FCC Part 15.247
Transmitter Certification

Hybrid Spread Spectrum Transmitter

Test Report

FCC ID: R32-RFRCU

FCC Rule Part: 15.247

ACS Report Number: 04-0170-15C247

Manufacturer: Onity, Inc.
Equipment Type: Modular Radio
Model: RFRCU

Test Begin Date: May 21, 2004
Test End Date: May 25, 2004

Report Issue Date: August 6, 2004

FOR THE SCOPE OF ACCREDITATION UNDER LAB Code 200612

Reviewed by:
Hernando Orozco
EMI/EMC Approvals Engineer
ACS, Inc.

Prepared by:
R. Sam Wismer
Engineering Manager
ACS, Inc.

This report contains 13 pages

Table of Contents

Additional Exhibits Included In Filing

Conducted Spurious Plots
Radiated Spurious Plots
Bill of Materials
Test Setup Photographs
Product Labeling Info
RF Exposure – MPE Calculations
Schematics
Internal Photographs
System Block Diagram
Theory of Operation
Manual

1.0 GENERAL

1.1 Introduction
The purpose of this report is to demonstrate compliance of a Limited Modular Approval to 15.247 of the FCC's Code of Federal Regulations.

1.2 Product Description
The Room Control Unit (RCU) is the 'brain' of the Onity's wireless energy management system. It receives the temperature, humidity, guest settings, fan mode, motion status, and door status from the various system devices and determines how to operate the HVAC system and lighting control.

The RCU has six relay drivers for outputs, a local door switch input, three setup buttons, three LED indicators, a local temperature sensor input, and a Real Time Clock (RTC) interface. The RCU receives transmissions from all the wireless devices via its on board radio.

Detailed photographs of the EUT are filed separately with this filing.

1.2.1 Intended Use
The RFRCU modular radio receives transmissions from all the wireless devices via its on board radio.

2.0 LOCATION OF TEST FACILTY
All testing was performed by qualified ACS personnel located at the following address:

ACS, Inc.
5015 B.U. Bowman Drive
Buford, GA 30518

2.1 DESCRIPTION OF TEST FACILITY
Both the Open Area Test Site(OATS) and Conducted Emissions site have been fully described, submitted to, and accepted by the FCC, Industry Canada and the Japanese Voluntary Control Council for Interference by information technology equipment.

In addition, ACS is compliant to ISO 17025 as certified by the National Institute of Standards and Technology under their National Voluntary Laboratory Accreditation Program. The following certification numbers have been issued in recognition of these accreditations and certifications:

FCC Registration Number: 89450
Industry Canada Lab Code: IC 4175
VCCI Member Number: 1831
- VCCI OATS Registration Number R-1526
- VCCI Conducted Emissions Site Registration Number: C-1608

NVLAP Lab Code: 200612

2.1.1 Open Area Test Site

The open area test site consists of a 40' x 66' concrete pad covered with a perforated electro-plated galvanized sheet metal. The perforations in the sheet metal are 1/8" holes that are staggered every 3/16". The individual sheets are placed to overlap each other by 1/4" and are riveted together to provide a continuous seam. Rivets are spaced every 3" in a 3 x 20 meter perimeter around the antenna mast and EUT area. Rivets in the remaining area are spaced as necessary to properly secure the ground plane and maintain the electrical continuity.

The entire ground plane extends 12' beyond the turntable edge and 16' beyond the antenna mast when set to a 10 meter measurement distance. The ground plane is grounded via 4 - 8' copper ground rods, each installed at a corner of the ground plane and bound to the ground plane using 3/4" stainless steel braided cable.

The turntable is an all aluminum 10' flush mounted table installed in an all aluminum frame. The table is remotely operated from inside the control room located 40' from the range. The turntable is electrically bonded to the surrounding ground plane via steel fingers installed on the edge of the turn table. The steel fingers make constant contact with the ground plane during operation.

Adjacent to the turntable is a 7' x 7' square and 4' deep concrete pit used for support equipment if necessary. The pit is equipped with 5 - 4" PVC chases from the pit to the control room that allow for cabling to the EUT if necessary. The underside of the turntable can be accessed from the pit so cables can be supplied to the EUT from the pit. The pit is covered with 2 sheets of 1/4" diamond style re-enforced steel sheets. The sheets are painted to match the perforated steel ground plane, however the underside edges have been masked off to maintain the electrical continuity of the ground plane. All reflecting objects are located outside of the ellipse defined in ANSI C63.4.

