Electromagnetic Compatibility Test Report

Tests Performed on a CTrack, LLC

GPS Tracking Device, Model Recon II

Radiometrics Document RP-7869B

ACCREDITED
TESTING CERT #1495.01

Product Detail:
FCC ID: 2ACNR-RECONII
Part 95, 216.025 - 216.975 MHz Low power transmitter
Equipment Class: TNB

Test Standards:
FCC Part 95 CFR Title 47: 2014

This report concerns: Original Grant for Certification
FCC Part 95 Subpart G; LPRS operating on 50 kHz extra channels

Tests Performed For:	*Test Facility:*
CTrack, LLC 8361 East Gelding Dr. Scottsdale, AZ 85260	**Radiometrics Midwest Corporation** 12 East Devonwood Romeoville, IL 60446 (815) 293-0772

Test Date(s): (Month-Day-Year)
July 14 thru August 1, 2014

Document RP-7869B Revisions:

Rev.	Issue Date	Affected Sections	Revised By
0	October 13, 2014		

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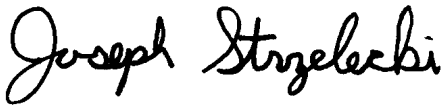
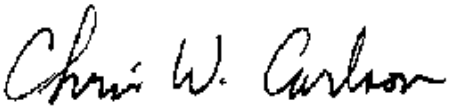
1 ADMINISTRATIVE DATA

Equipment Under Test: A CTrack, LLC, GPS Tracking Device Model: Recon II Serial Number: none This will be referred to as the EUT in this Report	
Date EUT Received at Radiometrics: (Month-Day-Year) July 8, 2014	*Test Date(s): (Month-Day-Year)* July 14 thru August 1, 2014
Test Report Written By: Joseph Strzelecki Senior EMC Engineer	*Test Witnessed By:* The tests were not witnessed by CTrack, LLC
Radiometrics' Personnel Responsible for Test:  10/08/2014 Joseph Strzelecki Senior EMC Engineer NARTE EMC-000877-NE	*Test Report Approved By*  10/08/2014 Chris W. Carlson Director of Engineering NARTE EMC-000921-NE

2 TEST SUMMARY AND RESULTS

The EUT (Equipment Under Test) is a GPS Tracking Device, Model Recon II, manufactured by CTrack, LLC. The detailed test results are presented in a separate section. The following is a summary of the test results.

Part 95 Test Results

Environmental Phenomena	Frequency Range	FCC Sections	Test Result
RF Power Output	216-217 MHz	2.1046 & 95.1013	Pass
Bandwidth Limitations & Emissions Masks	216-217 MHz	2.1049 & 95.633	Pass
Field Strength of Spurious Radiation; Substitution method	30-2,170 MHz	2.1053 & 95.635	Pass
Frequency Stability Vs. Temperature -30 to +50	216-217 MHz	2.1055 & 95.629	Pass
Frequency Stability Vs. Voltage	216-217 MHz	2.1055 & 95.629	Pass

There are no receive mode tests for the 216 MHz transmitter, since this product is not a receiver below 2.4 GHz.

2.1 RF Exposure Compliance Requirements

Since the power output is less than 10 mW, the EUT meets the FCC requirement for RF exposure. There are no power level adjustments available to the end user. The antenna is permanently attached. The detailed calculations for RF Exposure are presented in a separate document.

3 EQUIPMENT UNDER TEST (EUT) DETAILS

3.1 EUT Description

The EUT is a GPS Tracking Device, Model Recon II, manufactured by CTrack, LLC. The EUT was in good working condition during the tests, with no known defects.

3.1.1 FCC Section 15.203 Antenna Requirements

The antenna is permanently attached to the printed circuit board. The antenna is internal to the EUT and it is not readily available to be modified by the end user. Therefore, it meets the 15.203 Requirements.

3.2 Related Submittals

CTrack, LLC is not submitting any other products simultaneously for equipment authorization related to the EUT.

4 TESTED SYSTEM DETAILS

4.1 Tested System Configuration

The system was configured for testing in a typical fashion. The EUT was placed on an 80-cm high, nonconductive test stand. The testing was performed in conditions as close as possible to installed conditions. Wiring was consistent with manufacturer's recommendations.

The EUT was tested as a stand-alone device. Power was supplied at 115 VAC, 60 Hz single-phase to its external battery charger.

The identification for all equipment, plus descriptions of all cables used in the tested system, are:

Tested System Configuration List

Item	Description	Type*	Manufacturer	Model Number	Serial Number
	GPS Tracking Device	E	CTrack, LLC	Recon II	none
	USB power Supply (USB PS-01)	P	Apple	A1385	D292034F1QYDHLHAE

* Type: E = EUT, P = Peripheral,

List of System Cables

QTY	Length (m)	Cable Description	Shielded?
1	1.5	USB charging cable Cord from Charger to EUT	Yes
1	3.0	GPS cable	Yes
1	1.0	Interface cable	No
1	1.0	Audio Cable	No

4.2 Special Accessories

No special accessories were used during the tests in order to achieve compliance.

4.3 Equipment Modifications

No modifications were made to the EUT at Radiometrics' test facility in order to comply with the standards listed in this report.

