RHEIN TECH LABORATORIES, INC.

Engineering Solutions & Electromagnetic Compatibility Services

FCC & IC Certification Report

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UHF-H Base Station Radio
Model: HD-4CU2
(HD-3CU2, HD-2CU2)

FCC ID: OWDTR-0104-E
IC: 3636B-0104

December 19, 2012

Standards Referenced for this Report	
Part 2: 2011	Frequency Allocations and Radio Treaty Matters; General Rules and Regulations
Part 90: 2011	Private Land Mobile Radio Services
TIA-EIA-603-C August 2004	Land Mobile FM or PM Communications Equipment – Measurement and Performance Standards
Industry Canada RSS-119 Issue 11	Land Mobile and Fixed Radio Transmitters and Receivers Operating in the Frequency Range 27.41- 960 MHz

Frequency Range (MHz)	Rated Conducted Output Power (W)	Frequency Tolerance (ppm)	Transmit Mode	Emission Designator
450-512 (FCC) 512 – 520 (Federal) 450-470 (IC)	1.0 – 50.0	0.2	4-level FSK, digitized data or voice, 8 kbps	7K60FXD/E

Report Prepared By: Dan Baltzell

Document Number: 2012276

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These tests are accredited and meet the requirements of ISO/IEC 17025 as verified by ANSI-ASQ National Accreditation Board/ACLASS. Refer to certificate and scope of accreditation AT-1445.

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1 Test Result Summary

Test	FCC Reference	Result
RF Power Output	2.1046(a)	Complies
Spurious Emissions at Antenna Terminals	2.1051, 90.210	Complies
Field strength of spurious radiation	2.1053(a)	Complies
Occupied Bandwidth/Emission Masks	2.1049(c)(1)	Complies
Frequency Stability vs. Temperature and Voltage	2.1055, 90.213	Complies
Modulation Characteristics	2.1047(a)(b)	Not Applicable (Digital Modulation)

2 General Information

The following Certification Report is prepared on behalf of Harris Corporation in accordance with the Federal Communications Commission and Industry Canada rules and regulations. The Equipment Under Test (EUT) was the UHF-H base station radio, Model HD-4CU2.

The radio is subject to FCC DoC. DoC testing was performed and the data is contained in a separate DoC report.

All measurements contained in this application were conducted in accordance with the applicable sections of FCC Rules and Regulations CFR 47 Parts 2, and 90. Calibration checks are performed regularly on the instruments, and all accessories including high pass filter, coaxial attenuator, preamplifier and cables.

2.1 Test Facility

The open area test site and conducted measurement facility used to collect the radiated data is located on the parking lot of Rhein Tech Laboratories, Inc. 360 Herndon Parkway, Suite 1400, Herndon, Virginia 20170. This site has been fully described in a report submitted to, and approved by, the Federal Communications Commission to perform AC line conducted and radiated emissions testing.

2.2 Related Submittal(s)/Grant(s)

This is a new FCC and IC certification application for the Harris Corporation UHF-H base station radio, Model HD-4CU2 (four channel station), FCC ID: OWDTR-0104-E, IC: 3636B-0104. The IC certification will be a family certification that will also include Models HD-3CU2 (three channel station) and HD-2CU2 (two channel station). Model HD-4CU2 was tested as the worst case configuration.

2.3 Grant Notes

RF power switchable from 1 W to rated power 50 W.

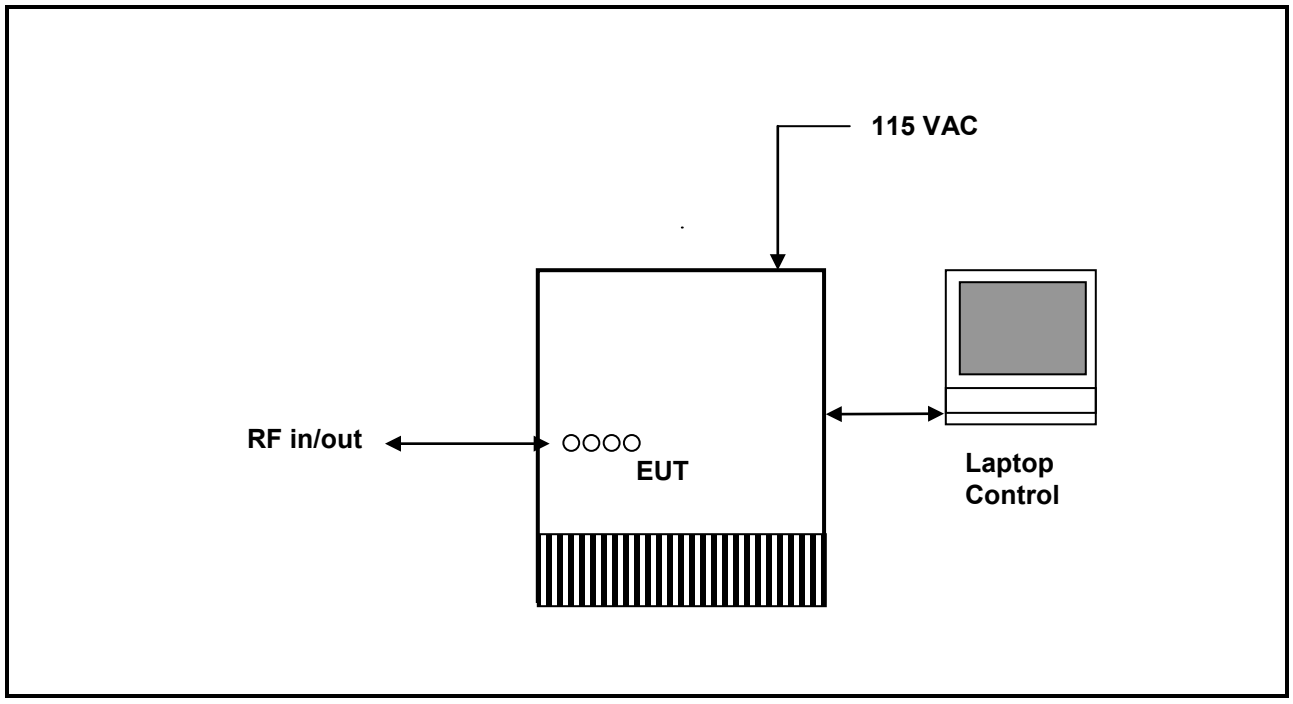
3 Tested System Details

The test sample was received on December 6, 2012. Listed below are the identifiers and descriptions of all equipment, cables, and internal devices used with the EUT for this test, as applicable. The device was programmed for multiple modes of operation.

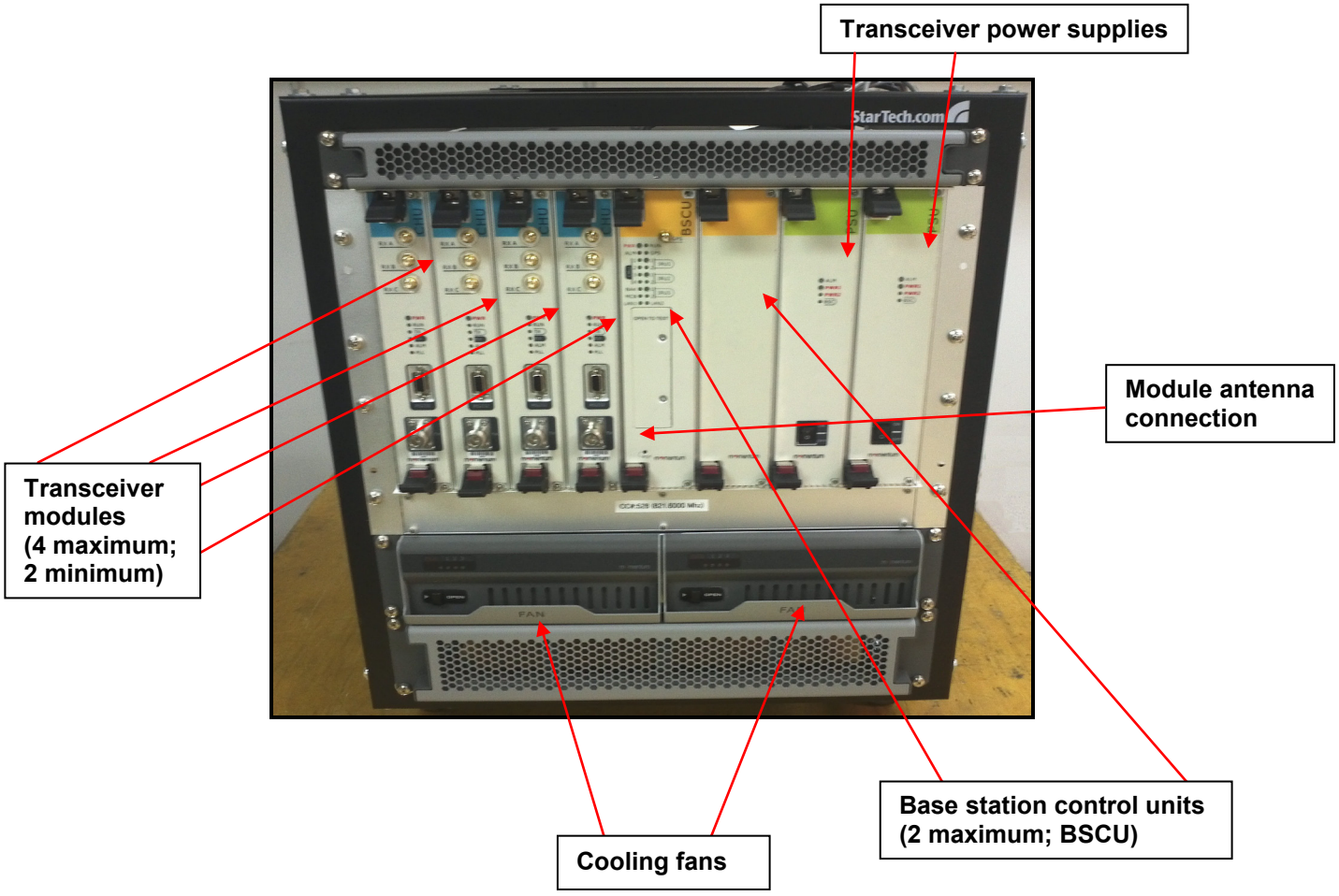
Table 3-1: Equipment Under Test (EUT)