A diagram of the Open Area Test Site is shown in Figure 2.1-1 below:

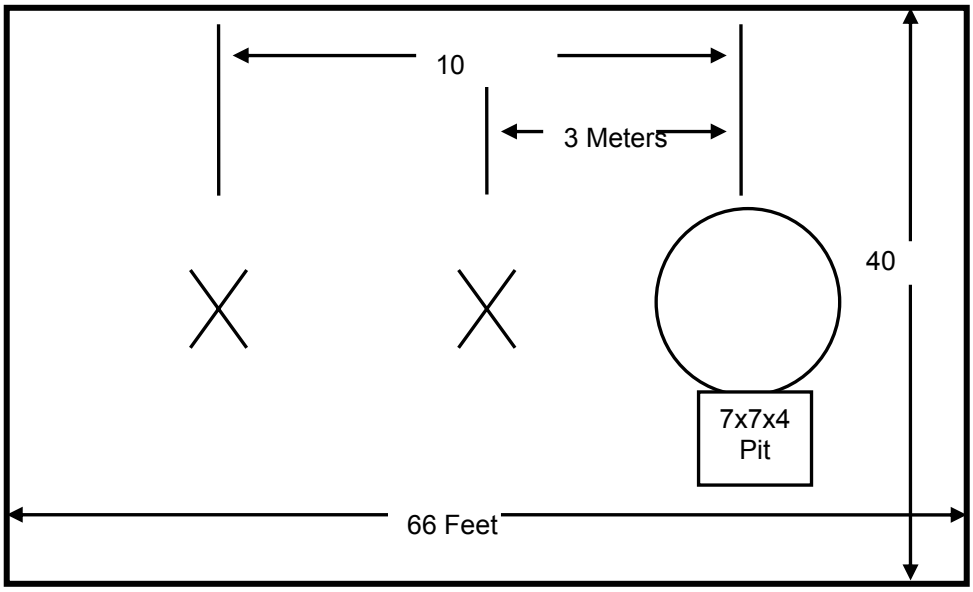


Figure 2.1-1: Open Area Test Site

2.1.2 Conducted Emissions Test Site Description

The AC mains conducted EMI site is a shielded room with the following dimensions:

- Height: 3.0 Meters
- Width: 3.6 Meters
- Length: 4.9 Meters

The room is manufactured by Rayproof Corporation and installed by Panashield, Inc. Earth ground is provided to the room via an 8' copper ground rod. Each panel of the room is connected electrically at intervals of 4".

Power to the room is filtered to prevent ambient noise from coupling to the EUT and measurement equipment. Filters are models 1B42-60P manufactured by Rayproof Corporation.

The room is of sufficient size to test table top and floor standing equipment in accordance with section 6.1.4 of ANSI C63.4.

A diagram of the room is shown below in figure 2.1.2-1:

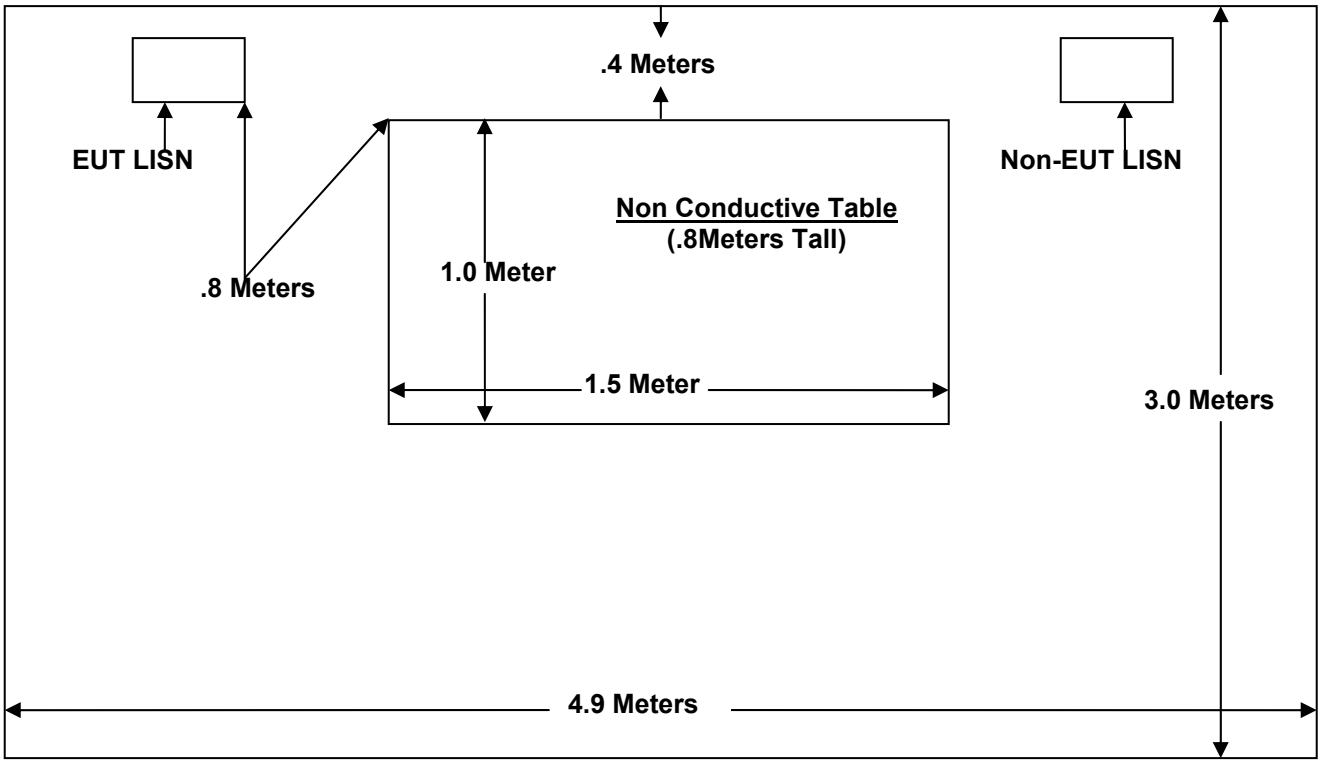


Figure 2.1.2-1: AC Mains Conducted EMI Site

3.0 APPLICABLE STANDARD REFERENCES

The following standards were used:

- ANSI C63.4-1992: Method of Measurements of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the 9KHz to 40GHz
- US Code of Federal Regulations (CFR): Title 47, Part 2, Subpart J: Equipment Authorization Procedures (October 2002)
- US Code of Federal Regulations (CFR): Title 47, Part 15, Subpart C: Radio Frequency Devices, Intentional Radiators (October 2002)
- FCC OET Bulletin 65 Appendix C - Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields

4.0 LIST OF TEST EQUIPMENT

All test equipment used for regulatory testing is calibrated yearly or according to manufacturer's specifications.

Table 4.0-1: Test Equipment

Equipment Calibration Information					
ACS #	**Mfg.**	**Eq. type**	**Model**	**S/N**	**Cal. Due**
---	Agilent	Spectrum Analyzer	E7402A	US40240259	02/26/05
26	Chase	Bi-Log Antenna	CBL6111	1044	10/14/04
152	EMCO	LISN	3825/2	9111-1905	01/08/05
153	EMCO	LISN	3825/2	9411-2268	12/11/04
193	ACS	OATS Cable Set	RG8	193	01/09/05
167	ACS	Conducted EMI Cable Set	RG8	167	01/09/05
5	Harbour Industries	Cable	LL-335	None	08/20/04
6	Harbour Industries	Cable	LL-335	None	08/06/04
22	Agilent	Pre-Amplifier	8449B	3008A00526	09/18/04
73	Agilent	Pre-Amplifier	8447D	272A05624	04/30/05
30	Spectrum Technologies	Horn Antenna	DRH-0118	970102	05/08/05
105	Microwave Circuits	High Pass Filter	H1G810G1	2123-01 DC0225	06/09/05
209	Microwave Circuits	High Pass Filters	H3G020G2	4382-01 DC0421	06/09/05
40	EMCO	Biconical Antenna	3104	3211	09/19/04
1	Rohde & Schwarz	Receiver	804.8932.52	833771/007	02/26/05
2	Rohde & Schwarz	Receiver	1032.5640.53	839587/003	02/26/05
213	Test Equipment Corp.	Pre-Amplifier	PA-102	44927	06/28/05
211	Eagle	Band Reject Filter	C7RFM3NFNM	n/a	06/28/05
168	Hewlett Packard	Pulse Limiter	11947A	3107A02268	04/30/05
93	Chase	EM Clamp	CIC 8101	65	01/12/05
184	ACS	Cable	RG8	184	01/09/05
169	Solar Electronics	LISN	9117-5-TS-50-N	031032	04/12/05