5 TEST SPECIFICATIONS AND RELATED DOCUMENTS

Document	Date	Title
FCC CFR Title 47	2014	Code of Federal Regulations Title 47, Chapter 1, Federal Communications Commission, Part 15 - Radio Frequency Devices
ANSI C63.4-2009	2009	Methods of Measurement of Radio Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
ANSI C63.10-2009	2009	American National Standard for Testing Unlicensed Wireless Devices
IC RSS-210 Issue 8	2010	Low Power Licence-Exempt Radiocommunication Devices (All Frequency Bands) Category I Equipment
IC RSS-Gen Issue 3	2010	General Requirements and Information for the Certification of Radiocommunication Equipment (RSS-Gen)

The test procedures used are in accordance with the ANSI document C63.10. Radiated testing was performed at an antenna to EUT distance of 3 meters.

6 RADIOMETRICS' TEST FACILITIES

The results of these tests were obtained at Radiometrics Midwest Corp. in Romeoville, Illinois, USA. Radiometrics is accredited by A2LA (American Association for Laboratory Accreditation) to conform to ISO/IEC 17025: 2005 "General Requirements for the Competence of Calibration and Testing Laboratories". Radiometrics' Lab Code is 121191 and Certification Number is 1495.01. Radiometrics' scope of accreditation includes all of the test methods listed herein. A copy of the accreditation can be accessed on our web site (www.radiomet.com). Radiometrics accreditation status can be verified at A2LA's web site (www.a2la2.org).

The following is a list of shielded enclosures located in Romeoville, Illinois used during the tests:

Chamber E: Is a custom made anechoic chamber that measures 52' L X 30' W X 18' H. The walls and ceiling are fully lined with RF absorber. Pro-shield of Collinsville, Oklahoma manufactured the chamber. The floor has a 9' x 9' section of microwave absorber for testing above 1 GHz.

Test Station F: Is an area that measures 10' D X 12' W X 10' H. The floor and back wall are metal shielded. This area is used for conducted emissions measurements.

A separate ten-foot long, brass plated, steel ground rod attached via a 6 inch copper braid grounds each of the above chambers. Each enclosure is also equipped with low-pass power line filters.

The FCC has accepted these sites as test site number US1065. The FCC test site Registration Number is 732175. Details of the site characteristics are on file with the Industry Canada as site number IC 8727A-1.

A complete list of the test equipment is provided herein. The calibration due dates are indicated on the equipment list. The equipment is calibrated in accordance to ANSI/NCSL Z540-1 with traceability to the National Institute of Standards and Technology (NIST).

7 DEVIATIONS AND EXCLUSIONS FROM THE TEST SPECIFICATIONS

There were no deviations or exclusions from the test specifications.

8 CERTIFICATION

Radiometrics Midwest Corporation certifies that the data contained herein was taken under conditions that meet or exceed the requirements of the test specification and the data contained herein was taken with calibrated test equipment. The results relate only to the EUT listed herein.

9 TEST EQUIPMENT TABLE

RMC ID	Manufacturer	Description	Model No.	Serial No.	Frequency Range	Cal Period	Cal Date
AMP-05	RMC/Celeritek	Pre-amplifier	MW110G	1001	1.0-12GHz	12 Mo.	07/01/14
AMP-22	Anritsu	Pre-amplifier	MH648A	M23969	0.1-1200MHz	12 Mo.	01/15/14
ANT-03	Tensor	Biconical Antenna	4104	2231	20-250MHz	24 Mo.	11/26/13
ANT-06	EMCO	Log-Periodic Ant.	3146	1248	200-1000MHz	24 Mo.	11/26/13
ANT-13	EMCO	Horn Antenna	3115	2502	1.0-18GHz	24 Mo.	12/05/12
ANT-36	Ailtech (Eaton)	Horn Antenna	96001	2013	1.0-18GHz	24 Mo.	10/22/12
ANT-44	ARA	Super Log Antenna	SL-20M2G	1002	20-2000MHz	24 Mo.	12/10/13
DMM-10	Keithley	DMM	2010	0773679	DC-10 kHz	12 Mo	11/13/13
LSN-01	Electrometrics	50 uH LISN	FCC/VDE 50/2	1001	0.01-30MHz	24 Mo.	06/21/13
REC-08	HP / Agilent	Spectrum Analyzer	8566B	2648A13481 2209A01436	30Hz-22GHz	24 Mo.	11/21/13
REC-10	HP / Agilent	EMI Receiver	8546A	3842A00521 3704A00484	30Hz-6GHz	24 Mo.	01/13/14
REC-11	HP / Agilent	Spectrum Analyzer	E7405A	US39110103	9Hz-26.5GHz	12 Mo	06/17/14
TC-01	TPS	Temperature Chamber	675-676	TC-01	N/A	12 Mo.	12/17/13
THM-02	Fluke	Temp/Humid Meter	971	93490471	N/A	24 Mo.	06/27/13

Note: All calibrated equipment is subject to periodic checks.