Part	Manufacturer	Model	Serial Number	FCC ID	RTL Bar Code
UHF-H Base Station Radio	Harris Corporation	HD-4CU2	K03A20099	OWDTR-0104-E	20821

Figure 3-1: Configuration of Tested System



Photograph 1: Configuration



4 FCC Rules and Regulations Part 2.1033(c)(8) Voltages and Currents Through The Final Amplifying Stage

Final PA Voltage: 13.6 VDC
Final PA Current: 4.2A@50W

5 FCC Rules and Regulations Part 2.1046(a): RF Power Output: Conducted, Part 90.541(b)/90.542(a)(6): Transmitting Power Limit; IC RSS-119 4.1 Transmitter Output Power

5.1 Test Procedure

ANSI/TIA/EIA-603-2004, section 2.2.1

The EUT was connected to a coaxial attenuator having a 50 Ω load impedance.

Manufacturer's rated power: 1-50 W.

5.2 Test Data

Table 5-1: RF Conducted Output Power – Measured

Frequency (MHz)	High Power (dBm)	High Power (W)
450.0125	47.4	55.0
454.0000	47.4	55.0
456.0000	47.4	55.0
470.0000	47.3	53.7
512.0000	47.3	53.7
519.9875	47.4	55.0

Table 5-2: Test Equipment Used For Testing RF Power Output - Conducted

RTL Asset #	Manufacturer	Model	Part Type	Serial Number	Calibration Due Date
901583	Agilent Technologies	N9010A	EXA Signal Analyzer (10 Hz-26.5 GHz)	MY51250846	3/13/13
901536	Aeroflex	48-40-34	40 dB Attenuator	CB6627	10/14/13

Test Personnel:

Daniel Baltzell		December 6, 2012
EMC Test Engineer	Signature	Date of Test

6 FCC Rules and Regulations Part 2.1051: Spurious Emissions at Antenna Terminals; Part 90.210: Emission Limitations

6.1 Test Procedure

ANSI/TIA/EIA-603-2004, Section 2.2.13

The transmitter is terminated with a 50 Ω load and interfaced with a spectrum analyzer.

Device with digital modulation: Modulated to its maximum extent using a pseudo-random data sequence.

6.2 Test Data

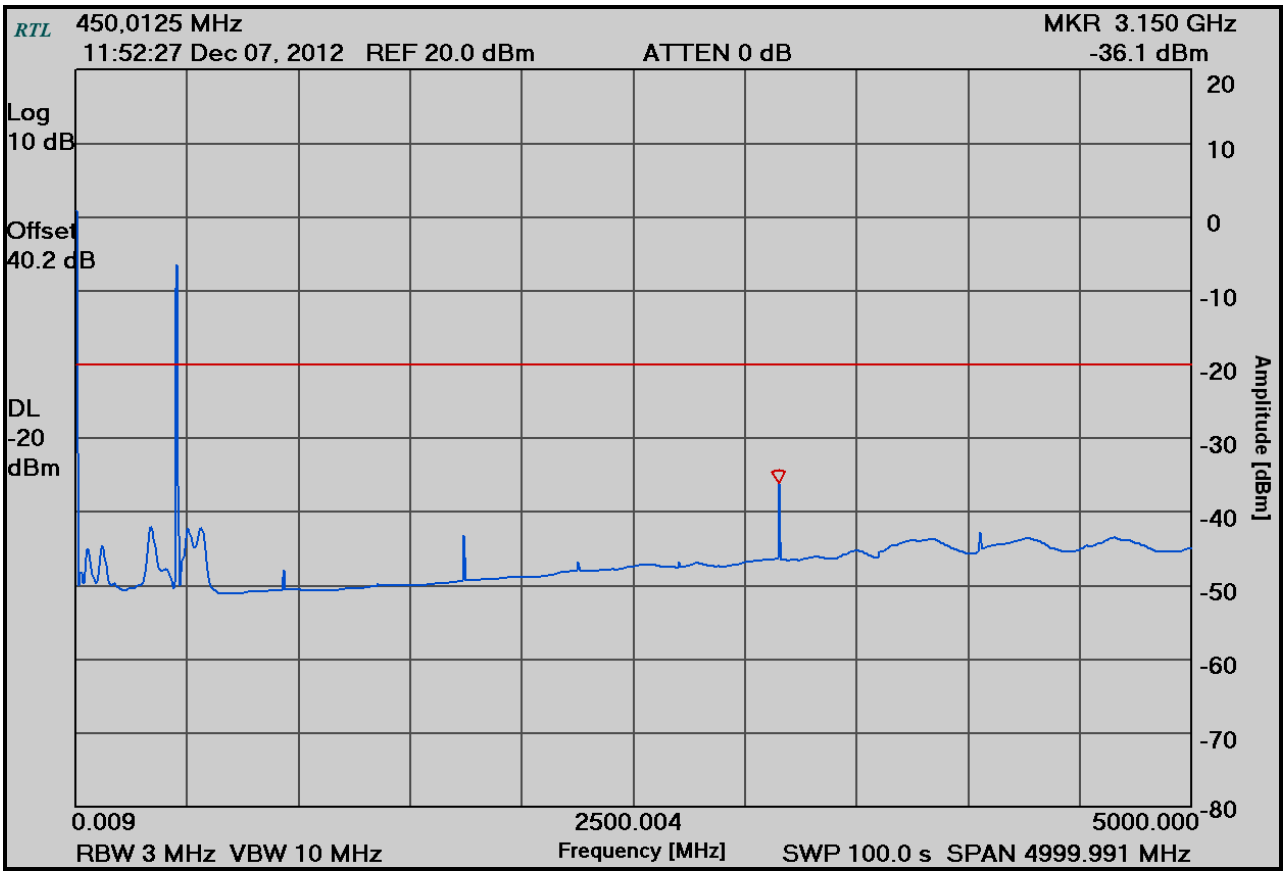
Frequency range of measurement per Part 2.1057: 9 kHz to 10 x Fc Limits: (50 + 10 LOG P(W))

The following channels (in MHz) were investigated:

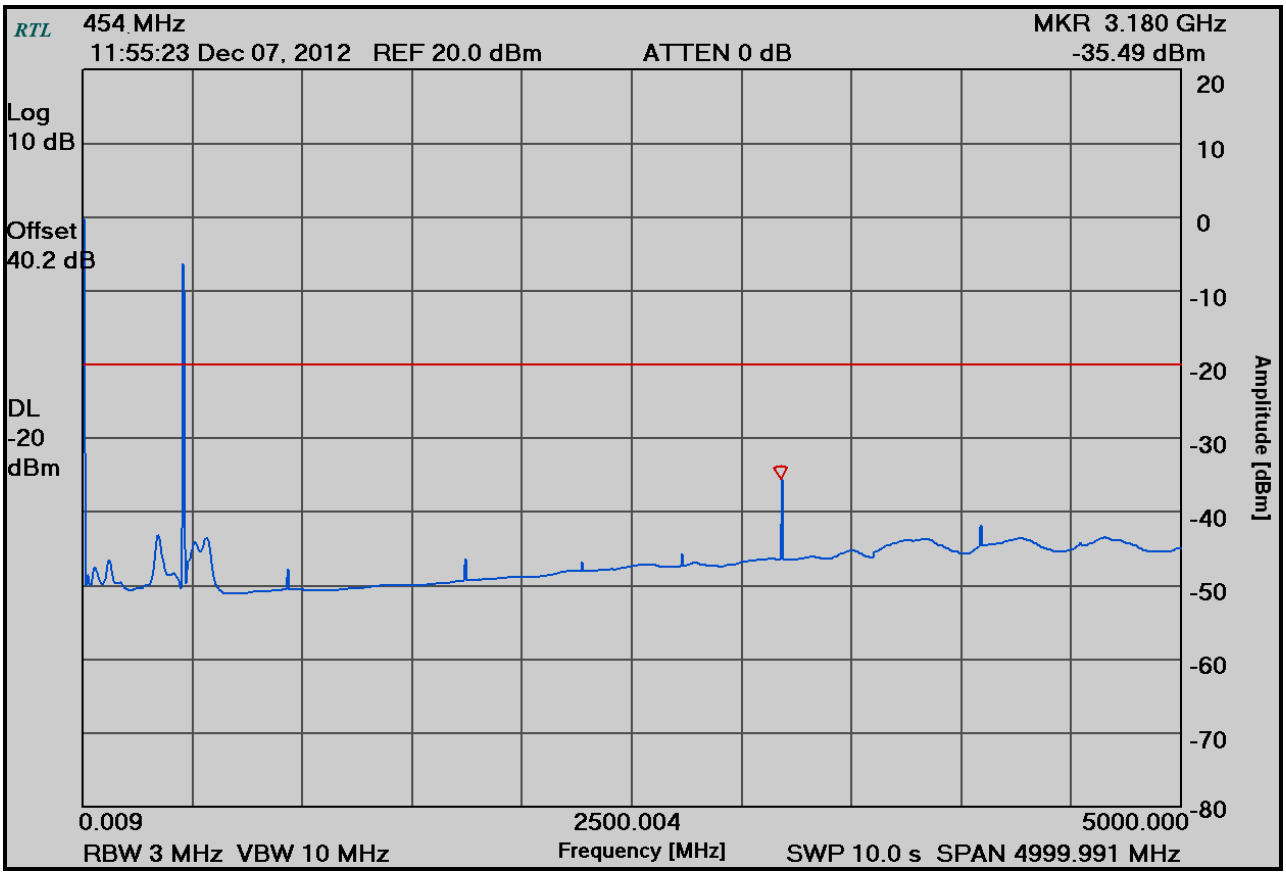
UHF-H
450.0125
454.0000
456.0000
470.0000
512.0000
519.9875

