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FCC PART 80 AND IC RSS-182 (i5)
TEST REPORT

APPLICANT	NAVICO AUCKLAND LTD
	3-5 OMEGA STREET ALBANY 0632 AUCKLAND NEW ZEALAND
FCC ID	RAYVHFRS90
IC CERTIFICATION	4697A-VHFRS90
MODEL NUMBER	RS90
PRODUCT DESCRIPTION	BASE STATION VHF RADIO
DATE SAMPLE RECEIVED	1/21/2014
DATE TESTED	1/24/2014
DATE REPORT ISSUED	2/5/2014
TESTED BY	Joe Scoglio
APPROVED BY	Joe Scoglio
TIMCO REPORT NO.	120AUT14TestReport.docx
TEST RESULTS	☒ PASS ☐ FAIL

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GENERAL REMARKS

The attached report shall not be reproduced except in full without the written permission of Timco Engineering Inc.

The test results relate only to the items tested.

Summary

The device under test does:
☒ fulfill the general approval requirements as identified in this test report
☐ not fulfill the general approval requirements as identified in this test report

Attestations

This equipment has been tested in accordance with the standards identified in this test report. To the best of my knowledge and belief, these tests were performed using the measurement procedures described in this report.

All instrumentation and accessories used to test products for compliance to the indicated standards are calibrated regularly in accordance with ISO 17025: 2005 requirements.

I attest that the necessary measurements were made, under my supervision, at:

Timco Engineering Inc.
849 NW State Road 45
Newberry, FL 32669

Authorized Signatory Name:

Joe Scoglio
Engineering Project Manager

Date: February 5, 2014

GENERAL INFORMATION

EUT Specification

EUT Description	BASE STATION VHF MARINE RADIO W DSC, ATIS, & AIS DECODER
FCC ID	RAYVHFRS90
IC Certification	4697A-VHFRS90
Model Number	RS90
Operating Frequency	156.025-157.425 MHz
Test Frequencies	156.050, 156.425 MHz
Type of Emission	16K0G3E, 16K0G2B
Modulation	FM
EUT Power Source	☐ 110–120Vac/50– 60Hz
	☒ DC Power 12V
	☐ Battery Operated Exclusively
Test Item	☐ Prototype
	☒ Pre-Production
	☐ Production
Type of Equipment	☐ Fixed
	☒ Mobile
	☐ Portable
Antenna Connector	SO-239
Test Conditions in the test laboratory	The temperature was 26°C Relative humidity of 50%.
Revision History to the EUT	None
Test Exercise	The EUT was placed in continuous transmit mode.
Applicable Standards	ANSI/TIA 603-C:2004, FCC CFR 47 Part 80, IC RSS-182 (issue 5) and RSS-GEN (issue 3)
Test Facility	Timco Engineering Inc. at 849 NW State Road 45 Newberry, FL 32669 USA.

TEST PROCEDURES

Power Line Conducted Interference: The procedure used was ANSI/TIA 603-C: 2004 using a 50uH LISN. Both lines were observed with the EUT transmitting. The bandwidth of the spectrum analyzer was 10 kHz with an appropriate sweep speed.

Bandwidth 20 dB: The measurements were made with the spectrum analyzer's resolution bandwidth (RBW) = 1 MHz and the video bandwidth (VBW) = 3 MHz and the span set as shown on plot.

Power Output: The RF power output was measured at the antenna feed point using a peak power meter.

Antenna Conducted Emissions: The RBW = 100 kHz, VBW = 300 kHz and the span set to 10.0 MHz and the spectrum was scanned from 30 MHz to the 10th harmonic of the fundamental. Above 1 GHz the resolution bandwidth was 1 MHz and the VBW = 3 MHz and the span to 50 MHz.

Radiation Interference: The test procedure used was ANSI C63.4-2004 using an Agilent spectrum receiver with pre-selector. The bandwidth (RBW) of the spectrum receiver was 100 kHz up to 1 GHz and 1 MHz above 1 GHz with an appropriate sweep speed. The VBW above 1 GHz was 3 MHz. The analyzer was calibrated in dB above a micro volt at the output of the antenna.

