

FCC Part 15.247 Transmitter Certification

900 MHz ISM Band
Frequency Hopping Spread Spectrum Transmitter

Test Report

FCC ID: TEB-HUNTSU746

FCC Rule Part: 15.247

Test Begin Date: 4/18/2008
Test End Date: 7-17-08

Report Issue Date: 7-17-08

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Additional Exhibits Included In Filing

External Photograph
Internal Photographs
Product Labeling
Test Setup Description
Test Setup Photos

Software Defined Radio Statement
Conducted Emissions Test Report
Radiated Emissions Test Report
Operational Statement
Schematics

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**

Hunt Technologies' FOCUS AX Universal RF endpoint model 0746-0001 consists of a Landis & Gyr solid-state, single phase meter measuring electrical energy consumption integrated with a Hunt Technologies 900 MHz and a separate ZigBee transceiver on a single printed circuit board. The 900 MHz circuit, operating in the 902-928 MHz frequency band, is a frequency hopping spread spectrum transceiver utilizing GFSK modulation. The ZigBee circuit is a direct sequence spread spectrum transmitter operating in the 2400-2485.5 MHz unlicensed band and utilizing O-QPSK modulation.

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

1.2.2 Intended Use

The FOCUS AX Universal RF endpoint model 0746-0001 will be a transmitting and receiving meter module that collects and transmits metering data over the 902-928 MHz ISM band for collection by electric utility companies and over the 2400-2485.5 MHz ISM band for in-home "Personal Energy Management" applications. It also can receive and repeat data from other similar meter modules or a central collector module.

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

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

7/30/2008

Each piece of equipment for which authorization will be granted will be uniquely identified with "FCC ID: TEB-HUNTSU746." 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 is the product's ship-sheet (pamphlet) provided to the end-user that contains the required compliance statement as defined by §15.19.

§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 O, "Radiated Emissions sketch Exhibit O.pdf" for a sketch of radiated measurement setup.

The radiated emissions, the power line conducted emissions, the RF conducted emissions above 1 GHz, 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, band edge compliance, and part of the RF conducted spurious emissions) 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 TBD. 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-HUNTSU746
 - 3. Brief Description of circuit functions and device operation:
See Exhibit F, "Op Statement.pdf" for operational description

See Exhibit G, "Schematic Exhibit G.pdf" for schematic

4. Block Diagram:
See Exhibit H, "Block Diagram Exhibit H.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 Exhibit A.pdf"
Internal: See Exhibit B, "Interior Photos Exhibit B.pdf"
Test Setup: See Exhibit E, "Test Setup Photos Exhibit E.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 Statement Exhibit E.pdf"

3.0 APPLICABLE STANDARD REFERENCES

The following standards were used:

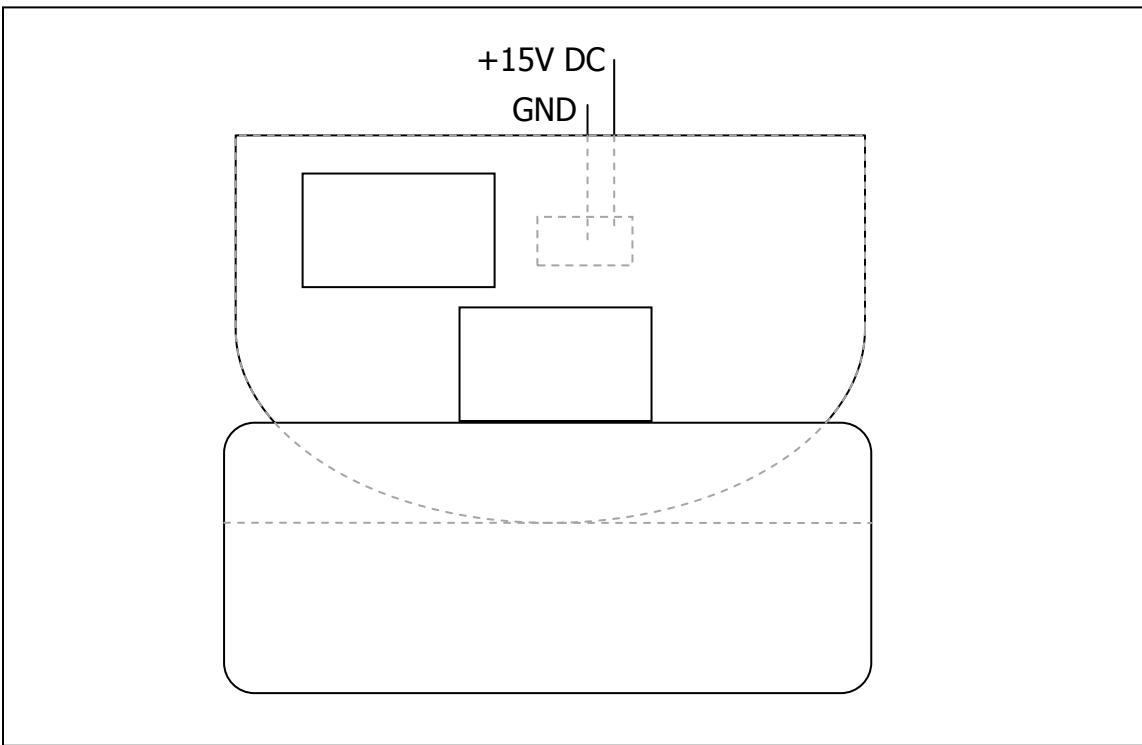
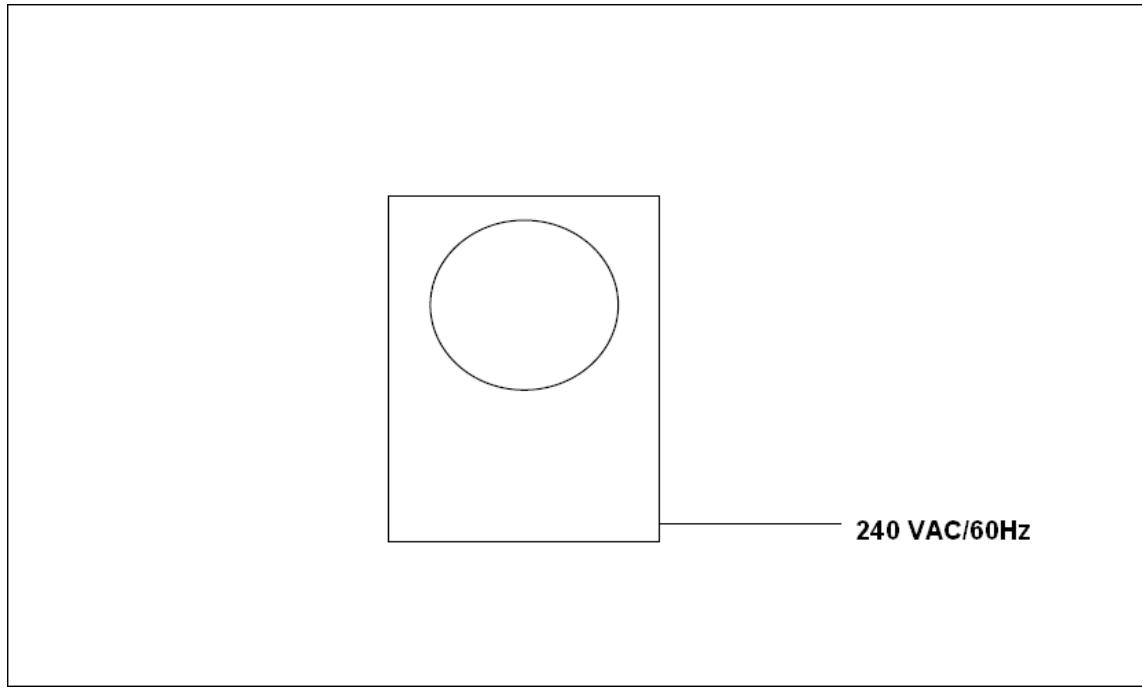
- ANSI C63.4-1992: Method of Measurements of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the 9KHz to 40GHz
- US Code of Federal Regulations (CFR): Title 47, Part 2, Subpart J: Equipment Authorization Procedures (October 2004)
- US Code of Federal Regulations (CFR): Title 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 was used at Hunt Technologies' facility to do all RF conducted measurements.