Both high and low power settings were checked; high power was found to be worst case and is presented. All modes were investigated and analog mode is presented as representative data.

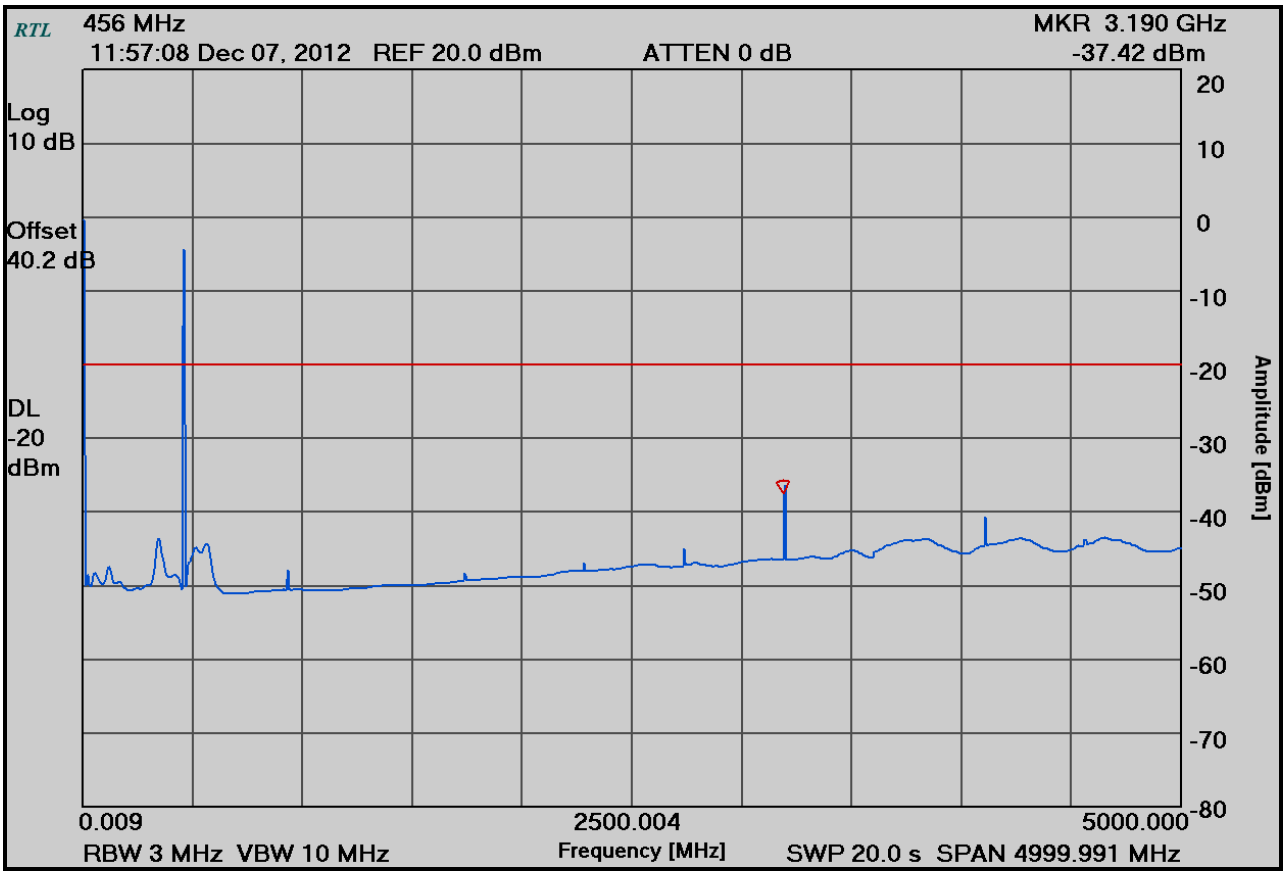
Plot 6-1: Spurious Emissions at Antenna Terminals – 450.0125 MHz



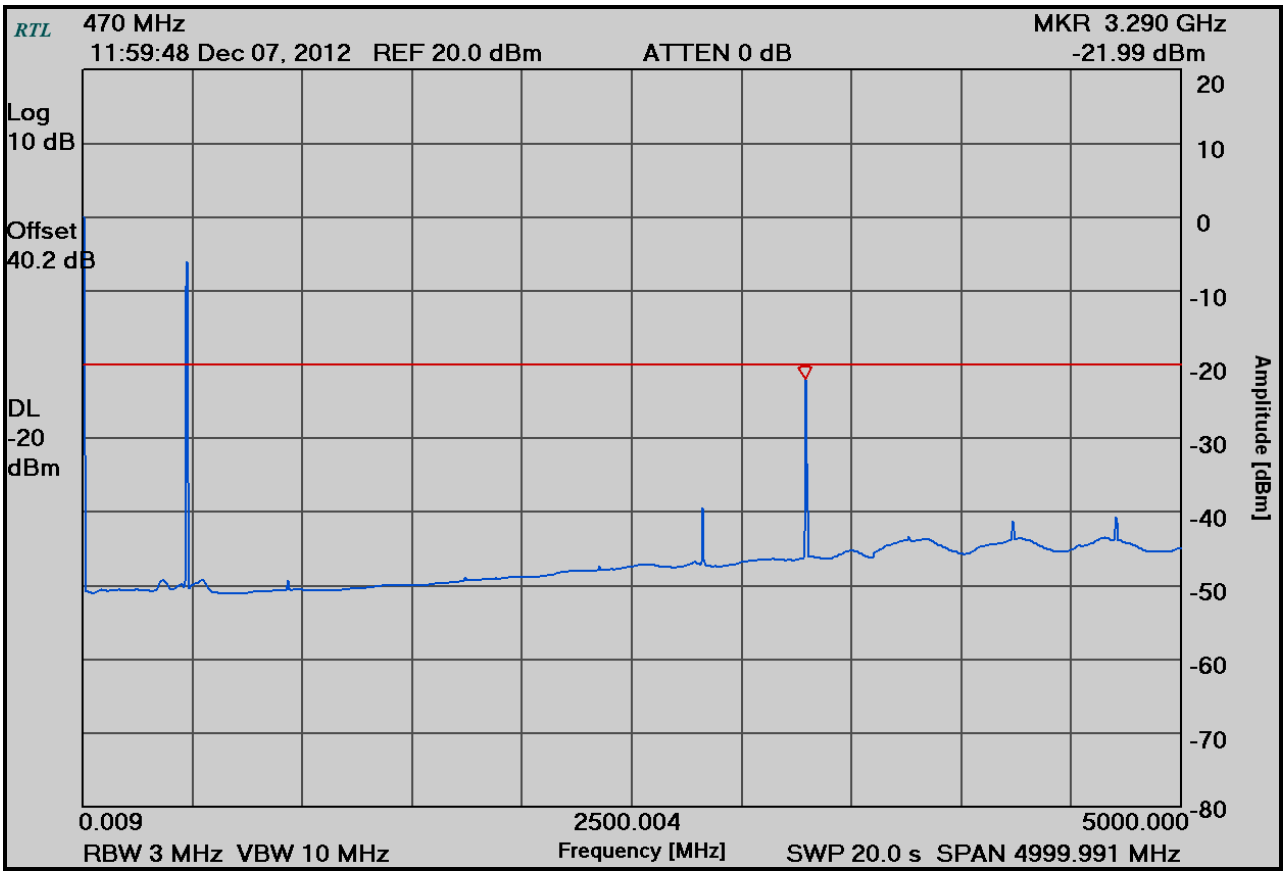
Plot 6-2: Spurious Emissions at Antenna Terminals – 454.0000 MHz