10 TEST SECTIONS

11 PART 95 TEST PROCEDURES AND RESULTS

11.1 Occupied Bandwidth; Emissions Masks

Model	Recon II	Specification	FCC Part 90.209
Serial Number	none	Test Date	08-01-2014
Test Personnel	Richard Tichgelaar	Test Location	Chamber B
Test Equipment	Spectrum Analyzer (REC-08)		

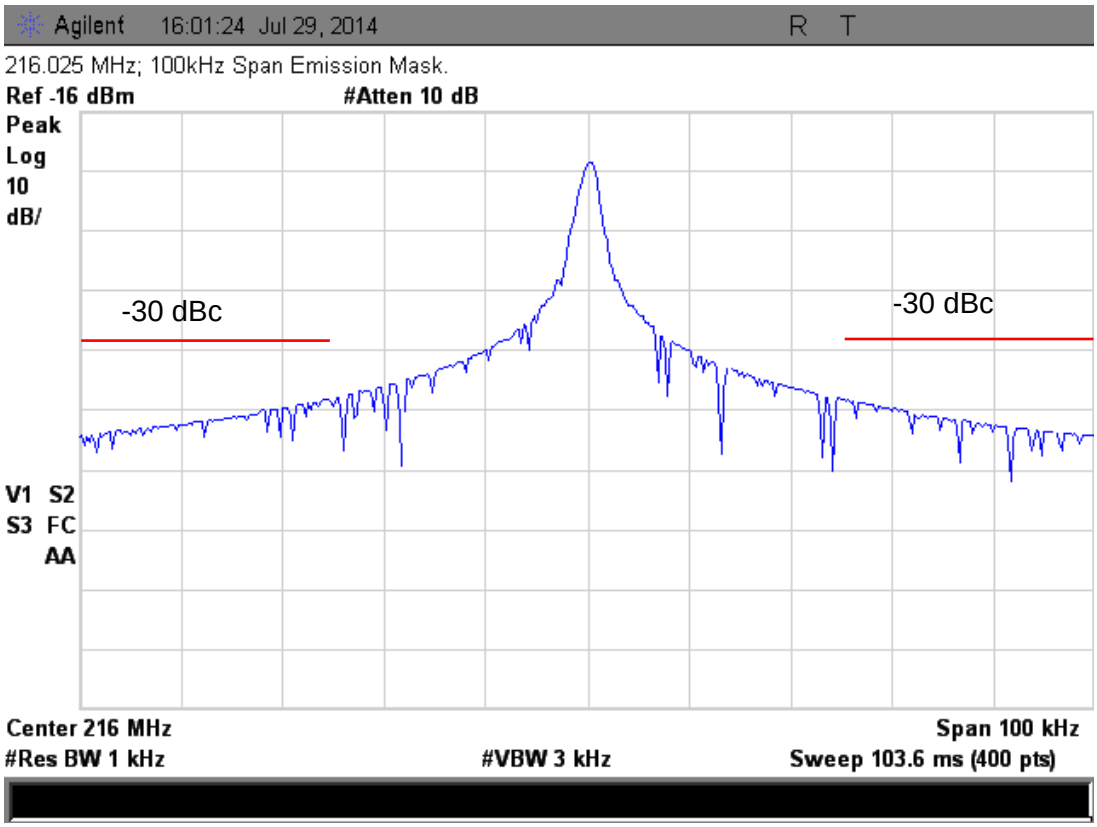
The spectrum analyzer was set to the MAX HOLD mode to record the worst case of the modulation. The EUT was transmitting at its maximum data rate. The trace was allowed to stabilize. A monopole antenna was used to measure the Emissions mask.

