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**REPORT ON**

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

**COMMERCIAL-IN-CONFIDENCE**

FCC ID: PJ5RAY54

Report No OR613446/01 Issue 3

December 2004

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Permissive Change to Grant of Equipment Authorisation of the  
Raymarine RAY54 VHF Marine Radio

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Report No OR613446/01 Issue 3

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**DATED** 20<sup>th</sup> December 2004

**DISTRIBUTION** Raymarine Inc Copy 1  
BABT Copy 2  
Copy No 1

**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;

  
J Holcombe  
EMC Engineer

  
R Blagg  
Radio Engineer





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## **SECTION 1**

### **REPORT SUMMARY**

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

Report OR613446-01 Issue 3 replaces Report OR613446-01 Issue 2. Corrections to typographical errors have been made to the issue 3 report.



## 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 <sup>th</sup> Street, Suite 130 Fort Lauderdale Florida 3309, USA
TYPE NUMBER	RAY54
SERIAL NUMBER	No. 1: 2004.10.11
TEST SPECIFICATION / ISSUE	FCC CRF47: Part 80:2003
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	FTL950
DATE	21 <sup>st</sup> October 2004
START OF TEST	22 <sup>nd</sup> October 2004
FINISH OF TEST	13 <sup>th</sup> December 2004
RELATED DOCUMENTS	FCC CRF47: Part 2:2003 Clause 2.1053 FCC CRF47: Part 15:2003 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 Permissive Change to 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	2.1053/80.211	Emission Limitations (Radiated)	Pass	-
2.2	2.1049/80.205	Bandwidths	Pass	-
2.3	2.1055/80.209	Transmitter Frequency Tolerance	Pass	-
2.4	2.1046/80.215	Transmitter Power	Pass	-



#### **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. The RAY54 also has a Data Port for a GPS input for automatic time and position updates. The data port was not populated during the testing.

### **1.5.2 Modes of Operation**

Applicable testing was carried out with the EUT transmitting at maximum power, except where stated.

## **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, except where stated.

## **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 Permissive Change to Grant of Equipment Authorisation of the Raymarine RAY54 VHF Marine Radio



## **2.1 EMISSION LIMITATIONS (RADIATED)**

### **2.4.1 FCC CRF47: Part 80 Clause 211 FCC CRF47: Part 2 Clause 1053 FCC CRF47: Part 15 Clause 109**

### **2.1.2 Equipment Under Test**

Raymarine RAY54 VHF Marine Radio

### **2.1.3 Date of Test**

22<sup>nd</sup> October 2004

### **2.1.4 Test Equipment Used (See Section 3.1 for details)**

Items 1 - 7

### **2.1.5 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.



## 2.1 EMISSION LIMITATIONS (RADIATED)-Continued

### 2.1.6 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	
				dB $\mu$ V/m	$\mu$ V/m	dB $\mu$ V/m	$\mu$ V/m
57.99	V	119	360	21.0	11.22	40.0	100.0
353.89	H	100	0	24.5	16.79	46.0	200.0
405.00	H	100	0	20.7	10.84	46.0	200.0
500.00	H	100	0	21.6	12.02	46.0	200.0
700.00	H	100	0	24.4	16.59	46.0	200.0
800.00	H	100	0	26.0	19.95	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	43.2	20.89
16 (Middle)	156.800	43.3	21.38
88 (Top)	157.425	43.3	21.38

#### **Conducted Output Power**



**2.1 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	43.2dBm	143.4
156.800	(-10dBm) 90.24	43.3dBm	143.5
157.425	(-10dBm) 90.22	43.3dBm	143.5

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 (20.893W) down on the FS 143.4dBµV/m = **87.2 dBµV/m**

156.800MHz

FS specification limit = (43+10log (20.38W) down on the FS 143.5 dBµV/m = **87.2 dBµV/m**

157.425MHz

FS specification limit = (43+10log (20.38W) down on the FS 143.5 dBµV/m = **87.2 dBµV/m**