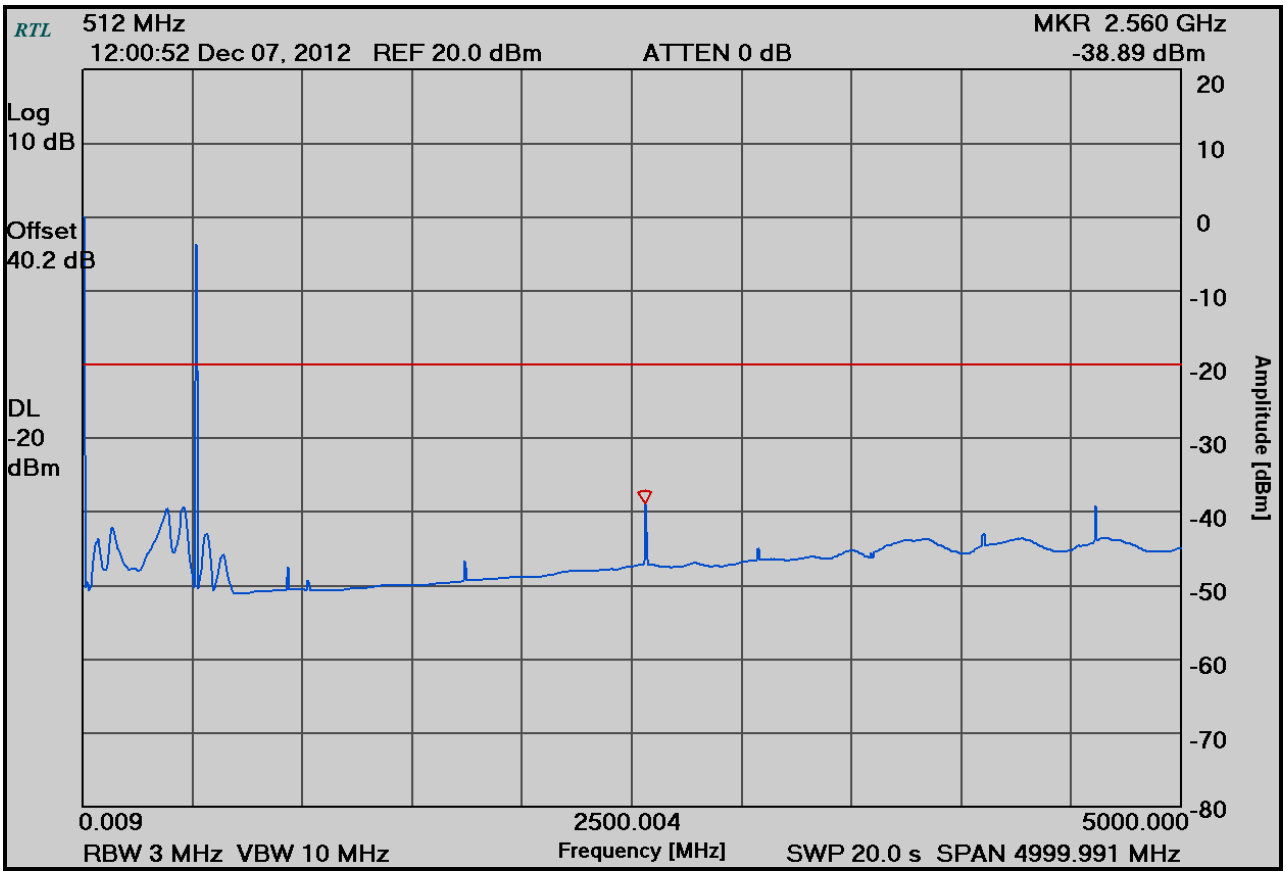
Plot 6-3: Spurious Emissions at Antenna Terminals – 456.0000 MHz



Plot 6-4: Spurious Emissions at Antenna Terminals – 470.0000 MHz



Plot 6-5: Spurious Emissions at Antenna Terminals – 512.0000 MHz



Plot 6-6: Spurious Emissions at Antenna Terminals – 519.9875 MHz

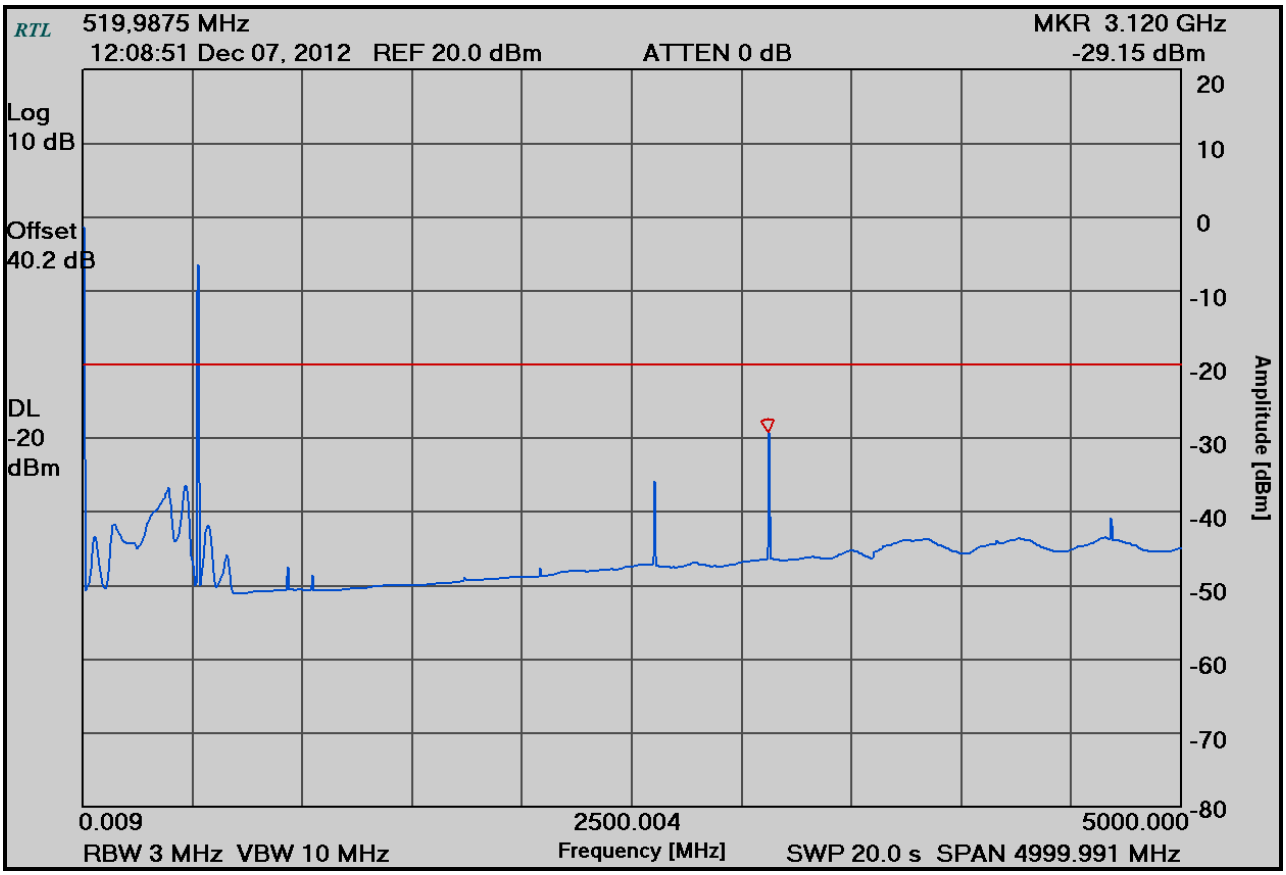


Table 6-1: Test Equipment Used For Testing Spurious Emissions

RTL Asset #	Manufacturer	Model	Part Type	Serial Number	Calibration Due Date
901581	Rohde & Schwarz	1166.1660.50	Spectrum Analyzer	2001006	6/3/13
901536	Aeroflex	48-40-34	40 dB Attenuator	CB6627	10/14/13
901133	Par Electronics	400-512 (25W)	UHF Notch Filter	N/A	2/29/13

Test Personnel:

Daniel Baltzell		December 7, 2012
EMC Test Engineer	Signature	Date of Test

7 FCC Rules and Regulations Part 90.210(g) and Part 2.1053(a): Field Strength of Spurious Radiation; IC RSS-119 5.8.9.2 Out-of-band Emission Limit

7.1 Test Procedure

ANSI/TIA-603-2004, section 2.2.12

The device uses digital modulation modulated to its maximum extent using a pseudo-random data sequence.

The spurious emissions levels were measured, and the device under test was replaced by a substitution antenna connected to a signal generator. This signal generator level was then corrected by subtracting the cable loss from the substitution antenna to the signal generator, and the gain of the antenna (dBd) was added to achieve the ERP level, then converted from the corrected signal generator level (dBm) to dBc and compared to the limit.