Table 4.0-1: Test Equipment

Mfg.	Equip. Type	Model	S/N	Cal. Due
Agilent	Spectrum Analyzer	E7401A	US40240359	7/17/2008
Agilent	Spectrum Analyzer	E4407B	MY45106578	10/12/2008

5.0 EQUIPMENT UNDER TEST SETUP BLOCK DIAGRAM**Figure 5.0-1 Radiated Emissions Test Setup****Figure 5.0-2 Power Line Conducted Emissions Test Setup****6.3.2 Antenna Manufacturer**

None; the antenna is part of the printed circuit board.

6.3.3 Antenna Gain

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

7/30/2008

The 1/4 wave monopole is a well known antenna type. The theoretical gain of an ideal 1/4 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]

See section 6.4 in the "TEB-HUNTSU746 FCC TEST Report.pdf" for the power line conducted emissions summary.

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, greater than 10 times the highest fundamental frequency. The restricted band tests were 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 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 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 O, "Radiated Emissions sketch Exhibit O.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. This device transmits packets less than 400 ms and longer than 100 ms, therefore, there is no duty cycle correction for this product.

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, "Radiated Emissions FCCB Exhibit K.pdf" and Exhibit N, "Restricted Bands Exhibit N 900MHz.pdf" The signals from the fundamental frequencies were all under the 1W limit. The highest signal in the restricted bands portion of the test was the 2.7 GHz harmonic produced by the Low channel transmission. This signal was 3.83 dB down from the average limit of 54 dBuV/m.

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.

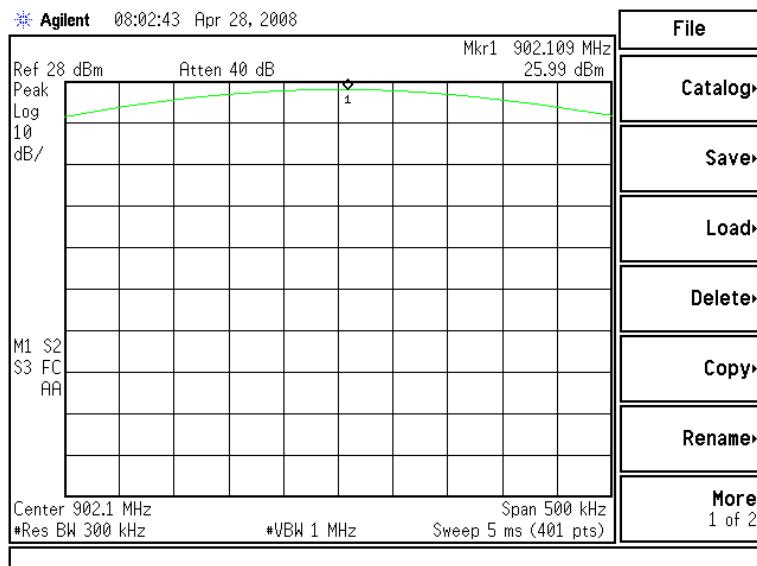
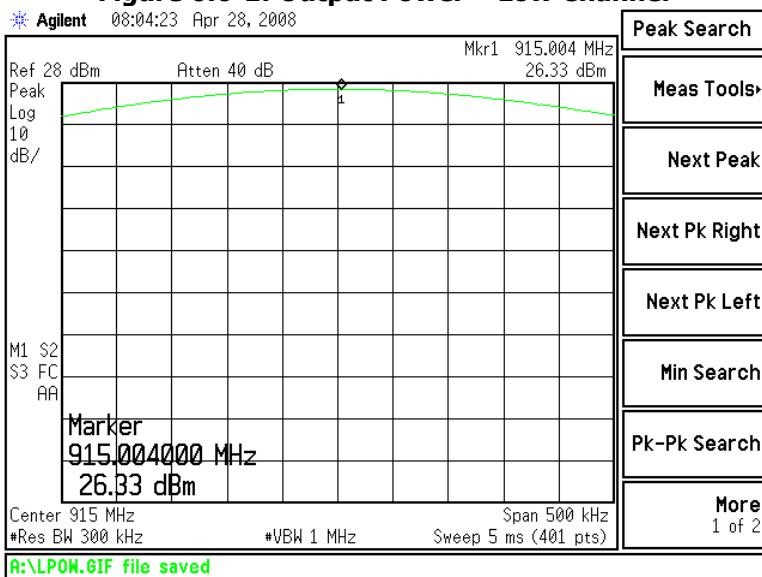
6.6.2 Test Results

