 47 Part 80.209(a)(5)(ii). The EUT does not exceed ±1.56kHz at the measured frequency at any temperature interval across the measured range.

EUT complies with CFR 47 Part 80.209. The EUT does not exceed ±1.56kHz at the measured frequency either at nominal or voltage variation.



2.3 EMISSION LIMITATIONS (CONDUCTED)

2.3.1 FCC Part , Section 2.1051/80.211(f)(1)(2) &(3)

2.3.2 Equipment Under Test RAY54

2.3.3 Date of Test 17th – 20th April 2004

2.3.4 Test Equipment Used 1, 2, 3, 4, 11

2.3.5 Test Procedure

Emission Limitations Greater Than 250% Of The Authorised Bandwidth, (80.211(f)(3))

The EUT was connected to a Spectrum Analyser via a 30dB attenuator. The path loss between the Spectrum Analyser and the EUT was established over the measurement range and inserted into the Spectrum Analyser as a reference level offset. Using a RBW of 100kHz and a VBW of 300kHz, the emissions were measured in the range 9kHz to 2GHz as defined in 2.1057(a)(1). Having entered the reference level offset, the limit line was displayed, showing the -13dBm , $(43+10\log P)$, limit.

Emission Limitations Within 250% Of The Authorised Bandwidth, (80.211(f)(1)(2))

The EUT was connected to a Spectrum Analyser via a 30dB attenuator. The path loss between the Spectrum Analyser and the EUT was established within the measurement range and inserted into the Spectrum Analyser as a reference level offset. The emission mask, as defined in the test clauses above, was set and displayed on the Spectrum Analyser. The reference point of the emission mask, (0dBc), was achieved with the carrier unmodulated. The EUT was then modulated in accordance with 2.1049(c), (Occupied Bandwidth). The measurement detector was set to average and the results recorded.

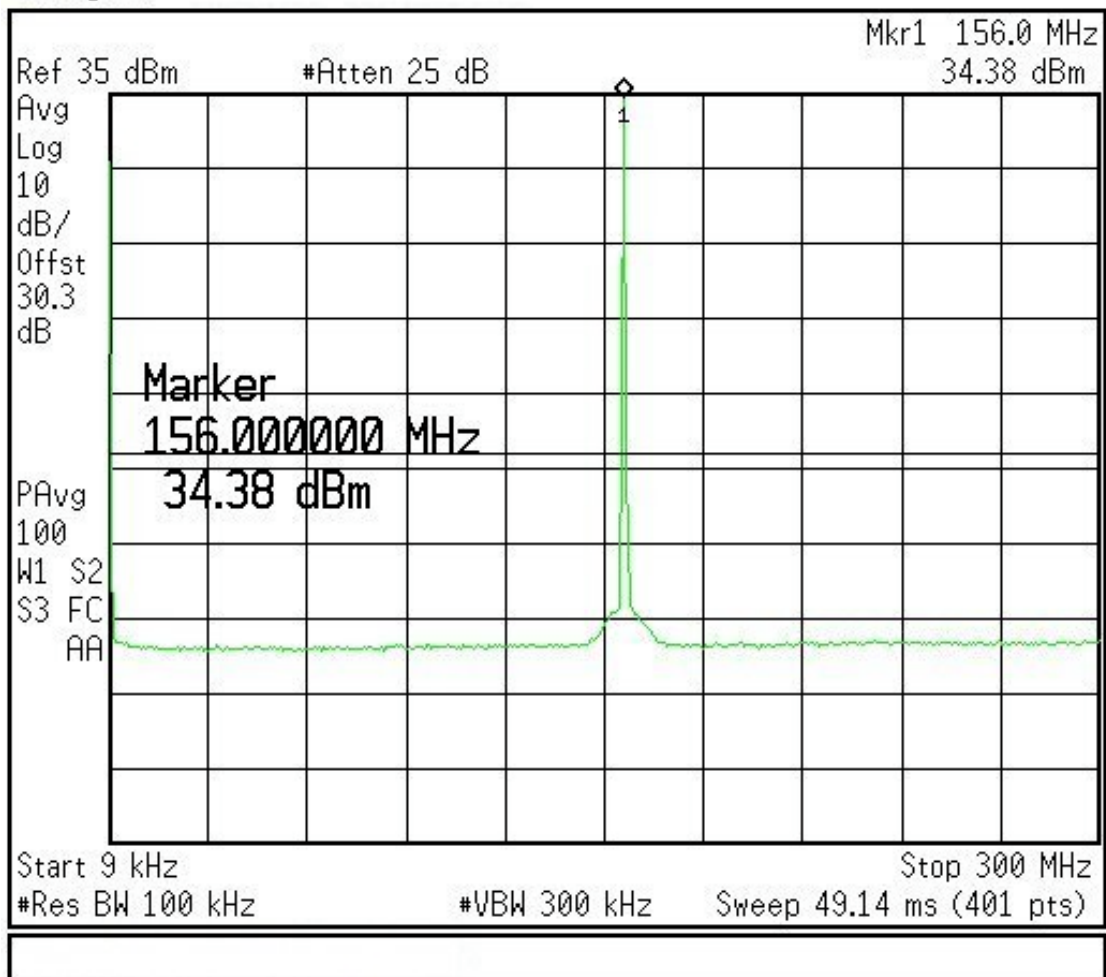
The EUT was tested on Channel 70 (DSC), bottom and top channels at both maximum and minimum power.

2.3.6 Results

The resulting plots are shown on the following pages.

**2.3 EMISSION LIMITATIONS (CONDUCTED)-Continued**

Rule Parts: 2.1051, 80.211(f)(3)
Spurious Emissions (9kHz – 300MHz)
Channel 1 (156.050MHz) – Maximum Power

* **Agilent**



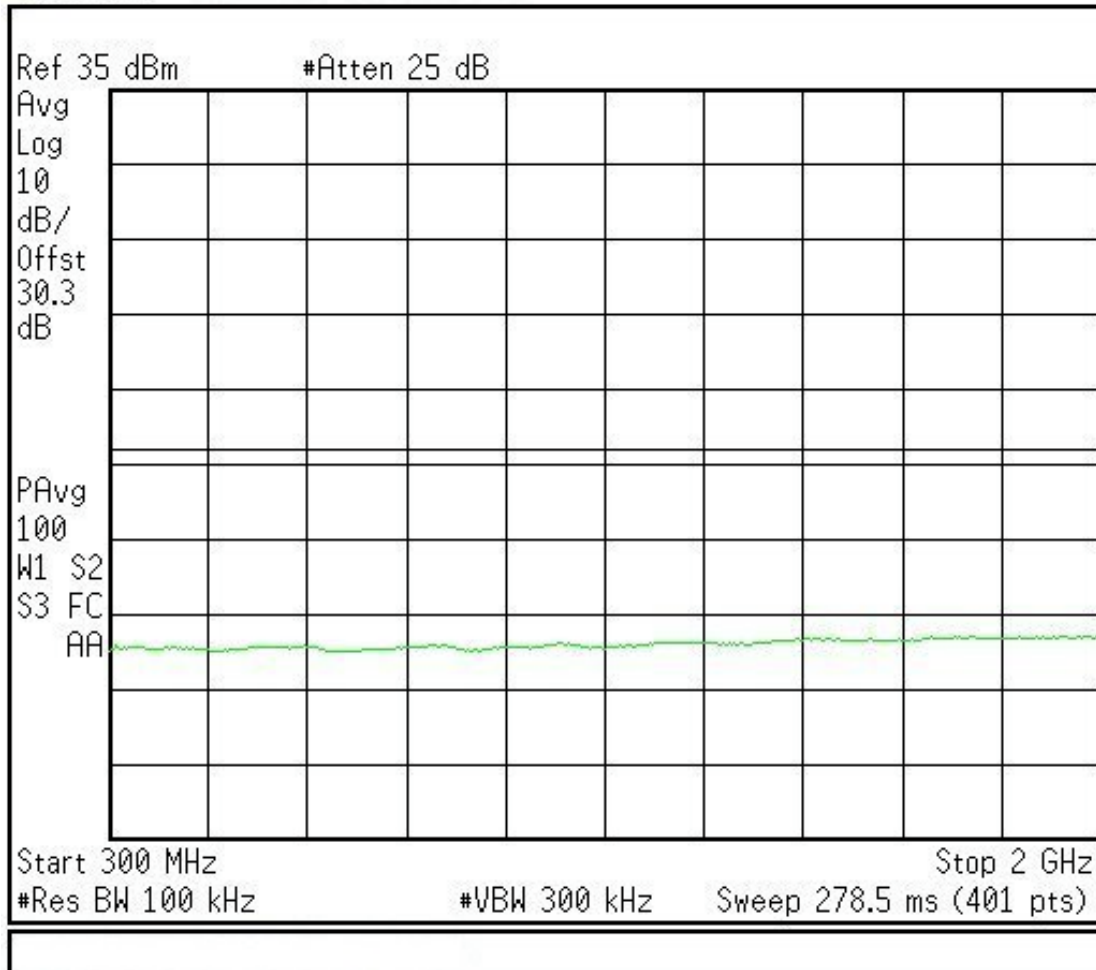
2.3 EMISSION LIMITATIONS (CONDUCTED)-Continued

Rule Parts: 2.1051, 80.211(f)(3)

Spurious Emissions (300MHz – 2GHz)

Channel 1 (156.050MHz) – Maximum Power

 **Agilent**

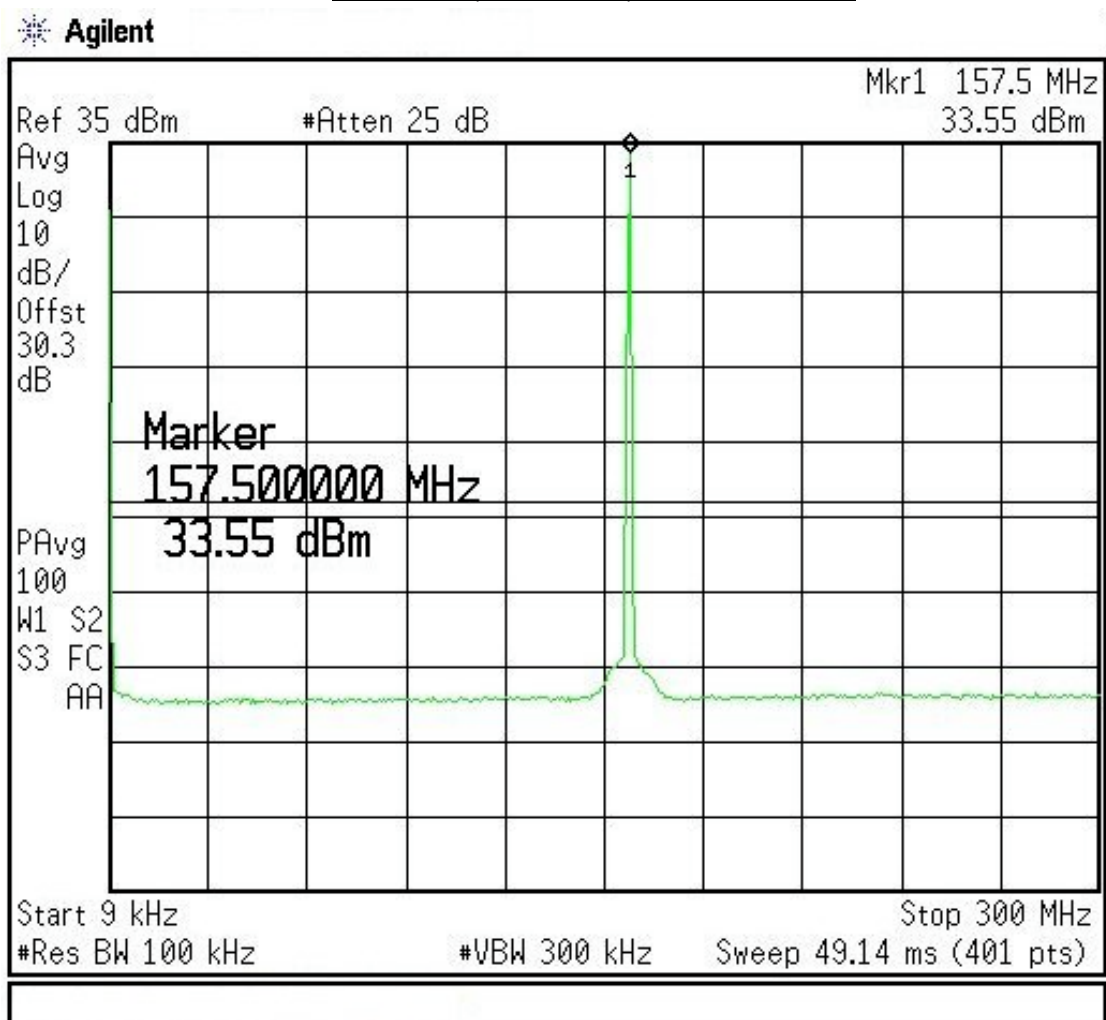




2.3 EMISSION LIMITATIONS (CONDUCTED)-Continued

Rule Parts: 2.1051, 80.211(f)(3)

Spurious Emissions (9kHz – 300MHz)
Channel 88 (157.425MHz) – Maximum Power



Remarks

All emissions greater than 250% from the authorised bandwidth are below -13dBm.