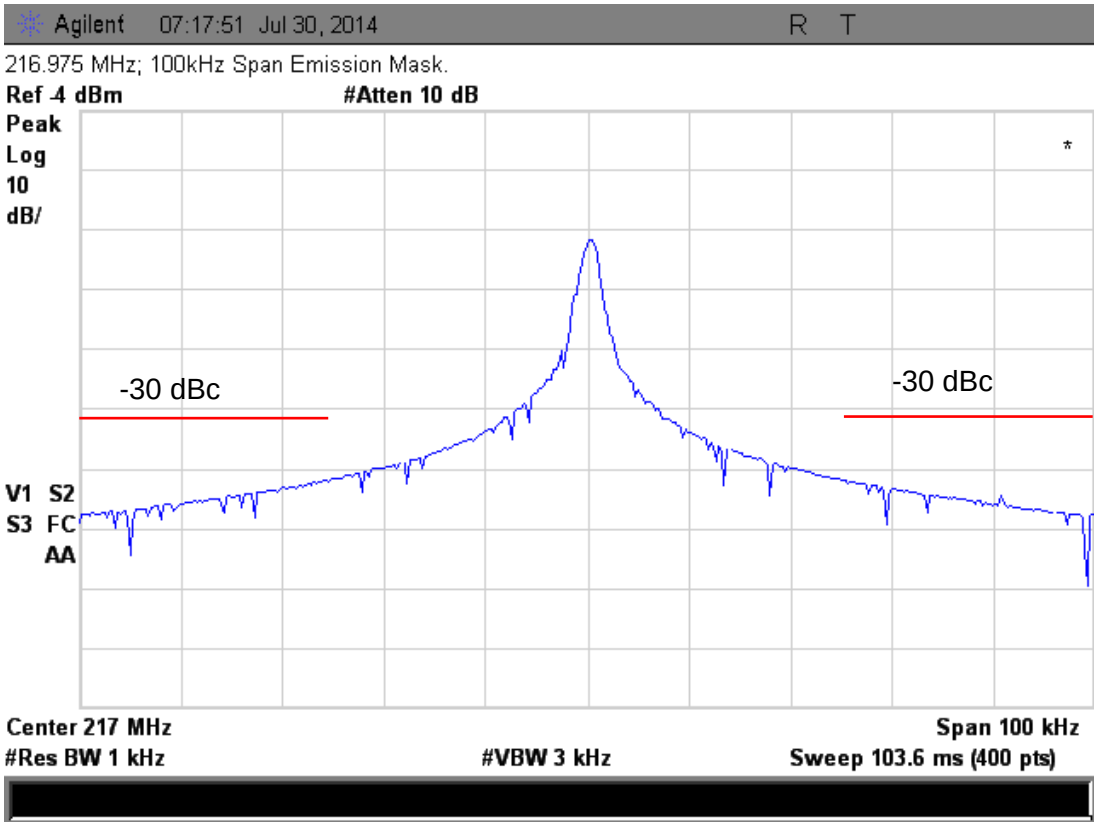
All Channels are 50 kHz

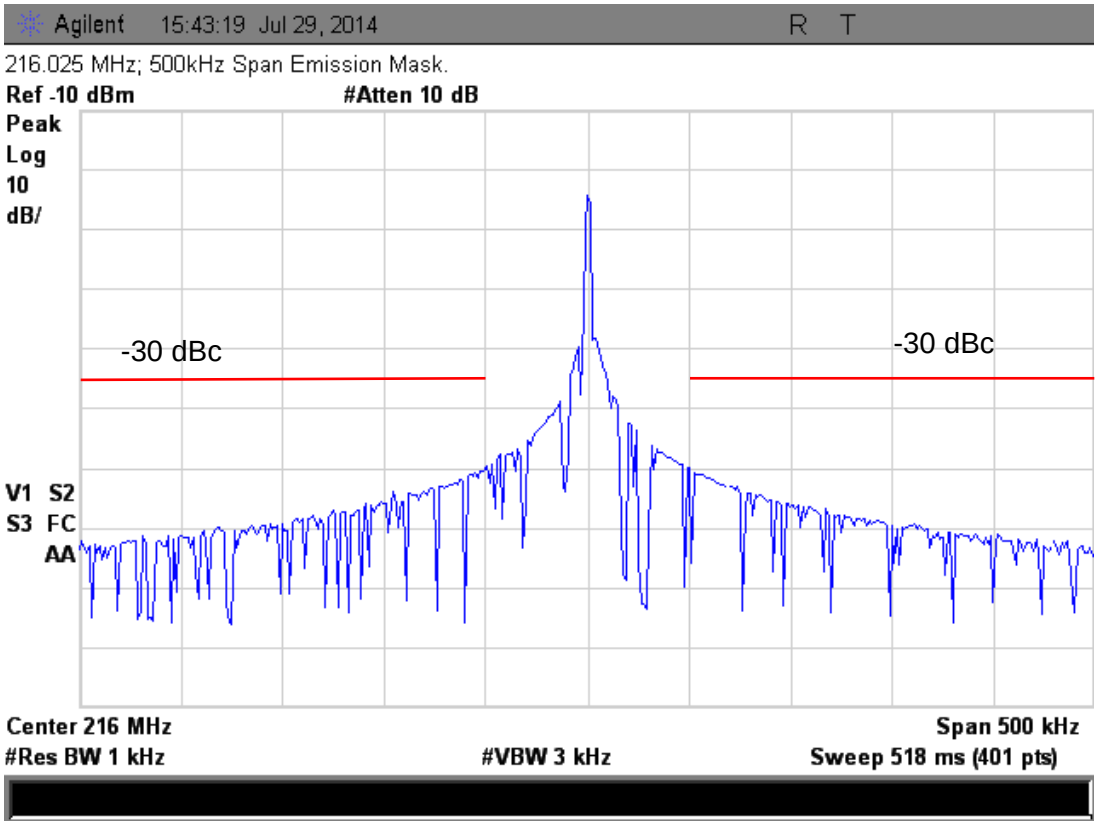
The emissions Masks are from FCC part 95.633 and 95.635 for LPRS channels.

