FCC Part 15.247
Transmitter Certification

Frequency Hopping Spread Spectrum Transmitter

Test Report

FCC ID: TEB-AIRPT657

FCC Rule Part: 15.247

Test Begin Date: March 15, 2006
Test End Date: April 7, 2006

Report Issue Date: April 11, 2006

Hunt Technologies, Inc.
6436 County Rd. 11
Pequot Lakes, MN 56472

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1.0 GENERAL

1.1 Purpose
The purpose of this report is to demonstrate compliance with Part 15, Subpart C of the FCC's Code of Federal Regulations.

1.2 Product Description

1.2.1 General
The High Power AirPoint (FASY-0657-0001) consists of a GE solid-state, single phase meter measuring electrical energy consumption integrated with a Hunt Technologies transmitter on a single printed circuit board. The Hunt Technologies transmitter is a frequency hopping spread spectrum transmitter utilizing OOK modulation. The FASY-0657-0001 will be a transmit-only meter module that collects and transmits metering data over the 902 - 928 MHz Industrial, Scientific and Medical (ISM) RF band.

Exhibits A and B are detailed internal and external photographs of the EUT.

1.2.2 Intended Use
The FASY-0657-0001 will be a transmit-only meter module that collects and transmits metering data over the 902-928 MHz ISM Band for collection by electric utility companies.

2.0 STATEMENT OF COMPLIANCE

§2.907 Certification
This is an application for certification.

§2.911 Application
a) This is an application and has been filed electronically with form 731.
b) All information required has been supplied.
c) The applicant has signed the application (electronically).
d) The technical data has been signed.
e) Applicant signature block on electronic form 731 completed by officer of the company or authorized company personnel.
f) The appropriate fee has been paid.

§2.915 Grant
This application demonstrates that all applicable technical standards have been met and a grant of this application will serve the public interest.

§2.925 Label
Each piece of equipment for which authorization will be granted will be uniquely identified with "FCC ID: TEB-AIRPT657." The required statement will appear with the FCC ID on the outside cover of the product. Exhibit C shows the external label and Exhibit D shows the internal label that will go on the PCB.

§2.947 Measurement Procedure

a) The scan of the restricted bands was made in a radiated manner. The radiated measurement procedure follows ANSI C63.4 procedure.
b) All other RF measurements were made in a conducted manner.
c) Procedural notes are contained in the laboratory report.
d) A list of test equipment used is contained in the lab report.

§2.948 Description of Measurement Facilities

Measurements were performed at TUV Testing Services Open Test Site. The FCC keeps a full description of the measurement facilities on file. TUV's acceptance and approval is dated as December 5, 1993 in a letter received from the FCC.

The address of the test facility is:

TÜV Product Service
19035 Wild Mountain Road
Taylors Falls, MN 55084-1758

Phone: 651-638-0297
Contact: Joel Schneider
Test Engineer in Charge

See Exhibit E, "Radiated_setup.pdf" for a sketch of radiated measurement setup.

The radiated emissions, the power line conducted emissions, and the RF conducted spurious emissions were tested at TUV.

The remainder of the RF conducted emissions tests (including peak output power, channel usage requirements tests, and band edge compliance) were done at the following address:

Hunt Technologies, Inc.
6436 County Rd. 11
Pequot Lakes, MN 56472

§2.1033 Application for Certification

a) Form 731 has been electronically filed on 4/11/2006. Items that did not apply were left blank.
b) This technical report contains the following information where applicable.
   1. Full name and mailing address of manufacturer and applicant for certification:
      Hunt Technologies, Inc.
      6436 County Rd. 11
      Pequot Lakes, MN 56472
   2. FCC Identifier:
      TEB-AIRPT657
   3. Brief Description of circuit functions and device operation:
      See Exhibit F, "Op Statement.pdf" for operational description
      See Exhibit G, "SCHM-00060_Rev05.pdf" for schematic
   4. Block Diagram:
      See Exhibit H, "block diagram.pdf"
   5. Report of the measurements of radiated and conducted emissions:
      See figs. in section 6 and Exhibits J and K shown and discussed later in this report
   6. Photographs
      External: See Exhibit A, "Exterior Photo.pdf"
      Internal: See Exhibit B, "Interior Photos.pdf"
      Test Setup: See Exhibit M, "Test Setup Photos.pdf"

7. Peripheral or Accessory devices:
   There are no peripheral or accessory devices designed to operate with this product.
8. Transition Rules
   This application is not pursuant to the transition rules of §15.37
9. Application for scanning receivers:
   Not applicable to this device.
10. Application for operation within the 59-64GHz band:
    Not applicable to this device.

c) Composite Systems
   Not applicable to this device.

d) Software Defined Radio
   Not applicable to this device. See Exhibit I, "SDR.pdf"

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 2004)

US Code of Federal Regulations (CFR): Title 47, Part 15, Subpart C: Radio Frequency Devices, Intentional Radiators (October 2004)

FCC OET Bulletin 65 Appendix C - Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields