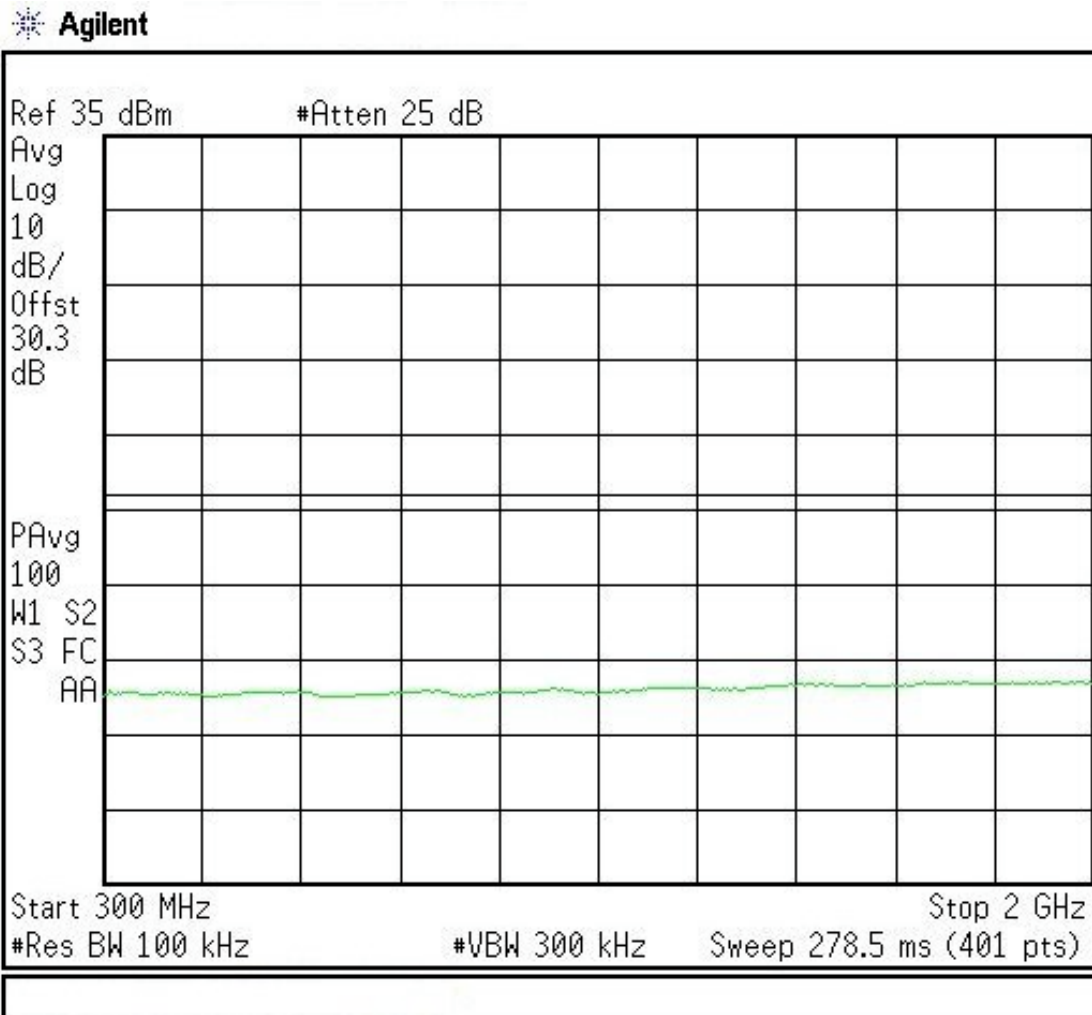
Test Equipment Used:

1, 2, 3, 4, 11

.....

**2.3 EMISSION LIMITATIONS (CONDUCTED)-Continued**

Rule Parts: 2.1051, 80.211(f)(3)

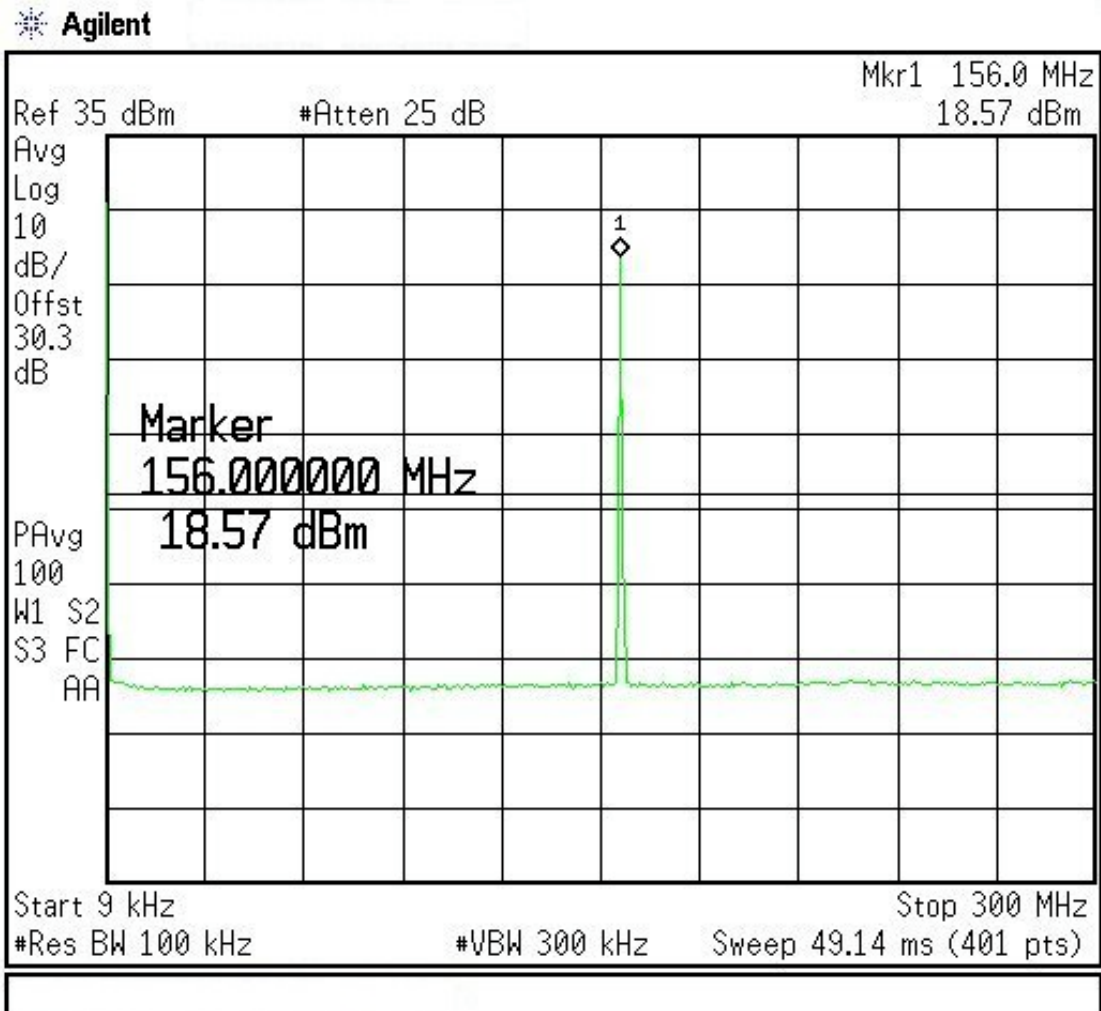
Spurious Emissions (300MHz – 2GHz)
Channel 88 (157.425MHz) – Maximum Power



2.3 EMISSION LIMITATIONS (CONDUCTED)-Continued

Rule Parts: 2.1051, 80.211(f)(3)

Spurious Emissions (9kHz – 300MHz)
Channel 1 (156.525MHz) – Minimum Power



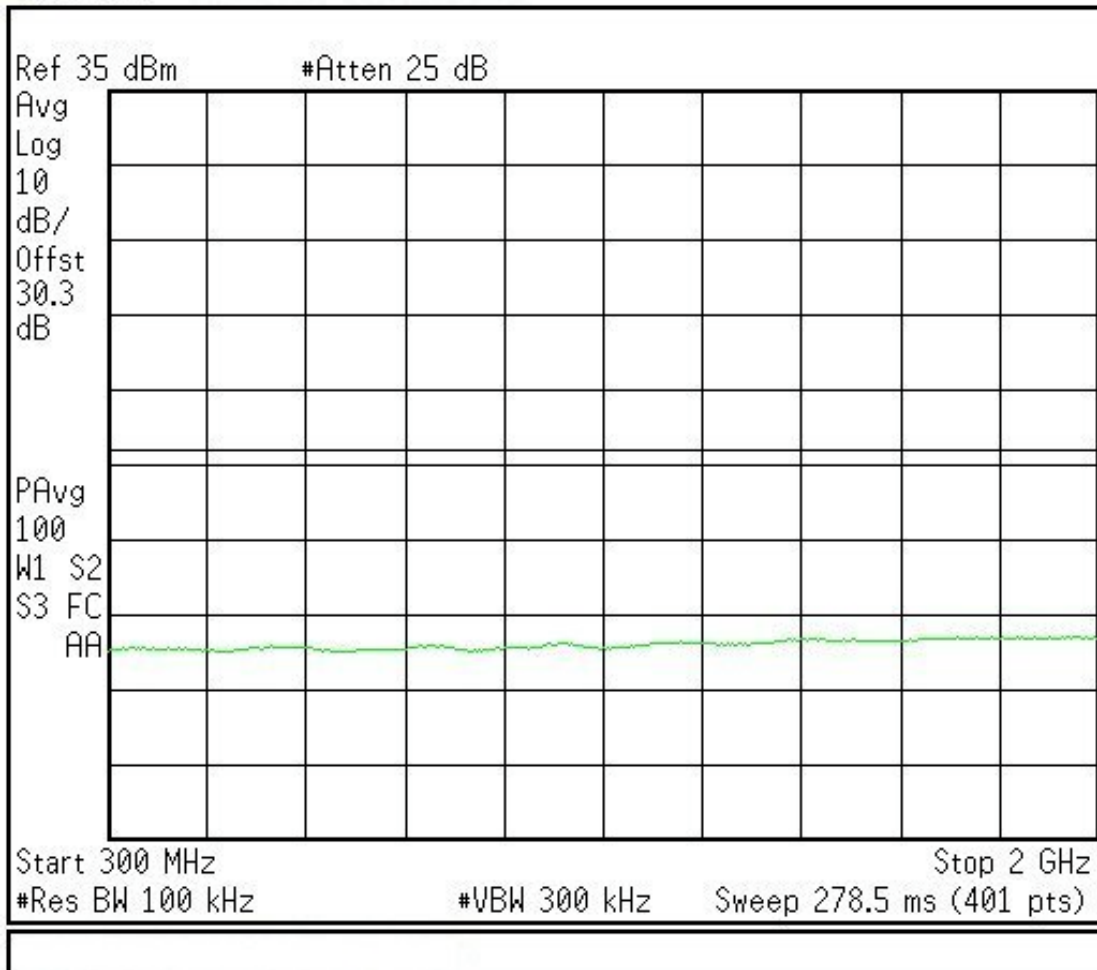


2.3 EMISSION LIMITATIONS (CONDUCTED)-Continued

Rule Parts: 2.1051, 80.211(f)(3)

