

FCC Part 15.247 Transmitter Certification

Frequency Hopping Spread Spectrum Transmitter

Test Report

FCC ID: TEB-HUNTSS710

FCC Rule Part: 15.247

Test Begin Date: 2-7-2008

Test End Date: 2-19-2008

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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**

The Hunt Technologies' STATSignal Gas Module (FASY-0710) consists of a CellNet Type 3 enclosure with a Hunt Technologies transceiver on a single printed circuit board. The Hunt Technologies transceiver is a frequency hopping spread spectrum unit utilizing GFSK modulation in the 902-928 MHz frequency band.

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

1.2.2 Intended Use

The FASY-0710 will be a transmitting and receiving meter module that collects and transmits metering data over the 902-928 MHz ISM Band for collection by utility companies. 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

Each piece of equipment for which authorization will be granted will be uniquely identified with "FCC ID: TEB-HUNTSS710." 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.

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

2/28/2008

§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 TÜV Testing Services Open Test Site. The FCC keeps a full description of the measurement facilities on file. TÜV'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, the RF conducted emissions above 1 GHz, and the RF conducted spurious emissions were tested at TÜV.

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-HUNTSS710
 - 3. Brief Description of circuit functions and device operation:
See Exhibit F, "Op Statement.pdf" for operational description
See Exhibit G, "SCHM-00092_RevA.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 L, "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)

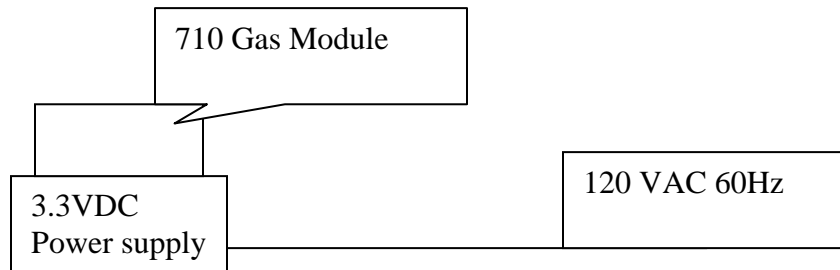
FCC OET Bulletin 65 Appendix C - Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields

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 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	E4404B	MY41440735	7/16/2008
Agilent	Spectrum Analyzer	E4407B	MY45106578	12/10/2008
Agilent	Spectrum Analyzer		-	

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 (910.493 MHz), middle (919.170 MHz), and highest (927.496 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 $\frac{1}{4}$ 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 $\frac{1}{4}$ wave monopole is a well known antenna type. The theoretical gain of an ideal $\frac{1}{4}$ 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]

Not applicable to this device. As per §15.207 C, this is a battery operated device and is not affiliated with the AC power lines.

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. 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 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. 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, "rad em FCCB.pdf" and Exhibit N, "restr bands.pdf" The signals from the fundamental frequencies were all under the 1W limit. Sweeps of the restricted bands show that the TEB-HUNTSS710 were all below those limits as well.

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)
910.5	23.06
919.170	23.09
927.496	22.04

