Engineering and Testing for EMC and Safety Compliance

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FCC Certification Report

Ohmart/VEGA Corporation
4170 Rosslyn Drive
Cincinnati, Ohio 45209, USA

MODEL: VEGA PULS 67
FCC ID: MOIPULS67

July 8th, 2008

Frequency Range	Output Power (W) Conducted	Frequency Tolerance (ppm)	Emission Designator
26 GHz	0.01	N/A	N/A

I, the undersigned, hereby declare that the equipment tested and referenced in this report conforms to the identified standard(s) as described in this test report. No modifications were made to the equipment during testing in order to achieve compliance with these standards. Furthermore, there was no deviation from, additions to, or exclusions from, the applicable parts of FCC Parts 15, 2 and ANSI C63.4.

Signature: _____ Date: July 8, 2008

Typed/Printed Name: Desmond A. Fraser Position: President

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1 General Information

The following measurement report is prepared on behalf of Ohmart/VEGA Corporation in accordance with the Federal Communications Commission Rules and Regulations. The Equipment Under Test (EUT) was Model VEGA PULS 67, FCC ID: MOIPULS67, a Level Probing Radar (LPR) with 10dBm conducted output power for closed tank applications. The test results reported in this document relate only to the items tested.

All measurements contained in this application were conducted in accordance with FCC Rules and Regulations CFR 47, including guidance from the FCC Millimeter Wave Procedure. The EUT was tested on Rhein Tech's open area test site with the LPR device configured pointing downwards inside the tanks. The tanks were placed on the OATS ground plane with all other test equipment arranged in accordance with C63.4, 2003. The instrumentation utilized for the measurements conforms to the ANSI C63.4 standard for EMI and Field Strength Instrumentation. Calibration checks are performed regularly on the instruments, and all accessories including high pass filter, coaxial attenuator, pre-amplifier, and cables. This report contains compliant FCC Part 15.209 data for the VEGA PULS 67 manufactured by Ohmart/VEGA installed in three types of tanks, namely metal, concrete, and reinforced fiberglass.

1.1 Test Facility

The open area test site and conducted measurement facility used to collect the radiated data is located on the parking lot of Rhein Tech Laboratories, Inc. (RTL), 360 Herndon Parkway, Suite 1400, Herndon, Virginia 20170. This site has been fully described in a report submitted to and approved by the Federal Communications Commission to perform AC line conducted and radiated emissions testing (ANSI C63.4 2003).

1.2 Referenced Standards

Standards Referenced for this Report	
Part 2: 2007	Frequency Allocations and Radio Treaty Matters; General Rules and Regulations
Part 15: 2007	Radio frequency devices - §15.209: Radiated Emissions Limits
ANSI C63.4-2003	Standard Format Measurement/Technical Report Personal Computer and Peripherals
FCC Part 15	FCC Millimeter Wave Procedure
Agilent Spectrum Analyzer Application Note	HP Application Note 150-2

2 EUT Configuration and Measurement

The EUT was configured pointing downward inside the closed tanks in constant measurement mode with PN code on, and in an attempt to improve dynamic range, the power management of the EUT was switched off to facilitate measurements in compliance of FCC Rules.

The VEGA PULS 67 is a 2-wire sensor that is supplied with a 4 to 20mA current loop. To conserve power, it incorporates a power management system that limits transmission time to about 200 ms (360,000 pulses) with power being switched off for 3 to 5 seconds. The length of the PN code is 127 bit; it influences the pulse spectrum by dividing the power of each spectral line into 127 new lines. These lines are spaced:

$$\frac{560ns(1.8MHz)}{127} = 14.2kHz$$

Hence, the EUT is in line spectrum mode such that using lower RBW does not reduce the amplitude of the carrier when PDF is added to the emission values and when appropriate sweep time is used; as described in Agilent Application Note 150-2, the RBW must be < 0.3*PRF, which for the EUT is 4.3 kHz. The Pulse Desensitization Factor is then independent of the RBW and can be calculated as:

$$\alpha_L = 20\log(\tau_{eff} \times PRF) = \quad 53.4dB$$

Since FCC measurements requiring 1 MHz RBW's were deemed impractical due to increased system noise floor level thereby creating insufficient measurement dynamic range, all measurements were performed at 10 kHz RBW by measuring the system noise floor with the EUT off and the noise level with the EUT on as reported in Section 3 of this report. All emissions were at or below the noise floor of the instrumentation and hence deemed to comply.

2.1 Exercising the EUT

The EUT was modified to produce a continuously transmitting line spectrum pulse by disabling the onboard power management. This modification is necessary to make measurements with lower resolution bandwidths for increasing the measurement system dynamic range.

The normal operating measurement mode of the EUT is a radar pulse with a duty cycle less than 1:100.

2.2 Test Equipment Consideration

Measurement system dynamic range is typically not sufficient at millimeter frequencies because of high instrument noise floor; as a result, measurements were made at 10 kHz RBW and 10 kHz VBW.

1. A high gain low noise figure Ciao Wireless pre-amplifier was installed directly at the test antenna input port to compensate cable loss, add gain and increase sensitivity.

2. A low loss high frequency cable (7.5dB total loss at 26 GHz) was used to connect the pre-amplifier to the spectrum analyzer/receiver.

3. Water was poured in the tanks in order to increase the carrier's reflected signal.

4. Tank Dimensions:
   Metal tank: height 1.2 m, diameter 44 cm;
   Concrete tank: height 90 cm, diameter 60 cm;
   Fiberglass tank: height 1.4 m, length and width 1 m.