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	Level
-----------	-------

(MHz)	(dBm)
902.10	25.99
915.00	26.33
927.900	26.02

**Figure 6.6-1: Output Power – Low Channel****Figure 6.6-2: Output Power – Mid Channel**

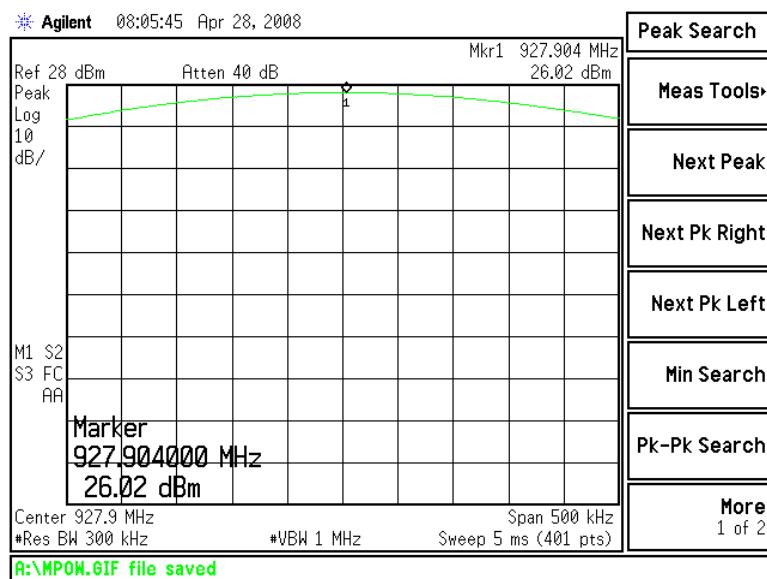


Figure 6.6-3: Output Power – High Channel

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 $\geq 1\%$ of the span.

6.7.1.2 Test Results

The adjacent channel separation for System One was measured to be approximately 348 kHz (programmed to be exactly 346.938 kHz) The adjacent channel separation for System Two was measured to be approximately 97.5 kHz (programmed to be exactly 100kHz. Results are shown in figure 6.7.1-1 below:

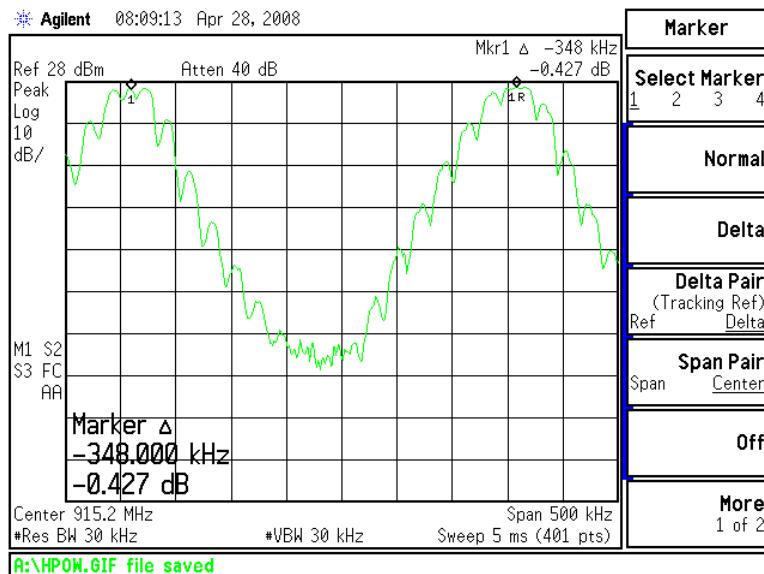


Figure 6.7.1-1: Carrier Frequency Separation System 1

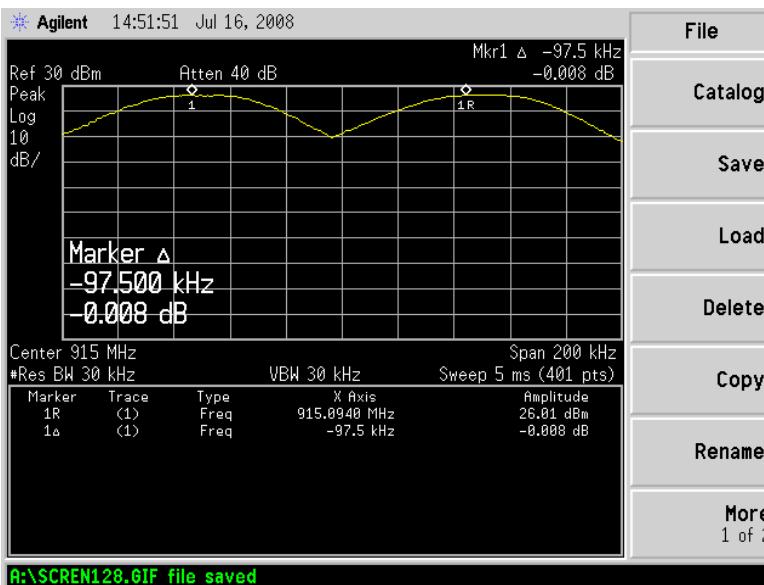


Figure 6.7.1-2: Carrier Frequency Separation System 2

6.7.2 Number of Hopping Channels

The 20dB bandwidth of the device is less than 250 kHz. The device employs at least 50 hopping channels as required. The device will use one of two frequency lists, System One list will contain

50 Frequencies, the other, System Two, 240 Frequencies. A list of the 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 channels in the list. Table 6.7.2-1 below lists the frequencies of all 50 channels and the order they are used and Table 6.7.2-2 list the frequencies of all 240 channels and the order:

Channel Number	Order Used:	Frequency
0	0	910.5
1	29	910.846938
2	12	911.193876
3	41	911.540814
4	31	911.887752
5	24	912.23469
6	17	912.581628
7	46	912.928566
8	42	913.275504
9	38	913.622442
10	11	913.96938
11	43	914.316318
12	36	914.663256
13	25	915.010194
14	16	915.357132
15	3	915.70407
16	5	916.051008
17	19	916.397946
18	8	916.744884
19	9	917.091822
20	49	917.43876
21	21	917.785698
22	6	918.132636
23	1	918.479574
24	2	918.826512
25	20	919.17345
26	27	919.520388
27	30	919.867326
28	32	920.214264
29	33	920.561202
30	10	920.90814
31	35	921.255078
32	22	921.602016
33	18	921.948954
34	4	922.295892
35	34	922.64283
36	39	922.989768
37	40	923.336706
38	26	923.683644
39	15	924.030582
40	45	924.37752
41	37	924.724458
42	48	925.071396
43	47	925.418334
44	28	925.765272
45	7	926.11221
46	23	926.459148
47	14	926.806086
48	44	927.153024
49	13	927.499962