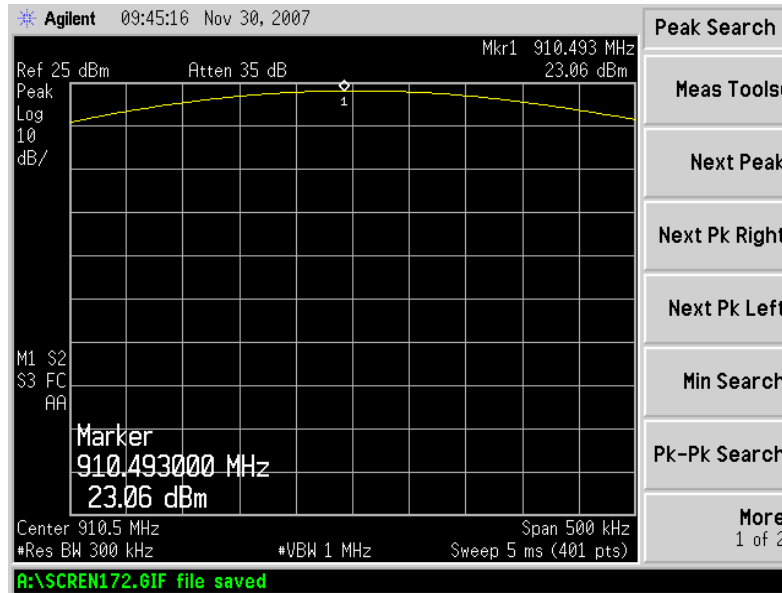


Figure 6.6-1: Output Power – Low Channel

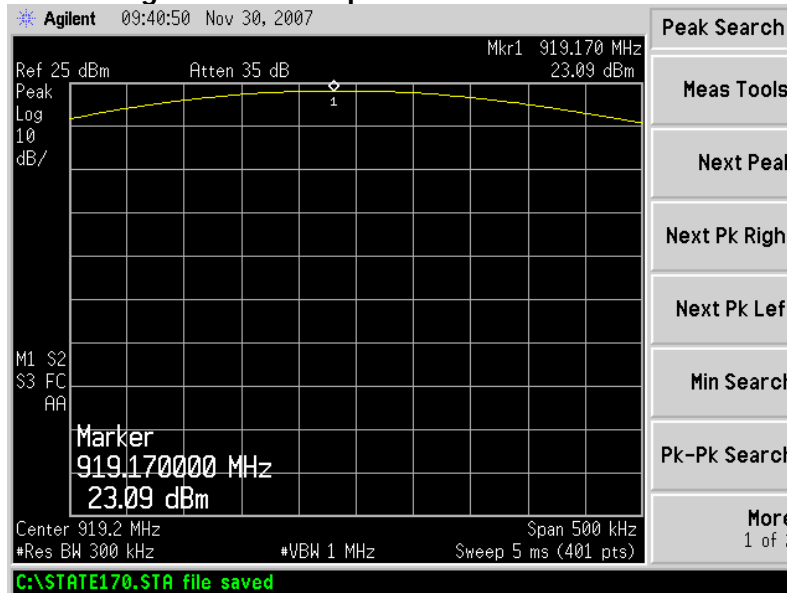


Figure 6.6-2: Output Power – Mid Channel

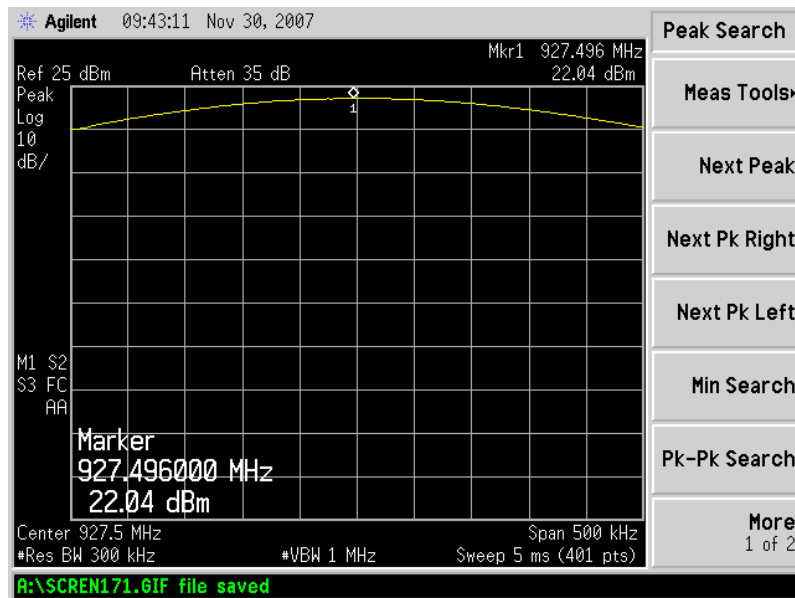


Figure 6.6-3: Output Power – High Channel

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 maximum 20dB bandwidth of the hopping channel was measured to be 31.124 kHz (See figure 6.7.4-1 to 6.7.4-3 below). The adjacent channel separation was measured to be approximately 347 kHz (programmed to be exactly 346.938 kHz). Results are shown in figure 6.7.1-1 below:

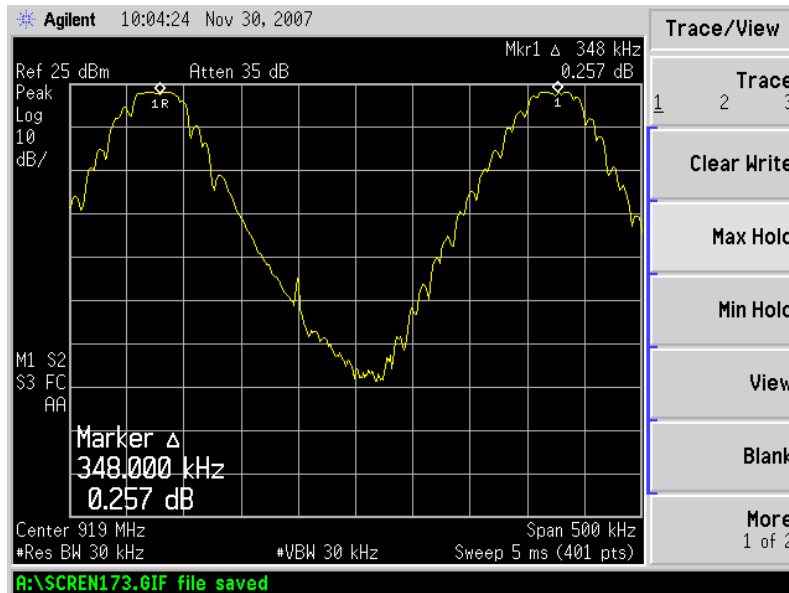


Figure 6.7.1-1: Carrier Frequency Separation

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. Table 6.7.2-1 below lists the frequencies of all 50 channels and the order they are used:

Channel No.	Order Used	Channel Frequency (Hz)
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

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:

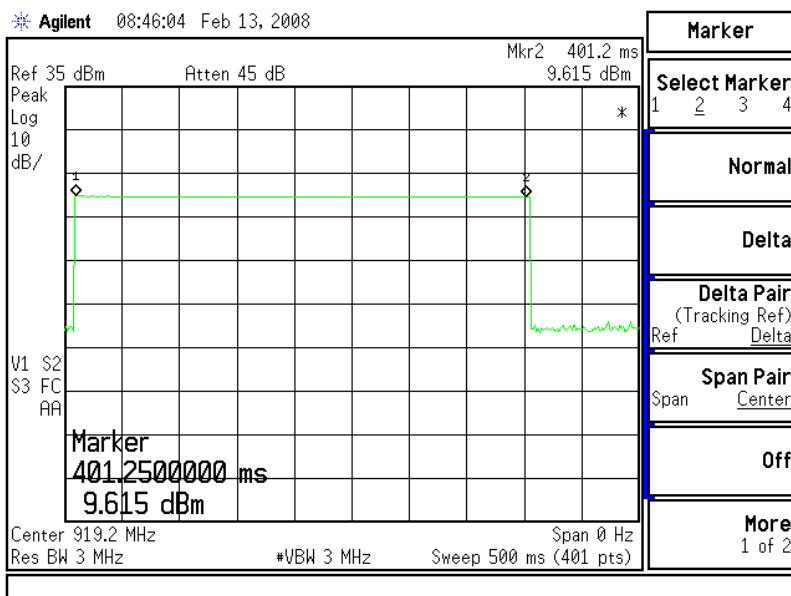


Figure 6.7.3-1: Channel Dwell Time

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 was found to be approximately 30.90 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	910.493	30.80
Mid	919.170	31.20
High	927.496	30.90



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 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.