2.3 Pulse De-sensitizing Factor and Duty Cycle

The Pulse width and Pulse period data values provided by the manufacturer were used to calculate the Pulse De-sensitizing Factor and the Duty Cycle.

Pulse width (τ_{eff}) = 1.2 nanosecond; Pulse period (T) = 560 nanosecond for standard radar configuration.

Pulse De-sensitizing Factor = $PDF = 20\log(\tau_{eff} \times PRF) = \ 53.4dB$;
where τ_{eff} = Pulse width PRF = Pulse Repetition Rate for line spectrum when RBW is less than 0.3 x PRF.

Pulse De-sensitizing Factor was used to calculate the FCC peak limit, which is 20 dB above the average limit.

Duty Cycle (DC) = $DC = 20\log(\tau_{eff} / T) = \ 53.4dB$

The Duty Cycle factor was used to calculate the final FCC average limit.

2.4 Field Strength Calculation

The final Peak and Average field strength were calculated using the following:

$$\text{Peak result} = \text{Spectrum Analyzer Level (dB}\mu\text{V/m)} + \text{SCF (dB/m)}$$

$$\text{Average result} = \text{Spectrum Analyzer Level (dB}\mu\text{V)} + \text{SCF (dB/m)} - \text{DC (dB)}$$

Pulse De-sensitizing Factor (PDF) = Pulse width/Pulse period = 20Log 1.2nS/560nS = 53.4dB

$$SCF = AF + CL - AG + PDF$$

Where:
AF [Antenna factor] = 37.2dB
CL [Cable loss] = 7.5dB
AG [Amplifier gain] = 36.4dB
PDF [Pulsed Desensitizing Factor for line spectrum] = 53.4dB

$$SCF = 61.7\text{dB}$$

2.5 Measurement System Noise Floor Sensitivity

Noise floor sensitivity = Analyzer reading [dBµV] + CL + AF - AG

2.6 EUT Antenna Data

Table 2-1: EUT Antenna Data

Type of Antenna	Gain (dBi)	3dB BW (°)	Diameter (mm)	Length (mm)
75mm Plastic Horn	24.8	11.0	75	98

2.7 Test Distance

The final radiated emissions tests were performed at a 3 meter horizontal distance from the edge of each tank to the test antenna. Investigations of the EUT were also performed at closer test distances along the horizontal EUT-to-test antenna distance in order to discern any emissions.