Table 6.7.2-1: Frequency Table, System One

Channel	Freq (MHz)								
86	910.6	69	908.9	252	927.2	214	923.4	208	922.8
211	923.1	256	927.6	200	922	28	904.8	84	910.4
173	919.3	176	919.6	185	920.5	158	917.8	21	904.1
141	916.1	52	907.2	36	905.6	77	909.7	121	914.1
72	909.2	134	915.4	131	915.1	124	914.4	125	914.5
166	918.6	242	926.2	32	905.2	61	908.1	81	910.1
63	908.3	228	924.8	22	904.2	147	916.7	165	918.5
23	904.3	187	920.7	235	925.5	191	921.1	95	911.5
180	920	82	910.2	222	924.2	150	917	182	920.2
227	924.7	174	919.4	108	912.8	171	919.1	122	914.2
40	906	230	925	99	911.9	41	906.1	229	924.9
144	916.4	241	926.1	126	914.6	188	920.8	216	923.6
33	905.3	133	915.3	152	917.2	89	910.9	253	927.3
195	921.5	169	918.9	193	921.3	220	924	204	922.4
154	917.4	30	905	254	927.4	127	914.7	70	909
190	921	136	915.6	146	916.6	20	904	44	906.4
236	925.6	178	919.8	34	905.4	217	923.7	259	927.9
149	916.9	210	923	49	906.9	114	913.4	240	926
143	916.3	71	909.1	255	927.5	111	913.1	48	906.8
181	920.1	205	922.5	129	914.9	213	923.3	66	908.6
232	925.2	192	921.2	209	922.9	35	905.5	79	909.9
123	914.3	86	910.5	94	911.4	42	906.2	132	915.2
233	925.3	63	907.3	140	916	172	919.2	245	926.5
38	905.8	202	922.2	83	910.3	25	904.5	120	914
118	913.8	37	905.7	257	927.7	59	907.9	67	908.7
60	908	43	906.3	237	925.7	87	910.7	183	920.3
201	922.1	54	907.4	135	915.5	168	918.8	248	926.8
198	921.8	243	926.3	234	925.4	196	921.6	78	909.8
116	913.6	64	908.4	92	911.2	223	924.3	80	910
91	911.1	68	908.8	57	907.7	24	904.4	93	911.3
212	923.2	100	912	109	912.9	225	924.5	184	920.4
221	924.1	239	925.9	249	926.9	103	912.3	74	909.4
96	911.5	29	904.9	215	923.5	151	917.1	153	917.3
157	917.7	177	919.7	179	919.9	203	922.3	65	908.5
247	926.7	139	915.9	258	927.8	197	921.7	159	917.9
167	918.7	117	913.7	186	920.6	219	923.9	142	916.2
224	924.4	148	916.8	244	928.4	97	911.7	58	907.8
246	926.6	75	909.5	189	920.9	51	907.1	164	918.4
238	925.8	206	922.6	31	905.1	98	911.8	163	918.3
46	906.6	226	924.6	73	909.3	45	906.5	90	911
39	905.9	155	917.5	130	915	156	917.6	106	912.6
251	927.1	47	906.7	194	921.4	101	912.1	145	916.5
115	913.5	62	908.2	162	918.2	50	907	76	909.6
128	914.8	138	915.8	119	913.9	27	904.7	199	921.9
110	913	231	925.1	107	912.7	207	922.7		
160	918	113	913.3	88	910.8	250	927		
56	907.6	137	915.7	175	919.5	102	912.2		
26	904.6	55	907.5	170	919	112	913.2		
161	918.1	105	912.5	218	923.8	104	912.4		

Table 6.7.2-2: Frequency Table, System Two

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 5 MHz and the VBW to 3 MHz. Sweep time was set to 500 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 transmission time is < 400 milliseconds and there are 50 transmitter frequencies used sequentially. The dwell time would be < 400 ms per channel within a 20 second period. A single transmission is shown in figure 6.7.3-1 below:

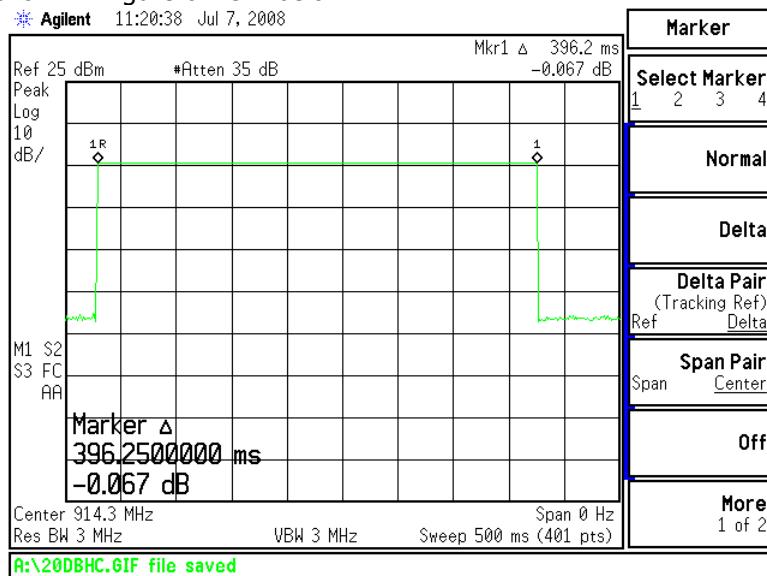


Figure 6.7.3-1: Channel Dwell Time

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 $\geq 1\%$ 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 $\geq 1\%$ of the 20 dB bandwidth for the RBW.

6.7.4.2 Test Results

The maximum 20dB bandwidth for System One was found to be approximately 30.80 kHz. The maximum 20dB bandwidth for System Two was found to be approximately 25.7 kHz. Results are summarized below in table 6.7.4-1 below. Plots are shown below in Figure 6.7.4-1 through 6.7.4-9.

