TIMCO ENGINEERING, Inc.

849 NW STATE ROAD 45
NEWBERRY, FL 32669 USA
PH: 888.472.2424 OR 352.472.5500
FAX: 352.472.2030
EMAIL: INFO@TIMCOENGR.COM
HTTP://WWW.TIMCOENGR.COM

TEST REPORT
PER FCC PT 15.247 AND IC RSS-210 (i8) FHSS

APPLICANT	NAVICO AUCKLAND LTD
ADDRESS	3-5 OMEGA STREET ALBANY 0632 AUCKLAND NEW ZEALAND
FCC ID	RAYVHFRS90
IC CERTIFICATION	4697A-VHFRS90
MODEL NUMBER	RS90
PRODUCT DESCRIPTION	2.4 GHZ MODULE
DATE SAMPLE RECEIVED	1/21/2014
DATE TESTED	1/24/2014
DATE REPORT ISSUED	2/6/2014
TESTED BY	Joe Scoglio
APPROVED BY	Joe Scoglio
TIMCO REPORT NO.	120IUT14TestReport.doc
TEST RESULTS	☒ PASS ☐ FAIL

THE ATTACHED REPORT SHALL NOT BE REPRODUCED EXCEPT IN FULL WITHOUT THE WRITTEN APPROVAL OF TIMCO ENGINEERING, INC.

A2LA ACCREDITED
Certificate # 0955-01

TABLE OF CONTENTS

ATTESTATION

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

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 by me or under my supervision, at Timco Engineering, Inc. located at 849 N.W. State Road 45, Newberry, Florida 32669 USA.

AUTHORIZED BY: Joe Scoglio

SIGNATURE: 

FUNCTION: Test Tech/ Project Manager

DATE: 2/6/2014

REPORT SUMMARY

Disclaimer:	The test results relate only to the items tested.
Purpose of Test:	To demonstrate that the DUT is compliant with FCC Pt 15.247 requirements for a FHSS radio.
Applicable Standards:	FCC Pt 15.247, ANSI C63.4: 2003, ANSI TIA-603: 2004, FCC Pt 15.109, DA00-705 rev March 30, 2000
Related Reports:	N/A

TEST ENVIRONMENT AND TEST SETUP

Test Facilities:	All measurements were made at one or more of the test sites of TIMCO ENGINEERING INC. located at 849 N.W. State Road 45, Newberry, FL 32669.
Laboratory Test Conditions:	Temperature: 26°C, Humidity: 55%
Test Exercise:	The DUT was set in continuous transmit mode of operation.
Deviation to the Standards:	There was no deviation from the standard.
Modification to the DUT:	Test cable and connector was added for conducted measurements.
Supporting Accessories:	None

DUT DESCRIPTION

DUT Description	2.4 GHz MODULE
FCC ID	RAYVHFRS90
IC	4697A-VHFRS90
Model Number	RS90
Maximum Output Power	.024W
Operating Frequency	2401-2480 MHz
DUT Power Source	☐ 110–120Vac/50– 60Hz
	☒ DC Power
	☐ Battery Operated Exclusively
Test Item	☐ Prototype
	☒ Pre-Production
	☐ Production
Type of Equipment	☐ Fixed
	☒ Mobile
	☐ Portable
Antenna	Internal
Antenna Connector	None

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	01/26/13	01/26/15
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
RF Power Meter	Boonton	4531		01/19/13	01/19/15
Sensor	Boonton	51072A	34647	01/19/13	01/19/15
RMS Voltmeter	HP	3400A	05856	08/27/13	08/27/15
Antenna Horn	Emco	3116	9011-2145	09/20/13	09/20/15

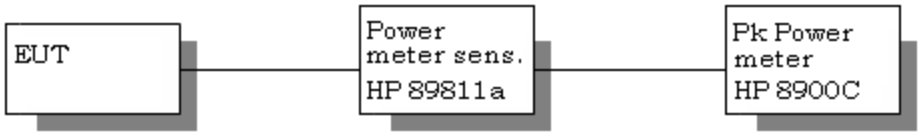
TEST PROCEDURES

POWER LINE CONDUCTED INTERFERENCE: The procedure used was ANSI C63.4-2003 using a 50uH LISN. Both lines were observed with the DUT transmitting. The resolution bandwidth of the spectrum analyzer was 10 kHz with an appropriate sweep speed.

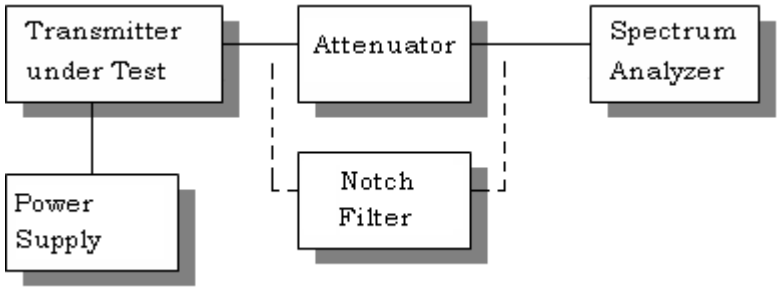
BANDWIDTH 20 dB: The measurements were made with the spectrum analyzer's resolution bandwidth (RBW) = 1 MHz and the video bandwidth (VBW) = 3 MHz and the span set as shown on plot.

