TIMCO ENGINEERING INC.
849 NW State Road 45
Newberry, Florida 32669
http://www.timcoengr.com
888.472.2424 F 352.472.2030 email: sid@timcoengr.com
b

Test Report

Product Name: VHF MARINE RADIO

FCC ID: RAYVHF7100US

Applicant:

NAVNAM NZ LTD.
13 – 17 KAWANA STREET
NORTHCOTE
AUCKLAND, NEW ZEALAND

Date Receipt: DECEMBER 23, 2003

Date Tested: JANUARY 15, 2004

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APPLICANT: NAVMAN NZ, LTD.

FCC ID: RAYVHF7100US

TEST REPORT:

EXHIBIT INCLUDING:

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GENERAL_INFORMATION_REQUIRED
FOR_TYPE_ACCEPTANCE

2.1033(c) NAVMAN NZ, LTD. will sell the FCC ID: RAYVHF7100US VHF Marine transmitter in quantity, for use under FCC RULES PART 80.

NAVMAN NZ LTD.
13 – 17 KAWANA STREET
NORTHCOTE
AUCKLAND, NEW ZEALAND

2.1033(c) TECHNICAL_DESCRIPTION

(4) Type of Emission: 15K0G3E / 15K0F3E

Bn = 2M + 2DK
M = 3000
D = 4.5KHz (Peak Deviation)
K = 1
Bn = 2(3.0K) + 2(4.5K)(1) = 6.0K + 9.0 = 15.0K

80.205 (a) ALLOWED AUTHORIZED BANDWIDTH = 20.00KHz.

TECHNICAL_DESCRIPTION

(4) Type of Emission: 13K5G2B

Bn = 2M + 2DK
M = 3000
D = 3.75KHz (Peak Deviation)
K = 1
Bn = 2(3.0K) + 2(3750)(1) = 6.0K + 7.5k = 13.5K

80.205 (a) ALLOWED AUTHORIZED BANDWIDTH = 20.00KHz.

2.1033(c)(5) Frequency Range: 156.025-157.425 MHz

2.1033(c)(6) Power Range and Controls: There is a user Power switch for High/Low Power.
Maximum output power Rating:
High = 25 Watts
Low = 1 Watt (Into a 50 ohm resistive load)

2.1033(c)(7) DC Voltages and Current into Final Amplifier:

POWER INPUT: FINAL AMPLIFIER ONLY

High	Low
Vce = 13.6 VDC	Vce = 13.6 VDC
Ice = 4.250 A	Ice = 0.880 A
Pin = 57.80 Watts	Pin = 11.97 Watts

Function of each electron tube or semiconductor device or other active circuit device is included in the Exhibits.

2.1033(c)(8) Complete Circuit Diagrams: The circuit diagram and block diagrams are included in the exhibits.

2.1033(c)(9) Instruction book. The instruction manual is included.

2.1033(c)(10) Tune-up procedure. The tune-up procedure is included in the exhibits.

Description of all circuitry and devices provided for determining and stabilizing frequency is included in the circuit description.

2.1033(c)(11) Digital modulation. This unit does NOT use digital modulation.

The data required by 2.1046 through 2.1055 is submitted below.

2.1046(a)
80.215 (e)(1) **RF_power_output.**

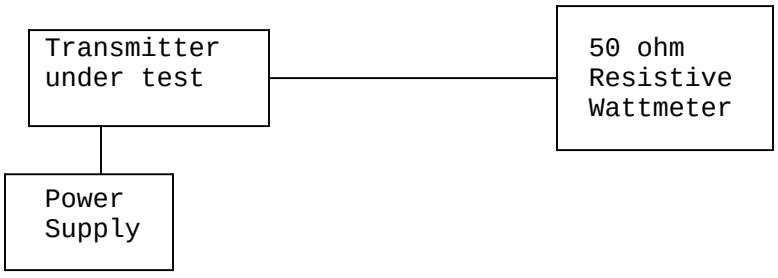
RF power is measured by connecting a 50 ohm, resistive wattmeter to the RF output connector. With a nominal battery voltage of 13.6 V, and the transmitter properly adjusted the RF output measures:

OUTPUT POWER: HIGH: 25 W CONDUCTED
LOW: 1 W CONDUCTED

80.911 (d)(5) For primary supply voltages, measured in accordance with the procedures in this paragraph, greater than 11.5 volts, but less than 12.6 volts, the required transmitter output power shall be equal or greater than the value calculated below:

P = 4.375(V) – 35.313 (For 12V this equals 17.2 Watts)

METHOD OF MEASURING RF POWER OUTPUT



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TECHNICAL DATA:

80.203 (b)	**External Controls:** The transmitter is capable of changing frequency between 156.05 – 157.425 MHz by external control. The available channels are shown in the User Manual description Channel List. These channels are preprogrammed by the manufacturer and change of frequency is inaccessible to the station operator.
80.203 (c)	Five minutes continuous transmission test. The antenna was connected to a dummy load and the radio was locked in a transmit PTT mode. An external timer digital clock was used to observe the duration of the un-modulated transmission. The transmitter turned off and the radio went to receive mode at 4 minutes, 58 seconds as displayed by the external digital clock.
80.203 (n)	This radio complies with the requirement for DSC capability in the 156 – 162 MHz band and in accordance with 80.225.
80.873; 80.956	Transmitter G3E emission capability: The transmitter was connected to 50 ohm resistive wattmeter and the frequency was set to 156.300 and to 156.800 MHz. With normal modulation, the output power displayed was 25 Watts at the high power setting and 1 watt at low power setting, consistent with previous measurements. The transmitter has been demonstrated to be capable, with normal operating voltages applied, of delivering 25 watts of carrier power into a 50 ohm resistive load over the specified frequencies.
80.911 (a)	80.956 G3E Transmissions: This radio is capable of G3E emission on 156.300 and 156.800 MHz
80.911 (c)	With 13.6 VDC applied and with the radio connected to a 50 ohm resistive wattmeter, the output power was measured at 156.300 and 156.800 MHz with a measured reading of 25 Watts under normal speech modulation.
80.911 (d)(2)	80.959 With the power supply set to 13.6 VDC, and the output of the transmitter terminated in a 50 ohm matching artificial load, the transmitter output power was monitored over a 10 minute continuous operational period while in full power. The output power varied from the nominal 25 Watts output power to 24.8 Watts output power

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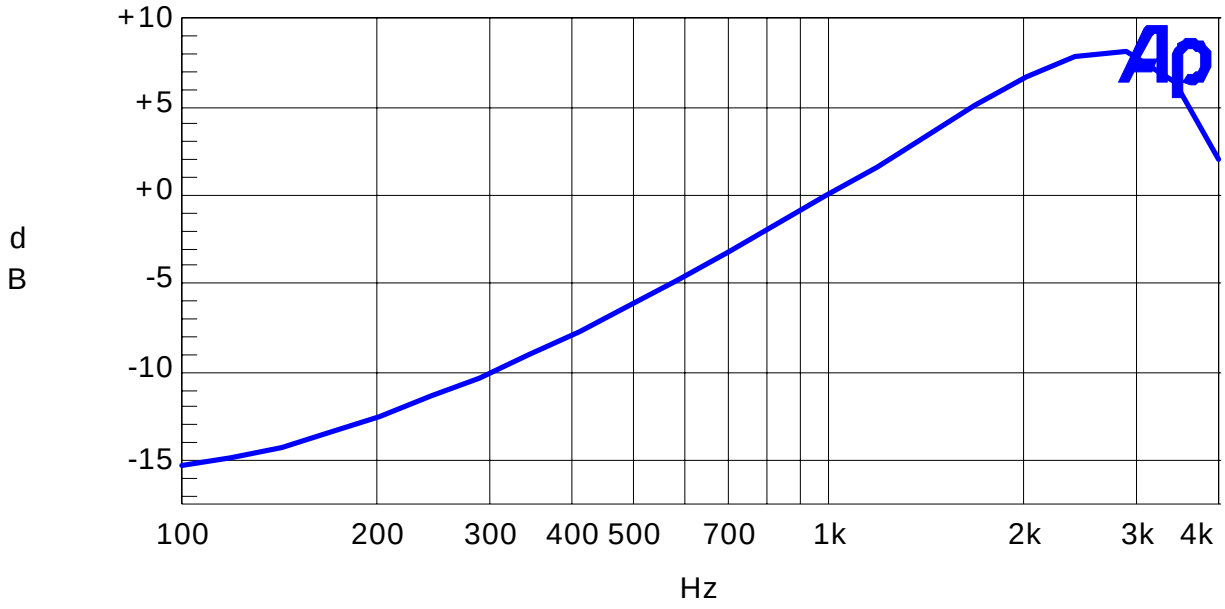
2.1047(a) Voice Modulation_characteristics:

(b) AUDIO_FREQUENCY_RESPONSE – See the following plot

Audio Frequency Response



Color	Line Style	Thick	Data	Axis
Blue	Solid	2	Anlr.Level A!Normalize	Left

MaxFreq.at1

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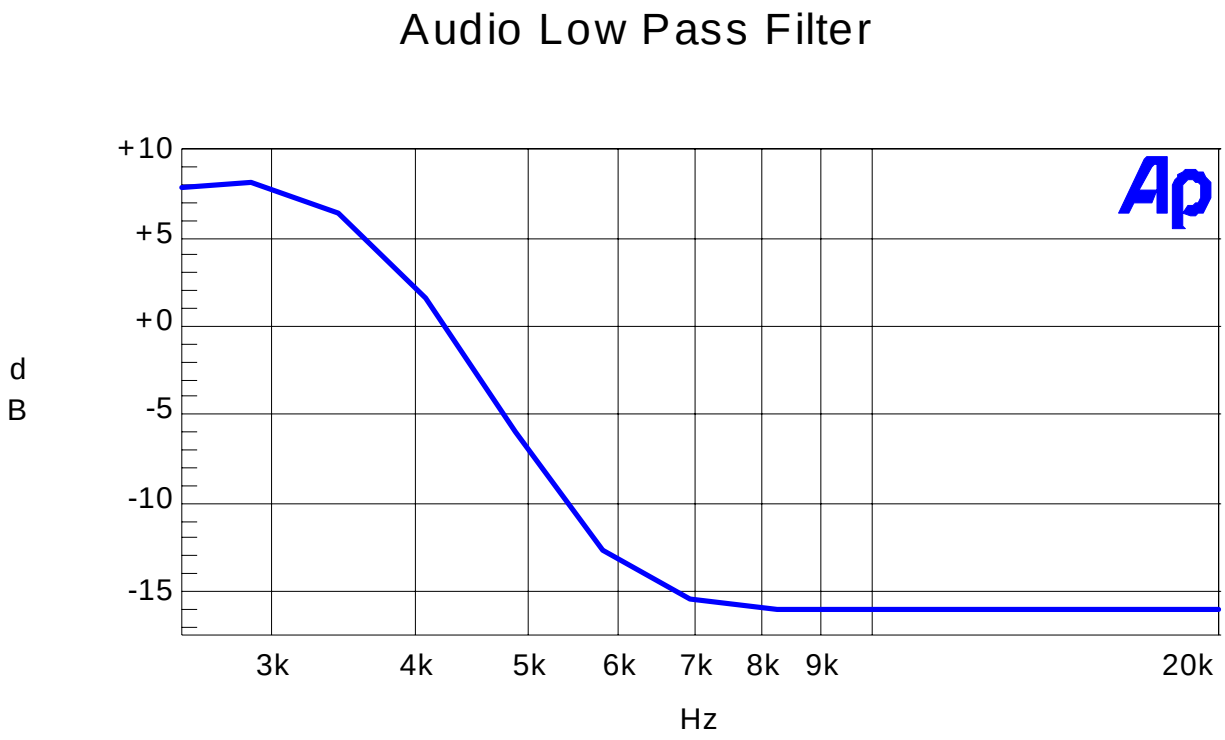
2.1047(a) AUDIO_LOW_PASS_FILTER

The audio low pass filter is included and the plot is shown below.