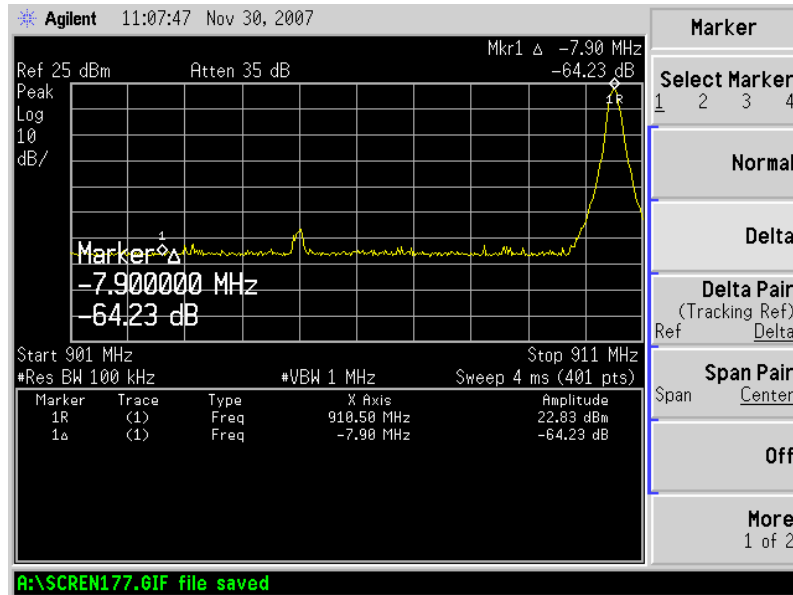


Figure 6.8.1-1: Lower Band-Edge

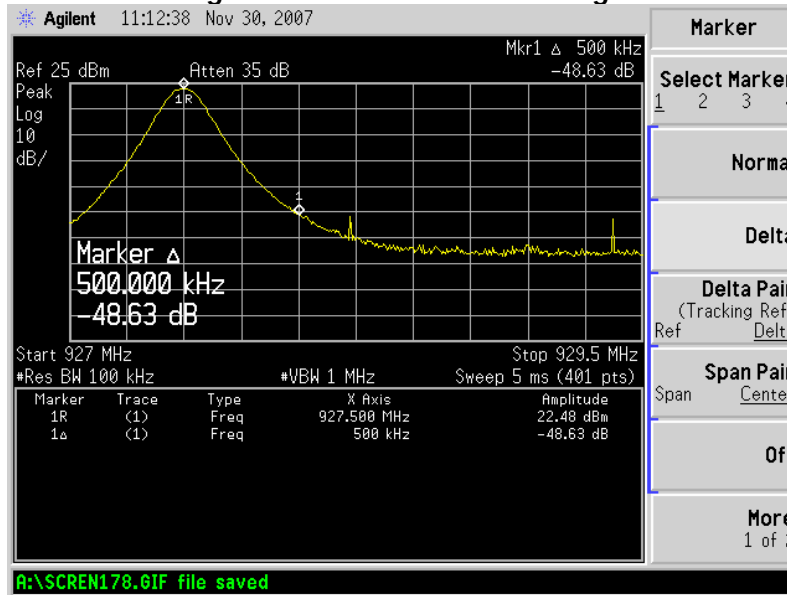


Figure 6.8.1-2: Upper Band-Edge

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.

