Excellence in Compliance Testing

# Certification Test Report

## FCC ID: IQ5-VOY1-2

## FCC Rule Part: CFR 47 Part 90.259

## ACS Report Number: 09-0301-LD

Applicant: Data Flow Systems Inc.
Model: Voyager 1 Radio

Test Begin Date: October 20, 2009
Test End Date: November 11, 2009

Report Issue Date: November 12, 2009

FOR THE SCOPE OF ACCREDITATION UNDER LAB Code 200612-0

This report is not be used to claim certification, approval, or endorsement by NVLAP, NIST or any government agency.


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## 1.0 GENERAL

### 1.1 Purpose

The purpose of this report is to demonstrate compliance with Part 2 Subpart J and Part 90 of the FCC's Code of Federal Regulations..

### 1.2 Product Description

The Voyager Telemetry Radio (VTR) is designed to provide a reliable wireless connection for digital communications in the 217-220 MHz frequency band.

Manufacturer Information:
Data Flow Systems Inc.
P. O. Box 2550
Melbourne, FL 32902

Test Sample Serial Numbers: ACS#2

Test Sample Condition: The test samples were provided in good working order with no visible defects.

Detailed photographs of the EUT are filed separately with this filing.

### 1.3 Test Methodology

#### 1.3.1 Test Configurations and Justification

The EUT is configured for detachable antennas via a BNC connector therefore for radiated emissions measurements the antenna port was loaded with a 50 Ohm non-radiating load.

The EUT is a digital data radio therefore modulation characteristics per Part 2.1047 are not applicable.

#### 1.3.2 In-Band Testing Methodology

For testing in accordance with 47 CFR 2.1046-2.1057, OET/Lab recommends that the following be used to select test frequencies for licensed devices:

| Frequency range over which device operates | Number of frequencies | Location in the range of operation |
|---|---|---|
| 1 MHz or less | 1 | Middle |
| 1 to 10 MHz | 2 | 1 near top and 1 near bottom |
| 10 to 100 MHz | 3 | 1 near top, 1 near middle and 1 near bottom |

The EUT is designed to operate in 217-220 MHz band therefore a single frequency at the low end of the band and a single frequency at the upper end of the band were selected for testing where applicable.

### 1.4 Emission Designators

The EUT transceiver produces 2-FSK modulation at 12.5 kHz and 25 kHz channel bandwidths. The emissions designators are as follows:

11K2F1D (12.5 kHz Channel Bandwidths)
20K0F1D (25 kHz Channel Bandwidths)

## 2.0 TEST FACILITIES

### 2.1 Location

The radiated and conducted emissions test sites are located at the following address:

Advanced Compliance Solutions
5015 B.U. Bowman Drive
Buford, GA 30518
Phone: (770) 831-8048
Fax: (770) 831-8598

### 2.2 Laboratory Accreditations/Recognitions/Certifications

The Semi-Anechoic Chamber Test Site, Open Area Test Site (OATS) and Conducted Emissions Site have been fully described, submitted to, and accepted by the FCC, Industry Canada and the Japanese Voluntary Control Council for Interference by information technology equipment. In addition, ACS is compliant to ISO/IEC 17025 as certified by the National Institute of Standards and Technology under their National Voluntary Laboratory Accreditation Program. The following certification numbers have been issued in recognition of these accreditations and certifications:

FCC Registration Number: 894540

- Industry Canada Lab Code: IC 4175A-1
- VCCI Member Number: 1831
- VCCI OATS Registration Number R-1526
- VCCI Conducted Emissions Site Registration Number: C-1608
- NVLAP Lab Code: 200612-0

## 2.3 Radiated Emissions Test Site Description

### 2.3.1 Semi-Anechoic Chamber Test Site

The Semi-Anechoic Chamber Test Site consists of a 20' x 30' x 18' shielded enclosure. The chamber is lined with Toyo Ferrite Grid Absorber, model number FFG-1000. The ferrite tile grid is 101 x 101 x 19mm thick and weighs approximately 550 grams. These tiles are mounted on steel panels and installed directly on the inner walls of the chamber.

The turntable is 150cm in diameter and is located 160cm from the back wall of the chamber. The chamber is grounded via 1 - 8' copper ground rod, installed at the center of the back wall, it is bound to the ground plane using 3/4" stainless steel braided cable.

The turntable is all steel, flush mounted table installed in an all steel frame. The table is remotely operated from inside the control room located 25' from the range. The turntable is electrically bonded to the surrounding ground plane via steel fingers installed on the edge of the turn table. The steel fingers make constant contact with the ground plane during operation.

Behind the turntable is a 3' x 6' x 4' deep shielded pit used for support equipment if necessary. The pit is equipped with 1 - 4" PVC chases from the turntable to the pit that allow for cabling to the EUT if necessary. The underside of the turntable can be accessed from the pit so cables can be supplied to the EUT from the pit.

A diagram of the Semi-Anechoic Chamber Test Site is shown in Figure 2.3-1 below:

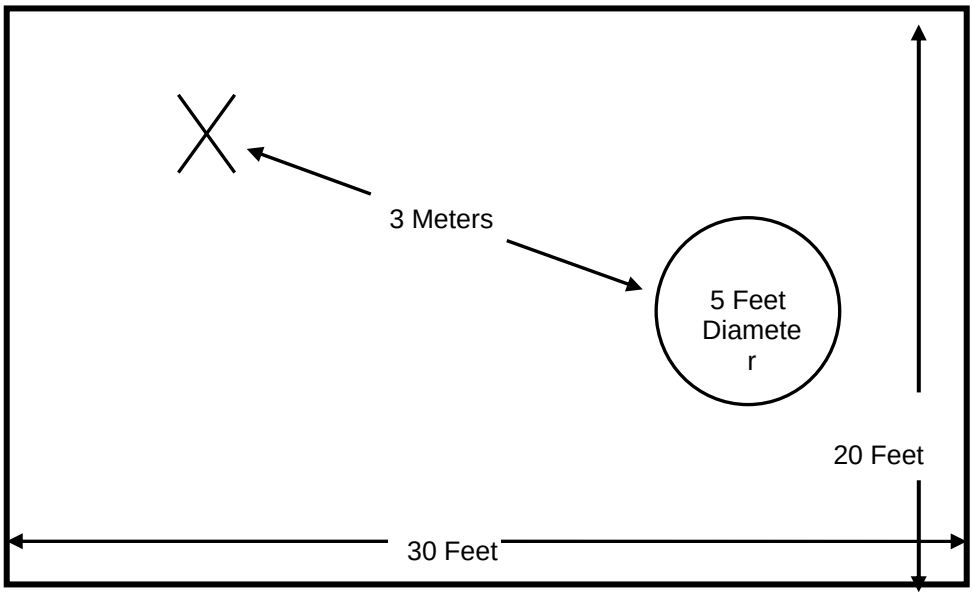


**Figure 2.3-1: Semi-Anechoic Chamber Test Site**

### 2.3.2 Open Area Tests Site (OATS)

The open area test site consists of a 40' x 66' concrete pad covered with a perforated electro-plated galvanized sheet metal. The perforations in the sheet metal are 1/8" holes that are staggered every 3/16". The individual sheets are placed to overlap each other by 1/4" and are riveted together to provide a continuous seam. Rivets are spaced every 3" in a 3 x 20 meter perimeter around the antenna mast and EUT area. Rivets in the remaining area are spaced as necessary to properly secure the ground plane and maintain the electrical continuity.

The entire ground plane extends 12' beyond the turntable edge and 16' beyond the antenna mast when set to a 10 meter measurement distance. The ground plane is grounded via 4 - 8' copper ground rods, each installed at a corner of the ground plane and bound to the ground plane using 3/4" stainless steel braided cable.