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 5 minutes, 0 seconds. 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	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 shown later in this report under normal speech modulation.

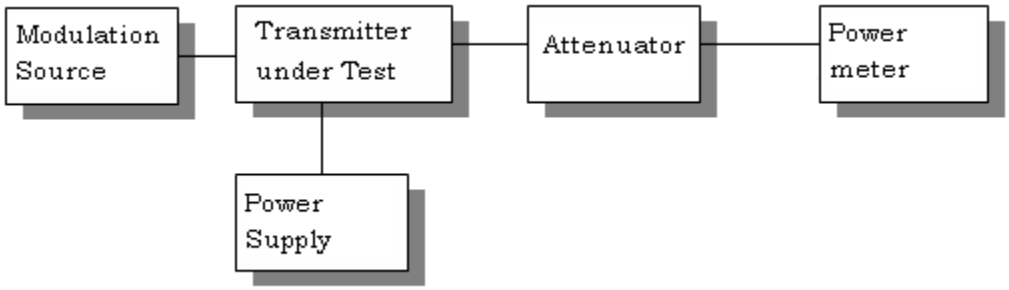
RF POWER OUTPUT

Rule Part No.: FCC Part 2.1046(a), 80.215(e)(1), IC RSS-82

Test Requirements:

Method of Measurement: RF power is measured by connecting as per setup diagram. With a nominal voltage, and the transmitter properly adjusted the RF output measures:

Test Setup Diagram:



Test Data:

	RF POWER (W)	
Tuned Frequency (MHz)	HI	LOW
156.0	24.8	0.9
157.4	24.9	0.9

Part 2.1033 (C)(8) DC Input into the final amplifier

FOR LOW POWER SETTING INPUT POWER: (12.0V)(0.53A) = 6.4 Watts
FOR HIGH POWER SETTING INPUT POWER: (12.0V)(4.0A) = 48.0 Watts

Rule Part No.: FCC Part 80.911 (d)(2) 80.959

Test Requirements: With the power supply set to 13.6 VDC, and the output of the transmitter terminated in a 50 ohm load, the transmitter output power was monitored over a 10 minute continuous operational period while in full power.

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Test Data:

OUTPUT POWER: The output power varied from the nominal 25 Watts output power to 24.8 Watts output power

MODULATION CHARACTERISTICS

Part 2.1033(c) (4) Type of Emission: 16K0G3E
FCC Part 80.205(a)
RSS-182, RSS-GEN

Bn = 2M + 2DK
M = 3000
D = 4.6kHz (Peak Deviation)
K =1
Bn = 2(3000)+2(4.6K)(1) = 16.0K

80.205(a) ALLOWED AUTHORIZED BANDWIDTH – 20.00 kHz

The 99 % bandwidth for the DSC is 16 kHz. 16K0G2B
DSC is a AFSK modulation at a 1200 baud data rate.