Spurious Emissions (300MHz – 2GHz)
Channel 1 (156.525MHz) – Minimum Power

 **Agilent**

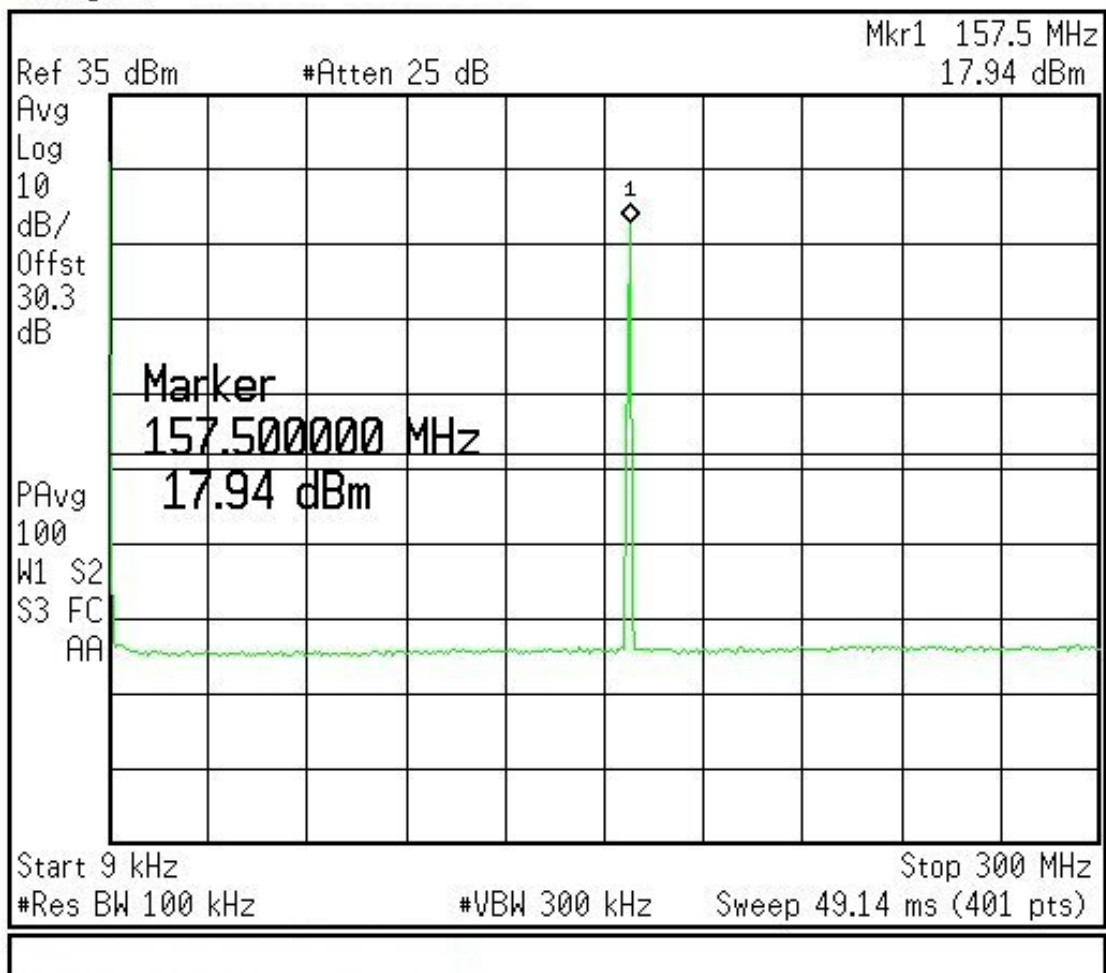


**2.3 EMISSION LIMITATIONS (CONDUCTED)-Continued**

Rule Parts: 2.1051, 80.211(f)(3)

Spurious Emissions (9kHz – 300MHz)
Channel 88 (157.425MHz) – Minimum Power

* Agilent



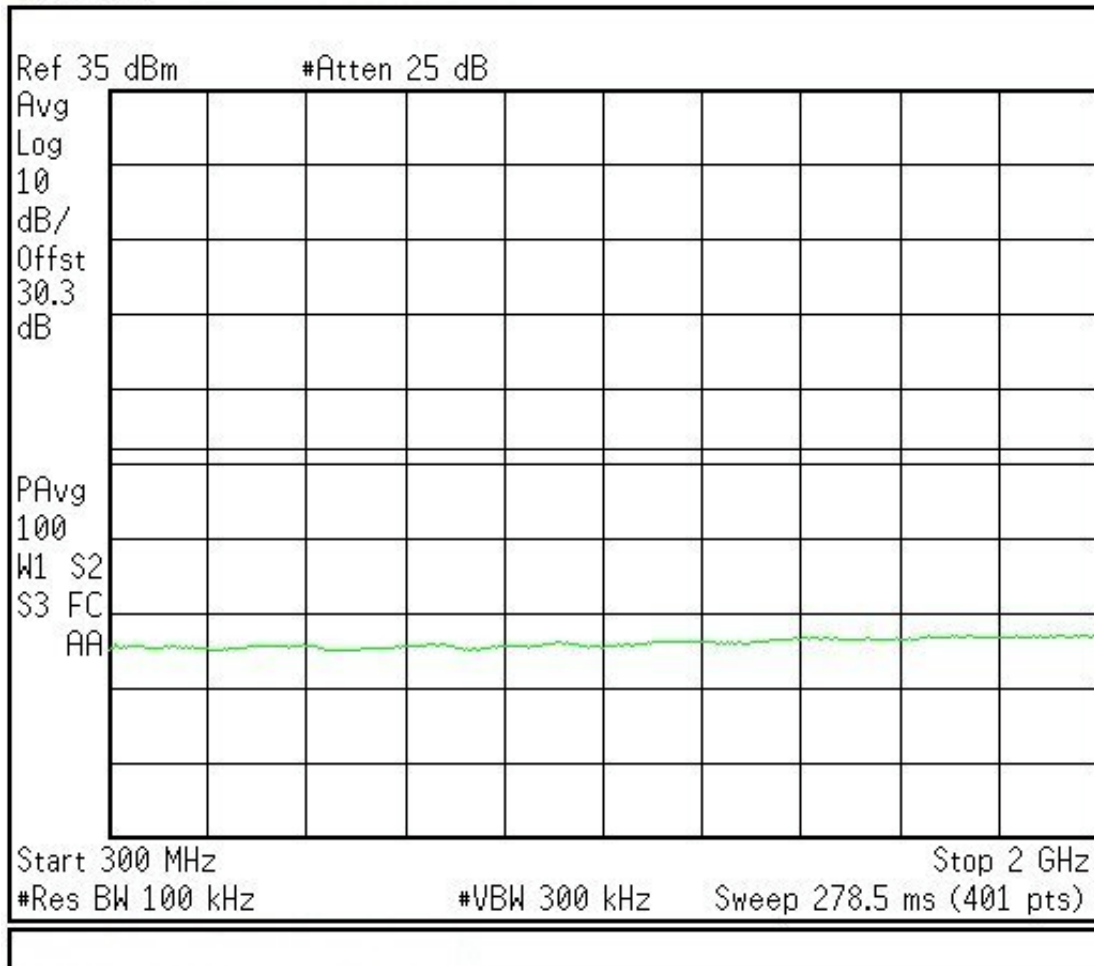


2.3 EMISSION LIMITATIONS (CONDUCTED)-Continued

Rule Parts: 2.1051, 80.211(f)(3)

Spurious Emissions (300MHz – 2GHz)
Channel 88 (157.425MHz) – Minimum Power

 **Agilent**

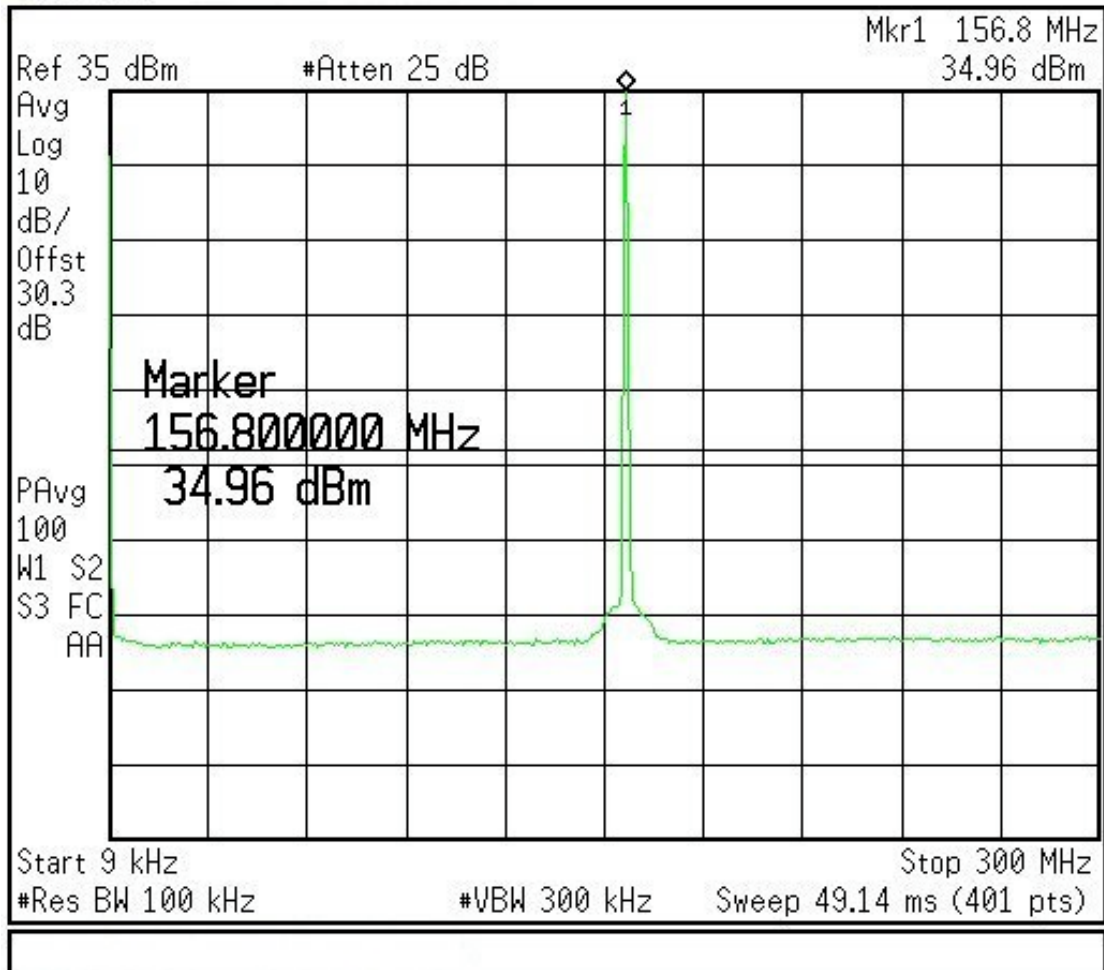


**2.3 EMISSION LIMITATIONS (CONDUCTED)-Continued**

Rule Parts: 2.1051, 80.211(f)(3)