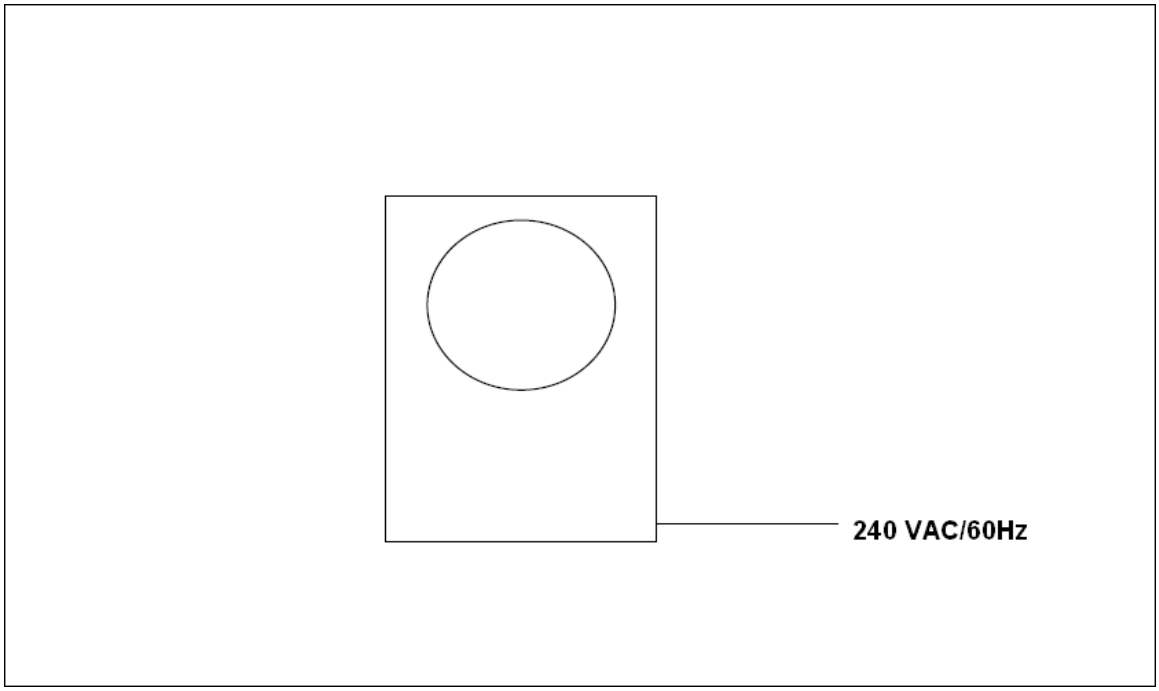
4.0 LIST OF TEST EQUIPMENT

All test equipment used for regulatory testing is calibrated yearly or according to manufacturer's specifications. The equipment used to do all Radiated testing, RF conducted spurious emissions, and Power Line Conducted Emissions is the property of TUV Product Services and is located at their Taylor's Falls facility. The FCC keeps a full description of TUV's measurement facilities on file. The equipment listed below is property of Hunt Technologies and was used at Hunt Technologies' facility to do all RF conducted measurements except for spurious emissions.

Table 4.0-1: Test Equipment

Mfg.	Eq. Type	Model	S/N	Cal. Due
Agilent	EMC Analyzer	E7401A	US40240359	7/13/2006
Fluke	DMM	87V	-	No cal. required

5.0 EQUIPMENT UNDER TEST SETUP BLOCK DIAGRAM



6.0 SUMMARY OF TESTS
Along with the tabular data shown below, plots were taken of all signals deemed important enough to document.

6.1 Frequencies to be Examined [§15.31(m)]
In accordance with the guidelines of §15.31(m), all conducted and radiated measurements were performed at the lowest (909.586 MHz), middle (915.614 MHz), and highest (921.773 MHz) frequencies that the product will transmit.

6.2 Antenna Requirement [§15.203]
The transmitter antenna is integral to the circuit board, and therefore complies with the requirement that no other antenna shall be used with the device.

6.3 Antenna Characteristics [§15.204]
There is only one antenna proposed for use with this device. This antenna has the following characteristics:

6.3.1 Antenna Type
The antenna is approximately a ¼ wave monopole at 915 MHz.

6.3.2 Antenna Manufacturer
None; the antenna is part of the printed circuit board.

6.3.3 Antenna Gain
The ¼ wave monopole is a well known antenna type. The theoretical gain of an ideal ¼ wave monopole is 5.15 dBi. The antenna on this transmitter has some non-ideal characteristics. The finite ground plane is the most significant non-ideal characteristic. Therefore, the antenna gain will be somewhat lower than the ideal number of 5.15 dBi.

6.4 Power Line Conducted Emissions [§15.207]

6.4.1 Test Methodology
ANSI C63.4 sections 6 and 7 were the guiding documents for this evaluation. Conducted emissions were performed from 150 kHz to 30 MHz.

6.4.2 Test Results
The summary of the results are shown below in table 6.4-1. For the complete test report, see Exhibit J, "cond_em.pdf"

Table 6.4-1: Power Line Conducted Emissions Summary

Measurement summary for limit1: FCC CLASS B - PK (Pk)					
FREQ	LEVEL (dBuV)	CABLE / ANT / PREAMP / ATTEN (dB)	FINAL (dBuV / m)	POL / HGT / AZ (m)(DEG)	DELTA1 FCC CLASS B - PK
1.844 GHz	75.8 Pk	4.04 / 27.06 / 49.78 / 0.0	57.12	V / 1.20 / 2	-16.88
2.729 GHz	70.6 Pk	4.57 / 29.38 / 48.26 / 0.0	56.3	H / 1.20 / 0	-17.7
2.747 GHz	68.1 Pk	4.6 / 29.42 / 48.26 / 0.0	53.86	H / 1.50 / 0	-20.14
2.765 GHz	64.15 Pk	4.63 / 29.45 / 48.26 / 0.0	49.97	H / 1.20 / 0	-24.03
5.457 GHz	48.65 Pk	6.8 / 33.36 / 44.67 / 0.0	44.13	V / 1.20 / 2	-29.87
1.066 GHz	62.44 Pk	2.73 / 25.17 / 49.23 / 0.0	41.12	V / 1.20 / 0	-32.88
1.008 GHz	59.95 Pk	2.65 / 25.2 / 48.79 / 0.0	39.01	V / 1.20 / 0	-34.99
1.062 GHz	55.7 Pk	2.73 / 25.18 / 49.2 / 0.0	34.41	V / 1.20 / 0	-39.59

6.5 Radiated Emissions [§15.109] and Radiated Spurious Emissions (Restricted Bands) [§15.205]

6.5.1 Test Methodology
Radiated emissions tests were performed over the frequency range of 30MHz to 1 GHz and in the restricted bands up to 10 GHz with the transmitter generating a continuous carrier on the designated channel. This test was done at the lowest, middle, and highest transmit frequencies. 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 EUT was rotated through 360° and the receive antenna height was varied from 1m to 3m 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 120 kHz and a video bandwidth (VBW) of 300 kHz. For frequencies above 1000MHz, average measurements were made using an RBW of 1 MHz and a VBW of 10 Hz and peak measurements were made with RBW of 1 MHz and a VBW of 1 MHz. See Exhibit E, "Radiated_setup.pdf," for a sketch of the test setup.

6.5.2 Calculation of allowed limit for Radiated Spurious Emissions
For spurs above 1000 MHz, §15.205(b) allows duty cycle averaging per §15.35. The following is the derivation of the allowed duty cycle correction factor for this transmitter.

The transmitter employs amplitude modulation and transmits 96 bits. Each bit is 61us long. The total time of a single packet is:

96 * 61 us = 5.86 ms.

The interpacket delay time is at least 250ms, enforced by software, which ensures that only one packet is sent in any given 100 ms window. The duty cycle correction factor is therefore:

20 * log(5.86ms/100) = -24.6 dB

The limit for peak transmissions can be relaxed up to 20 dB above the average limit for spurs falling above 1 GHz. After adding 20 dB to the 54 dBuV/m limit, the limit for this transmitter for spurs above 1 GHz is 74 dBuV/m.