AUDIO FREQUENCY RESPONSE

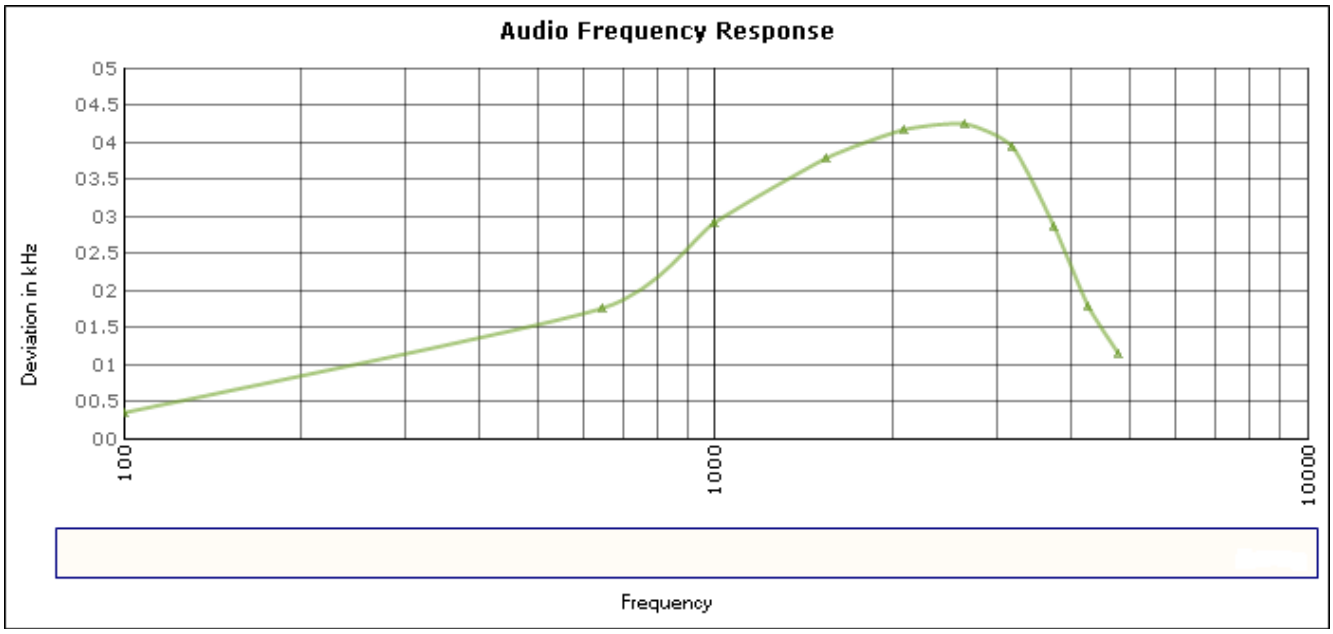
Rule Part No.: FCC Part 2.1047(a)(b), IC RSS-182

Test Requirements:

Method of Measurement:

The audio frequency response was measured in accordance with ANSI/TIA 603-D: 2010. A curve or equivalent data showing the frequency response of the audio modulating circuit over a range of 100 – 5000Hz shall be submitted. The audio frequency response curve is shown below.