Spurious Emissions (9kHz – 300MHz)
Channel 70 (156.525MHz) – Maximum Power

* Agilent



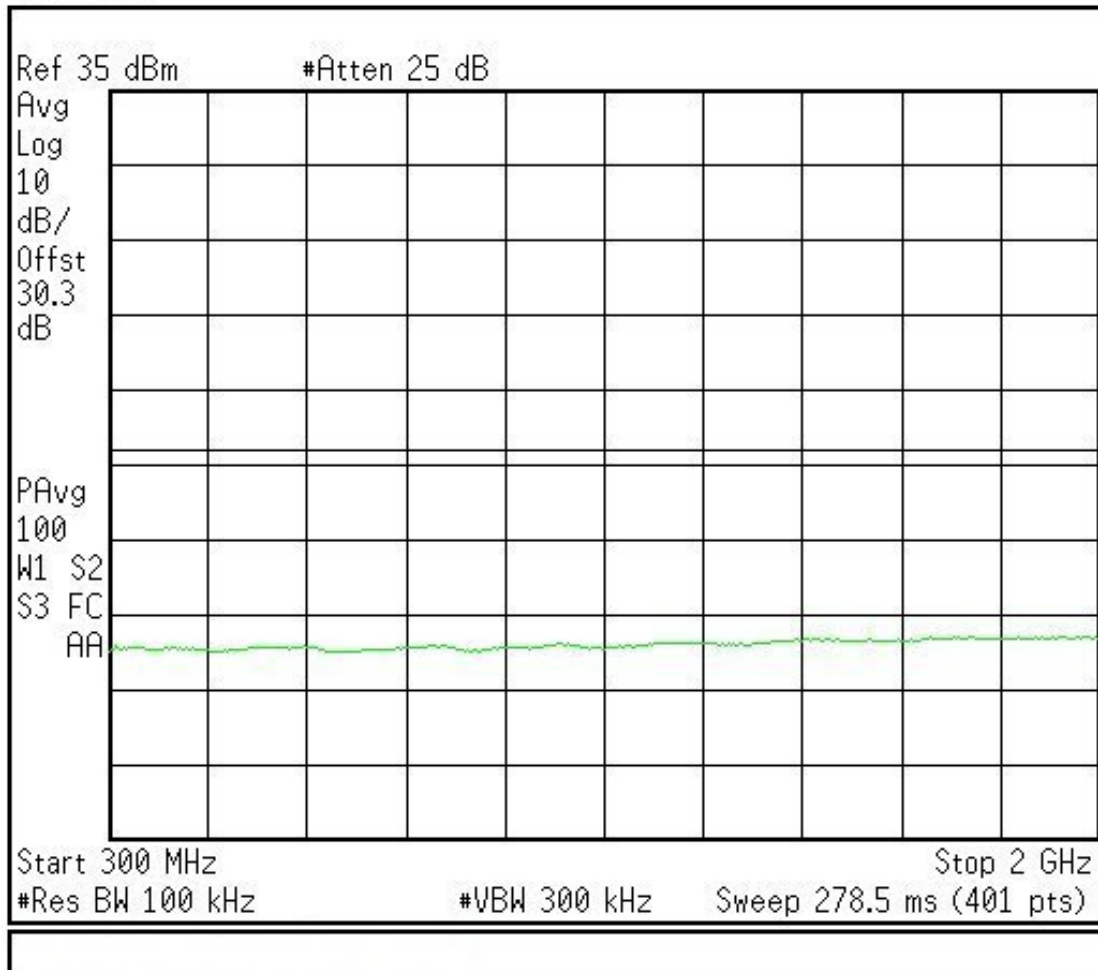


2.3 EMISSION LIMITATIONS (CONDUCTED)-Continued

Rule Parts: 2.1051, 80.211(f)(3)

Spurious Emissions (300MHz – 2GHz)
Channel 70 (156.525MHz) – Maximum Power

Agilent



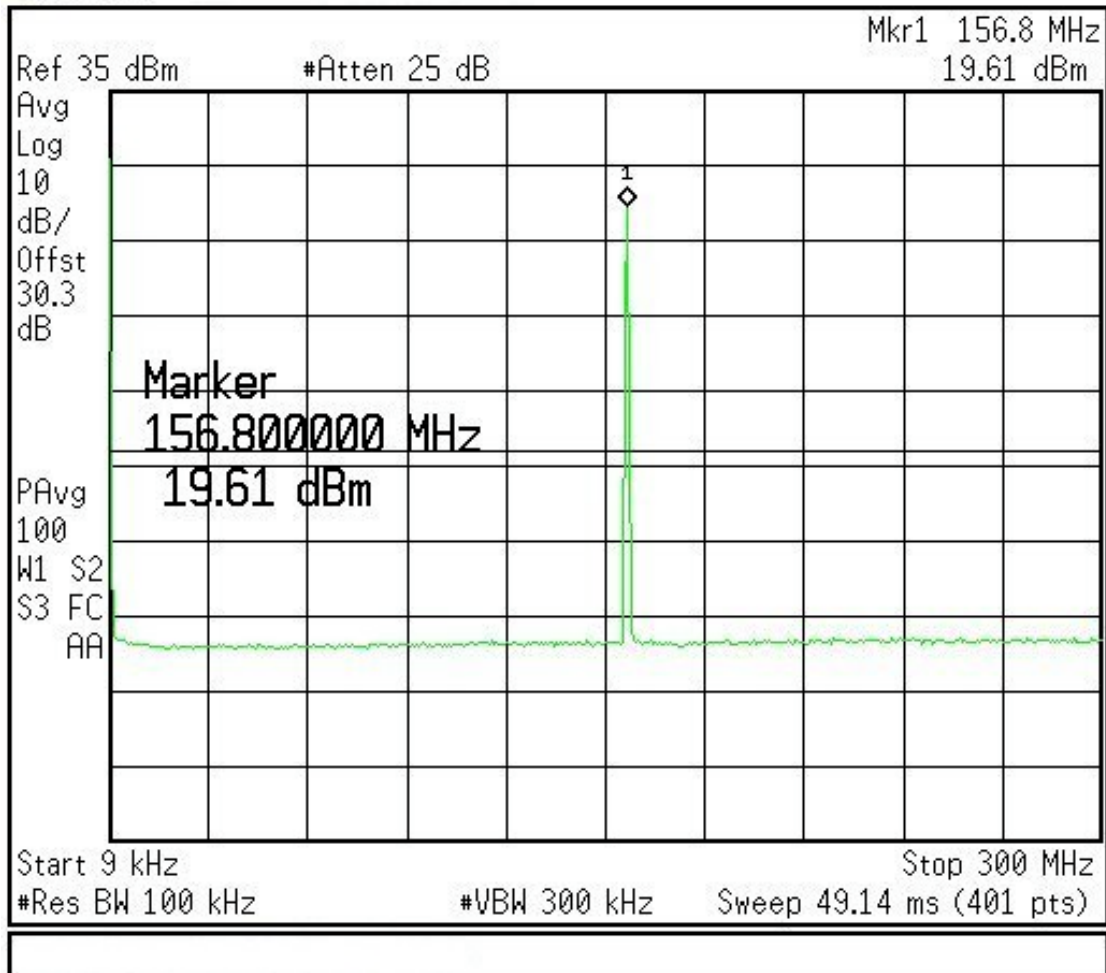
**2.3 EMISSION LIMITATIONS (CONDUCTED)-Continued**

Rule Parts: 2.1051, 80.211(f)(3)

Spurious Emissions (9kHz – 300MHz)

Channel 70 (156.525MHz) – Minimum Power

* Agilent



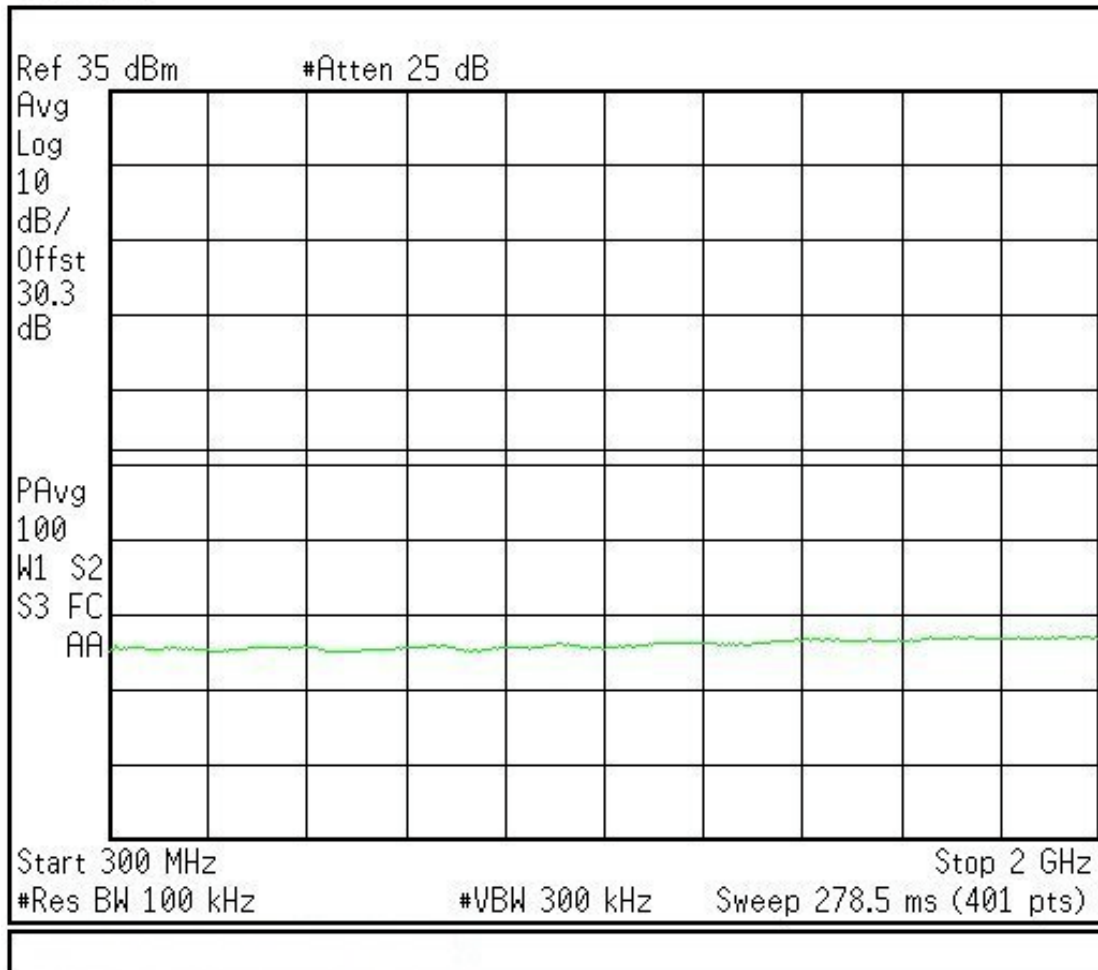


2.3 EMISSION LIMITATIONS (CONDUCTED)-Continued

Rule Parts: 2.1051, 80.211(f)(3)

Spurious Emissions (300MHz – 2GHz)
Channel 70 (156.525MHz) – Minimum Power

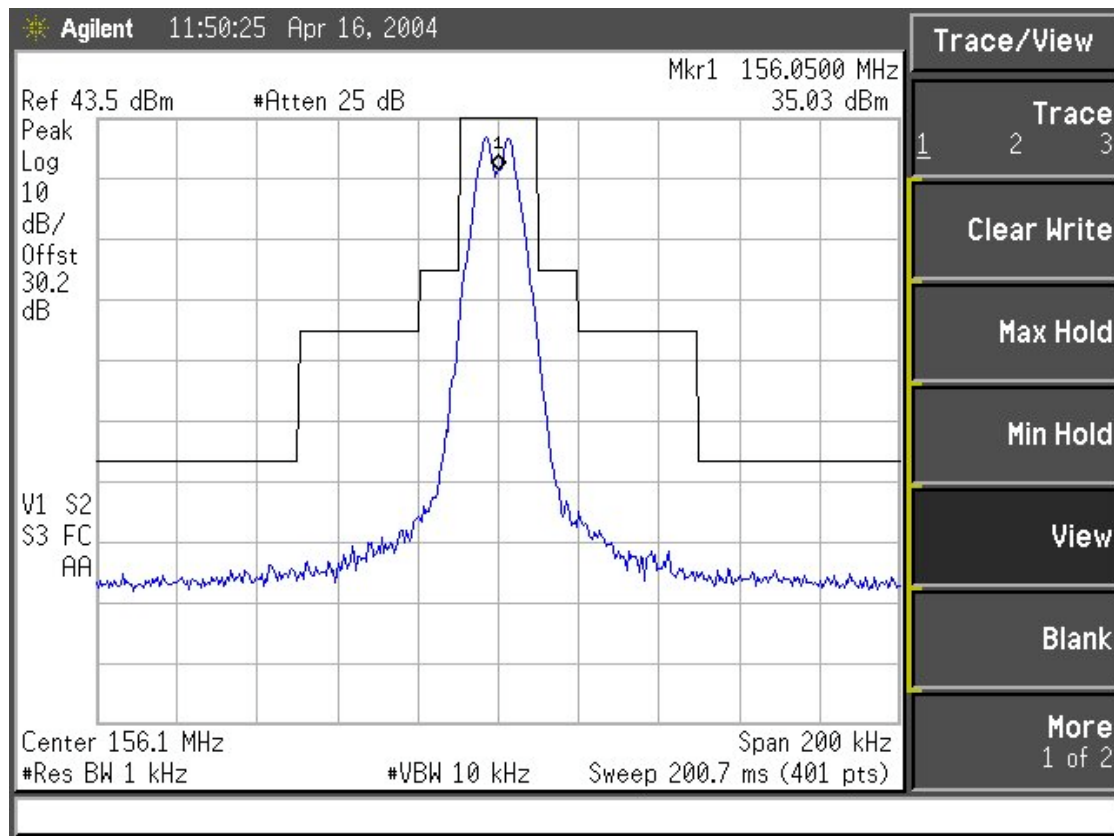
✱ Agilent



**2.3 EMISSION LIMITATIONS (CONDUCTED)-Continued**

Rule Parts: 2.1051, 80.211(f)(1)(2)