7.2 Test Data

Table 7-1: Field Strength of Spurious Radiation – 450.0125 MHz

Conducted Power 47.4 dBm; 55 W; Limit=50+10LogP=67.4 dBc

Frequency (MHz)	Spectrum Analyzer Level (dBuV)	Signal Generator Level (dBm)	Cable Loss to Transmit Antenna (dB)	Substitution Antenna Gain (dBd)	Corrected Signal Generator Level (dBc)	Margin (dB)
900.0250	62.0	-57.1	0.2	-1.2	106.0	-38.6
1350.0375	44.8	-70.0	0.3	4.5	113.3	-45.9
1800.0500	47.9	-64.1	0.4	7.5	104.4	-37.0
2250.0625	35.0	-78.8	0.5	7.5	119.1	-51.7
2700.0750	46.9	-66.3	0.5	7.8	106.5	-39.1
3150.0875	36.5	-75.3	0.6	7.4	115.9	-48.5
3600.1000	30.4	-79.7	0.7	7.5	120.3	-52.9
4050.1125	43.3	-65.0	0.7	7.9	105.3	-37.9
4500.1250	44.8	-60.8	0.8	8.9	100.1	-32.7

Table 7-2: Field Strength of Spurious Radiation – 454.0000 MHz

Conducted Power 47.4 dBm; 55 W; Limit=50+10LogP=67.4 dBc

Frequency (MHz)	Spectrum Analyzer Level (dBuV)	Signal Generator Level (dBm)	Cable Loss to Transmit Antenna (dB)	Substitution Antenna Gain (dBd)	Corrected Signal Generator Level (dBc)	Margin (dB)
908.0000	38.2	-80.7	0.3	-1.2	129.6	-62.2
1362.0000	43.9	-70.9	0.3	4.5	114.1	-46.7
1816.0000	43.2	-68.8	0.4	7.4	109.2	-41.8
2270.0000	38.7	-75.2	0.5	7.6	115.4	-48.0
2724.0000	49.8	-63.3	0.5	7.9	103.4	-36.0
3178.0000	55.6	-56.1	0.6	7.4	96.7	-29.3
3632.0000	35.0	-74.8	0.7	7.4	115.4	-48.0
4086.0000	46.8	-57.8	0.7	8.0	97.9	-30.5
4540.0000	39.2	-66.3	0.8	8.9	105.6	-38.2

Table 7-3: Field Strength of Spurious Radiation – 456.0000 MHz

Conducted Power 47.4 dBm; 55 W; Limit=50+10LogP=67.4 dBc

Frequency (MHz)	Spectrum Analyzer Level (dBuV)	Signal Generator Level (dBm)	Cable Loss to Transmit Antenna (dB)	Substitution Antenna Gain (dBd)	Corrected Signal Generator Level (dBc)	Margin (dB)
912.0000	49.1	-69.7	0.3	-1.2	118.5	-51.1
1368.0000	42.0	-72.7	0.3	4.6	115.9	-48.5
1824.0000	41.9	-70.2	0.4	7.3	110.7	-43.3
2280.0000	37.3	-76.7	0.5	7.7	116.9	-49.5
2736.0000	50.8	-62.2	0.5	7.9	102.2	-34.8
3192.0000	56.8	-54.8	0.6	7.4	95.4	-28.0
3648.0000	30.7	-79.0	0.7	7.4	119.7	-52.3
4104.0000	48.0	-56.6	0.7	8.1	96.6	-29.2
4560.0000	42.2	-63.3	0.8	8.9	102.6	-35.2

Table 7-4: Field Strength of Spurious Radiation – 470.0000 MHz

Conducted Power 47.3 dBm; 53.7 W; Limit=50+10LogP=67.3 dBc

Frequency (MHz)	Spectrum Analyzer Level (dBuV)	Signal Generator Level (dBm)	Cable Loss to Transmit Antenna (dB)	Substitution Antenna Gain (dBd)	Corrected Signal Generator Level (dBc)	Margin (dB)
940.0000	64.8	-53.1	0.3	-1.0	101.7	-34.4
1410.0000	43.2	-71.3	0.3	4.8	114.1	-46.8
1880.0000	43.1	-69.2	0.4	6.8	110.1	-42.8
2350.0000	41.6	-72.5	0.5	7.7	112.6	-45.3
2820.0000	50.2	-62.5	0.6	8.1	102.2	-34.9
3290.0000	54.8	-56.9	0.6	7.3	97.5	-30.2
3760.0000	32.1	-76.8	0.7	7.2	117.6	-50.3
4230.0000	42.7	-62.3	0.8	8.7	101.7	-34.4
4700.0000	45.8	-59.1	0.8	9.1	98.1	-30.8

Table 7-5: Field Strength of Spurious Radiation – 512.0000 MHz

Conducted Power 47.3 dBm; 53.7 W; Limit=50+10LogP=67.3 dBc

Frequency (MHz)	Spectrum Analyzer Level (dBuV)	Signal Generator Level (dBm)	Cable Loss to Transmit Antenna (dB)	Substitution Antenna Gain (dBd)	Corrected Signal Generator Level (dBc)	Margin (dB)
1024.0000	54.8	-61.8	0.3	3.1	106.3	-39.0
1536.0000	48.3	-65.5	0.4	5.9	107.3	-40.0
2048.0000	41.6	-71.4	0.4	6.4	112.7	-45.4
2560.0000	41.6	-72.0	0.5	7.5	112.3	-45.0
3072.0000	43.1	-70.5	0.6	7.6	110.8	-43.5
3584.0000	40.6	-69.6	0.7	7.5	110.1	-42.8
4096.0000	47.1	-57.5	0.7	8.1	97.4	-30.1
4608.0000	41.5	-65.9	0.8	9.0	105.0	-37.7
5120.0000	66.8	-37.0	0.9	8.7	76.4	-9.1

Table 7-6: Field Strength of Spurious Radiation – 519.9875 MHz

Conducted Power 47.4 dBm; 55 W; Limit=50+10LogP=67.4 dBc

Frequency (MHz)	Spectrum Analyzer Level (dBuV)	Signal Generator Level (dBm)	Cable Loss to Transmit Antenna (dB)	Substitution Antenna Gain (dBd)	Corrected Signal Generator Level (dBc)	Margin (dB)
1039.9750	48.8	-67.7	0.3	3.0	112.3	-44.9
1559.9625	49.8	-63.9	0.4	6.2	105.5	-38.1
2079.9500	42.9	-70.2	0.4	6.4	111.7	-44.3
2599.9375	43.8	-69.7	0.5	7.5	110.1	-42.7
3119.9250	43.2	-68.7	0.6	7.5	109.2	-41.8
3639.9125	36.5	-73.3	0.7	7.4	114.0	-46.6
4159.9000	44.1	-60.6	0.7	8.4	100.3	-32.9
4679.8875	42.9	-62.0	0.8	9.1	101.2	-33.8
5199.8750	59.3	-44.4	0.9	8.7	84.0	-16.6

Table 7-7: Test Equipment Used For Testing Field Strength of Spurious Radiation

RTL Asset #	Manufacturer	Model	Part Type	Serial Number	Calibration Due Date
900932	Hewlett Packard	8449B OPT H02	Preamplifier (1-26.5 GHz)	3008A00505	8/10/13
900878	Rhein Tech Laboratories	AM3-1197-0005	3 meter antenna mast, polarizing	OATS1	N/A
901592	Insulated Wire Inc.	KPS-1503-3600-KPR	SMK RF Cables 20'	NA	8/16/13
901593	Insulated Wire Inc.	KPS-1503-360-KPR	SMK RF Cables 36"	NA	8/16/13
901594	Insulated Wire Inc.	KPS-1503-360-KPR	SMK RF Cables 36"	NA	8/16/13
901242	Rhein Tech Laboratories	WRT-000-0003	Wood rotating table	N/A	N/A
900791	Chase	CBL6111B	Bilog Antenna (30 MHz–2000 MHz)	N/A	1/31/13
900321	EMCO	3161-03	Horn Antennas (4–8 GHz)	9508-1020	4/19/14
900772	EMCO	3161-02	Horn Antenna (2-4 GHz)	9804-1044	4/19/14
900928	Hewlett Packard	83752A	Synthesized Sweeper, 0.01 to 20 GHz	3610A00866	2/18/13
901595	Mini-Circuits	ZHL-4240V	Amplifier	H090293-5	2/17/13
900323	EMCO	3160-07	Horn Antenna (8.2-12.4 GHz)	9605-1054	4/19/14
901581	Rohde & Schwarz	1166.1660.50	Spectrum Analyzer	2001006	6/3/13

Test Personnel:

Daniel Baltzell		December 10, 2012
Test Engineer	Signature	Date of Tests

8 FCC Rules and Regulations Part 2.1049(c)(1): Occupied Bandwidth; Part 90.210 Authorized Bandwidth; IC RSS-119 5.5 Channel Spacing, Authorized Bandwidth, Occupied Bandwidth and Spectrum Masks