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

Output Power Test Setup Diagram



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. Power was measured by disconnecting the antennas and measuring across a 50 ohm load as recommended by the manufacturer using a peak power meter. The antenna is non-directional and doesn't exceed 6 dBi gain. The power output was measured at three places in the band highest is reported below.



RADIATION INTERFERENCE: The test procedure used was ANSI C63.4-2003 using an Agilent spectrum receiver with preselector. 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 microvolt at the output of the antenna.

RADIATED SPURIOUS EMISSIONS INTO ADJACENT RESTRICTED BAND: An in band field strength measurement of the fundamental emission using the RBW and detector function required by ANSI C63.4-2003 and the FCC rules.

Tests unique to FHSS transmitters were tested using the procedures available in FCC DA 00-705 rev March 30, 2000.

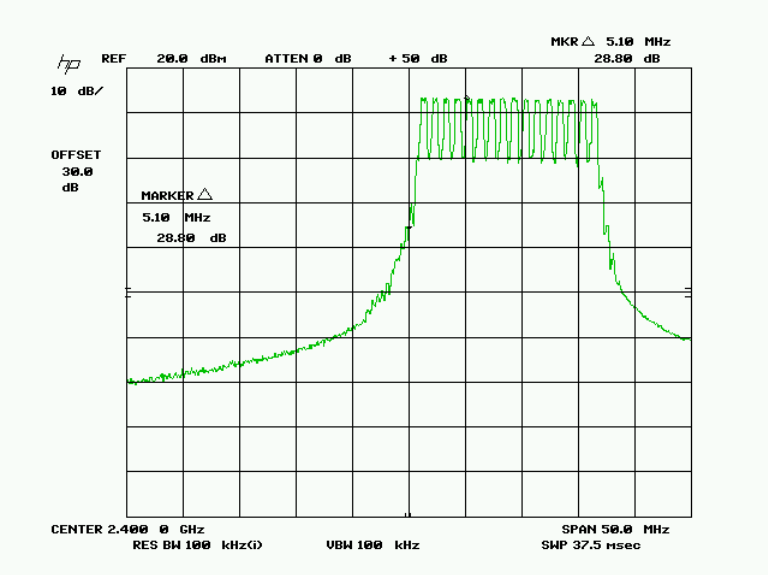
NUMBER OF HOPPING CHANNELS

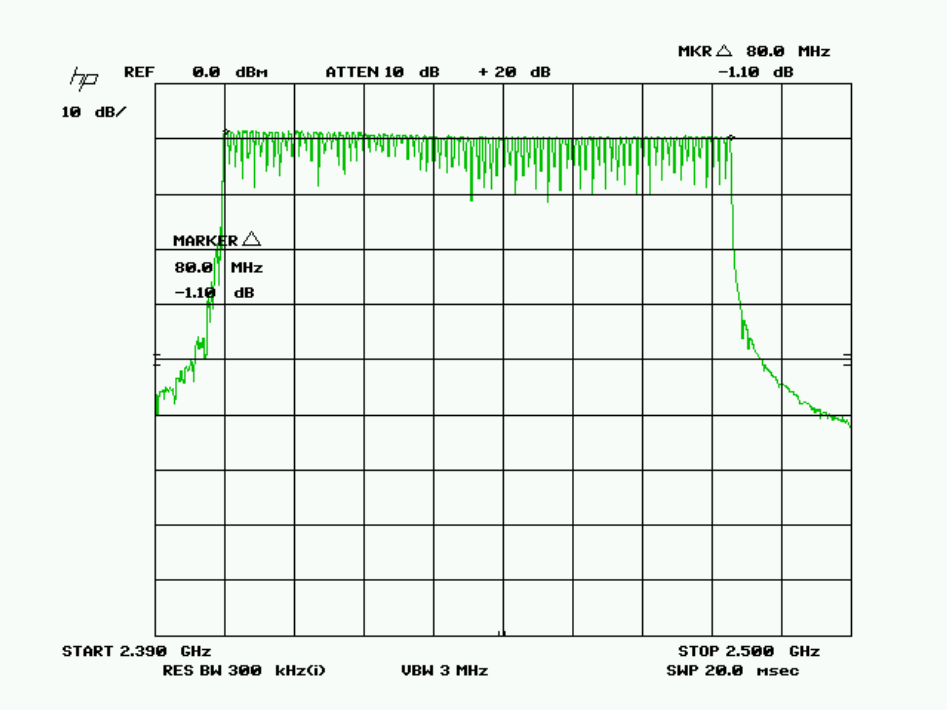
Rules Part No.: 15.247(a)(1), RSS-210

Requirements:

902-928 MHz	If the 20 dB bandwidth is < 250 kHz, the system shall use at least 50 hopping frequencies.
	If the 20 dB bandwidth is 250 kHz or greater, the system shall use at least 25 hopping frequencies.
2400-2483.5 MHz	**At least 15 channels**
5725-5850 MHz	At least 75 channels