6.5.3 Test Results

Radiated spurious emissions found in the band of 30MHz to 10GHz are all below the applicable limits. Each emission found to be in a restricted band as defined by section 15.205, was compared to the radiated emission limits as defined in section 15.209. Results are shown in Exhibit K, "rad_em.pdf"

6.6 Peak Output Power – [§15.247(b)(2)]

6.6.1 Test Methodology (Conducted Method)

The 20dB bandwidth of the EUT was within the resolution bandwidth of spectrum analyzer, therefore the power measurement was made using the spectrum analyzer method. The resolution and video bandwidth were set to > 20 dB bandwidth of the emission measured (300 kHz/1 MHz). The device employs 50 channels, therefore the power is limited to 1 Watt.

6.6.2 Test Results

Results are shown below in table 6.6-1 and the worst case was plotted and shown in figure 6.6-1 to 6.6-3 below:

Table 6.6-1: RF Output Power

Frequency (MHz)	Level (dBm)
909.5861	21.7
915.6142	21.54
921.7733	20.86

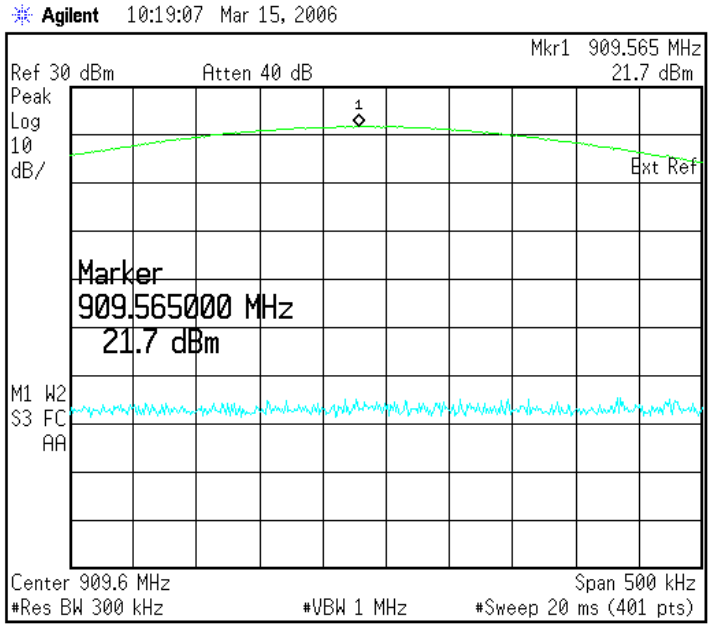


Figure 6.6-1: Output Power – Low Channel

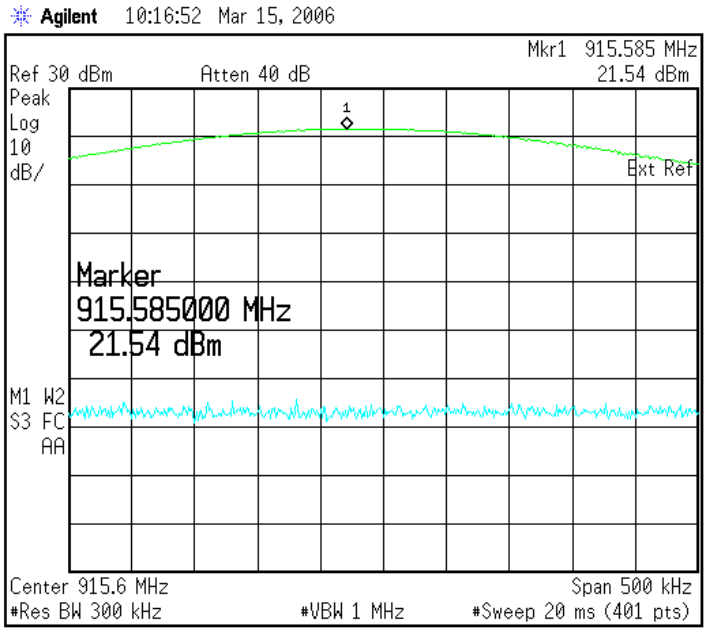


Figure 6.6-2: Output Power – Mid Channel

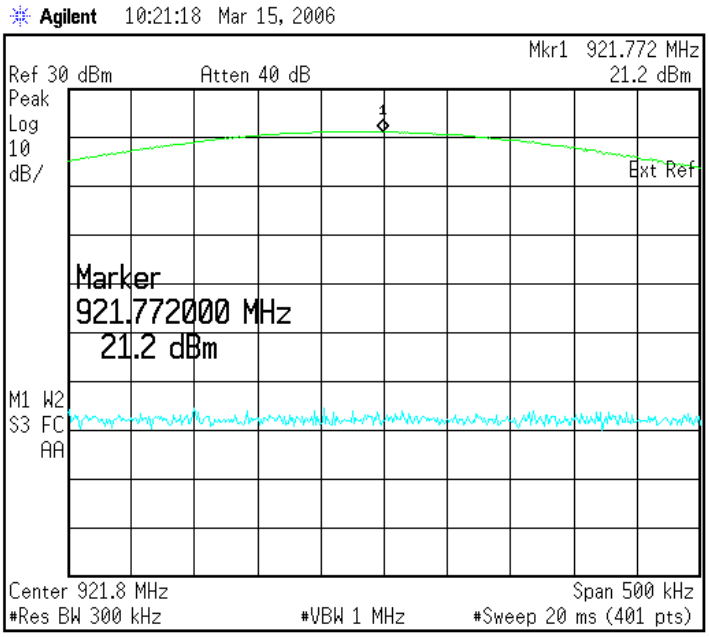


Figure 6.6-3: Output Power – High Channel

6.6.3 De Facto EIRP Limit

The gain of the transmit antenna is given earlier in this report. Because the gain of the antenna is less than 6 dBi, the peak output power need not be reduced to comply with this requirement.

6.6.4 RF Exposure Compliance Requirements

This device is not intended to operate within 20 cm of a person's body. Therefore, RF exposure requirements are not applicable to this application for certification.

6.7 Channel Usage Requirements [§15.247(a) (1)]

15.247(a)(1): Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

15.247(a) (1) (i): For frequency hopping systems operating in the 902–928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

6.7.1 Carrier Frequency Separation

6.7.1.1 Test Methodology

The span of the spectrum analyzer was set wide enough to capture two adjacent peaks and the RBW and VBW were set to ≥ 1% of the span.