Occupied Bandwidth - Compliance with the Emission Masks

8.1 Test Procedure

ANSI/TIA/EIA-603-2004, section 2.2.11

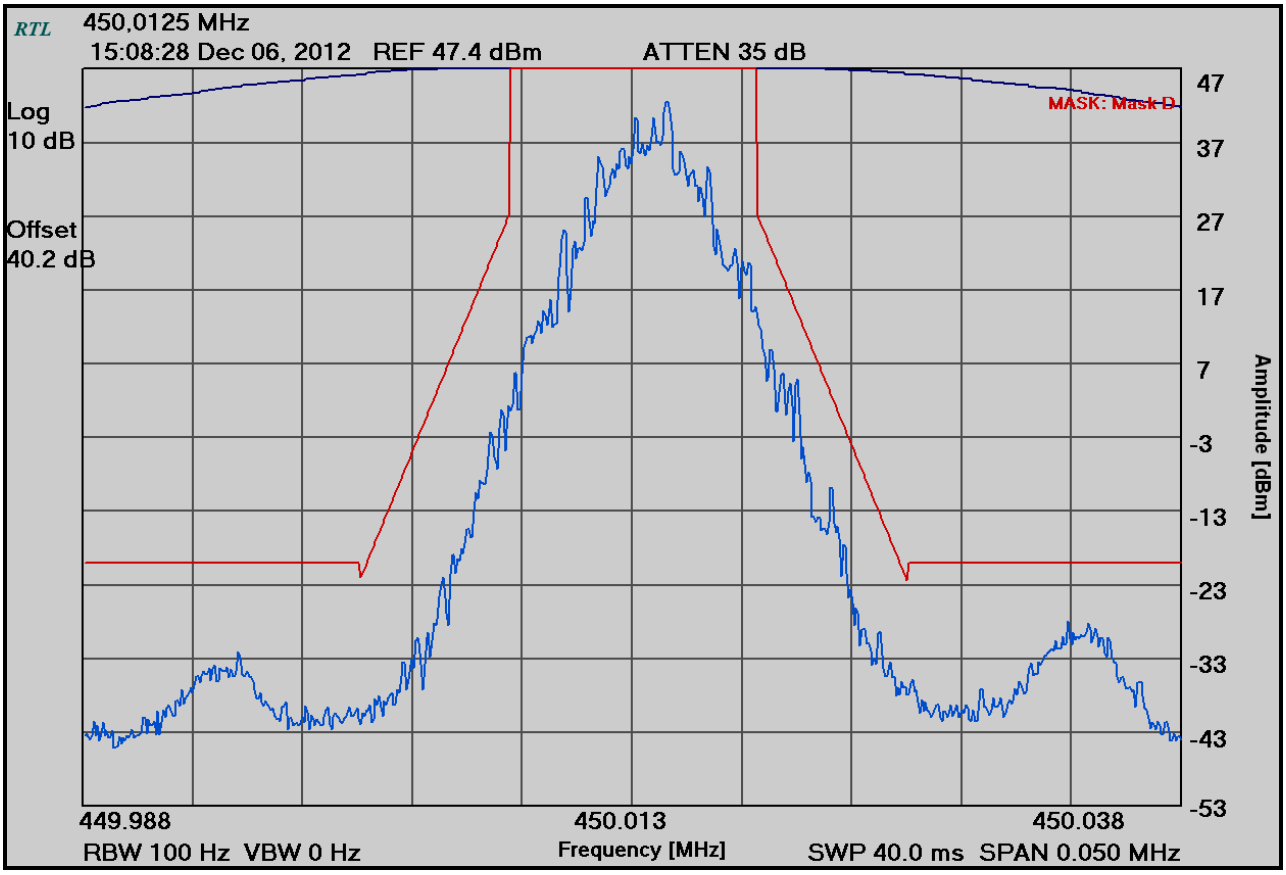
Device with digital modulation: Modulated to its maximum extent using a pseudo-random data sequence.

Applicable Emission Masks		
Frequency Band (MHz)	**Mask for Equipment With Audio Low Pass Filter**	**Mask for Equipment Without Audio Low Pass Filter**
Below 25 [1]	A or B	A or C
25–50	B	C
72–76	B	C
150–174 [2]	B, D, or E	C, D, or E
150 Paging-only	B	C
220–222	F	F
421–512 [2]	B, D, or E	C, D, or E
450 Paging-only	B	G
806–809/851–854	B	H
809–824/854–869 [3]	B	G
896–901/935–940	I	J
902–928	K	K
929–930	B	G
4940–4990 MHz	L or M	L or M
5850–5925 [4]		
All other bands	B	C

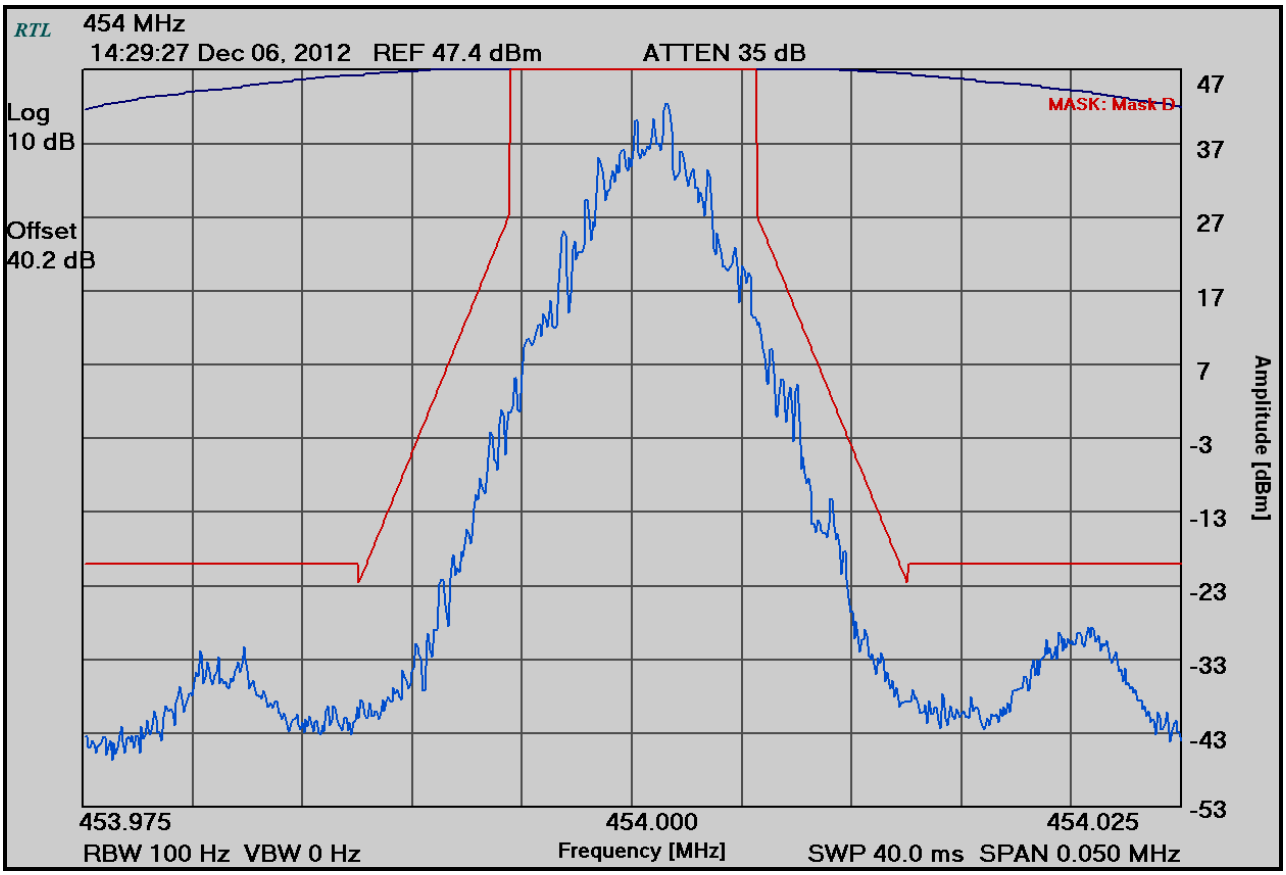
[1] Equipment using single sideband J3E emission must meet the requirements of Emission Mask A. Equipment using other emissions must meet the requirements of Emission Mask B or C, as applicable.
[2] Equipment designed to operate with a 25 kHz channel bandwidth must meet the requirements of Emission Mask B or C, as applicable. Equipment designed to operate with a 12.5 kHz channel bandwidth must meet the requirements of Emission Mask D, and equipment designed to operate with a 6.25 kHz channel bandwidth must meet the requirements of Emission Mask E.
[3] Equipment used in this licensed to EA or non-EA systems shall comply with the emission mask provisions of §90.691.
[4] DSRCS Roadside Unit equipment in the 5850–5925 MHz band is governed under subpart M of this part.