Color	Line Style	Thick	Data	Axis
Blue	Solid	2	Anlr.Level A!Normalize	Left

MaxFreq.at1

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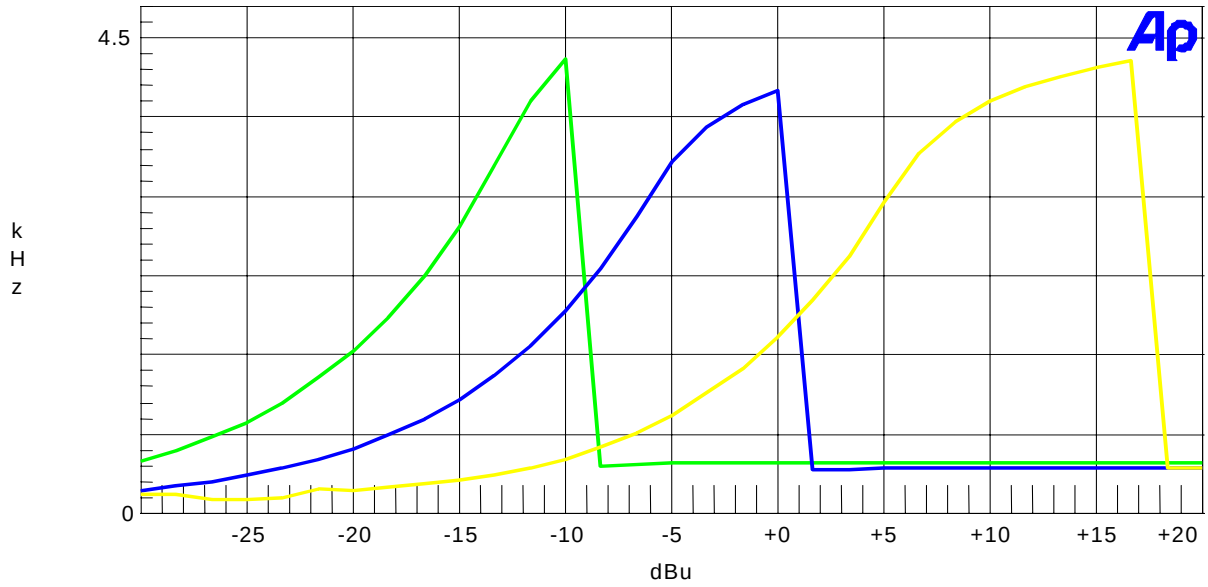
2.1047(b)
80.213 (d)

Audio_input_versus_modulation

A plot of the audio input versus deviation is shown below.

Modulation Limiting Plots:
2.5 KHz (Green), 1.0 KHz (Blue), and 300 Hz (Yellow)



80.213(a)(2)
2.1047 With modulation frequencies of 300, 1000, and 2500 Hz respectively, system deviation must not exceed + or – 5kHz when using phase or frequency modulation.

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2.1049(c) **Occupied bandwidth:**

80.213 (b)

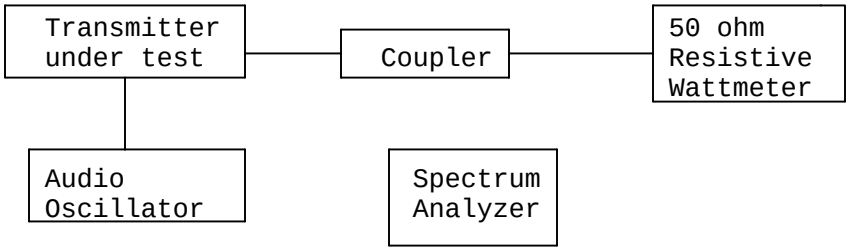
Data in the plots shows that on any frequency removed from the assigned frequency by more than 50%, but not more than 100%: At least 25dB. On any frequency removed from the assigned frequency by more than 100%, but not more than 250%: At least 35dB. On any frequency removed from the assigned frequency by more than 250%, of the authorized bandwidth: At least 43+log(P)dB.

Radiotelephone transmitter with modulation limiter.

Test procedure: TIA/EIA-603 para 2.2.11 , with the exception that various tones were used.