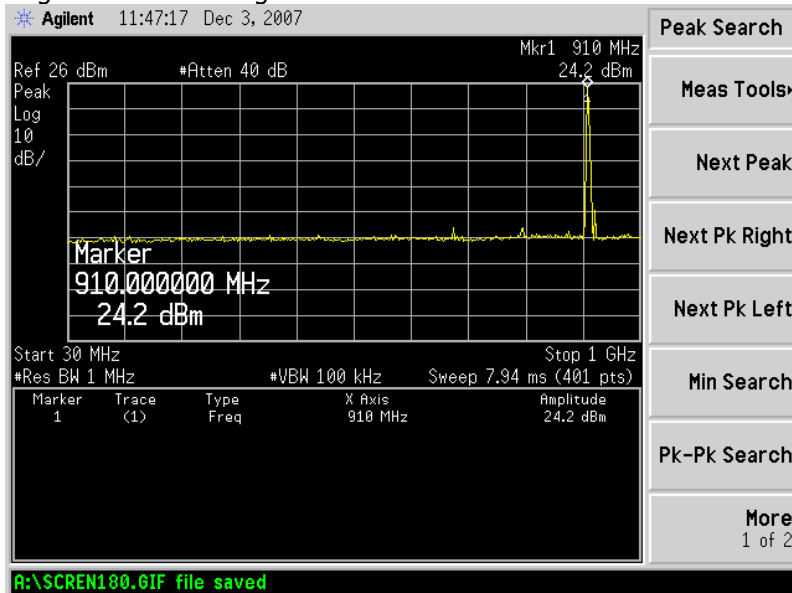


Figure 6.8.2-1: RF Conducted Spurious Emissions – Low Channel

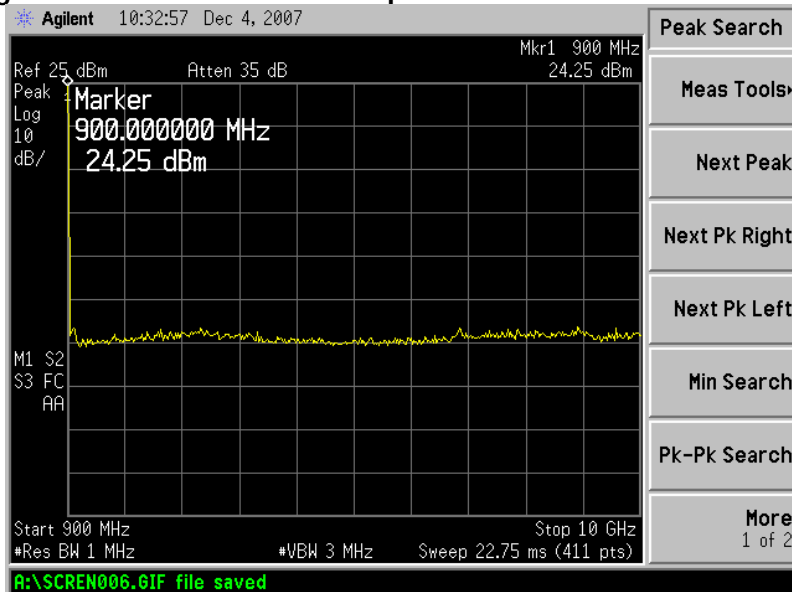


Figure 6.8.2-2: RF Conducted Spurious Emissions – Low Channel

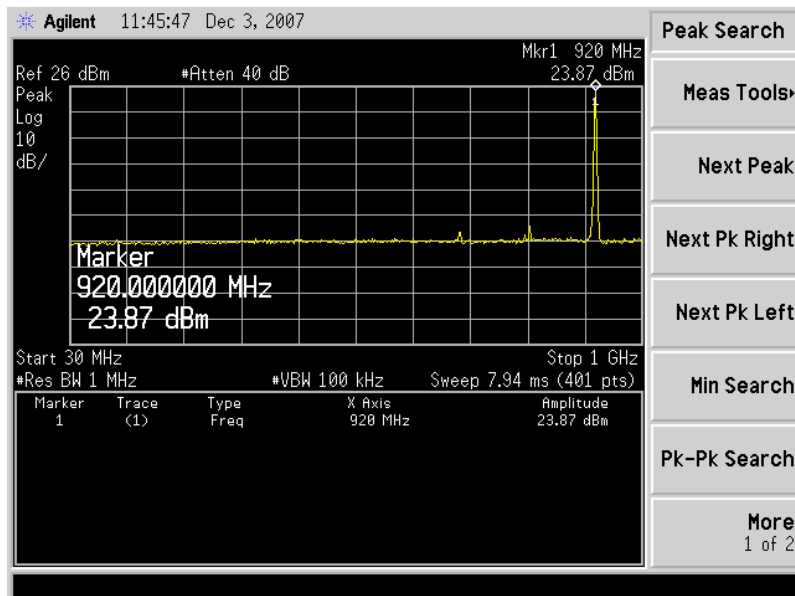


Figure 6.8.2-3: RF Conducted Spurious Emissions – Mid Channel

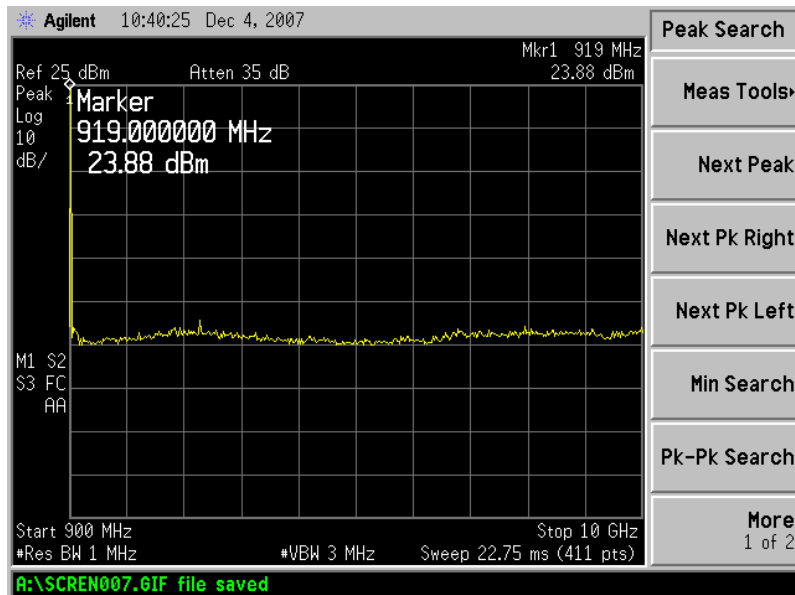