**Table 6.7.4-1: 20dB Bandwidth
System 2 and 1**

Channel	Frequency (MHz)	20dB Bandwidth (kHz)
Low sys 1	910.50	30.80
Mid sys 1	919.170	30.80
High sys 1	927.50	30.80
Low sys 2 (9.6)	902.10	20.8
Mid sys 2 (9.6)	915.00	21.2
High sys 2 (9.6)	927.900	25.7
Low sys 2 (19.2)	902.10	22.8
Mid sys 2 (19.2)	915.00	25.0
High sys 2 (19.2)	927.900	24.5

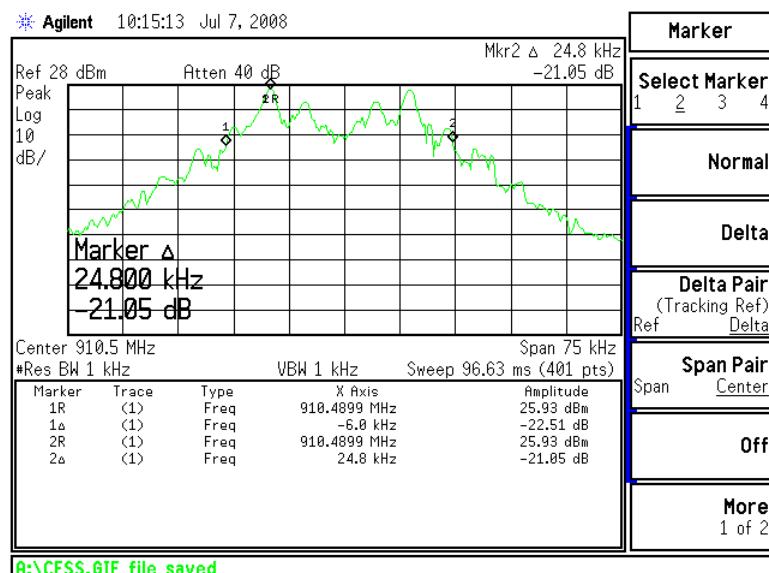


Figure 6.7.4-1: 20dB Bandwidth – Low Channel System 1

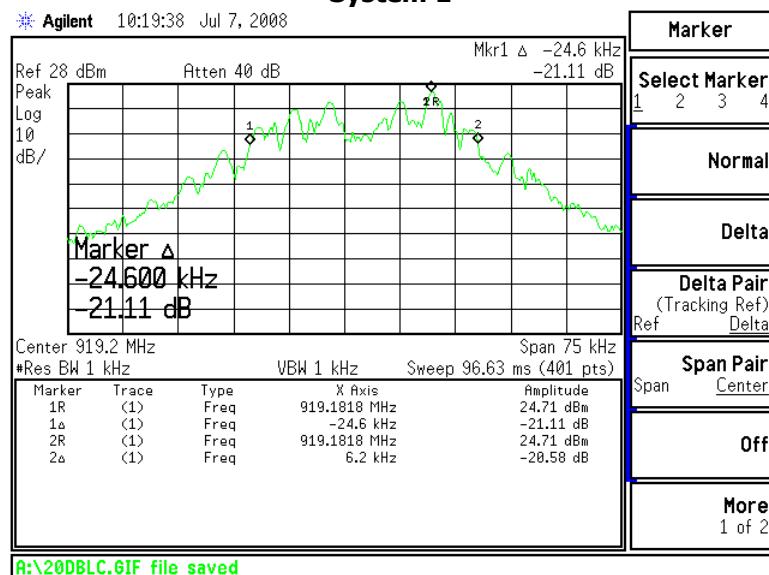


Figure 6.7.4-2: 20dB Bandwidth – Mid Channel System 1

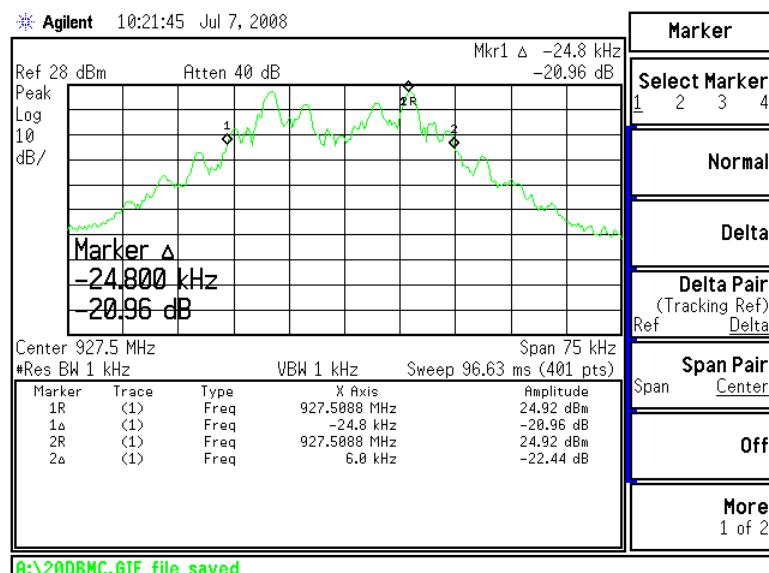


Figure 6.7.4-3: 20dB Bandwidth – High Channel System 1

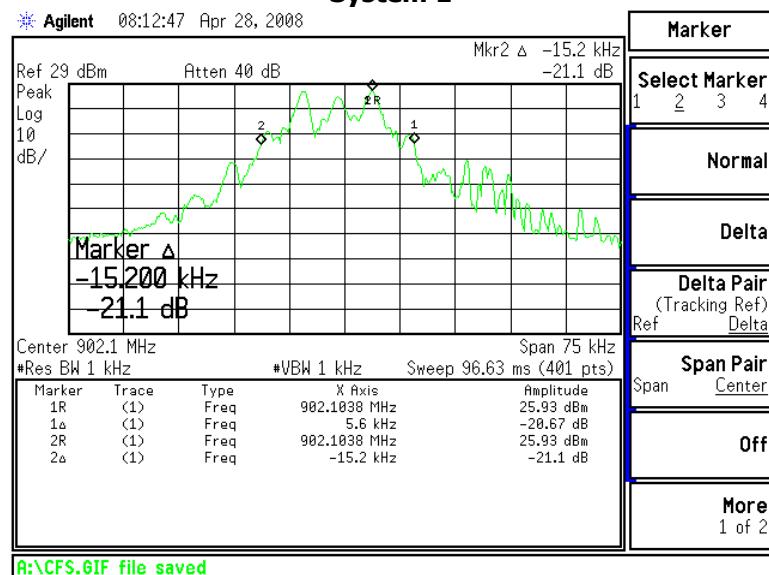


Figure 6.7.4-4: 20dB Bandwidth – Low Channel System 2 (9600 Baud Rate)