The turntable is an all aluminum 10' flush mounted table installed in an all aluminum frame. The table is remotely operated from inside the control room located 40' from the range. The turntable is electrically bonded to the surrounding ground plane via steel fingers installed on the edge of the turn table. The steel fingers make constant contact with the ground plane during operation.

Adjacent to the turntable is a 7' x 7' square and 4' deep concrete pit used for support equipment if necessary. The pit is equipped with 5 - 4" PVC chases from the pit to the control room that allow for cabling to the EUT if necessary. The underside of the turntable can be accessed from the pit so cables can be supplied to the EUT from the pit. The pit is covered with 2 sheets of 1/4" diamond style re-enforced steel sheets. The sheets are painted to match the perforated steel ground plane; however the underside edges have been masked off to maintain the electrical continuity of the ground plane. All reflecting objects are located outside of the ellipse defined in ANSI C63.4.

A diagram of the Open Area Test Site is shown in Figure 2.3-2 below:

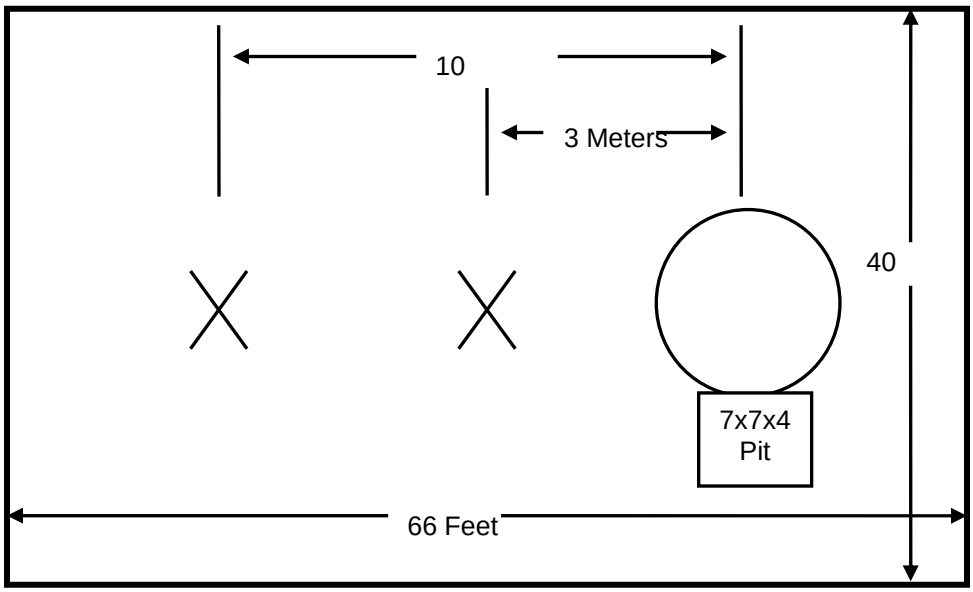


**Figure 2.3-2: Open Area Test Site**

### 2.4 Conducted Emissions Test Site Description

The AC mains conducted EMI site is located in the main EMC lab. It consists of an 8' x 8' solid aluminum horizontal group reference plane (GRP) bonded every 3" to an 8' X 8' vertical ground plane.

The site is of sufficient size to test table top and floor standing equipment in accordance with section 6.1.4 of ANSI C63.4.

A diagram of the room is shown below in figure 4.1.3-1:

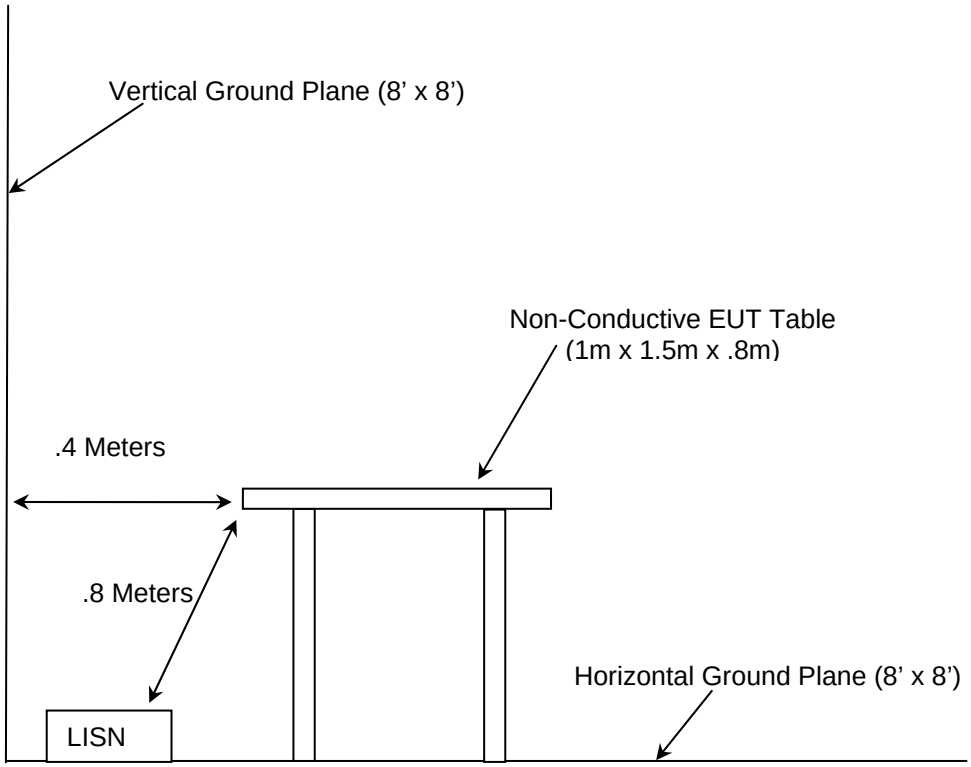


**Figure 2.4-1: AC Mains Conducted EMI Site**

### 3.0 APPLICABLE STANDARD REFERENCES

The following standards were used:

1 -US Code of Federal Regulations (CFR): Title 47, Part 2, Subpart J: Equipment Authorization Procedures - 2009
2 - US Code of Federal Regulations (CFR): Title 47, Part 90, Subpart I: Private Land Mobile Radio Services - 2009
3 – TIA-603-C: Land Mobile FM or PM - Communications Equipment - Measurement and Performance Standards – 2004

## 4.0 LIST OF TEST EQUIPMENT

The calibration interval of test equipment is annually or the manufacturer's recommendations. Where the calibration interval deviates from the annual cycle based on the instrument manufacturer's recommendations, it shall be stated below.

**Table 4-1: Test Equipment**

| Equipment Calibration Information | | | | | |
|---|---|---|---|---|---|
| **ACS#** | **Mfg.** | **Eq. type** | **Model** | **S/N** | **Cal. Due** |
| 22 | Agilent | Amplifiers | 8449B | 3008A00526 | 09-21-2010 |
| 25 | Chase | Antennas | CBL6111 | 1043 | 09-02-2010 |
| 30 | Spectrum Technologies | Antennas | DRH-0118 | 970102 | 05-08-2010 |
| 40 | EMCO | Antennas | 3104 | 3211 | 01-22-2010 |
| 140 | Thermotron | Environmental Chamber | SM-16C | 19639 | 08-30-2010 |
| 193 | ACS | Cable Set | OATS Cable Set | 0193 | 01-05-2010 (See Note1) |
| 211 | Eagle | Filters | C7RFM3NFNM | HLC-700 | 01-05-2010 (See Note1) |
| 213 | TEC | Amplifier | PA 102 | 44927 | 12-22-2009 |
| 222 | Andrew | Cables | F1-SMSM | 473703-A0138A | 08-14-2010 (See Note1) |
| 277 | EMCO | Antennas | 93146 9904 | 5199 | 09-18-2010 |
| 283 | Rohde & Schwarz | Spectrum Analyzers | FSP40 | 1000033 | 09-21-2010 |
| 321 | Hewlett Packard | Amplifiers | HPC 8447D | 1937A02809 | 10-06-2010 |
| 329 | A.H.Systems | Antennas | SAS-571 | 721 | 08-04-2010 |
| 338 | Hewlett Packard | Amplifiers | 8449B | 3008A01111 | 10-16-2010 |
| 339 | Aeroflex/Weinschel | Attenuators | AS-18 | 7142 | 07-02-2010 (See Note2) |
| 343 | Florida RF | Cables | SMRE-200W-12.0-SMRE | NA | 05-04-2010 (See Note1) |
| 430 | Florida RF | Cables | SMS-290AW-480-SMS | NA | 05-04-2010 (See Note1) |
| NA | Agilent | Signal Generator | E8257D | MY46521977 | 02-23-2010 |

**Note1:** Items characterized on an annual cycle. The date shown indicates the next characterization due date.
**Note2:** Items verified on an annual cycle. The date shown indicates the next verification due date.