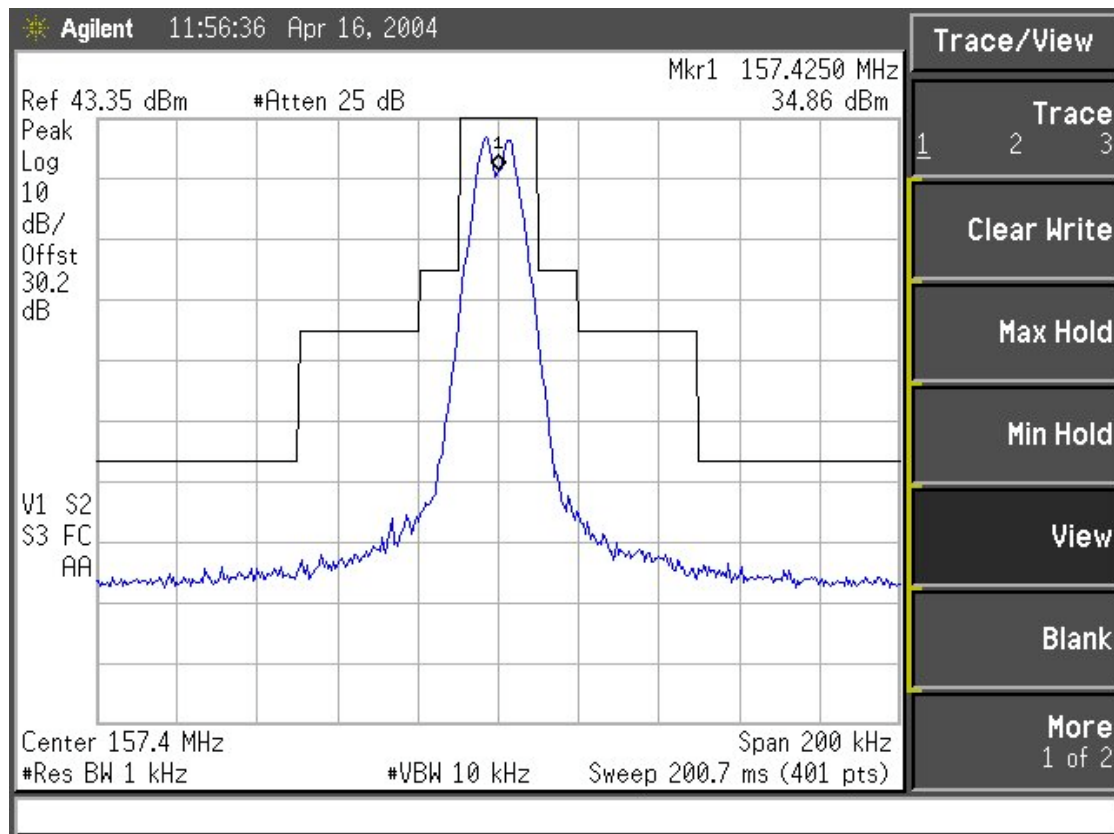
Emission Mask

Channel 1 (156.050MHz) – Maximum Power

**2.3 EMISSION LIMITATIONS (CONDUCTED)-Continued**

Rule Parts: 2.1051, 80.211(f)(1)(2)

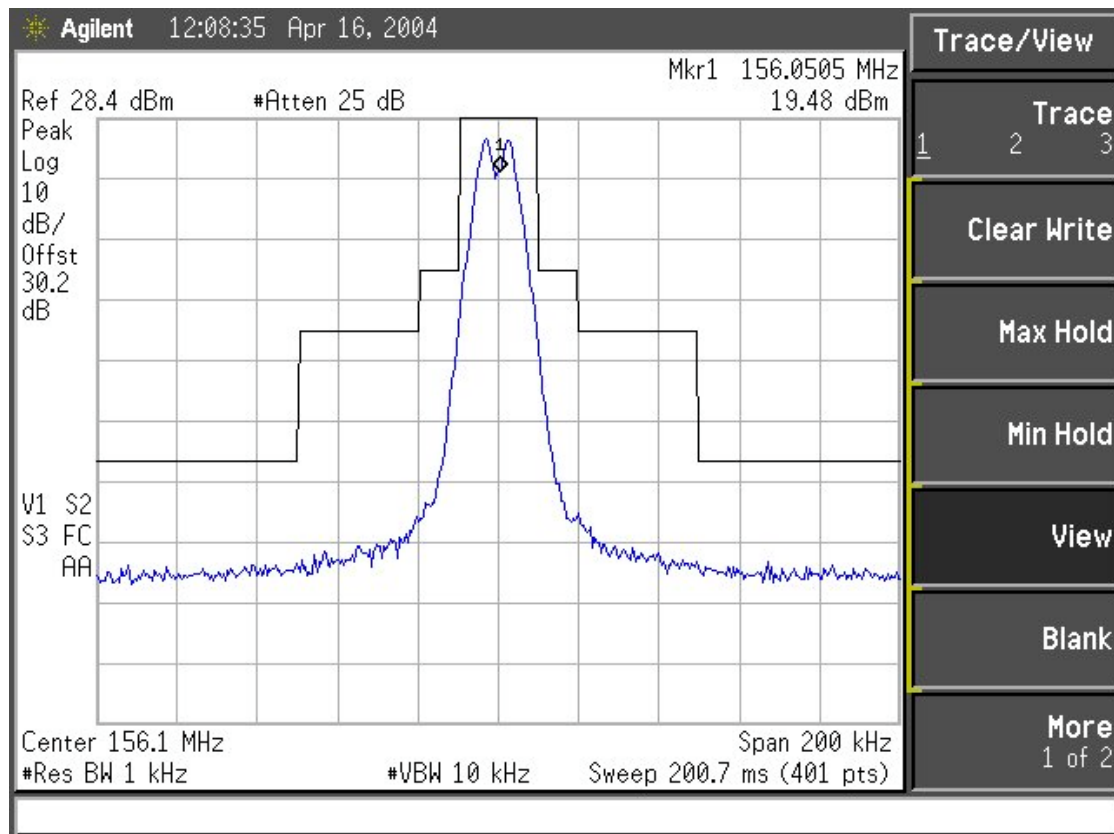
Emission Mask

Channel 88 (157.425MHz) – Maximum Power

**2.3 EMISSION LIMITATIONS (CONDUCTED)-Continued**

Rule Parts: 2.1051, 80.211(f)(1)(2)

Emission Mask
Channel 1 (156.050MHz) – Minimum Power



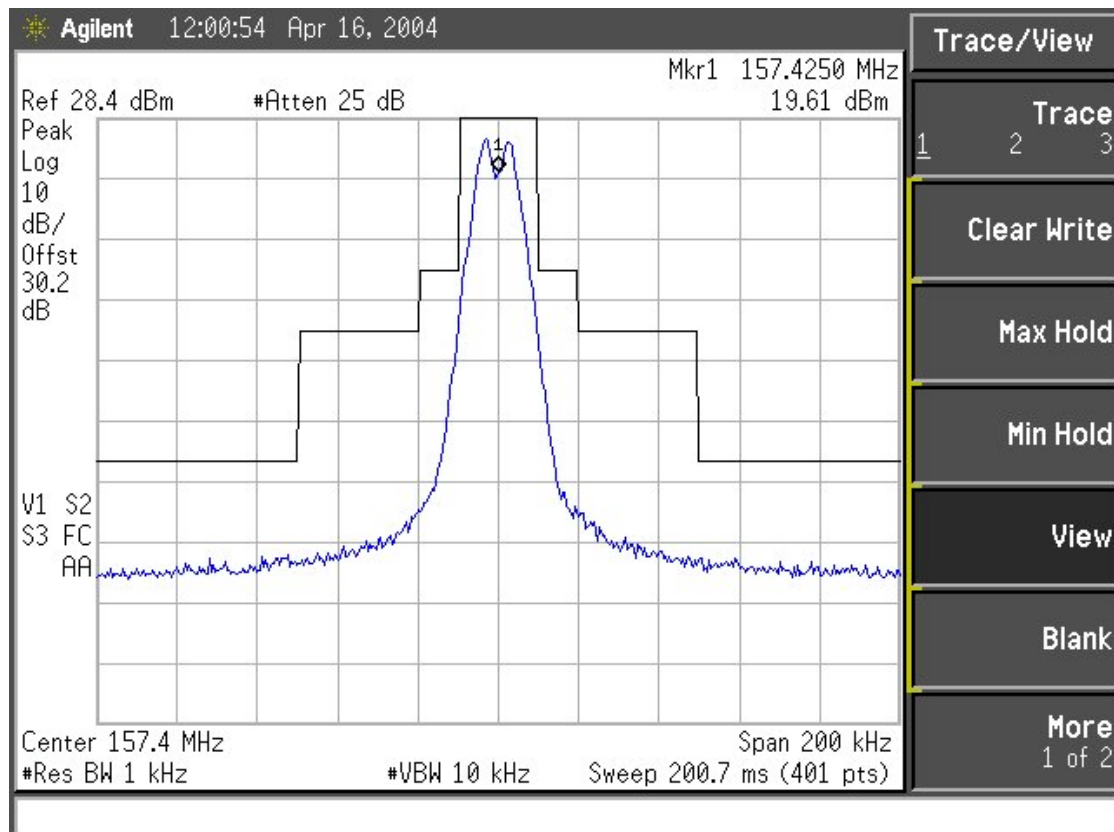


2.3 EMISSION LIMITIATIONS (CONDUCTED)-Continued

Rule Parts: 2.1051, 80.211(f)(1)(2)

Emission Mask

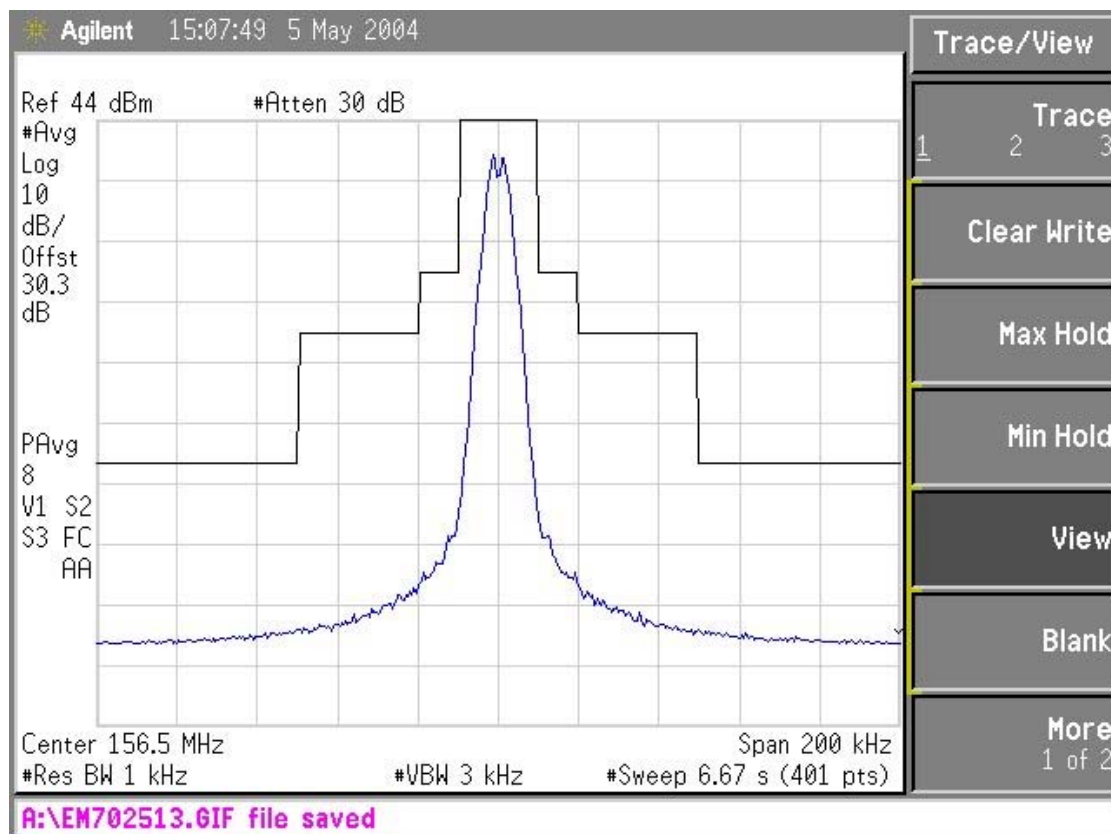
Channel 88 (157.425MHz) – Minimum Power



**2.3 EMISSION LIMITATIONS (CONDUCTED)-Continued**

Rule Parts: 2.1051, 80.211(f)(1)(2)