5.0 SYSTEM BLOCK DIAGRAM

Table 5.0: System Block Diagram

Diagram Number	Manufacturer	Equipment Type	Model Number	Serial Number	FCC ID
1	EUT	Room Control Unit	RFRCU	None	R32-RFRCU
2	Onity	Host Device	Thermostat, Door Switch, & Motion Sensor	N/A	N/A

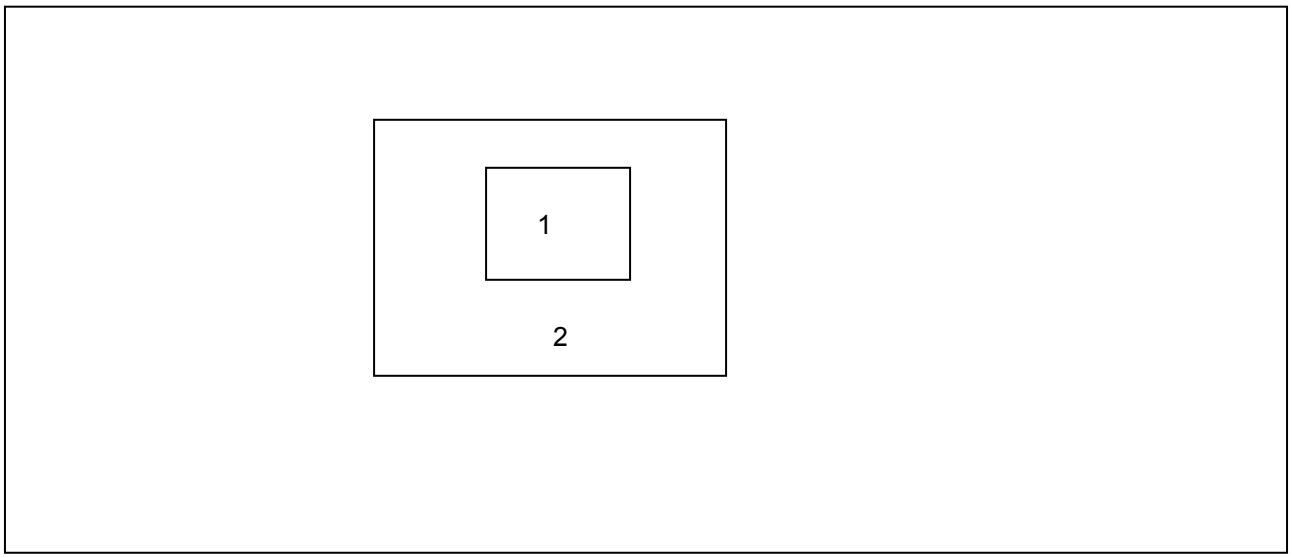


Figure 5.0-1: EUT Test Setup

6.0 SUMMARY OF TESTS

6.1 Antenna Requirement – FCC Section 15.203

The EUT employs an integrated antenna that cannot be modified without damaging the device.

6.2 Power Line Conducted Emissions - FCC Section 15.207

6.2.1 Test Methodology

ANSI C63.4 sections 6 and 7 were the guiding documents for this evaluation. Conducted emissions were performed from 150kHz to 30MHz with the spectrum analyzer's resolution bandwidth set to 9kHz and the video bandwidth set to 30kHz.

6.2.2 Test Results

The EUT will be provided DC power by the host device in which it is installed. With no connection to the AC mains this requirement is not applicable to the EUT.