**2.1 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 MHz	Polarisation Horizontal/ Vertical	Height cm	Azimut h degree	Field Strength		ERP	
				Result dBµV/m	Limit dBµV/m	Result dB/m	Limit dB/m
<b>EUT Transmit on Bottom Channel - Ch 1 (156.05MHz)</b>							
624.21	H	147	41	53.8	87.2	-46.4	-13
624.21	V	100	200	50.0	87.2	-50.2	-13
780.26	H	116	62	49.8	87.2	-50.4	-13
780.26	V	100	82	50.3	87.2	-49.9	-13
<b>EUT Transmit on Middle Channel - Ch 16 (156.80MHz)</b>							
627.22	V	104	203	49.5	87.2	-50.7	-13
627.22	H	137	27	52.4	87.2	-47.8	-13
784.02	V	100	110	50.0	87.2	-50.2	-13
784.02	H	107	64	49.2	87.2	-51.0	-13
<b>EUT Transmit on Top Channel - Ch 88 (157.425MHz)</b>							
629.70	H	144	200	54.3	87.2	-45.9	-13
629.70	V	107	190	47.8	87.2	-52.4	-13
787.13	H	100	60	46.5	87.2	-53.7	-13
787.13	V	100	80	49.1	87.2	-51.1	-13

All other emissions were 38dB or more below the specification limit.

Note

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



## 2.2 BANDWIDTHS

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

### 2.2.2 Equipment Under Test RAY54

### 2.2.3 Date of Test 13<sup>th</sup> December 2004

### 2.2.4 Test Equipment Used (See Section 3.1 for details) 8, 9, 10, 11, 12, 13, 16, 17

### 2.2.5 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 2.53 kHz. Thus, the Audio Analyser was set to supply the EUT with an audio tone of 2.53 kHz at an amplitude which produced a deviation corresponding to 50% of the maximum permissible frequency deviation, ( $\pm 2.5$  kHz). 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 16, bottom and top channels on both maximum and minimum power levels.

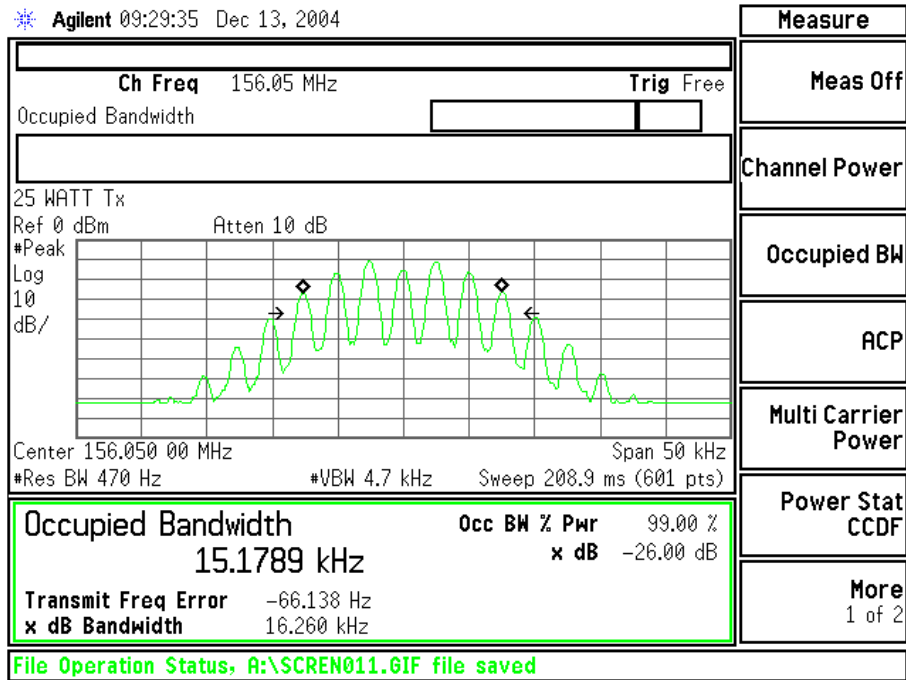
### 2.2.6 Test Results

Channel Number/Frequency	Power Level (W)	Result (kHz)	Authorised Bandwidth (kHz)
1 / 156.050MHz	25	15.18	20
1 / 156.050MHz	1	15.20	20
16 / 156.800MHz	25	15.24	20
16 / 156.800MHz	1	15.26	20
88 / 157.425MHz	25	15.33	20
88 / 157.425MHz	1	15.30	20

The test result plots are shown in the following pages.