Emission Mask

Channel 70 (156.525MHz) – Maximum Power

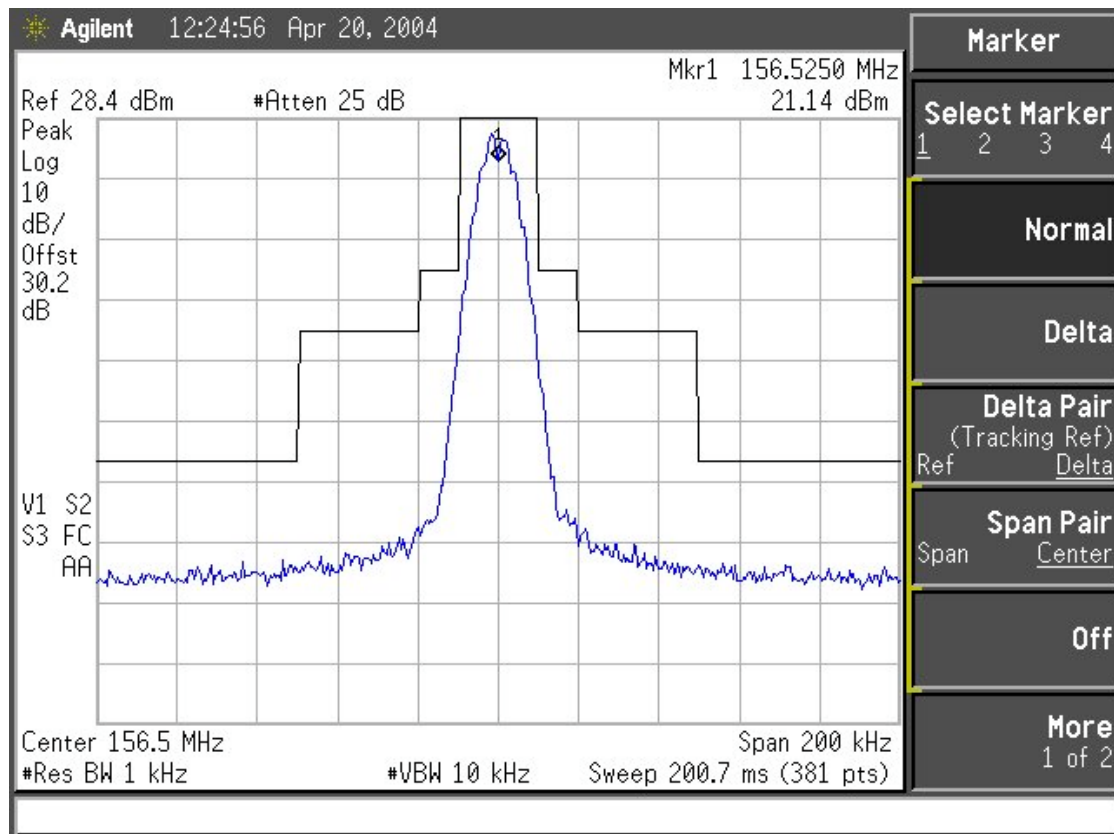


2.3 EMISSION LIMITATIONS (CONDUCTED)-Continued

Rule Parts: 2.1051, 80.211(f)(1)(2)

Emission Mask

Channel 70 (156.525MHz) – Minimum Power





2.3 EMISSION LIMITATIONS (CONDUCTED)-Continued

2.3.7 Limits

Remarks

Rule Parts: 2.1051, 80.211(f)(3)

All emissions greater than 250% from the authorised bandwidth are below -13dBm.

Rule Parts: 2.1051, 80.211(f)(1)(2)

All emissions within 250% of the authorised bandwidth conform to the emission mask.



2.4 EMISSION LIMITATIONS (RADIATED)

2.4.1 FCC Part 80 Section 2.1053/80.211

2.4.2 Equipment Under Test RAY54

2.4.3 Date of Test 5th April 2004

2.4.4 Test Equipment Used (See Section 3.1 for details) items 12, 13, 14, 15, 16, 17, 18 and 19

2.4.5 Test Procedure

Test Performed in accordance with ANSI C63.4.

In order to determine the Radiated Emission Limits, measurements of transmitter power (P) were first carried out on the top middle and bottom channels using a peak detector.

A preliminary profile of the Spurious Radiated Emissions was obtained by operating the EUT on a remotely controlled turntable within a semi-anechoic chamber. Measurements of emissions from the EUT were obtained with the Measurement Antenna in both Horizontal and Vertical Polarisations. The profiling produced a list of the worst-case emissions together with the EUT azimuth and antenna polarisation.

Using the information from the preliminary profiling of the EUT. The list of emissions was then confirmed or updated under Alternative Open Site conditions. Emission levels were maximised by adjusting the antenna height, antenna polarisation and turntable azimuth.

Emissions identified within the range 30MHz – 1GHz were then formally measured using a CISPR Quasi-Peak detector with the EUT in Receive mode.

Emissions identified within the range 30MHz – 1.6GHz were then formally measured using a Peak Detector, as appropriate, with the EUT in Transmit mode.

The measurements were performed at a 3m distance unless otherwise stated.



2.4 EMISSION LIMITATIONS (RADIATED)-Continued

2.4.6 Test Results & Limits

FCC Part 15.109 – Radiated Emissions

EUT in Receive Mode

The levels of the six highest emissions measured in accordance with the specification are presented below: -

Emission Frequency	Polarisation	Height	Azimuth	Field Strength		Limit	
				dBµV/m	µV/m	dBµV/m	µV/m
277.24	Horizontal	110	33	29.7	30.5	46.0	200.0
278.49	Horizontal	110	36	31.3	36.7	46.0	200.0
280.17	Horizontal	111	44	20.2	10.2	46.0	200.0
294.60	Horizontal	100	112	25.1	18.0	46.0	200.0
324.30	Horizontal	100	92	24.2	16.2	46.0	200.0
417.75	Horizontal	100	261	28.3	26.0	46.0	200.0

FCC Pt 15 Idle (Channel 1)

FCC Part 80.211- Peak Carrier Power (performed within Civil EMC)

Channel	Frequency MHz	Result dBm	Result Watts
1 (Bottom)	156.050	40.86	12.190
16 (Middle)	156.800	40.80	12.023
88 (Top)	157.425	40.98	12.531

Conducted Output Power



2.4 EMISSION LIMITATIONS (RADIATED)-Continued

FCC Part 80.211(f) - Radiated Emission Limitations

Due to the EUT not having a fixed or supplied antenna, the following procedure was performed to enable Field Strength measurements to be compared to a Calculated Field Strength limit. In addition ERP results were performed to a -13dBm ERP specification limit.

Step 1)

At each of the 3 transmit frequencies a known ERP level of -10dBm was transmitted from a Transfer Standard Calibrated Antenna (placed 3m from the measurement antenna, and at a height of 1.5m). Each frequency was measured to give a reference Field Strength (dBμV/m)

Frequency MHz	Ref. Field Strength (dBμV/m)
156.050	90.22
156.800	90.24
157.425	90.22

Step 2)

The Peak Carrier Power was then measured at each of the 3 transmit frequencies (see previous Page).

The Peak Carrier level (theoretically) connected to the Transfer Standard Antenna (mentioned above) instead of the -10dBm level, would give an increased Calculated Field Strength.

Frequency (MHz)	Ref Field Strength (dBμV/m)	EUT Peak Carrier Power	Increased (calculated) Field Strength (dBμV/m)
156.050	(-10dBm) 90.22	40.86dBm (12.19W)	141.1
156.800	(-10dBm) 90.24	40.80dBm (12.02W)	141.0
157.425	(-10dBm) 90.22	40.98dBm (12.53W)	141.2

Step 3)

From the Increased Calculated Field Strength for each channel, the 43 +10log Power down on the carrier equation, can be applied to give us a Field Strength Limit for each individual Channel.

156.050MHz

FS specification limit = (43+10log (12.19W) down on the FS 141.1dBμV/m = **87.2 dBμV/m**

156.800MHz

FS specification limit = (43+10log (12.02W) down on the FS 141.0dBμV/m = **87.2 dBμV/m**

157.425MHz

FS specification limit = (43+10log (12.53W) down on the FS 141.2dBμV/m = **87.2 dBμV/m**



2.4 EMISSION LIMITATIONS (RADIATED)-Continued

FCC Part 80.211(f) - Radiated Emission Limitations Test Results

(30MHz – 1.6GHz Range)

EUT in Transmit Mode

The levels of the highest emissions measured in accordance with the specification are presented below: -

Emission Frequency	Polarisation	Height	Azimuth	Field Strength		ERP	
MHz	Horizontal/ Vertical	cm	degree	Result dBμV/m	Limit dBμV/m	Result dB/m	Limit dB/m
EUT Transmit on Bottom Channel - Ch 1 (156.05MHz)							
312.10	Horizontal	100	255	59.2	87.2	-41.5	-13.0
624.20	Vertical	100	98	51.1	87.2	-49.8	-13.0
EUT Transmit on Middle Channel - Ch 16 (156.80MHz)							
313.60	Horizontal	100	264	65.3	87.2	-35.6	-13.0
EUT Transmit on Top Channel - Ch 88 (157.425MHz)							
314.86	Horizontal	100	250	58.7	87.2	-42.3	-13.0

All other emissions were 35dB or more below the specification limit.

Note

The -13.0dBm ERP limit is based on $43 + 10\log$ Power, down on the Transmitter.



2.4 EMISSION LIMITATIONS (RADIATED)-Continued



Radiated Emissions Set-up photograph



2.5 MODULATION REQUIREMENTS

2.5.1 FCC Part 80 Section 2.1047, 80.213

2.5.2 Equipment Under Test RAY54

2.5.3 Date of Test 7th April 2004

2.5.4 Test Equipment Used (See Section 3.1 for details) 1, 2, 3, 4, 5, 6, 7

2.5.5 Test Procedure

The carrier of the EUT is Frequency Modulated, (FM), when used for speech. The EUT utilises an audio low pass filter to limit the deviation.

The carrier of the EUT is Frequency Modulated, (FM), when in it's DSC mode.

Clause 80.213(b)

The EUT was connected to a Modulation Analyser via a 30dB attenuator. An audio signal of varying frequency and amplitude was applied to the EUT microphone input using an Audio Analyser. To demonstrate compliance with the test limits, the test was conducted in two parts. The first to demonstrate a variety of input levels over a set frequency range and the second to demonstrate the limiting effect on the deviation when large signal levels are applied to its input.

2.5.6 Test Results

Channel 1 – Deviation vs Input Voltage/Frequency – 25W

The input voltage and frequency were varied across the range shown in the table below. This demonstrates the point at which the deviation limits for a given input voltage and frequency.