6.3 Radiated Emissions - FCC Section 15.109(Unintentional Radiation)

6.3.1 Test Methodology

ANSI C63.4 Sections 6 and 8 were the guiding documents for this evaluation. Radiated emissions tests were performed over the frequency range of 30MHz to 5000MHz. Measurements of the radiated field strength were made at a distance of 3m from the boundary of the equipment under test (EUT) and the receiving antenna. The antenna height was varied from 1m to 4m so that the maximum radiated emissions level would be detected. Radiated measurements were made with the Spectrum Analyzer's resolution bandwidth set to 120KHz for measurements above 30MHz.

The EUT was caused to go into a "Standby" mode of operation for this test.

6.3.2 Test Results

Results of the test are given in Tables 6.3.2-1through 6.3.2-3 below:

Table 6.3.2-1: Radiated Emissions Tabulated Data (Unintentional Radiators)

Frequency (MHz)	Uncorrected Reading (dBµV)	Antenna Polarity (H/V)	Antenna Height (cm100)	Turntable Position (°)	Total Correction Factor (dB)	Corrected Reading (dBµV)	Limit (dBµV)	Margin (dB)	Results
31.07	12.57	V	200	0	19.45	32.02	40.0	8.0	**Pass**
117.94	22.55	H	200	158	12.84	35.39	43.5	8.1	**Pass**
176.92	21.0	V	144	268	11.55	32.55	43.5	10.9	**Pass**
191.66	23.03	H	125	362	11.05	34.08	43.5	9.4	**Pass**
221.16	21.43	H	100	133	11.56	32.99	46.0	13.0	**Pass**
294.9	36.9	H	150	218	-8.32	28.58	46.0	17.4	**Pass**
353.86	39.77	V	200	101	-6.04	33.73	46.0	12.3	**Pass**
904.99	37.53	H	200	90	5.17	42.70	46.0	3.3	**Pass**

6.4 Peak Output Power – FCC Section 15.247(b)(3)

6.4.1 Test Methodology (Conducted Method)

The 6dB bandwidth of the EUT was within the resolution bandwidth of the Agilent E7402A spectrum analyzer, therefore the power measurement was made using the spectrum analyzer method. The resolution and video bandwidth were set to 3MHz. A 10dB pad was used for this measurement therefore a correction factor of 10dB was adjusted up in the table to reflect the use of the pad. The EUT was caused to transmit a continuous signal at the low, center and high channels.

6.4.2 Test Results

Results are shown below in table 6.4.2-1 and in figure 6.4.2-1 below:

Table 6.4.2-1: RF Output Power

Frequency [MHz]	Level [dBm]	Limit [dBm]	Margin [dB]
904.79	3.6	30	25.4
918.87	4.3	30	25.7
924.84	3.5	30	26.5