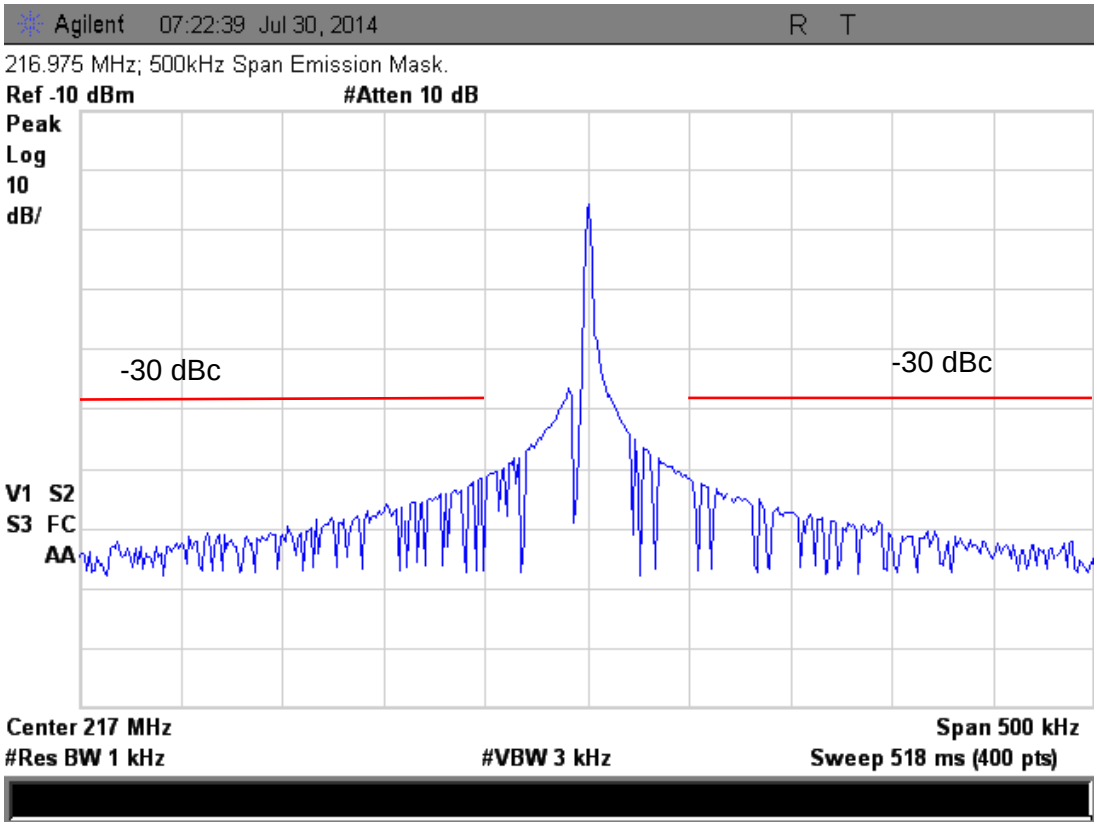
Emissions for LPRS transmitters operating on extra band channels (50 kHz) shall be attenuated below the unmodulated carrier in accordance with the following:

- Emissions 25 kHz to 35 kHz from the channel center frequency: at least 30 dB; and
- Emissions more than 35 kHz away from the channel center frequency: at least 43 + 10*Log(carrier power in watts) dB. For an output power of 1.2mW, this is a reduction of 13.8 dB.




Agilent 07:17:51 Jul 30, 2014
R T
216.975 MHz; 100kHz Span Emission Mask.
Ref 4 dBm
#Atten 10 dB
Peak
Log
10
dB/
-30 dBc
-30 dBc
V1 S2
S3 FC
AA
Center 217 MHz
Span 100 kHz
#Res BW 1 kHz
#VBW 3 kHz
Sweep 103.6 ms (400 pts)

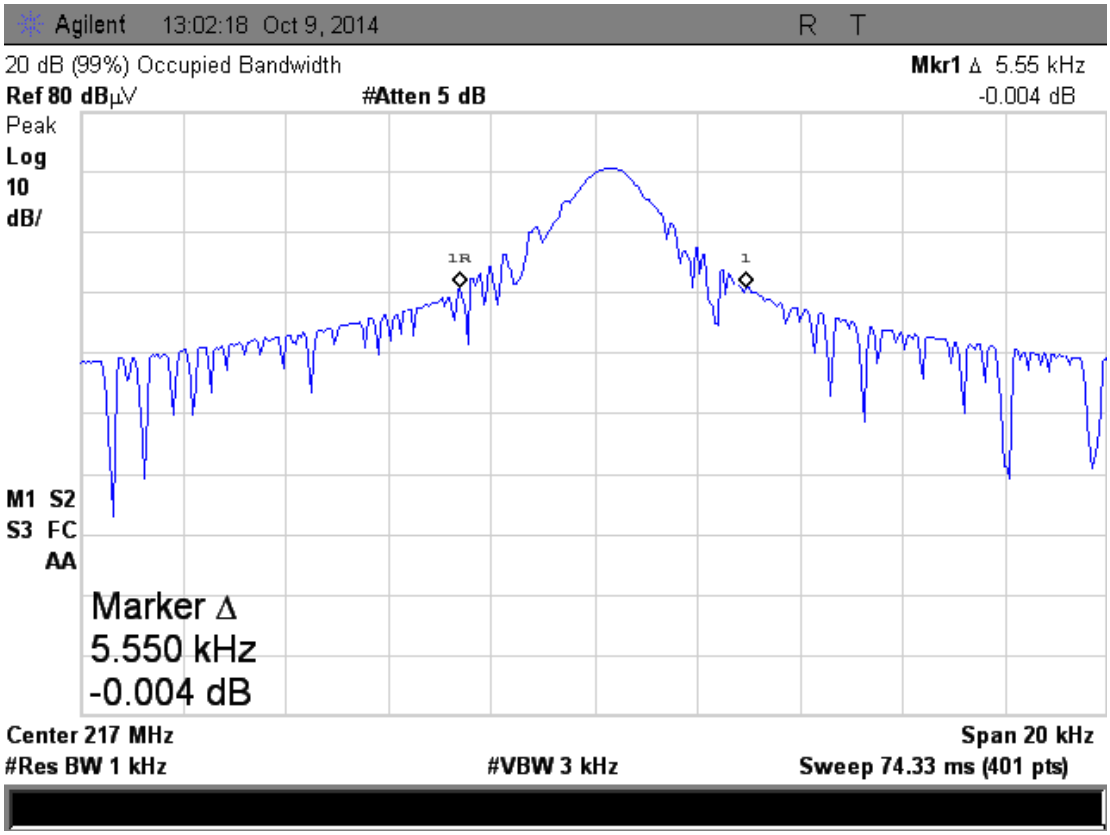

Agilent 15:43:19 Jul 29, 2014
R T
216.025 MHz; 500kHz Span Emission Mask.
Ref 10 dBm
#Atten 10 dB
Peak
Log
10
dB/
-30 dBc
-30 dBc
V1 S2
S3 FC
AA
Center 216 MHz
Span 500 kHz
#Res BW 1 kHz
#VBW 3 kHz
Sweep 518 ms (401 pts)