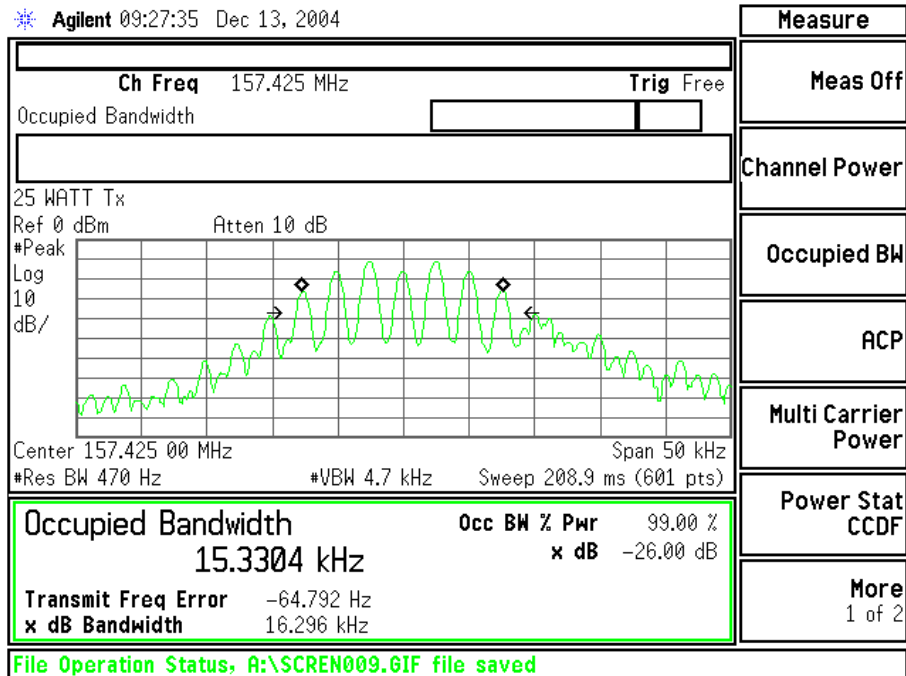


2.2 BANDWIDTHS - Continued



Measure
Meas Off
Channel Power
Occupied BW
ACP
Multi Carrier Power
Power Stat CCDF
More 1 of 2

99% Bandwidth – Channel 1 - 25W

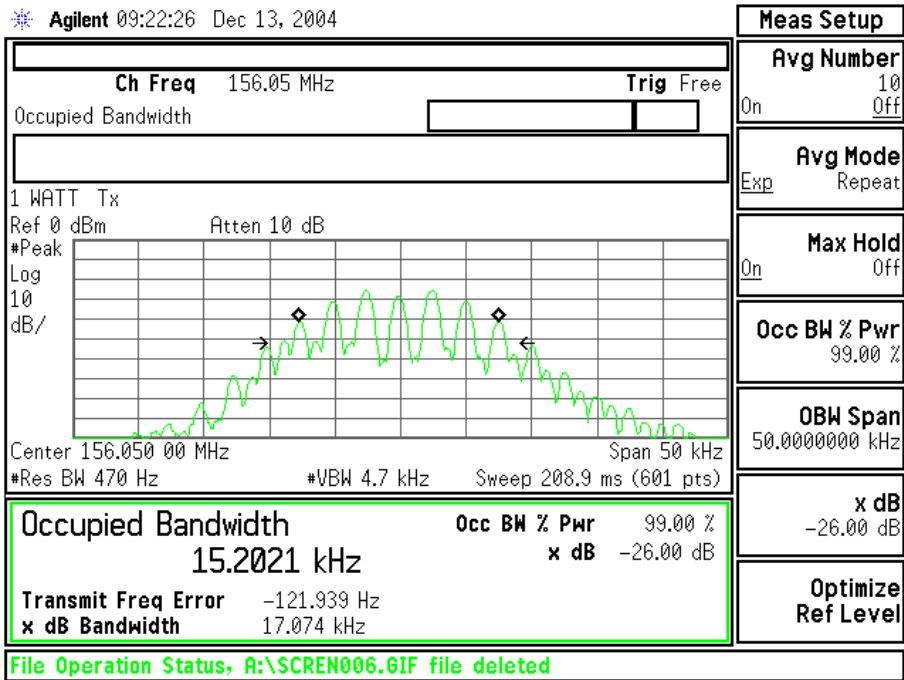


Measure
Meas Off
Channel Power
Occupied BW
ACP
Multi Carrier Power
Power Stat CCDF
More 1 of 2