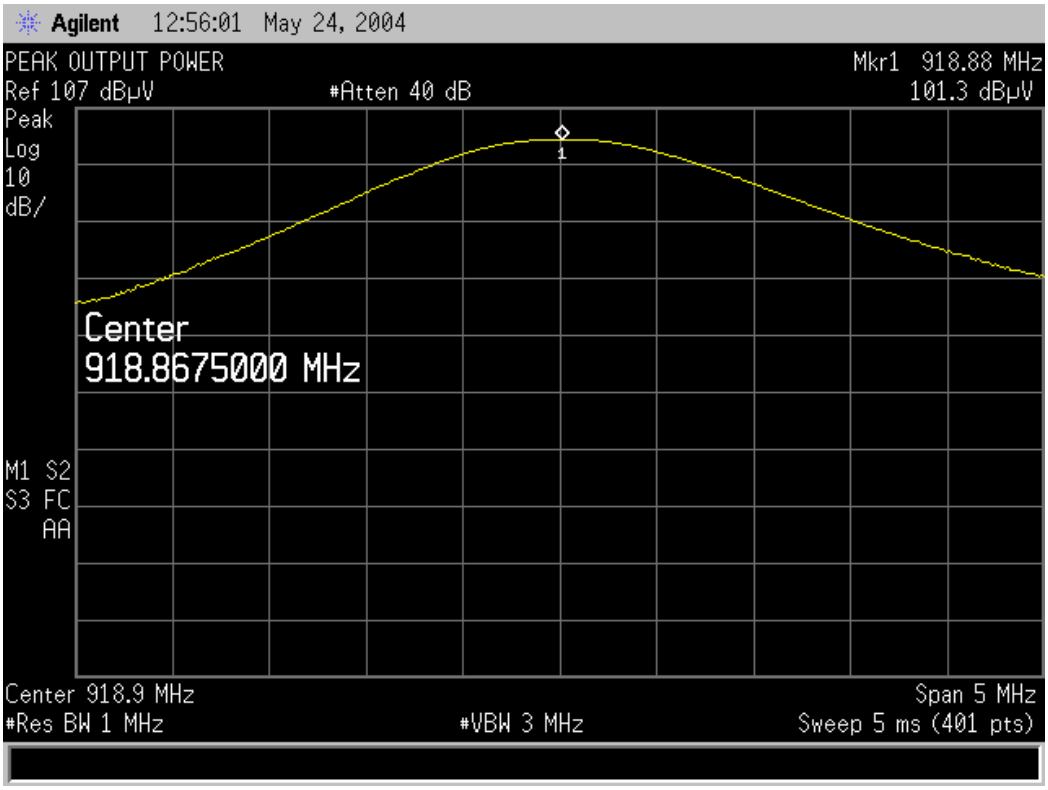


Figure 6.4.2-1: Peak Output Power

Result: PASS

6.5 6dB Bandwidth – FCC Section 15.247(a)(2)

6.5.1 Test Methodology

The 6dB bandwidth was measured in accordance with FCC 97-114 Appendix C. The EUT was caused to generate a continuous at the low, center and high channels.

6.5.2 Test Results

The unit uses hybrid technology therefore there is no requirement for this system to comply with the 500kHz minimum bandwidth associated with a DTS system in accordance with Section 15.247(f).

6.6 Spurious Emissions – FCC Section 15.247(c)

6.6.1 Conducted Spurious Emissions

6.6.1.1 Test Methodology

The EUT was investigated for conducted spurious emissions from 30MHz to 10GHz, 10 times the highest fundamental frequency. Measurements were made at the low, center and high channels of the EUT. For each measurement, the spectrum analyzer's VBW was set to 100kHz and the RBW was set to 1MHz. No averaging factor was applied.

6.6.1.2 Test Results

All emission found were greater than 20dB down from the fundamental carrier. The RF conducted spurious emissions found in the band of 30MHz to 10GHz are reported graphically separately with this filing in a file titled "04-0170 Conducted Spurious Plots.pdf".

6.6.2 Radiated Spurious Emissions

6.6.2.1 Test Methodology

Radiated emissions tests were made over the frequency range of 30MHz to 10GHz, 10 times the highest fundamental frequency.

The EUT was rotated through 360° and the receive antenna height was varied from 1m to 4m so that the maximum radiated emissions level would be detected. For frequencies below 1000MHz, quasi-peak measurements were made using a resolution bandwidth (RBW) of 120kHz and a video bandwidth(VBW) of 300kHz. For frequencies above 1000MHz, average measurements were made using an RBW of 1MHz and a VBW of 10Hz and peak measurements were made with RBW of 1MHz and a VBW of 1MHz.

The EUT was caused to generate a constant carrier signal for the test.

An averaging factor was applied to the measurements to account for the duty cycle of the EUT. The factor was determined based on the 16.5% duty cycle of the EUT. The factor was calculated using the formula 20 log(.165) = 15.6dB. This corrected result was then compared to the average limits.

6.6.2.2 Test Results

Radiated spurious emissions found in the band of 30MHz to 10GHz are reported in Table 6.6.2.2-1 through 6.6.2.2-3. Plots of these emissions are also presented separately in a file titled "04-0170 Radiated Spurious Plots". Each emission found to be in a restricted band as defined by section 15.205, was compared to the radiated emission limits for as defined in section 15.209.

Table 6.6.2.2-1: Radiated Spurious Emissions (Low)

Frequency (MHz)	Level (dBuV)	Detector (P/A)	Antenna Polarity (H/V)	Correction Factors (dB)	Corrected Level (dBuV)	Limit (dBuV)	Margin (dB)	Final Result (Pass/Fail)
2714	56.19	P	H	-1.58	54.61	74.00	19.39	**PASS**
2714	54.79	A	H	-17.18	37.61	54.00	16.39	**PASS**
3619	45.54	P	V	4.83	50.37	74.00	23.63	**PASS**
3619	45.54	A	V	-10.77	34.77	54.00	19.23	**PASS**
4524	49.36	P	H	6.46	55.82	74.00	18.18	**PASS**
4524	45.67	A	H	-9.14	36.53	54.00	17.47	**PASS**
5429	41.56	P	H	9.18	50.74	74.00	23.26	**PASS**
5429	41.56	A	H	-6.42	35.14	54.00	18.86	**PASS**