AUDIO FREQUENCY RESPONSE PLOT



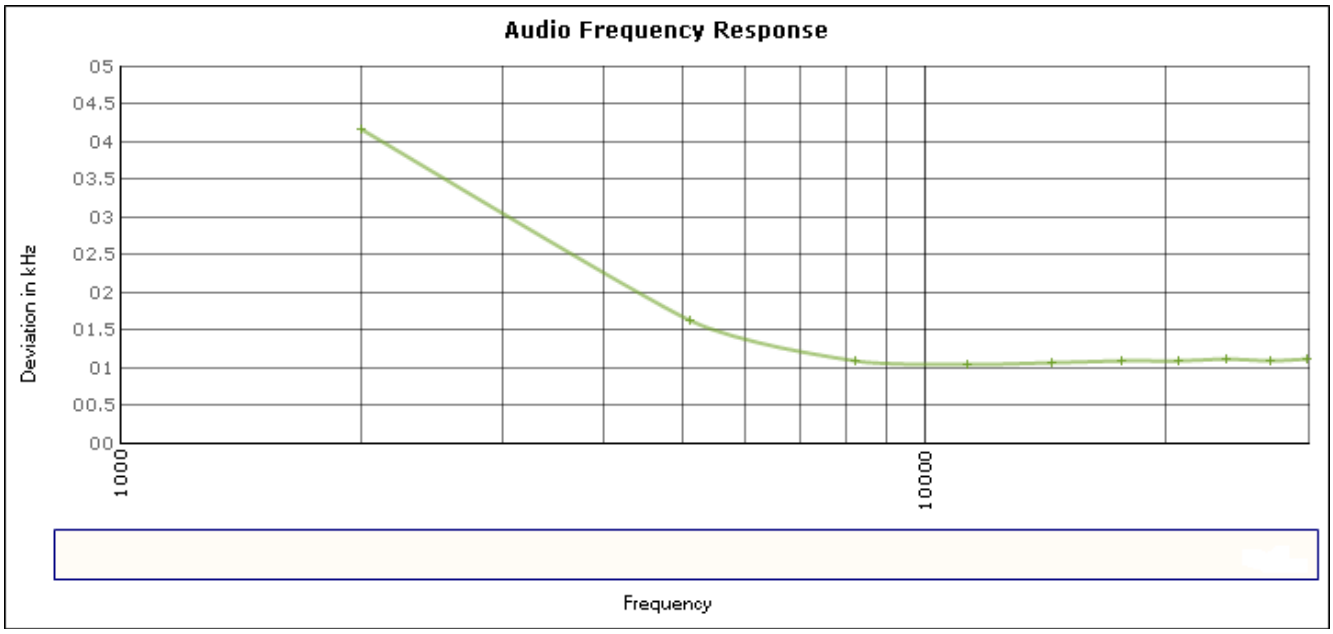
AUDIO LOW PASS FILTER

VOICE MODULATED COMMUNICATION EQUIPMENT

Rule Part No.: 2.1047(a)

For equipment required to have an audio low-pass filter, a curve showing the frequency response of the filter, or of all the circuitry installed between the modulation limiter and the modulated stage shall be submitted.

AUDIO LOW PASS FILTER



AUDIO INPUT VERSUS MODULATION

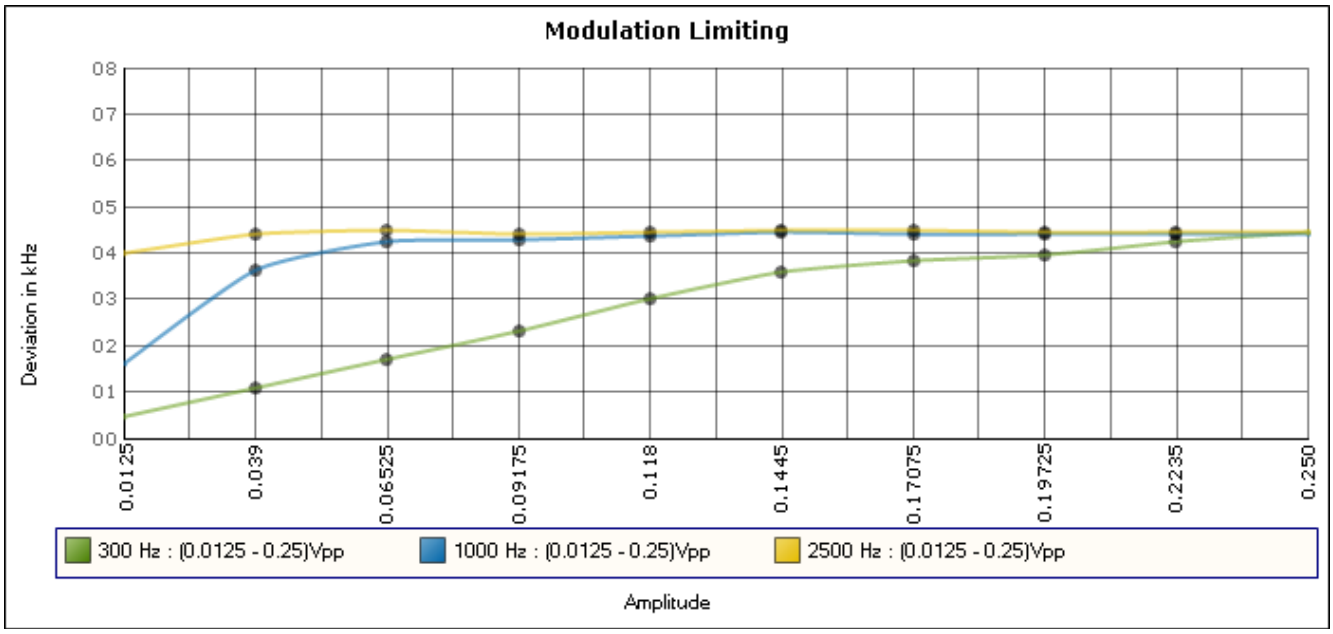
Rule Part No.: FCC Part 2.1047(b) & 80, IC RSS-182

Test Requirements: Modulation cannot exceed 100%.