Audio Input Level To EUT (mV)	Peak Frequency Deviation (kHz)					Maximum Deviation Limit (kHz)
-	100Hz	500Hz	1000Hz	3000Hz	5000Hz	-
1	-0.131	0.292	-0.515	-1.210	0.285	5.0
2	-0.141	0.482	-0.909	2.315	0.466	5.0
4	-0.171	0.852	1.718	-4.150	0.709	5.0
6	0.210	1.234	2.529	4.470	0.742	5.0
8	0.237	1.618	-3.268	4.550	0.751	5.0
10	0.273	1.992	-3.635	4.600	0.755	5.0
12	0.306	2.370	-3.928	4.610	0.760	5.0
14	0.348	2.750	-4.150	4.630	0.763	5.0
16	0.382	3.072	-4.300	4.630	0.765	5.0
18	0.410	-3.240	4.400	4.640	0.765	5.0
20	0.442	-3.351	-4.480	4.640	0.761	5.0
25	0.532	-3.524	4.600	4.640	0.760	5.0
30	0.632	-3.672	4.660	4.640	-0.760	5.0
35	0.743	-3.874	4.700	4.640	0.766	5.0
40	0.873	-4.080	4.730	4.630	0.764	5.0
50	1.062	-4.410	4.750	4.610	0.766	5.0



2.5 MODULATION REQUIREMENTS-Continued

Channel 88 – Deviation vs Input Voltage/Frequency – 25W

The input voltage and frequency were varied across the range shown in the table below. This demonstrates the point at which the deviation limits for a given input voltage and frequency.

Audio Input Level To EUT (mV)	Peak Frequency Deviation (kHz)					Maximum Deviation Limit (kHz)
	100Hz	500Hz	1000Hz	3000Hz	5000Hz	
-						-
1	0.130	0.300	-0.522	1.254	0.299	5.0
2	0.135	0.479	0.924	2.414	0.497	5.0
4	0.170	0.857	1.752	4.370	0.756	5.0
6	0.191	1.235	2.575	4.690	0.792	5.0
8	0.211	1.610	-3.345	4.780	0.802	5.0
10	0.242	1.993	-3.725	4.820	0.810	5.0
12	0.273	2.376	-4.050	4.840	0.812	5.0
14	0.301	2.754	4.290	4.850	0.815	5.0
16	0.332	3.129	4.460	4.860	0.816	5.0
18	0.363	3.302	4.570	4.870	0.815	5.0
20	0.390	3.442	4.650	4.870	0.815	5.0
25	0.462	-3.648	4.790	4.870	0.818	5.0
30	0.550	-3.785	4.860	4.870	0.816	5.0
35	0.643	-3.992	4.890	4.860	0.816	5.0
40	-0.734	-4.240	4.930	4.860	0.816	5.0
50	0.927	-4.580	4.950	4.840	0.817	5.0



2.5 MODULATION REQUIREMENTS-Continued

Channel 1 – Maximum Permissible Frequency Deviation – 25W

The EUT was connected as described in the tests above. Initially, an Audio signal of 1kHz was applied to the input and the amplitude varied to give a deviation of 3kHz, which in this case was 6.9mV. This level was then increased by 20dB to a level of 69mV. The maximum peak deviation was then measured across the frequency range 100Hz to 10kHz.

Modulating Frequency (kHz)	Peak Frequency Deviation (kHz)	Maximum Deviation Limit (kHz)
0.1	1.480	5.0
0.2	-3.725	5.0
0.4	-4.550	5.0
0.6	-4.810	5.0
0.8	4.820	5.0
1.0	4.840	5.0
1.2	-4.670	5.0
1.4	4.560	5.0
1.6	4.600	5.0
1.8	4.700	5.0
2.0	-4.820	5.0
2.5	-4.990	5.0
3.0	-4.540	5.0
3.5	-3.207	5.0
4.0	1.935	5.0
4.5	1.128	5.0
5.0	-0.696	5.0
6.0	0.324	5.0
7.0	0.201	5.0
8.0	0.154	5.0
9.0	0.132	5.0
10.0	0.125	5.0



2.5 MODULATION REQUIREMENTS-Continued

Channel 88 – Maximum Permissible Frequency Deviation- 25W

Modulating Frequency (kHz)	Peak Frequency Deviation (kHz)	Maximum Deviation Limit (kHz)
0.1	1.402	5.0
0.2	3.722	5.0
0.4	-4.630	5.0
0.6	-4.940	5.0
0.8	4.950	5.0
1.0	4.970	5.0
1.2	4.820	5.0
1.4	4.680	5.0
1.6	4.690	5.0
1.8	4.790	5.0
2.0	4.930	5.0
2.5	5.000	5.0
3.0	4.720	5.0
3.5	3.422	5.0
4.0	2.082	5.0
4.5	1.230	5.0
5.0	0.750	5.0
6.0	0.342	5.0
7.0	0.210	5.0
8.0	-0.157	5.0
9.0	-0.137	5.0
10.0	-0.125	5.0

2.5.7 Limits

Limit	≤5kHz
-------	-------

Remarks

EUT complies with CFR 47 2.1047 and 80.213(b). The EUT does not exceed 5kHz peak deviation at the measured frequencies.



2.6 MODULATION CHARACTERISTICS

2.6.1 FCC Part 80 Section 2.1047a

2.6.2 Equipment Under Test RAY54

2.6.3 Date of Test 7th April 2004

2.6.4 Test Equipment Used (See Section 3.1 for details) 1, 2, 3, 4, 5, 6, 7

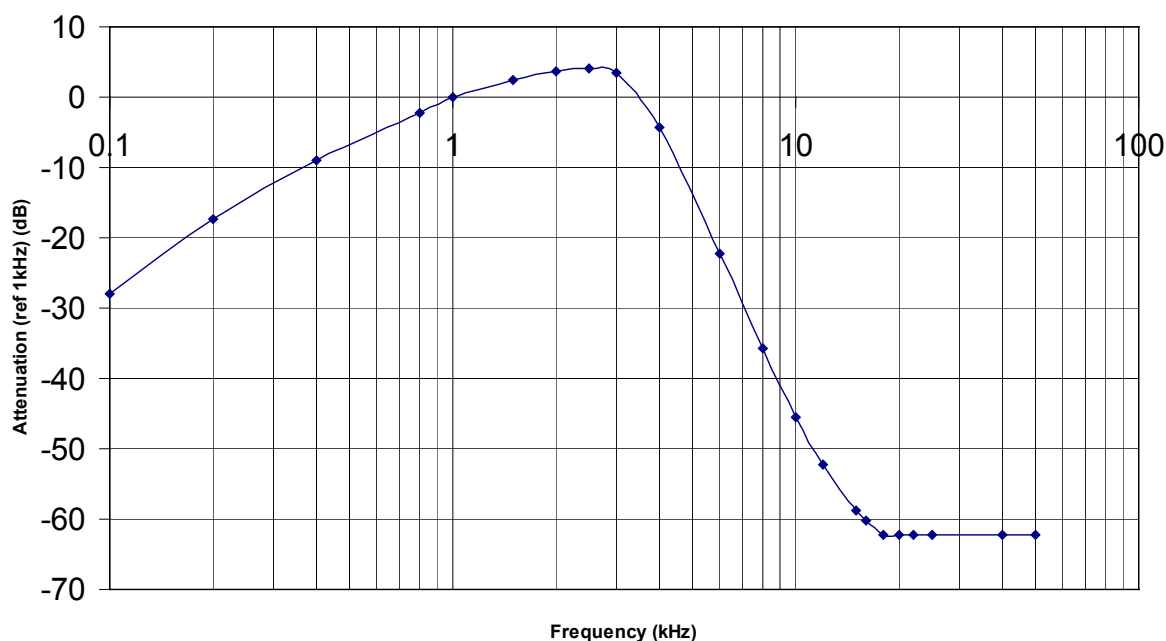
2.6.5 Test Procedure

In accordance with 2.1047(a), a curve has been produced displaying the frequency response of the audio modulating circuit over a range of 100Hz to 5kHz. The plot shows the data for all of the circuitry installed between the modulation limiter and the modulated stage.

The EUT was connected to a Modulation Analyser via a 30dB Attenuator. An Audio Analyser was connected to the microphone input at a set voltage level and the frequency varied between 100Hz and 5kHz. The demodulated audio was measured and plotted as a graph, which is shown below.

2.6.6 Test Results

A Graph To Show The Frequency Response Of The Audio Modulating Circuit





2.7 TRANSMITTER POWER

2.7.1 FCC Part 80 Section 2.1046, 80.215(a)(2)(e)(1)

2.7.2 Equipment Under Test RAY54

2.7.3 Date of Test 7th April 2004

2.7.4 Test Equipment Used (See Section 3.1 for details) 1, 2, 3, 4, 5, 6, 7

2.7.5 Test Procedure

The EUT was connected via a 30dB attenuator to a power meter and sensor. The path loss between the EUT and the power sensor was measured and recorded. The power meter reading was recorded and adjusted by the path loss value.

The emission designator for the EUT is declared as G3E. In Clause 80.215(a)(2), the measurement of G3E designations is defined as being Carrier Power. In accordance with Clause 2.1, the Carrier Power was measured unmodulated.

The carrier power was measured on the top and bottom channels of the operating frequency band and at maximum and minimum power levels.

2.7.6 Test Results

Maximum Power – 25W

Frequency (MHz)	Output Power, (Uncorrected) (dBm)	Path Loss (dB)	Result (dBm)	Result (W)
156.050	13.26	30.3	43.56	22.70
157.425	13.17	30.3	43.47	22.23

Minimum Power- 1W

Frequency (MHz)	Output Power, (Uncorrected) (dBm)	Path Loss (dB)	Result (dBm)	Result (mW)
156.050	-1.82	30.3	28.48	0.705
157.425	-1.88	30.3	28.42	0.695

2.7.7 Limits

Limit	≤25W or <+43.98dBm
-------	--------------------

Remarks

EUT complies with CFR 47 2.1046 and 80.215(e)(1). The EUT does not exceed 25W or +43.98dBm at the measured frequencies.



2.8 SUPPRESSION OF INTERFERENCE ABOARD SHIPS

2.8.1 FCC Part 80 Section 80.217(b)

2.8.2 Equipment Under Test RAY54

2.8.3 Date of Test 17th April 2004

2.8.4 Test Equipment Used (See Section 3.1 for details) 1, 2, 3, 11

2.8.5 Test Procedure

The EUT was connected to a Spectrum Analyser via an RF cable. No external attenuation was inserted, as there is no carrier present in this mode of operation. The emissions were measured from 9kHz to 2GHz.

The manufacturer declares a maximum antenna gain of 3dBi to be used with the EUT. Thus, in accordance with 80.217(b), the 3dBi gain has been accounted for in the limit line and the derivation of the limits are shown in the table below.

Frequency Of Interfering Emissions (MHz)	Power To Artificial Antenna (μ W)	Power To Artificial Antenna (dBm)	Power To Artificial Antenna including Maximum Declared Antenna Gain (dBm)
<30	400	-4	-7
30 – 100	4000	6	3
100 – 300	40000	16	13
300 - 2000	400000	26	23