Table 6.6.2.2-2: Radiated Spurious Emissions (Mid)

Frequency (MHz)	Level (dBuV)	Detector (P/A)	Antenna Polarity (H/V)	Correction Factors (dB)	Corrected Level (dBuV)	Limit (dBuV)	Margin (dB)	Final Result (Pass/Fail)
2756	61.93	P	H	-1.51	60.42	74.00	13.58	**PASS**
2756	31.634	A	H	-17.11	44.23	54.00	9.77	**PASS**
36.75	46.26	P	V	5.03	51.29	74.00	22.71	**PASS**
3675	46.26	A	V	-10.57	35.69	54.00	18.31	**PASS**
4594	55.73	P	H	6.77	62.50	74.00	11.50	**PASS**
4594	54.44	A	H	-8.83	45.61	54.00	8.39	**PASS**
7353	40.9	P	V	12.48	53.38	74.00	20.62	**PASS**
7353	40.9	A	V	-3.12	37.78	54.00	16.22	**PASS**

Table 6.6.2.2-3: Radiated Spurious Emissions (High)

Frequency (MHz)	Level (dBuV)	Detector (P/A)	Antenna Polarity (H/V)	Correction Factors (dB)	Corrected Level (dBuV)	Limit (dBuV)	Margin (dB)	Final Result (Pass/Fail)
2774	60.83	P	H	-1.48	59.35	74.00	14.65	**PASS**
2774	60.22	A	H	-17.08	43.14	54.00	10.86	**PASS**
3699	46.72	P	V	5.12	51.84	74.00	22.16	**PASS**
3699	46.72	A	V	-10.48	36.24	54.00	17.76	**PASS**
4624	54.44	P	H	6.90	61.34	74.00	12.66	**PASS**
4624	53.09	A	H	-8.70	44.39	54.00	9.61	**PASS**
7398	42.07	P	V	12.37	54.44	74.00	19.56	**PASS**
7398	34.81	A	V	-3.23	31.58	54.00	22.42	**PASS**

Sample Calculations

$R_C = R_U + CF_T$

Where:

CF_T	=	Total Correction Factor (AF+CA+AG)-DC(Average Measurements Only)
R_U	=	Uncorrected Reading
R_C	=	Corrected Level
AF	=	Antenna Factor
CA	=	Cable Attenuation
AG	=	Amplifier Gain
DC	=	Duty Cycle Correction Factor (If applicable)

Example Calculation:

Corrected Level: 56.19 + (-1.58) = 54.61 dBuV

Margin: 74dBuV – 54.61 dBuV = 19.39 dB

6.7 Channel Dwell Time- FCC Section 15.247(f)

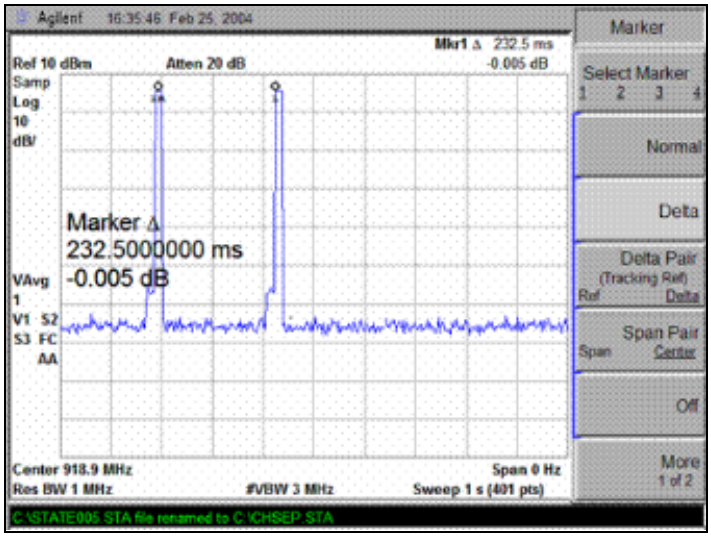
6.7.1 Test Methodology

Under 15.247(f) the frequency hopping operation of the hybrid system, with the direct sequence or digital modulation turned off, the unit shall have an average time of occupancy on any frequency not to exceed 0.4 seconds within a time period in seconds equal to the number of hopping frequencies employed multiplied by 0.4. The EUT uses 5 channels therefore the channel dwell time must be less than .4 seconds in a 2 second period.