2.8 Test Set-up

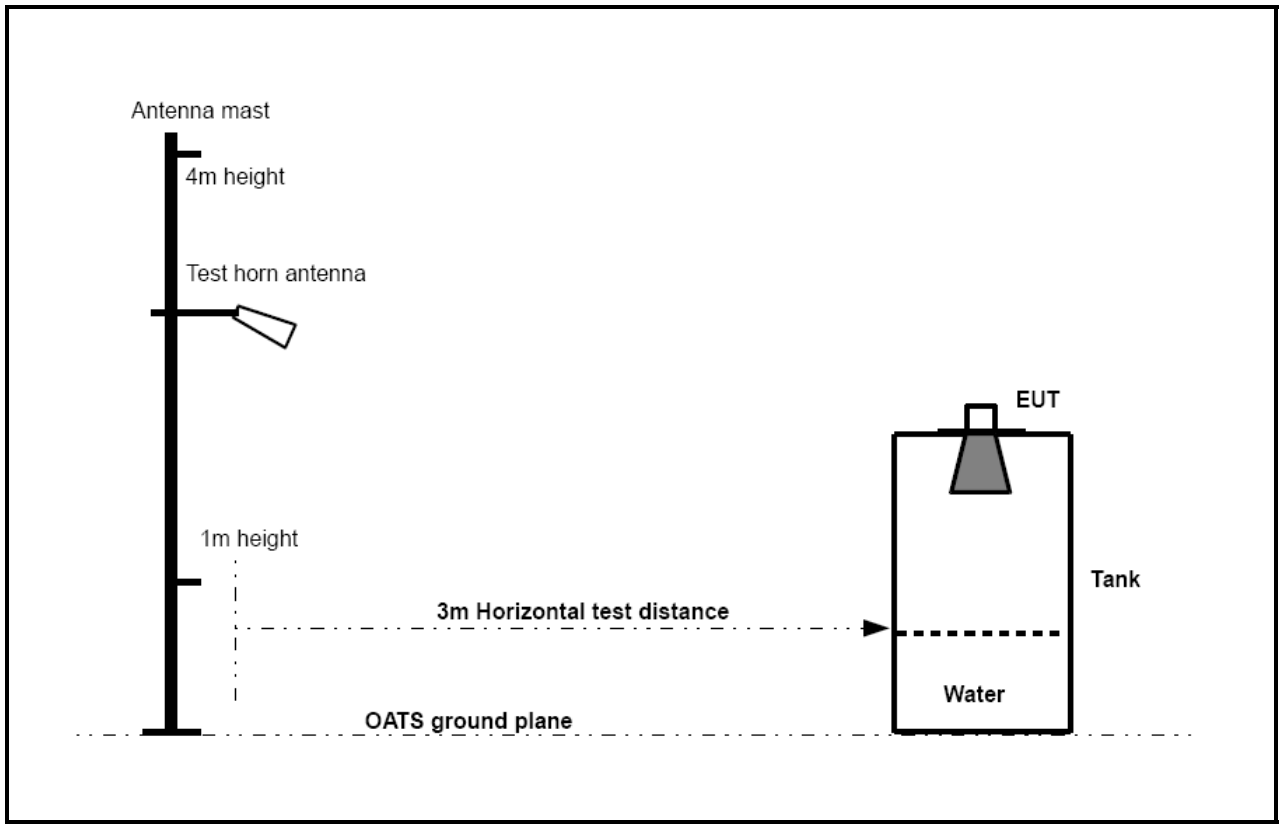


Figure 2-1: Radiated Emissions Test Set-Up

3 Conducted Emissions - §15.207

3.1 Conducted Limits Test Procedure

Conducted emissions were performed on the EUT using an off-the-shelf 24 volt power supply. The general conducted limit under Part 15.207 was applied. The EUT was investigated and tested with two housings, namely Aluminum, and Plastic, there were no difference in the conducted data from the two housings. The data below is the worst-case conducted emissions measured.

3.2 Conducted Emission Limits Test Data

Table 3-1: Conducted Emissions Test Data - Phase Conductor

Temperature: 74°F; Humidity: 33%							
Emission Frequency (MHz)	Test Detector	Analyzer Reading (dBuV)	Site Correction Factor (dB)	Emission Level (dBuV)	FCC Class B QP Limit (dBuV)	FCC Class B Margin (dBuV)	Pass/ Fail
1.552	Qp	37.4	0.8	38.2	48.0	-9.8	Pass
1.664	Qp	43.9	0.8	44.7	48.0	-3.3	Pass
2.828	Qp	46.1	1.1	47.2	48.0	-0.8	Pass
4.241	Qp	41.3	1.3	42.6	48.0	-5.4	Pass
7.120	Qp	36.8	1.5	38.3	48.0	-9.7	Pass
19.020	Qp	32.5	2.5	35.0	48.0	-13.0	Pass
26.520	Qp	30.1	2.7	32.8	48.0	-15.2	Pass

Table 3-2: Conducted Emissions Test Data - Neutral Conductor

Temperature: 74°F; Humidity: 33%							
Emission Frequency (MHz)	Test Detector	Analyzer Reading (dBuV)	Site Correction Factor (dB)	Emission Level (dBuV)	FCC Class B QP Limit (dBuV)	FCC Class B Margin (dBuV)	Pass/ Fail
0.671	Qp	32.8	0.3	33.1	48	-14.9	Pass
1.672	Qp	18.4	0.8	19.2	48	-28.8	Pass
2.839	Qp	32.3	1.1	33.4	48	-14.6	Pass
3.063	Qp	28.9	1.2	30.1	48	-17.9	Pass
19.080	Qp	34.1	2.5	36.6	48	-11.4	Pass
26.840	Qp	31.7	2.7	34.4	48	-13.6	Pass

Test Personnel:

Desmond Fraser		June 18, 2008
EMC Test Engineer	Signature	Date Of Test

4 Radiated Emissions – §15.209

4.1 Radiated Emission Limits & Test Procedure

Radiated spurious emissions of harmonics and spurious emissions that fall in the restricted and non-restricted bands were investigated from 0.009 kHz to 110 GHz, the restricted bands are listed in Part 15.205. Sections of the FCC Millimeter Wave Procedure and ANSI 63.4, 2003 were used to configure and test the EUT.

The maximum permitted average field strength for the restricted band is listed in Part 15.209. The EUT was configured pointing downward in a metal tank, a concrete tank, and a Fiberglass tank. The tanks were positioned 3 meters away in line with the test antenna on the OATS ground plane.

The EUT was rotated along its vertical axis while installed in the tank so that emissions could be maximized; the test antenna height was varied between 1 to 4 meters and polarized horizontally and vertically during testing to measure worst case emissions. Additionally, the test antenna bore-sight position for each test was also varied in order to measure worst-case reflected emissions.

When the carrier could not be measured during tank measurements, the horizontal test antenna distance was reduced to 1 meter and the test repeated. Also, handheld measurements were made in and around the tanks to detect and determine the carrier for worst-case emissions as well as repeatability. The data in this report represents the worst-case configurations.