Figure 6.8.2-4: RF Conducted Spurious Emissions – Mid Channel

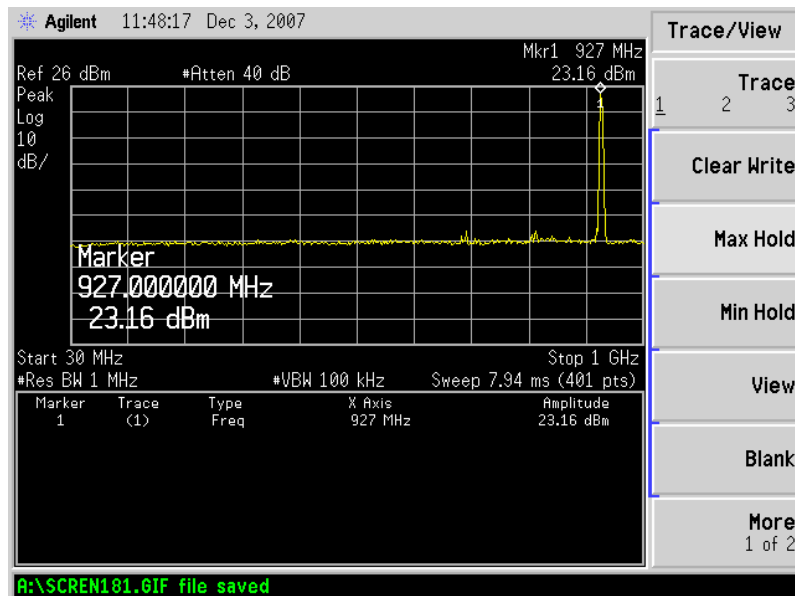


Figure 6.8.2-5: RF Conducted Spurious Emissions – High Channel

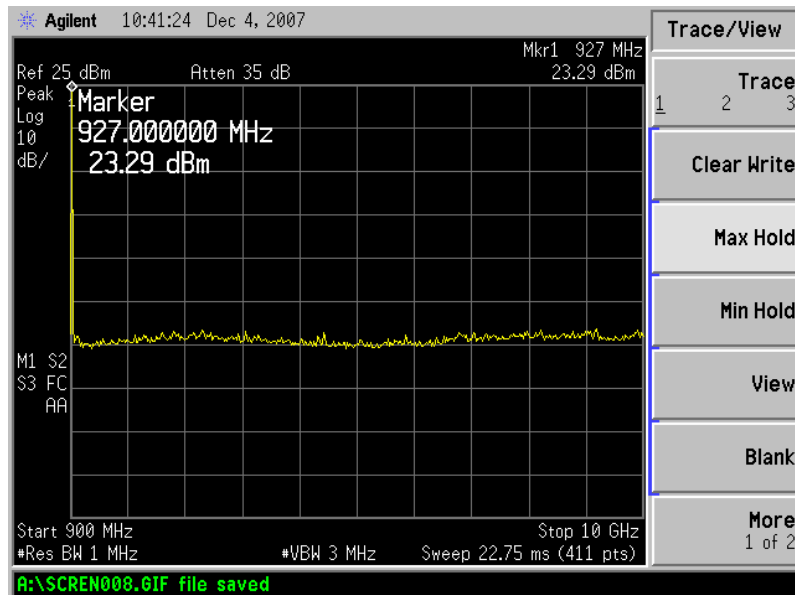


Figure 6.8.2-6: RF Conducted Spurious Emissions – High Channel

7.0 CONCLUSION

The Hunt Technologies' STATSignal Gas Module (FASY-0710), meets the requirements of FCC Part 15 subpart C.