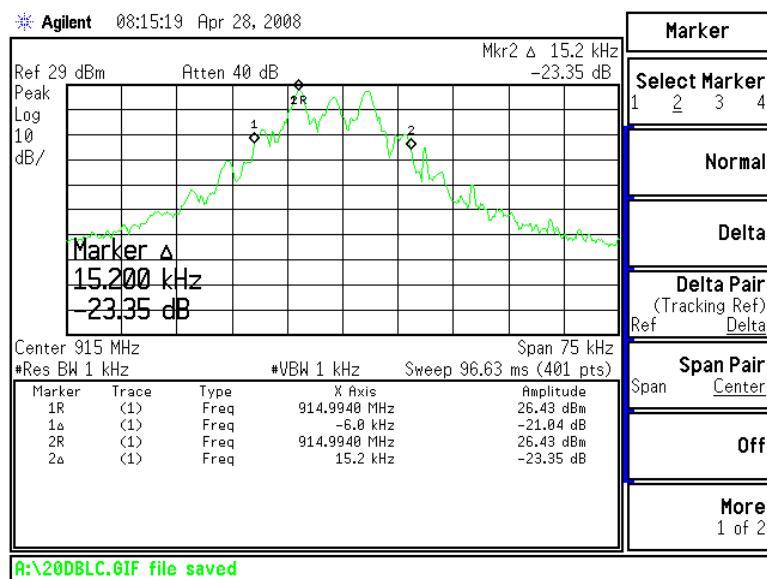


Figure 6.7.4-5: 20dB Bandwidth – Mid Channel System 2 (9600 Baud Rate)

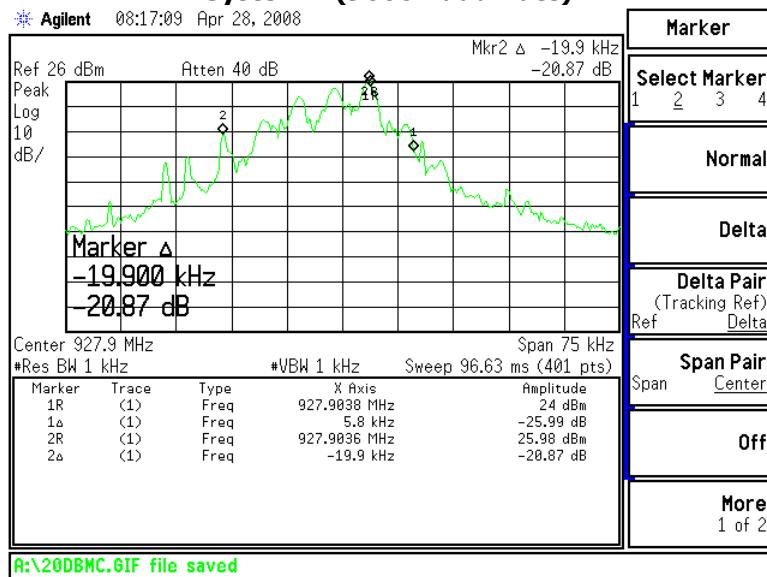


Figure 6.7.4-6: 20dB Bandwidth – High Channel System 2 (9600 Baud Rate)

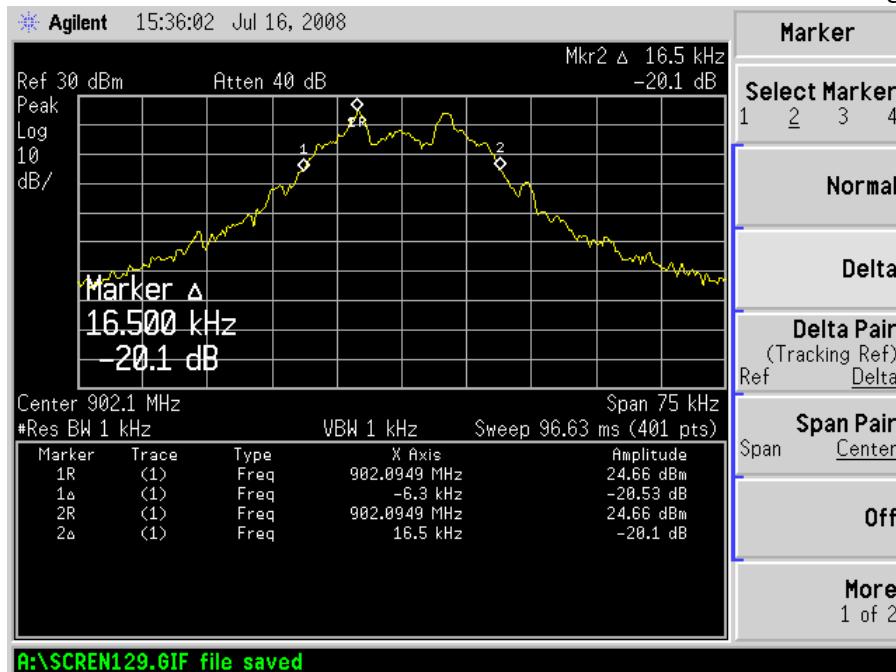


Figure 6.7.4-1: 20dB Bandwidth – Low Channel System 2 (19200 Baud Rate)



Figure 6.7.4-1: 20dB Bandwidth – Mid Channel System 2 (19200 Baud Rate)

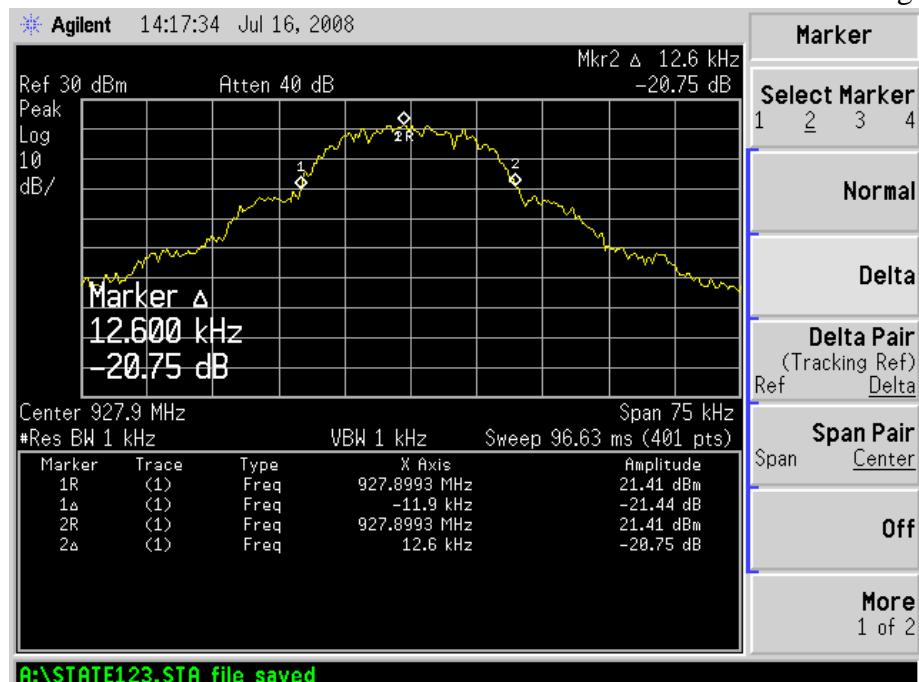


Figure 6.7.4-1: 20dB Bandwidth – High Channel System 2 (19200 Baud Rate)