Test Data: There are 80 hopping channels
16 Active Channels out of a pool of 80 channels
(See operational description)




REF 0.0 dBm
ATTEN 10 dB + 20 dB
MKR △ 80.0 MHz
-1.10 dB
10 dB/
MARKER △
80.0 MHz
-1.10 dB
START 2.390 GHz
RES BW 300 kHz(i)
VBW 3 MHz
STOP 2.500 GHz
SWP 20.0 msec

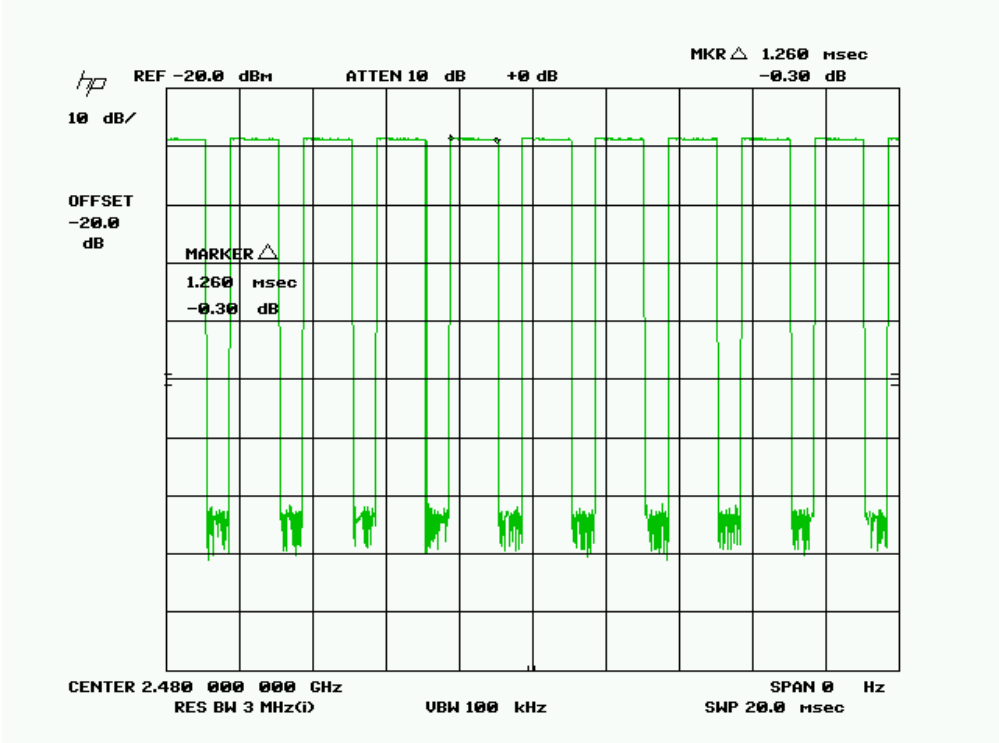
DWELL TIME OF A HOPPING CHANNEL

RULES PART NO.: 15.247(a)(1)(i), RSS-210

REQUIREMENTS:

902-928 MHz	If 20 dB bandwidth is < 250 kHz, average time of occupancy of any frequency shall not exceed 0.4 sec in 20 seconds.
	If 20 dB bandwidth is 250 kHz or greater, dwell time < = 0.4 seconds n a 10 second period.
2400-2483.5 MHz	< = 0.4 seconds in a 0.4 seconds multiplied the number of hopping channels employed.
5725-5850 MHz	< = 0.4 seconds in a 30 second period.

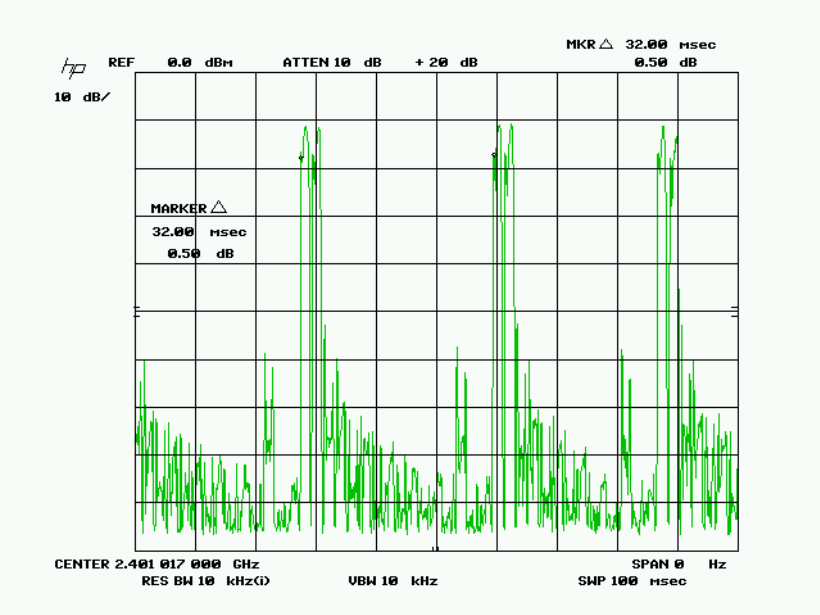
TEST DATA: The dwell time is 1.25 msec per hop.
Three places in the band were measured and the worst case presented.