4.2 Radiated Emission Limits Test Data

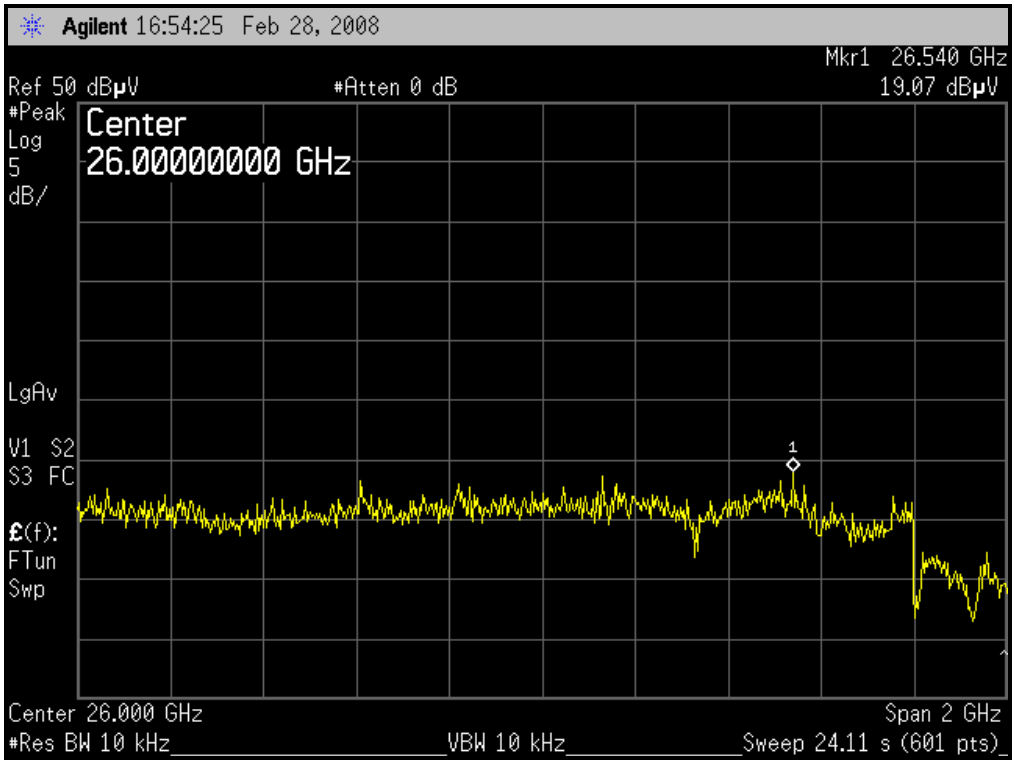
The calculated PDF value was not added to the analyzer level with the EUT operating since there were no discernable emissions in the three tank configurations, namely metal, concrete and fiberglass, and furthermore the corrected noise floor levels with the EUT off were the same or higher than when the EUT was operating.

4.2.1 Metal Tank Test Data

Table 4-1: Field Strength of Carrier in Metal Tank

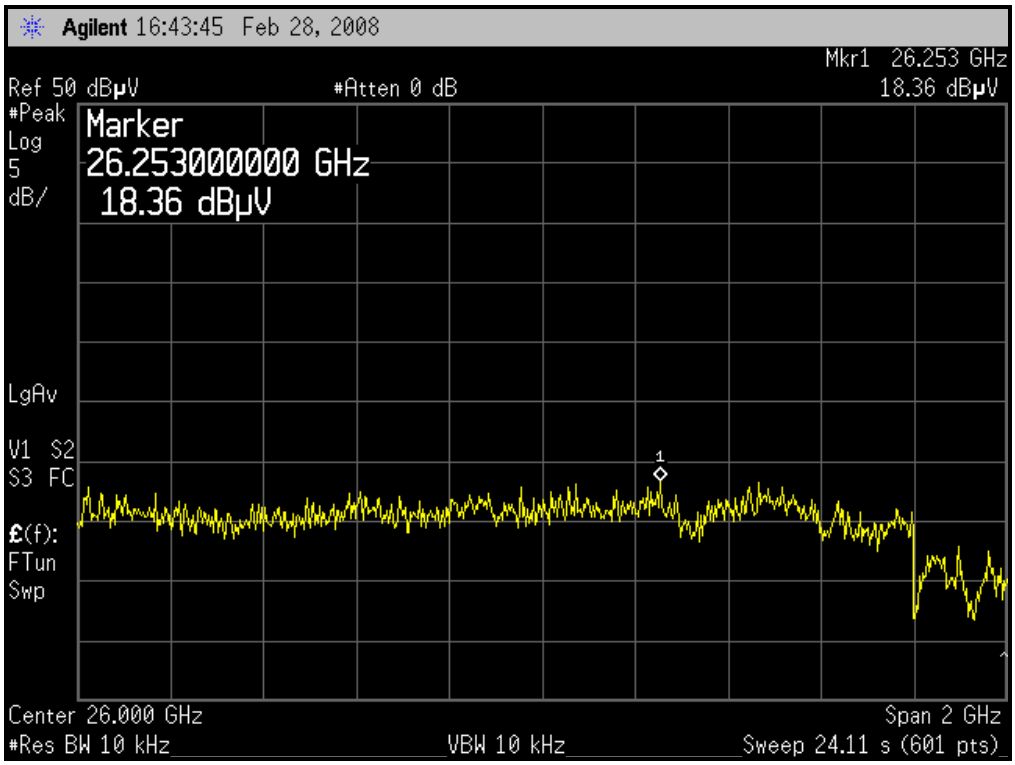
Antenna Type	Detector	Antenna Pol. (H/V)	Spectrum Analyzer Level (dBµV)	Site Correction Factor (dBµV/m)	Spectrum Analyzer Level Corrected (dBµV/m)	Duty Cycle (dB)	Spectrum Analyzer Level Final (dBµV/m)	FCC Limit (dBµV)	Margin (dB)	Notes
75mm Plastic Horn	Peak	H/V	EUT Operating in Metal Tank, Level below the noise floor level with EUT OFF		No discernable emissions			74.0		See Plots 4-1 & 4-2

Note 1, measurements at RBW = 10 kHz:
No other emission above the system noise floor was detected for the metal tank configuration. The system noise floor is calculated to be 27.4dBµV/m from Plot 4-1, Analyzer Noise Floor Level - EUT OFF in Metal Tank. Plot 4-2 is the measured analyzer level of the EUT operating in the metal tank.