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

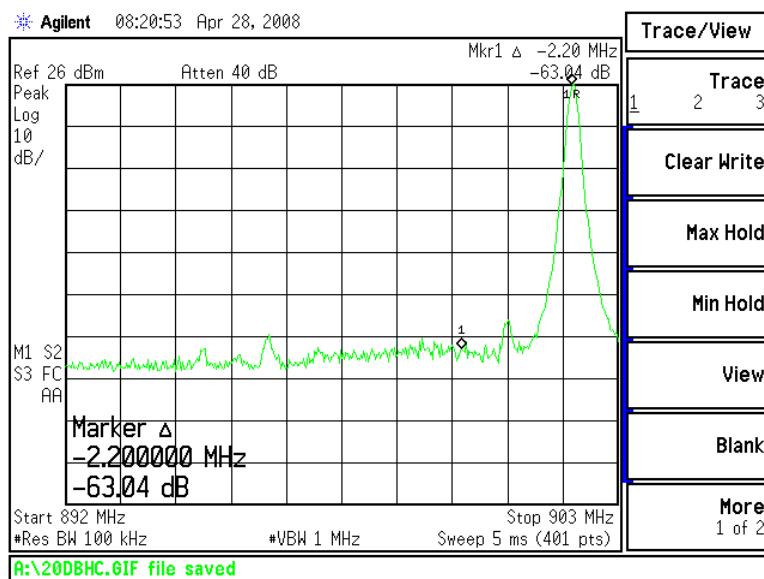
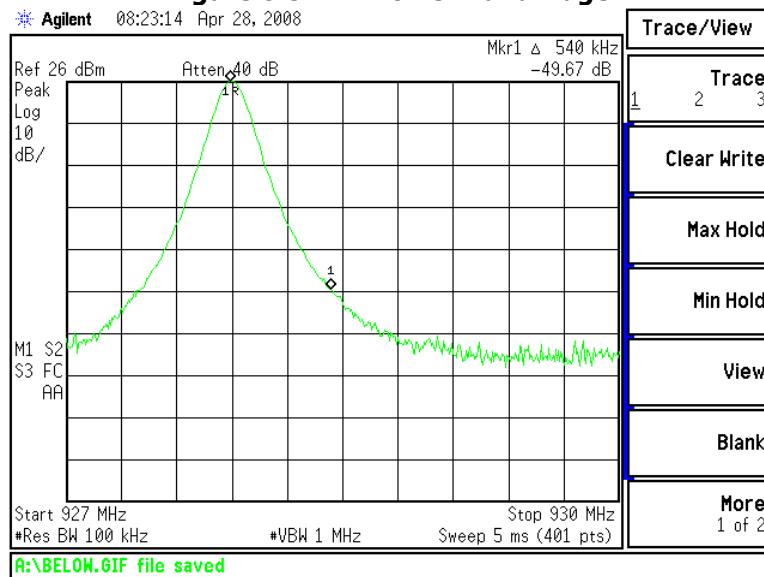
6.8.1 Band-Edge Compliance of RF Conducted Emissions

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 100 kHz, which is $\geq 1\%$ 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.