6.7.1.2 Test Results

The maximum 20dB bandwidth of the hopping channel was measured to be 112.50 kHz (See figure 6.7.4-1 to 6.7.4-3 below). The adjacent channel separation was measured to be 196.0 kHz. Results are shown in figure 6.7.1-1 below:

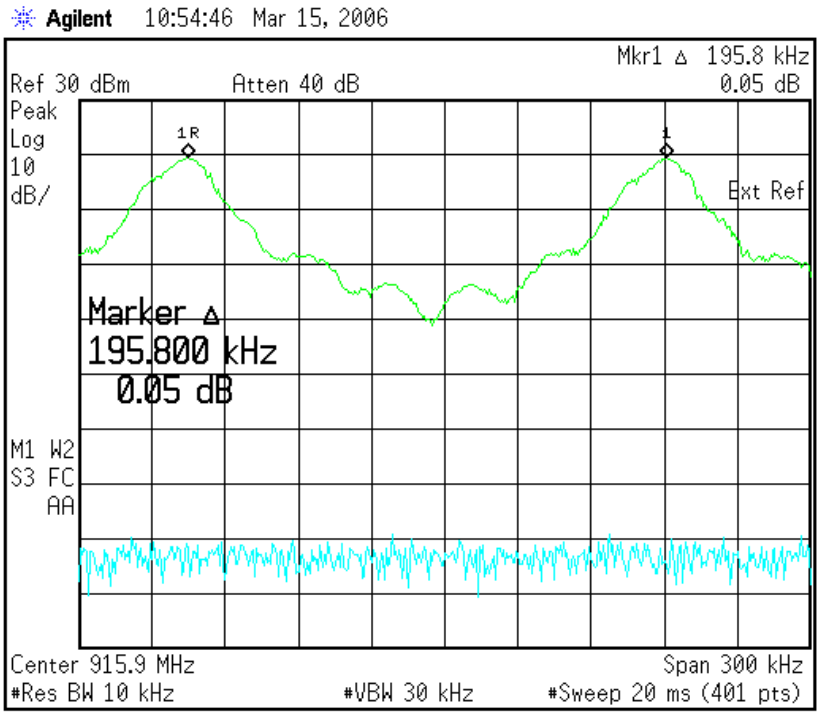


Figure 6.7.1-1: Carrier Frequency Separation

6.7.2 Number of Hopping Channels

The 20dB bandwidth of the device is less than 250 kHz. The device employs 50 hopping channels as required. A list of the 50 channels in pseudo-random order resides in non-volatile memory. The device starts at the first frequency in the list, then proceeds through to the end of the list, looping back around to the first frequency when done. This guarantees equal usage of all 50 channels. There are 256 versions of this list, and the version of the list that is put in a particular unit is dependent on the last byte of its ID. Exhibit L, "freq hop table.pdf" lists the 256 versions of the 50-channel ordering. Table 6.7.2-1 below lists the frequencies of all 50 channels:

Offset (Base = 1594)	Value	Channel Frequency (Hz)	Channel No.
0	1594	909586111	0
3	1597	909782679	1
6	1600	909979247	2
9	1603	910175815	3
25	1619	911224178	4
28	1622	911420746	5
31	1625	911617314	6
34	1628	911813882	7
37	1631	912010451	8
40	1634	912207019	9
43	1637	912403587	10
46	1640	912600155	11
49	1643	912796723	12
52	1646	912993291	13
55	1649	913189859	14
58	1652	913386427	15
61	1655	913582995	16
64	1658	913779563	17
67	1661	913976132	18
83	1677	915024495	19
86	1680	915221063	20
89	1683	915417631	21
92	1686	915614199	22
95	1689	915810767	23
98	1692	916007335	24
101	1695	916203903	25
104	1698	916400471	26
107	1701	916597040	27
110	1704	916793608	28
113	1707	916990176	29
116	1710	917186744	30
119	1713	917383312	31
122	1716	917579880	32
125	1719	917776448	33
141	1735	918824811	34
144	1738	919021379	35
147	1741	919217947	36
150	1744	919414516	37
153	1747	919611084	38

156	1750	919807652	39
159	1753	920004220	40
162	1756	920200788	41
165	1759	920397356	42
168	1762	920593924	43
171	1765	920790492	44
174	1768	920987060	45
177	1771	921183628	46
180	1774	921380197	47
183	1777	921576765	48
186	1780	921773333	49

Table 6.7.2-1: Frequency Table

6.7.3 Channel Dwell Time

6.7.3.1 Test Methodology

The analyzer is centered on the measured emission's center frequency and the span set to 0 Hz. The RBW was set to 1 MHz and the VBW to 300 kHz. Sweep time was set to 20 ms to capture the burst duration of the emission. The marker –delta function of the analyzer was employed to measure the burst duration.

6.7.3.2 Test Results

The High Power AirPoint will operate with a transmission timing of 1 RF transmission every 2 seconds (minimum) randomized. The transmission time is < 7 milliseconds and there are 50 transmitter frequencies used. Based on the average timing of 2 seconds per transmission per channel the dwell time would be < 7 ms per channel within a 20 second period. A single transmission is shown in figure 6.7.3-1 below:

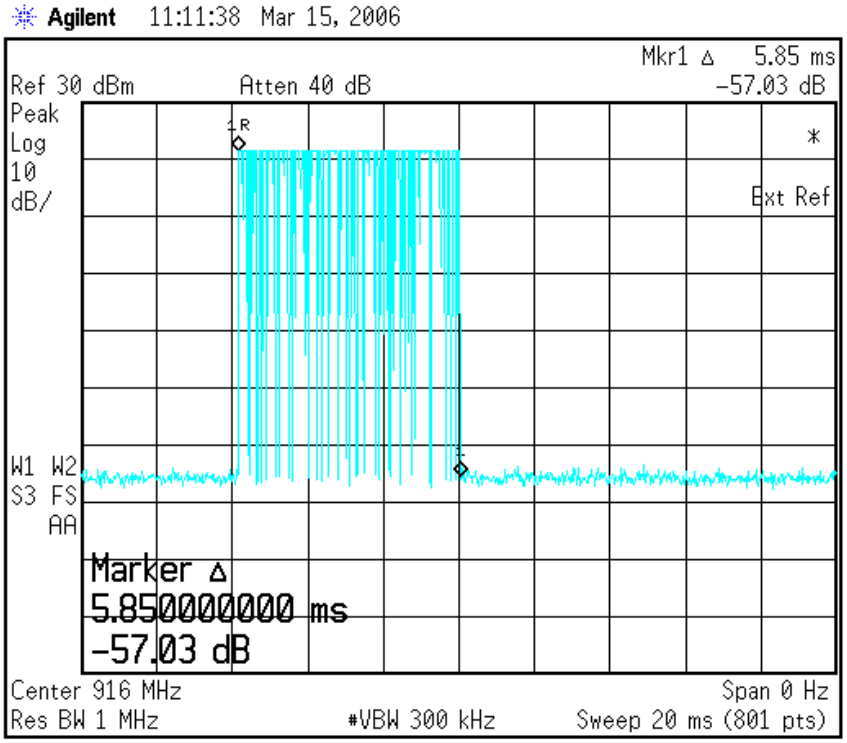


Figure 6.7.3-1: Channel Dwell Time

6.7.4 20dB Bandwidth

6.7.4.1 Test Methodology

The spectrum analyzer span was set to 2 to 3 times the estimated 20 dB bandwidth of the emission. The RBW was to ≥ 1% of the estimated 20 dB bandwidth. The trace was set to max hold with a peak detector active. The N-dB Down function of the analyzer was utilized to determine the 20 dB bandwidth of the emission. The span and RBW were examined and re-adjusted if necessary to meet the requirements of 2 to 3 time the 20 bandwidth for the span and ≥ 1% of the 20 dB bandwidth for the RBW.