Method of Measurement: The audio input level needed for a particular percentage of modulation was measured in accordance with ANSI/TIA 603-D: 2010. The audio input curves versus modulation are shown below. Curves are provided for audio input frequencies of 300, 1000, and 3000 Hz.

Test data:

Modulation Limiting Plot



OCCUPIED BANDWIDTH

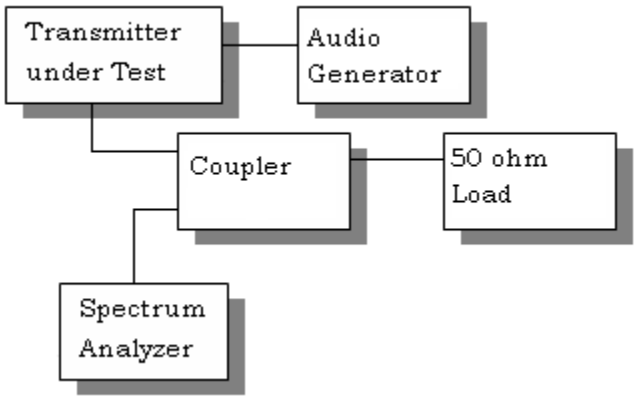
FCC Part 2.1049(c), RSS-GEN 4.6 EMISSION BANDWIDTH
FCC Part 80.213(b) RSS-182

Data in the plots show 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 35 dB. On any frequency removed from the assigned frequency by more than 250%, of the authorized bandwidth: At least 43 + 10log(P)dB.

Method of Measurement: ANSI/TIA-603-D: 2010

Test Setup Diagram:

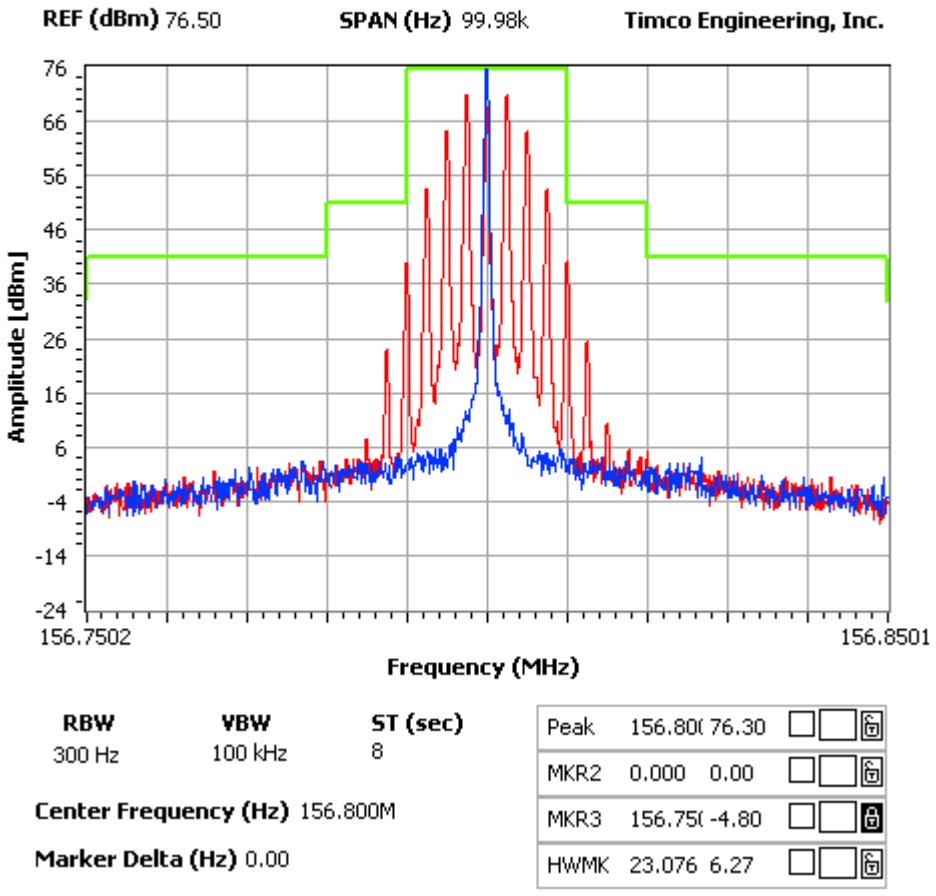
OCCUPIED BANDWIDTH MEASUREMENT



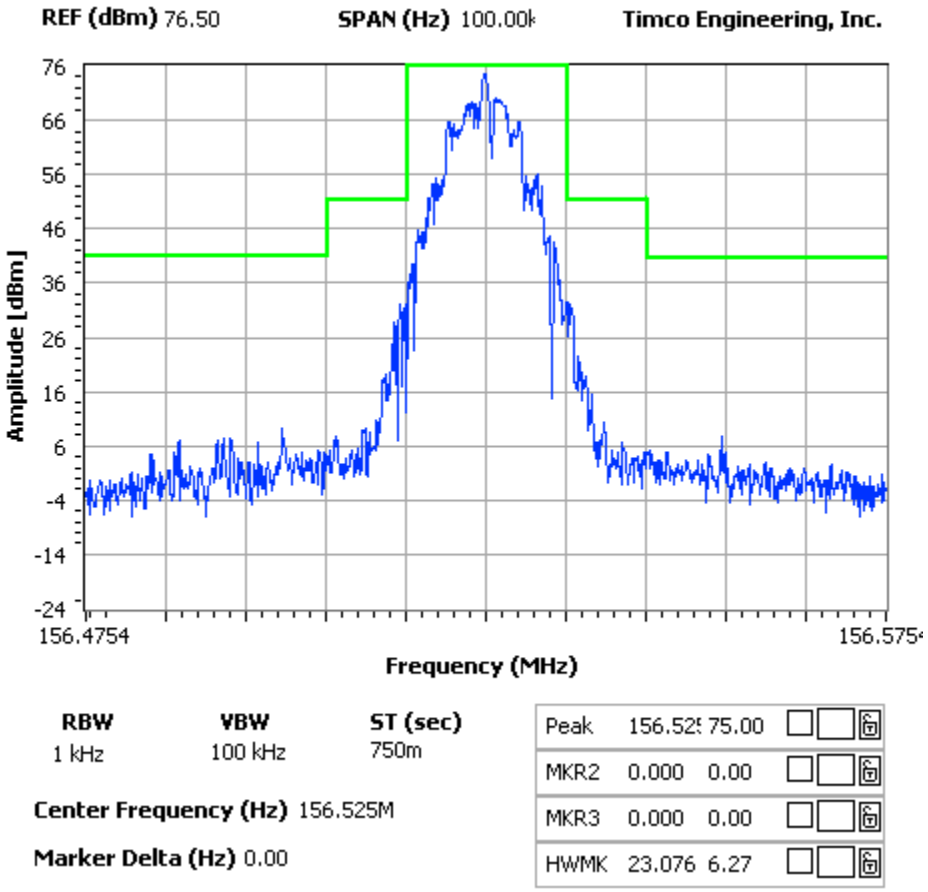
Test Data: See the plot below

Occupied bandwidth audio

NOTES:



Occupied BW DSC



SPURIOUS EMISSIONS AT ANTENNA TERMINALS (CONDUCTED)

Rule Part No.: FCC Part 2.1051(a), 80.211, RSS-182

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

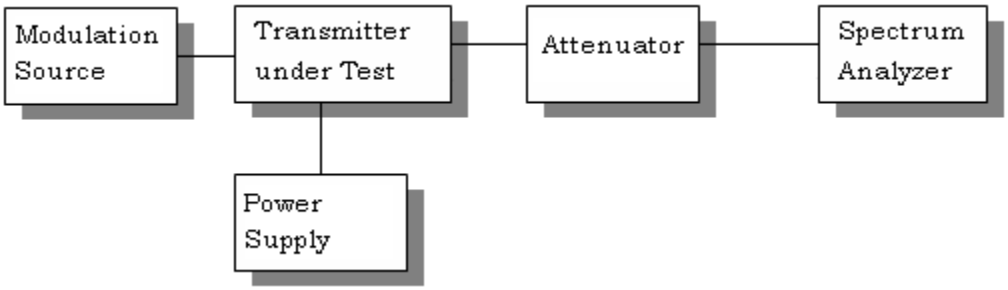
Method of Measurement: The carrier was modulated 100% using a 2500 Hz tone. The spectrum was scanned from 0.4 to at least the 10th harmonic of the fundamental. The measurements were made in accordance with standard ANSI/TIA 603-D: 2010.