Plot 4-1: Analyzer Noise Floor Level - EUT OFF in Metal Tank

Noise level = Spectrum Analyzer Level (dBµV/m)-AG+CL + AF = 19.1dBµV - 36.4dB + 37.2dB/m + 7.5dB = 27.4dBµV/m



Plot 4-2: Analyzer Level of EUT Operating in Metal Tank

Test Personnel:

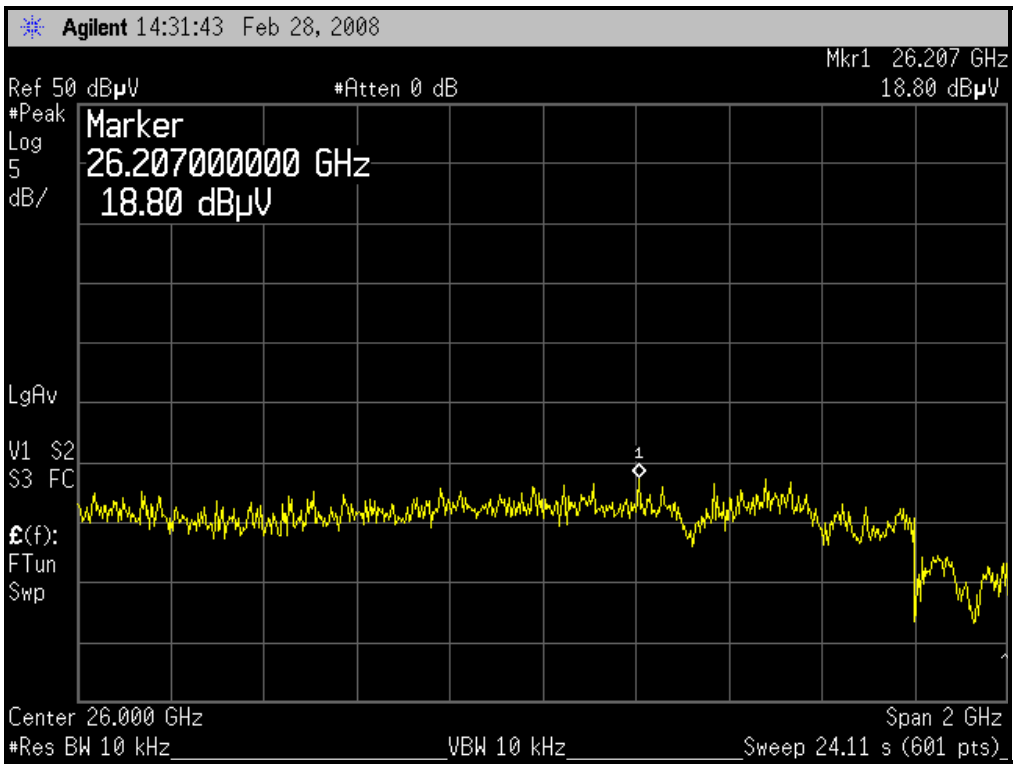
Desmond Fraser		February 28, 2008
EMC Test Engineer	Signature	Date Of Test

4.2.2 Concrete Tank Test Data

Table 4-2: Field Strength of Carrier with Concrete Tanks

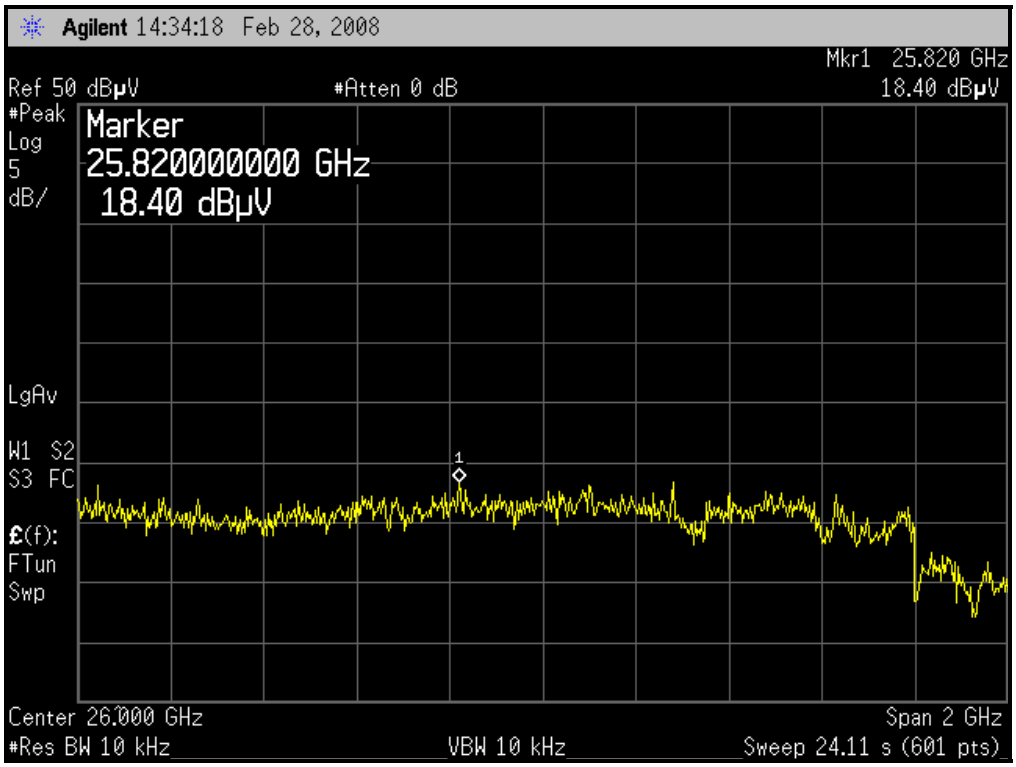
Antenna Type	Detector	Antenna Pol. (H/V)	Spectrum Analyzer Level (dBµV)	Site Correction Factor (dBµV/m)	Spectrum Analyzer Level Corrected (dBµV/m)	Duty Cycle (dB)	Spectrum Analyzer Level Final (dBµV/m)	FCC Limit (dBµV)	Margin (dB)	Notes
75mm Plastic Horn	Peak	V	EUT Operating in Concrete Tank, Level below the noise floor level with EUT OFF		No discernable emissions			74.0		See Plots 4-3 & 4-4