6.7.4.2 Test Results

The maximum 20dB bandwidth was found to be approximately 112.5 kHz. Results are summarized below in table 6.7.4-1 below. Plots are shown below in Figure 6.7.4-1 through 6.7.4-3.

Table 6.7.4-1: 20dB Bandwidth

Channel	Frequency (MHz)	20dB Bandwidth (kHz)
Low	909.5861	111.9
Mid	915.6142	112.5
High	921.7733	112.5

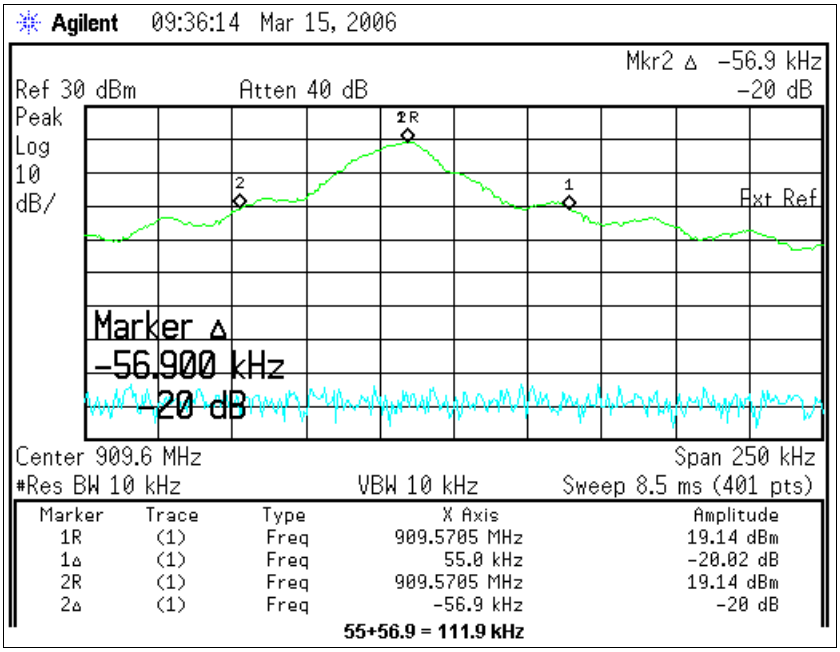


Figure 6.7.4-1: 20dB Bandwidth – Low Channel

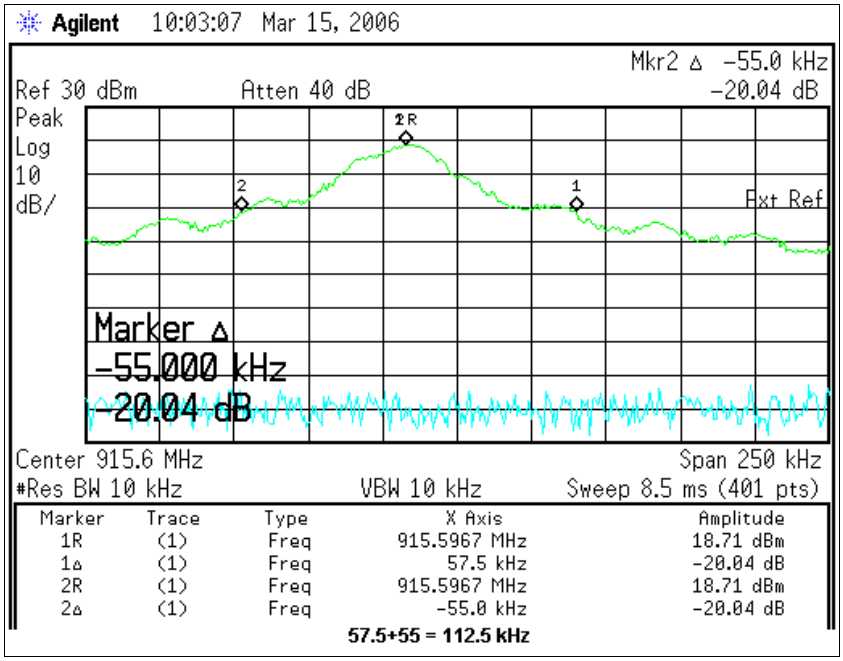


Figure 6.7.4-2: 20dB Bandwidth – Mid Channel

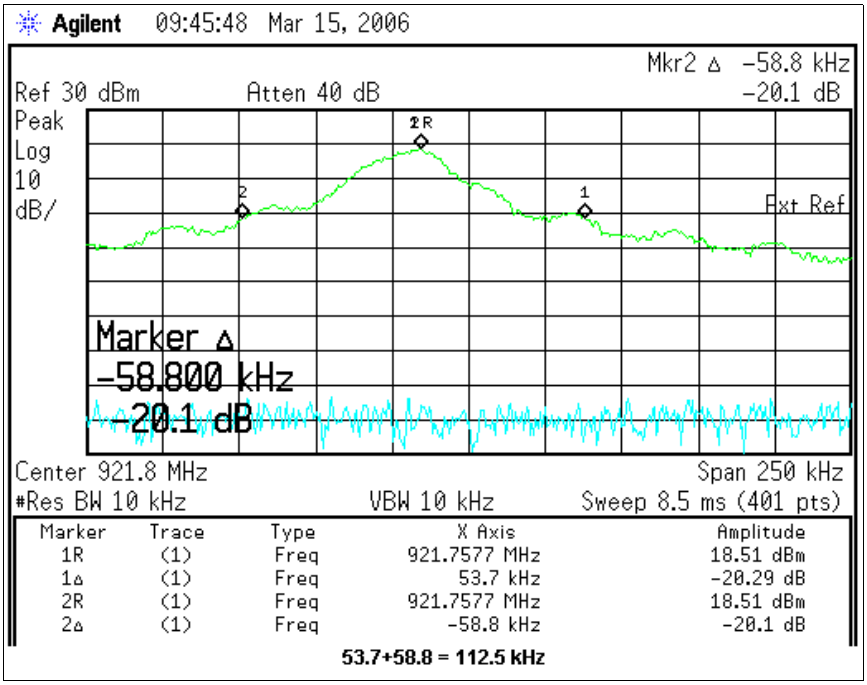


Figure 6.7.4-3: 20dB Bandwidth – High Channel

6.8 Band-Edge Compliance and Spurious Emissions [§15.247(c)]

6.8.1 Band-Edge Compliance of RF Conducted Emissions

6.8.1.1 Test Methodology

The EUT was investigated at the lowest and highest channel available to determine band-edge compliance. For each measurement the spectrum analyzer's RBW was set to 300 kHz, which is ≥1% of the span, and the VBW was set to 1 MHz.