2.8.6 Results

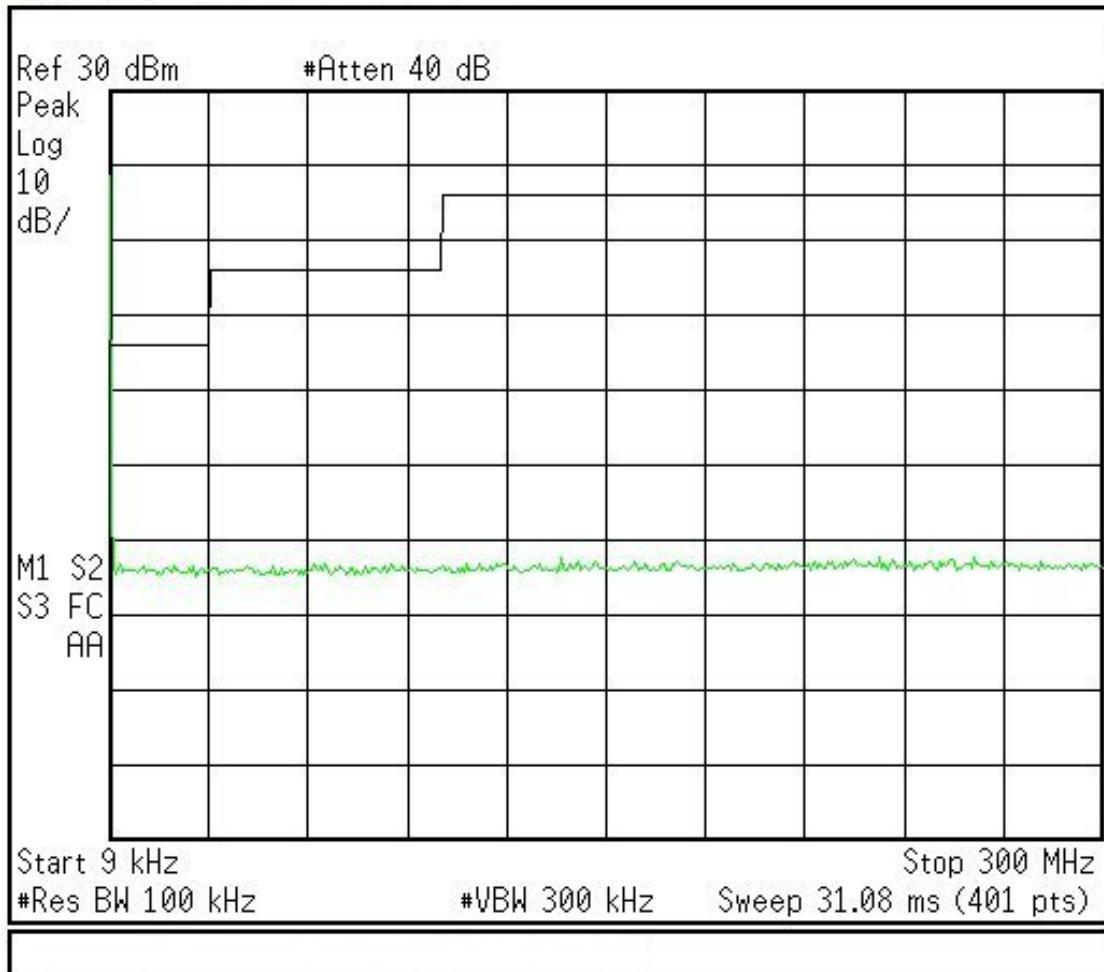
The results plots are shown in the following pages.



2.8 SUPPRESSION OF INTERFERENCE ABOARD SHIPS-Continued

Channel 1 – Receive
9kHz – 300MHz

Agilent

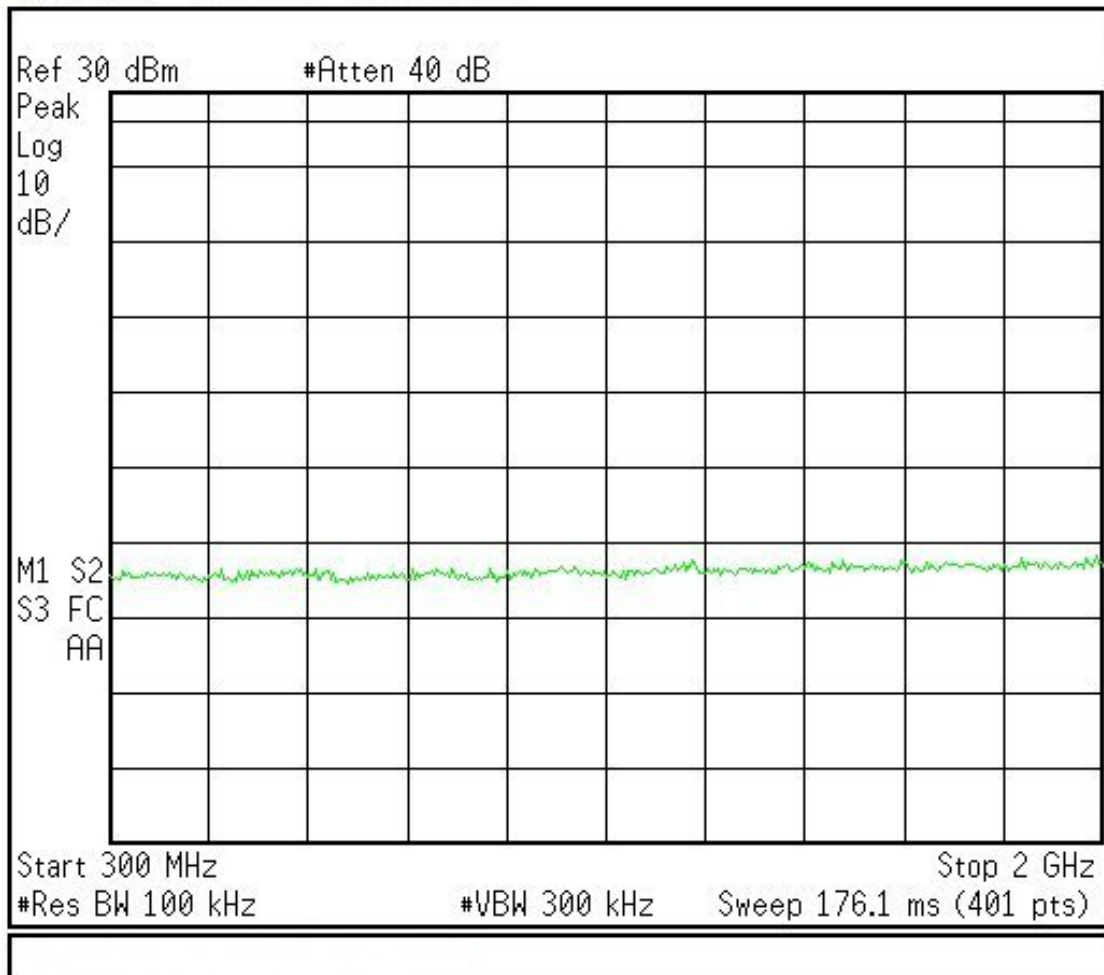




2.8 SUPPRESSION OF INTERFERENCE ABOARD SHIPS-Continued

Channel 1 – Receive
300MHz – 2GHz

 Agilent



2.8.7 Limits

Remarks

All emissions were below the requirements defined in 80.217(b).



2.9 MPE CALCULATION

2.9.1 FCC Part 80 Section 1.1307(b)/80.227

2.9.2 Equipment Under Test RAY54

2.9.3 Date of Test N/A

2.9.4 Test Equipment Used (See Section 3.1 for details) N/A

2.9.5 MPE Calculation

A Raymarine device, RAY 54, has a maximum output power of 25 W. The manufacturer declares a duty cycle of 50% with a worst-case antenna gain of 3.0dBi. The equipment is proposed as meeting the OET65 requirements for use at 1.5m.

The wavelength of the equipment is:

$$\frac{3 \times 10^8}{156.050 \times 10^6} = 1.92\text{m}$$

Thus, the far field region is defined as being:

$$\frac{\lambda}{2\pi} = \frac{1.92}{6.283} = 0.306\text{m or } 30.60\text{cm}$$

Therefore, the formula below is applicable as any distance greater than 30.60cm is in the far field. Thus, at a distance of 1.5m from the antenna, the Power Density is calculated as:

$$S = \frac{P \times G}{4\pi R^2} = \frac{25000 \times 2.0}{12.57 \times 150^2} = 0.177\text{mW/cm}^2$$

where:

P = power measured in mW
G = antenna gain as numeric gain, (2.0 numeric / 3.0dBi)
R = distance in cm

MPE for Occupational/Controlled Exposure at 156.050MHz is 1mW/cm²

MPE for General Population/Uncontrolled Exposure at 156.025MHz is 0.2mW/cm²

Therefore, the unit under test has a power density, which is less than both the General Population and Occupational exposure limits where a separation distance of 1.5m from the antenna exists. The table below shows the Power Density result for the bottom channel and manufacturer declared antenna configuration.

Frequency (MHz)	Measured Conducted Power (mW)	Antenna Gain		Power Density (mW/cm ²)
		dBi	Numeric	
156.050	25000	3.0	2.0	0.177



SECTION 3

TEST EQUIPMENT USED



3.1 TEST EQUIPMENT USED

Item	Instrument	Type No	Manufacturer	Serial No	EMC / INV No	Cal. Due
1	Hygrometer	1 - 1000	Rotronic	182615	INV 3227	10/4/04
2	DC Power Supply	6267B	Hewlett Packard	2333A08844	963	TU
3	Multimeter	70 III	Fluke	72320985	INV 4159	9/16/04
4	30 dB Attenuator	8321	Bird	1312	INV 3807	10/7/04
5	Power Sensor	8482A	Hewlett Packard	2349A07547	777	5/7/04
6	Power Meter	436A	Hewlett Packard	2347A16889	757	6/7/04
7	Signal Generator	SMY01	Rohde & Schwarz	842065/037	2256	3/23/05
8	Sensor	11722A	Hewlett Packard	3111A04314	1987	5/7/04
9	Modulation Analyser	8901B	Hewlett Packard	3005A02539	1510	5/28/04
10	Digital Storage Oscilloscope	9410	LeCroy	1855	1628	1/29/05
11	Spectrum Analyser	E4407B	Hewlett Packard	US41442853	2783	3/22/05
12	Turntable & Controller	HD 050	HD Gmbh	050/396	2528	TU
13	Antenna Mast	2070	Emco	-	-	TU
14	Antenna Mast Controller	2090	Emco	-	-	TU
15	Screened Room 5	EAC54300	Siemens	-	2533	-
16	Test Receiver	8542E	Hewlett Packard	3617A00165_00154	2286	12/9/2004
17	Bilog Antenna	CBL6143	Chase	5064	2860	4/11/2004
18	Log Periodic Antenna	UPA6109	Chase	1036	2422	02/17/04
19	Bicon Antenna	VBS 6106A	Chase	1160	2059	02/17/04



3.2 MEASUREMENT UNCERTAINTY

For a 95% confidence level, the measurement uncertainties for defined systems are:-

IN THE FREQUENCY RANGE 30MHz TO 1000MHz		
TEST	FREQUENCY	AMPLITUDE
For Occupied Bandwidth	$\pm 23.677\text{kHz}$	$\pm 0.5\text{dB}$
For Maximum Output Power	Not Applicable	$\pm 0.5\text{dB}$
For Radiated Emissions, Quasi-Peak Measurements taken in Zero Span using the Hewlett Packard EMI Receiver and Bilog Antenna	$\pm 2 \times 10^{-7} \times \text{Centre Frequency}$	5.15dB calculated in accordance with CISPR 16-4
For Spurious Conducted Emissions	Not Applicable	$\pm 1.8\text{dB}$
IN THE FREQUENCY RANGE 1GHz TO 20GHz		
TEST	FREQUENCY	AMPLITUDE
For Spurious Radiated Emissions measurements	$\pm 2 \times 10^{-7} \times \text{Centre Frequency}$	$\pm 3.4\text{dB}$
Transmitter frequency Tolerance	$\pm 45\text{Hz}$	Not Applicable
Modulation Requirements	$\pm 0.6\text{dB}$ (of reading)	Not Applicable



SECTION 4

EUT PHOTOGRAPHS



4.1.1 EUT PHOTOGRAPHS



RAY54 VHF Marine Radio



SECTION 5

ACCREDITATION, DISCLAIMERS AND COPYRIGHT



5.1 ACCREDITATION, DISCLAIMERS AND COPYRIGHT



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APPENDIX A

TITCHFIELD FCC SITE COMPLIANCE LETTER



FEDERAL COMMUNICATIONS COMMISSION

**Laboratory Division
7435 Oakland Mills Road
Columbia, MD 21046**

October 18, 2002

Registration Number: 90987

TUV Product Service Ltd
Segensworth Road
Titchfield
Fareham, Hampshire, PO15 5RH
United Kingdom
Attention: Kevan Adsetts

Re: Measurement facility located at Titchfield
Anechoic chamber (3 meters) and 3 & 10 meter OATS
Date of Listing: October 18, 2002

Gentlemen:

Your request for registration of the subject measurement facility has been reviewed and found to be in compliance with the requirements of Section 2.948 of the FCC rules. The information has, therefore, been placed on file and the name of your organization added to the list of facilities whose measurement data will be accepted in conjunction with applications for Certification under Parts 15 or 18 of the Commission's Rules. Please note that the file must be updated for any changes made to the facility and the registration must be renewed at least every three years.

Measurement facilities that have indicated that they are available to the public to perform measurement services on a fee basis may be found on the FCC website www.fcc.gov under E-Filing, OET Equipment Authorization Electronic Filing, Test Firms.

Sincerely,

Thomas W Phillips
Electronics Engineer