8.2 Test Data

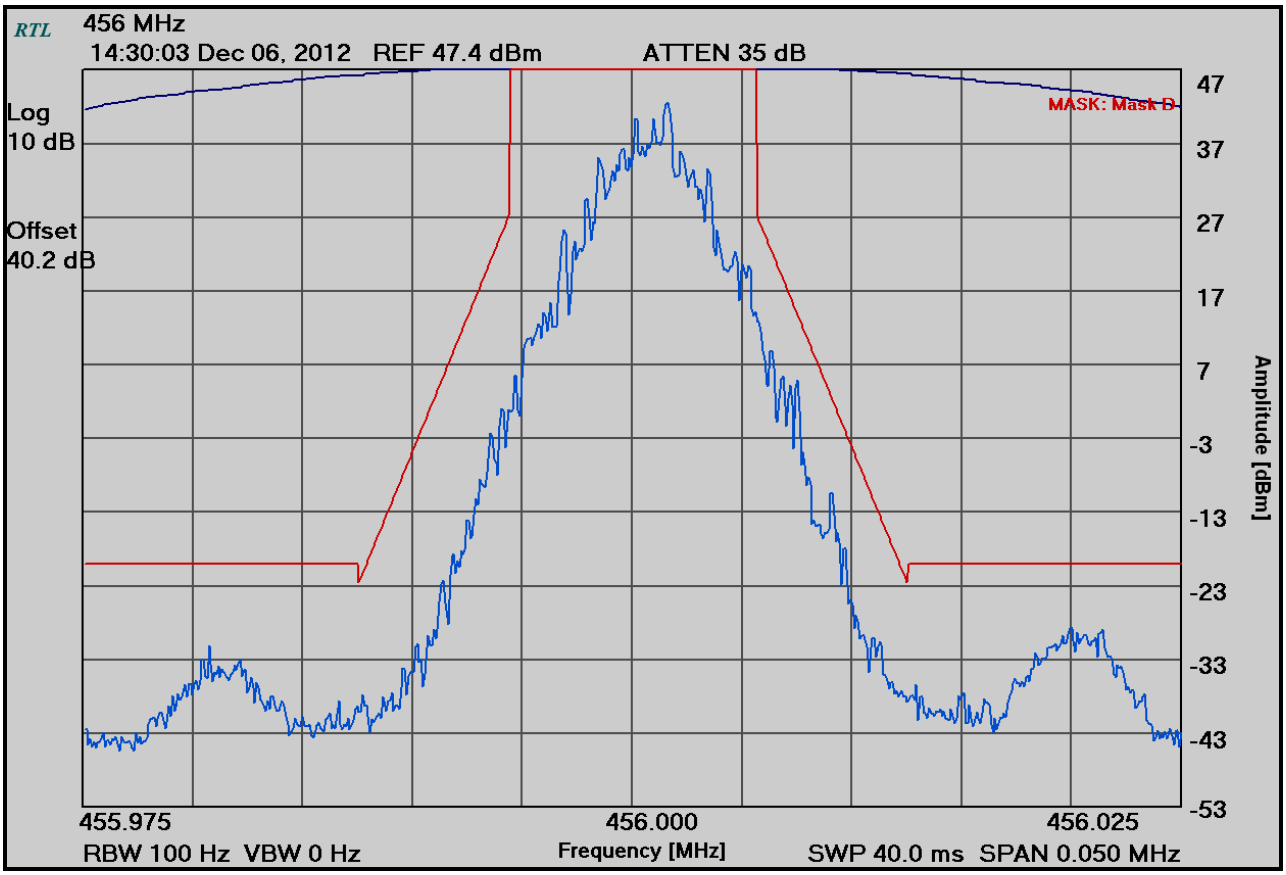
Plot 8-1: Occupied Bandwidth – 450.0125 MHz; Mask D



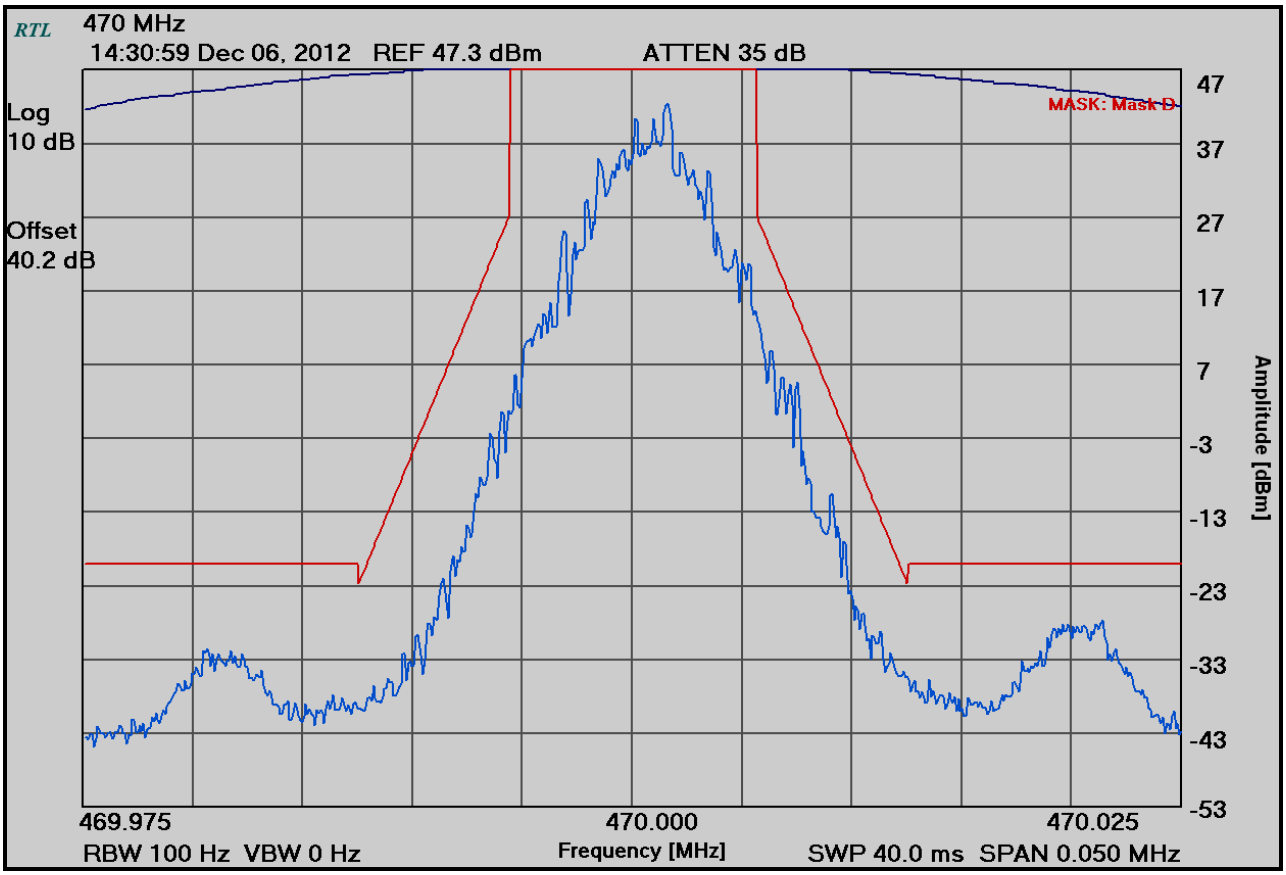
Plot 8-2: Occupied Bandwidth – 454.0000 MHz; Mask D



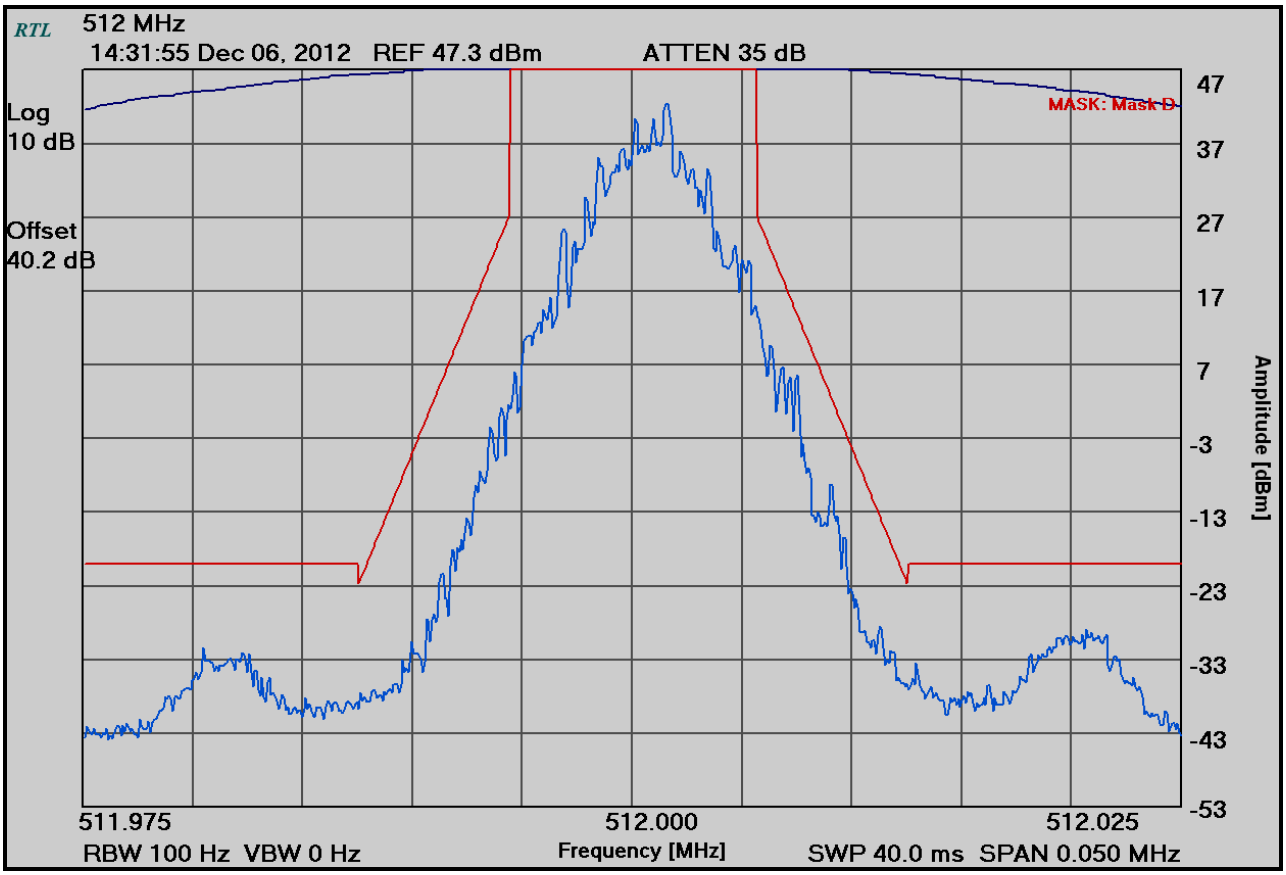
Plot 8-3: Occupied Bandwidth – 456.0000 MHz; Mask D