6.8.1.2 Test Results

In a 100 kHz bandwidth at the lower and upper band-edge, the radio frequency power that was produced by the EUT is at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of desired power. Band-edge compliance is displayed in Figures 6.8.1-1 and 6.8.2-2.

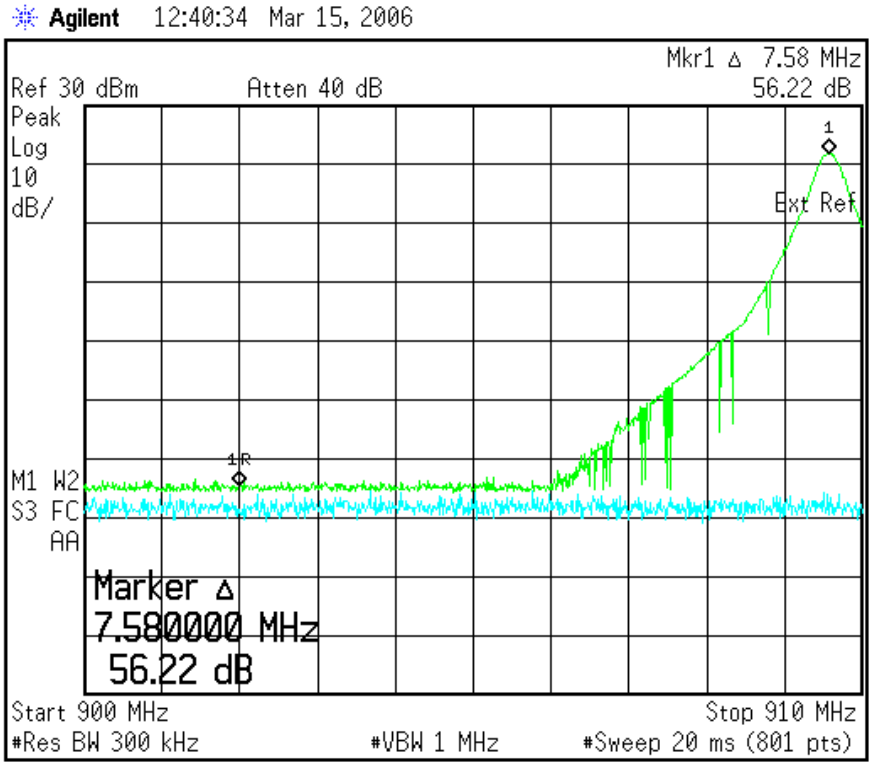


Figure 6.8.1-1: Lower Band-Edge

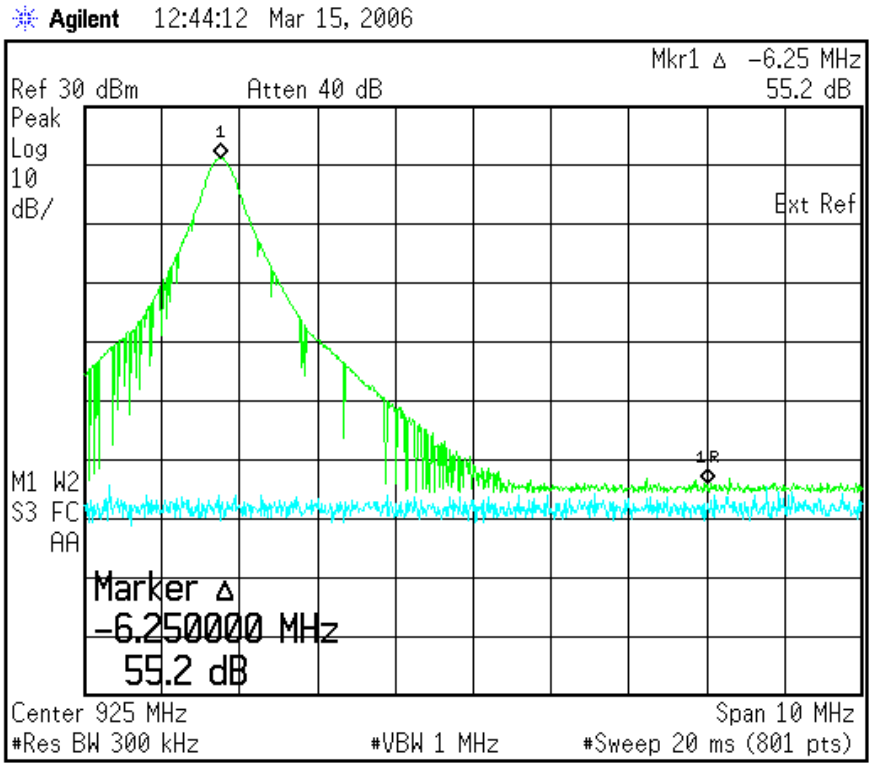


Figure 6.8.1-2: Upper Band-Edge

6.8.2 RF Conducted Spurious Emissions

6.8.2.1 Test Methodology

The EUT was investigated for conducted spurious emissions from 30MHz to 10GHz, 10 times the highest fundamental frequency. 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. A peak detector function was used with the trace set to max hold.

6.8.2.2 Test Results

All emission found were greater than 20dB down from the fundamental carrier. The RF conducted spurious emissions were measured in the band of 30MHz to 10GHz. Results are shown below in Figure 6.8.2-1 through 6.8.2-6.