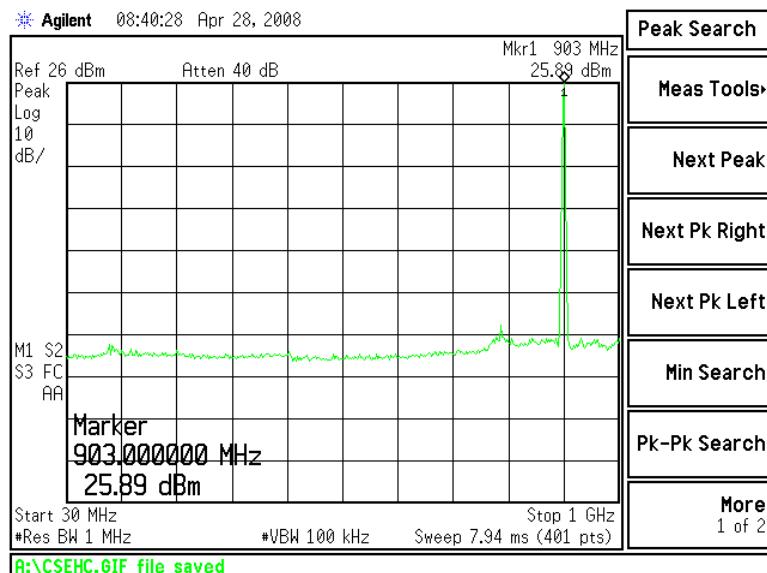


Figure 6.8.2-1: RF Conducted Spurious Emissions – Low Channel

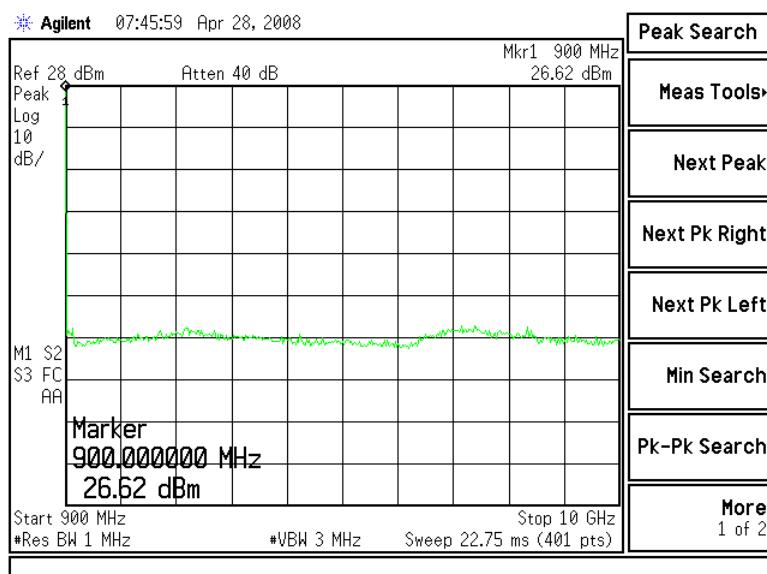


Figure 6.8.2-2: RF Conducted Spurious Emissions – Low Channel

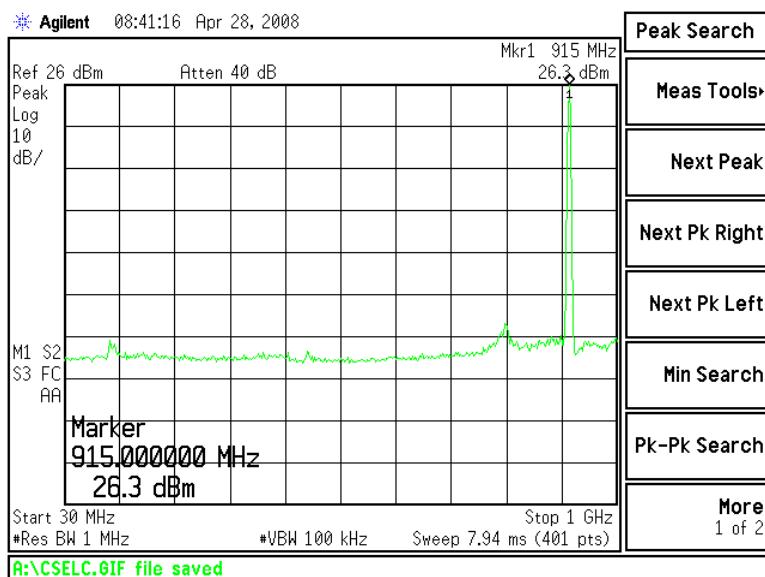


Figure 6.8.2-3: RF Conducted Spurious Emissions – Mid Channel

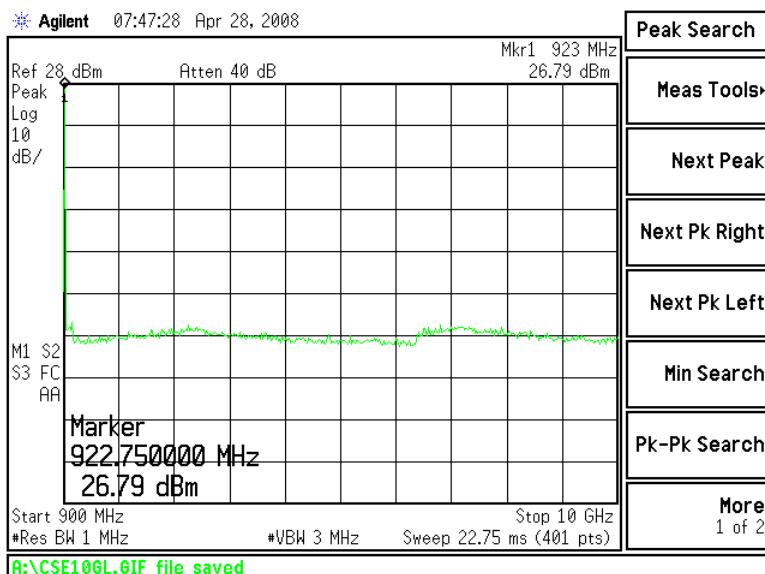


Figure 6.8.2-4: RF Conducted Spurious Emissions – Mid Channel

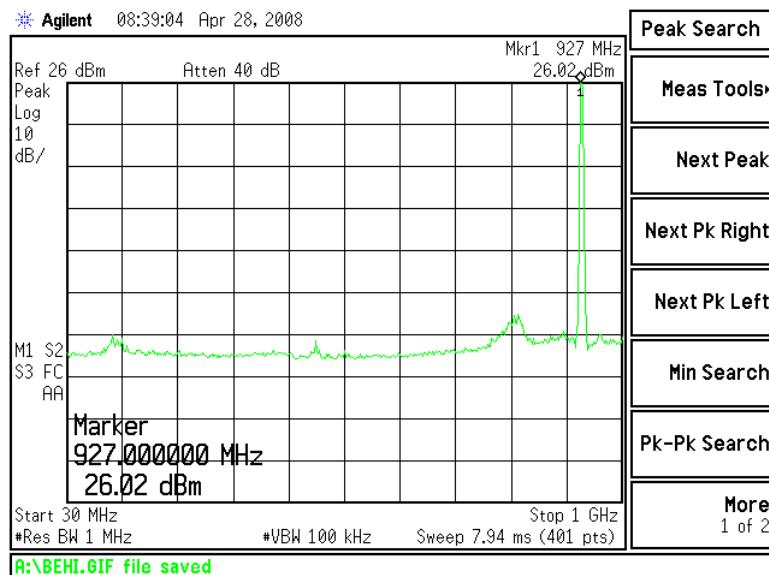


Figure 6.8.2-5: RF Conducted Spurious Emissions – High Channel

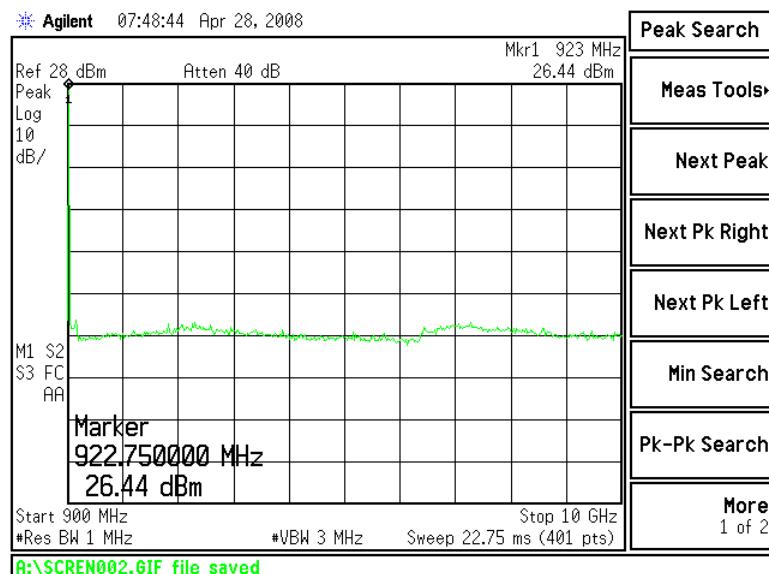


Figure 6.8.2-6: RF Conducted Spurious Emissions – High Channel

7.0 CONCLUSION

The Hunt Technologies' FOCUS AX Universal RF endpoint model 0746-0001 meets the requirements of FCC Part 15 subpart C.