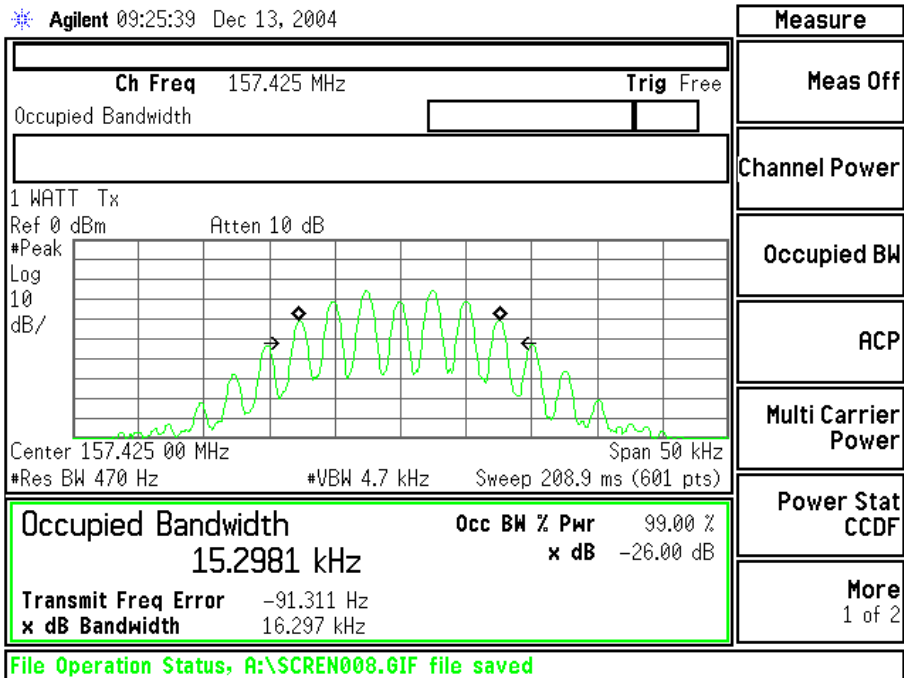
99% Bandwidth – Channel 88 - 25W



2.2 BANDWIDTHS – Continued



99% Bandwidth – Channel 1 - 1W

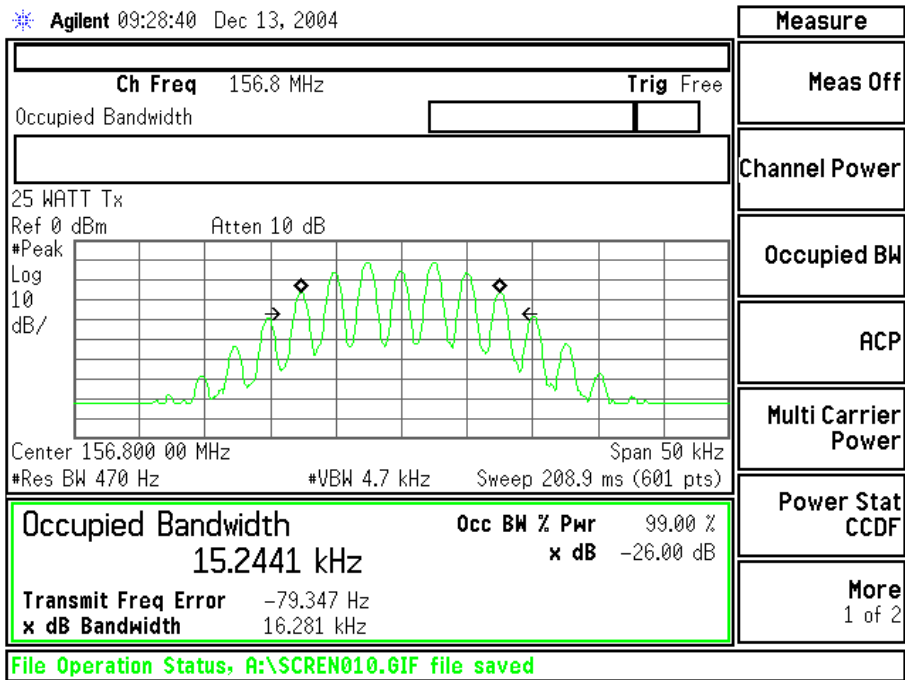


99% Bandwidth – Channel 88 - 1W

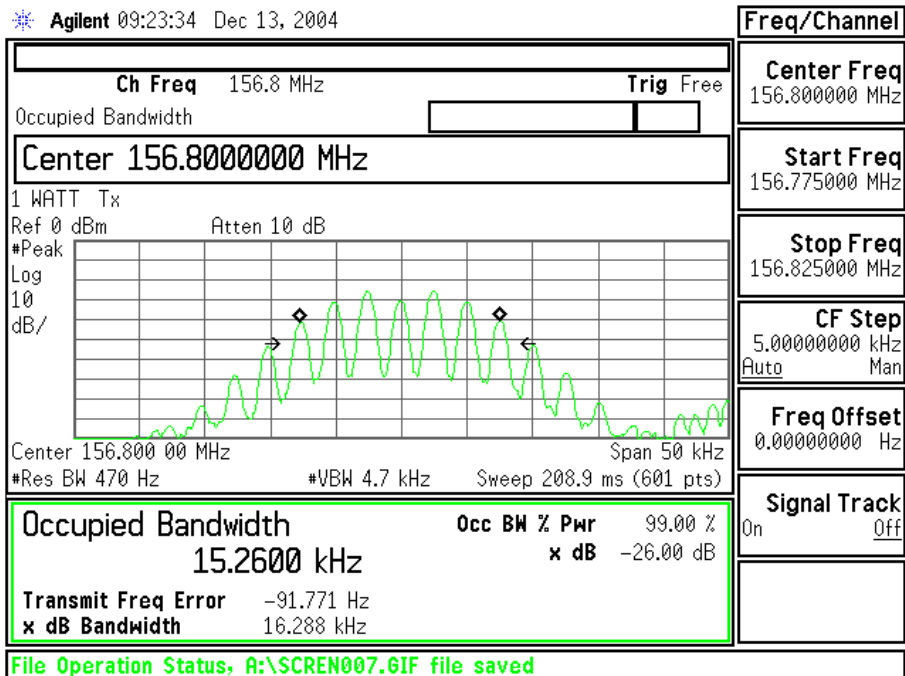




2.2 BANDWIDTHS – Continued



99% Bandwidth – Channel 16 - 25W



99% Bandwidth – Channel 16 - 1W



**2.2 BANDWIDTHS - Continued**

**2.2.7 LIMITS**

Limit	<20kHz
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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.



**2.3 TRANSMITTER FREQUENCY TOLERANCE**

**2.3.1 FCC Part 80, Section 2.1055/80.209**

**2.3.2 Equipment Under Test**  
RAY54

**2.3.3 Date of Test**  
10<sup>th</sup> December 2004

**2.3.4 Test Equipment Used (See Section 3.1 for details)**  
8, 9, 10, 11, 12, 13, 14, 15

**2.3.5 Test Procedure**

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

**2.3.6 Test Results**



**2.3 TRANSMITTER FREQUENCY TOLERANCE**

Voltage and Temperature Variation

Measurements taken at 11.56 V Supply

<u>Temp °C</u>	Ch 1	ppm	Ch88	ppm