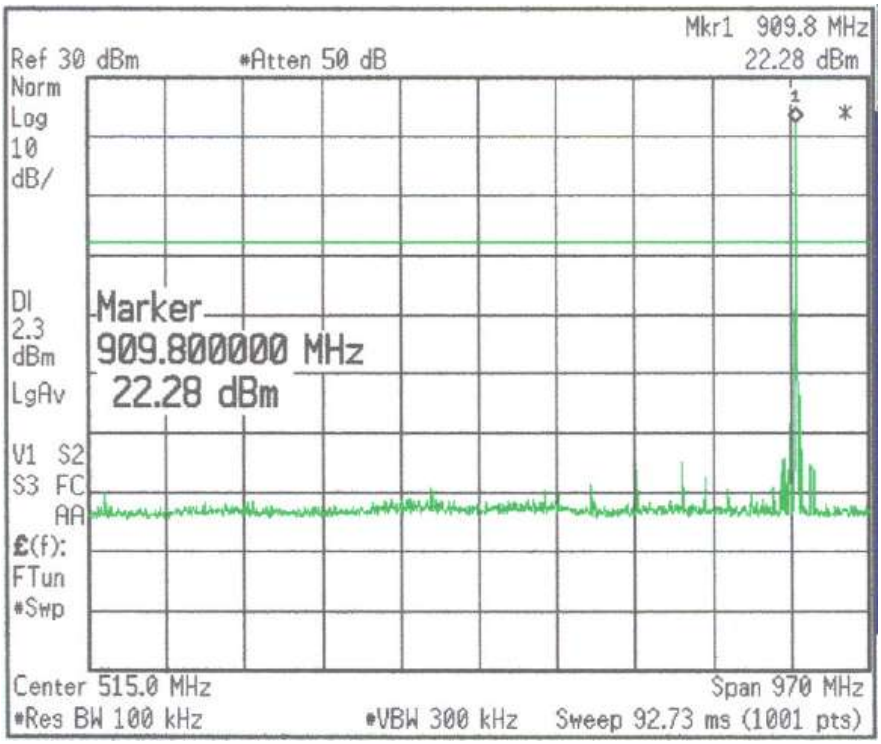


Figure 6.8.2-1: RF Conducted Spurious Emissions – Low Channel

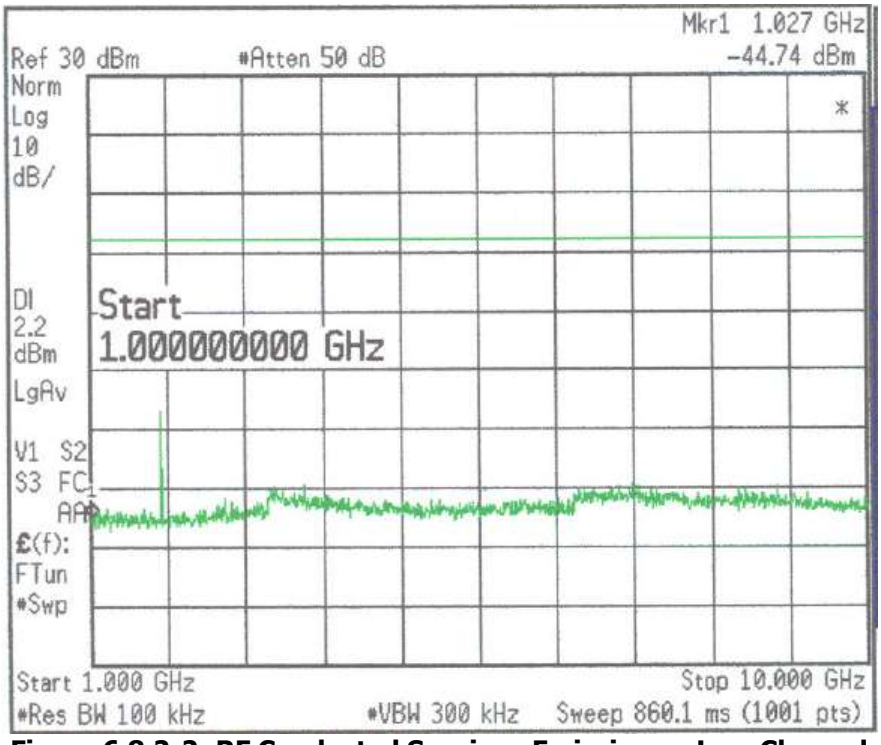


Figure 6.8.2-2: RF Conducted Spurious Emissions – Low Channel

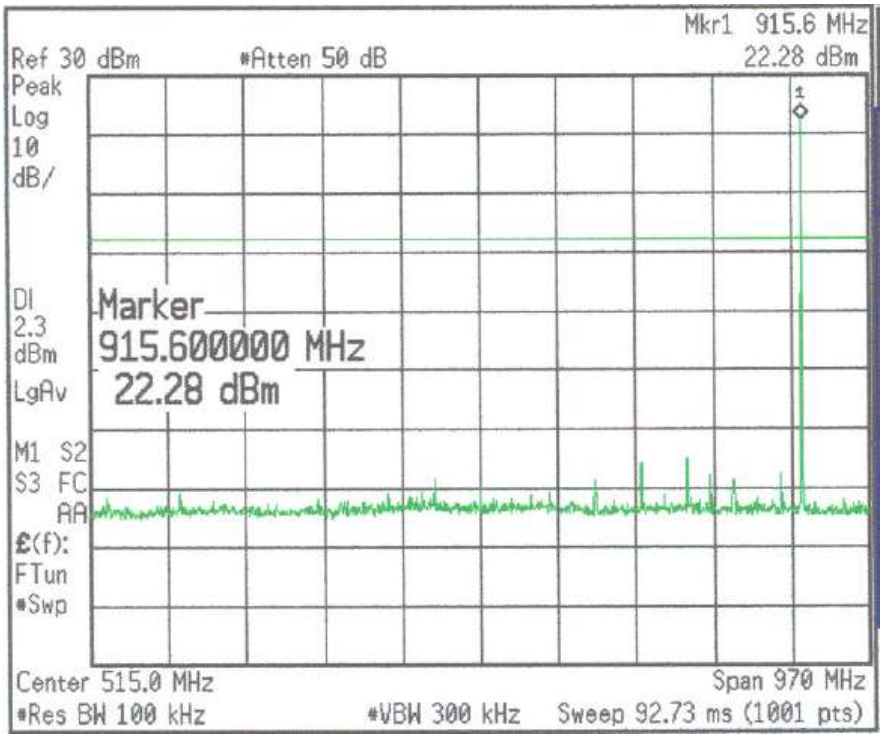


Figure 6.8.2-3: RF Conducted Spurious Emissions – Mid Channel

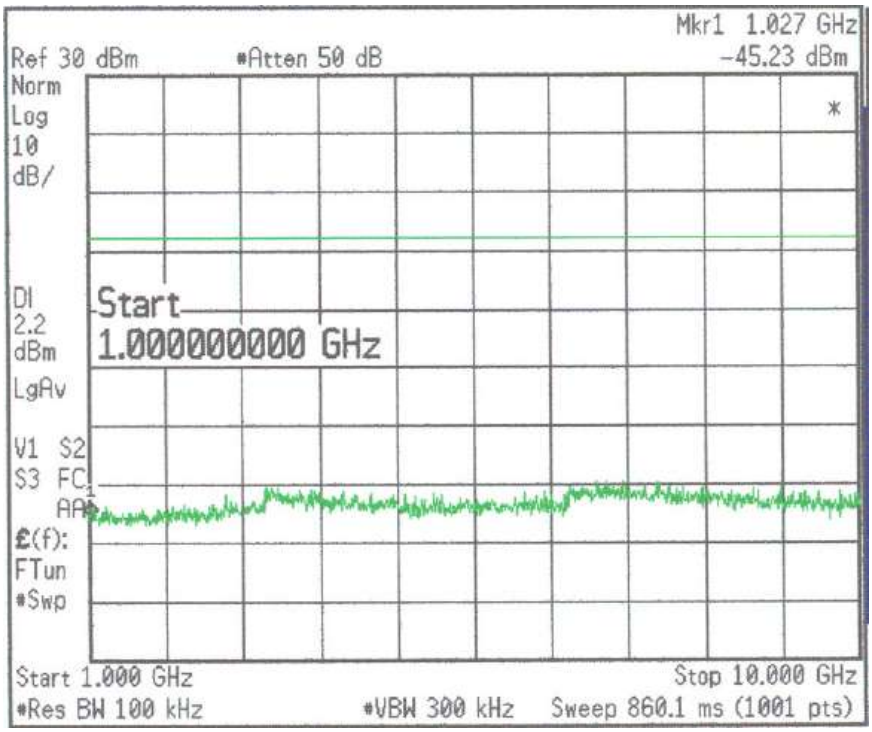