Note 2, measurements at RBW = 10 kHz:
No other emission above the system noise floor was detected for the concrete tank configuration. The system noise floor is calculated to be 27.4dBµV/m from Plot 4-3, Analyzer Noise Floor Level - EUT OFF in Concrete Tank. Plot 4-4 is the measured analyzer level of the EUT operating in the concrete tank.



Plot 4-3: Analyzer Noise Floor Level - EUT OFF in Concrete Tank

Noise level = Spectrum Analyzer Level (dBµV/m)-AG+CL +AF = 18.8dBµV - 36.4dB + 37.2dB/m + 7.5dB = 27.1dBµV/m



Plot 4-4: Analyzer Level of EUT Operating in Concrete Tank

Test Personnel:

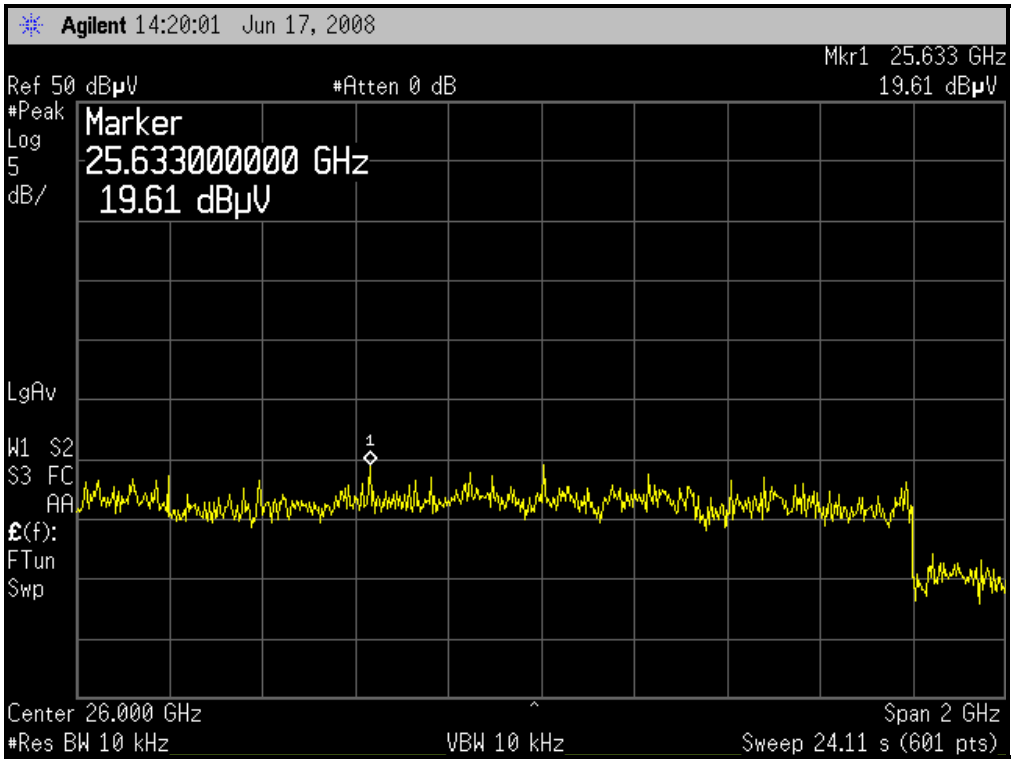
Desmond Fraser		February 28, 2008
Test Technician/Engineer	Signature	Date Of Test