-20	156.049507	-3.1592	157.424505	-3.1444
-10	156.049601	-2.5569	157.424597	-2.5599
0	156.049678	-2.0634	157.424677	-2.0518
+10	156.049785	-1.3778	157.424779	-1.4038
+20	156.049871	-0.8267	157.424871	-0.8194
+30	156.049898	-0.6536	157.424895	-0.6670
+40	156.049969	-0.1987	157.424992	-0.0508
+50	156.050160	+1.0253	157.425169	+1.0735
+55	156.050304	+1.9481	157.425299	+1.8993

Measurements taken at 15.64 V Supply

<u>Temp °C</u>	Ch 1	ppm	Ch88	ppm
-20	156.049551	-2.8773	157.424556	-2.8204
-10	156.049602	-2.5505	157.424597	-2.5599
0	156.049685	-2.0186	157.424680	-2.0327
+10	156.049793	-1.3265	157.424782	-1.3848
+20	156.049876	-0.7946	157.424879	-0.7686
+30	156.049899	-0.6472	157.424898	-0.6479
+40	156.049967	-0.2115	157.424990	-0.0635
+50	156.050147	+0.9420	157.425137	+0.8703
+55	156.050314	+2.0122	157.425323	+2.0518

**2.3.7 LIMITS**

Limit	± 10ppm
-------	---------

Remarks

EUT complies with CFR 47 Part 80.209(a)(5)(ii). The EUT Transmitter Frequency Tolerance does not exceed ±10 ppm at the measured frequency at any temperature interval across the measured range.