Test procedure diagram

OCCUPIED BANDWIDTH MEASUREMENT



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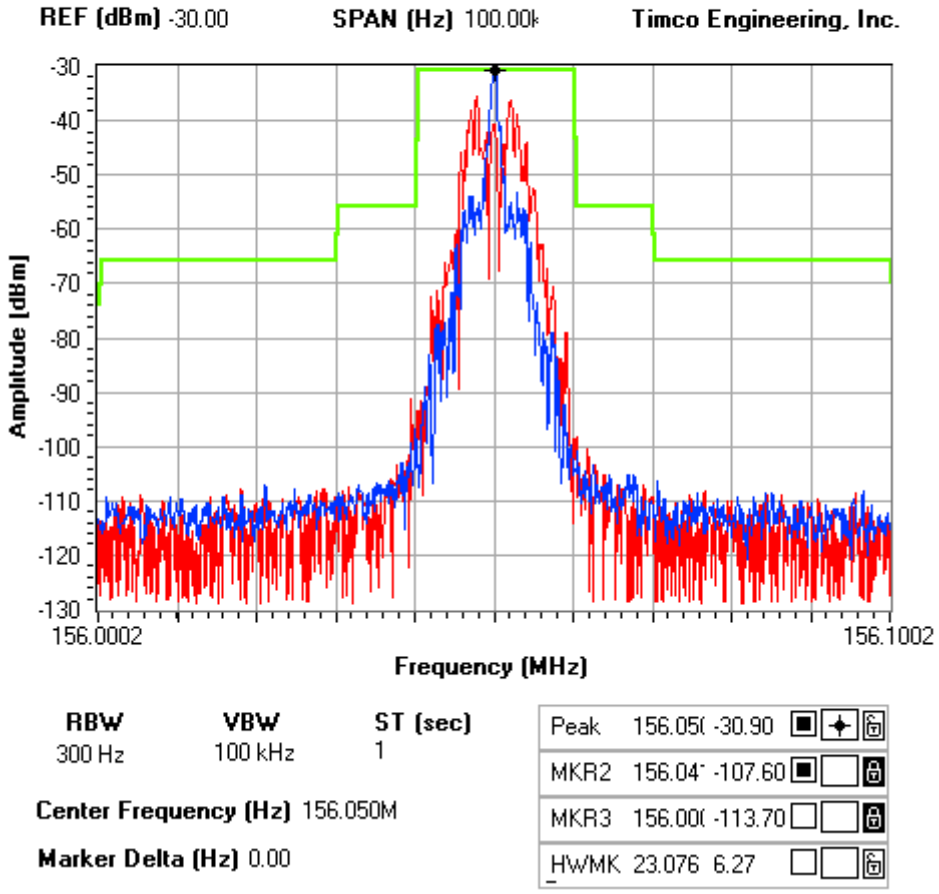
OCCUPIED BANDWIDTH PLOT

NOTES:
NAVMAN NZ, LTD. - FCC ID: RAY7100US
OCCUPIED BANDWIDTH PLOT



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2.1051 Spurious_emissions_at_antenna_terminals(conducted):
80.211 The data on the following page shows the level of conducted spurious responses. The carrier was modulated 100% using a 2500 Hz tone. The spectrum was scanned from 0.4 to at least the 10th harmonic of the fundamental. The measurements were made in accordance with standard TIA/EIA-603.

REQUIREMENTS: Emissions must be 43 +10log(Po) dB below the mean power output of the transmitter.

43 + 10log(25) = 57 **43 + 10log(1) = 43**

TF HIGH POWER	EF	dB below carrier	TF LOW POWER	EF	dB below carrier
156.05	156.05	0.0	156.05	156.05	0.0
	312.10	107.8		312.10	99.0
	468.15	103.4		468.15	99.0
	624.20	99.5		624.20	98.0
	780.25	150.9		780.25	98.7
	936.30	105.2		936.30	99.1
	1092.35	107.3		1092.35	99.8
	1248.40	97.7		1248.40	96.5
	1404.45	105.6		1404.45	97.4
	1560.50	110.7		1560.50	97.2

TF HIGH POWER	EF	dB below carrier	TF LOW POWER	EF	dB below carrier
157.42	157.42	0.0	157.42	157.42	0.0
	314.84	106.5		314.84	99.1
	472.26	102.7		472.26	99.7
	629.68	102.1		629.68	97.9
	787.10	112.8		787.10	98.8
	944.52	105.4		944.52	99.4
	1101.94	105.1		1101.94	132.5
	1259.36	96.2		1259.36	98.3
	1416.78	108.9		1416.78	98.5
	1574.20	111.7		1574.20	97.0