Figure 6.8.2-4: RF Conducted Spurious Emissions – Mid Channel

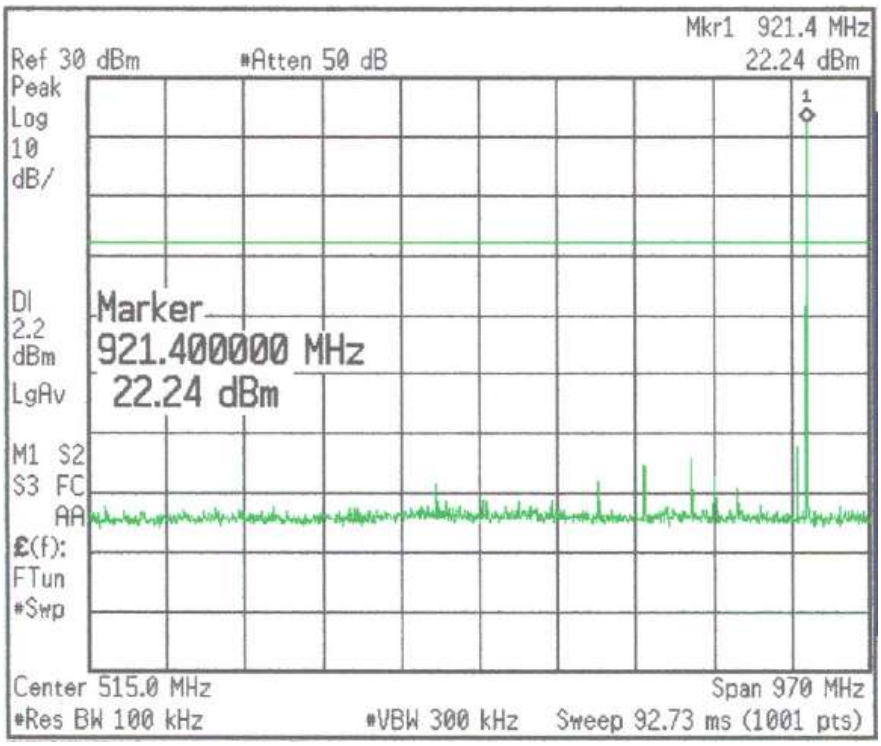


Figure 6.8.2-5: RF Conducted Spurious Emissions – High Channel

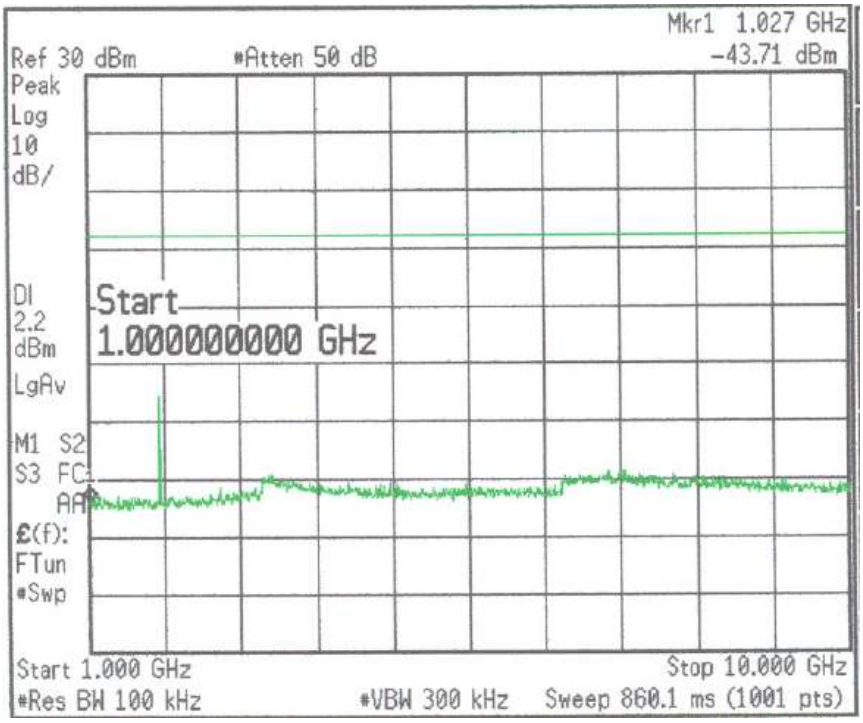


Figure 6.8.2-6: RF Conducted Spurious Emissions – High Channel

7.0 CONCLUSION

The HP AirPoint (FASY-0657-0001), manufactured by Hunt Technologies, Inc., meets the requirements of FCC Part 15 subpart C.