EUT complies with CFR 47 Part 80.209. The EUT Transmitter Frequency Tolerance does not exceed ±10 ppm at the measured frequency at voltage variation.



**2.4 TRANSMITTER POWER**

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

**2.4.2 Equipment Under Test**  
RAY54

**2.4.3 Date of Test**  
9<sup>th</sup> December 2004

**2.4.4 Test Equipment Used (See Section 3.1 for details)**  
8, 9, 10, 11, 12, 13

**2.4.5 Test Procedure**

The EUT was connected via a 30dB attenuator to a sensor and Modulation Analyser. The path loss between the EUT and the power sensor was measured and recorded. The Modulation Analyser reading was 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.

**2.4.6 Test Results**

Maximum Power

Frequency (MHz)	Result (dBm)	Result (W)
156.050	43.858	24.31
157.425	43.784	23.90

Minimum Power

Frequency (MHz)	Result (dBm)	Result (W)
156.050	28.976	0.79
157.425	28.859	0.769

**2.4.7 Limits**

Limit – Max Power	<25W or <+43.98 dBm
Limit – Min Power	<1W or <+30 dBm

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.



### **SECTION 3**

#### **TEST EQUIPMENT USED**



### 3.1 TEST EQUIPMENT USED

Item	Instrument	Type No	Manufacturer	EMC / INV No	Cal. Due
1	EMI Receiver	8542E	Hewlett Packard	EMC2286	09/12/2004
2	Bilog Antenna	CBL 6143	Chase	EMC2965	12/09/2005
3	Turntable and Controller	HD050	HD Gmbh	EMC2528	TU
4	Antenna Mast	1051	EMCO	EMC2182	TU
5	Antenna Mast Controller	2090	EMCO	-	TU
6	Screened Room 5	EAC54300	Siemens	EMC2533	TU
7	Bilog Antenna	CBL6143	Chase	EMC2860	28/04/2005
8	Thermohygrograph	I-1000	Rotronic	INV3227	21-10-05
9	Power Supply	6269B	HP	EMC978	TU
10	DVM	IDM-101	Isotech	EMC2296	18-02-05
11	30dB Attenuator	8321	Bird	INV3807	15-10-05
12	Sensor	11722A	HP	INV1873	29-05-05
13	Modulation Analyser	8901B	HP	EMC1986	19-12-04
14	Digital Thermometer	51	Fluke	INV4223	17-03-05
15	Environmental Chamber	2F3	Montford	INV3037	TU
16	20dB Attenuator	1	Weinschel	INV2651	15-10-05
17	Spectrum Analyser	E4445A	Agilent	INV4963	22-12-04



### 3.2 MEASUREMENT UNCERTAINTY

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

<b>IN THE FREQUENCY RANGE 30MHz TO 1000MHz</b>		
<b>TEST</b>	<b>FREQUENCY</b>	<b>AMPLITUDE</b>
For Occupied Bandwidth	±681Hz	±0.5dB
For Maximum Output Power	Not Applicable	±0.5dB
For Radiated Emissions, Quasi-Peak Measurements taken in Zero Span using the Hewlett Packard EMI Receiver and Bilog Antenna	±2x10 <sup>-7</sup> x Centre Frequency	5.15dB calculated in accordance with CISPR 16-4
For Spurious Conducted Emissions	Not Applicable	±1.8dB
<b>IN THE FREQUENCY RANGE 1GHz TO 20GHz</b>		
<b>TEST</b>	<b>FREQUENCY</b>	<b>AMPLITUDE</b>
For Spurious Radiated Emissions measurements	±2x10 <sup>-7</sup> x Centre Frequency	±3.4dB
Transmitter frequency Tolerance	±45Hz	Not Applicable
Modulation Requirements	±0.6dB (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



This report relates only to the actual item/items tested.

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

Results of tests not covered by our UKAS Accreditation Schedule are marked NUA (Not UKAS Accredited).

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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](http://www.fcc.gov) under E-Filing, OET Equipment Authorization Electronic Filing, Test Firms.

Sincerely,

Thomas W Phillips  
Electronics Engineer