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Method of Measuring Conducted Spurious Emissions

METHOD OF MEASUREMENT: The procedure used was TIA/EIA-603 STANDARD without any exceptions. An audio generator was connected to the UUT through a dummy microphone circuit and the output of the transmitter connected to a standard load and from the standard load through a pre-selector filter of the spectrum analyzer. The spectrum was scanned from 400kHz to at least the tenth harmonic of the fundamental using a HP model 8566B spectrum analyzer. The measurements were made using the shielded room located at TIMCO ENGINEERING INC. 849 STATE ROAD, NEWBERRY FLORIDA 32669.

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2.1053(a) **Field_strength_of_spurious_emissions:**

NAME OF TEST: RADIATED SPURIOUS EMISSIONS (CHANNEL 1)

REQUIREMENTS: Emissions must be 43 + 10log(Po) dB below the mean power output of the transmitter.

HIGH: 43 + 10log(25) = 57
LOW: 43 + 10log(1) = 43

TEST DATA (HIGH):

Emission Frequency MHz	Ant. Polarity	Corrected EUT Signal Reading	Coax Loss (dB)	Substitution Antenna (dBd)	dB Below Carrier (dBc)
156.05	H	42.9	0.00	0.00	0.00
312.10	V	-62.1	0.00	-1.25	103.75
468.15	H	-56.3	0.00	-0.53	98.67
624.20	H	-52.7	0.00	-0.25	95.35
1092.35	V	-70.3	1.02	3.32	115.50
1248.40	V	-67.7	1.05	3.95	113.50
1404.45	H	-70.4	1.08	4.57	116.79
1560.50	H	-68.8	1.11	4.99	115.58

TEST DATA (LOW):

Emission Frequency MHz	Ant. Polarity	Corrected EUT Signal Reading	Coax Loss (dB)	Substitution Antenna (dBd)	dB Below Carrier (dBc)
156.05	H	28.7	0.00	0.00	0.00
312.10	H	-56.7	0.00	-1.25	84.15
468.15	H	-65.9	0.00	-0.53	94.07
624.20	H	-68.2	0.00	-0.25	96.65
1092.35	V	-72.0	1.02	3.32	103.00
1404.45	H	-71.4	1.08	4.57	103.59
1560.50	H	-69.1	1.11	4.99	101.68

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2.1053(a) **Field_strength_of_spurious_emissions:**

NAME OF TEST: RADIATED SPURIOUS EMISSIONS (CHANNEL 88)

REQUIREMENTS: Emissions must be 43 + 10log(Po) dB below the mean power output of the transmitter.

HIGH: 43 + 10log(25) = 57
LOW: 43 + 10log(1) = 43

TEST DATA (HIGH):

Emission Frequency MHz	Ant. Polarity	Corrected EUT Signal Reading	Coax Loss (dB)	Substitution Antenna (dBd)	dB Below Carrier (dBc)
157.42	H	42.8	0	0.00	0.00
314.84	H	-66.4	0	-1.25	107.95
472.26	H	-57.7	0	-0.54	99.96
629.68	H	-54.7	0	-0.23	97.27
1101.94	V	-71.9	1.02	3.36	117.04
1259.36	H	-60.5	1.05	3.99	106.24
1416.78	H	-70.0	1.08	4.62	116.34
1574.20	H	-68.4	1.11	4.99	115.08

TEST DATA (LOW):

Emission Frequency MHz	Ant. Polarity	Corrected EUT Signal Reading	Coax Loss (dB)	Substitution Antenna (dBd)	dB Below Carrier (dBc)
157.42	H	28.5	0	0.00	0.00
314.84	H	-54.9	0	-1.25	82.15
472.26	H	-64.6	0	-0.53	92.57
629.68	H	-67.1	0	-0.24	95.36
1101.94	H	-65.2	1.02	3.34	96.02
1259.36	H	-67.2	1.05	3.97	98.62
1416.78	H	-72.4	1.08	4.60	104.42
1574.20	H	-69.1	1.11	4.99	101.48