Test Data:

TF HIGH POWER	EF	dB below carrier		TF LOW POWER	EF	dB below carrier
156	156	0		156	156	0
	312.1	97.6			312.1	97.2
	468.1	101.8			468.1	99.4
	624.2	81.8			624.2	84.7
	780.2	93.1			780.2	91.3
	936.3	100.6			936.3	104
	1092.3	114.4			1092.3	100.5
	1248.4	117.6			1248.4	103.8
	1404.4	116			1404.4	102.1
	1560.5	116.6			1560.5	102.8

TF HIGH POWER	EF	dB below carrier		TF LOW POWER	EF	dB below carrier
157.4	157.4	0		157.4	157.4	0
	314.8	99.3			314.8	97.2
	472.2	106.2			472.2	98.3
	629.7	83.3			629.7	86.7
	787.1	92.3			787.1	91
	944.5	103.1			944.5	103.9
	1101.9	116.1			1101.9	102.3
	1259.4	118.1			1259.4	104.4
	1416.8	117.2			1416.8	103.3
	1574.2	117			1574.2	103.1

Method of Measuring Conducted Spurious Emissions



METHOD OF MEASUREMENT: The procedure used was ANSI/TIA 603-D: 2010.

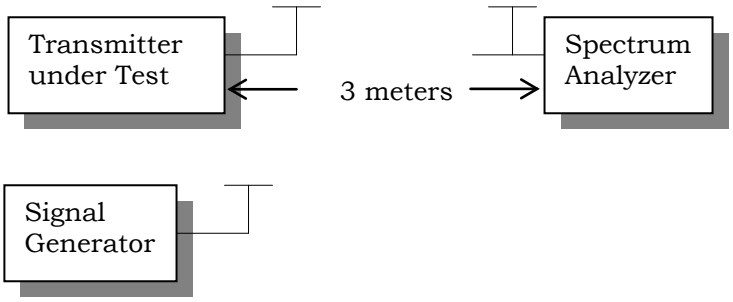
FIELD STRENGTH OF SPURIOUS EMISSIONS

Rule Parts. No.: FCC Part 2.1053, RSS-182

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

METHOD OF MEASUREMENT: The tabulated data shows the results of the radiated field strength emissions test. The spectrum was scanned from 30 MHz to at least the tenth harmonic of the fundamental. This test was conducted per ANSI/TIA 603-D: 2010 using the substitution method. Measurements were made at the test site of TIMCO ENGINEERING, INC. located at 849 NW State Road 45, Newberry, FL 32669.

Test Setup Diagram:



Test Data:

High Power

Emission Frequency MHz	Ant. Polarity	dB Below Carrier (dBc)
156.00	V	0
312.10	H	110.2
468.10	V	106.9
624.20	H	90.2
780.20	V	100.1
936.30	V	102.4
1092.30	V	99.7
1284.40	V	97.1
1404.40	H	98.3
1560.50	V	98.1

Low Power

Emission Frequency MHz	Ant. Polarity	dB Below Carrier (dBc)
156.00	V	0
312.10	H	95.5
468.10	V	97.0
624.20	H	89.6
780.20	H	91.7
936.30	H	88.5
1092.30	V	85.9
1284.40	V	83.9
1404.40	H	85.0
1560.50	V	84.6

High Power

Emission Frequency MHz	Ant. Polarity	dB Below Carrier (dBc)
157.40	V	0
314.80	V	112.0
472.20	H	110.4
629.70	H	88.2
787.10	V	100.6
944.50	V	102.8
1101.90	V	99.8
1259.40	V	97.2
1416.80	H	98.2
1574.20	V	98.0