## 5.0 SUPPORT EQUIPMENT

**Table 5-1: Support Equipment**

| Diagram # | Manufacturer | Equipment Type | Model Number | Serial Number | FCC ID |
|---|---|---|---|---|---|
| 1 | SL Power Electronics Corp. | ITE / Switch Mode Power Supply | PW173KB1203F01 | NA | NA |
| 2 | Hewlett Packard | Bench DC Power Supply | 6286A | 2109A-06095 | NA |

## 6.0 EQUIPMENT UNDER TEST SETUP AND BLOCK DIAGRAM

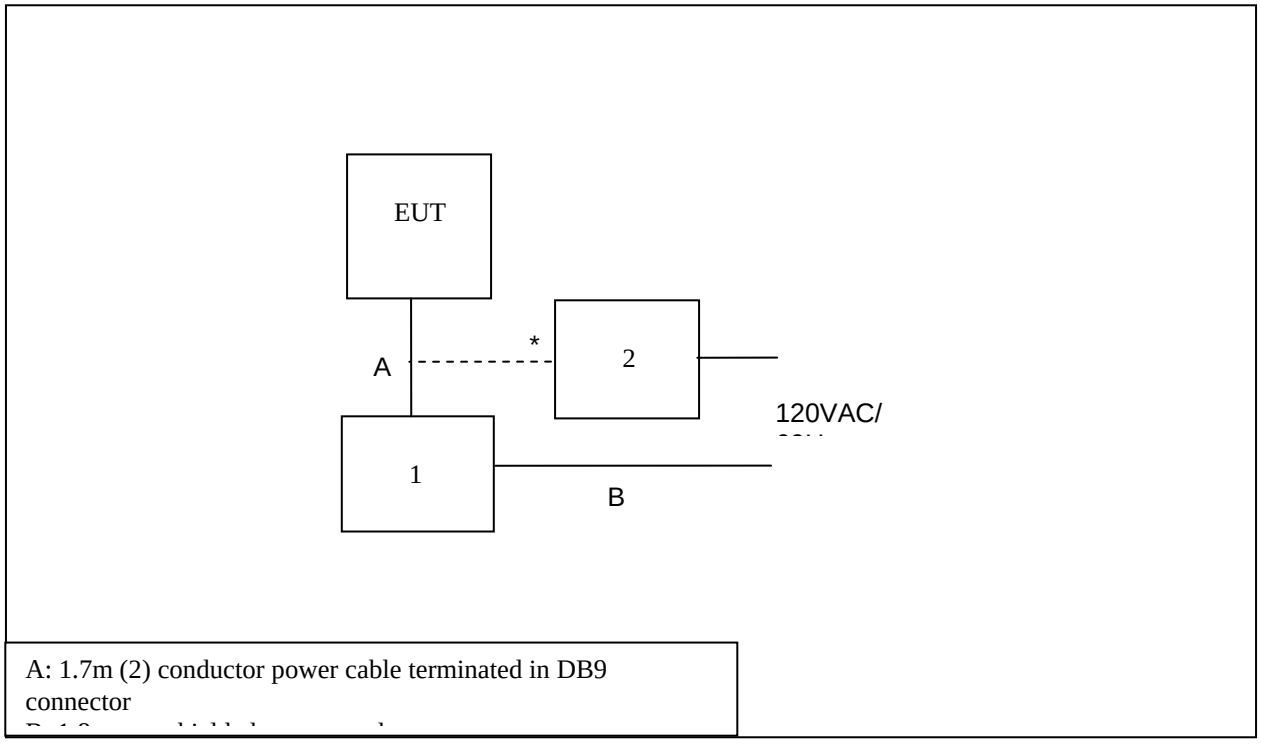


**Figure 6-1: EUT Test Setup**

* For Frequency stability testing, the ITE / Switch Mode Power Supply was replaced with a bench DC supply to allow for voltage variation.

## 7.0 SUMMARY OF TESTS

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

### 7.1 RF Power Output

#### 7.1.1 Measurement Procedure

The RF output of the equipment under test was directly connected to the input of the Spectrum Analyzer through a 20 dB passive attenuator. The resolution and video bandwidths of the spectrum analyzer were set at sufficient levels, >> signal bandwidth, to produce accurate results. The internal correction factors of the spectrum analyzer were employed to correct for any cable or attenuator losses. Results are shown below in Table 7.1.2-1 and Figure 7.1.2-1 through 7.1.2-2.

#### 7.1.2 Measurement Results

**Table 7.1.2-1: Peak Output Power**

| Frequency (MHz) | Output Power (dBm) |
|---|---|
| 217.0125 | 32.35 |
| 219.9875 | 32.27 |