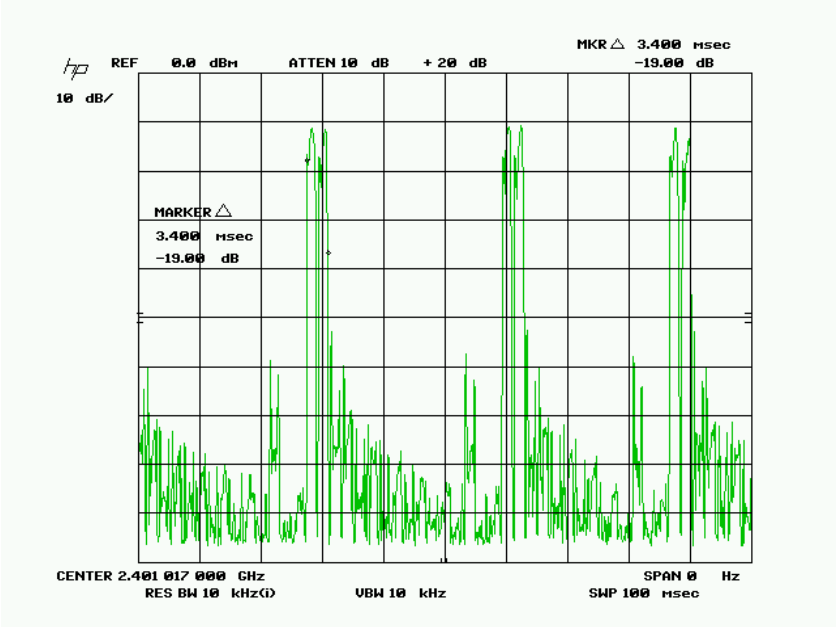
DUTY CYCLE

Total # of pulses: 10 in 100 ms
Duration of pulse: 8.5 or 8 ms maximum duration of pulse.
20*log ((1*8) + (9*8)=20*log (72.5) = 2.8 dB

Length of pulse train to pulse train



Length of pulse

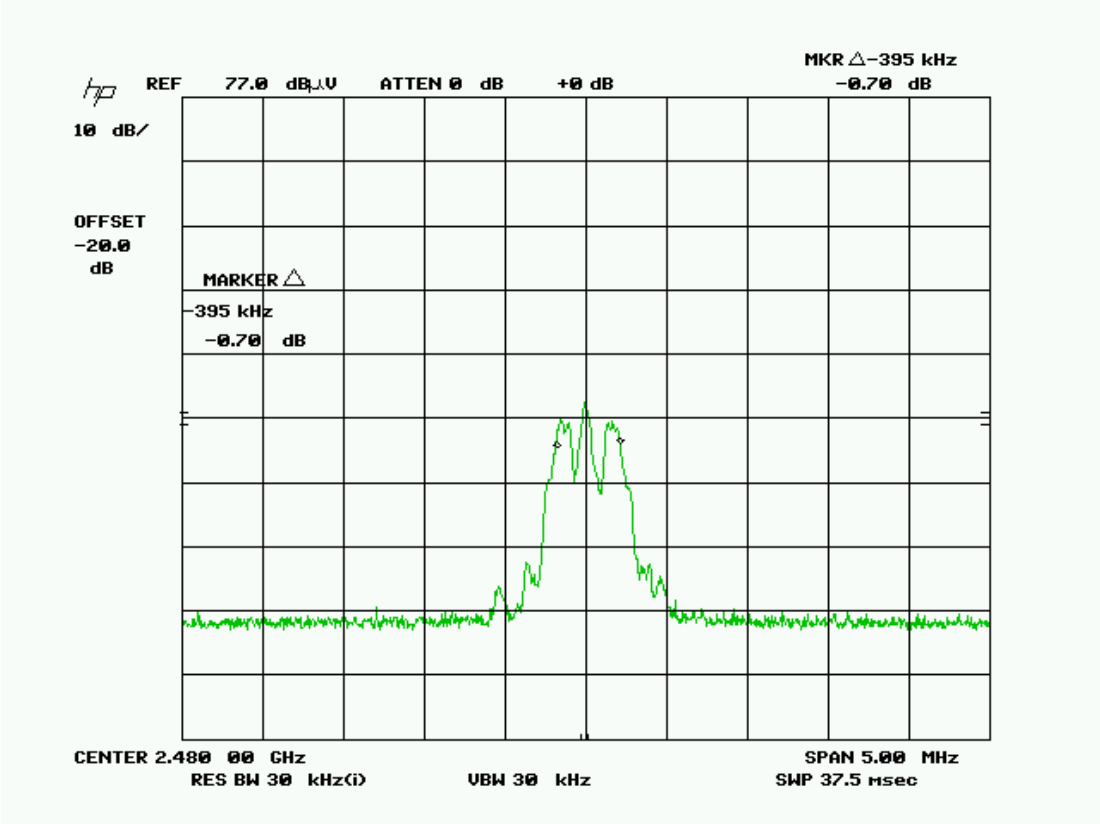


6 dB BANDWIDTH

RULES PART NO.: 15.247(a)(2), RSS-210

REQUIREMENTS:

TEST DATA: See the following plot(s). 395 kHz



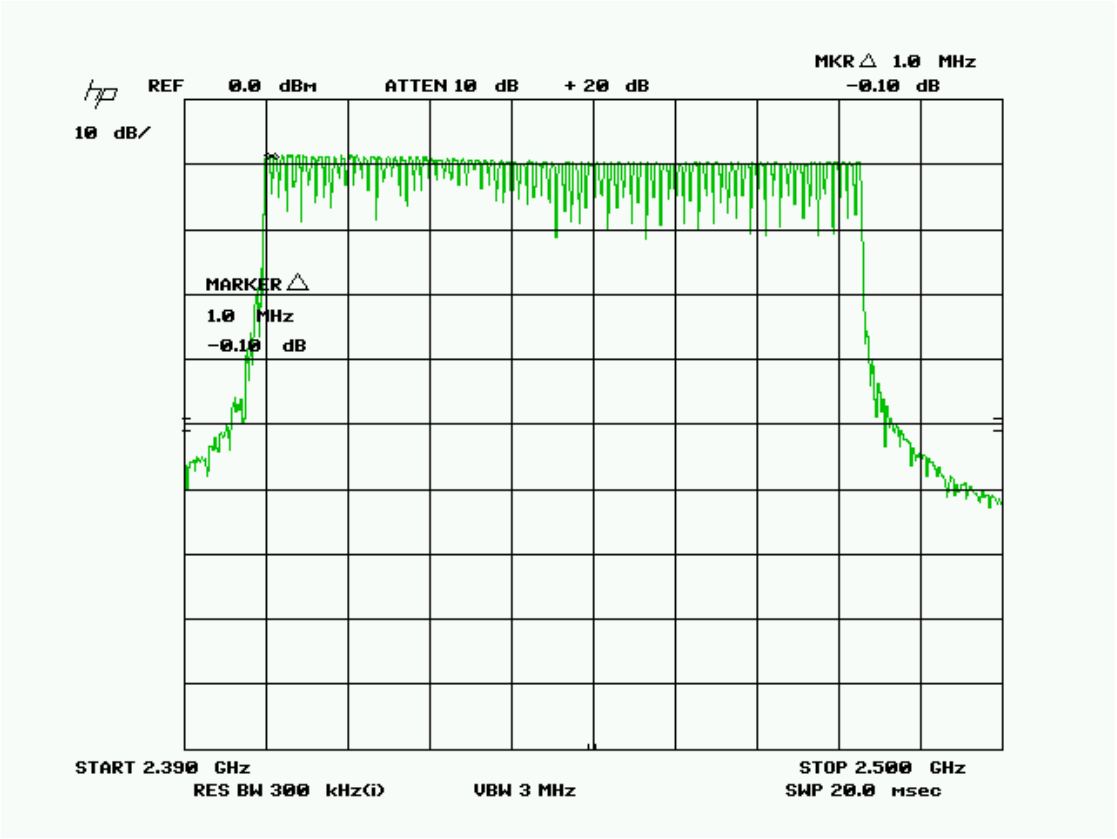
Three places in the band were measured and the worst case presented above.

CARRIER FREQUENCY SEPARATION

RULES PART NO.: 15.247(a)(2),RSS-210

REQUIREMENTS: The hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

TEST DATA: See the following plot. 1.0 MHz



POWER OUTPUT

Rules Part No.: 15.247(b) , RSS-210

Requirements: The maximum peak output power shall not exceed 1 watt (30 dBm). If directional transmitting antennas with a gain of more than 6 dBi are used, the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

Test Data: The device under test has an integral antenna of < 6dBi gain

Test cable and connector was added for this test

Frequency MHz	Po Watts
2401	.024
2440	.023
2480	.020

SPURIOUS EMISSIONS AT ANTENNA TERMINALS

RULES PART NO.: 15.247(c), RSS-210

REQUIREMENTS: Emissions must be at least 20 dB down from the highest emission level within the authorized band as measured with a 100 kHz RBW.

Note: The spectrum was scanned to the tenth harmonic.