6.7.2 Test Results

Results are shown below in and figure 6.5.3-1.

Result: The duration of the RF transmission is 16.5ms. The EUT is designed to transmit twice per channel for redundancy and there are a total of 5 channels. There is 232mS delay between the 2 transmissions and then the EUT hops to another channel according to the pseudorandom frequency table before transmitting again. Therefore the period is 16.5mS(TXon) + 232mS(TXoff) = 248.5mS. There are 8 transmissions of 16.5mS in the 2 second period, resulting in a channel dwell time of 133mS. See Figure 6.7.2-1 below for a single hop:



6.8 Peak Power Spectral Density- FCC Section 15.247(d)

6.8.1 Test Methodology

The power spectral density was measured in accordance with OET bulletin 97-114, appendix C. The EUT was caused to generate a constant carrier on the middle fundamental channel. A 10dB pad was used for this measurement therefore a correction factor of 10dB was adjusted up in the table to reflect the use of the pad. The hopping function was turned off for the measurement.

6.8.2 Test Results

Results are shown below in figure 6.8.1-1.

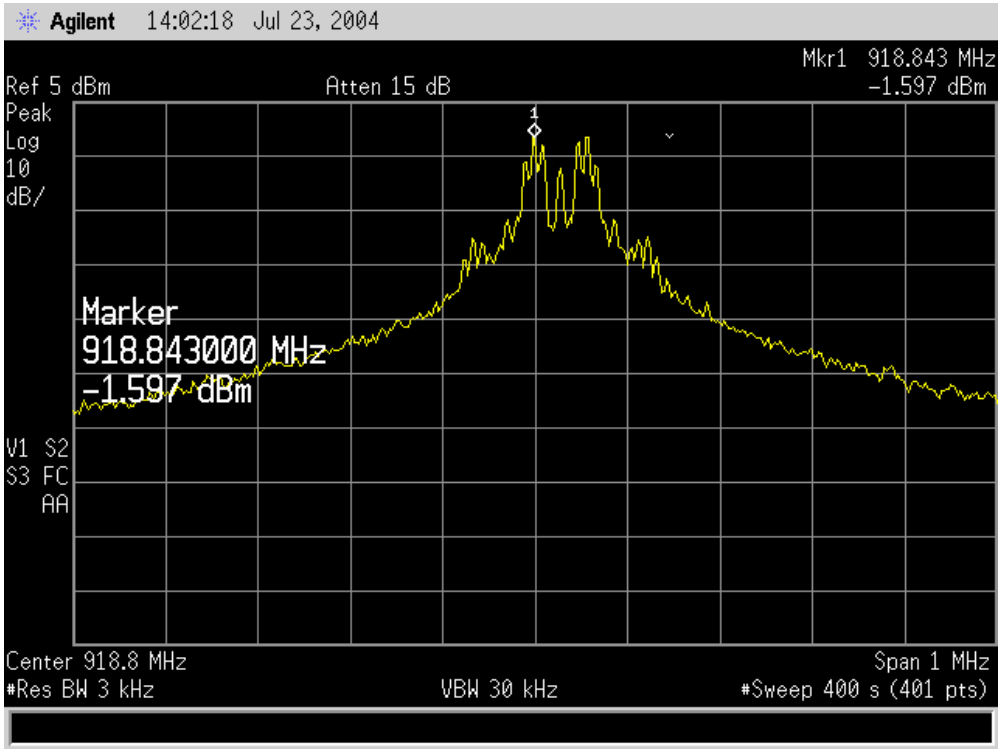


Figure 6.8.1-1: Peak Power Spectral Density

7.0 MODIFICATIONS

No modifications were made to bring the EUT into compliance with the rules.

8.0 CONCLUSION

In the opinion of ACS, Inc. the RFRCU manufactured by Onity, Inc., meets the relevant requirements of FCC Parts 2 and 15, as required.