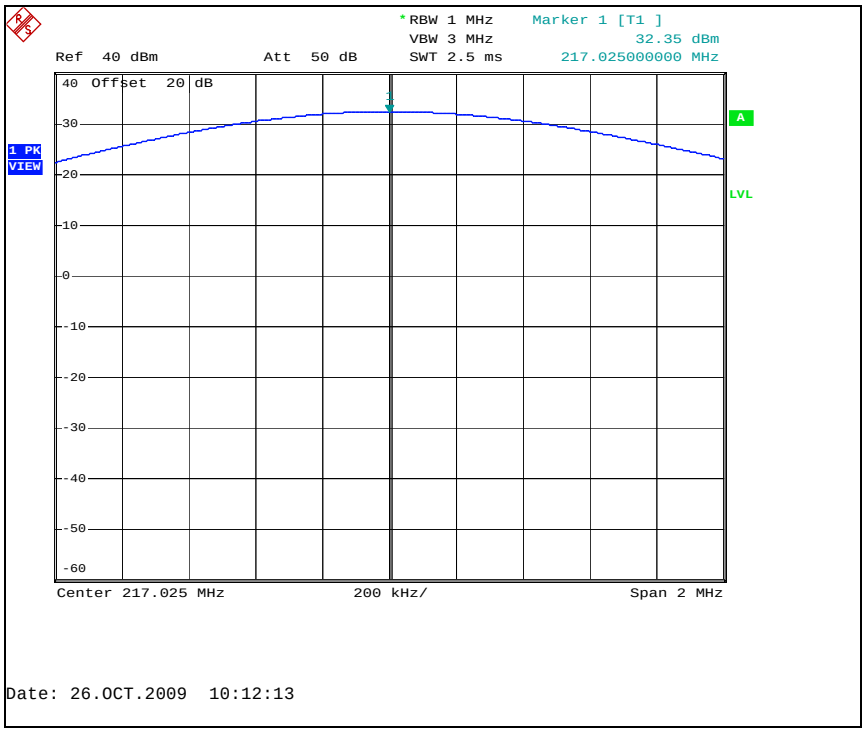


**Figure 7.1.2-1: Peak Output Power 217.025 MHz**

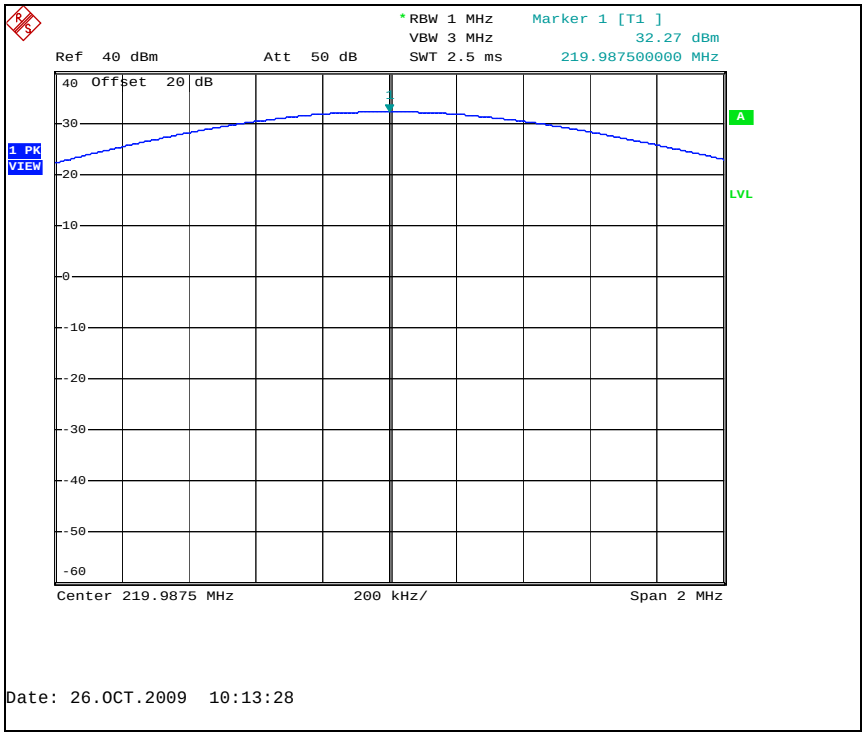


**Figure 7.1.2-2: Peak Output Power 219.9875 MHz**

## 7.2 Occupied Bandwidth (Emission Limits)

### 7.2.1 Measurement Procedure

The RF output of the equipment under test was directly connected to the input of the Spectrum Analyzer through a 20 dB passive attenuator. The spectrum analyzer resolution and video bandwidths were set to 300 Hz and 300 Hz respectively. The internal correction factors of the spectrum analyzer were employed to correct for any cable or attenuator losses. Results of the test are shown below for all modes of operation. Results are shown below in Figure 7.2.2-1 through 7.2.2-4.