TEST DATA

Freq	dB Down
2401	0
4802	85.2
7203	80.4
9604	73.2
12005	56.4
14406	81.6
16807	81.5
19208	50.1
21609	76.3

Freq	dB Down
2440	0
4880	89.2
7320	78.3
9760	72
12200	76
14640	80.6
17080	81.5
19520	76.7
21960	77.5

Freq	dB Down
2480	0
4960	78.6
7440	81.2
9920	83.4
12400	78
14880	80.9
17360	81.6
19840	75.8
22320	75.3

FIELD STRENGTH OF SPURIOUS EMISSIONS

RULES PART NO.: 15.247(c), 15.205 &15.209(b), RSS-210

REQUIREMENTS:

§15.247(c)& §15.205	
(Fundamental) Frequency	(Field Strength) Limits
902 – 928MHz 2.4 – 2.4835GHz	127.37 dBµV /m
§15.209	
30 - 88 MHz	40 dBµV/m @3M
88 -216 MHz	43.5 dBµV/m @3M
216 -960 MHz	46 dBµV/m @3M
ABOVE 960 MHz	54dBuV/m

Emissions that fall in the restricted bands (15.205) must be less than or equal to 500 uV/m (54 dBuV/m). Spurious not in a restricted band must be 20 dBc.

Measurements were made from the lowest frequency generated or 9 kHz to the 10th harmonic.

Emissions were measured from the lowest frequency generated or 9 kHz and were measured to the 10th harmonic.

Test Data:

Tuned Frequency MHz	Emission Frequency MHz	Meter Reading dBµV	Ant. Polarity	Coax Loss dB	Correction Factor dB/m	Duty Cycle Correction dB	Field Strength dBµV/m	Margin dB
2,401.00	2,401.00	71.4	V	3.18	32.4	2.8	104.18	23.18
2,401.00	2,401.00	77.7	H	3.18	32.4	2.8	110.48	16.88
2,401.00	4,802.00	14.2	H	4.9	34.38	2.8	50.68	3.32
2,401.00	4,802.00	14.4	V	4.9	34.38	2.8	50.88	3.12
2,401.00	7,203.00	11.9	H	5.72	36.16	2.8	50.98	3.02
2,401.00	7,203.00	12	V	5.72	36.16	2.8	51.08	2.92
2,401.00	9,604.00	12.8	V	6.78	36.72	2.8	53.5	0.5
2,401.00	9604PK	16.7	H	6.78	36.72	2.8	57.4	16.6
2,401.00	9,604.AV	6.8	H	6.78	36.72		50.30	3.70
2,440.00	2,440.00	70	V	3.21	32.48	2.8	102.89	24.47
2,440.00	2,440.00	77.4	H	3.21	32.48	2.8	110.29	17.07
2,440.00	4,880.00	17	H	4.94	34.43	2.8	53.57	0.43
2,440.00	4880PK	18.8	V	4.94	34.43	2.8	55.37	18.63
2,440.00	4,880.AV	6.4	V	4.94	34.43		45.77	8.23
2,440.00	7,320.00	13.6	V	5.79	36.14	2.8	52.73	1.27
2,440.00	7,320.00	13.9	H	5.79	36.14	2.8	53.03	0.97
2,440.00	9,760.00	11.3	V	6.83	36.91	2.8	52.24	1.76
2,440.00	9760PK	16.1	H	6.83	36.91	2.8	57.04	16.96
2,440.00	9,760.AV	6.7	H	6.83	36.91		50.44	3.56
2,480.00	2,480.00	68.9	V	3.24	32.56	2.8	101.9	25.46
2,480.00	2,480.00	74.6	H	3.24	32.56	2.8	107.6	19.76
2,480.00	4960PK	18.1	H	4.98	34.48	2.8	54.76	19.24
2,480.00	4,960.AV	11.5	H	4.98	34.48		50.96	3.04
2,480.00	4960PK	18.8	V	4.98	34.48	2.8	55.46	18.54
2,480.00	4,960.AV	8.4	V	4.98	34.48		47.86	6.14

All readings are peak unless marked otherwise.
PK= Peak, AV= Average, R= Restricted band frequency