4.2.3 Fiberglass Tank Test Data

Table 4-3: Field Strength of Carrier with Fiberglass Tank

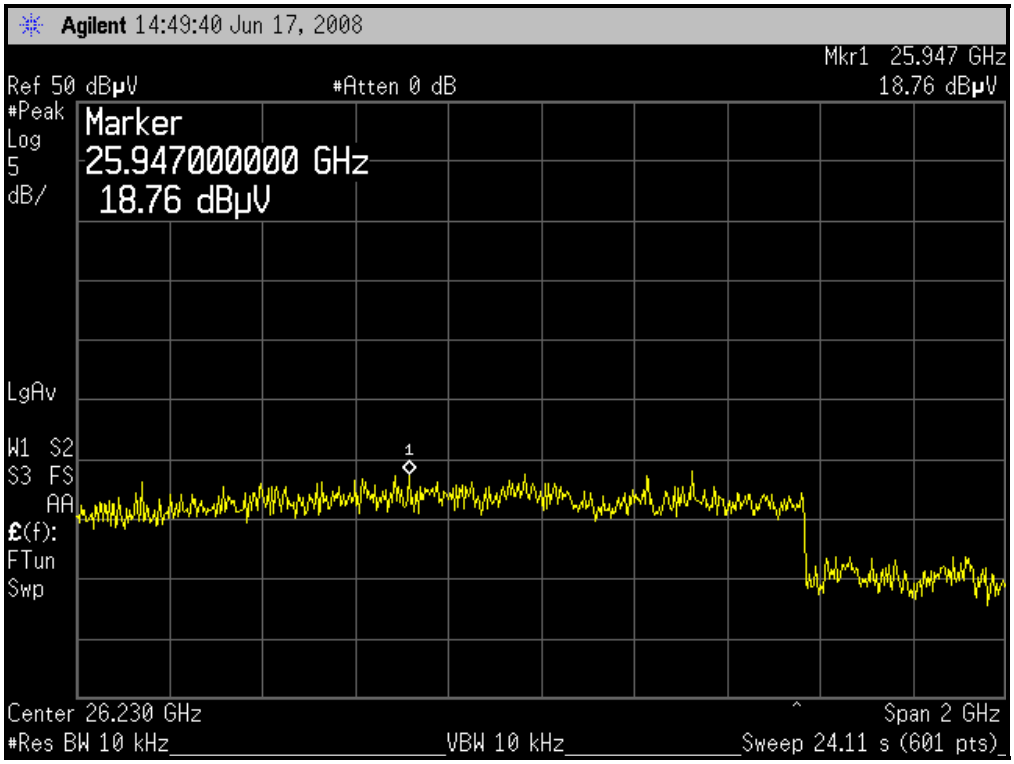
Antenna Type	Detector	Antenna Pol. (H/V)	Spectrum Analyzer Level (dBµV)	Site Correction Factor (dBµV/m)	Spectrum Analyzer Level Corrected (dBµV/m)	Duty Cycle (dB)	Spectrum Analyzer Level Final (dBµV/m)	FCC Limit (dBµV)	Margin (dB)	Notes
75mm Plastic Horn	Peak	V	EUT Operating in Fiberglass Tank, Level below the noise floor level with EUT OFF		No discernable emissions			74.0		See Plots 4-5 & 4-6

Note 3, measurements at RBW = 10 kHz:
No other emission above the system noise floor was detected for the Fiberglass tank configuration. The system noise floor is calculated to be 27.9dBµV/m from Plot 4-5, Analyzer Noise Floor Level - EUT OFF in Fiberglass Tank. Plot 4-6 is the Analyzer Level of the EUT Operating in Fiberglass tank.



Plot 4-5: Analyzer Noise Floor Level - EUT OFF in Fiberglass Tank

Noise level = Spectrum Analyzer Level (dBµV/m)-AG+CL +AF = 19.6dBµV - 36.4dB + 37.2dB/m + 7.5dB = 27.9dBµV/m



Plot 4-6: Analyzer Level of EUT Operating in Fiberglass Tank

Test Personnel:

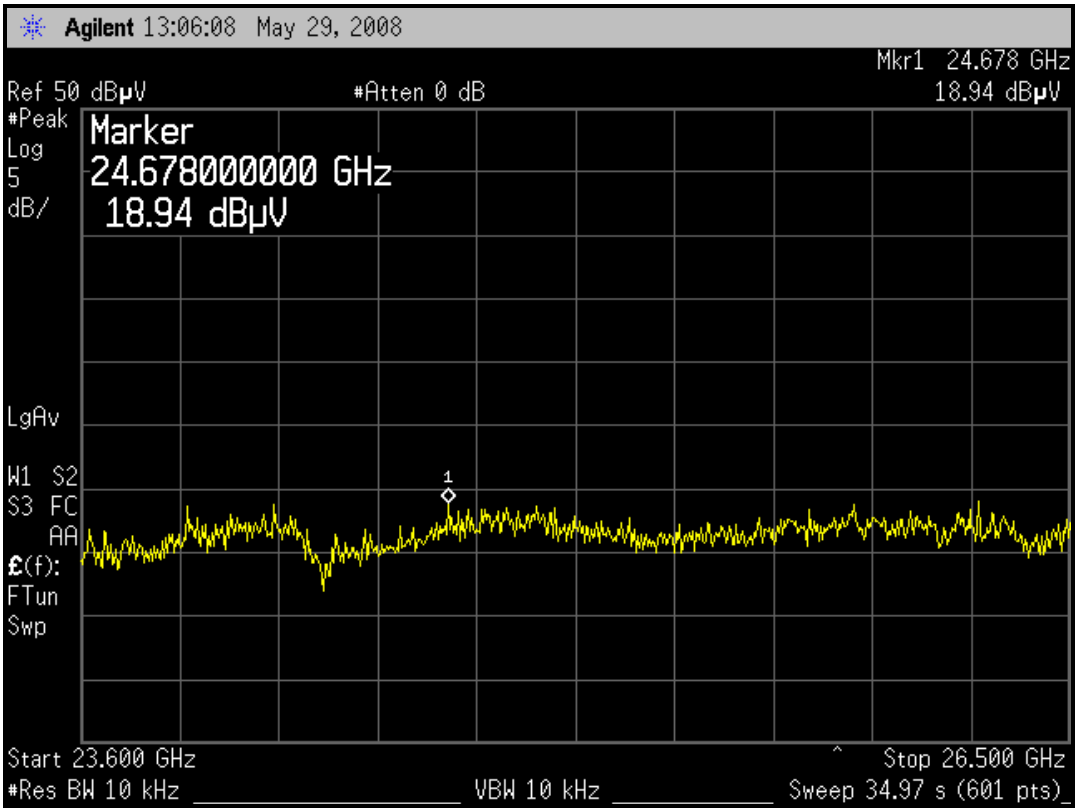
Desmond Fraser		June 17, 2008
Test Technician/Engineer	Signature	Date Of Test

5 Restricted Bands & Limits - §15.205

5.1 Compliance with 23.6-24 GHz Adjacent Band

The EUT shall ensure that any emissions within restricted frequency bands in accordance with authority are spurious emissions only. Unless otherwise specifically authorized, the spurious emissions shall meet the prescribed limits in accordance with 47 CFR §15.209.