### 7.2.2 Measurement Results

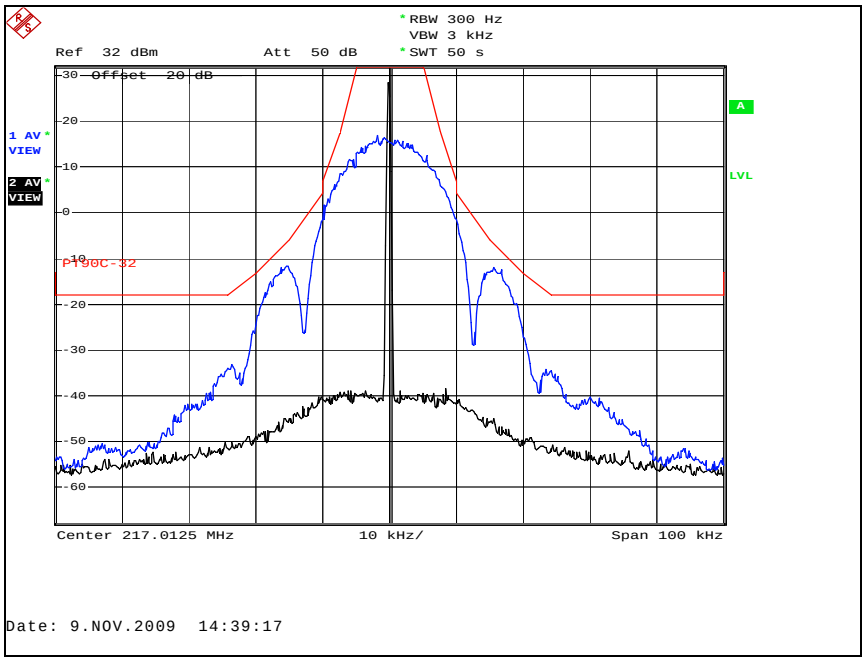


**Figure 7.2.2-1: 217.0125 MHz – 25 kHz Channel**

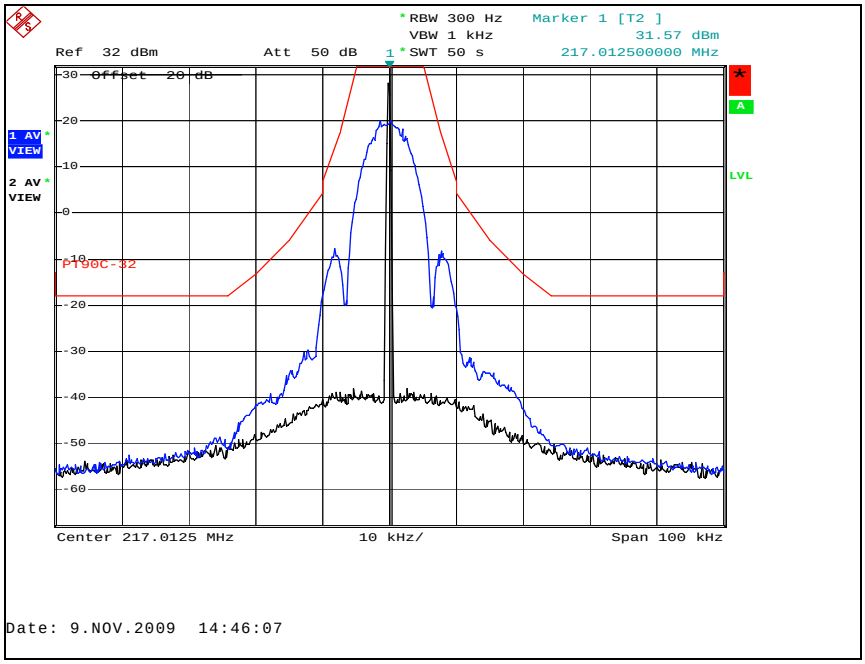


**Figure 7.2.2-2: 217.0125 MHz – 12.5 kHz Channel**

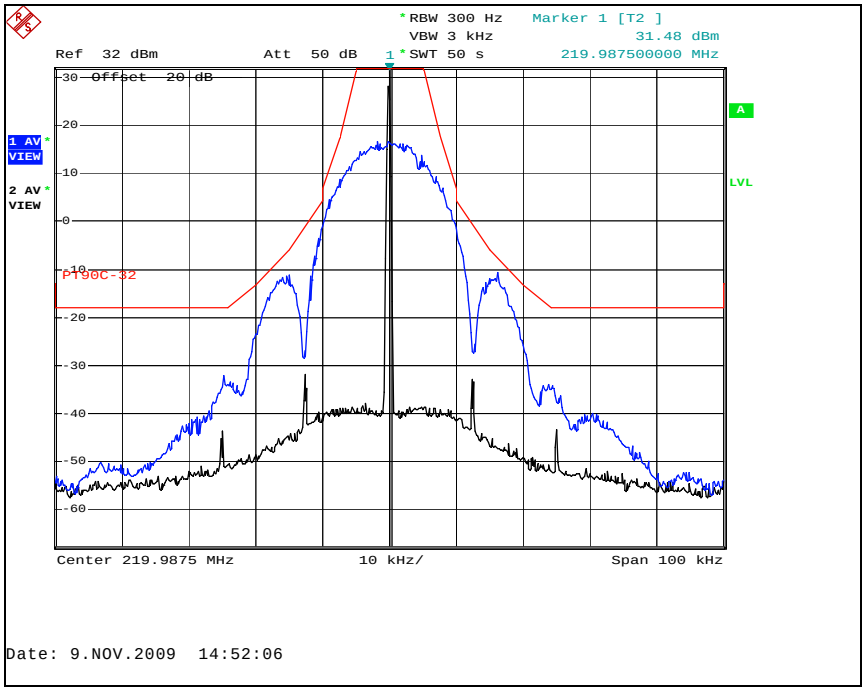


**Figure 7.2.2-3: 219.9875 MHz – 25 kHz Channel**

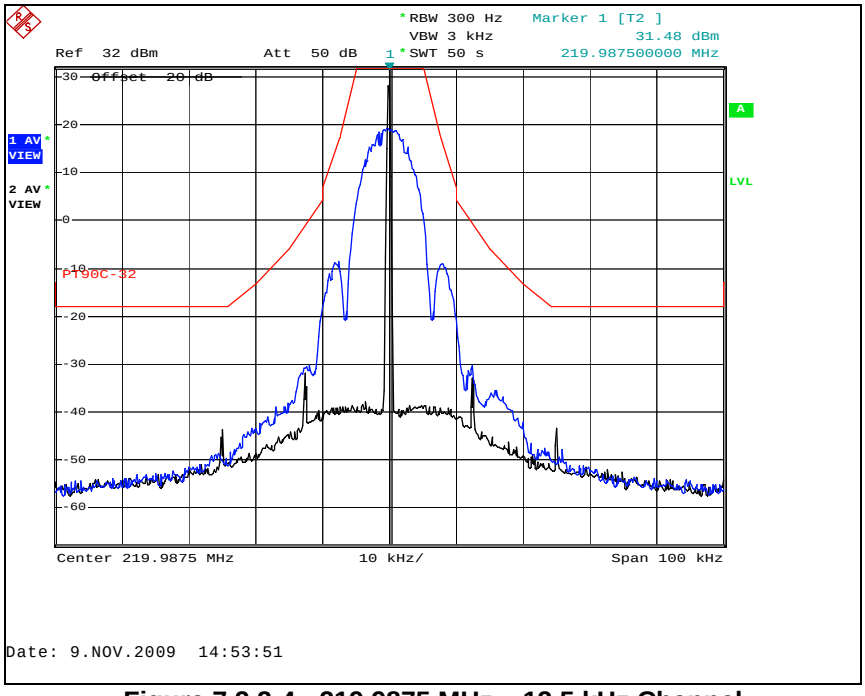


**Figure 7.2.2-4: 219.9875 MHz – 12.5 kHz Channel**

## 7.3 Spurious Emissions at Antenna Terminals

### 7.3.1 Measurement Procedure

The RF output of the equipment under test was directly connected to the input of the Spectrum Analyzer through a 20 dB passive attenuator for measurements below 1000 MHz. A high pass filter was used for measurements above 1000 MHz. The spectrum analyzer resolution bandwidth was set to 100 kHz below 1000 MHz and 1 MHz above 1000 MHz. The internal correction factors of the spectrum analyzer were employed to correct for any cable or attenuator losses. The spectrum was investigated in accordance to CFR 47 Part 2.1057. Results are shown below in Figure 7.3.2-1 through 7.3.2-8.