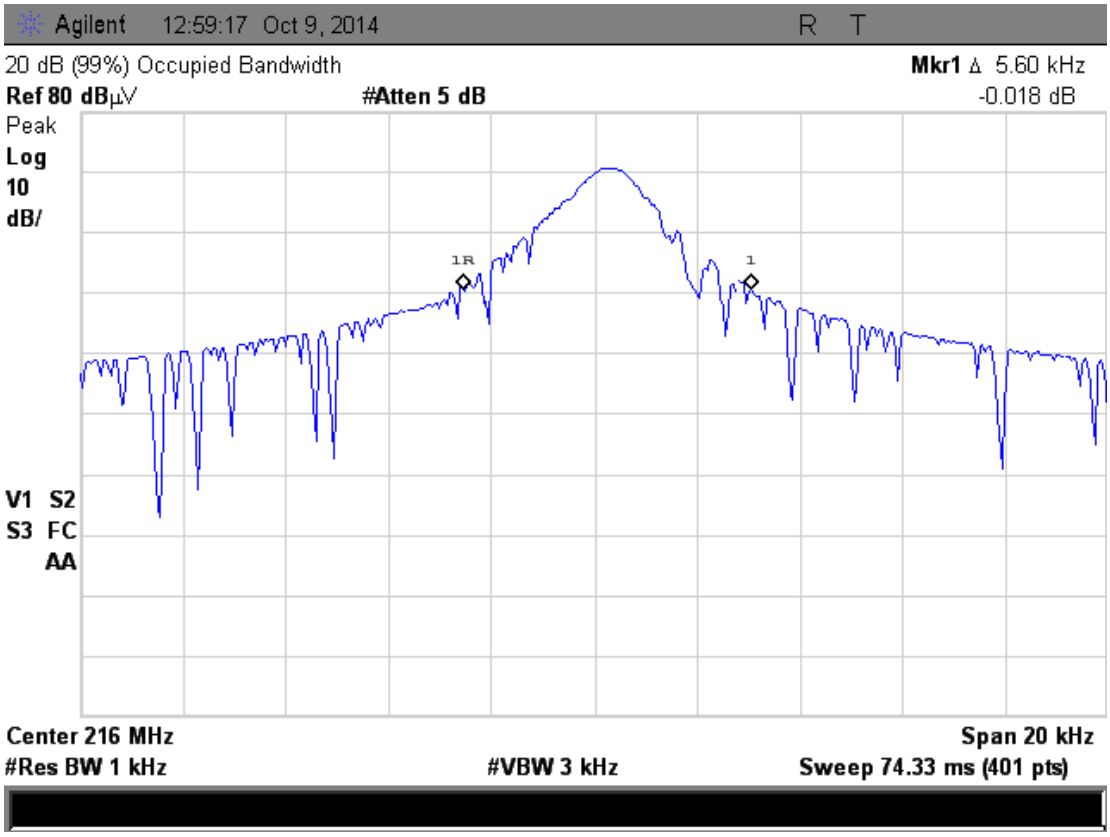


Since it met the -30 dBc limit, the -13.8 dBc limit was not applied.

11.1.1 20 dB Occupied bandwidth

This is the 99% occupied bandwidth as per 2.1049.





11.2 Field Strength of Wanted and Unwanted Radiation

11.2.1 Test Procedures

Radiated emission measurements in the Restricted bands were performed with linearly polarized broadband antennas. The results obtained with these antennas can be correlated with results obtained with a tuned dipole antenna. A 10 dB linearity check is performed prior to start of testing in order to determine if an overload condition exists. From 30 to 2,170 MHz, a spectrum analyzer with a preselector was used for measurement. Radiated emissions measurements were performed at the anechoic chamber at a test distance of 3 meters. The entire frequency range from 30 to 4700 MHz was slowly scanned and the emissions in the restricted frequency bands were recorded. Measurements were performed using the peak detector function.

The spectrum analyzer was adjusted for the following settings:

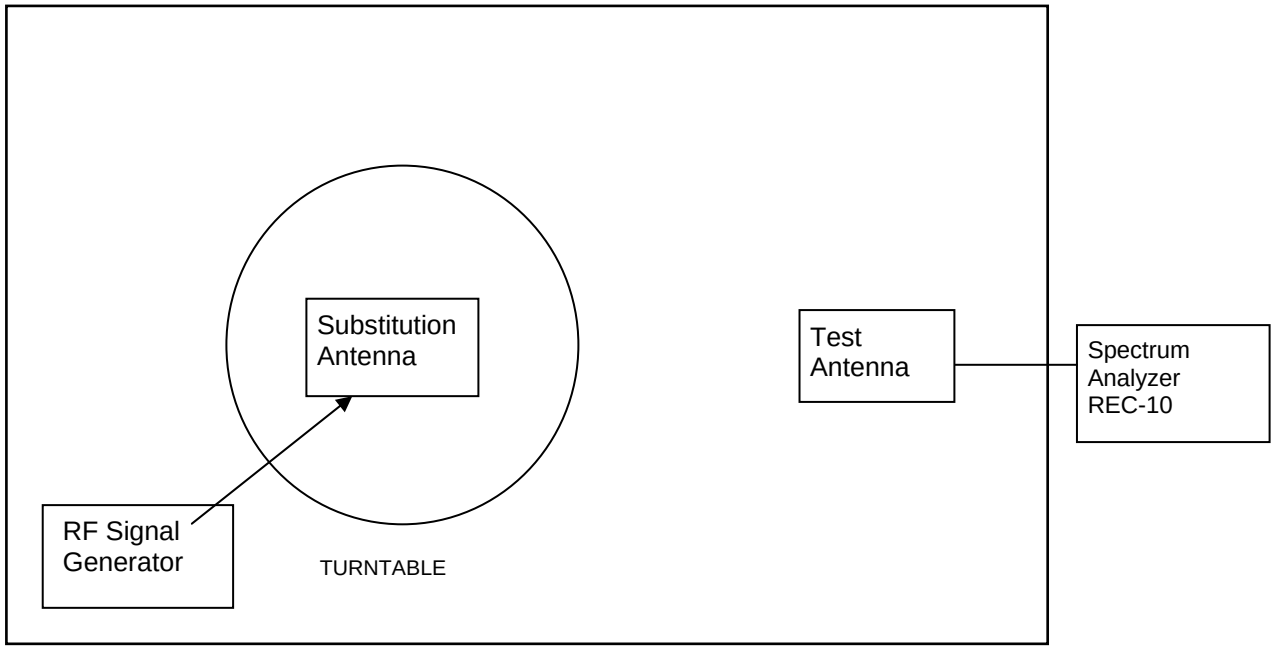
1) Resolution Bandwidth = 100 kHz for spurious emissions below 1 GHz, and 1 MHz for spurious emissions above 1GHz.
2) Video Bandwidth = 300 kHz for spurious emissions below 1 GHz, and 3 MHz for spurious emissions above 1 GHz.
3) Sweep Speed slow enough to maintain measurement calibration.
4) Detector Mode = Positive Peak.

The transmitter to be tested was placed on the turntable in the standard test site, or an FCC listed site compliant with ANSI C63.4. The transmitter is transmitting into a non-radiating load that is placed on the turntable (except for the fundamental reading which had an antenna). Since the transmitter has an integral antenna, the tests are to be run with the unit operating into the integral antenna. Measurements were made from the lowest radio frequency generated in the equipment to the tenth harmonic of the carrier. The transmitter was keyed during the tests.

For each spurious frequency, the test antenna was raised and lowered from 1 m to 4m to obtain a maximum reading on the spectrum analyzer with the test antenna at horizontal polarity. Then the turntable was rotated 360°to determine the maximum reading. This procedure was repeated to obtain the highest possible reading. This maximum reading was recorded.

Each measurement was repeated for each spurious frequency with the test antenna polarized vertically.

Figure 1. Drawing of Radiated Emissions Setup



Notes:
- Test Antenna height varied from 1 to 4 meters
- Distance from antenna to tested system is 3 meters
- Not to Scale
- ANSI C63.4 Listed Test Site; Used from 30 to 1000 MHz
- Fully Anechoic Chamber Used from 1 to 5 GHz

Frequency MHz	Test Antenna	Substitution Antenna	Receiver to Coupler	Signal Generator
30 – 200	ANT-44	ANT-03	REC-11	SIG-21
200 – 1000	ANT-44	ANT-06	REC-11	SIG-21
1000 - 2200	ANT-13	ANT-36	REC-11	SIG-21

The transmitter was removed and replaced with a broadband substitution antenna. The substitution antenna is calibrated so that the gain relative to a dipole is known. The center of the substitution antenna was approximately at the same location as the center of the transmitter.

The substitution antenna was fed at the transmitter end with a signal generator connected to the antenna by means of a non-radiating cable. With the antennas at both ends horizontally polarized, and with the signal generator tuned to a particular spurious frequency, the test antenna was raised and lowered to obtain a maximum reading at the spectrum analyzer. The level of the signal generator output was adjusted until the previously recorded maximum reading for this set of conditions was obtained.

The measurements were repeated with both antennas horizontally and vertically polarized for each spurious frequency.

The power in dBm into a reference ideal half-wave dipole antenna was calculated by reducing the readings obtained in steps k) and l) by the power loss in the cable between the generator and the antenna, and further corrected for the gain of the substitution antenna used relative to an ideal half-wave dipole antenna by the following formula:
Pd(dBm) = *Pg*(dBm) – *cable loss* (dB) + *antenna gain* (dB)

where:
Pd is the dipole equivalent power and
Pg is the generator output power into the substitution antenna.
The *Pd* levels record in step m) are the absolute levels of radiated spurious emissions in dBm.

Any emission must be attenuated below the power (P) of the highest emission contained within the authorized bandwidth as follows:

Emissions for LPRS transmitters operating on extra band channels (50 kHz) shall be attenuated below the unmodulated carrier in accordance with the following:

- Emissions 25 kHz to 35 kHz from the channel center frequency: at least 30 dB; and
- Emissions more than 35 kHz away from the channel center frequency: at least 43 + 10*Log(carrier power in watts) dB. For an output power of 1.2mW, this is a reduction of 13.8 dB.