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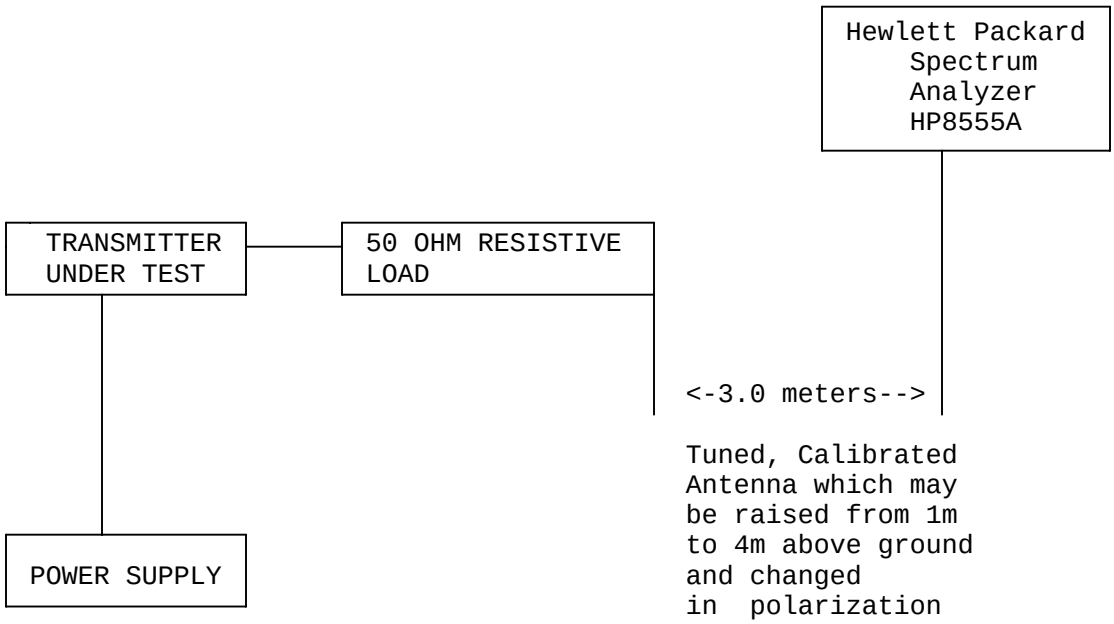
2.1053(a) Continued Field_strength_of_spurious_emissions:

Method of Measuring Radiated Spurious Emissions



Equipment placed 80 cm above ground
on a rotatable platform.

METHOD OF MEASUREMENT: The tabulated data shows the results of the radiated field strength emissions test. The spectrum was scanned from 30 to at least the tenth harmonic of the fundamental. This test was conducted per TIA/EIA STANDARD 603 using the substitution method. Measurements were made at the open field test site of TIMCO ENGINEERING, INC. located at 849 N.W. State Road 45, Newberry, FL 32669.

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Frequency stability:

2.1055(a)(2)
80.209 (a)

Temperature and voltage tests were performed to verify that the frequency remains within the .005%, 5.0 ppm specification limit, for 20kHz spacing. The test was conducted as follows: The transmitter was placed in the temperature chamber at 25° C and allowed to stabilize for one hour. The transmitter was keyed ON for one minute during which four frequency readings were recorded at 15 second intervals. The worse case number was taken for temperature plotting. The assigned channel frequency was considered to be the reference frequency. The temperature was then reduced to -30° C after which the transmitter was again allowed to stabilize for one hour. The transmitter was keyed ON for one minute, and again frequency readings were noted at 15 second intervals. The worst-case number was recorded for temperature plotting. This procedure was repeated in 10 degree increments up to + 50° C.

Readings were also taken at minus 15% of the battery voltage of 11.5 V, which we estimate to be the battery endpoint.

MEASUREMENT DATA:

Assigned Frequency (Ref. Frequency): 156.800 000 MHz

TEMPERATURE_C	FREQUENCY_MHz	PPM
REFERENCE	156.800 000	0.00
-30	156.799 382	-3.94
-20	156.799 352	-4.13
-10	156.799 578	-2.69
0	156.799 765	-1.50
+10	156.799 877	-0.78
+20	156.799 943	-0.36
+30	156.800 017	0.11
+40	156.800 190	1.21
+50	156.800 536	3.42

	VOLTS	**Batt. Data**	**Batt. PPM**
-15%	11.5	156.875 133	0.50

RESULTS OF MEASUREMENTS: The test results indicates that the EUT meets the requirements.