### 7.3.2 Measurement Results

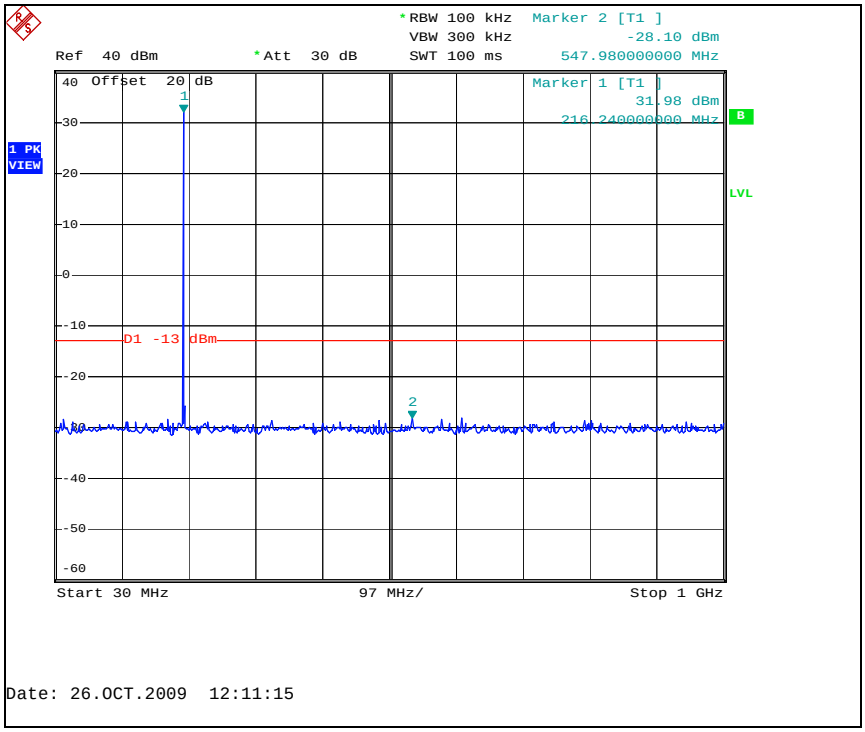


**Figure 7.3.2-1: 217.0125 MHz (25k) – 30MHz to 1GHz**

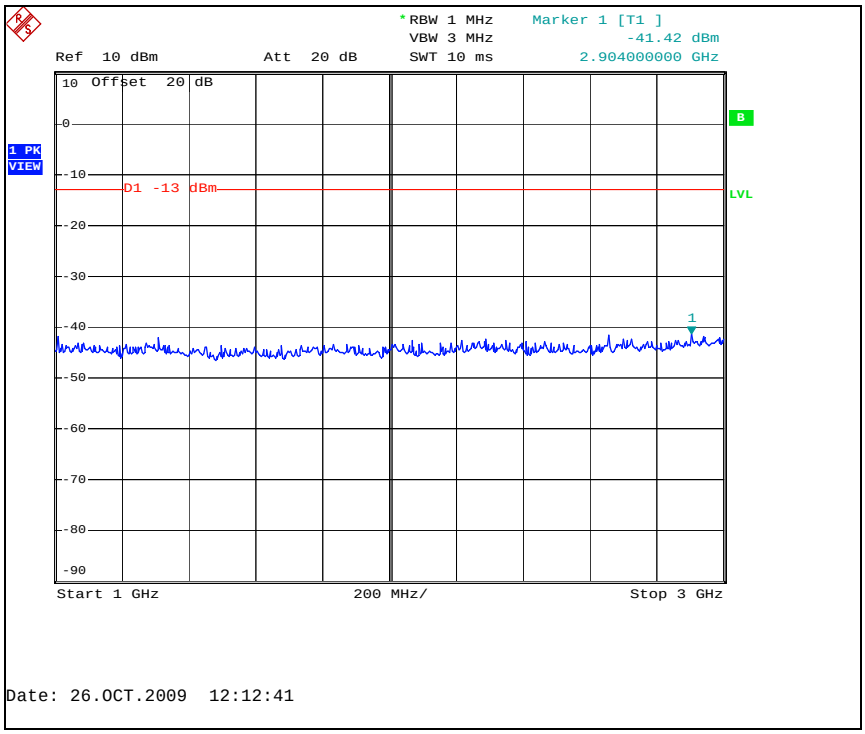


**Figure 7.3.2-2: 217.0125 MHz (25k) – 1GHz to 3GHz**

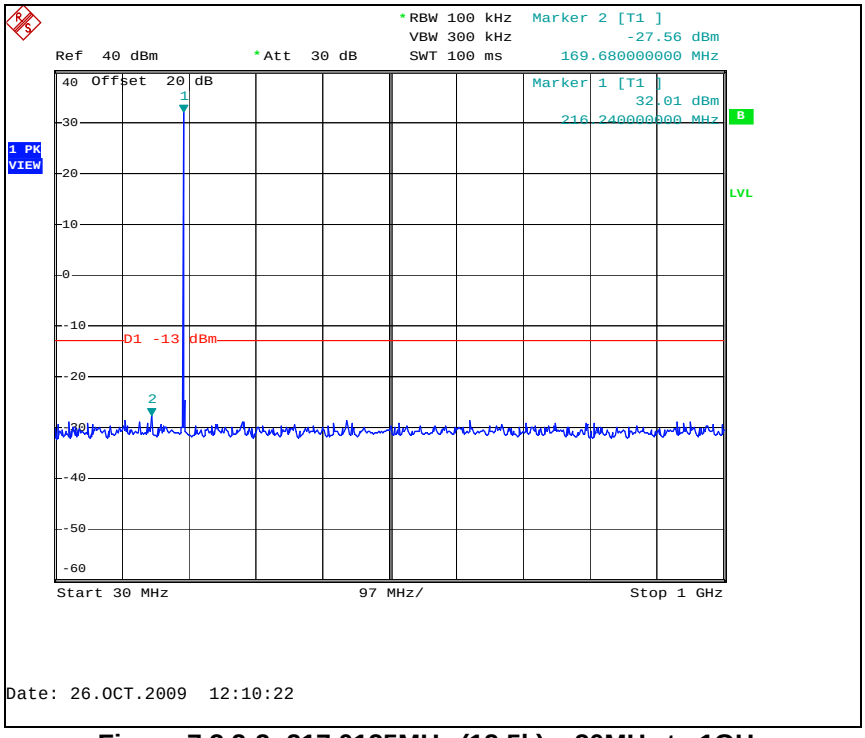


**Figure 7.3.2-3: 217.0125MHz (12.5k) – 30MHz to 1GHz**

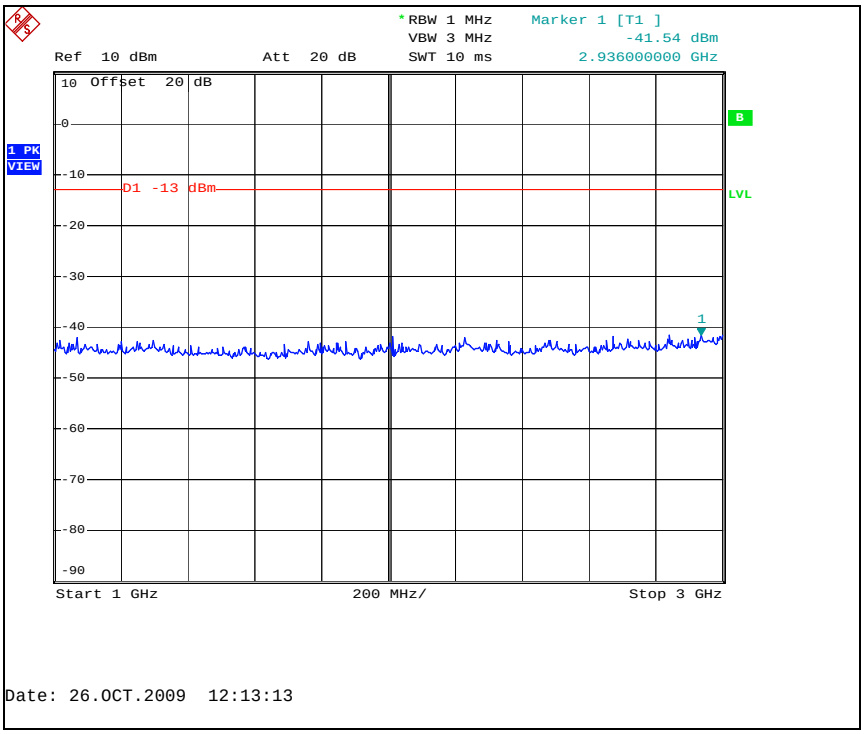


**Figure 7.3.2-4: 217.0125 MHz (12.5k) – 1GHz to 3GHz**

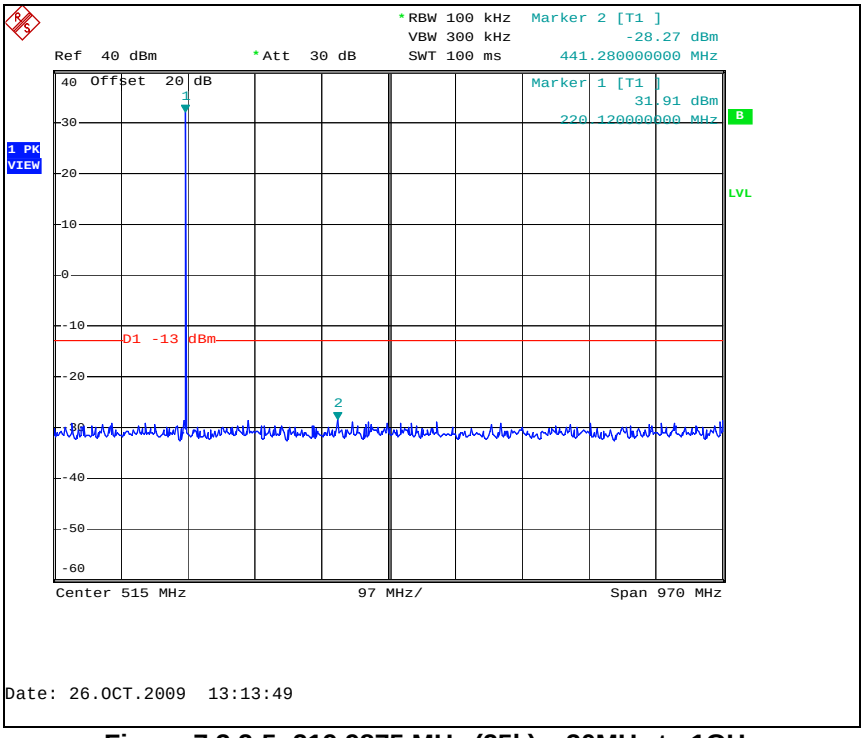


**Figure 7.3.2-5: 219.9875 MHz (25k) – 30MHz to 1GHz**

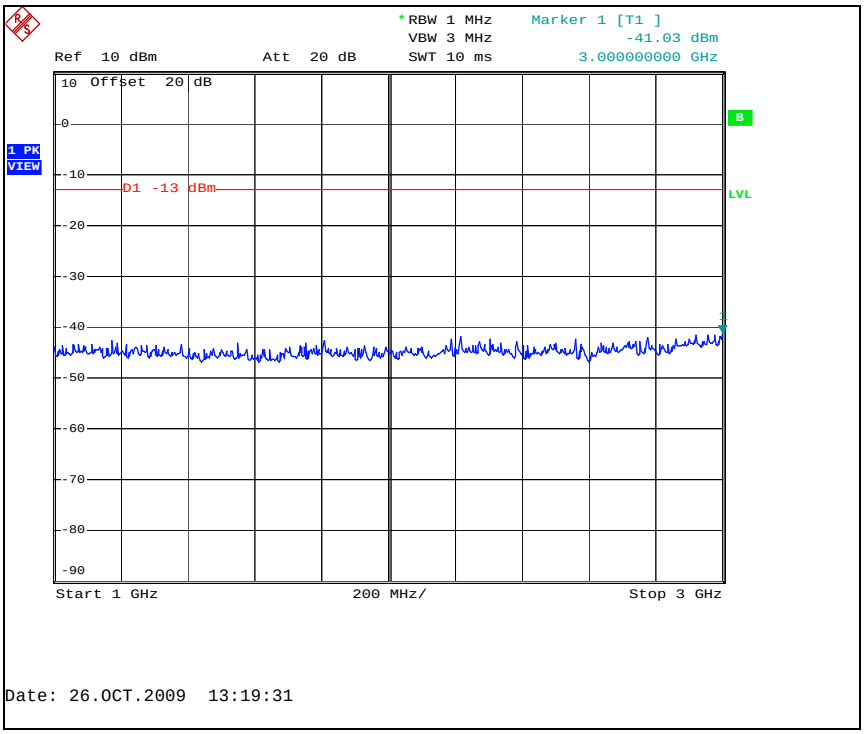


**Figure 7.3.2-6: 219.9875 MHz (25k) – 1GHz to 3GHz**

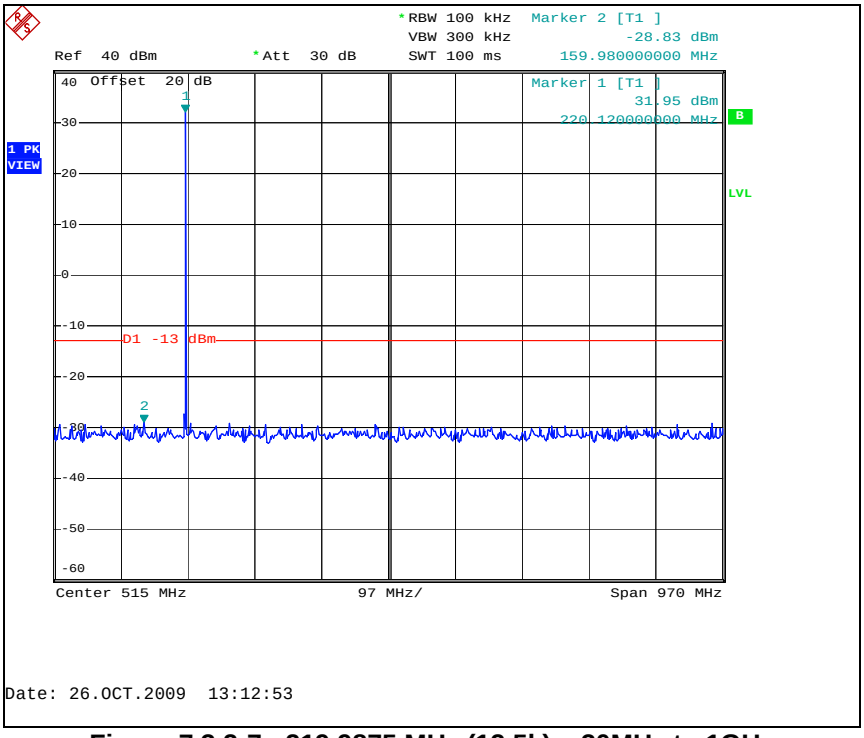


**Figure 7.3.2-7: 219.9875 MHz (12.5k) – 30MHz to 1GHz**

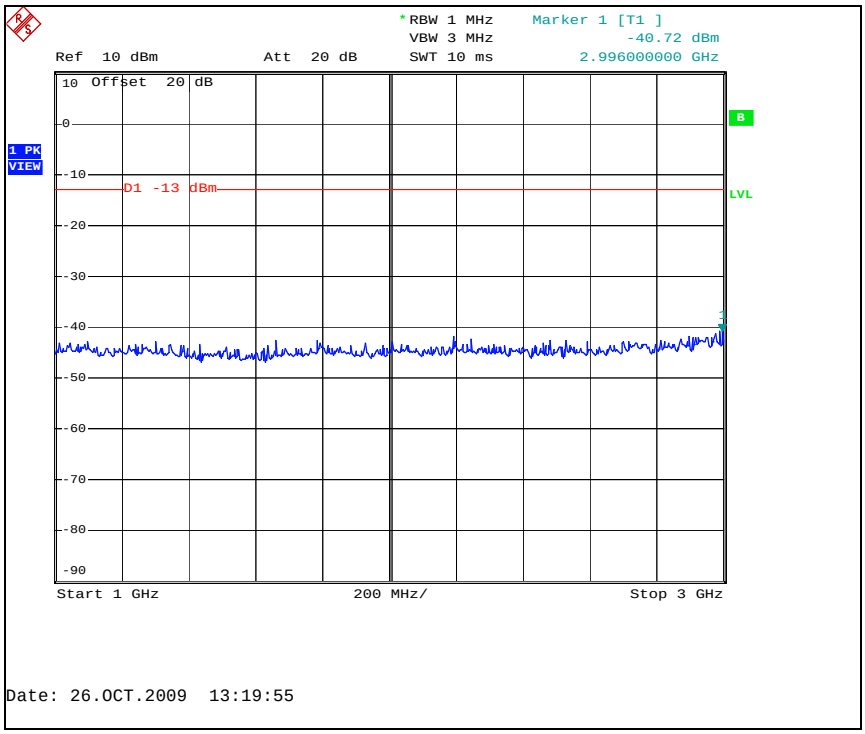


**Figure 7.3.2-8: 219.9875 MHz (12.5k) – 1GHz to 3GHz**

## 7.4 Field Strength of Spurious Emissions

### 7.4.1 Measurement Procedure

The equipment under test is placed in the Semi-Anechoic Chamber (described in section 2.3.1) on a wooden table at the turntable center. For each spurious emission, the antenna mast is raised and lowered from one (1) to four (4) meters and the turntable is rotated 360º and the maximum reading on the spectrum analyzer is recorded. This was repeated for both horizontal and vertical polarizations of the receive antenna.

The equipment under test is then replaced with a substitution antenna fed by a signal generator. The signal generator's frequency is set to that of the spurious emission recorded from the equipment under test. The antenna mast is raised and lowered from one (1) to four (4) meters to obtain a maximum reading on the spectrum analyzer. The output of the signal generator is then adjusted until the reading on the spectrum analyzer matches that obtained from the equipment under test. The signal generator level is recorded. The power in dBm of each spurious emission is calculated by correcting the signal generator level for the cable loss and gain of the substitution antenna referenced to a dipole. The spectrum was investigated in accordance to CFR 47 Part 2.1057.