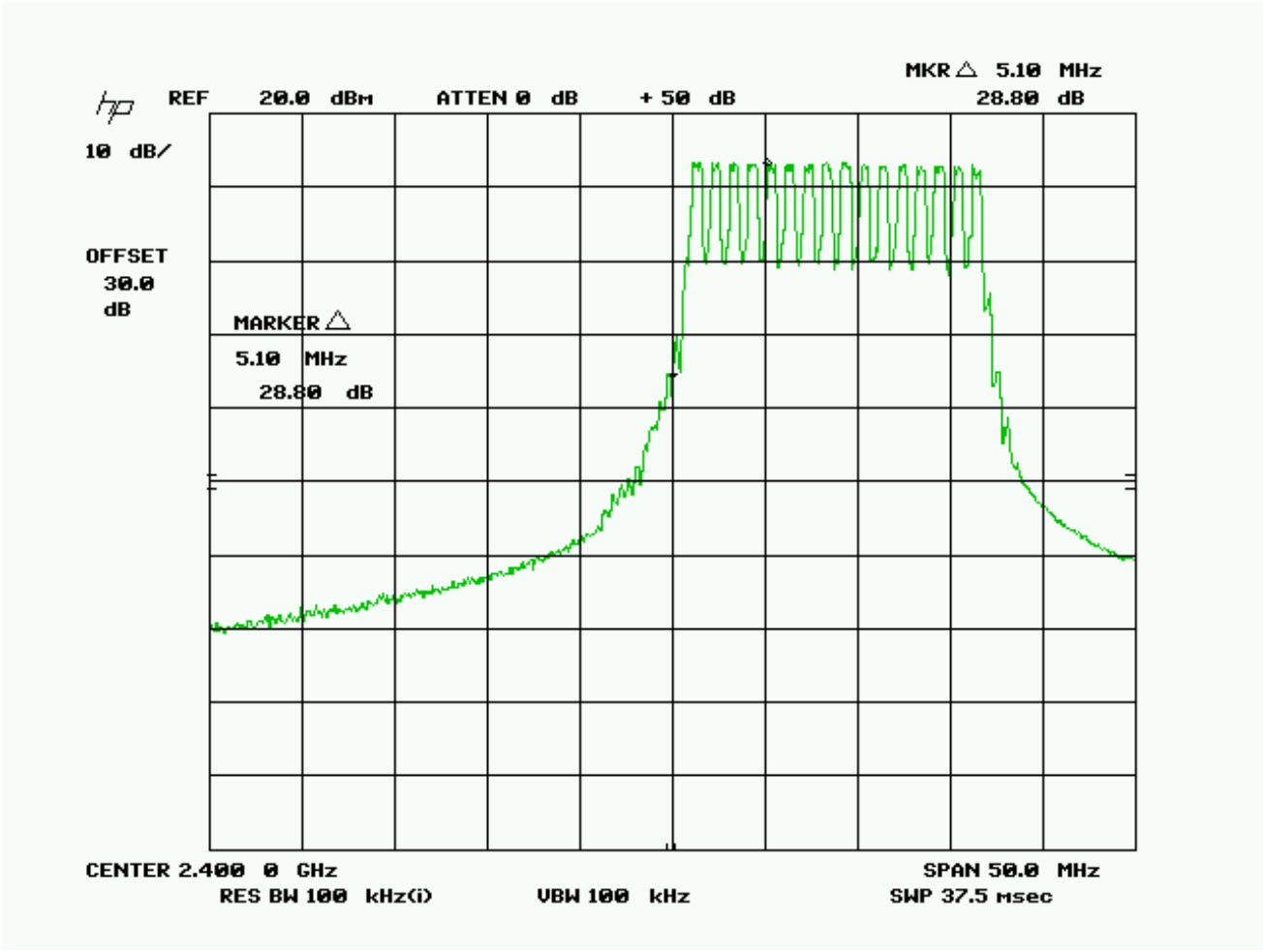
Tuned Frequency MHz	Emission Frequency MHz	Meter Reading dBµV	Ant. Polarity	Coax Loss dB	Correction Factor dB/m	Duty Cycle C/F dB	Field Strength dBµV/m	Margin dB
2,480.00	7,440.00	12	H	5.86	36.11	2.8	51.17	2.83
2,480.00	7,440.00	14.6	V	5.86	36.11	2.8	53.77	0.23
2,480.00	9,920.00	10	V	6.88	37.1	2.8	51.18	2.82
2,480.00	9,920.00	12.5	H	6.88	37.1	2.8	53.68	0.32