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FCC RF Exposure Requirements

General information:

FCCID: RAY7100US
Device category: Mobile per Part 2.1091
Environment: General Population/Uncontrolled Exposure

Antenna:

The manufacturer does not specify any antenna to be used with this device.

This device has provisions for operation in a boat.

Configuration	Antenna p/n	Type	Max. Gain (dBi)
Boat	Any	-	5 dBi (3 dBd)

Operating configuration and exposure conditions:

Part 2.1091 states that devices are excluded from routine evaluation if the EIRP is less than 2.46 Watts (or 1.5 WERP).

A 50% on time (15 minutes transmitting over a 30 minute period) is used to average.

Boat Operation: Cable length = 32 ft exposed and 3 feet internal to random = 35 ft. total. 35 feet of cable loss including connector insertion loss at 156 MHz is 2.5 dB. The maximum antenna gain that can be used is 5 dBi (3 dBd).

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MPE CALCULATION

$W := 25.0$ power in Watts

$D := 1$ Duty Factor in decimal % (1=100%)

$E := 15.0$ exposure time in minutes

$U := 30$ (use 6 for controlled and 30 for uncontrolled)

$$Wexp := W \cdot D \cdot \left(\frac{E}{U} \right)$$

$$PC := \frac{E}{U}$$

$PC = 0.5$ percent on time

$Wexp = 12.5$ Watts

$Po := 12500$ mWatts

$dBd := 3.$ antenna gain

$f := 156$ Frequency in MHz

$G := dBd + 2.15 - 2.5$ gain in dBi

$G = 2.65$

$Gn := 10^{\frac{G}{10}}$ gain numeric

$S := 0.2$

controlled exposure
0.2 for controlled
1.0 for uncontrolled

$Gn = 1.841$

$S = 0.2$

$$R := \sqrt{\frac{(Po \cdot Gn)}{(4 \cdot \pi \cdot S)}}$$

$$Rinches := \frac{R}{2.54}$$

$R = 95.683$ distance in centimeters required for compliance

$Rinches = 37.67$

Conclusion:

The device complies with the MPE requirements for a typical transceiver with 50 % transmit time by providing a safe separation distance of 96 cm between the antenna, including any radiating structure, and any persons when normally operated .

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EMC Equipment List

Device	Manufacturer	Model	Serial Number	Cal/Char Date	Due Date
3/10-Meter OATS	TEI	N/A	N/A	Listed 3/26/01	3/26/04
3-Meter OATS	TEI	N/A	N/A	Listed 1/13/03	1/13/06
Audio Generator	B&K Precision	3010	8739686	CHAR 12/1/02	12/1/04
Audio Oscillator	HP	653A	832-00260	CHAR 12/1/02	12/1/04
Biconnical Antenna	Eaton	94455-1	1057	CAL 3/18/03	3/18/05
Biconnical Antenna	Eaton	94455-1	1096	CAL 10/1/01	10/1/03
Biconnical Antenna	Electro-Metrics	BIA-25	1171	CAL 4/26/01	4/26/03
Blue Tower Quasi-Peak Adapter	HP	85650A	2811A01279	CAL 4/15/03	4/15/05
Blue Tower RF Preselector	HP	85685A	2926A00983	CAL 4/15/03	4/15/05
Blue Tower Spectrum Analyzer	HP	8568B	2928A04729 2848A18049	CAL 4/15/03	4/15/05
Frequency Counter	HP	5352B	2632A00165	CAL 11/28/01	11/28/03
Frequency Counter	HP	5382A	1620A03535	CHAR 3/2/01	Out of Service
Frequency Counter	HP	5385A	2730A03025	CAL 3/7/03	3/7/05
Frequency Counter	HP	5385A	3242A07460	CAL 3/7/03	3/7/05
LISN	Electro-Metrics	ANS-25/2	2604	CAL 10/9/01	10/9/03
LISN	Electro-Metrics	EM-7820	2682	CAL 3/12/03	3/12/05
Log-Periodic Antenna	Eaton	96005	1243	CAL 5/8/03	5/8/05