For compliance with the adjacent band at 23.6-24 GHz, the test configuration set-up in Figure 2-1 was used again, including the same analyzer settings used for measuring the carrier, that is RBW, VBW, Peak detector function, and Attenuator setting. The sweep time on the analyzer was set to auto. The trace was allowed to stabilize during the measurement. The restricted band average limit is 54dBµV per 47 CFR §15.205.



Plot 5-1: 23.6-24 GHz Restricted Band

Test Personnel:

Desmond Fraser		May 29, 2008
Test Technician/Engineer	Signature	Date Of Test

6 Bandwidth Measurement

6.1 26 dB Emission Bandwidth

The Emission Band-Width (EBW) is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated at least 26 dB below the maximum level of the modulated carrier (from 47 C.F.R. Section 15.403(c)).

The EBW was measured using the spectrum analyzer with the EUT configuration test set-up as shown in the figure below.

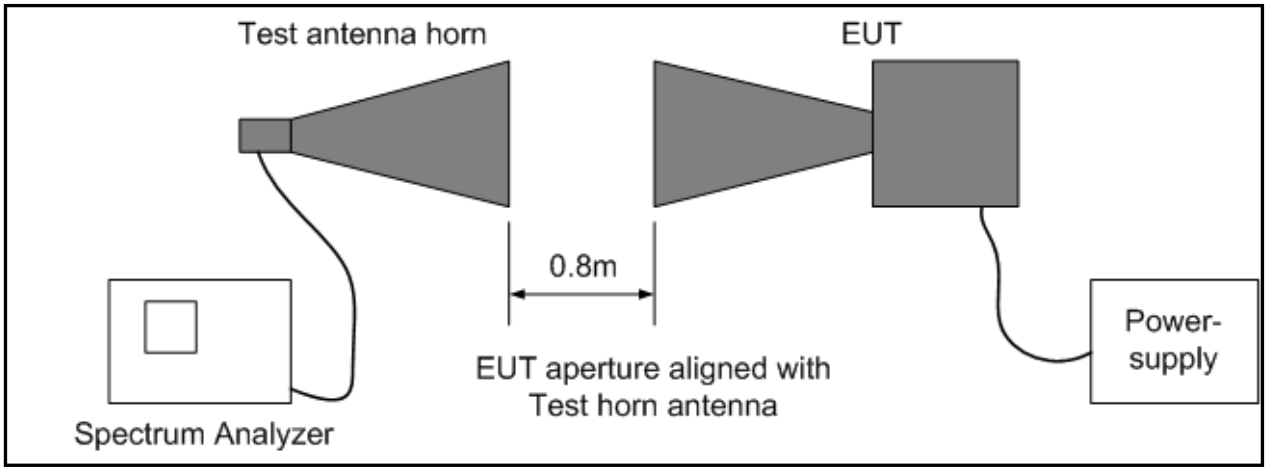


Figure 6-1: Test Set-up for Bandwidth Measurement

The following spectrum analyzer settings were used:

Span = 5 GHz
RBW = VBW = 100 kHz
Sweep = auto
Detector function = peak
Trace = max hold

The EUT should be transmitting at its maximum data rate. Allow the trace to stabilize.

Use the marker-to-peak function to set the marker to the peak of the emission. Use the marker-delta function to measure 26 dB down one side of the emission.

Reset the marker-delta function, and move the marker to the other side of the emission, until it is even with the reference marker level. The marker-delta reading at this point is the 26 dB bandwidth of the emission. The 26 dB bandwidth is 2.88 GHz.

Plot 6-1: 26 dB Bandwidth

6.2 2/ (τ_{eff}) Bandwidth Calculation

The main lobe bandwidth is calculated by using $2/(\tau_{eff})$, where τ_{eff} is the Pulse width for Pulse radar devices.

With τ_{eff} = 1.2ns, the main lobe bandwidth = $2/(\tau_{eff}) = 2/(1.2x10^{-9}s)$ = 1.67 GHz

7 Test Equipment

Table 7-1: Test Equipment

RTL Asset #	Manufacturer	Model	Part Type	Serial Number	Cal Due Date
901218	EMCO	3160-09	Horn Antenna (18 – 26 GHz)	960281-003	5/9/09
900392	Hewlett Packard	E4448	Spectrum Analyzer	3525A00159	7/9/09
900388	Ciao Wireless	CA1826-302	Pre-Amplifier	N/A	7/9/10
900669	Flann	20240-20 UBR220	Horn Antenna (18 – 26 GHz)	805 1905-1	7/9/10
900888	Huber + Suhner	Sucoflex 104	2m Coaxial Cable	171100/4	7/9/09
900889	Huber + Suhner	Sucoflex 104	2m Coaxial Cable	97045/4	7/9/09

8 Conclusion

The data in this report demonstrates that the Ohmart/VEGA, Inc., Model VEGA PULS 67 configured pointing downwards in closed metal, concrete and reinforced fiberglass tanks when tested on an OATS site complies with the emissions requirements of Parts 2 and 15 of the FCC Rules and Regulations.