RADIATED SPURIOUS EMISSIONS INTO ADJACENT RESTRICTED BAND

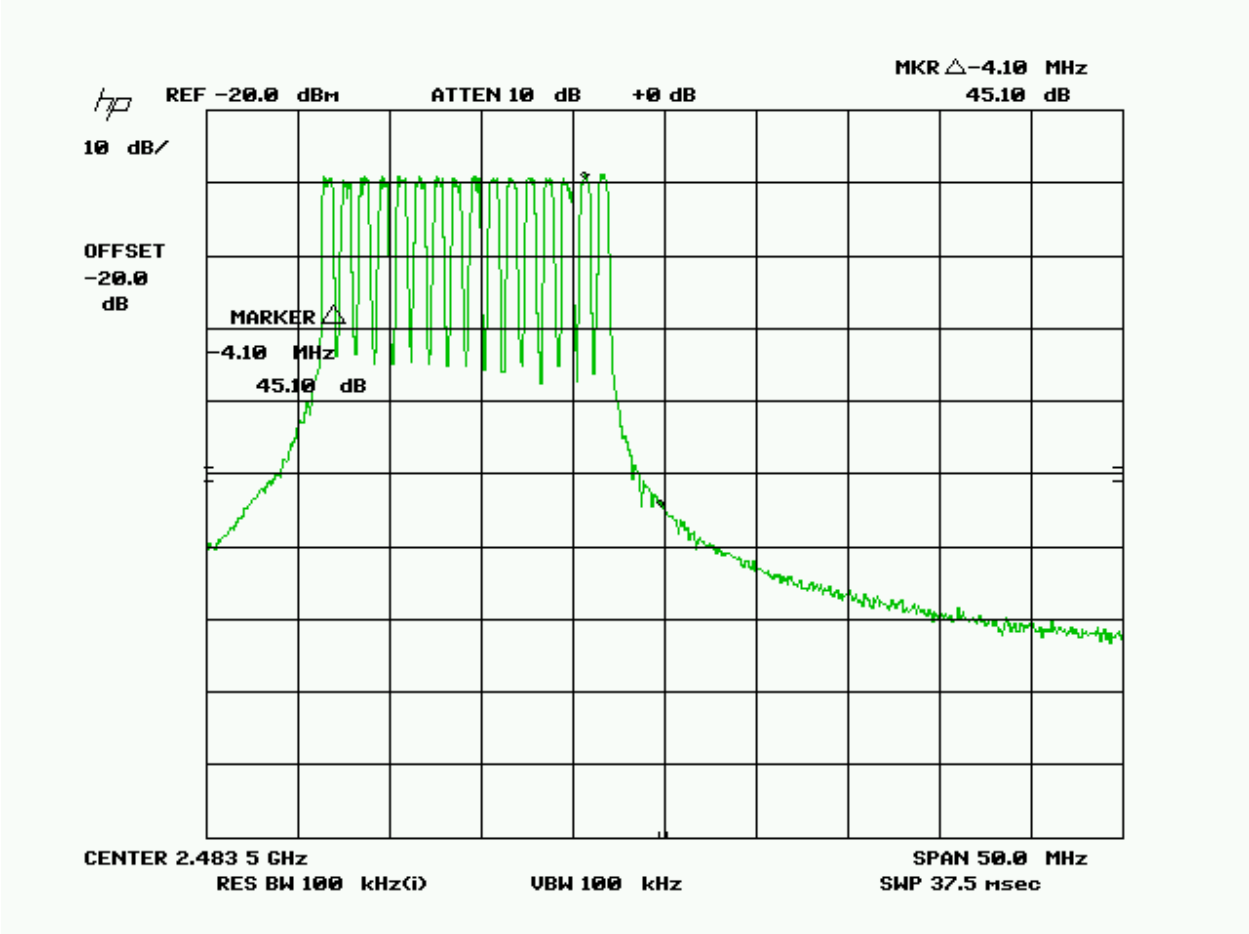
REQUIREMENTS: For emissions that fall in the restricted bands (15.205). These emissions must be less than or equal to 500 uV/m (54dBuV/m). Emissions not in the restricted band must be 20 dBc.

TEST DATA: The plots are presented below.

Lower bandedge Peak



Upper bandedge Peak



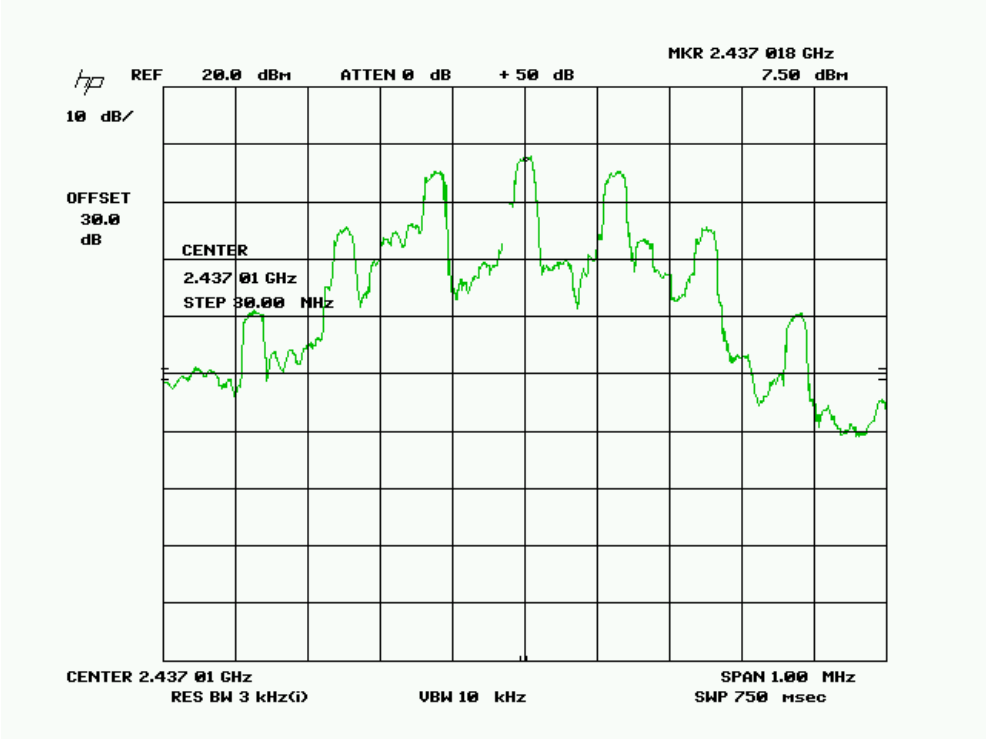
Freq.	Field Strength	2483.5	Field Strength
2480	97.8 dBµV	45.1 dB	52.7 dBµV

POWER SPECTRAL DENSITY

Rules Part No.: 15.247(d), RSS-210

Requirements: The peak level measured must be less than +8.0 dBm in a 3 kHz RBW.

Test Data: SEE THE FOLLOWING PLOT



+7.5 dBm is less than +8 dBm

Three places in the band were tested and the worst case presented.