Plot 8-4: Occupied Bandwidth – 470.0000 MHz; Mask D



Plot 8-5: Occupied Bandwidth – 512.0000 MHz; Mask D



Plot 8-6: Occupied Bandwidth – 519.9875 MHz; Mask D

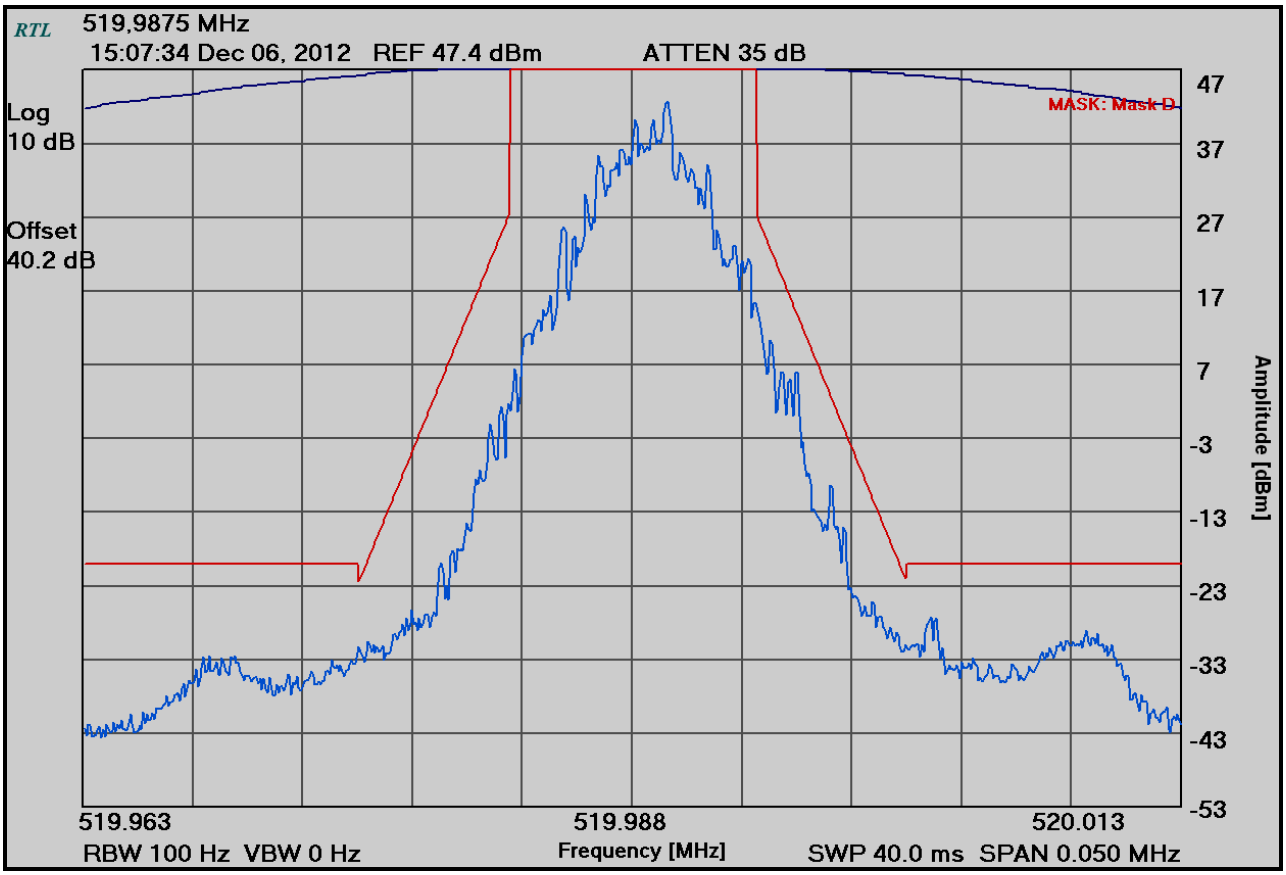


Table 8-1: Test Equipment Used For Testing Occupied Bandwidth

RTL Asset #	Manufacturer	Model	Part Type	Serial Number	Calibration Due Date
901581	Rohde & Schwarz	1166.1660.50	Spectrum Analyzer	2001006	6/3/13
901536	Aeroflex	48-40-34	40 dB Attenuator	CB6627	10/14/13
901594	Insulated Wire Inc.	KPS-1503-360-KPR	SMK RF Cables 36"	NA	8/16/13

Test Personnel:

Daniel Baltzell		December 6, 2012
Test Engineer	Signature	Date of Tests

9 FCC Rules and Regulation Part 2.1055: Frequency Stability; Part 90.213: Frequency Stability; IC RSS-119 5.3 Transmitter Frequency Stability

9.1 Test Procedure

ANSI/TIA-603-C-2004, section 2.2.2.

The carrier frequency stability is the ability of the transmitter to maintain an assigned carrier frequency.

The EUT was evaluated over the temperature range -30°C to +60°C.

The temperature was initially set to -30°C and a 2-hour period was observed for stabilization of the EUT. The EUT was then operated in standby mode for 15 minutes before proceeding. The frequency stability was measured within one minute after application of primary power to the transmitter. The temperature was raised at intervals of 10°C through the range. A ½ hour period was observed to stabilize the EUT at each measurement step, and the frequency stability was measured within one minute after application of primary power to the transmitter. Additionally, the power supply voltage of the EUT was varied +/-15% nominal input voltage.

Limit for frequency block 400–470 MHz for Base Station: 5ppm

The worst case test data are shown below in Table 9-1 and Table 9-2.

9.2 Test Data

9.2.1 Temperature Frequency Stability

Table 9-1: Temperature Frequency Stability – 454.0000 MHz

Temperature (°C)	Measured Frequency (Hz)	ppm
-30	454.000045	0.10
-20	454.000004	0.01
-10	454.000004	0.01
0	454.000041	0.09
10	453.999994	-0.01
20 (reference)	454.000000	0.00
30	454.000011	0.02
40	453.999958	-0.09
50	454.000023	0.05
60	454.000058	0.13

Table 9-2: Temperature Frequency Stability – 470.0000 MHz

Temperature (°C)	Measured Frequency (Hz)	ppm
-30	470.000044	0.09
-20	470.000071	0.15
-10	470.000015	0.03
0	470.000044	0.09
10	470.000013	0.03
20 (reference)	470.000000	0.00
30	470.000002	0.00
40	469.999997	-0.01
50	470.000059	0.13
60	470.000109	0.23

Results: The EUT is compliant.

9.2.2 Frequency Stability/Voltage Variation

Table 9-3: Frequency Stability/Voltage Variation – 454.0000 MHz

Voltage (VDC)	Measured Frequency (Hz)	ppm
97.75	454.000012	0.03
115.00	454.000000	0.00
132.25	453.999976	-0.05

Table 9-4: Frequency Stability/Voltage Variation – 470.0000 MHz

Voltage (VDC)	Measured Frequency (Hz)	ppm
97.75	454.000012	0.03
115.00	454.000000	0.00
132.25	453.999976	-0.05

Table 9-5: Test Equipment Used For Testing Frequency Stability

RTL Asset #	Manufacturer	Model	Part Type	Serial Number	Calibration Due Date
900946	Tenney Engineering, Inc.	TH65	Temperature Chamber with Humidity	11380	1/13/13
901300	Agilent Technologies	53131A	Frequency Counter	MY40001345	7/18/13
901536	Aeroflex	48-40-34	40 dB Attenuator	CB6627	10/14/13
901350	Meterman	33XR	Multimeter	040402802	12/28/12
901594	Insulated Wire Inc.	KPS-1503-360-KPR	SMK RF Cables 36"	NA	8/16/13

Test Personnel:

Daniel Baltzell		December 8, 2012
EMC Test Engineer	Signature	Date of Test

10 FCC Part 2.1047: Modulation Characteristics; IC RSS-119 5.8 Types of Modulation

No data is presented since the radio is digitally modulated.

11 FCC Rules and Regulations Part 2.202: Necessary Bandwidth and Emission Bandwidth

Type of Emissions: DXW

Calculation:
Data rate in bps (R) = 8000
Peak deviation of carrier (D) = 1800
Bn = [8000/$\log_2$(4) + 2 (1800) (1) = 7.600 kHz
Emission designator: 7K60FXD/E

12 Conclusion

The data in this measurement report shows that the Harris Corporation UHF-H base station radio, Model HD-4CU2, FCC ID: OWDTR-0104-E, IC: 3636B-0104, complies with all the applicable requirements of Parts 90 and 2 of the FCC Rules and Industry Canada RSS-119.