Low Power

Emission Frequency MHz	Ant. Polarity	dB Below Carrier (dBc)
157.40	V	0
314.80	V	99.1
472.20	V	97.6
629.70	V	88.1
787.10	V	90.9
944.50	V	90.1
1101.90	V	85.9
1259.40	V	83.8
1416.80	H	84.9
1574.20	V	84.5

FREQUENCY STABILITY

Rule Parts. No.: FCC Part 2.1055, Part 80.209(a), RSS-182, RSS-GEN

Requirements: Temperature and voltage tests were performed to verify that the frequency remains within the .0010%, 10.0 ppm, specification limit, for 20 kHz 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 worst-case number was taken for temperature plotting. The assigned channel frequency was considered to be the reference frequency. The temperature was then reduced to -20˚C after which the transmitter was again allowed to stabilize for one hour. The transmitter was keyed ON for one minute and was again allowed to stabilize for one hour. The transmitter was keyed ON for one minute and again frequency readings were noted at 15 sec intervals. The worst-case number was recorded for temperature plotting. This procedure was repeated in 10-degree increments up to +50˚C.

Method of Measurements: ANSI/TIA 603-D: 2010

Test Data:

Assigned Frequency (Ref. Frequency) (MHz)		156.800000
Temperature (ºC)	**Frequency (MHz)**	**Frequency Stability (PPM)**
-30	156.799960	-0.26
-20	156.800010	0.01
-10	156.800044	0.28
0	156.800096	0.61
+10	156.800074	0.47
+20	156.800060	0.38
+30	156.800043	0.27
+40	156.800023	0.15
+50	156.800016	0.10

Assigned Frequency (Ref. Frequency) (MHz)		
% Battery (%)	**Frequency (MHz)**	**Frequency Stability (PPM)**
-15%	156.800050	0.32
0	156.800050	0.32
+15%	156.800045	0.29

EMC EQUIPMENT LIST

Device	Manufacturer	Model	Serial Number	Cal/Char Date	Due Date
3-Meter Semi-Anechoic Chamber	Panashield	N/A	N/A	12/31/13	12/31/15
Analyzer Tan Tower Preamplifier	HP	8449B-H02	3008A00372	01/15/14	01/15/16
Analyzer Tan Tower Quasi-Peak Adapter	HP	85650A	3303A01690	01/15/14	01/15/16
Analyzer Tan Tower RF Preselector	HP	85685A	3221A01400	01/15/14	01/15/16
Analyzer Tan Tower Spectrum Analyzer	HP	8566B Opt 462	3138A07786 3144A20661	01/15/14	01/15/16
Antenna: Biconnical	Eaton	94455-1	1096	05/10/13	05/10/15
Antenna: Double-Ridged Horn/ETS Horn 2	ETS-Lindgren	3117	00041534	10/05/12	10/05/14
Antenna: Log-Periodic	Electro-Metrics	LPA-25	1122	05/09/13	05/09/15
Audio Generator	B&K Precision	3010	8739686	09/11/12	09/11/14
Bi-Directional Coupler	HP	778D	1144A01731	05/06/13	05/06/15
Coaxial Cable - Chamber 3 cable set	Semiflex	Unknown	Chamber 3 cable set	01/26/12	01/26/14
Digital Multimeter	Fluke	77	35053830	08/22/13	08/22/15
EMI Test Receiver	Rhode & Schwarz	ESIB 40	100274	03/13/12	03/16/14
Hygro-Thermometer	Extech	445703	0602	06/20/13	06/20/15
Measuring Tape-20M	Kraftixx	0631-20		05/20/13	05/20/15
Measuring Tape-7.5M	Kraftixx	7.5M PROFI		05/20/13	05/20/15
Modulation Analyzer	HP	8901A	3050A05856	09/26/12	09/26/14
RF Power Meter	Boonton	4531		01/19/13	01/19/15
Sensor	Boonton	51072A	34647	01/19/13	01/19/15
Function Generator	SRS	DS345	38435	06/19/13	06/19/15
RMS Voltmeter	HP	3400A	05856	08/27/13	08/27/15