Data was collected at frequencies according to Section 1.3.2. Results of the test are shown below. The magnitude of all spurious emissions not reported were attenuated below the noise floor of the measurement system and therefore not specified in this report.

The EUT was evaluated for all modulation modes with the worst case presented. Results are shown below in Table 7.4.2-1 through 7.4.2-2.

### 7.4.2 Measurement Results

**Table 7.4.2-1: Field Strength of Spurious Emissions – 217.0125 MHz**

| Frequency (MHz) | Spectrum Analyzer Level (dBm) | Generator Level (dBm) | Antenna Polarity (H/V) | Correction Factors (dB) | Corrected Level (dBm) | Limit (dBm) | Margin (dB) |
|---|---|---|---|---|---|---|---|
| **434.025** | -22.90 | -27.60 | H | 4.02 | -23.58 | -13.00 | 10.58 |
| **434.025** | -30.67 | -34.4 | V | 4.02 | -30.38 | -13.00 | 17.38 |
| **651.0375** | -46.06 | -48.4 | H | 4.03 | -44.37 | -13.00 | 31.37 |
| **651.0375** | -48.97 | -49.6 | V | 4.03 | -45.57 | -13.00 | 32.57 |
| **868.05** | -63.87 | -62.9 | H | 2.98 | -59.92 | -13.00 | 46.92 |
| **1085.0625** | -47.97 | -51.9 | H | 4.21 | -47.69 | -13.00 | 34.69 |
| **1085.0625** | -48.96 | -53.6 | V | 4.21 | -49.39 | -13.00 | 36.39 |
| **1302.075** | -45.92 | -49.5 | H | 4.93 | -44.57 | -13.00 | 31.57 |
| **1302.075** | -45.77 | -50.5 | V | 4.93 | -45.57 | -13.00 | 32.57 |
| **1519.0875** | -50.31 | -54.4 | H | 5.54 | -48.86 | -13.00 | 35.86 |
| **1519.0875** | -47.56 | -52 | V | 5.54 | -46.46 | -13.00 | 33.46 |
| **1736.1** | -50.39 | -52.1 | H | 5.00 | -47.10 | -13.00 | 34.10 |
| **1736.1** | -50.31 | -52 | V | 5.00 | -47.00 | -13.00 | 34.00 |

NOTE: All frequencies not listed were below the noise floor if the spectrum analyzer.