Note that a reduction of 43 + 10*Log(power in watts) is mathmatically equivalent to an absolute limit of -13 dBm equivalent radiated power.

11.2.2 Radiated Emissions Test Results

Model	Recon II	Specification	FCC Part 90.210
Serial Number	None	Test Date	July 25, 2014
Test Distance	3 Meters	Notes	Transmit Mode
Test Personnel	Richard Tichgelaar		
Test Equipment	REC-10, ANT-44 and ANT-13		

	Tx	Measured	Equivalent Radiated power into Dipole			Margin Under Limit	
Harmonic	Freq	Freq	Vertical	Horizontal	Limit	Vertical	Horizontal
#	MHz	MHz	dBm	dBm	dBm	dB	dB
1	216.0250	216.03	0.8	-6.3	20.0	19.2	26.3
2	216.0250	432.05	-47.7	-52.2	-13.0	34.7	39.2
3	216.0250	648.08	-46.2	-43.5	-13.0	33.2	30.5
4	216.0250	864.10	-49.6	-43.5	-13.0	36.6	30.5
5	216.0250	1080.13	-56.3	-57.1	-13.0	43.3	44.1
6	216.0250	1296.15	-58.1	-57.3	-13.0	45.1	44.3
7	216.0250	1512.18	-57.8	-57.9	-13.0	44.8	44.9
8	216.0250	1728.20	-56.0	-55.7	-13.0	43.0	42.7
9	216.0250	1944.23	-54.9	-54.3	-13.0	41.9	41.3
10	216.0250	2160.25	-54.5	-54.1	-13.0	41.5	41.1
1	216.9750	216.975	0.2	-4.8	20.0	19.8	24.8
2	216.9750	433.95	-45.2	-49.0	-13.0	32.2	36.0
3	216.9750	650.93	-53.4	-45.9	-13.0	40.4	32.9
4	216.9750	867.90	-52.6	-53.7	-13.0	39.6	40.7
5	216.9750	1084.88	-57.1	-57.9	-13.0	44.1	44.9
6	216.9750	1301.85	-56.7	-57.2	-13.0	43.7	44.2
7	216.9750	1518.83	-57.0	-56.9	-13.0	44.0	43.9
8	216.9750	1735.80	-55.5	-57.5	-13.0	42.5	44.5
9	216.9750	1952.78	-56.4	-56.7	-13.0	43.4	43.7
10	216.9750	2169.75	-56.8	-56.6	-13.0	43.8	43.6

Judgment: Emissions passed by at least 15 dB.

Note that a reduction of 43 + 10*Log(power in watts) is mathmatically equivalent to an absolute limit of -13 dBm equivalent radiated power. The fundamental power limit is 100mW in accordance to FCC 95.639.

No other emissions were detected within 15 dB of the limits.

11.3 Frequency Stability

11.3.1 Frequency Stability Vs Temperature

The chamber was then set to the lowest temperature. The transmitter was in the chamber and allowed to stabilize for 15 minutes. The transmitter was then keyed and the frequency was recorded. The chamber was then incremented in 10°C steps with a minimum of 15 minute stabilization period for each temperature measurement. The transmitter was off during the temperature transitions.

Model	Recon II	Specification	FCC part 90.213
Serial Number	None	Test Date	July 31, 2014
Test Personnel	Rich Tichgelaar	Test Location	Chamber F
Test Equipment	Spectrum Analyzer (REC-10); Temperature Chamber TC-01		

	Nominal Freq		216.025	
Temp	Freq.		EUT	Limit
Deg C	(MHz)	Dev Hz	PPM	PPM
50	216.023718	-1282	-5.93	50
40	216.024145	-855	-3.96	50
30	216.02515	150	0.69	50
20	216.025455	455	2.11	50
10	216.02584	840	3.89	50
0	216.02625	1250	5.79	50
-10	216.02628	1280	5.93	50
-20	216.02585	850	3.93	50
-30	216.024725	-275	-1.27	50

Judgement: Pass

11.3.2 Frequency Stability Vs Supply Voltage

The EUT was allowed to stabilize with the nominal primary power supply voltage applied. The primary input voltage was varied from the lowest to the highest rated levels specified by the manufacturer. Frequency readings were taken at increments of 0.1 VDC.

Model	Recon II	Specification	FCC part 90.213
Serial Number	None	Test Date	July 31, 2014
Test Personnel	Rich Tichgelaar	Test Location	Chamber F
Test Equipment	Spectrum Analyzer (REC-10); Digital Multimeter (DMM-10)		

	Nominal Freq	216.025		
Volts	Freq.		EUT	Limit
DC	(MHz)	Dev Hz	PPM	PPM
3.4	216.024775	-225	-1.04	50
3.5	216.024744	-256	-1.19	50
3.6	216.024748	-252	-1.17	50
3.7	216.024780	-220	-1.02	50
3.8	216.024780	-220	-1.02	50
3.9	216.024735	-265	-1.23	50
4.0	216.024789	-211	-0.98	50
4.1	216.024803	-197	-0.91	50
4.2	216.024806	-194	-0.90	50
4.3	216.024813	-187	-0.87	50
4.4	216.024823	-177	-0.82	50

Judgement: Pass