**Table 7.4.2-2: Field Strength of Spurious Emissions – 219.9875 MHz**

| Frequency (MHz) | Spectrum Analyzer Level (dBm) | Generator Level (dBm) | Antenna Polarity (H/V) | Correction Factors (dB) | Corrected Level (dBm) | Limit (dBm) | Margin (dB) |
|---|---|---|---|---|---|---|---|
| **439.975** | -21.62 | -26.20 | H | 4.13 | -22.07 | -13.00 | 9.07 |
| **439.975** | -29.81 | -33 | V | 4.13 | -28.87 | -13.00 | 15.87 |
| **659.9625** | -47.86 | -49 | H | 4.38 | -44.62 | -13.00 | 31.62 |
| **659.9625** | -54.78 | -51.9 | V | 4.38 | -47.52 | -13.00 | 34.52 |
| **879.95** | -64.58 | -62.7 | H | 4.07 | -58.63 | -13.00 | 45.63 |
| **1099.9375** | -47.01 | -51.8 | H | 4.25 | -47.55 | -13.00 | 34.55 |
| **1099.9375** | -48.55 | -54.1 | V | 4.25 | -49.85 | -13.00 | 36.85 |
| **1319.925** | -46.02 | -50.4 | H | 4.99 | -45.41 | -13.00 | 32.41 |
| **1319.925** | -44.87 | -49.3 | V | 4.99 | -44.31 | -13.00 | 31.31 |
| **1539.9125** | -53.53 | -57.4 | H | 5.49 | -51.91 | -13.00 | 38.91 |
| **1539.9125** | -49.73 | -53.4 | V | 5.49 | -47.91 | -13.00 | 34.91 |
| **1759.9** | -50.41 | -52.4 | H | 4.94 | -47.46 | -13.00 | 34.46 |
| **1759.9** | -50.73 | -52.7 | V | 4.94 | -47.76 | -13.00 | 34.76 |

NOTE: All frequencies not listed were below the noise floor if the spectrum analyzer.

## 7.5 Frequency Stability

### 7.5.1 Measurement Procedure

The equipment under test is placed inside an environmental chamber. The RF output is directly coupled to the input of the measurement equipment and a power supply is attached to the primary supply voltage.

Frequency measurements were made at the extremes of the of temperature range -30º C to +50º C and at intervals of 10º C at normal supply voltage. A period of time sufficient to stabilize all components of the equipment was allowed at each frequency measurement. At a temperature 20º C the supply voltage was varied to +/-15% of nominal voltage. The maximum variation of frequency was recorded.

Results are shown below in Table 7.5.2-1.

### 7.5.2 Measurement Results

# Frequency Stability

**Frequency (MHz):** 218.5
**Deviation Limit (PPM):** 1ppm

| Temperature | Frequency | Frequency Error | Voltage | Voltage |
|---|---|---|---|---|
| C | MHz | (PPM) | (%) | (VDC) |
| | | | | |
| -30 C | 218.500004 | 0.018 | 100% | 12.00 |
| -20 C | 218.500016 | 0.073 | 100% | 12.00 |
| -10 C | 218.500000 | 0.000 | 100% | 12.00 |
| 0 C | 218.499984 | -0.073 | 100% | 12.00 |
| 10 C | 218.499968 | -0.146 | 100% | 12.00 |
| 20 C | 218.499952 | -0.220 | 100% | 12.00 |
| 30 C | 218.499945 | -0.252 | 100% | 12.00 |
| 40 C | 218.499940 | -0.275 | 100% | 12.00 |
| 50 C | 218.499944 | -0.256 | 100% | 12.00 |
| | | | | |
| 20 C | 218.499944 | -0.256 | 85% | 10.200 |
| 20 C | 218.499944 | -0.256 | 115% | 13.800 |

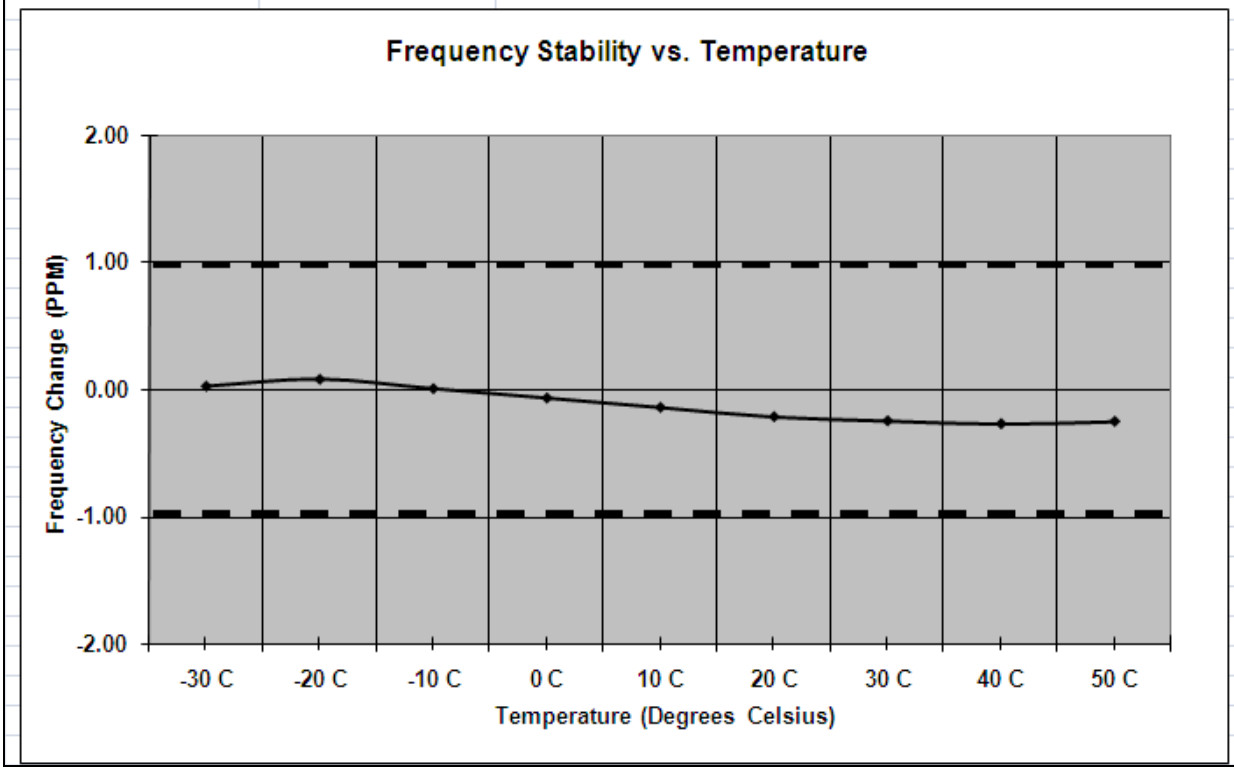


**Figure 7.5.2-1: Frequency Stability – 218.5 MHz**

## 8.0 CONCLUSION

In the opinion of ACS, Inc. the Voyager 1 Radio, manufactured by Data Flow Systems Inc., meets all the requirements of FCC Part 2 and 90 as applicable.

End Report